Journal of Environmental Protection and Ecology 17, No 2, 427–434 (2016)

Atmospheric pollution

ODOUR CAUSING DISCOMFORT AND THEIR IMPACT ON HUMAN HEALTH

C. CERCELARU, I. IONEL*, R. M. BALOGH

Faculty of Mechanical Engineering, Politehnica University Timisoara, Mihai Viteazu Blvd., 300 222 Timisoara, Romania
E-mail: *ioana.ionel@upt.ro*; *ramon.balog@upt.ro*;
cristina.cercelaru@yahoo.com

Abstract. Urban air pollution is rapidly becoming an environmental problem of public concern worldwide. Monitoring and evaluation of air pollution became a necessity of great importance for the sustainable development of the society and protection of the ecosystems. Compounds such as hydrogen sulphide (H_2S) and ammonia (NH_3) are clearly identified to be major odours specific for urban areas, and due to their high olfactory impact, they have to be monitored. The paper relates to such results, with respect to the urban and industrial area of Timisoara, considered one of the largest cities in Romania which has a highly developed industry, and also a large urban crowded traffic. The present paper presents results of a campaign accomplished in urban areas in the Timisoara city, and conclusions driven versus measured values are indicated.

Keywords: pollution, odours, emission, health.

AIMS AND BACKGROUND

The need for continuous monitoring of non-standard pollutant concentration in the air has increased considerably over recent years, driven by health and safety concerns (toxic gases) and odour related nuisance or discomfort[1]. Nevertheless many authors achieved research in the domain, for the Balkan region especially[2,3].

The paper refers to a special campaign during which, for the first time in the Timisoara area, monitoring compounds such as hydrogen sulphide (H_2S), ammonia (NH_3) were clearly identified. These species have been selected for monitoring due to their high olfactory impact. Besides healthy risks linked to particles or bio aerosol emission, significant odour emissions are regularly encountered even if species are emitted at low ppbv level.

The ecosystem of Timisoara is constantly changing also due to increased surface constructed and measurements taken to reduce them; by this way the risk of air pollution with particles is under control, as through the complex phenomena of the annual average temperature global growth, thermal inversions are more occurring. Air pollution with odour/smell/ is considered as the introduction by man,

* For correspondence.

directly or indirectly, or the presence in the atmosphere and enclosed areas, of chemical biological or physical agents having prejudicial consequences likely to cause odour nuisance. Under these circumstances, in order to be accepted by the population, but also in order to avoid potential financial penalties, industrials have to manage as well as possible their emissions of odourous compounds[4].

EXPERIMENTAL

There are many ways to measure air odour, with both simple chemical and physical methods and with more sophisticated electronic techniques, in addition to modelling possibilities, according special tailored programs, according emission factors and pollutant inventory, for real or probable meteorological conditions[5,6]. A lot of analysers available in the market, including fluorescence-based detection[7] or flame photometric detector[8] provide very precise measurements at a given time and place, but such analytical devices are expensive in investment, operation and/or not easily field transported. Focusing on hydrogen sulphide, the World Health Organisation recommends, to avoid substantial complaints about odour annoyance among the exposed population, hydrogen sulphide concentrations should not be allowed to exceed 4.7 ppbv, with a 30-min averaging period'[9].

The Cair CLIP sensors[12] have been developed recently. These gas sensors are based on electro-chemicals or semi-conductors. They are used to ensure health and safety, mostly in open spaces or even on closed ones, at work, by measuring occupational exposure values in ppm. In the original time display mode, the level of pollution measured appears on the screen only when a specific threshold is reached. In the air quality measurement mode, the concentration of H_2S and mercaptans is given continuously by the 3 digits to the left of the separator (2 points), the time of exposure is indicated by 2 digits to the right as multiple of 10 min (Ref. 12), as presented by Fig. 1.

Fig. 1. Cairclip sensor 'Networks of miniature sensors for low concentrations (ppb) of H_2S'

Under the first threshold of information, only the green light flashes. On the first level of information threshold, equivalent to 30 ppb of H_2S and mercaptans, yellow light flashes. At the second information threshold, orange light is flashing and is equivalent to 70 ppb. At this level nausea and headaches were reported. At the first warning level, equivalent to 110 ppb is flashing red light. On the second warning level, equivalent to 200 ppb is flashing purple light. The third warning level corresponds to 600 ppb and flashing maroon light.

Hydrogen sulphide (H_2S) is a weak non-organic acid. In its pure state it is a colourless, flammable, toxic, with a strong odour. The low concentration has the smell of rotten eggs. Depending on the concentration and duration of exposure can cause acute or chronic effects. At concentrations above 0.1% by volume it can kill in seconds.

Ammonia (NH_3) is a gas with pungent smell toxic, lighter than air. Caustic action of ammonia gas is in contact with wet surfaces, an irritant of the skin, respiratory mucosa, digestive and eye. An ammonia concentration of 0.5% to the inhaled air occurs over 30–60 min death. Romania quantified emission reduction target for 2020 includes the reduction of the Emission Trading Scheme (EU ETS) emissions (–21% compared to 2005) and the positive limit established for non-EU ETS sector (+19% compared to 2005), in line with Decision 406/2009/EC (Ref. 16).

Ozone (O_3) is an allotropic form of oxygen, with the molecule consists of three atoms; is a strong oxidant, has a characteristic odour, colour blue and is very toxic. Ozone is formed in the troposphere as main atmospheric pollutant generated in industrialised countries and traffic affected cities, especially during summers. Ozone causes respiratory system (breathing difficulties, reduced lung function, asthma), eye irritation, nasal congestion, reducing resistance to infection, premature degradation of the lungs.

RESULTS AND DISCUSSION

The monitoring campaigns were performed in Timisoara in the region of Freidorf Industrial Park (a highly developed industrial area), and at the Faculty of Mechanical Engineering, which is located in the central area of the city, having historical footprint with traffic congestions. The technique such as described in Ref. 17 could not be applied even main items were proofed and possible as similarity. Measurements were accomplished by 2014, during two episodes: first by March 21 and lasted one day, and the second between May 28 to June 4 and values of H_2S, NH_3 and O_3 with CAIR CLIP sensors were recorded.

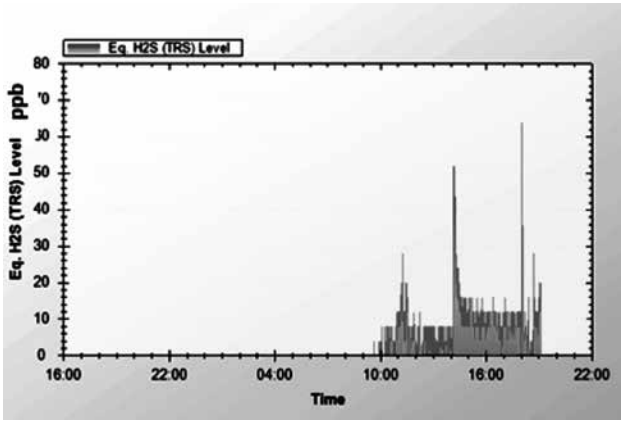


Fig. 2. Level of hydrogen sulphide (H_2S) measured in the Freidorf Industrial Park

As seen from Fig. 2, the first peak of H_2S is recorded around 11 ppb, it has a value of about 30 ppb. The next peak at around 14 exceeds 50 ppb, the last and the highest being recorded at 17 and measuring 65 ppb. The presence of the hydrogen sulphide (H_2S) measured in the Freidorf Industrial Park can be associated with the regular industrial activity in the area.

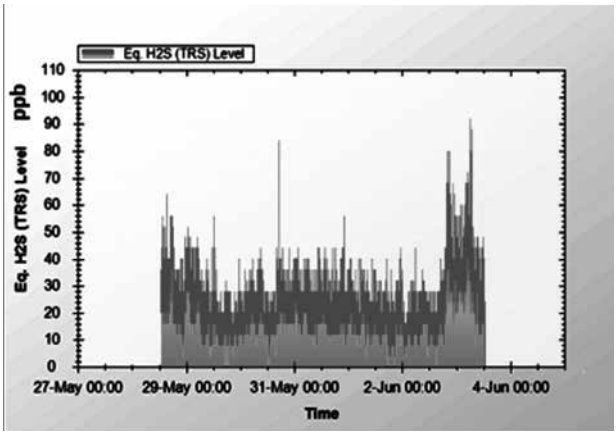


Fig. 3. Level of hydrogen sulphide (H_2S) measured at the Faculty of Mechanical Engineering

According to the schedule (presented in Fig. 3), there were several peaks of H_2S; the most prominent values reached were in May 28, with a value of 65 ppb, in May 30, with the value of 85 ppb. The highest peak was achieved on 3 June and reaching the level of 94 ppb. The values are higher as compared to those in Fig. 2. An explanation can be associated to the influence of the different meteorological parameters and also to the intense traffic in the area representing a main route in the central area of the city.

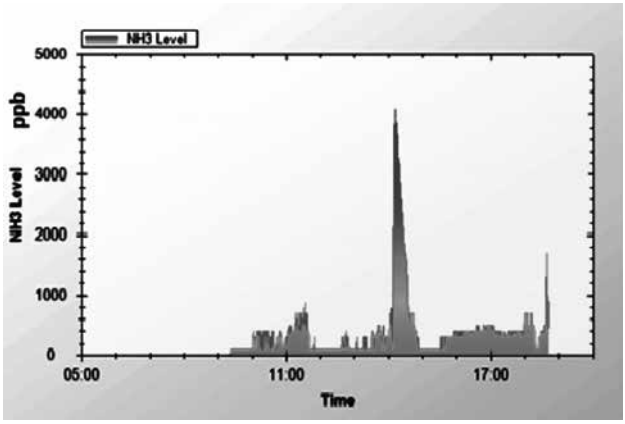


Fig. 4. Level of ammonia (NH_3) measured in the Freidorf Industrial Park

Measured ammonia level (Fig. 4) reaches a high peak at around 14 o'clock, and was measured as 4200 ppb.

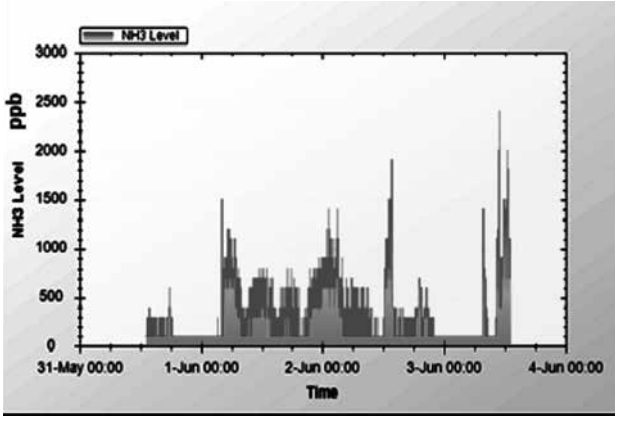


Fig. 5. Level of ammonia (NH_3) measured at the Faculty of Mechanical Engineering

There were several peaks of ammonia (Fig. 5), the most important being: in June 1 with a value of 1500 ppb, in June 2 with a value of 1800 ppb, and the highest being the value of 2300 ppb, by June 3.

According to data from the two charts (Figs 4 and 5), one can conclude that the peaks of ammonia recorded in the Industrial Park Freidorf are much higher than those measured at the Faculty of Mechanical Engineering. The result is expected and explained by the much much higher industrial specific activity in the Freidorf region.

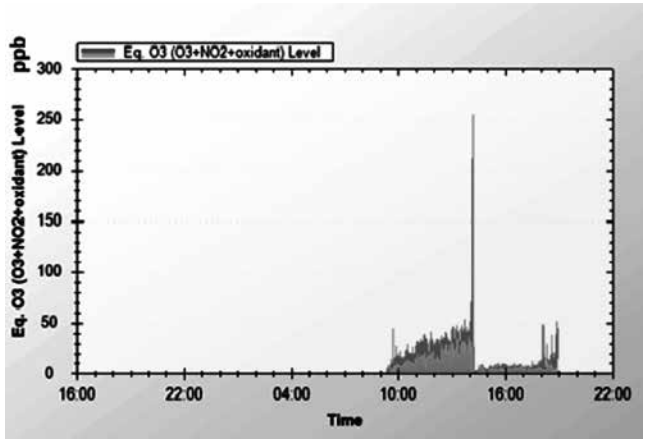


Fig. 6. Level of ozone (O_3) measured in the Freidorf Industrial Park

The ozone level (Fig. 6) reached a maximum of 270 ppb at 14:00

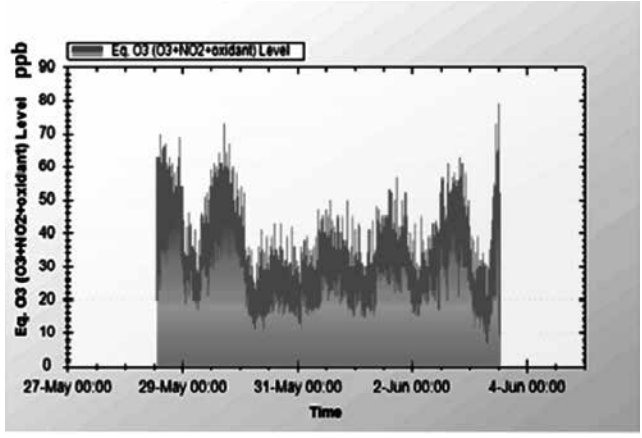


Fig. 7. Level of ozone (O_3) measured at the Faculty of Mechanical Engineering

The most important ozone peaks recorded (Fig. 7) are: in May 28 with a value of 70 ppb, in May 30 with a value of 75 ppb, and the highest in June 3 with a value of 79 ppb.

Comparing the data obtained in the two campaigns (Figs 6 and 7), it results that the ozone levels measured in the Industrial Park Freidorf are much higher than that of the Faculty of Mechanical Engineering. Again the explanation is connected by the industrial activity in the Freidorf area.

All sensors have shown peaks of exposure during peak hours and working hours. The shape and the values reached can be explained by the influence of the traffic and by production activity in the industrial area. The measured values were

influenced also by weather conditions as by May 31 and June 1 rainfall and wind beat occurred.

CONCLUSIONS

The measurement shows that CairClip sensors perform well when detecting hydrogen sulphide (H_2S), ammonia (NH_3) and ozone (O_3) in real-life situations, and that they can be used to monitor odour emission sources and occurrence in great detail. As such, it is possible to take partial but precise action with a view to reducing odour emissions. It has been proved that even the concentrations are low, these three odour pollutants are still existing, in various sites (industrial or traffic specific zones).

The next step will consist in combining this new sensor network approach with multiple source modelling of wind movement, in order to obtain greater details of the impact on the surrounding area and possibly forecast odour nuisance.

Acknowledgements. The authors gratefully acknowledge the substantial financial support from project AirQ (Ref. 13) project financed by UEFISCDI (http://mec.upt.ro/airq), as well from the project TRANSAIRCULTUR – 'Contribution to sustainable development by assessing the transboundary air pollution upon the cultural & touristical heritage in HU – RO border', supported by the HUNGARY-ROMANIA Cross Border Cooperation Programme 2007–2013 (ID HURO/1001/139/1.3.4), not at least the project 'Sustainable Development for Banat Region by Means of Academic Education and Scientific Research and Development in Transboundary Air Quality Monitoring Issues', (http://banatair.mec.upt.ro) in the frame of the cross border program Romania-Serbia. Also the Ph.D. program offered by UPT to the first author must be acknowledged.

REFERENCES

1. Y. NAGATA: Measurement of Odour Threshold by Triangle Odour Bag Method, Odour Measurement Review. Japan Ministry of the Environment, 2003, 118–127.
2. M. KOCHUBOVSHI, J. JANEVSKI, M. DIMOVSKA, P. SIMJANOSKI, V. RISTOVA: Monitoring of the Ambient Air Quality in Skopje and Veles and Evaluation of the Health Effects in 1990–2006. J Environ Prot Ecol, **9** (4), 743 (2008).
3. F. VOSNIAKOS, J. TRAIANDAFYLLIS, D. PRAPAS, A. KARYDA, P. MENYZELOU, G. VASILIKIOTIS, D. KARAGIANNIS, P. LAZOU, A. PAPASTAMOU, K. VOSNIAKOS, V. ARGIRIADIS: Urban Air Pollution due to Vehicles in Katerini City on Comparison Basis (1999–2006). J Environ Prot Ecol, **9** (3), 485 (2008).
4. Research Findings and Literature Review (The ADEME (French Environment and Energy Managemnt Agency) Research Programme on Atmospheric Emissions from Compositing), 2012. http://www.ademe.fr/sites /default/files/assets/documents/85087_emission_miseenligne_anglais2.pdf, accessed 06.2015.
5. D. NICOLAE, C. TALIANU, E. CARSTEA, C. RADU: Using Classification to Derive Aerosol Number Density from Lidar Measurements. J Optoelectron Adv Mater, **9** (11), 3518 (2006).
6. S. S. AFLALO, O. ZAOUAK, R. AKIKI , F. CROISÉ, Y. STITOU, C. OLRY, D. BUTY, J. BARONI , S. CARIOU, J. FANLO, B. AUBERT: Environnement SA, Cairpol, Mejannes-

les-Ales, Iséo, Aria Technologies, Alliance Environnement, Mines d'Alès Engineering School, Cairpol, Odourant Dispersion and Emissions Monitoring System, Paper: 13224, June 2013.
7. M. A. M. SMEETS, P. J. BULSING, S. van ROODEN, R. STEINMANN, J. A. de RU, N. W. M. OGINK, C. van THRIEL, P. H. DALTON: Odour and Irritation Thresholds for Ammonia: a Comparison between Static and Dynamic Olfactometry, Chem Sense, **32**, 11 (2007).
8. B. AUBERT, J.-L. FANLO, J.-M. GUILLOT, C. RENNER: Networks of Miniature Sensors for Low Concentrations (ppb) of H_2S. Available by January 2016 from: http://hydroflo.net/images/stories/PDF_Files/Products/Cairpol/Introduction-to-the-Cairclip.pdf.
9. WHO: Air Quality Guidelines for Europe. World Health Organization Regional Office for Europe, WHO Regional Publications: Copenhagen, Denmark, 2005, 146–148.
10. K. TODA, P. K. DASGUPTA, J. LI, G. A. TARVER: Fluorometric Field Instrument for Continuous Measurement of Atmospheric Hydrogen Sulfide. Anal Chem, **73**, 5716 (2001).
11. F. LESTREMAU, V. DESAUZIERS, J.-C. ROUX, J.-L. FANLO: Development of a Quantification Method for the Analysis of Malodourous Sulphur Compounds in Gaseous Industrial Effluents by Solid-phase Microextraction and Gas Chromatography-pulsed Flame Photometric Detection. J Chrom A, **999**, 71 (2003).
12. O. ZAOUAK, A. BEN DAOUD, M. FAGES, J.-L. FANLO, B. AUBERT: High Performance Cost Effective Miniature Sensor for Continuous Network Monitoring of H_2S. Chem Eng Trans, **30**, 325 (2012).
13. http://mec.upt.ro/airq 'Innovative Instrument for Air Quality Analysis in Urban Areas', Research Project PN-II-ID-JRP-2011- 1, No 5 Ro Fr, (2012), accessed May 2015.
14. C. CERCELARU, I. IONEL, I. VETRES: Air Pollution Analysis Established by a DOAS System. J Environ Prot Ecol, **15** (2), 395 (2014).
15. F. POPESCU, I. IONEL, C. UNGUREANU: Ambient Air Quality Measurements in Timisoara. Current Situation and Perspectives. J Environ Prot Ecol, **10**, 1 (2009).
16. O. FALUP, I. MIRCEA, R. IVAN, I. IONEL: Novel Approach for the Current State of Greenhouse Gases Emissions. Romanian Case Study. J Environ Prot Ecol, **15** (3), 807 (2014).
17. M. DONCHEVA, G. BONEVA: Particulate Matter Air Pollution in Urban Areas in Bulgaria. J Environ Prot Ecol, **14** (2), 422 (2013).

Received 11 February 2016
Revised 16 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 435–444 (2016)

Water pollution

DEVELOPMENT AND VALIDATION OF A RAPID AND ENVIRONMENTALLY FRIENDLY ANALYSIS METHOD FOR DETERMINATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN WATER BY MODIFICATION OF QuEChERS EXTRACTION METHOD

B. SIK*, T. TONGUR, T. ERKAYMAZ, H. A. YATMAZ

Food Safety and Agricultural Research Centre, Akdeniz University, Antalya, Turkey
E-mail: *bulentilgaz@gmail.com*

Abstract. In this study a rapid and environmentally friendly analysis method for the determination of 16 polycyclic aromatic hydrocarbon compounds (PAHs) in water was developed and validated. Water samples were extracted by modified QuEChERS method and analysed by gas chromatography mass spectrometer (GC-MS). Analytical separation was achieved in 18 min. The calibration curves were linear in the selected range of each analyte. Limit of detections of PAHs were between 0.16 and 0.31 μg kg^{-1}. % Recovery, repeatability (RSD_r) and reproducibility (RSD_R) values met AOAC method validation acceptance criteria.

Keywords: PAH, water, analysis, method development, contamination.

AIMS AND BACKROUND

PAHs are one of the most significant potential polluters in waters. PAHs, as environmental contaminants, being present in very natural environments like air, water, soil, have a stable and resistant chemical structure and high toxicity[1–3]. Polycyclic aromatic hydrocarbon compounds emerge for several reasons, particularly spilling and burning of fossil fuels, home-industrial wastes, activities of energy, mining and manufacturing sectors, and contaminate aquatic environments, air and soil[4,5].

PAH compounds can be easily adsorbed in the organic matter of the soil and sediments[4]. Consequently, it was indicated that PAH compounds are found in tap waters, rain waters, underground waters and waste waters[1].

More than 500 PAH compounds were found in the environment. However, 16 PAH compounds whose carcinogenic and toxic effects are considered higher have been accepted as primary contaminants by the Environmental Protection Agency of the United States of America (US-EPA). Also PAH compounds (15 of them)

* For correspondence.

have been included in monitoring studies by the European Union[3,5,6]. Benzo(a) pyrene is widely used as an indicator of PAH content in environmental analyses[6–8].

Although the method of liquid-liquid extraction[9] is used in sample preparation stage in PAH analyses, various extraction methods such as solid phase extraction[10], cold fibre solid phase microextraction[2], passive sampling extraction systems[11] and QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe)[12] method have also been developed as alternative sample preparation methods. Some of those extraction methods use a high amount of solvent or despite a low amount of organic solvent and good precision, long extraction periods may be needed to reach adequate detection limits[13,14]. In recent years the QuEChERS method has become widely adopted for preparing dietary samples.

Gas chromatography mass spectrometer (GC-MS) and tandem mass spectrometer (GC-MS/MS) techniques are the leading analytic techniques used most in PAH analyses[2,15,16]. There are various methods based on liquid chromatography in the literature[17–19].

In this study, it has been researched if it is possible to develop a method for detection via GC-MS of 16 polycyclic aromatic hydrocarbons notified by EPA as a control requirement in waters by making some modifications on the QuEChERS extraction method. The accuracy, precision, linearity, detection and measurement limit, etc. significant performance criteria of the method have been determined via method validation study.

EXPERIMENTAL

PAHs subject to the study have respectively been: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a] anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno(1,2,3-cd)pyrene, dibenz[ah]anthracene, benzo[ghi]perylene. Single primary stock standard solutions from the standards procured as powder from Dr. Ehrenstorfer in high purity (> 98%) have been prepared as approximately 1000 mg kg^{-1} concentration in methanol. 5 mg kg^{-1} primary stock standard mixture has been prepared using those single primary stock standards. Calibration and recovery works were conducted on the mixture standard solution.

For PAH analysis in waters a method was developed on the basis of QuEChERS method. The analyses were made using GC-MS. Acetonitrile was used as extraction solvent, and the quality of the extraction made was checked using Antrasen D10 as internal standard (ISTD).

Six different concentration points were used to prepare the calibration curve. 50 ml ultrapure water was weighed into a teflon-lid sealed Erlenmeyer flask of 250 ml to use in preparation of matrix-matched calibration solvent in 6 different concentrations, and all procedures applied to the sample were applied in the same

manner. Quality control (QC) study was held to test the reliability of the method throughout the period of the study. Into 250 ml Teflon-lid sealed Erlenmeyer flask, 50 g ultrapure water was weighed and 20 µl PAH standard working solution (5 mg kg^{-1}) added for quality control study. Each sample with such addition theoretically contains 2 µg kg^{-1} of each PAH analyte in theory.

Fifty g sample were weighed into teflon-lid sealed Erlenmeyer flask of 250 ml. For blank sample study, however, 50 g ultrapure water have been weighed into teflon-lid sealed Erlenmeyer flask of 250 ml. 10 ml MeCN solvent including 1% glacial HAc (acetic acid) were added with dispenser to each 50 g sample containing 250 ml Erlenmeyer flask. 100 µl ISTD (5 mg kg^{-1}) solution is added via automatic pipette to the sample and quality control sample to be analysed. The sample theoretically includes 10 µg kg^{-1} ISTD. ISTD solution was not added to the blank samples to be used preparing in matrix-matched calibration standards.

Twenty g anhydrous $MgSO_4$ and 1 g anhydrous NaAc (sodium acetate) were added to each Erlenmeyer flask and the Erlenmeyer lid is tightly closed. Rise of the extraction temperature to 40–45°C was expected. Erlenmeyer flasks were kept and agitated in an ice bath for 3 min to take temperature under control. The lid of the Erlenmayer was tightly closed to avoid any leakage. Effective decomposition of crystal agglomeration during the agitation has been checked to ensure interaction of the solvent with the entire sample. The Erlenmayer flasks including the sample were incubated for 10 min, and having ensured that the organic phase and the water phase were separated, transfer was made to 50 ml falcon tubes in a way to take all of the organic phase remaining above. The tubes were placed in cooled centrifuge and centrifuged at 4000 rpm for 10 min. After completion of the centrifuging process, 4 ml MeCN extract (supernatant) were carefully transferred to another 15 ml lidded falcon centrifuge tube including 400 mg PSA (100 mg for each 1 ml extract) and 1200 mg anhydrous $MgSO_4$ (300 mg for each 1 ml extract). The lid of the centrifuge tubes was tightly closed and mixed manually (or by vortex) for 60 s, and then centrifuged at 4000 rpm for 5 min. From the extraction solution acquired after the centrifuge, 1000 µl were taken for injection to GC-MS and transferred to 2 ml vials. The oven program used in GC-MS to separate PAHs is given in Table 1. The quantification ions, confirmation ions and the retention times of each PAH analytes used in determination via GC-MS are shown in Table 2. Information on the total ion chromatogram obtained under the working conditions set forth in Tables 1 and 2 via the injection of 50 µg kg^{-1} standard mixture solution and on the retention times of each PAH analyte is given in Fig. 1.

Table 1. GC-MS oven program

Oven step	Ramping rate (°C/min)	Temperature (°C)	Hold time (min)
Initial		50	0.1
Ramp 1	25	150	1
Ramp 2	20	180	1
Ramp 3	20	250	1
Ramp 4	20	300	3.5

Table 2. Retention times (RT), quantification and confirmation ions of PAHs

No	RT (min)	PAHs	Quantification ion	Confirmation ions
1	3.12	naphthalene	128	129, 127
2	4.73	acenaphthylene	152	151, 153
3	4.99	acenaphthene	153	154, 152
4	5.80	fluorene	166	165, 167
5	7.29	phenanthrene	178	179, 176
6	7.36	anthracene D10 (ISTD)	188	189, 186
7	7.40	anthracene	178	179, 176
8	7.43	fluoranthene	202	200, 203
9	9.75	pyrene	202	200, 203
10	11.45	benzo[a]anthracene	228	229, 226
11	11.50	chrysene	228	229, 226
12	13.21	benzo[b]fluoranthene	252	253, 125
13	13.25	benzo[k]fluoranthene	252	253, 125
14	13.64	benzo[a]pyrene	252	253, 125
15	14.95	indeno(1,2,3-cd)pyrene	276	138, 277
16	14.99	dibenz[ah]anthracene	278	139, 279
17	15.27	benzo[ghi]perylene	276	138, 277

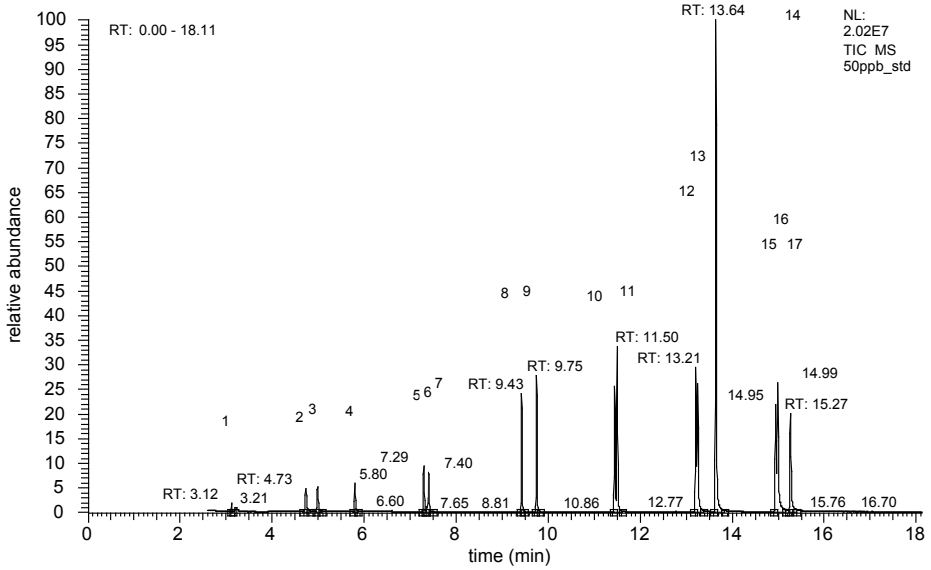


Fig. 1. Total ion chromatogram (TIC) of PAHs
naphthelene (1), acenaphthylene (2), acenaphthene (3), fluorene (4), phenanthrene (5), anthracene (6), anthracene d10 (7) fluoranthene (8), pyrene (9), benzo[a]anthracene (10), chrysene (11), benzo[b] fluoranthene (12), benzo[k]fluoranthene (13), benzo[a]pyrene (14), indeno(1,2,3-cd)pyrene (15), dibenz[ah]anthracene (16), benzo[ghi]perylene (17)

RESULTS AND DISCUSSION

A method with an analysis period of 18 min has been developed for determination of 16 PAH analytes that might be found in waters upon investigation and whose investigation has been set as a requirement by EPA. QuEChERS extraction method, a method used in pesticides, in foods was used as the extraction method[20,21]; however, that method was modified to realise PAH extraction from waters. In the QuEChERS method used in foods, sample of 10 or 15 g is weighed for analysis, and 10 or 15 ml acetonitrile is used for extraction, respectively. Generally, concentration change shall not be realised at the stage of extraction step. With the method we modified, it was aimed by extraction of 50 g water sample with 10 ml acetonitrile, to extract PAHs, which are at very low concentrations in waters, at a rate as high as possible by for sample ensuring extraction with less solvent at a higher amount compared to the original method. As a result of the trials, LOQ levels for analysed PAHs could be drawn below 1 $\mu g\ kg^{-1}$ level.

In the studies via QuEChERS method for foods, generally, the water amount in the medium at extraction stage is 12 ml maximum. Approximately 6 g of anhydrous magnesium sulphate are adequate to remove that amount of water from organic phase, acetonitrile. Magnesium sulphate is a salt that can take water into

its crystal structure, and is generally used in drying processes. It also allows easy separation of organic and aqueous phases with its featuring soluble in water and almost insoluble in organic phase[22]. Due to the high amount of water as sample used in analysis, it was concluded that utilisation of 20 g anhydrous magnesium sulphate would be appropriate at the stage of separation of acetonitrile, the extraction solvent, from water phase. Anhydrous magnesium sulphate taking water in its crystal structure is an exothermic reaction which gives heat to the environments. Extraction was realised under cold circumstances considering that excessive rising of the temperature at extraction step would lead to distancing from medium of and thus inability to detect some PAHs. In studies held with original QuEChERS method, extraction temperature would not pass 40°C because the water amount is little, and thus no cooling process is necessary. However, because the water amount is 50 g and the magnesium sulphate used is 20 g in the developed method, the extraction temperature to control the heat to reveal was taken under control using an ice bath.

Method validation studies were held to determine the performance criteria of the developed analysis method. In this context, linearity, recovery (trueness), repeatability (intra-day precision) and reproducibility (inter-day precision) works have been made. Matrix-matched calibration curve was prepared in the linearity study, and was worked at 0, 2, 5, 10, 25 and 50 μg kg^{-1} range. Linearity (R^2) was found higher than 0.99 for all PAHs in the study. Limit of detection (LOD) and limit of quantification (LOQ) studies were determined making 10 recovery studies with the water sample where each PAH standard is at 2 μg kg^{-1} concentration. The standard deviation value from the study was multiplied by 3 to calculate LOD, and by 9 to calculate LOQ values for each analyte. Linearity (R^2), LOD-LOQ and recovery rate values are given in Table 3.

Recovery, repeatability and reproducibility studies were made with 5 replicate with 2 different analysts in two different concentrations. Percentage recovery and relative standard deviation pool (RSD pool %) including the study results of 2 different concentrations have been calculated.

Repeatability studies were made the same day, however reproducibility studies on successive 5 different days. Average and percentage recovery, %RSD and %RSDpool values for Analyst 1 and Analyst 2 are shown in Tables 4 and 5, respectively.

Table 3. LOD, LOQ, correlation coefficient (R^2) and % recovery values of PAHs

Analyte	2.0 µg kg^{-1} spike result	SD	LOD (µg kg^{-1})	LOQ (µg kg^{-1})	Recovery (%)	R^2
Naphthalene	1.31	0.08	0.24	0.79	65.5	0.998
Acenaphthylene	1.70	0.08	0.25	0.83	85.0	0.998
Acenaphthene	1.80	0.09	0.27	0.91	90.0	0.998
Fluorene	1.96	0.08	0.23	0.77	98.0	0.997
Phenanthrene	1.63	0.07	0.21	0.69	81.5	0.999
Anthracene	1.64	0.10	0.30	1.01	82.0	0.999
Fluoranthene	1.68	0.09	0.26	0.86	84.0	0.999
Pyrene	1.98	0.08	0.23	0.78	99.0	0.999
Benzo[a]anthracene	1.68	0.09	0.27	0.91	84.0	0.997
Chrysene	1.82	0.10	0.29	0.97	91.0	0.998
Benzo[b]fluoranthene	1.53	0.10	0.31	1.04	76.5	0.996
Benzo[k]fluoranthene	1.63	0.09	0.26	0.86	81.5	0.996
Benzo[a]pyrene	1.92	0.08	0.23	0.78	96.0	0.996
Indeno(1,2,3-cd)pyrene	1.74	0.10	0.30	0.99	87.0	0.997
Dibenz[ah]anthracene	1.77	0.05	0.16	0.55	88.5	0.995
Benzo[ghi]perylene	1.71	0.08	0.24	0.79	85.5	0.999

Table 4. Average and percentage recovery, %RSD and % RSDpool values for Analyst 1

Analyte	At 2.5 µg kg^{-1} Analyst 1 average/recovery %	At 10 µg kg^{-1} Analyst 1 average/recovery %	Analyst 1 %RSD 2.5 µg kg^{-1}	Analyst 1 %RSD 10 µg kg^{-1}	Analyst 1 %RSD pool
Naphthalene	1.51/60.4	6.36/63.6	6.69	8.08	7.42
Acenaphthylene	1.90/76.0	9.22/92.2	5.80	7.59	6.76
Acenaphthene	1.90/76.0	8.55/85.5	5.62	3.31	4.61
Fluorene	1.93/77.2	8.40/84.0	5.58	4.74	5.18
Phenanthrene	1.98/79.2	10.42/104.2	8.71	5.30	7.21
Anthracene	1.95/78.0	9.46/94.6	7.50	5.07	6.40
Fluoranthene	2.10/84.0	10.05/100.5	7.31	4.77	6.17
Pyrene	1.98/79.2	8.75/87.5	7.89	7.66	7.78
Benzo[a]anthracene	2.11/84.4	9.13/91.3	13.27	8.20	11.03
Chrysene	1.86/74.4	8.47/84.7	6.39	7.74	7.10
Benzo[b]fluoranthene	1.96/78.4	9.33/93.3	7.28	8.71	8.03
Benzo[k]fluoranthene	2.06/82.4	9.75/97.5	4.87	10.28	8.04
Benzo[a]pyrene	1.86/74.4	8.74/87.4	2.08	7.21	5.31
Indeno(1,2,3-cd)pyrene	2.08/83.2	8.63/86.3	8.91	8.15	8.54
Dibenz[ah]anthracene	2.03/81.2	9.27/92.7	5.80	7.05	6.46
Benzo[ghi]perylene	2.14/85.6	8.54/85.4	8.54	5.80	7.30

Table 5. Average and percentage recovery, %RSD and %RSDpool values for Analyst 2

Analyte	At 2.5 μg kg^{-1} Analyst 2 average/recovery %	At 10 μg kg^{-1} Analyst 2 average/recovery %	Analyst 2 %RSD 2.5 μg kg^{-1}	Analyst 2 %RSD 10 μg kg^{-1}	Analyst 2 %RSDpool
Naphthalene	1.62/64.8	6.21/62.1	13.27	8.20	11.03
Acenaphthylene	1.86/74.4	8.79/87.9	9.46	12.95	11.34
Acenaphthene	1.83/73.2	8.64/86.4	6.19	4.81	5.54
Fluorene	1.94/77.6	9.60/96.0	4.98	3.35	4.24
Phenanthrene	1.90/76.0	9.61/96.1	7.08	6.34	6.72
Anthracene	1.97/78.8	9.77/97.7	6.00	9.02	7.66
Fluoranthene	2.11/84.4	9.41/9.41	6.79	8.71	7.81
Pyrene	2.09/83.6	9.20/9.20	3.55	6.39	5.17
Benzo[a]anthracene	2.03/81.2	9.41/94.1	12.45	6.88	10.06
Chrysene	1.89/75.6	8.85/88.5	4.70	5.76	5.26
Benzo[b]fluoranthene	1.98/79.2	9.03/90.3	5.94	6.37	6.16
Benzo[k]fluoranthene	2.00/80.0	9.98/99.8	6.94	8.46	7.74
Benzo[a]pyrene	1.82/72.8	8.67/86.7	4.73	4.19	4.47
Indeno(1,2,3-cd)pyrene	2.03/81.2	9.36/93.6	12.42	8.39	10.60
Dibenz[ah]anthracene	2.03/81.2	9.24/92.4	6.50	3.92	5.37
Benzo[ghi]perylene	2.11/84.4	9.67/96.7	11.46	11.66	11.56

Results regarding the repeatability study of each analyst are shown in Tables 4 and 5. % RSDpool calculation was made from the results obtained by the analysts, and it was found out that the obtained results complied with the method validation criteria, RSD < 21 % and 60–115 % recovery, suggested by AOAC (Refs 23 and 24).

It was found out that the results obtained from reproducibility studies conducted by two different analysts on two different days complied with the method validation criteria, general RSDpool < 32%, suggested by AOAC (Refs 23 and 24).

CONCLUSIONS

A method of short analysis time and high accuracy and precision value has been developed that gives results within 18 min for 16 PAHs whose examination in waters is important. The results of the validation study conducted to determine the performance criteria of the method have been evaluated according to method validation acceptance criteria in AOAC document (Refs 23 and 24). It was specified in the concerned document that at 10 μg kg^{-1} level, average recovery should be at 60–115% interval, repeatability RSD% should be less than 21, and reproducibility RSD% less than 32. The values obtained for 16 PAHs as a result of the validation study comply completely with the aforementioned criteria. QuEChERS extraction method is considered an environmentally friendly method because of

the little amount of solvent used and because the example cleaning process steps are based on a low amount of chemical use. The analysis method developed makes PAH analysis in waters possible with some changes in the QuEChERS method with high accuracy and precision values. In point of fact LOD values were not sufficient for drinking water analysis but due to QuEChERS based the extraction method this method is applicable for foods.

REFERENCES

1. M. H. KOVACS, D. RISTOIU, T. RISTOIU: PAH Transfer from Soil to Selected Vegetables Grown on Industrially Contaminated Soil. J Environ Prot Ecol, 13 (2A), 900 (2012).
2. H. C. MENEZES AND FRIENDS: A Sensitive GC/MS Method Using Cold Fiber SPME to Determine Polycyclic Aromatic Hydrocarbons in Spring Water. Microchem J, **110**, 209 (2013).
3. A. K. M. KABZINSKI, J. CYRAN, R. JUSZCZAK: Determination of Polycyclic Aromatic Hydrocarbons in Water (Including Drinking Water) of Lodz. Pol J Environ Stud, **11** (6), 695 (2002).
4. B. CHEN, X. XUAN, L. ZHU, J. WANG, Y. GAO, K. YANG, X. SHEN, B. LOU: Distributions of Polycyclic Aromatic Hydrocrbons in Surface Waters, Sediments and Soils of Hangzhou City, China. Water Res, **38**, 3558 (2004).
5. S. BARREK, C. CREN-OLIVÉA, L. WIESTA, R. BAUDOTA, C. ARNAUDGUILHEMA, M. F. GRENIER-LOUSTALOTA: Multi-residue Analysis and Ultra-trace Quantification of 36 Priority Substances from the European Water Framework Directive by GC–MS and LC-FLD-MS/MS in Surface Water. Talanta, **79**, 712 (2009).
6. P. PLAZA-BPLANOS, A. G. FRENICH, J. L. M. VIDAL: Polycyclic Aromatic Hydrocarbons in Food and Beverages. Anal Methods Trends, 2010.
7. European Union (EU): Commission Regulation (EC) No 835/2011. Off J Eur Union, L215, 4 (2006).
8. T. R. CROMPTON: Determination of Organic Compounds in Natural and Treated Waters. Taylor & Francis Group, 2002. 929 p.
9. E. WEGRZYN, S. GRZESKIEWICZ, W. POPLAWSKA, B. K. GLOD: Modified Analytical Method for Polycyclic Aromatic Hydrocarbons, Using Sec for Sample Preparation and RP-HPLC with Fluorescence Detection, Application to Different Food Samples. ACTA Chromatographica, (17), 233 (2006).
10. J. R. L. BISPO, S. NAVICKIENE, H. S. DOREA: Method Validation for SPE Applied to Determination of PAH in Petroliferous Industry Effluent Water. Am J Anal Chem, (2), 971 (2011).
11. A. NEZIRI, P. LAZO, J. BRUMMER, A. PASCHKE: New Passive Sampling Systems for Monitoring Organic Micropollutants and Heavy Metals in the Shkodra Lake. J Environ Prot Ecol, **12** (4A), 2218 (2011).
12. A. SADOWSKA-ROCIEK, M. SURMAAND E. CIESLIK: Comparison of Different Modifications on QuEchERS Sample Preparation Method for PAHs Determination in Black, Green, Red and White Tea. Environ Sci Pollut Res Int, **21** (2), 1326 (2014).
13. S. TRIANES, T. PENA, C. CASAIS, C. MEJUTO: Development of a New Sorptive Extraction Method Based on Simultaneous Direct and Headspace Sampling Modes for the Screening of Polycyclic Aromatic Hydrocarbons in Water Samples. Talanta, **132**, 433 (2005).
14. W. C. TSENG, P. S. CHEN, S. D. HUANG: Optimization of Two Different Dispersie Liquid-liquid Microextraction Methods Followed by Gas Chromatography-Mass Spectrometry Determination for Polycyclic Aromatic Hydrocarbons (PAHs) Analysis in Water. Talanta, **120**, 425 (2014).
15. SO-YOUNG JUNG, JU-SUNG PARK, MIN-SU CHANG, MI-SUN KIM, SANG-MI LEE, JUNG-HUN KIM, AND YOUNG-ZOO CHAE: A Simple Method for the Determination of

Polycyclic Aromatic Hydrocarbons (PAH) in Edible Oil Employing Solid Phase Extraction (SPE) Cartridge Purification. Food Sci Biotechnol, **22** (S), 241 (2013).
16. M. BATES, P. BRUNO, M. CAPUTI, M. CASELLI, G. de GENNARO, M. TUTINO: Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) in Airborn Particles by Direct Sample Introduction Thermal Desorption GC MS. Atmos Environ, **42**, 6144 (2008).
17. S. J. MOJA, F. MTUNZI: Application of Solid Phase Extraction (SPE) Method in Determining Polycyclic Aromatic Hydrocarbons (PAHs) in River Water Samples. J Environ Chem Ecotoxicol, **5** (11), 278 (2013).
18. C. BECOUZE, L. WIEST, R. BAUDOT, J. L. BERTRAND-KRAJEWSKI, C. CREN-OLIVÉ: Optimisation of Pressurised Liquid Extraction for the Ultra-trace Quantification of 20 Priority Substances from the European Water Framework Directive in Atmospheric Particles by GC–MS and LC–FLD–MS/MS. Anal Chim Acta, **693**, 47 (2011).
19. B. RAMSAUER, K. STERZ, H. W. HAGEDORN, J. ENGL, G. SCHERER, M. MCEWAN, G. ERRINGTON, J. SHEPPERD, F. CHEUNG: A Liquid Chromatography/Tandem Mass Spectrometry (LC-MS/MS) Method for the Determination of Phenolic Polycyclic Aromatic Hydrocarbons (OH-PAH) in Urine of Non-smokers and Smokers. Anal Bioanal Chem, **399**, 877 (2011).
20. A. WILKOWSKA, M. BIZIUK: Determination of Pesticide Residues in Food Matrices Using the QuEChERS Methodology. Food Chem, **125**, 803 (2011).
21. A. ANGIONI, L. PORCU, M. SECCI, P. ADDIS: QuEChERS Method for the Determination of PAH Compounds in Sardinia Sea Urchin (*Paracentrotus lividus*) Roe, Using Gas Chromatography ITMS-MS Analysis. Food Anal Methods, **5**, 1131 (2012).
22. S. J. LEHOTAY: Determination of Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate: Collaborative Study. J AOAC Int, **90** (2), 485 (2007).
23. AOAC Official Methods of Analysis: Guidelines for Standard Method Performance Requirements, 2012.
24. AOAC International: AOAC Guidelines for Single Laboratory Validation of Chemical Methods for Dietary Supplements and Botanicals, Arlington, Va. Available from http://www.aoac.org, 2002.

Received 8 January 2016
Revised 16 February 2016

Journal of Environmental Protection and Ecology 17, No 2, 445–452 (2016)

Water pollution

EVALUATION OF THE EFFECTS OF 2,6-DINITRO-N,N-DIPROPYL-4-TRIFLUOROMETHYLANIL HERBICIDE ON THE GROUNDWATER CONTAMINATION IN THE THRACE REGION

U. K. CEBI[a], R. CAKIR[b], H. H. TOK[c]*

[a]*Ataturk Soil Water and Agricultural Meteorology Research Institute, Kirklareli, Turkey*
E-mail: *ulviyecebi@yahoo.com*
[b]*Lapseki Vocational College, Canakkale Onsekiz Mart University, Lapseki, 17 800 Canakkale, Turkey*
E-mail: *rcakir@comu.edu.tr*; *crec56@yahoo.com*
[c]*Soil Science Department, Faculty of Agriculture, Namik Kemal University, Tekirdag, Turkey*
E-mail: *hasanhayritok@gmail.com*

Abstract. The contamination effects of 2,6-dinitro-N,N-dipropyl-4-trifluoromethylanil (trifluralin) herbicide, widely used in sunflower farming were studied on the fields of Turgutbey irrigation project in Thrace region. Shallow irrigation water wells, drilled by farmers across the irrigation project covering approximately 320 ha fields, were evaluated in the study. Water samples collected from the irrigation wells at monthly intervals along the irrigation season, were analysed for trifluralin residuals. General evaluation of the results obtained during the years of the study showed, that residual concentrations determined in the well waters varied depending on location and time of sampling. It was found out also that the lowest and highest residual concentrations of trifluralin in water samples collected from the investigated wells, were 3.2 and 86.9 ppb, respectively. Higher residual concentrations in larger number of wells were available in the beginning of the season, and incidence as well as concentrations of herbicide residual decrease towards the autumn.

Keywords: trifluralin, water, contamination, residuals.

AIMS AND BACKGROUND

The number of macro and micro live creatures that damage farming crops is around 65 000–70 000 and product loss due to various pest, weeds and diseases is estimated to be in the ranges of 15 and 30%. The use of pesticides accepted as easiest and cheapest way to cope with these damaging factors became widespread after 1950s.

Despite the fact that the amount of pesticides used in our country as a whole is much lower than the amounts used in developed countries, the use of the mentioned

* For correspondence.

chemicals is a matter of serious concern in regions with polycultural intensive agriculture[1]. On the other hand, contamination of surface and groundwater due to pesticide application in agriculture has been well documented around the world. Pesticide residues in surface waters have been a concern since the first years of use[2,3]. Actually nowadays the persistence of pesticide residues in the soil and their movement in the water–soil system are accepted as key aspects in their environmental behaviour. Furthermore the environmental fates of pesticides have attracted recent attention because of their increasing pollution potential to the environment. Ground waters, lake and river waters can undoubtedly be contaminated with runoff water from adjacent agricultural fields if pesticides are uncontrolled used.

Recently, the fate of pesticides in the environment has attracted more attention because of its polluting effect on the surrounding environment. Despite the recognised benefits of pesticides in protecting crop yields, pesticide contamination of the non-target system is undesirable because of the difficulties in predicting the long term ecological and health effects[4].

Among the chemicals applied in agricultural farming, herbicides are the most used pesticide group in our country and in the Thrace region. The most widely used herbicides in the region of the study are 2,4-D, trifluralin and propanil. Trifluralin [2,6-dinitro-N,N-dipropyl-4-(trifluoro-methyl) benzenamine] is selective herbicide used for pre-emergence control of annual grasses and broadleaf weeds in sunflower, maize, vegetables and other crops grown in Thrace region of Turkey.

In the classification on the bases of formulations trifluralin belongs to concentrated emulsion (EC) pesticide group. The chemicals into the mentioned group are rapidly mixed and are persistent for a long period into water sources. Owing to its physicochemical properties trifluralin is also long persistent in the soil which cause damaging effect on wheat seed germination in the conditions of sunflower-wheat rotation applied in region of the study. In some studies[5] trifluralin residuals are determined in lake and underground waters, while in other studies[6] no trace of the pesticide is found in any of the investigated 299 drinking water sources in Italy[7]. In other studies carried out in Greece[8,9] were determined presence of one or more pesticides in water samples collected from Axios river in concentrations lower than 0.1 μg/l, which is the highest permitted limit for each pesticide in drinking water, according to the Directive 778/80 of the European union.

According to publications of EPA, FAO and International Cancer Research Centre, trifluralin is cancerogenic and is highly toxic to aquatic organisms even at low doses. Due to mentioned harmful effects, in the final notification of the 3rd North Sea Conference was declared that the amount of pesticide use should be decreased by 50% during the period of 1985–1995. Nevertheless the herbicide is still widely used in Thrace region of Turkey.

This paper discussed the results obtained in the study aiming determination the effects of trifluralin on underground water contamination along the lands of Turgutbey irrigation project.

EXPERIMENTAL

Study area. The investigations were carried out on the lands of Turgutbey irrigation project, located in the northern part of Kirklareli district in the Thrace region of Turkey. The geographical position of the studied 16 water wells were determined as 41°27′, 41°28′ and 41°29′ North latitude, and 27°23′, 27°24′ and 27°25′ East longitude and elevation varied in the ranges of 73–96 m (Table 1).

Long-term precipitation and temperature averages for the investigation region were determined as 589.6 mm and 13°C, respectively. The highest average monthly precipitation rates of 76.1 and 83.3 mm are determined for December and January, while the hottest summer months July and August are characterised with lowest precipitation averages of 21.7 and 24.6 mm, respectively[10]. The studied area is characterised with xeric-usticmoisture and mesic temperature regimes, and prevailing transition Marmara (Black Sea-Mediterranean Sea) climate type[11].

The general geology of the region is quite similar to that described by Arkoc[12] for a study area located nearby to the area of our study. The investigated area owns flat or slight sloped (2–3%) topographic conditions and covered with medium deep Alluvial soils (Entisol), with prevailing loamy clay texture in the upper and sandy clay loam in the deeper part of the soil profile. No salinity or alkalinity problems are reported for the studied soils[13].

Table 1. Geographical position of the evaluated water wells

Well number	Geographical position		Elevation (m)	Well number	Geographical position		Elevation (m)
	north	east			north	east	
Drinking water	41°27′49	27°23′26	87	9	41°27′27	27°23′36	74
2	41°28′35	27°23′51	90	10	41°27′52	27°23′32	82
3	41°28′19	27°23′37	86	11	41°27′54	27°23′35	80
4	41°28′16	27°23′34	83	12	41°28′03	27°23′42	82
5	41°28′23	27°23′19	84	13	41°28′30	27°24′13	83
6	41°27′59	27°23′32	84	14	41°29′09	27°25′11	96
7	41°27′53	27°23′18	85	15	41°29′02	27°24′51	95
8	41°27′24	27°23′20	73	16	41°28′58	27°24′43	96

Sampling and analysing procedures. Water samples from one drinking water and 15 irrigation water wells were collected at monthly intervals during the irrigation season (May, June, July, August and September) of the investigation years. Water samples collected from wells located along the investigated irrigation project

were analysed in the laboratories of Ataturk Soil and Water Resources Research Institute in Kirklareli. A PERICHROM PR 2100 gas chromatography apparatus equipped with electron capture detector (ECD) and capillary column of 0.32 mm inner diameter and 25 m long, was used in the analysing process. Pesticide residuals in water samples were determined using Environmental Chemistry in Water Analysis Method (ECM) 155 978 (Fig. 1).

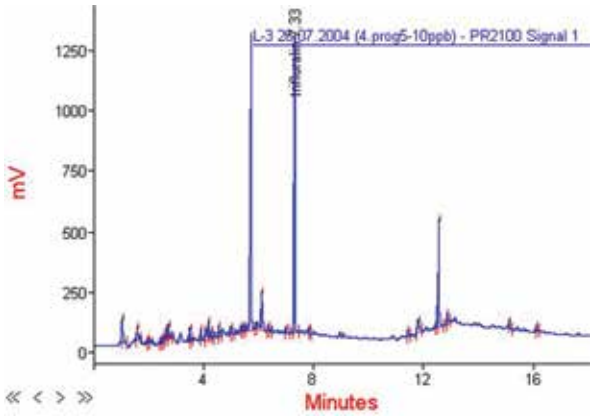


Fig. 1. Typical diagram for trifluralin residues in water samples

RESULTS AND DISCUSSION

Farmer wells located on the lands of Turgutbey irrigation project were used as material of the study. Results of the analysis of samples collected in the beginning of irrigation season (May) of the first experimental year showed, that the lowest and highest amounts (3.6 and 86.9 ppb) of trifluralin respectively, existed in water samples taken from wells 9 and 13. Pesticide residuals in water determined during the following months (June, July and September) of the irrigation season were in the ranges of 3.9–62.3, 7.14–79.2 and 3.8–9.6 ppb, respectively. As could be seen from data illustrated in Fig. 2, during the first experimental year, the higher residual concentrations, in larger number of wells, are available in the beginning of the season, and incidence and levels of pesticide residual decrease with time.

As a general, from data plotted in Fig. 2 it could be derived, that though herbicide residuals were available in all wells located close to fields with trifluralin herbicide application in 2006, the maximum residue concentrations of 86.9 and 62.3 ppb were obtained in water samples collected from wells 13 and 15, respectively in May and June. The concentrations of the pesticide in water of the mentioned wells were determined to decrease, during the following month (July), when residual amounts were increasing up to 43.6, 59.2 and 79.2 ppb in waters sampled from wells 6, 12 and 16, respectively.

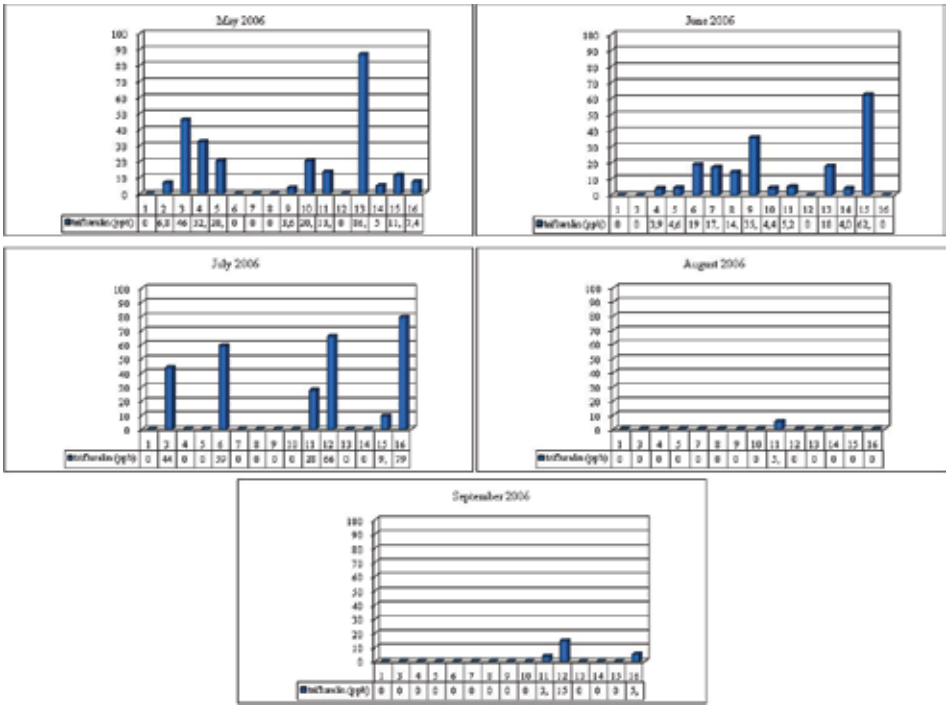


Fig. 2. Trifluralin residuals in water of evaluated wells determined during irrigation season of the first experimental year

Sampling and analysis applied approximately 3–4 months after utilisation of the herbicide pointed out for presence of trifluralin residuals in very low concentrations in the range of 3.8–14.7 ppb in waters of only few wells.

Although determined less concentrations due to decreased sunflower acreages during the second experimental year, results were similar to those obtained during 2006. Just as in the case of the previous year, pesticide residuals detected in water samples during 2007, exhibited variation depending on interval between application and sampling time. Moreover there were variations also in terms of trifluralin concentrations in water samples taken from different wells. Sampling in June showed low quantities of pesticide residuals in the range of 7.6–12.7 ppb only in waters of wells 2, 4 and 5. Much more evident pollution of the ground waters was observed during the next month July in water samples collected from wells 2, 3, 4, 5, 6, 7, 8, 9 and 10, located in the central part of the irrigation project.

Relatively high residual rates up to 40 and 60 ppb were recorded for some of the pointed wells. In a manner similar to the first experimental year, only in few of the water samples taken 3 or 4 months after trifluralin application were determined herbicide residuals (Fig. 3).

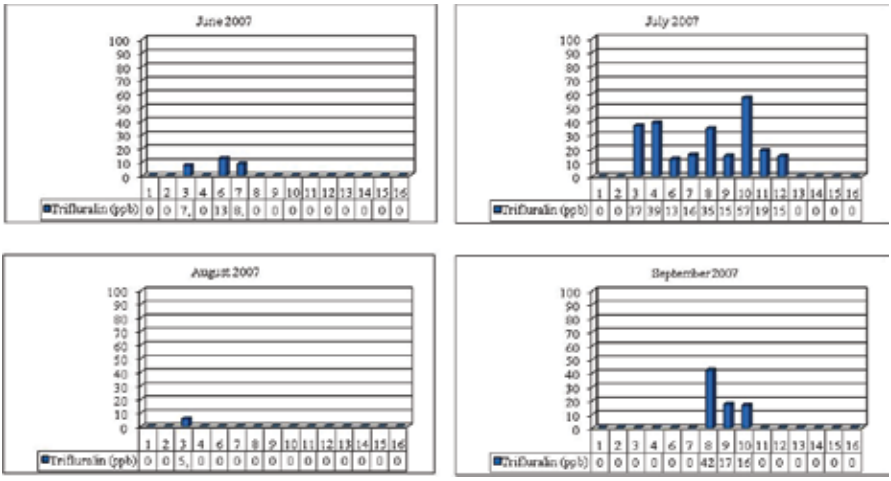


Fig. 3. Pesticide concentrations detected in water of the evaluated wells during the irrigation season of 2007 year

The highest and lowest residual concentrations detected in wells used as an irrigation water source across the irrigation project in Turgutbey were, 86.9 and 3.2 ppb, respectively.

All the wells drilled for the mentioned purpose are shallow, with depth in the ranges of 15–20 m, and in the majority of the water samples collected from the wells were detected pesticide residuals in more or less amounts, during one or another period of the study. On the contrary, no trifluralin residuals were determined during any period of the investigation in water samples drawn from the 196 m deep well (No 1), drilled to serve as a drinking water source for the population of Turgutbey. A similar situation was observed also in investigations carried out abroad. In a study conducted in the United States, a total of 2047 surface and 507 underground water samples have been analysed, and only in 172 of them trifluralin residuals have been detected. In addition, it was also determined that in 85% of samples with designated residuals, the concentrations were less than 0.54 ppb. In a similar study carried out in Italy, Funari and Sampaolo[6] evaluated pesticide availability in 299 drinking water samples, most of them from underground water sources, and found no trifluralin residuals in any of the investigated sources. This situation is in agreement with our results in the absence of any residuals in the studied drinking water well. The lack of the pollution in this case could be explained with deep laying aquifer (200 m) surrounded by clay formations, probably preventing the water body from contamination with trifluralin. It could be suggested also that the molecules of the pesticide are tightly held by the soil colloids and prevent the contamination.

According to Brignon[14], in the directives of the European maximum trifluralin levels in spring and drinking waters are limited to 2 and 0.10 ppb, respectively. No

relevant norms for trifluralin exist in national Turkish standards (TS- 266) related to the hazardous levels of substances in spring and drinking waters. Evaluation of the results related to residual levels in analysed water samples on the base of mentioned European standards shows that pesticide amounts detected in some of the irrigation wells are much higher than those pointed out in the European documents mentioned above.

CONCLUSIONS

Trifluralin herbicide has been widely used in our country since 1976, especially in regions as Thrace with popular sunflower agriculture. Because of its carcinogenic properties, the standard norms and values existing in the Directives of the European Union should be accepted and included in the list of hazardous substances given the national standard document TSS-266.

Currently, the recommended amount of the herbicide in summer crops farming is 150–200 g da^{-1} which should be reduced, though overdosage is a common practice in the country. Decreased amounts of trifluralin and/or application of equivalent herbicides are supposed to be strong tools for limitation of hazardous effect of the pesticide especially in the localities with shallow ground waters.

Use of shallows wells as drinking water source in areas with intensive use of trifluralin, as in the case of the evaluated irrigation project lands should be avoided.

Acknowledgements. This paper includes some of the results obtained from a research project (02210L01) funded by the Former General Directorate of Rural Services and General Directorate for Agricultural Research, Ankara.

REFERENCES

1. H. H. TOK: Pesticide Usage in Thrace Region and Negative Effects of Pesticides on Environment. In: Proc. of Thrace Agriculture and Environment Symposium, Corlu, 1996.
2. R. P. RICHARDS, D. B. BAKER: Pesticide Concentration Patterns in Agricultural Drainage Networks of the Lake Erie Basin. Environ Toxicol Chem, **12**, 13 (1993).
3. S. J. LARSON, P. D. CAPEL, D. A. GOOLSBY, S. D. ZAUGG, M. W. SANDSTROM: Relations between Pesticide Use and Riverine Flux in the Mississippi River Basin. Chemosphere, **31**, 305 (1995).
4. A. S. FELSOT, J. K. MITCHELL, L. KENIMER: Assessment of Management Practices for Reducing Pesticide Runoff from Sloping Cropland in Illinois. J Environ Qual, **19**, 539 (1990).
5. M. T. MOORE, R. E. LIZOTTE, S. S. KNIFHT, S. SMITH, C. M. COPPER: Assessment of Pesticide Contamination in Three Mississippi Delta Oxbow Lakes Using Hyalella Aztec. Chemosphere Science for Environmental Technology, May 2007.
6. E. FUNARİ, A. SAMPAOLO: Herbicides in Drinking Water. Annali dell Istituto Superiore di Sanità, **25**, 353 (1989).
7. ANONYMOUS: Guidelines for Drinking Water Quality. 2nd ed. Vol. 2. Health Criteria and Other Supporting Information. World Health Organization, Geneva, Switzerland, 1996.

8. F. VOSNIAKOS, T. ALMPANIS, G. VASILIKIOTIS, K. DIAMANTOPOULOS, E. CHRISTOFORIDOU, A. KARIDA, K. ZAVLARIS, P. METZELOU, D. LAMPROPOULOU, P. SELIMI, A. KOUGOLOS, K.VOSNIAKOS, S. AVDIMIOTIS: Evaluation of Transboundary Pollution Levels in The Axios River (Greece, Former Yugoslavian Republic of Macedonia) – Direct and Indirect Impacts on Man and Environment. J Environ Prot Ecol, **8** (3), 526 (2007).
9. T. ALBANIS , F. VOSNIAKOS, K. NIKOLAOU , G. VASILIKIOTIS, M. KOCHUBOVSKI, D. GJORGJEF, Ch. DIAMANTOPOULOS, D. LAMPROPOULOU, K. ZAVLARIS, P. SELIMI: Axios River Pollution. Part I. The Pesticides. J Environ Prot Ecol, **10** (1), 32 (2009).
10. Average Extreme Temperature and Precipitation Values Bulletin. T.R. Prime Ministry of General Directorate of Meteorology Editions, Ankara, 1984. 678 p.
11. U. DINC, S. SENOL, S. KAPUR, I. ATALAY, C. CANGIR: Turkey Soils. C. U. Agricultural Faculty. General Edition No 51, Edition No 12 (1995).
12. O. ARKOC: Assessment of Water Quality of East Part of the Ergene Basin, Turkey. J Environ Prot Ecol, **12** (4), 1644 (2011).
13. Land Existence of Kirklareli Province. Ministry of Agriculture, Forestry and Rural Services. Report No: 39. Ankara (1991)
14. J. M. BRIGNON : Données technico-économiques sur les substances chimiques en France: Trifluraline. Données technico-économiques sur les substances chimiques en France, 2007, p. 23.

Received 11 February 2016
Revised 22 February 2016

Journal of Environmental Protection and Ecology 17, No 2, 453–459 (2016)

Water pollution

DRINKING-UTILITY WATER PREFERENCES OF THE PEOPLE WHO LIVE IN THE CENTRE OF TRABZON PROVINCE AND THE REASONS FOR THESE PREFERENCES

A. UFACIK[a]*, M. TOPBAS[b], S. S. NAS[a], C. C. KOLAYLI[b], E. ORTAHISAR[a], T. SAGDIC[a], S. CANKAYA[b], Z. S. ERDOGAN[a], B. BEYOGLU[a]

[a]*Faculty of Medicine, Karadeniz Technical University, 61 080 Trabzon, Turkey*
E-mail: *arife428@gmail.com*
[b]*Faculty of Medicine Department of Public Health, Karadeniz Technical University, Trabzon, Turkey*

Abstract. The objective of the study was to research the drinking and utility water preferences of the individuals who live in different neighbourhoods with different socio-economic characteristics in the centre of Trabzon province and the reasons for these preferences. It was a cross-sectional study in which the data were stratified according to socio-economic levels. Data were collected with simple random method in the face-to-face interviews with 586 people from different neighbourhoods. 31.7% of the participants stated that they only prefer city water for drinking purposes, 13.3% of them expressed that they prefer plastic bottled water, 9.9% of them pointed out that they prefer dispenser size water and 3.1% of them indicated that they prefer water that springs from village. In the study, it was found out that the use of city water as drinking water is highly low. The income and educational level have an effect on this rate. In terms of quality, city water ranks the last according to the views of the participants. In order to provide sufficient, clean, favourable and accessible water that is the most basic need and right of humanity, relevant water policies should be established and every central and local stakeholder should implement these policies.

Keywords: drinking water, water preferences, packaged water, tap water, spring water.

AIMS AND BACKGROUND

The major component of the human body, water is indispensable and unique for the continuation of the life of any living form including human[1]. According to a report prepared by the United Nations, 884 million people do not have access to clean water and clean and safe utility water should be provided for any individual in order to protect and improve public health[2].

Today, water requirement of the public has increased due to the industrial development, widespread urban life, irregular urbanisation, high life standards

* For correspondence.

and increasing population[3,4]. As water requirement increases, the water resources decrease due to irresponsible consumption, which may cause ecologic imbalance and climate change. This creates a vicious circle in which any incident triggers one another and water resources are not enough to meet the needs. In parallel with these changes, people have begun to prefer different type of water for drinking purposes.

Tap water should be clean and safe in order to provide public health. It is one of the main duties of the municipalities to provide clean and safe tap water. However, drinking and utility water preferences of Turkish people have recently changed. After water-born diseases and outbreaks emerged in almost every province in Turkey, news announced that city water is not healthy. Therefore, public perception towards city water changed and people thought that it would not be healthy to drink tap water. Additionally, as a result of packaged water advertisements and lack of access to clean water outside home in school, office and street, people prefer packaged water to tap water. Are these changes that we observe real? Which type of water do the public prefer in daily life? It is the main duty of the municipalities to provide clean and safe city water but what is the perception of the public towards city water? Studies and information on this issue are very scarce in Turkey. Trabzon is a warm and rainy (800–850 kg/m^2/year) province that is located in northwest part of the Black Sea Region. The coast leaves a confined residential area in Trabzon province. There is limited area between coast and hills and mountains. Therefore, people own a house both in the city centre and in their village. There is spring water running from the mountains. However, this spring water can be described as uncontrolled water and some people prefer it for drinking purposes.

The objective of this study to research the drinking and utility water preferences of individuals who live in different neighbourhood with different socioeconomic characteristics in the centre of Trabzon province and the reasons for these preferences.

EXPERIMENTAL

The population of this cross-sectional study is the people above the age of 18 who live in Ortahisar district of Trabzon province. Sample was chosen among 231999-person population, in 95% confidence interval, 50% unknown prevalence and with 1.5 design effect and 576 people were identified as target population. Neighbourhoods in Ortahisar district were stratified according to their socioeconomic levels and a research was conducted on 586 people in 3 different neighbourhoods (Besirli, Bahcecik and Kalkinma neighbourhoods) with random sampling method.

Data were collected on a volunteer basis and data forms were filled in face-to-face interviews in the opted neighbourhoods between February 20–April 30,

2015. Relevant approval was received from Karadeniz Technical University Ethics Committee for the study. There were questions regarding the socio-demographic features such as the sex, age, educational level of the participants, the number of the people in their household, the number of the children under the age of 6 and survey also included questions concerning chronic diseases and the amount of daily fluid consumption (water/ tea/ ayran/ soft drinks). Additionally, there were other questions to identify the daily drinking-utility water preferences of the participants (city/ dispenser size/ plastic bottled/ spring water preferences for drinking/ cooking/ tea-coffee preparing/ dishwashing – laundering/bath-home-toilet cleaning purposes). Participants stated that they prefer one type of water because they think it is the healthy way or it is the economic way or they like its taste-smell-colour or other people prefer this or they like the hardness of this water type.

SPSS 13.0 statistical software package was used in data analysis. Qualitative data were represented in figures and percentages and numeric data were represented in arithmetic mean and standard deviation. Chi-square test was used while comparing qualitative data. Significance level of statistical alpha was identified as $p < 0.05$.

RESULTS

281 women (48%) and 304 men (52%) participated in the study. The average age was 37.3 ± 14.2 and 59.6% of the participants ($n = 349$) were married and 37% ($n = 217$) of them were bachelor. The reasons of the preference of the participants who use only one type of water among city water, dispenser size water, packaged water and spring water are shown in Table 1.

Table 1. Reasons of the preference of specific type of water

Water type	Healthiness		Economy		Taste, smell and colour		Other people preference		Softness	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
City water	101	54.3	60	32.3	33	17.7	45	24.2	14	7.5
Dispenser size water	39	67.2	13	22.4	26	44.8	2	3.4	15	25.9
Packaged water	54	69.2	14	17.9	32	41.0	9	11.5	13	16.7
Spring water	15	83.3	0	0	8	44.4	0	0	3	16.7

32% of the participants ($n = 186$) stated that they only prefer city water for drinking purposes, 13.3% of them ($n = 78$) expressed that they prefer plastic bottled water, 9.9% of them ($n = 58$) pointed out that they prefer dispenser size water and 3.1% of them ($n = 18$) indicated that they prefer water that springs from village.

The rate of city water preference as drinking water among people who graduated from at least university was 24.0% ($n = 56$), who graduated from high school was 31.4% ($n = 71$) and who graduated from primary school was 47.5% ($n = 57$) ($p < 0.001$).

The rate of city water preference as drinking water among people whose income is above TRY 2000 was 23.4% (n = 61) and whose income is below TRY 2000 was 37.4% (n = 113) ($p < 0.001$).

The reasons for their drinking water preferences, 63.8% of participants (n = 374) stated that they think their preference is the healthiest way to drink water, 32.6% of them (n = 191) expressed that they do like the smell and taste of their preference, 26.8% (n = 157) of them pointed out that their preference is the economic way for drinking water, 18.1% (n = 106) remarked that other people prefer this alternative and 17.1% (n = 100) emphasised that it is smooth.

The opinions of the participants about the quality of water are shown in Table 2. Accordingly spring water is determined as the most qualified water.

Table 2. Opinions of the participants about the quality of water

Water type	Very bad		Bad		Average		Good		Very good	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
City water	59	10.3	99	17.2	237	41.3	161	28.0	18	3.1
Packaged water	6	1.1	82	15.1	194	35.7	244	44.9	18	3.3
Dispenser size water	15	2.8	107	20.1	193	36.3	197	37.0	20	3.8
Spring water	2	0.4	15	2.9	59	11.6	185	36.3	249	48.8

When the daily water consumption of the participants were examined, the average water consumption is 6.32 ± 3.6 water glass, tea consumption is 6.28 ± 4.4 water glass; and ayran and soft drink consumption is 1.59 ± 0.9. The types of water that the participants prefer to meet variety of needs are shown in Table 3.

Table 3. Types of water that participants prefer to meet variety of needs

Water type	Cooking		Tea / coffee preparing		Dish washing		Laundry		Bathing		House cleaning		Bathroom cleaning	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
City water	501	87.7	497	86.7	566	99.0	566	99.3	566	99.3	566	99.3	566	99.3
Dispenser size water	52	9.1	50	8.7	3	0.5	2	0.4	2	0.4	2	0.4	2	0.4
Packaged water	8	1.4	14	2.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Spring water	10	1.8	12	2.1	3	0.5	2	0.4	2	0.4	2	0.4	2	0.4

DISCUSSION

In addition to ensuring public to have an access to clean and safe water, public preference of water type is also an important issue. In parallel with the development that occurs in Turkey and in world, people have begun to prefer different type of water.

Tap water, packaged water, dispenser size water and spring water are preferred for drinking purposes. City water should be the main source of drinking and utility water since individuals and public have a right to access to healthy and safe water. Since packaged waters are expensive and there is the package waste problem and also other water types are uncontrolled, they should not be preferred. In this study, 31.7% of the participants prefer only city water, 19.3% prefer drinking packaged water, 9.9% prefer dispenser size water. According to a study conducted by Til et al. on workers in Denizli province, these rates change as such, 39.5% city water, 36.3% dispenser size water, 5.8% consume packaged water[5]. In Tokat province, according to the study conducted by Onder et al. with university students, it was found that 93.2% of the students consume packaged water in dormitory, 6.8% of the students drink city water as drinking water[6]. According to the study conducted by Huerta-Saenz et al. in Philadelphia, 17% of the parents consume only tap water, 38% of the parents drink only packaged water[7]. In the study that Mcleod et al. conducted was found that both tap water and packaged water are preferred for daily consumption[8]. In this sense, these results show that people have a tendency to prefer different types of water to city water.

In our study, it is seen that the participants think spring water, packaged water and dispenser size water are healthier and in good quality, therefore, this opinion affects their drinking water preference. The studies in literature show that people think packaged water is healthier than city water, and they do not drink city water because of the fear that they may get sick and they also do not let their children drink too and the increase in packaged water consumption in recent years explains this situation[9–13]. In addition to these reasons, we think that the epidemics emerged because of the malfunctions in city water system, inadequate explanations of local governors about the water quality and epidemics and also the news broadcasted with the negative perception of media about water sources caused people to prefer packaged water more.

In our study, it is seen that highly educated people and people with high income prefer city water less. In the study conducted in Denizli, while there was a relation among these criteria, in America where different ethnic groups live, any relation was not found in the study conducted by Gorelick et al.[5,14] According to study conducted in Mediterranean region by Gul et al. it was found that highly educated people and people with high income prefer packaged water[15]. In the study conducted in Purdue University by Saylor et al. it was found that undergraduate students still prefer packaged water comparing to graduated students[16]. In our

study, people who live in Trabzon province and prefer packaged water claimed that they think packaged water is healthier and also better in taste and smell. When the studies are examined, it is seen that the socio-demographic characteristics affect the water consumption preferences of the public.

In our studies it is found that people think spring water is more in good quality and prefer to consume spring water more because they think it is healthy and soft and they like its taste and colour. Since spring water is not included in city water, samples may not be taken to check regularly and test its chemical, physical and microbiological convenience, this will cause health problems because of not utilising healthy and safe water.

CONCLUSIONS

In our study, it was found out that city water preference of participants is very low. The people with low income prefer city water utilisation more and economic reasons matter in city water preference. The people who at least graduated from university prefer city water less. According to participants opinions, city water quality ranks the last in terms of quality. It is necessary to establish water policies and every central and local stakeholder should implement these policies in order to provide accessible, clean and proper water, which is the fundamental right of humanity.

REFERENCES

1. M. POPA, M. GLEVITZKY, D. M. POPA, G. A. DUMITREL: Study Regarding the Water Contamination and the Negative Effects on the Population from the Blaj Area, Romania. J Environ Prot Ecol, **15** (4), 1543 (2014).
2. N. SHAHID, Z. ZIA, M. SHAHID, H. F. BAKHAD, S. ANWAR, G. M. SHAH, M. R. ASHRAF: Assessing Drinking Water Quality in Punjab, Pakistan. Pol J Environ Stud, **24** (6), 2597 (2015).
3. M. KARATAS, S. CEVIK: Water as a Strategic and Natural Resource: An Evaluation of Turkey's Position. Journal of Academic Studies, **45**, 1 (2010) (in Turkish).
4. S. A. ENE, A. Y. HOEKSTRA, M. M. MEKONNEN, C. TEODOSIU: Water Footprint Assessment in North-eastern Region of Romania. A Case Study for the Iasi Country, Romania. J Environ Prot Ecol, **13** (2), 506 (2012).
5. A. TIL, S. TOPALOGLU, M. ZENCIR: Employee Population's Water Preferences and Affecting Factors in Denizli Province. In: Proc. of the National Water and Health Congress, Antalya, 2015 (in Turkish).
6. Y. ONDER, R. CITIL, G. EMEKDAR: Drinking Water Preferences of University Students Who Stay at Dormitory: Packaged Water. In: Proc. of the National Water and Health Congress, Antalya, 2015 (in Turkish).
7. L. HUERTA-SAENZ, M. IRIGOYEN, J. BENAVIDES, M. MENDOZA: Tap or Bottled Water: Drinking Preferences among Urban Minority Children and Adolescents. J Community Health, **37** (1), 54 (2012).
8. L. McLEOD, L. BHARADWAJ, C. WALDNER: Risk Factors Associated with the Choice to Drink Bottled Water and Tap Water in Rural Saskatchewan. Int J Environ Res Public Health, **11** (2), 1626 (2014).

9. D. DUPONT, C. WALDNER, L. BHARADWAJ, R. PLUMMER, B. CARTER, K. CAVE, R. ZAGOZEWSKİ: Drinking Water Management: Health Risk Perceptions and Choices in First Nations and Non-first Nations Communities in Canada. Int J Environ Res Public Health, **11** (6), 5889 (2014).
10. D. DUPONT, W. L. ADAMOWICZ, A. KRUPNICK: Differences in Water Consumption Choices in Canada: The Role of Socio-demographics, Experiences and Perceptions of Health Risks. J Water Health, (4), 671 (2010).
11. Z. BAL: A Study on Consumers' Packed Water Consumption in the Central District of Tokat. Master Thesis, Gaziosmanpasa University, Tokat, 2014, 26–27 (in Turkish).
12. L. A. WARD, O. L. CAIN, R. A. MULLALLY, K. S. HOLLIDAY, A. G. WERNHAM, P. D. BAILLIE, S. M. GREENFIELD: Health Beliefs about Bottled Water: A Qualitative Study. BMC Public Health, **19** (9), 196 (2009).
13. W. L. HOBSON, M. L. KNOCHEL, C. L. BYINGTON, P. C. YOUNG, C. J. HOFF, K. F. BUCHI: Bottled, Filtered, and Tap Water Use in Latino and Non-Latino Children. Arch Pediatr Adolesc Med, **161** (5), 457 (2007).
14. M. H. GORELICK, L. GOULD, M. NIMMER, D. WAGNER, M. HEATH, H. BASHIR, D. C. BROUSSEAU: Perceptions about Water and Increased Use of Bottled Water in Minority Children. Arch Pediatr Adolescmed, **165** (10), 928 (2011).
15. M. GUL, M. G. AKPINAR: An Assessment of Consumer Preferences on the Drinking Water Market: Today to the Future. J Water Supply Res T, **63** (7), 525 (2014).
16. A. SAYLOR, L. S. PROKOPY, S. AMBERG: What's Wrong with the Tap Examining Perceptions of Tap Water and Bottled Water at Purdue University. Environ Manage, **48** (3), 588 (2011).

Received 8 January 2016
Revised 15 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *460–468* (*2016*)

Water pollution

EVALUATION OF THE EFFECTS OF DISINFECTION METHODS ON VOLATILE ORGANIC POLLUTANT LEVELS AND SOME PHYSICOCHEMICAL PARAMETERS OF WATER

M. A. BABAYIGIT*, R. OGUR, O. F. TEKBAS

Department of Public Health, Gulhane Medical Faculty, Division of Environmental Health, Etlik, 06 018 Ankara, Turkey
E-mail: *mababayigit@gata.edu.tr*; *rogur@gata.edu.tr*; *oftekbas@gata.edu.tr*

Abstract. The presence of volatile organic pollutants in city water supply networks may cause effects on health such as anemia, reduced platelet levels, chromosomal fractures and increased cancer risk. The purpose of this study is to demonstrate the effects of various disinfection methods of drinking water on some physicochemical parameters and levels of volatile organic pollutants. Samples of at least 500 ml belonging to 75 different brands of packaged water sold commercially were obtained from supermarkets and commercial distribution companies. For comparison 42 city supply water samples (200 ml) and 38 well water samples (200 ml) were collected and kept at +4°C. Five different disinfection methods (chlorine, chlorine dioxide, ozone, ultraviolet and boiling) were applied to selected 22 water samples. While all of the disinfection methods reduced the levels of chloroform and tetrachloroethane, bromodichloromethane levels were reduced by methods other than chlorine and the levels of 1,2-dichloroethane and dibromochloromethane were reduced statistically significantly only by UV treatment and boiling ($p < 0.001$). In general, it was observed that the reduction of trichloroethane, epichlorohydrin and bromoform was not statistically significant, ozone caused bromoform levels to rise and chlorine caused dibromochloromethane levels to rise. It can be concluded that boiling the water leads to a higher reduction in volatile organic pollutants than chlorine, chlorine dioxide and ozone.

Keywords: packaged water, tap water, well water, disinfection methods, volatile organic pollutants.

AIMS AND BACKGROUND

As information suggesting that drinking water and utility water are polluted by some organic and inorganic pollutants gains public attention from time to time, recently it has been observed that packaged water that is considered to be safer than city supply in all aspects is being used especially for children[1]. Because of the importance of this issue, all kinds of drinking water resources (city network, ground water and packaged water) are subject to quality control analysis[2–5].

It has been reported that more than fifty volatile organic compounds (VOC) were detected in various water sources and that eight of these are classified as

* For correspondence.

cancerogenic. When the effects of volatile organic compounds on public health are being researched each of these chemicals are reviewed individually. Scientific publications in this field have reported that individuals exposed to levels of benzene higher than the international limit [maximum contaminant level (MCL)] over years are at higher risk for anemia, low platelet counts and cancer development[6]. Exposure to benzene, that is defined as a group I carcinogen by the International Cancer Agency through water increases the lifelong cancer risk[7,8]. In the World Health Organisation sources, it is also reported that high doses of exposure affect the central nervous system, and that lower doses of exposure affect the hematopoietic system and cause leukemia, and although these doses are not mutagenic, they may also cause chromosomal fractures[9].

It is proposed that one of the most commonly identified volatile compounds in water, chloroform, forms due to chlorine treatment[10]. However, the fact that chloroform is also one of the most commonly identified volatile compounds in well water untreated with chlorine cannot be explained. Thus, this study is also very important as it examines the effect of chlorine and other disinfection methods on the formation of some VOCs such as chloroform.

When scientific literature was reviewed it was seen that there are publications about the identification of volatile compounds in surface water, spring water, packaged water and especially drinking water using the purge and trap method[11–17].

The purpose of this study is to demonstrate the effect of various disinfection methods (chlorine, chlorine dioxide, ozone, ultraviolet and boiling) on some physicochemical parameters and the levels of some volatile organic pollutants (VOC = vinyl chloride, chloroform, benzene, 1,2-dichloroethane, trichloroethane, tetrachloroethane, bromodichloromethane, dibromochloromethane, epichlorohydrin and bromoform) in different types of drinking water (packaged water, tap water and well water).

EXPERIMENTAL

Samples of at least 500 ml belonging to 75 different brands of packaged water commercially available were obtained from markets and commercial water distribution companies and were kept at +4°C until the analyses were completed. For comparison, a total of 42 (200 ml) tap water samples were obtained from 33 different areas of Ankara and 38 well water samples (200 ml) were obtained from the Ankara Kizilcahamam district and were kept at +4°C until the analyses were completed. Five different disinfection methods (chlorine, chlorine dioxide, ozone, ultraviolet and boiling) were applied to the selected 22 samples (10 city network tap water, 7 well water and 5 packaged water). The analyses of the basic water parameters (pH, conductivity and total dissolved solids (TDS)) were performed using a multi-analyser (Boeco, Hamburg, Germany), the ion levels were analysed

using an ion chromatography device (Dionex, Thermo-Scientific, CA, USA), and the VOC levels were measured using DSQ™ II GC-MS (Thermo-Scientific, CA, USA) and Purge and Trap Concentrator (Teledyne Tekmar, OH, USA) using the EPA 5242 and 8260b methods[10,18,19] (Fig. 1).

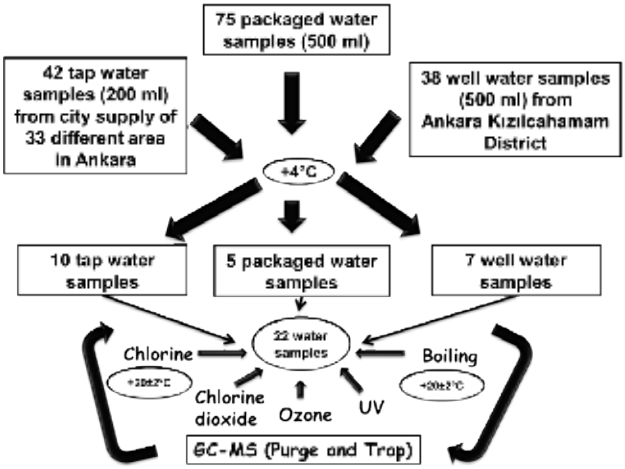


Fig. 1. Stages of obtaining water samples and their analysis

Treatment. The treatments were performed in the Gulhane Military Medical Academy (GATA) Public Health Laboratories after bringing the samples to room temperature (+20 ± 2°C) between the 14th of April and 20th of May 2015.

Active chlorine treatment. Samples of 20 ml were put in Erlenmeyer flasks and were treated with 13.5 µl of 15% active chlorine (1/100) (≈ 0.5–0.7 ppm). After the treatment they were rested for 30 min with closed lids, then 5 ml samples were taken and analysed by using GC-MS (with purge and trap).

Chlorine dioxide treatment. Samples of 20 ml were put in Erlenmeyer flasks and were treated with 4.5 µl of 0.45% chlorine dioxide (≈ 0.25 ppm). After the treatment they were rested for 30 min with a closed lid, then 5 ml samples were taken and analysed by using GC-MS (with purge and trap).

Ozone treatment. Samples of 20 ml were put in Erlenmeyer flasks and the flasks were closed with stoppers. 20 ml of air was suctioned and 20 ml of ozone was added to the flasks containing the ozone (20 ml of water was treated with 920 µg/20 ml ozone at a dose of 46 µg/l) (≈ 1 ppm). After the treatment they were rested for 30 min with closed lids, then 5 ml samples were taken and analysed by using GC-MS (with purge and trap).

Ultraviolet treatment. Samples of 20 ml of water were put into 50 ml beakers and were exposed to UV-C for 3 min at a distance of 20 cm from the UV-C lamp. After

the treatment they were rested for 30 min with closed lids, then 5 ml samples were taken and analysed by using GC-MS (with purge and trap).

Boiling treatment. Samples of 20 ml were put into Erlenmeyer flasks and boiled for 1 min on a laboratory type electrical heater. After the treatment they were rested for 30 min with closed lids, then 5 ml samples were taken and analysed by using GC-MS (purge and trap).

The water samples were subjected to GC/MS (with purge and trap) analysis. The GC/MS conditions were: initial temperature of 40ºC held for 4 min, temperature increase to 90ºC at a rate of 4ºC/min and held for 0.10 min, and final temperature of 220ºC at a rate of 20ºC/min and held at final temperature for 10 min. TG-5MS column (30 M × 250 µM × 0.25 µM) (Thermo Scientific, CA, USA) was used. The identification and quantification of VOCs were conducted by comparing retention times and mass spectra of samples to the values obtained from standard VOC preparations.

Statistical analysis. Continuous variables were expressed as mean ± standard deviation. Group comparisons for non-normal distributed continuous variables were performed using the one-way analysis of variance (ANOVA) test, and the Freidman test was used in dependent groups[20]. To identify the source group of the differences, the Bonferroni and Wilcoxon Tests were used for further analysis of paired group comparisons[20]. The calculations were done using statistics software (Statistical Package for the Social Sciences (SPSS)) for Windows 15.0 (SPSS Inc., Chicago, IL)). The statistical significance value was taken as $p < 0.05$ with a confidence interval of 95%.

Ethical board permission. The ethical board approval for the study was obtained from the GATA Ethical Board on the 11th of March of 2015.

RESULTS AND DISCUSSION

The mean pH value before the treatment was 7.53 ± 0.48 and it was identified that the UV (8.07 ± 0.43) and the boiling (8.65 ± 0.31) methods statistically significantly raised the pH levels of the water samples in general ($p < 0.001$). Whereas, the other disinfection methods like chlorine, chlorine dioxide and ozone did not make a significant difference in the pH levels (7.82 ± 0.40, 7.50 ± 0.55 and 7.60 ± 0.48, respectively). It was detected that the median conductivity values of the water samples were 200.6 µS before treatment, and after the treatment the median conductivity was 215.2 µS for chlorine, 217.6 µS for chlorine dioxide and 260.5 µS for boiling ($p < 0.001$). The review of the TDS values showed that statistically significant differences occurred after treatment with methods other than ultraviolet (median = 139.2 mg/l) (chlorine = 151.4 mg/l, chlorine dioxide =

154.2 mg/l, ozone = 144 mg/l, boiling = 182.7 mg/l) when compared to the levels before treatment (median=138.9 mg/l) ($p < 0.05$).

While chlorine, chlorine dioxide and boiling treatment significantly decreased the fluorine levels, ozone led to a significant increase ($p < 0.05$). It was detected that ozone treatment caused a general statistically significant increase in the anion and cation levels examined in this study (Figs 2 and 3).

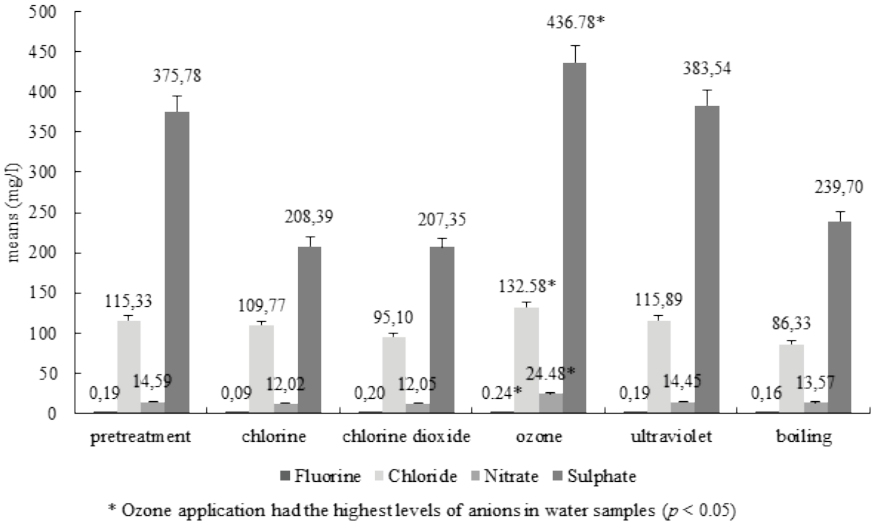


Fig. 2. Comparison of some anion levels for water samples treated by disinfection methods

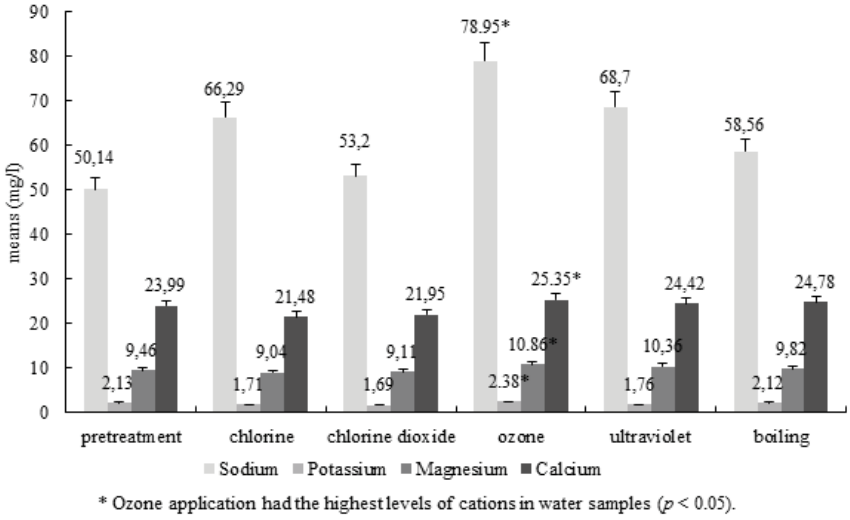


Fig. 3. Comparison of some cation levels for water samples treated by disinfection methods

No vinyl chloride or benzene was detected in any of the water samples. The mean values of the 155 samples were: chloroform = 0.019 ± 0.007 µg/l, 1,2-dichloroethane = 0.013 ± 0.002 µg/l, trichloroethane = 0.025 ± 0.023 µg/l, bromodichloromethane = 4.41 ± 0.65 µg/l, trichloroethane = 0.167 ± 0.108 µg/l, epichlorohydrin = 0.002 ± 0.0006 µg/l, dibromochloromethane = 0.32 ± 0.10 µg/l and bromoform = 0.031 ± 0.031 µg/l. It was identified that the chloroform (18.52 ± 0.82 µg/l), bromodichloromethane (15.80 ± 1.28 µg/l) and dibromochloromethane (1.08 ± 0.36 µg/l) levels were statistically significantly higher in tap water when compared to packaged water and well water ($p < 0.001$). On the other hand, the 1,2-dichloroethane (0.03 ± 0.009 µg/l) and epichlorohydrin (0.005 ± 0.002 µg/l) levels measured in well water were statistically significantly higher than the readings of packaged water ($p < 0.001$ and $p = 0.004$, respectively). The organic pollutant levels detected in all of the samples were lower than the limit values of the water intended for human consumption by law (Table 1).

The chloroform, 1,2-dichloroethane, trichloroethane, bromodichloromethane, tetrachloroethane, epichlorohydrin, dibromochloromethane and bromoform levels were 9.84 ± 2.34, 0.03 ± 0.01, 0.16 ± 0.16, 9.85 ± 2.62, 0.98 ± 0.74, 0.006 ± 0.002, 0.93 ± 0.49, 0.22 ± 0.22 µg/l, respectively before treatment. All of the disinfection methods applied have decreased the chloroform and tetrachloroethane levels significantly ($p < 0.001$). Bromodichloromethane levels were reduced by methods except chlorine treatment, and 1,2-dichloroethane and dibromochloromethane levels were reduced only by the UV and boiling methods ($p < 0.001$). It was observed that the reduction of the trichloroethane, epichlorohydrin and bromoform levels was not statistically significant, and that ozone increased bromoform levels and chlorine increased dibromochloromethane levels (Table 2).

Table 1. VOC levels before treatment in all of the water samples (packaged water, well water and tap water)

Type of VOC	Total (n = 155) mean±SD (µg/l)	Packaged water (n = 75) mean±SD (µg/l)	Tap water (n = 42) mean±SD (µg/l)	Well water (n = 38) mean±SD (µg/l)	p
Vinyl chloride	0.00	0.00	0.00	0.00	NA
Chloroform	0.019±0.007	0.030±0.03	18.52±0.82*	0.030±0.02	<0.001
Benzene	0.00	0.00	0.00	0.00	NA
1,2-Dichloroethane	0.013±0.002	0.004±0.002*	0.015±0.004	0.030±0.009*	<0.001
Trichloroethane	0.025±0.023	0.040±0.04	0.00	0.008±0.008	>0.050
Bromodichloromethane	4.410±0.65	0.070±0.02	15.80±1.28*	0.360±0.14	<0.001
Tetrachloroethane	0.167±0.108	0.320±0.22	0.028±0.003	0.001±0.0006	>0.050
Epichlorohydrin	0.002±0.0006	0.001±0.0004*	0.002±0.0008	0.005±0.002*	0.004
Dibromochloromethane	0.320±0.10	0.028±0.008	1.080±0.36*	0.080±0.02	<0.001
Bromoform	0.031±0.031	0.060±0.06	0.00	0.00	>0.050

* One way ANOVA test (Bonferroni Corrected).

Table 2. VOC levels of the water samples disinfected before and after the treatment (packaged water, well water and tap water)

Type of VOC	Pre-treatment (n = 22) mean±SD (µg/l)	Post-treatment (n = 22) (µg/l)				
		chlorine mean±SD	chlorine dioxide mean±SD	ozone mean±SD	ultraviolet (UV) mean±SD	boiling mean±SD
Vinyl chloride	0.00	0.00	0.00	0.00	0.00	0.00
Chloroform	9.840±2.34	7.21±3.16*	5.64±1.48*	3.7100±0.95*	3.350±0.84*	0.0700±0.05*
Benzene	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethane	0.030±0.01	0.03±0.009	0.04±0.01	0.0100±0.009	0.00*	0.00*
Trichloroethene	0.160±0.16	0.16±0.10	0.12±0.07	0.0800±0.04	0.120±0.07	0.1000±0.05
Bromodichloromethane	9.850±2.62	9.71±2.27	6.89±1.78*	5.1300±1.48*	4.330±1.05*	0.3000±0.09*
Tetrachloroethene	0.980±0.74	0.57±0.42*	0.39±0.28*	0.0090±0.003*	0.090±0.06*	0.00*
Epichlorohydrin	0.006±0.002	0.004±0.002	0.006±0.005	0.0005±0.0005	0.001±0.0008	0.0015±0.0008
Dibromochloromethane	0.930±0.49	2.42±0.68	0.86±0.40	1.3200±0.39	0.510±0.21*	0.0600±0.25*
Bromoform	0.220±0.22	0.20±0.20	0.14±0.14	41.030±13.31	0.120±0.12	0.00

* Friedman test (Wilcoxon Signed Ranks test for post-hoc analysis).

CONCLUSIONS

According to the results of the study, it may be concluded that boiling water and UV treatment result in a further reduction of volatile organic pollutants than the other disinfection methods such as chlorine, chlorine dioxide and ozone treatment. Thus, the quality of water that will be disinfected is extremely important in choosing the disinfection method. To prevent the formation of organic/inorganic disinfection byproducts and their negative impact on water quality, water should be appropriately treated before disinfection. Even if the levels of trihalomethane formation are under the standard limits, these pollutants must be monitored and precautions must be taken to prevent public from long-term exposure.

Acknowledgements. This project was supported by the Gulhane Military Medical Academy Research and Development Centre (Project number: AR-2014/27). We would like to thank Mehmet Cinar, Nedime Oflaz, Sercan Kurklu and Aykut Kilic, the laboratory assistants and technicians that participated in the laboratory analyses.

REFERENCES

1. S. V. LEIVADARAA, A. D. NIKOLAOUB, T. D. LEKKAS: Determination of Organic Compounds in Bottled Waters. Food Chem, **108**, 277 (2008).
2. M. A. RASHEED, P. L. S. RAO, B. A. RADHA, M. LAKSHMI, A. M. DAYAL: Assessment of Ground Water Quality Using ICP-MS in the Eastern Region of Adilabad District, Andhra Pradesh, India. J Environ Prot Ecol, **12** (2), 425 (2011).
3. O. ARKOC: Assessment of Water Quality of East Part of the Ergene Basin, Turkey. J Environ Prot Ecol, **12** (4), 1644 (2011).
4. S. PARISA, H. MIRESANA, D. MARGARITTIA, G. STANCIUB, C.-L. ERIMIAA, D. DOICESCUA: Management of Water Quality Monitoring in the Constanta County. J Environ Prot Ecol, **15** (1), 61 (2014).
5. L. MOLLA, D. BOCARI, G. BOCARI, E. ABAZAJ, B. AGOLLI: Estimation of the Safety Parameters of Imbottled Drinking Water in Albania. J Environ Prot Ecol, **12** (1), 40 (2011).
6. EPA: National Primary Drinking Water Regulations: Benzene. EPA 811-F-95-004b-T. October 1995.
7. International Agency for Research on Cancer: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Suppl. 7. Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs ,Vol 1–42, Lyon, 1987, 120–122.
8. Benzene in Drinking-water. Background Document for Development of WHO Guidelines for Drinking-water Quality, World Health Organization, 2003 (http://www.who.int/water_sanitation_health/dwq/benzene.pdf).
9. Guidelines for Drinking-water Quality: 4th ed. World Health Organization, 2011 (http://whqlibdoc.who.int/publications/2011/9789241548151_eng.pdf).
10. S. K. GOLFINOPOULOS, T. D. LEKKAS, A. D. NIKOLAOU: Comparison of Methods for Determination of Volatile Organic Compounds in Drinking Water. Chemosphere, **45** (3), 275 (2001).
11. R. A. KETOLA, V. T. VIRKKI, M. OJALA, V. KOMPPA, T. KOTIAHO: Comparison of Different Methods for the Determination of Volatile Organic Compounds in Water Samples. Talanta, **44**, 373 (1997).

12. A. IKEM: Measurement of Volatile Organic Compounds in Bottled and Tap Waters by Purge and Trap GC–MS: Are Drinking Water Types Different? J Food Compos Anal, **23**, 70 (2010).
13. H. W. KUO, T. F. CHIANG, I. I. LOA, J. S. LAI, C. C. CHANB, J. D. WANG: VOC Concentration in Taiwan's Household Drinking Water. Sci Total Environ, **208** (1–2), 41 (1997).
14. H. F. Al-MUDHAF, F. A. ALSHARIFI, A. S. I. ABU-SHADY: A Survey of Organic Contaminants in Household and Bottled Drinking Waters in Kuwait. Sci Total Environ, **407**, 1658 (2009).
15. P. KAVCARA, M. ODABASI, M. KITIS, F. INAL, S. C. SOFUOGLU: Occurrence, Oral Exposure and Risk Assessment of Volatile Organic Compounds in Drinking Water for Izmir. Water Res, **40**, 3219 (2006).
16. I. SILGONER, E. ROSENBERG, M. GRASSERBAUER: Determination of VOCs in Water by Purge-and-Trap Gas Chromatography Coupled to Atomic Emission Detection. J Chromatogr A, **768**, 259 (1997).
17. N. S. CHARY, A. R. FERNANDEZ-ALBA: Determination of Volatile Organic Compounds in Drinking and Environmental Waters. Trends in Analytical Chemistry, **32**, 60 (2012).
18. USEPA: Method 524.2, Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Revision 4.1. Environmental Monitoring Systems Laboratory, Office of Research and Development, Cincinnati, OH, 1995 (http://water.epa.gov/scitech/methods/cwa/bioindicators/upload/2007_11_27_methods_method_524_2.pdf).
19. USEPA: Method 8260b Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS). 1996 (http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/8260b.pdf).
20. C. H. ACIKEL, S. KILIC: Selecting Statistical Methods in Medical Researches. TAF Prev Med Bull, **3**, 162 (2004).

Received 8 January 2016
Revised 14 February 2016

Journal of Environmental Protection and Ecology 17, No 2, 469–476 (2016)

Water pollution

IMPORTANT EMERGING PUBLIC HEALTH PROBLEM IN THERMAL SPRINGS: AMOEBA. A PRELIMINARY STUDY FROM TURKEY

D. CAMUR[a]*, S. DEGERLI[b], S. A. VAIZOGLU[c], C. I. YAVUZ[d], H. ILTER[a], C. GULER[e]

[a]*Environmental Health Department, Public Health Institution of Turkey, Ministry of Health, 06 100 Sihhiye, Ankara, Turkey*
E-mail: *drderyacamur@yahoo.com*
[b]*Department of Parasitology, Faculty of Medicine, Cumhuriyet University, Sivas, Turkey*
[c]*Department of Public Health, Faculty of Medicine, Near East University, Nicosia, Turkish Republic of Northern Cyprus*
[d]*Ankara Directorate of Public Health, Ministry of Health, Ankara, Turkey*
[e]*Department of Public Health, Faculty of Medicine, Hacettepe University, Ankara, Turkey*

Abstract. Thermal springs are important for community health since they are public places and being widespreadly used. Free-living amoeba are common in nature. Naegleria and Acanthamoeba species in particular are found in thermal springs and may cause serious health problems. At the first stage of the study, it is aimed to research the presence of Naegleria and Acanthamoeba species in thermal springs in Turkey while the second stage looks into the frequency of subtypes of these species by genotyping through molecular techniques. The results of the first stage are presented in this article. The second stage is currently in progress. This is the first research where all the thermal springs licensed in Turkey are included. The parasitological examination of 434 samples revealed that 34.1% of the samples were amoeba positive. Upon the completion of this study, the frequency of pathogen species and health risks linked to the amoeba will have been laid bare. Chlorination, FLA determination and typology should be incorporated into monitoring criteria for thermal spring water. To prevent health risks regarding amoeba, it would be beneficial to raise the awareness of users about hygienic practices and thwart health risks induced by amoeba in thermal springs.

Keywords: thermal spring, free-living amoeba, Naegleria sp., Acanthamoeba sp., public health.

AIMS AND BACKGROUND

Thermal springs are widely-used public places where natural healing is offered. The hygiene of thermal springs is of capital importance to prevent communicable diseases. Free-living amoeba (FLA) are very common in the nature and Naegleria and Acanthamoeba, which may cause serious health problems, are frequently

* For correspondence.

isolated from hot springs[1–8]. These amoeba are likely to be present in rivers, pools, geo-thermal waters, soil and tap water. They cannot survive in salty water[2,3,6,8–13]. The frequency of FLA in recreational and environmental water samplings is between 20–92.9% in various countries[14–19]. In a study conducted in Turkey, the frequency of FLA was found to account for 15–40% as evidenced from samples of environmental water, tap water and soil[20–22]. FLA may stream into thermal springs via geothermal water. Therefore, it is of vital importance to protect ground water resources from contaminants[23].

In recent years, Naegleria species have been emphasised more among the infectious agents all over the world since Naegleria fowleri is likely to lead to primary amoebic meningo-encephalitis (PAM). PAM is a rare but a fatal central nervous system disease. Amoeba enters the body from nasal mucosa and causes a disease similar to bacteriological meningitides which mostly results in death[2,6–8,13,14,24–35]. Despite the fact that Naegleria is highly common in environment, it is fortunate that PAM cases are relatively rare. While there is not enough knowledge about the frequency of PAM in Turkey, we know for sure that use of thermal therapies and thermal springs are increasing. Therefore, more importance should be attached to hygienic practices in such settings.

At the first stage, this study aims at identifying the presence of Naegleria and Acanthamoeba species in thermal springs in Turkey while the second stage focuses on the frequency of subtypes (pathogen and non-pathogen) of these species by genotyping through molecular techniques. The results of the first stage are presented in this article. The second stage is currently in progress.

This is the first research where all the licensed thermal springs in Turkey are included and genotyping through molecular techniques is conducted.

EXPERIMENTAL

This descriptive study was conducted by a collaboration protocol held between the Turkish Public Health Association, the Ministry of Health, Cumhuriyet University and Hacettepe University. The ethical permission for this descriptive study was obtained from the Senate Ethical Committee of Cumhuriyet University (2013–11/04). The research was conducted in all of the licensed thermal springs across 38 provinces and 203 facilities. Sampling of thermal water was conducted by well-trained healthcare professionals by making use of a guideline released by researchers.

First-round sampling. The water samples were taken from the common thermal pools and in case there was not a pool in the facility, the sample was taken from the source of water in the building water supply. No sample was taken from any personal or private pool or the bath. The samples from the surface of the pools were taken into 1-l plastic bottles. The status and frequency of water replacement was informed by a pool operator.

Second-round sampling. In case the parasitological examination of the pool water pointed to positive results for amoeba, a second-round sampling was conducted to determine the location of pollution. The samples were taken from the source of water and the water tank. If there was not a water tank, then the sample was taken only from the source of water. If there was only one water tank for various facilities, only one sample was taken. If amoeba were found in the source of water, a second-round sampling was not conducted since the pollution was considered to be in the source of water.

Parasite examination. The preceding parasite examinations for all of the samples were filtered. Filter papers were sowed on Non-Nutrient Agar Medium on which *E. coli* was spread and followed to observe reproduction for 3 weeks. The passages were done from the amoeba breeding plaques to the new mediums covered with paraffin and kept at room temperature. The presence of trophozoite was examined through a light microscope and Flagellum Test was conducted for the trophozoite positive plaques to differ Naegleria species from other amoeba species. The plaques were excluded from the procedure when there was no reproduction at least until the end of three weeks. Following the DNA isolation and PCR application from the reproduced amoeba, the amplified PCR sample will be put into use for genotyping[36–44].

RESULTS AND DISCUSSION

At the first sampling stage, 92.2% of 434 samples were taken from the surface of the pool whereas the ones taken from the source of the thermal water accounted for 7.8%. The parasitologic examination revealed various types of amoeba reproduction in 148 (34.1%) of the samples. One hundred and forty two of them were taken from the pool water while only 6 samples were from the source of thermal water. There was amoeba reproduction in 35.5% of the pool water samples and 17.6% of the water source samples (Table 1).

Table 1. Characteristics of water samples

Characteristics	Number	Percentage
Place of sampling (n = 434)		
Pool surface	400	92.2
Water source	34	7.8
Amoeba reproduction (n = 434)		
Positive	148	34.1
Negative	286	65.9
Place of sampling among amoeba positive samples		
Pool	142	35.5*
Water source	6	17.6**

* n = 400, line percent is given; ** n = 34, line percent is given.

For the second-round sampling, only the amoeba positive sources were included. This aims at evaluating the source of amoeba in thermal water. Fifty-five samples from the source of thermal water and 32 samples from the water tanks were put under analysis for amoeba. 10 (11.5%) of these samples (6 from the water source and 4 from the water tanks) pointed to amoeba reproduction. In the source of tanks, which were positive for amoeba for the first-round sampling, no amoeba reproduction was observed (Table 2).

Table 2. Second-round samples taken from pool water sources and tanks with amoeba positive

Characteristics of second-round samples	Number	Percentage
Number of sample (n = 87)		
From the water source	55	63.2
From the water tank	32	36.8
Amoeba reproduction (n = 87)		
Positive	10	11.5
Negative	77	88.5
Place of sampling among amoeba positive samples		
Water source	6	10.9*
Water tank	4	12.5**

*n = 55, line percent is given; **n = 32, line percent is given.

Although the typology with PCR and pathogenic- non-pathogenic differentiation had not been conducted, the morphological examination, which pointed to Naegleria and Acanthamoeba species of amoeba in 34.1% of the samples, is a significant result. In a research conducted in Taiwan, the frequency of Naegleria species in thermal waters turned out to be 43.3% (Ref. 45). In Italy, the frequency of Naegleria and Acanthamoeba species in thermal waters ranged from 5.2 to 66.7 and 33.6%, respectively. In another research in Italy, the FLA frequency was calculated to be 33% (Refs 46 and 47). In Iran, the frequency of FLA in thermal waters was 26.7% and in Guadeloupe, the frequency of amoeba was 37.5% in thermal baths[7,48]. We have to keep in mind that the typology of species has not been conducted yet. In all the samples positive for amoeba, the typology studies with PCR are still in progress. Upon the completion of the study, it will be possible to establish the presence of pathogenic types, and the health risks induced by amoeba for residents of thermal facilities.

The pool operators stated that the pool water is replaced in 97.0% of the pools. The figure accounts for 47.9% when it comes to daily basis while it is 8.8% for less than once a week (Table 3).

Table 3. Status and frequency of water replacement in thermal pools

Status and frequency of pool water replacement	Number	Percent
Status of pool water replacement (n = 400)		
Being replaced	388	97.0
Not being replaced	6	1.5
No knowledge	6	1.5
Frequency of pool water replacement (n = 388)		
Daily	186	47.9
2–5 times a week	128	33.0
Once a week	40	10.3
Less than once a week and more than once a month	15	3.9
Once a month	5	1.3
Less than once a month	14	3.6

CONCLUSIONS

The hygiene of the thermal springs is controlled and supervised by Ministry of Health in Turkey. In accordance with the Thermal Springs Regulation, disinfection of thermal water is not obligatory in Turkey[49]. Health problems, which may be caused by pathogenic amoeba in thermal springs, can be prevented by complying with hygienic principles, providing standard operational rules and supplying high quality thermal water. Upon the completion of the second phase of the study, and identification of the frequency of pathogenic agents, the chlorination of thermal spring waters will be put on the agenda of the Turkish Ministry of Health. The free chlorine level for the thermal spring waters is recommended as 1–3 ppm by the WHO, CDC and various countries[8,12,34,35]. Amoeba determination and typology can also be added to the monitoring criteria of thermal spring waters. The source of amoeba is likely to be thermal water or amoeba may be carried by residents of thermal facilities. Since the amoeba reproduction was mostly observed in the pool water samples, and although there was amoeba reproduction in the pool water but not in the source or the tank of the thermal spring water, it is safe to consider that the pools were contaminated by the users, and not cleaned properly. Therefore, a guideline drawn up by researchers on operation and maintenance of thermal spring waters will be disseminated among thermal springs to prevent amoeba infections and the current regulations will be updated. In addition, awareness should be raised on hygienic principles among residents of thermal spring facilities. Such residents should be informed of not diving into such water and putting their head above the water surface in thermal springs[2,8,12,38]. All of the thermal springs should feature posters, brochures and warning sideboards to inform residents. In addition, the physicians practising in endemics for *N. fowleri* and thermal springs should be knowledgeable with signs and symptoms of PAM.

A common health problem causes severe disability and suffering while mortality is a major public health problem. Although PAM is not a common disease since it is mortal, it is a major problem for the public health. Therefore, it would be beneficial to protect community health, and introduce regulations in consideration of the importance of thermal springs in terms of medical tourism and the sustainability of tourism in general.

REFERENCES

1. Guidance on Water Quality for Heated Spas. National Environmental Health Forum Monographs Water Series, No 2, 2015. http://www.health.vic.gov.au/archive/archive2014/nphp/enhealth/council/pubs/pdf/heatspas.pdf (2015).
2. Facts about *Naegleria fowleri* and Primary Amebic Meningoencephalitis; http://www.cdc.gov/parasites/naegleria/naegleria_factsheet508c.pdf (2015).
3. N. A. KHAN: Acanthamoeba: Biology and Increasing Importance in Human Health. FEMS Microbial Rev, **30**, 364 (2006).
4. N. BRINDLY, A. MATIN, N. A. KHAN: Acanthamoeba Castellanii: High Antibody Prevalence in Racially and Ethnically Diverse Populations. Exp Parasitol, **121**, 254 (2009).
5. J. MARTINEZ: Acanthamoebiasis and Immunosuppression. J Neuropathol Exp Neurol, **41**, 548 (1982).
6. R. SIDDIQUI, N. A. KHAN: Primary Amoebic Meningoencephalitis Caused by Naegleria fowleri: An Old Enemy Presenting New Challenges. PLOS Neglected Tropical Diseases, **8**, e3017 (2014).
7. M. MOUSSA, J. F. DE JONCKHEERE, J. GUERLOTTE, V. RICHARD, A. BASTARAUD, M. ROMANA, A. TALARMIN: Survey of *Naegleria fowleri* in Geothermal Recreational Waters of Guadeloupe (French West Indies). PLOS ONE, **8** (11), e54414 (2013).
8. CDC: *Naegleria fowleri*-Primary Amebic Meningoencephalitis (PAM)-Amebic Encephalitis. Source: http://www.cdc.gov/parasites/naegleria (2015).
9. N. A. KHAN, E. L. JARRROLL, J. PANJWANİ, Z. CAO, T. A. PAGET: Proteases as a Marker for Differentiation of Pathogenic and Non Pathogenic Species of Acanthomoeba. J Clin Microbiol, **38**, 2858 (2000).
10. C. KISS, Z. BARNA, M. VARGHA, J. K. TOROK: Incidence and Molecular Diversity of Acanthamoeba Species Isolated from Public Baths in Hungary. Parasitol Res, **113**, 2551 (2014).
11. G. S. VISVESVARA, H. MOURA, F. L. SCHUSTER: Pathogenic and Opportunistic Free-living Amoebae: Acanthamoeba spp., *Balamuthia mandrillaris*, *N. fowleri*, and *Sappinia diploidea*. FEMS Immunol Med Microbial, **50**, 1 (2007).
12. Queensland Government: *Naegleria fowleri*: Qs and As. http://conditions.health.qld.gov.au/HealthCondition/media/pdf/14/165/101/naegleria-fowleri-qs-and-as-v4 (2015).
13. T. W. HEGGIE: Swimming with Death: *Naegleria fowleri* Infections in Recreational Waters. Travel Medicine and Infectious Disease, **8**, 201 (2010).
14. M. C. TUNG, B. M. HSU, C. W. TAO, W. C. LIN, H. F. TSAI, D. D. J, S. M. SHEN, J. S. CHEN, F. C. SHIH, Y. L. HUANG: Identification and Significance of *Naegleria fowleri* Isolated from the Hot Spring Which Related to the First Primary Amebic Meningoencephalitis (PAM) Patient in Taiwan. Int J Parasitol, **43** (9), 691 (2013).
15. Z. Al-HERRAWY, S. H. MOHAMED, M. ALI, A. H. MOHAMMED, M. A. GAD: Distribution of Naegleria in Water Resources in Egypt. Egyptian Journal of Environmental Research, **2**, 1 (2014).
16. W. WANG, F. WEI, J. LI, N. LI, Q. LIU: Isolation and Identification of Naegleria Species from Environmental Water in Changchun, Northeastern China. Iranian J Parasitol, **9** (2), 254 (2014).

17. A. PANDA, S. KHALIL, B. R. MIRDHA, Y. SINGH, S. KAUSHIK: Prevalence of *Naegleria fowleri* in Environmental Samples from Northern Part of India. PLoS ONE, **10** (10), e0137736 (2015).
18. N. TSVETKOVA, M. SCHILD, S. PANAIOTOV, R. KURDOVA-MINTCHEVA, B. GOTTSTEIN, J. WALOCHNIK, H. ASPOCK, M. S. LUCAS, N. MULLER: The Identification of Free-living Environmental Isolates of Amoebae from Bulgaria. Prasitol Res, **92**, 405 (2004).
19. A. LASS, I. SVOSTAKOWSKA, L. CHOMICZ: The First Genotype Determination of Acanthamoeba Potential Threat to Human Health, Isolated from Natural Water Reservoirs in Poland. Parasitol Res, **113**, 2693 (2014).
20. S. DOGAN, S. YAZAR, S. KUK: Solation and Molecular Characterization of Some Free-living Amoeba in Soil Which Can Be Parasitising in Human. Journal of Health Sciences, **23**, 187 (2013) (in Turkish).
21. S. OZCELIK, K. ACIKALIN COSKUN, O. YUNLU, A. ALIM, E. MALATYALI: The Prevalence, Isolation and Morphotying of Potentially Pathogenic Free-living Amoebae from Tap Water and Environmental Water Sources in Sivas. Turkish Journal of Parasitology, **36**, 198 (2012) (in Turkish).
22. K. ACIKALIN COSKUN, S. OZCELIK, L. TUTAR, N. ELALDI, Y. TUTAR: Isolation and Identification of Free-living Amoebae from Tap Water in Sivas, Turkey. Hindawi Publishing Corporation BioMed Research International, 2013, Article ID 675145, 8 p., http://dx.doi.org/10.1155/2013/675145.
23. G. BATRINESCU, E. BIRSAN, G. VASILE, B. STANESCU, E. STANESCU, I. PAUN, M. PETRESCU, C. FILOTE: Identification of the Aquatic Ecosystems Integrating Variables in the Suceava Hydrographic Basin and Their Correlations. J Environ Prot Ecol, **12** (4), 1627 (2011).
24. F. MARCIANO-CABRAL, R. MACLEAN, A. MENSAH, L. LAPAT-POLASKO: Identification of *Naegleria fowleri* in Domestic Water Sources by Nested PCR. Appl Environ Microbiol, **56** (10), 5864 (2003).
25. R. EKE, L. N. CHIGBU, E. ENWEREJI: Unfamiliarity of Primary Amoebic Meningoencephalitis in Developing Countries. Eur J Gen Med, **3** (4), 190 (2006).
26. Texas Department of Health: Primary *Amebic meningoencephalitis* in Texas, 1983–1996. Disease Prevention News, **57** (15), (1997).
27. P. E. COGO, M. SCAGLIA, S. GATTI, F. ROSSETTI, R. ALAGGIO, A. M. LAVERDA, L. ZHOU, L. XIAO, G. S. VISVESVARA: Fatal *Naegleria fowleri* Meningoencephalitis, Italy. Emerging Infectious Diseases, **10** (10), 1835 (2004), www.cdc.gov/eid.
28. C. LOPEZ, P. BUDGE, J. CHEN, S. BILYEU, A. MIRZA, H. CUSTODIO, J. IRAZUZTA, G. VISVESVARA, K.J. SULLIVAN: Primary Amebic Meningoencephalitis, a Case Report and Literature Review. Pediatric Emergency Care, **28**, 3 (2012).
29. T. A. BARTRAND, J. J. CAUSEY, J. L. CLANCY: *Naegleria fowleri*: an Emerging Drinking Water Pathogen. American Water Works Association, Journal AWWA, http://dx.doi.org/10.5942/jawwa.2014.106.0140 (2014).
30. W. HANNISCH, L. F. HALLAGAN: Primary Amebic Meningoencephalitis: A Review of the Clinical Literature. Wilderness Environ Med, **8** (4), 211 (1997).
31. J. R. COPE, R. C. RATARD, V. R. HILL, T. SOKOL, J. J. CAUSEY, J. S. YODER, G. MIRANI, B. MULL, K. A. MUKERJEE, J. NARAYANAN, M. DOUCET, Y. QVARNSTROM, C. N. POOLE, O. A. AKINGBOLA, J. M. RITTER, Z. XIONG, A. J. da SILVA, D. ROELLIG, R. B. van DYKE, H. STERN, L. XIAO, M. J. BEACH: The First Association of a Primary Amebic Meningoencephalitis Death with Culturable *Naegleria fowleri* in Tap Water from a US Treated Public Drinking Water System. Clin Infect Dis, 15, 60 (8), e36 (2015).
32. G. SAYGI, Z. POLAT: Free-living Amebae and the Parasitosies They Cause Primary Amebic Meningoencephalitis–Granulomatous Encephalitis–Keratitis. Cumhuriyet Medical Journal, **25** (3), 140 (2003) (in Turkish).

33. I. GRATE: Primary Amebic Meningoencephalitis: A Silent Killer. Can J Emerg Med, **8** (5), 365 (2006)**.**
34. Guideline for the Inspection and Maintenance of Swimming Pools and Spa Pools in South Australia. Health Protection Programs, Ed. Revised 2013, (e-book).
35. Queensland Government: Primary Amoebic Meningoencephalitis (PAM). http://conditions.health.qld.gov.au/HealthCondition/media/pdf/14/165/115/primary-amoebic-meningoencephalitis-pam-v4 (2015).
36. L. CHOMICHZ, M. PADZIK, Z. GRACZYK, B. STARROSCIAK, T. GRACZYK, A. NAPRAWSKA, G. OLEDZKA, B. SZOSTAKOWSKA: Acanthamoeba Castelani: *in vitro* Effects of Selected Biological, Physical and Chemical Factors. Exp Parasitol, **126**, 103 (2010).
37. I. DYOKOVA, J. LOM, J. M. SCHROEDER-DIEDRICH, G. C. BOOTON, T. J. BYERS: Acanthamoeba Strains Isolated from Organs of Freshwater Fishes. J Parasitol, **85**, 1106 (1999).
38. S. Y. LIANG, D. R. JI, K. T. HSIA, C. C. HUNG, W. H. SHENG, B. M. HSU, J. S. CHEN, M. H. WU, C. H. LAI, D. D. JI: Isolation and Identification of Acanthamoeba Species Related to Amoebic Encephalitis and Non-oathogenic Free-living Amoeba Species from the Rice Field. J Appl Microbiol, **109**, 1422 (2010).
39. D. S. ALVES, A. S. MORAES, N. NITZ, M. G. de OLIVERIA, M. M. HECHT, R. GURGEL-GONCALVES, C. A. CUBA: Occurrence and Characterization of Acanthamoeba Similar to Genotypes T4, T5 and T2/T5 Isolated from Environmental Sources in Brasilia Federal District, Brazil. Exp Parasitol, **131**, 239 (2012).
40. M. RAHDAR, M. NIYYATI, M. SALEHI, M. FEGHHI, M. MAKVANDI, M. POURMEHDI, S. FARNIA: Isolation and Genotyping of Acanthamoeba Strains from Environmental Sources in Ahvaz City, Khuszestan Province, Southern Iran. Iranian J Parasitol, **7** (4), 22 (2012).
41. L. DUARTE, C. FURST, D. R. KLISIOWİCZ, G. KLASSEN, A. O. COSTA: Morphological, Genotypic and Physiological Characterization of Acanthamoeba Isolated from Keratitis Patients and the Domestic Environment in Vitoria, Espirito Santo, Brazil. Exp Parasitol, **135**, 9 (2013).
42. H. HOOSHYAR, B. HOSSEINBIGI, M. SARAEI, S. ALIZADEH, M. EFTAKHAR, S. RASTI, N. KHOSRO-SHAHI: Genotyping of Acanthamoeba Isolated from Surface and Stagnant Waters of Qazvin, Central Iran. Iranian Red Crescent Medical Journal, **15** (6), 536 (2013).
43. A. RISLER, B. COUPAT-GOUTALAND, M. PELANDAKİS: Genotyping and Phylogenetic Analysis of Acanthamoeba Isolates Associated with Keratitis. Parasitol Res, **112**, 3807 (2013).
44. F. de JONCKHEERE: Occurrence of *Naeglaria* and *Acanthamoeba* in Aquaria. Appl Environ Microbial, **38**, 590 (1979).
45. P. M. KAO, M. C. TUNG, B. M. HSU, C. J. HSUEH, Y. C. CHIU, N. H. CHEN, S. M. SHEN, Y. L. HUANG: Occurrence and Distribution of Naegleria Species from Thermal Spring Environments in Taiwan. Lett Appl Microbiol, **56** (1), 1 (2013).
46. M. SCAGLIA, S. GATTI, R. BRUSTIA, M. STROSSELLI, A. M. BERNUZZI, C. CEVINI: Pathogenic and Non-pathogenic Naegleria and Acanthamoeba spp.: A New Autochthonous Isolate from an Italian Thermal Area. Microbiologica, **10** (2), 171 (1987).
47. M. DI FILIPPO, M. SANTORO, P. LOVREGLIO, R. MONNO, C. CAPOLONGO, C. CALIA, L. FUMAROLA, R. D'ALFONSO, F. BERRILLI, D. di CAVE: Isolation and Molecular Characterization of Free-living Amoebae from Different Water Sources in Italy. International Journal of Environmental Research and Public Health, **12**, 3417 (2015).
48. R. SOLGI, M. NIYYATI, A. HAGHIGHI, E. N. MOJARAD: Occurrence of Thermotolerant Hartmannella Vermiformis and Naegleria spp. in Hot Springs of Ardebil Province, Northwest Iran. Iranian J Parasitol, **7** (2), 47 (2012).
49. Thermal Spring Regulation. Official Gazette, Date: 24.07.2001, No 24472 (in Turkish).

Received 8 January 2016
Revised 15 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 477–487 (2016)

Water pollution

EFFECTS OF POLLUTION ON SOME TISSUES OF FISH COLLECTED FROM DIFFERENT REGIONS OF BUYUK MENDERES RIVER: A HISTOPATHOLOGICAL STUDY

Y. ADALI, Y. BASIMOGLU KOCA*

Department of Biology, Arts and Science Faculty, Adnan Menderes University, Aydin, Turkey
E-mail: *ykoca@adu.edu.tr*

Abstract. In this study, it is aimed to investigate the effects of pollution in the Buyuk Menderes River on fish in terms of histopathological changes. For histopathological examinations, the tissues samples of gills, liver, muscle and intestine of *C. gibelio* were studied by using light microscopy. Additionally, surface water samples were also collected from the localities mentioned in the study and thereafter water analysis was conducted. Aluminium and nitrite nitrogen were determined as most accumulated chemicals in water. As a result of examinations and evaluations, it was determined that irreversible histopathological changes were formed in *C. gibelio* gill, muscle, intestine and liver tissues. The results of water analysis have also supported the findings. When water pollution, which occurs due to many reasons and its effects on environment, public health and economy is considered, the results of the study are of great importance for contributing to the identification of measures to be taken.

Keywords: Buyuk Menderes River, *Carassius gibelio*, histopathology, water pollution.

AIMS AND BACKGROUND

Water pollution can be defined as quality changes, resulting from anthropogenic influences, limiting or preventing utilisation of water, disrupting the ecological balance[1,2]. Buyuk Menderes River, located at Aegean Region has a length of 570 km (Ref. 3). Its major tributaries are: Banaz Stream, Curuksu Stream, Dandalaz Stream, Cine Stream and Akcay Stream. Buyuk Menderes River and its tributary rivers constitute basic water power of the Buyuk Menderes basin[4]. Buyuk Menderes River is visibly polluted and its pollution increases year by year because of many reasons such as excessive pop-industrial enterprises in the region, domestic wastes released from towns and villages growing without infrastructure, industrial wastes formed in industrial organisations and wrong fertiliser and pesticide use in agriculture[5,6]. Particularly, aquatic organisms are negatively affected by pollution in water. Fish, since they are in contact with the environment in which they live, is often preferred for pollution detection. In this study, it is aimed to determine the physicochemical parameters causing pollution of Buyuk Menderes River and the effects of pollution on *Carassius gibelio* tissues histologically.

* For correspondence.

EXPERIMENTAL

Study area and sampling. Fish (*C. gibelio*) used in this study were caught at two different stations (Kocarli and Umurlu Region) and in quantity by 10 samples for each station (Fig. 1). These samples were then transported in tanks also contained river water belonging to both localities and delivered to Laboratory of Histology-Embryology, Department of Biology, Adnan Menderes University on the same day. The study was performed after obtaining permission from Animal Experiments Ethical Committee, Adnan Menderes University (HADYEK Decision No 2014/017) and special care has been taken to comply with policies and procedures on catching, transporting and euthanising fishes were established by Animal Experiments Ethical Committee. Fishes used as a control group (n = 10, for each locality) were placed in aquariums, filled with clean water which was subsequently thoroughly aired, and kept in them for approximately 30 days. Fishes were fed with standard fish food during this period. In this study, fishes 15–25 cm in diameter were used.

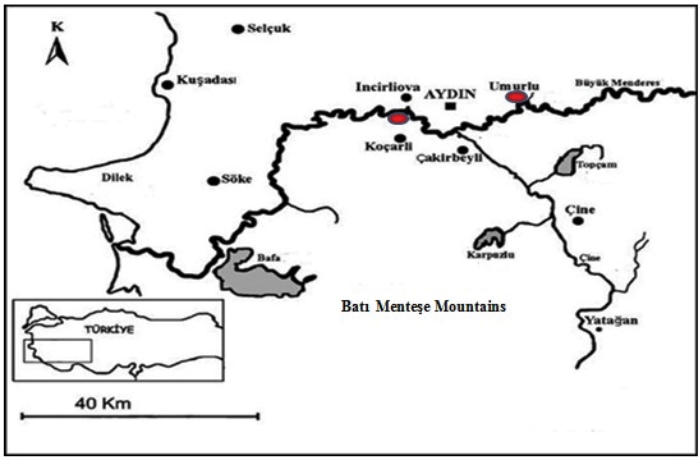


Fig. 1. Map of Buyuk Menderes River (the station is marked by oval circle

Analytical procedures. Tanks filled with water samples, obtained from stations in the vicinity of Kocarli Bridge and Umurlu region located along Buyuk Menderes River in accordance with the established procedures, were kept in refrigerator and transported to Izmir/Turkey People Health Laboratory in cold chain. The results of water analyses performed by this laboratory were statically evaluated. The results of water analyses were compared with Water Pollution Control Regulation, Potable Water Standards[7]. The mean values of analysed pysicochemical parameters are given in Table 1.

Table 1. Physical and chemical parameters of Umurlu and Kocarli region

Parameters	Umurlu	Kocarli	Units of analysis	1st class water quality standards (TSI)
Aluminium (Al)	0.57*	0.241*	mg/l	0.2 mg/l
Copper (Cu)	<0.003	<0.003	mg/l	20 µg/l
Boron(B)	0.36	0.3	mg/l	1000 µg/l
Zinc (Zn)	<0.005	<0.005	mg/l	200 µg/l
Iron (Fe)	110	68	µg/l	300 µg/l
Phosphate (PO_4)	0.97	0.73	mg/l	–
Conductivity (20°C)	1220	1176	µS/cm	–
Cadmium (Cd)	<2	<2	µg/l	3 µg/l
Calcium (Ca)	98	81	mg/l	75 mg/l
Cobalt (Co)	<2	<2	µg/l	10 µg/l
Chromium (Cr)	<2	<2	µg/l	20 µg/l
Lead (Pb)	<2	<2	µg/l	0.05 mg/l
Manganese (Mn)	11	6	µg/l	100 µg/l
Molybdenum (Mo)	4	3	µg/l	–
Nickel (Ni)	4	4	µg/l	–
pH	8.9	8.7	–	6.5–8.5
Potassium (K)	9	8	mg/l	–
Sodium (Na)	96	87	mg/l	125 mg/l
Ammonia nitrogen (NH_3–N)	0.24	0.94	mg/l	–
Dissolved oxygen	49.1	53.7	%	8 mg/l
Amonium nitrogen (NH_4–N)	0.26	0.97	mg/l	0.2 mg/l
Nitrite nitrogen (NO_2–N)	0.07*	0.05*	mg/l	0.50 mg/l
Diazinon	●	●	µg/l	–
Ethion	●	●	µg/l	–
Malathion	●	●	µg/l	–
Endrin	●	●	µg/l	–
Lindan	●	●	µg/l	–
Aldrin	●	●	µg/l	–
Dieldrin	●	●	µg/l	–

● – Could not be determined; TSI – Turkish Standardisation Institute.

Histological procedures. For light microscope analyses, the gill, liver, muscle and intestine tissues from *C. gibelio* were fixed in Saint-Marie fixative (at +4°C and for 24 h), dehydrated in graded ethanol series, cleared in xylene, and embedded in paraffin. Sections (5–7 µm) cut by means of a rotary microtome (Leica RM2145), stained with Mayer's Haematoxylin-Eosin (H-E), Gomori trichrom and Periodic Acid Shiff-Haematoxylin (PAS-H) stain[8]. The sections were examined and photographed using an Olympus BX 51 microscope.

RESULTS AND DISCUSSION

After measuring the physicochemical and chemical parameters of the Büyük Menderes River, the mean values were found to be 0.57 mg/l (Kocarli) and 0.241 mg/l (Umurlu) for aluminium, 0.07 mg/l (Kocarli) and 0.05 mg/l (Umurlu) for nitrite nitrogen (NO_2–N). The mean values of other analysed pysicochemical parameters are given in Table 1.

The control gill lamellae are regular in normal shape (Figs 2A,B,C). Deformation in lamella shapes observed in gill tissues of fishes collected from both localities is a common symptom. Having obviously observed rupture points in some primary lamellae, it was notable that secondary lamellae were shortened and even these sections do not contain secondary lamella following a rupture. It was observed that clavate lamellae, dissociation of the epithelia dependent on oedema formation and ballooning dilatation of the veins were formed in the secondary lamellae. A distinctive hyperplasia starting from primary lamellae and progressing towards tips of secondary lamellae was determined. As a result of hyperplasia, it was determined that partial and advance level of fusion was formed in secondary lamellae. It was observed that mucus cells increase at especially primary lamellae tips ruptured and fused secondary lamellae region (Figs 2D–I).

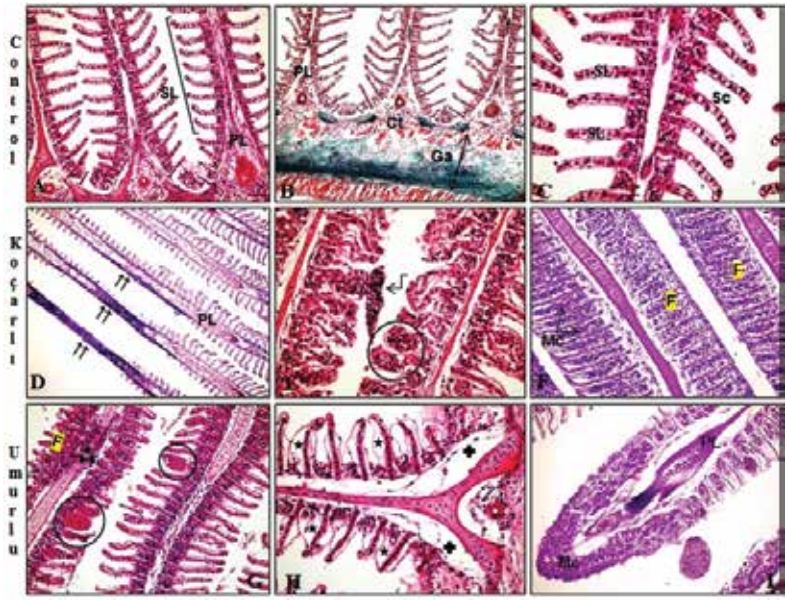


Fig. 2. Observed changes in gill of *C. gibelio*
↑↑ – rupture in primary lamellae and loss at secondary lamellae; Mc – increase in mucus cell; F – fusion of secondary lamellae; ⁂ – degeneration of primary lamellae cartilage; + – oedema in primary lamellae; ★ – separation of secondary lamellae epithelium, ballooning dilatation (circle), rupture of capillaries and erythrocyte releases ( ) in secondary lamellae; PL – primer lamel; SL – sekonder lamel; Ct – connective tissue; Ga – gill arch; Sc – support cell; E – epithelium. Staining: A,C,E,G,H,I. H and E; B – Gomori trichrome, D,F,I. – PAS. Magnification: A,B,F,G – 20×, D – 10×, C,E,H,I – 40×

Muscular tissue of control group is composed of longitudinal muscular fibres and muscle cell (myocyte) held together with connective tissue (Figs 3A, B, C). But some histopathological changes in muscular tissue of *C. gibelio*, caught at both localities, were determined as a result of examinations made. Intermyofibrilar oedema and reduction in muscular fibres atrophy is a characteristic symptom for both localities. Necrotic myocytes, related to intermyofibrilar oedema, and vacuolisation are among the important symptoms. Dissociation at connective tissue among muscular myotomes and necrotic muscle fibrils indicating strain differences are noteworthy symptoms. Myocytes, which can partially store glycogen or can not store any glycogen, in fish muscle tissues were also determined (Figs 3D–I).

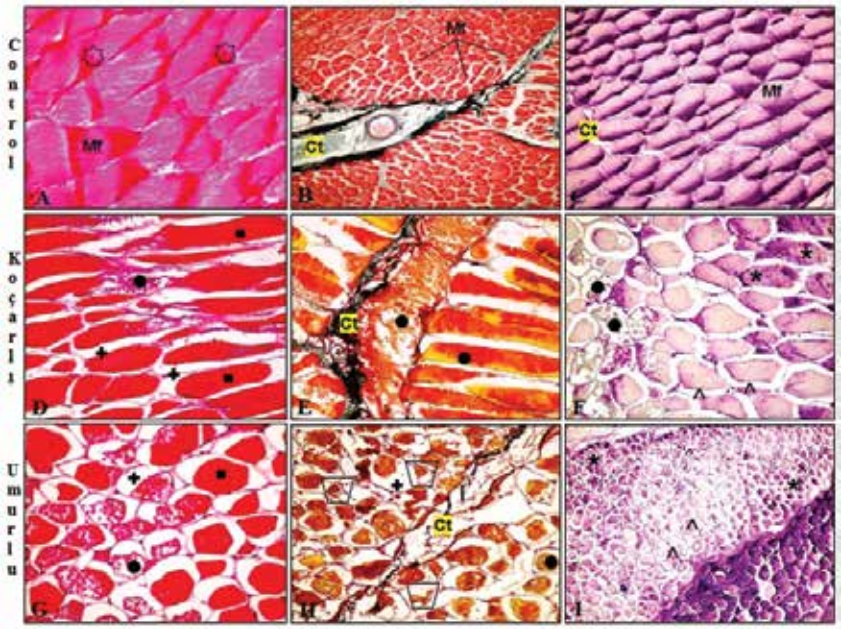


Fig. 3. Light micrographs of muscle of *C. gibelio*
⁂ – myocyte nucleus, ● – necrosis in myofibrils, + – intermyofibrillar oedema, ■ – eosinophilic muscle fibrils, * – myocytes stored partially glycogen, ^ – myocytes not stored glycogen, ★ – myofibrillar atrophy; Mf – myofibril, Ct – connective tissue; Staining: A, D, G, H and E; B, E, H – Gomori trichrome; C, F, I – PAS; Magnification: A, C, D, E, F, G – 40×; B, H – 20×; I – 10×

Control group liver tissue consists of two sections: parenchyma and stroma (Figs 4A, B, C). Some histopathological changes in liver tissue, caught at both localities, were determined as a result of examinations made. Necrosis and oedema is a characteristic symptom for both localities. Oedema-related expansion in the perivascular area and vacuolar degeneration is also observed. Increase in the number of eosinophilic leukocytes, congestion and hemorrhage is determined in some sections. Glycogen accumulation and distortion of veins, in some sections,

are observed. Stain differences and hepatocellular degeneration are among the notable symptoms. In some hepatocytes, pyknotic nucleus is observed and it was determined these hepatocytes could not store glycogen (Figs 4D–I).

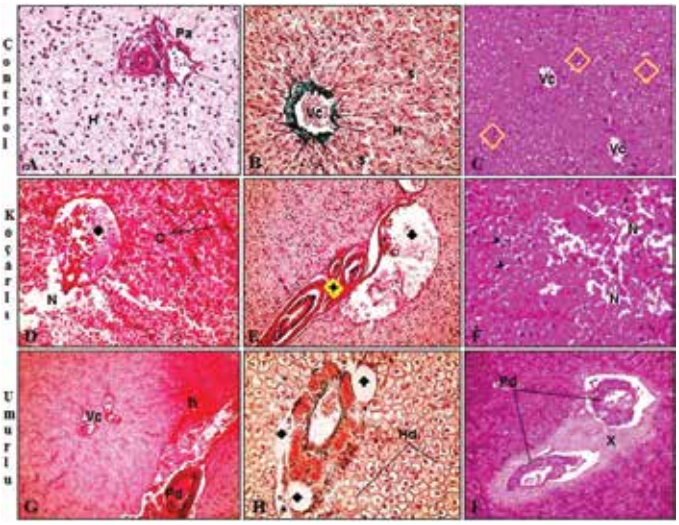


Fig. 4. Micrographs of liver of *C. gibelio*. ► – vacuolar degeneration and pyknotic nuclei in hepatocytes; ◇ – hepatocytes stored glycogen; ✦ – disruption in vessel; ◆ – oedema in hepatopancreatic and perivascular region; x – altered stainning in hepatocytes; H – hepatocyte; S – sinusoid; Pa – portal area; Vc – vena centralis; N – necrosis in hepatic parenchyma; C – congestion; Pd – hepatopancreatic ductus; h – hemorrhage; Staining: A, D, E, G, H and E, B, H – Gomori trichrome; C, F, I – PAS; Magnification: A, B, F, H – 40×, C, D, E – 20×, G, I – 10×

Intestinal tissue is composed of four layers: mucosa, submucosa, muscular and serosa (Figs 5A, B, C). Epithelial oedema and epithelial cell hyperplasia in intestine tissues of fishes were frequently encountered for both localities. Vacuolisation of epithelial cells and distortion at basal lamina were also determined. Stain differences due to increasing in collagen fibres forming the stratum compactum, submucosa increase in number of eosinophils and dissolution at muscular fibres and hemorrhage were observed. Epithelial hyperplasia at the tips of intestine tissue, lymphocyte infiltration and necrosis were seen (Figs 5D–I).

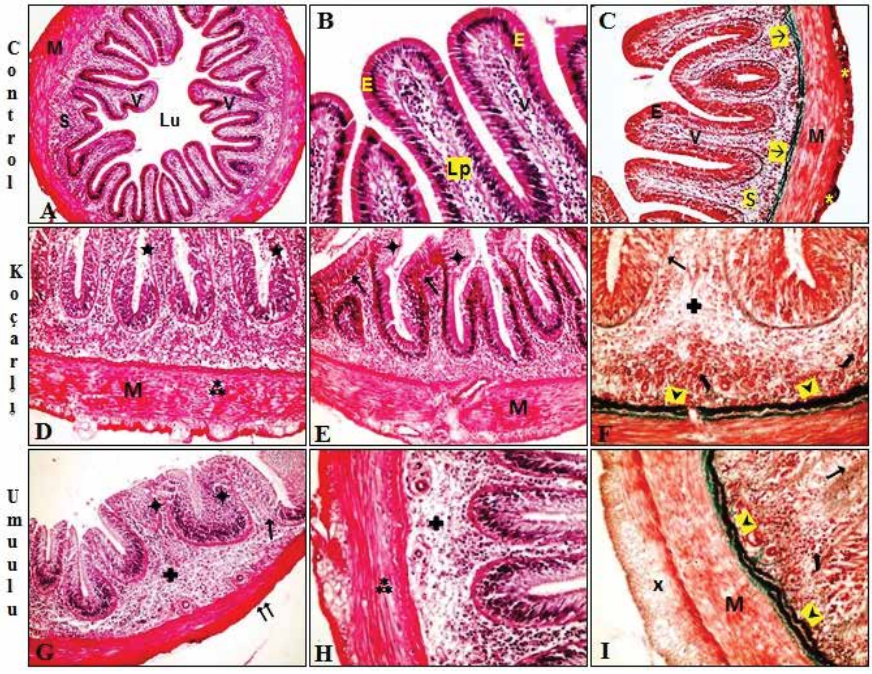


Fig. 5. Observed changes in intestine of *C. gibelio*. ⌀ – collagen fibrils; ► – darker colour in collagen fibrils of str. Compactum; ➥ – increase in eosinophilic leukocytes in submucosa; ★ – epithelial exfoliation; ▯ – disruption in basal lamina of epithelium; ✚ – degeneration in submucosa; ✦ – epithelial hyperplasia; ⁂ – dissolution in muscle fibrils; ⇈ – altered in muscle fibrils; Lu – lumen; V – villus; E – epithelium, L*p* – lamina propria; S – submucosa; M – muscular layer; * – serosa; Staining: A, D, E, G, H, E; B, H – Gomori trichrome; C, F, I – PAS; Magnification: A, B, F, H – 40×, C, D, E. 20×, G, I. 10×

Acute or chronic poisoning may occur in human and animals depending on the quantity and chemical structure of nitrite ingested[9,10]. It has been reported nitrites formed N-nitrosamines by reacting with secondary amines and other nitrogen containing substances, and caused liver, esophagus, kidney, stomach, intestinal, central nervous system lymphoid system cancers. Industrial wastewater containing nitrogen, fertilisers and degraded organic matters constitute the most important source of nitrate and nitrite[11,12].

According to Aydin environmental status report, Buyuk Menderes River, within Aydin Province, has water quality of 3rd class in terms of inorganic pollutants and 4th class in terms of organic pollutants (very dirty, cannot be used for agricultural irrigation)[13]. In water analysis performed in this study, according to Turkish Standards Institute (TSI) Water Pollution Control Regulation, it is determined that the Umurlu region has water quality of 4th class and Kocarli region has water quality of 3rd class in terms of nitrite nitrogen. Considering the increase in the amount of nitrite in human bodies feeding with agricultural products irrigated with water

containing high nitrite levels and fish caught from same water, it is possible to say the people living in this region will face serious health problems in the future.

Gills are important organs allowing passage of approximately 48 l of water per hour. Therefore, gills can easily be affected by salt water, heavy metals, pesticides and wastewater in the environment they are present[14]. It is possible to say that the results of studies conducted with the aluminum are in compliance with our research. In a study made by Hadi and Alwan[15], *Tilapia zillii* fish species were treated with varying doses of aluminum and as a result of this treatment the damages observed in fish gills tissues were similar to the results obtained in our study. When aluminum affects fish gills function, it leads to increased mucus secretion[16–18]. According to our water analysis, the aluminum concentration is higher than the acceptable value of the TSI in both localities (Umurlu – 0.57 µg/l, Kocarli – 0.241 µg/l). High aluminum content identified in the analysis of water and other toxic substances in the water can be one of the reasons in the gill structure degeneration.

Kanthan and Richards[19] have found that hyperplasia was formed by the increase in the thickness of epithelial and thus it caused to a slowdown of blood flow. Fusion and hyperplasia of gill lamellae may occur due to toxic substances in the water[20]. Epithelial separation observed at gills is most likely due to intense oedema[21]. Congestion, aneurysm and telangiectasia in lamellae is also a defense mechanism aims to minimise the tissue damage when oxygen in the water diffuses into the blood[22]. The accumulation of aluminum in gill tissue with a high concentration can be explained by mucus secretion and structural disorder formed in gill tissue due to contamination[23]. In our study, the increase in mucus cell numbers detected in gill tissues can be considered as a defense mechanism that is intended to reduce the absorption of aluminum and other toxic substances in water. Additionally, the ability of ion exchange of chloride cells became impossible due to dense fusion observed in secondary lamellae.

Fish mortality usually occurs through poisoning by toxic substances ingested orally. Toxic substances absorbed in the digestive tract, can reach the whole body through blood circulation. The absorption of toxic substances orally is higher at small intestine. During the process of absorption in mucosa through villi and microvilli, toxic substances stay in intestine longer and as a result of this they come in more contact with mucosa[24,25]. In this study serious pathological findings were determined in intestine tissues. We think that the reason of villus fusion is a structural reaction evidenced by reduction of surface area to ensure minimum absorption of the toxic material.

Generally, muscle tissue in fish does not play an active role in the metal accumulation. In the studies performed with freshwater fish, muscle tissue accumulates lower level of aluminum content compared to other tissues[26–28]. In studies with different species of fish caught from the natural environment[29,30], similar to the findings in our study pathologic evidence were identified. Damage to the muscle

fibres due to toxic substances might have caused the release of calcium ion. As a result of this, myocyte membranes might have lost their glycogen storage capabilities by malfunctioning. Calcium ion release is also a reason for atrophy in muscle fibres. Damage to the muscles may increase lactic acid secretion and prevent important vital functions such as searching or capturing by affecting movement performance in fish.

Liver, often exposed to toxic substances, is a good biomarker in the observation of histological changes[31,32]. In this study, similarly to previous studies[33–36], serious histopathological changes in liver tissue such as parenchymal necrosis, oedema in the perivascular areas, congestion, pyknotic nucleus in some hepatocytes, staining differences and decrease in glycogen storage are identified and also it is determined that pollution affected fish organ systems negatively.

CONCLUSIONS

Based on the findings obtained from this study, it is possible to say that pollution is present at the region where study is performed and fish are negatively affected by this pollution. Better policies should be developed and necessary plans and programs should be made in order to prevent pollution became a critical issue in the region, eliminate pollutant factors and preserve water resources.

Acknowledgements. We thank the Adnan Menderes University Research Fund for financial support of this research through grant number (2014-FEF-14017).

REFERENCES

1. M. SOYLAK, M. DOGAN: Water Chemistry. 1st ed., Erciyes University Printing Press, Kayseri, 2000.
2. I. DOKMECI: Toxicology, Diagnosis and Treatment in Poisoning. 4th ed. Nobel Medical Bookshop, Istanbul, 2005. 75 p.
3. Y. OZDEMIR: Investigation of Land Use and Water Management of Buyuk Menderes River Basin. Ph.D. Thesis, Istanbul University, Graduate School of Social Sciences, Istanbul, 2009.
4. E. KACAN: Identification and Evaluation of Pollution Parameters of River Gumuscay and Curuksu. Master Thesis, Pamukkale University, Graduate School of Natural and Applied Sciences, Denizli, 2006.
5. B. KESER: Investigation of Heavy Metal Pollution in Some Vegetables and Fruits in Irrigated Area with the Buyuk Menderes River in Aydin. Master Thesis, Adnan Menderes University, Graduate School of Natural and Applied Sciences, Aydin, 2008.
6. ANONYMOUS: Buyuk Menderes Basin Environmental Protection Project. Aydin Proconsulate, Country Environmental Management, Aydin, 2000.
7. ANONYMOUS: Water Pollution Control Regulation. T.C. Ministry of Environment and Forests, 31 December 2004/25687 number Official Newspaper, Premiership Printing Office, Ankara, 2004.
8. J. D. BANCROFT, H. C. COOK: Manual of Histological Techniques and Their Diagnostic Application. Churchill Livingstone, London, 1994.

9. R. CAMMACK, C. L. JOANNOU, X. V. CUI, C. T. MARTINEZ, S. R. MARAJ, M. N. HUGHES: Nitrite and Nitrosyl Compound in Food Preservation. Biochim Biophys Acta, **1411**, 474 (1999).
10. K. EKICI, M. ALISARLI, Y. C. SANCAK: Nitrite and Nitrosamines of Cheese Type. Yuzuncu Yil University. Journal of Veterinary Medicine, **2,** 71 (2008).
11. S. AGAOGLU, M. ALISARLI, S. ALEMDAR, S. DEDE: Investigation of Nitrate and Nitrite Levels in Drinking and Using Waters of Van Region. Yuzuncu Yil University. Journal of Veterinary Medicine, **18** (2), 17 (2007).
12. H. H. ORUC, S. CEYLAN: Investigation of Methemoglobin Level in the Blood and Nitrite, Nitrate in Drinking Water, Feed and Rumen Content of Cattles in Bursa Region. J Fac Vet Med, **20**, 25 (2001).
13. ANONYMOUS: Environmental Status Report of Aydin in 2012. Directorate of Aydin Environmental and Urbanization, 2013.
14. D. DIETRICH, C. SCHLATTER: Aluminum Toxicity to Rainbow Trout at Low pH. Aquat Toxicol, **15** (3), 197 (1989).
15. A. A. HADI, S. F. ALWAN: Histopathological Changes in Gills, Liver and Kidney of Fresh Waterfish, *Tilapia zillii*, Exposed to Aluminum. Int J Pharmacy Life Sci, **3** (11), 0976 (2012).
16. C. M. NEVILLE. Physiological Response of Juvenile Rainbow Trout, *Salmo gairdneri*, to Acid and Aluminum-prediction of Field Responses from Laboratory Data. Can J Fish Aquat Sci, **42**, 2004 (1985).
17. D. G. McDONALD, Y. TANG, R. G. BOUTILIER: Acid and Ion Transfer Across the Gills of Fish: Mechanisms and Regulation. Can J Zool, **67**, 3046 (1989).
18. G. HOWELLS, T. R. K. DALZIEL, J. P. READER, J. F. SOLBE: Aluminum and Fresh Waterfish Water Quality Criteria. Gordon and Breach Science Publication, **55**, 115 (1994).
19. K. P. KANTHAM, R. H. RICHARDS: Effect of Buffers on the Gill Structure of Common Carp, *Cyprinus carpio* and Rainbow Trout, *Oncorhynchus mykiss*. J Fish Diseases, **18**, 411 (1995).
20. H. W. FERGUSON: Gills and Pseudobranchs. Textbook of Systemic Pathology of Fish, **1**, 18 (1989).
21. E. F. PANE, A. HAQUE C. M. WOOD: Mechanistic Analysis of Acute, N-induced Respiratory Toxicity in the Rainbow Trout, *Oncorhynchus mykiss*: an Exclusively Branchial Phenomenon. Aquat Toxicol, **69**, 11 (2004).
22. M. N. FERNANDES, A. F. MAZON: Environmental Pollution and Fish Gill Morphology. Fish Adaptations, 203 (2003).
23. H. B. PRATAP, S. E. BONGA: Effects of Ambient and Dietary Cadmium on Pavement Cells, Chloride Cells and Na-ATPase of the Fresh Water Teleost *Oreochromis mossambicus* at Normal and High Calcium Levels in the Ambient Water. Aquat Toxicol, **26**, 133 (1993).
24. H. KARADEDE: Investigation of Heavy Metal Accumulation in Water, Sediment and Fish Species from Ataturk Dam. Master Thesis, Dicle University, Graduate School of Natural and Applied Sciences, Diyarbakir, 1997.
25. E. KOSE: Investigation of Heavy Metal Accumulation in Fish Living in Enne Dam. Master Thesis, Dumlupinar University, Graduate School of Natural and Applied Sciences, Kutahya, 2007.
26. S. J. TULASI, P. U. REDDY, J. V. R. RAO: Accumulation of Lead and Effects on Total Lipids and Lipid Derivatives in the Freshwater Fish *Anabas testudines*. Ecotoxicol Environ Safe, **23**, 33 (1992).
27. F. KARGIN: Metal Concentrations in Tissues of the Freshwater Fish *Capoeta barroisi* from the Seyhan River (Turkey). Water Air and Soil Pollution, **60** (5), 822 (1998).
28. Y. H. COGUN, G. URAS: The Protective Effects of Calcium on Aluminum Toxicity in *Oreochromis niloticus* Tissues. Ege University, Journal of Aquaculture, **29** (1), 41 (2012).
29. S. YILDIZ, B. GURCU, Y. B. KOCA, S. KOCA: Histopathological and Genotoxic Effects of Pollution on *Anguilla anguilla* in the Gediz River (Turkey). J Anim Vet Adv, **9** (23), 2890 (2010).

30. B. GURCU, S. YILDIZ, Y. B. KOCA, S. KOCA: Investigation of Histopathological and Cytogenetic Effects of Heavy Metals Pollution on *Cyprinus carpio* (Linneaus, 1758) in the Golmarmara Lake. Turkey. J Anim Vet Adv, **9** (4), 798 (2010).
31. A. UCAR, M. ATAMANALP: Toxicopathological Lesions in Fish I. Ataturk University, Journal of Agriculture Faculty, **39** (2), 255 (2008).
32. I. VELCHEVA, A. ARNAUDOV, E. GEORGIEVA, P. ATANASOVA: Influence of Copper on the Hepatic Morphology of the Gibelio Carp (*Carassius gibelio*). J Environ Prot Ecol, **13** (3A), 1928 (2012).
33. M. G. SIMPSON, T. H. HUTCHINSON: Toxicological Pathology of Dab *Limanda limanda* along Pollution Gradients in the Southern North Sea. Mar Ecol Prog Ser, **91,** 155 (1992).
34. Y. B. KOCA, S. KOCA, S. YILDIZ, B. GURCU, E. OSANC, O. TUNCBAS, G. AKSOY: Investigation of Histopathological and Cytogenetic Effects on *Lepomis gibbosus* (Pisces: Perciformes) in Cine Stream (Aydin/Turkey) with Determination of Water Pollution. Environ Toxicol, **20** (6), 560 (2005).
35. S. KOCA, Y. B. KOCA, S. YILDIZ, B. GURCU: Genotoxic and Histopathological Effects of Water Pollution on Two Fish Species, *Barbus capito pectoralis* and *Chondrostoma nasus* in the Buyuk Menderes River, Turkey. Biol Trace Elem Res. **122**, 276 (2008).
36. M. M. N. AUTHMAN, S. A. IBRAHIM, M. A. El-KASHEIF, H. S. GABER: Heavy Metals Pollution and Their Effects on Gills an Liver of the Nile Catfish *Clarias garipeinus* Inhabiting El-Rahawy Drain, Egypt. Global Veterinaria, **10** (2), 103 **(**2013).

Received 8 January 2016
Revised 14 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *488–497* (*2016*)

Water pollution

USE OF WASTEWATER FOR AGRICULTURAL IRRIGATION AND INFECTIOUS DISEASES. DIYARBAKIR EXAMPLE

N. UZEN

Department of Agricultural Structures and Irrigation, Agricultural Faculty, Dicle University, 21 280 Diyarbakir, Turkey
E-mail: *nuzen@dicle.edu.tr*

Abstract. In order to meet the demand for scarce water resources, which decrease in quantity and quality in many countries, especially domestic waste water is primarily treated and re-used. Discharging of waste water is an important resource to meet water demand in addition to achieving the minimum flow in rivers. Treated wastewater could be used as an alternative water resource in many areas especially in landscaping and irrigation of major agricultural products. Wastewater treatment level and accuracy requirements vary based on the field of use. Biological treatment requires taking into consideration of the public health in agricultural irrigation. Treated wastewater used in agricultural irrigation could meet a portion or all nutrient requirements for plant growth. In addition, particularly heavy metals and excessive amount of certain pathogens might have caused the adverse effects on human health and also soil accumulation. Therefore, certain basic standards must be established even if wastewater was treated for the purpose of utilisation. In this study, the suitability of treated wastewater for irrigation and the possible effects on public health were discussed. Additionally, infectious diseases arising from the drinking and potable water were examined in Diyarbakir Province between the years 2005–2015.

Keywords: treated municipal wastewater, water quality, public health.

AIMS AND BACKGROUND

Concurrent increase in population and nutritional and freshwater demand creates an expansion in the land reserved for agricultural production and a requirement to increase the yield in the agricultural production. A significant input in agricultural production, which increases the yield by 1 to 5-fold, water is utilised mainly (70%) in agricultural irrigation[1]. Use of urban wastewater as an alternative to scarce freshwater resources for agricultural irrigation became a rational solution. Furthermore, increase in urban population creates an increasing demand for domestic water consumption. Utilisation of wastewater in agricultural irrigation ensures the safe removal of the excessive discharge of domestic wastewater as well. Also ensures the conservation of quality water for use in domains other than agricultural irrigation.

Especially the nutrient content of domestic wastewater such as nitrogen (N) and phosphorus (P) provides for a part or the whole fertiliser requirements for

the plants. Furthermore, wastewater irrigation increases the metabolic activities of nutritious microorganisms in the soil[2,3]. However, if the urban wastewater is of industrial origin, it could contain heavy metals with toxic effects such as arsenic (As), copper (Cu), zinc (Zn), cadmium (Cd), chrome (Cr), and lead (Pb). These heavy metals are of specific concern due to their toxicity, bio-accumulation tendency. Heavy metal pollution of agricultural soils is a major environmental problem that can affect plant productivity, food quality and human health[4]. Only small doses of these elements could cause toxicity in plants. The most significant pollutant detriments for public health that could be found in wastewater used for irrigation are pathogen microorganisms[2].

It is inevitable for the agricultural soil, which is irrigated with wastewater, to become the host station for pathogens that cause diseases and toxic effects such as sodification and heavy metal concentration. Protective measures should be taken to reduce these negative effects on environmental and public health.

POTENTIAL RISKS ON PUBLIC HEALTH DUE TO UTILISATION OF WASTEWATER IN IRRIGATION

One of the most important problems that urban wastewater cause are the unicellular or multicellular pathogenic organisms that result in significant health problems. Several studies reported pathogen microorganisms in urban wastewater such as viruses (*Enteroviruses*), bacteria (pathogen *E. coli*, *Salmonella* ssp, *Shigella* ssp, *Vibrio cholerae*), protozoa (*Entamoeba histolytica*) and entozoa (*Ascaris lumbricoides*, *Schistosoma mansoni*, *Trichuris trichiura*)[5]. These pathogen microorganisms found in wastewater utilised in agricultural irrigation could cause a threat risk through direct contact for workers who directly work on agricultural lands or in transportation of the produce.

Risk factors connected to pathogens and chemicals contained in wastewater are presented in Table 1.

The risks created by wastewater, which is an alternative resource for irrigation, on human health are studied worldwide as well as Turkey. It was identified that the rate of pathogen microorganisms such as *Salmonella shigella*, *E. coli*, *Enterobacter* and *Klebsiella* increased in lands irrigated with Konya province sewage discharge when compared to the lands not irrigated by this water[7]. In a study conducted again on lands irrigated with Konya province wastewater, *Mycobacterium* ssp and several micro-fungi, protozoa and nematodes were identified[5]. In a study conducted at Hevsel Gardens in Diyarbakir, Turkey, irrigated directly with untreated domestic wastewater, Hepatitis-E infection risk induced by eating uncooked vegetables and irrigation applications that utilise untreated wastewater was investigated and it was found that 34.8% of the workers were anti-HEV positive[8].

Table 1. Risk sources of wastewater related to pathogens and chemicals[6]

	Pathogens	Chemicals
Risk sources	bacteria viruses helminths protozoa	heavy metals nitrates and nitrites organic micropollutants
Cause of the risk	one time or repeated consumption or directly touching	repeated consumption
Risk occurrence ways (the ways of exposure to risk sources)	by eating of shellfish, such as mussels and vegetables by drinking water as sourced from aerosols to be in contact with water from directly or indirectly via vectors (such as insects living around water)	by eating of various foods and/or drinking water
Emergence of effect	generally it is observed for a short time	generally it is observed for a long time

To prevent similar health problems and deterioration of environmental health, the wastewater that would be utilised in alternative irrigation should meet certain physical, chemical and biological quality standards. For this purpose, different quality standards are implemented in different countries (WHO, FAO, EPA,…). In Turkey, the current measures are implemented through Water Pollution Control Regulations Technical Procedures Communiqué[10]. Quality standards for classification of irrigation water based on this communication are presented in Table 2.

Although national irrigation water quality standards are in effect since 1991 (Ref. 8), since water shortage is not yet significant in Turkey, reuse of treated wastewater is still not a priority in the country. However, in near future, reuse of wastewater will be the most significant environmental issue in Turkey[9]. Certain technical limitations were introduced by Water Pollution Control Regulations Technical Procedures Communiqué[9] for use in implementation based on cultivated plants and irrigation method used to minimise potential risks for public health even though the wastewater complies with the quality standards depicted in Table 2. Table 3 demonstrates that wastewater utilisation is especially appropriate for the produce that is not used for human nutrition. Furthermore, wastewater to be used in irrigation of plants for human nutrition should be well-treated against pathogens and to decrease the heavy metal load, in addition to the preference of drip irrigation method where the water is provided to the root section without any direct contact to the plant.

Table 2. Irrigation water quality parameters for classification[9]

Quality parameters	Water quality class				
	I class (excellent)	II class (good)	III class (permissible)	IV class (doubtful)	V class (unsuitable)
$EC_{25} \times 10^6$	0–250	250–750	750–2000	2000–3000	> 3000
Exchangeable sodium percentage (ESP)	< 20	20–40	40–60	60–80	> 80
Sodium adsorption ratio (SAR)	< 10	10–18	18–26	> 26	
Residual sodium carbonate, meq l^{-1} mg l^{-1}	> 1.25 < 66	1.25–2.5 66–133	> 2.5 > 133		
Chloride (Cl^-), meq l^{-1} mg l^{-1}	0–4 0–142	4–7 142–249	7–12 249–426	12–20 426–710	> 20 > 710
Sulphate (SO_4^{2-}), meq l^{-1} mg l^{-1}	0–4 0–192	4–7 192–336	7–12 336–575	12–20 575–960	> 20 > 960
Total dissolved solids (TDS), mg l^{-1}	0–175	175–525	525–1400	1400–2100	> 2100
Boron, mg l^{-1}	0–0.5	0.5–1.12	1.12–2.0	> 2.0	–
Class of water*	C_1S_1	C_1S_2, C_2S_2, C_2S_1	C_1S_3, C_2S_3, C_3S_3, C_3S_2, C_3S_1	C_1S_4, C_2S_4, C_3S_4, C_4S_4, C_4S_3, C_4S_2, C_4S_1	–
NO_3^- or NH_4^+, mg l^{-1}	0–5	5–10	10–30	30–50	> 50
Fecal coliform** 1/100 ml	0–2	2–20	20–100	100–1000	> 1000
BOI_5 , mg l^{-1}	0–25	25–50	50–100	100–200	> 200
Suspended solids, mg l^{-1}	20	30	45	60	> 100
pH	6.5–8.5	6.5–8.5	6.5–8.5	6.5–9	< 6 veya > 9
Temperature, °C	30	30	35	40	> 40

Table 3. Principles and technical limitations associated with the use of agricultural wastewaters[9]

Agricultural species	Technical limitations
Fruits and viticulture	– sprinkler irrigation method is prohibited – fruits falling to the ground should not be eaten – number of fecal coliform bacteria 1000/l00 ml
Fibre crops and seed production	– surface or sprinkler irrigation can be done – biologically purified and chlorinated wastewater used in sprinkler irrigation – number of fecal coliform bacteria 1000/100 ml
Forage crops, oil crops, raw inedible plants and floricultural	– surface irrigation, mechanical treated wastewater

INFECTIOUS DISEASES ASSOCIATED WITH WATER AND/OR WASTEWATER

Infectious diseases could be examined in five main groups based on their modes of transmission (Table 4).

Table 4. Diseases related to water or/and treated wastewater[6]

Categories	Descriptions, observation, examples
Waterborne diseases	infections that can be spread through the system in which water is provided. water acts as a carrier for pathogens; typhoid fever, cholera, giardiasis (diarrhea), dysentery, infectious hepatitis
Sanitation and hygiene-related diseases	diseases resulting from lack of water for personal hygiene; it affects external surface of the body; conjunctivitis, trachoma, leprosy, tinea, ascariasis, yaws disease, giardiasis, cryptosporidiosis
Diseases suffering from water	infections are moved by animals aquatic spineless an important part of the life cycle of the organism causing the infection occurs in these aquatic animals; schistosomiasis, guinea worm, filariasis
Vector or insect-borne diseases associated with water	these infections are spread through insects living near surface water sources trypanosomiasis, yellow fever, dengue, onchocerciasis (river blindness), malaria
Infections caused by poor sanitation precautions	usually it spreads in the community due to lack of proper sanitation practices hookworm, roundworm, ascariasis

The life span of the pathogens transmitted to the soil by the use of wastewater for irrigation varies based on their endurance and compatibility to natural conditions. According to Ref. 12, viruses (enteroviruses) and helminths (*Ascaris lumbricoides* eggs, *Taenia saginata* eggs, *Trichuris trichiura* eggs, tepid larvae) could survive longer both in the soil and on plant surfaces when compared to bacteria (*Fecal coliform, Salmonella* spp., *Vibrio cholera*), and protozoa (*Entamoeba histolytica* cysts).

In Turkey, due to the distribution of water resources, differences in the amount of available water, different climate characteristics, habits and differences in feudal system, and partially because of socio-economic conditions, the prevalence of waterborne diseases differ based on the regions. 2004 statistical data for waterborne disease cases such as Typhoid fever, Paratyphoid fever, B. dysentery, A. dysentery and Hepatitis A and morbidity rate based on regions are presented in Table 5.

Table 5. Waterborne disease frequency distribution based on regions (typhoid fever, paratyphoid fever, B. dysentery, A. dysentery and Hepatitis A), (one per hundred thousand)[12]

Regions	Typhoid fever		Paratyphoid fever		B – dysentery		A – dysentery		Hepatitis A	
	case	morb	case	morb	case	morb	case	morb	case	morb
Marmara	307	1.64	9	0.05	126	0.67	1252	6.70	1116	5.97
Aegean	244	2.62	21	0.23	85	0.91	1591	17.09	988	10.61
Mediterranean	1871	20.25	5	0.05	66	0.71	5318	57.57	1107	11.98
Central Anatolia	122	1.01	26	0.22	179	1.48	2966	24.58	1107	9.17
Black Sea	17	0.20	27	0.32	15	0.18	822	9.89	522	6.28
Eastern Anatolia	704	11.09	50	0.79	42	0.66	472	7.44	447	7.04
Southeastern Anatolia	20663	286.98	295	4.10	82	1.14	7848	109.00	3314	46.03
Turkey	23901	33.59	429	0.60	605	0.85	20463	28.76	8824	12.40

* Population figures used for morbidity rate (morb) were based on the projection made by utilising 2000 census figures by Turkey Statistical Institute[13].

Data presented in Table 5 show significantly high prevalence of all disease groups and the high morbidity rates in Southeastern Anatolia region. For instance, 86.45% of all typhoid fever cases in Turkey; 68.76% of all paratyphoid cases, 13.55% of all B. dysentery cases, 38.35% of all A. dysentery cases, and 37.55% of all Hepatitis A cases were observed in the Southeastern Anatolia region. It could be argued that this situation might be due to the level of education and habits of the local population, climate conditions and feudal and cultural structure of the region.

RESULTS AND DISCUSSION

Diyarbakir province is a significant part of Southeastern Anatolia region with its size, population, land and water resources, and transportation and employment potential. According to census data, Diyarbakir province population in 2012 was approximately 1 635 048 (Ref. 14) and it continuously increases. This development causes an increase in agricultural production due to nutritional demands, an increase in the demand for potable water and water for domestic use and similar social problems. Local government has modern facilities for potable and domestic water and treatment of such and a modern urban wastewater treatment plant. Construction of the wastewater treatment plant commenced in 2004 and in 2007, the anaerobic sludge digester and a consequent pre-treatment) treatment facility, which includes mechanical dehydration became operational. Construction of Diyarbakir Advanced Biological Wastewater Treatment Plant started in 2012, and it is operational today, causing a significant reduction in the pollution load of Dicle River.

Furthermore, there are numerous existing and construction phase dams and ponds in Diyarbakir province, which provide or will provide irrigation water in the future within the Southeastern Anatolia Project (GAP). In addition, water from

Dicle River, which dissects the city centre, is also used by farmers for irrigation. Dicle River has good quality standards as irrigation water and is a 2nd class water based on by Water Pollution Control Regulations Technical Procedures Communiqué standards. Thus, toxic element and salt accumulations are not expected in the soil even after long years of irrigation. However, in certain small and irregular settlements around the province, domestic wastewater and agricultural irrigation drainage water with worse quality are discharged directly into Dicle River. Similarly, it is very common to encounter certain cases in the city due to irrigation using biologically bad quality water taken directly from the river. Table 6 presents the waterborne bacterial cases surveyed in Diyarbakir Province by Diyarbakir Province Public Health Directorate during the decade between 2005 and 2015.

Table 6. Number of bacterial infections transmitted by water in Diyarbakir Province, 2005–2015 (Ref. 13)

Bacteria	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Salmonella typhi	–	–	4	2	5	15	–	1	–	–	–	27
Salmonella paratyphi A	1	–	–	–	1	1	–	–	–	–	–	3
Salmonella paratyphi B	–	–	1	–	1	1	–	–	–	–	–	3
Salmonella (other)	–	–	4	1	99	29	–	–	–	–	–	133
Shigella flexneri	–	–	3	17	25	21	3	2	–	–	–	71
Shigella sonnei	–	–	2	11	22	10	2	–	–	–	–	47
Shigella dysenteriae	–	–	–	2	2	–	–	–	–	–	–	4
Shigella boydi	–	–	–	–	–	2	–	–	2	–	–	4
Chlamydra trachomatis	2	–	–	–	2	1	–	–	–	–	–	5

One of the riveting facts about Table 6 is the low number of cases observed in 2005 and 2006 when compared to the figures in later years. This could be due to the fact that all cases did not apply to a health institution or due to the unreliability of the records. Another interesting issue was another decrease in number of cases after 2011 and especially observation of no cases in 2013, 2014 and 2015. This could be a result of the supply of healthy potable tap water to almost whole province by local governments, active operation of wastewater treatment facility, and sensitivity of farmers for informed irrigation and fertilisation techniques. In addition, the reason for high number of cases during the four-year period between 2007 and 2010 could be the fact that Wastewater Treatment System of Metropolitan Municipality of Diyarbakir was not functioning properly during this period.

Table 7 demonstrates waterborne viral and protozoan cases observed in the decade between 2005 and 1015 in Diyarbakir Province based on the data obtained from Diyarbakir Province Public Health Directorate[13].

Table 7. Number of viral and protozoal infections transmitted by water borne in Diyarbakir Province, 2005–2015 (Ref. 13)

Diseases agents	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Entamoeba histolytica	182	214	559	515	792	134	610	356	79	1581	493	6724
Giardia intestinalis	402	38	270	369	687	602	532	170	–	217	157	3444
Hepatit A	38	59	62	58	103	111	273	225	59	50	4	1042

It could be observed in Table 7 that the *Entamoeba histolytica* amoeba had the risk to cause infections in every year of the study period. This amoeba is a human parasite. It causes an intestine infection called *Intestinal amebiasis* that is basically indicated with bloody-mucous diarrhea. This protozoon cysts, which are prevalent in nature, could cause the disease via drinking water and nutrients that are consumed raw.

The source of parasite in giardiasis, which is induced by *Giardia intestinalis*, is the humans that host this parasite in their bodies. Parasite is excreted via the feces of these individuals. It is transmitted into other human bodies via consumed vegetables and fruits when the agricultural lands are irrigated with river and irrigation water that are infected due to non-treatment of sewage discharge.

Hepatitis A virus, which was prevalent in Diyarbakir for the duration of the present study, could be transmitted with inter-personal contact and infected food or food washed in infected water. Raw or insufficiently cooked food (i.e. salads, unpeeled fruits, seafood, etc.) is another mode of transmission. Known as jaundice, Hepatitis A is a highly contagious viral disease. It affects numerous people via epidemics that occur from time to time. Hepatitis A is 10–100 times more prevalent than typhoid fever and 1000 times more frequent than cholera.

CONCLUSIONS

Solid waste and urban and industrial wastewater created as a result of increasing urban and rural population should be collected properly and treated biologically, physically and chemically. The standards for the discharge of domestic and industrial wastewater should be meticulously considered and this water should be exposed to necessary treatment processes before delivering these into any receiving environment.

It is utmost beneficial to research the possibilities of utilisation for irrigation before the removal of treated wastewater by discharge into surface waters and the design studies should be conducted accordingly during the planning and project phases of wastewater treatment facilities. Utilisation of wastewater in agricultural irrigation should be encouraged. However, the implementation should be conducted according to the regulations, without contact to the water and using appropriate irrigation techniques and vegetation. Irrigation workers should use clothing that would prevent direct contact with water such as gloves and boots. Authorised institutions and organisations, primarily health institutions should provide information on the significance of waterborne diseases and ways of protection from these at schools, businesses and health institutions. Toilet and hand wash training should be provided for school age and young children, in a fun way. Training should be provided for housewives, who do the cleaning and cooking chores of the household, on improving the quality of wastewater by using natural disinfectants such as vinegar and using less chemicals by Provincial Health Directorates, administrative physicians and nurses of Family Healthcare Centres and Public Health Centre staff. Sealed system sewage network infrastructure service should be provided for the rural population. Disinfection of potable water should be performed using different methods (boiling, chlorination, pH change, etc.). Preventive medicine should be emphasised.

REFERENCES

1. O. CETIN: Agricultural Irrigation Methods. Administration of Publishing and Publications of Food Agriculture and Livestock Ministry, Farmer Training Series, Publication No 2012/7, Ankara, 2012, p. 7.
2. M. B. PESCOD: Wastewater Treatment and Use in Agriculture. FAO Irrigation Drainage Paper, 1992, 47–124.
3. S. TOZE: Reuse of Effluent Water – Benefits and Risks. Agr Water Manage, **80**, 147 (2006).
4. M. ALBULESCUA, H. POPOVICIA, L. TURUGAA, S. MASUB, A. CHIRIAC: Analysis of Heavy Metals Content of Soil and *Vitis vinifera* in Two Vineyard Areas of the Caras-Severin County, Romania. J Environ Prot Ecol, **13** (1), 48 (2012).
5. R. UYANOZ: The Effects of Using Wastewater as Irrigation Water on Some Physical, Chemical and Biological Characteristics of Agricultural Land in Konya. Ph.D. Thesis. Selcuk University, Konya, 2000. 100 p. (in Turkish).
6. M. SALGOT: Hygienic Aspects of DESAR: Water Circuits. In: Decentralized Sanitation and Reuse. Integrated Envir. Tech. Series, IWA Publishing, London, UK, 2001, 469–484.
7. K. GUR, R. UYANOZ, M. ZENGIN: Microbial Contamination in Agricultural Soils Irrigated by Urban Wastewater in Konya. In: Proc. of the Agriculture-Environment Relationship Symposium, Sustainable Use of Natural Resources, Mersin University. Engineering Faculty 13–15 May 1996, Mersin, 1996, 43–51.
8. A. CEYLAN, M. ERTEM, M. ILCIN, T. OZEKINCI: A Special Risk Group for Hepatitis E Infection: Turkish Agricultural Workers Who Use Untreated Waste Water for Irrigation. Epidemiol Infect J, **131**, 753 (2003).

9. Official Gazette: Water Pollution Control Technical Procedures Communiqué, Issue 20748, Ankara, 1991. 40 p.
10. WHO: Guidelines for the Safe Use of Wastewater, Excreta and Greywater, Vol. 2, Wastewater Use in Agriculture, World Health Organization, France, 2006.
11. D. W. WESTCOT: Quality Control of Wastewater for Irrigated Crop Production. Water Reports, No 10, FAO, Rome, 1997. 86 p.
12. Anonymous: Ministry of Health, TSH Study Yearbook 2004, New York, Ministry of Health Publications, 2005.
13. ANONYMOUS: Diyarbakir Provincial Directorate of Health Statistics (2005–2015). (2015b)
14. Anonymous: Diyarbakir. http://tr.m.wikipedia.org/wiki/Diyarbak%C+%B1r (2015c).

Received 8 January 2016
Revised 10 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *498–502* (*2016*)

EFFECT OF HOUSEHOLD WATER TREATMENT DEVICES ON THE MICROBIOLOGICAL QUALITY OF TAP WATER

S. KURKLU, M. CINAR, R. OGUR*, O. F. TEKBAS

Gulhane Medical Faculty, Department of Public Health, Division of Environmental Health, Ankara, Turkey
E-mail: *rogur@gata.edu.tr*

Abstract. Although commercial household water treatment (HWT) devices are presented and accepted as a complete and absolute solution in order to improve water quality both for chemical and microbiological aspects, their effects on microbial quality of water when they are used with municipal tap water were not investigated. We examined water samples taken from tap waters and corresponding HWT devices for heterotrophic plate and total coliform counts. Heterotrophic bacteria were seen in 12 (75.0%) processed water samples while five (41.7%) unprocessed tap water samples contained colonies. It was determined that 62.5% of the water samples processed by HWT devices contained coliform bacteria and were not potable. According to these results, it could be concluded that some of the HWT devices may be source of microbiological contamination rather than disinfecting it.

Keywords: water treatment, water disinfection, household water treatment devices.

AIMS AND BACKGROUND

It was estimated that 842 000 diarrhea deaths had been caused by unsafe drinking-water, together with poor sanitation and poor hygiene, and this number equates to 1.5% of the total disease burden and 58% of diarrheal diseases[1]. Just like other well known considerations, also this estimate confirms the importance of improving water and sanitation in low- and middle-income settings for the prevention of diarrheal disease and related deaths[1,2].

Commercial household water treatment (HWT) units are presented as a complete and absolute solution in order to improve water quality both for chemical and microbiological aspects. Also some findings, resulting from water quality interventions, suggest that household water treatment activities, if combined with safe storage is effective at improving drinking water quality and in preventing diarrhea[3–5]. But also there is evidence that the health impact from HWT may be exaggerated due to reporting bias, the World Health Organisation (WHO) and UNICEF have recommended the use of HWT for populations relying on unsafe supplies as part of a comprehensive strategy to prevent diarrhea[4]. WHO declared that household water treatment and safe storage is one particular option within a

* For correspondence.

broader Water Safety Plans to make water safer to drink. HWT and safe storage are not a substitute for sustainable access to safe drinking-water but it does provide an interim measure for removing pathogens from drinking-water, particularly where access to clean and safe water supplies is not available[6].

Although it is clear that HWT units should be used in developing areas which people could not reach microbiologically safe drinking water in order to prevent diarrheal diseases[3,4,7,8], in municipal areas which treated and disinfected water was presented to population, commercial firms try to sell HWT devices by emphasising the effects of them on physical properties which are not very important for preventing microbiological diseases, and people generally believe that clear and soft waters do not contain microorganisms which could cause disease burdens and in cities it is not clear whether HWT devices reduce diarrheal diseases or not[2]. And it is interesting that independent of source water quality, residents with higher income and higher education levels were more likely to treat their water[9].

It was planned to study the effect of using HWT devices, which are used generally in order to improve aesthetical properties of water, like taste and hardness, on microbiological quality of tap water in a big city which treated and disinfected water are available for all of the population.

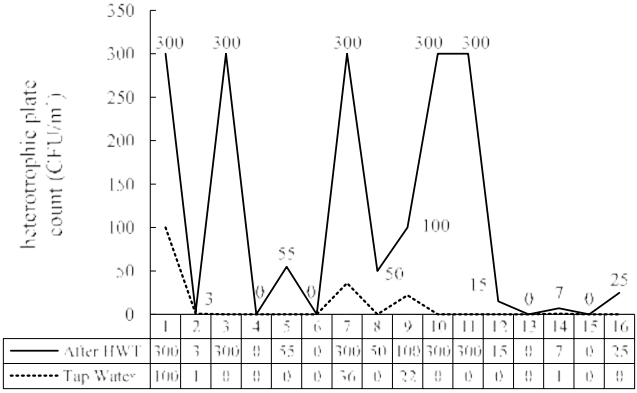
EXPERIMENTAL

This study was performed on April–May 2015 in Ankara where people could reach treated and disinfected municipal water in homes/buildings. Short information about study was announced and all of the HWT devices of volunteers were accepted for study. All of the devices were connected to top water directly and used in kitchen; they were preferred by users for the improving effects on hardness and taste properties. Also all of the devices have disinfecting properties. The number of devices which were tested in the study was 16.

Two water samples were taken from every HWT units (one of the samples was taken from tap water just before tap water entrance of HWT and the other sample was taken from the clean water output of HWT unit), into 250 ml sterile water sample bottles by using sterile sampling techniques. Samples were reached to GATA Laboratory of Department of Public Health in 2 h and they were incubated at 35ºC without any dilution, for analyses of heterotrophic plate count (heterotrophic bacteria, total germ count or total viable microorganisms) and total coliform bacteria for 48 and 24 h, respectively. Membrane filtration method and Endo agar were used for the analyses of total coliform bacteria, while heterotrophic bacteria were analysed by using 'Pour Plate Method', which is also known as the standard plate count, and Tryptone Glucose Yeast Agar were used. Following incubation, plates were examined for growth. The number of colonies was counted and results were expressed as number of colony forming units (CFU) per ml of sample.

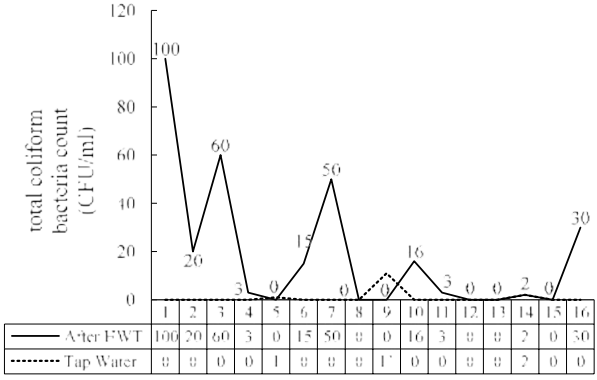
RESULTS AND DISCUSSION

We examined water samples taken from tap waters and corresponding HWT devices for heterotrophic plate and total coliform counts. Heterotrophic bacteria and total coliform bacteria counts before and after HWT units are presented in Figs 1 and 2.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
After HWT	300	3	300	0	55	0	300	50	100	300	300	15	0	7	0	25
Tap Water	100	1	0	0	0	0	36	0	22	0	0	0	0	1	0	0

Fig. 1. Heterotrophic plate counts of sampled tap waters and corresponding HWT devices



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
After HWT	100	20	60	3	0	15	50	0	0	16	3	0	0	2	0	30
Tap Water	0	0	0	0	1	0	0	0	1	0	0	0	0	2	0	0

Fig. 2. Total coliform bacteria counts of sampled tap waters and corresponding HWT devices

Heterotrophic bacteria were observed in 12 (75.0%) processed water samples of 16 HWT devices and 6 plates (37.5%) contained more than 100 CFU/ml colonies. When we compare the results of corresponding unprocessed tap water samples for heterotrophic bacteria counts, we determined that five of the samples (41.7%) contained colonies and only in one of them total colony count was over 100 CFU/ml (Fig. 1).

Total coliform bacteria counts were obtained by examining plates after 24 h incubation. Among water samples taken from HWT-processed waters, 10 (62.5%) of them contained coliform bacteria (Fig. 2). It means that 62.5% of the water samples processed by HWT units were not potable, for the devices included in

this study. This finding is very important, because only one of these samples contained total coliform bacteria before processed by HWT unit. Many studies which were performed in order to evaluate HWT and safe storage activities in different countries showed that availability of coliform free drinking water in homes were low, although most of the residents declared that they used HWT devices[2,3,7,9–12].

Microorganisms recovered through heterotrophic plate count tests generally include those that are part of the natural and typically non-hazardous microbiota of water, although in some instances, they may also include organisms derived from diverse pollutant sources[13]. So it could be considered that the HWT devices that caused increasing in the number of heterotrophic bacteria colonies may caused changes in micro-environment of water that leads to changes in microbiota of tap water. Biofilm formation may also contribute to the increase in heterotrophic bacteria counts as providing supporting background for bacteria. It may be hypothesised that chloramines may be able to better penetrate into distribution system of biofilms and inactivate attached bacteria[13–15].

CONCLUSIONS

According to results obtained from this study, it could be concluded that HWT devices may cause microbiological contamination in water rather than disinfecting it and it is clear that HWT units may cause diarrheal disease in homes even in developed countries, and people should be informed and educated about possible risks and proper usage of these devices.

REFERENCES

1. A. PRUSS-USTUN, J. BARTRAM, T. CLASEN, J. M. COLFORD, Jr., O. CUMMING, V. CURTIS, S. BONJOUR, A. D. DANGOUR, J. DE FRANCE, L. FEWTRELL, M. C. FREEMAN, B. GORDON, P. R. HUNTER, R. B. JOHNSTON, C. MATHERS, D. MAUSEZAHL, K. MEDLICOTT, M. NEIRA, M. STOCKS, J. WOLF, S. CAIRNCROSS: Burden of Disease from Inadequate Water, Sanitation and Hygiene in Low- and Middle-income Settings: A Retrospective Analysis of Data from 145 Countries. Trop Med Int Health, **19** (8), 894 (2014).
2. J. WRIGHT, S. W. GUNDRY: Household Characteristics Associated with Home Water Treatment: An Analysis of the Egyptian Demographic and Health Survey. J Water Health, **7** (1), 21 (2009).
3. L. FEWTRELL, R. B. KAUFMANN, D. KAY, W. ENANORIA, L. HALLER, J. M. COLFORD, Jr.: Water, Sanitation, and Hygiene Interventions to Reduce Diarrhoea in Less Developed Countries: A Systematic Review and Meta-analysis. Lancet Infect Dis, **5** (1), 42 (2005).
4. G. ROSA, M. L. HUAYLINOS, A. GIL, C. LANATA, T. CLASEN: Assessing the Consistency and Microbiological Effectiveness of Household Water Treatment Practices by Urban and Rural Populations Claiming to Treat Their Water at Home: A Case Study in Peru. PloS one, **9** (12), e114997 (2014).
5. M. KOCHUBOVSKI: Water Safety in Small-scale Supplies and New Approaches. J Environ Prot Ecol, **12** (4A), 2011 (2011).

6. WHO: A Toolkit for Monitoring and Evaluating Household Water Treatment and Safe Storage Programmes. WHO, Geneva, 2012.
7. P. B. PAVLINAC, J. M. NAULIKHA, L. CHABA, N. KIMANI, L. R. SANGARE, K. YUHAS, B. O. SINGA, G. JOHN-STEWART, J. L. WALSON: Water Filter Provision and Home-based Filter Reinforcement Reduce Diarrhea in Kenyan HIV-infected Adults and Their Household Members. Amer J Trop Med Hygiene, **91** (2), 273 (2014).
8. N. BUSHATI, A. NEZIRI, I. MALOLLARI, F. BUSHATI: Bacteriological Investigations of Wells Water near the Shkodra Lake. J Environ Prot Ecol, **10** (3), 645 (2009).
9. N. LOTHROP, S. T. WILKINSON, M. VERHOUGSTRAETE, A. SUGENG, M. M. LOH, W. KLIMECKI, P. I. BEAMER: Home Water Treatment Habits and Effectiveness in a Rural Arizona Community. Water, **7** (3), 1217 (2015).
10. G. ROSA, P. KELLY, T. CLASEN: Consistency of Use and Effectiveness of Household Water Treatment Practices among Urban and Rural Populations Claiming to Treat Their Drinking Water at Home: A Case Study in Zambia. Am J Trop Med Hyg, (2015).
11. P. L. GURIAN, G. CAMACHO, J. Y. PARK, S. R. COOK, K. D. MENA: Evaluating In-home Water Purification Methods for Communities in Texas on the Border with Mexico. Revista Panamericana De Salud Publica (Pan American Journal of Public Health), **20** (6), 403 (2006).
12. S. P. LUBY, A. H. SYED, N. ATIULLAH, M. K. FAIZAN, S. FISHER-HOCH: Limited Effectiveness of Home Drinking Water Purification Efforts in Karachi, Pakistan. Int J Inf Dis, **4** (1), 3 (2000).
13. WHO: Heterotrophic Plate Counts and Drinking-water Safety: The Significance of HPCs for Water Quality and Human Health (Eds J. Bartram, J. Cotruvo, M. Exner, C. Fricker, A. Glasmacher). IWA Publishing, London, 2003.
14. M. W. LECHEVALLIER, C. D. LOWRY, R. G. LEE: Disinfecting Biofilms in a Model Distribution System. J Am Water Works Assoc, **82** (7), 87 (1990).
15. M. W. LECHEVALLIER, W. SCHULZ, R. G. LEE: Bacterial Nutrients in Drinking Water. Appl Environ Microbiol, **57** (3), 857 (1991).

Received 8 January 2016
Revised 18 February 2016

Journal of Environmental Protection and Ecology 17, No 2, 503–511 (2016)

Soil pollution – effect of soil acidification on the soil microbiological activity

EFFECTS OF ACIDIFICATION ON THE SOIL MICROBIOLOGICAL ACTIVITY IN THE ZLATNA AREA

A. MANEA*, M. DUMITRU, M. MATEI, A. LACATUSU, S. MATEI, S. DUMITRU

National Research and Development Institute for Soil Science Agro-Chemistry and Environment – ICPA, Bucharest, 61 Marasti Blvd, District 1, 73 331 Bucharest, Romania
E-mail: *alexandrinamanea@yahoo.com*

Abstract. The paper presents the effects of soil acidification on the soil microbiological activity (bacteria, fungi, and soil respiration) studied in 22 sites for two layers (0–10 and 10–20 cm). The number of bacteria is quite low in the analysed samples, the bacterial population being not completely inhibited, but only reduced to the level of bacterial species adapted to adverse soil conditions. For the same soil type, the bacteria counts were influenced by soil reaction, organic matter content, and the distance from the pollution source. The soils near the pollution source, being strongly acidified, have lower values of bacterial counts and low diversity, only several species of *Bacillus*, *Athrobacter* and *Pseudomonas* being found. The soil data revealed the existence of a relatively low number of fungi microorganisms. Generally, the *Fusarium* and *Penicillium* species, followed by *Cladosporium* and *Aspergillus* species were most frequently identified, with a high tolerance to limiting soil conditions. Generally, the highest diversity is found in soils with neutral pH. Therefore, over 80% of soil samples had a low potential and only 20% show a medium potential of soil respiration. At soil type level, average content can be found in Fluvisols with neutral – slightly alkaline pH and medium content of organic matter, allowing the development of numerous bacterial communities while fungi counts were medium.

Keywords: Zlatna, soil acidification, soil microbiological activity.

AIMS AND BACKGROUND

In Zlatna area, a mineral processing plant and smelter released large quantities of SO_2, SO_3, heavy metal oxides, and sulphates leading to acid deposition[1–3] during its function. The main effects of the increased soil acidity are as following: decrease of cation exchange capacity, mobilisation of aluminium ions, as well as a decrease of biological activity[4–6].

The effect of acid precipitation on soil microorganisms includes changes in the bacteria counts and activity, changes in nutrient cycle and in organic matter decomposition. The microorganisms counts in the soil also decreased with increasing acidity[7].

* For correspondence.

Soil reaction exerts great influence on activity and abundance of different groups of soil microorganisms. As a general line, in soils with neutral or higher pH the bacteria are predominant in the microbial activity[8]. The optimum conditions for bacterial growth are on neutral reaction, whereas in the extremes of acidity or alkalinity reaction, the diversity is reduced and only the tolerant bacteria are found. Generally, bacteria are less tolerant to acidification than fungi. The number of bacteria was significantly reduced in acid soils and soil biological activity was severely affected at pH 3.0 (Ref. 9).

Actinomycetes do not tolerate acid soils and do not develop in soils with pH below 5.0. They develop more slowly, starting when nutrient contents and pressure of most active competitors tend to decrease[10].

The paper presents the effects of soil acidification on the soil microbiological activity (bacteria, fungi and soil respiration) studied in 22 sites for two soil (0–10 and 10–20 cm) layers.

EXPERIMENTAL

Soil samples were collected from 22 sites for two depths (0–10 and 10–20 cm). The soil diagnostics were based on the concept of elementary pedogenetic processes, in agreement with the World Reference Base for Soil Resources[11].

Soil reaction (pH) was determined by potentiometric method, in water suspension (1:2.5). The values of the percentage base saturation ($V_{8.3}$, %) were determined by calculation, sum of exchangeable bases (SB, me/100 g soil) and hydrolytic acidity (HA) by the Kappen-Schofield-Chirita method[12], and the total cationic exchange capacity by calculation; the Ca^{2+} was determined by the Schollenberger, Dreibelbis, Cernescu method[12] and total humus content – by wet oxidation, Walkley-Black method modified by Gogoasa[13].

Microbiological analyses of soil samples were performed by plating soil decimal dilutions on specific solid culture media, topping for heterotrophic bacteria and Czapek for fungi[14]. After incubation, the developed colonies were counted and the densities of microbial structures were reported to a gram of dry soil. Global physiological activities of microbial communities were determined by the substrate-induced respiration method[15].

RESULTS AND DISCUSSION

The bacterial microflora species identified in soils from the Zlatna areas belong to the *Arthrobacter* (*Arthobacter simplex*, *Arthobacter globiformis*, *Arthobacter citreus*), *Bacillus* (*Bacillus circulans*, *Bacillus polymyxa*, *Bacillus cereus*, *Bacillus megaterium*), *Pseudomonas*, *Actinomycetes*, *Mycobacterium*, and *Micrococus* genera.

The most common soil bacteria belong to the *Bacillus* (7–67%), *Arthobacter* (5–60%) and *Agrobacterium* (1–20%) (Ref. 10) genera.

The highest frequency were recorded by *Pseudomonas* (70%, present at least at one depth), followed by *Circulans Bacillus* (71%) and *Arthrobacter* (86%).

Among the *Bacillus* species, the most frequently are *Bacillus circulans* (70%), followed by *Bacillus Polymyxa* (34%), while *Bacillus cereus* and *Bacillus megaterium* were identified only in 4 samples.

The *Arthrobacter* genus is represented by *Arthrobacter globiformis* in most soil profiles, excepting 2 profiles where *Arthrobacter simplex* replaced them.

The most abundant bacterial community is present in soils with neutral reaction. Higher contents of calcium and neutral pH caused abundant and diverse bacterial populations. With respect to soil properties, bacterial diversity strongly increases with soil reaction from acid soil to low alkaline soil[7].

Generally, the bacteria count are decreasing from topsoil to depth, but an intense proliferation in the 10–20 cm layer in some soils with very strong acid reaction were found.

High contents of bacteria were found in some Eutric Cambisols and Eutric Fluvisols, due to soil reaction and humus content. Within the same type of soil, the bacteria counts were determined by soil reaction, humus content and distance from the pollution source. Close to the emission source, soils are strongly acidified and few number and low diversity of bacterial communities being found for *Bacillus, Pseudomonas* and *Athrobacter* species.

The bacteria community is poor in Distric Cambisols, Regosols, and Luvisols which have very strong – strong acid reaction.

In soils with neutral – weak alkaline reaction and high organic matter content, high contents of bacteria were determined in both layers (38 $\times 10^6$ CFU/100 g soil in 0–10 cm layer and 22.38 cm $\times 10^6$ CFU/100 g in 10–20 cm layer). Soils with strong acid reaction have the lowest bacteria counts, generally below 5$\lambda\times$ 10^6 CFU/g dry soil.

The microbial community in soils with strong acid reaction and very low organic matter content is represented only by the *Pseudomonas* genus in the 0–10 cm layer, and a small number of bacteria represented by *Bacillus circulans* and *Arthrobacter globiformis* in the 10–20 cm layer.

The bacteria number is quite low (Table 1), the bacterial population being not completely inhibited, but only reduced to the level of bacterial species adapted to poor/adverse soil conditions.

Table 1. Statistical parameters of microbiological activity (bacterial counts, fungal counts, soil respiration)

Statistical parameter	Bacteria counts ($\times 10^6$ CFU/g dry soil)	Fungal counts ($\times 10^3$ CFU/g dry soil)	Soil respiration (mg CO_2/100 g soil)
Counts	44	44	44
Minimum	1	10.3	5.42
25%	5.4	37.5	11.90
Mediana	11.6	49.55	19.69
Average	14.7	66.21	21.59
75%	19.53	89.35	26.45
90%	35.8	120.51	40.55
Maximum	44.5	294.5	53.50
Cv%	80	78	60

In the same soil type, bacteria counts can greatly vary, from 38 $\times 10^3$ CFU/100 g soil to 1.04 $\times$ 10^3 CFU /100 g soil, being directly influenced by soil properties. To explain the differences, correlations between the soil bacteria number and soil chemical characteristics were studied. Thus, correlations between bacteria counts and the soil reaction, organic matter content, as well as the characteristics of the cation exchange properties were revealed (Fig. 1).

The strongest correlation was determined for the soil type with the reaction ($r = 0.573^{***}$), followed by the degree of base saturation ($r = 0.525^{**}$), calcium content ($r = 0.498^{**}$), the sum of the exchangeable base ($r = 0.494^{**}$) and organic matter content ($r = 0.423^{**}$).

Strong correlations between the number of bacteria and humus content were highlighted in the literature[16], taking into the relationships between microbiological indicators and physicochemical properties according to soil type, ecological characterisation and the effects of different pollutants.

Fungi are an important part of microbial biomass in different soil types. They are spread especially in the first 10 cm of the soil profile in the litter with organic substances under decomposition, in the cultivated soils, in forest soils and in the acid soils. Fungi are very tolerant to extreme pH values, respectively, between pH 2.0 and 9.0 (Ref. 10). At low pH values, fungi are dominant in soil[8], because they tolerate easier soil acidification than bacteria or other organisms. The lowest diversity of fungal species is present in ecosystems with extremely conditions for one or more environmental factors[10.]

From a microbiological point of view, the soil profiles revealed the existence of a relatively low number of microorganisms belonging to the fungi group. The highest counts detected, in one site, were 148.626 $\times$ 10^3 CFU/g dry soil in the topsoil, respectively, 294.532 $\times$ 10^3 CFU/g in the 10–20 cm layer. Although this site has a large population, diversity of genera and species is extremely low being represented by *Paecilomyces marquandii* and *Fusarium* sp. in 0–10 cm layer and

only *Paecilomyces marquandii* in 10–20 cm layer. Also, values over 100 × 10^3 CFU/g dry soil were found in another two sites.

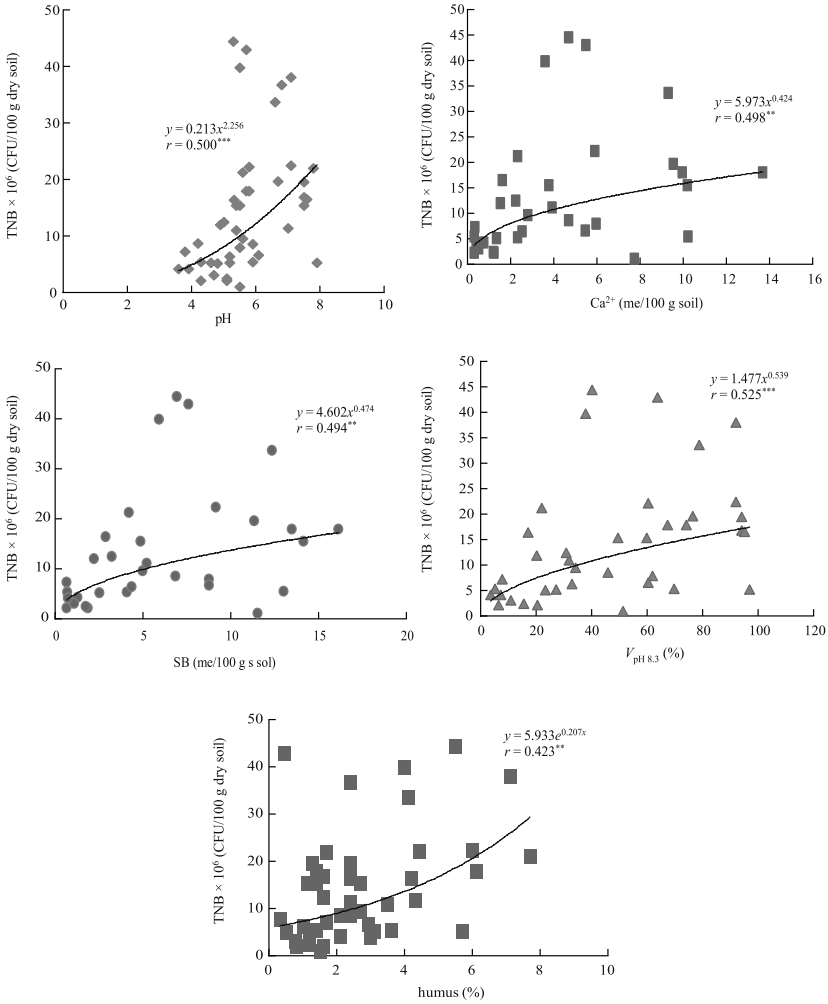


Fig 1. Correlation between different soil properties (pH, H^+, Ca^{2+}, SB, $V_{pH\ 8.3}$, humus contents) and bacterial counts

In other soils, the values did not exceed 100 × 10^3 CFU /g dry soil, the fungal populations decreasing progressively from topsoil to less aerated depth. Decreases of the fungal populations are accompanied by a decrease of specific diversity.

In soils with very strong acid reaction (pH 3.5, respectively, pH 3.6), less favourable to fungal growth, fungal microflora is poor in both layers. In these soils, the lowest fungi counts were determined: 11.619 × 10^3 CFU/g dry soil in topsoil, respectively, 10.302 × 10^3 CFU/g dry soil in 10–20 cm depth.

Also, these soils have been affected in terms of species diversity, *Rhizopus stolonifer*, *Penicillium janthinellum* and *Geotrichum candidum* in 0–10 cm and *Rhizopus stolonifer* in 10–20 cm layers being isolated.

In another soil with strong acid reaction, the topsoil was populated with up to 22.890 $\times 10^3$ CFU/g dry soil, while, in the next soil layer, the fungi counts were smaller compared with values recorded on the topsoil (12.604 $\times 10^3$ CFU/g dry soil). In terms of diversity, *Epicoccum nigrum*, in the first layer, and *Aspergillus terreus* in the next layer were isolated.

Decreases of the fungal populations are accompanied by a decrease in specific diversity in the 10–20 cm layer, in 20% of soil samples, only one species or maximum two species have been isolated due to the existing conditions soil.

Generally, the *Fusarium* and *Penicillium* genera, followed by the *Cladosporium* and *Aspergillus* genera were most frequently identified, highlighting a high degree of tolerance to the poor conditions of the soil. High diversity generally characterises soils with a neutral reaction. Correlation between soil chemical properties and fungi counts (Fig. 2) have positive trends, and distinct significant or significant values for soil reaction, the degree of base saturation, cation exchange capacity and calcium contents. Correlations, although significant, are smaller than those found for bacteria.

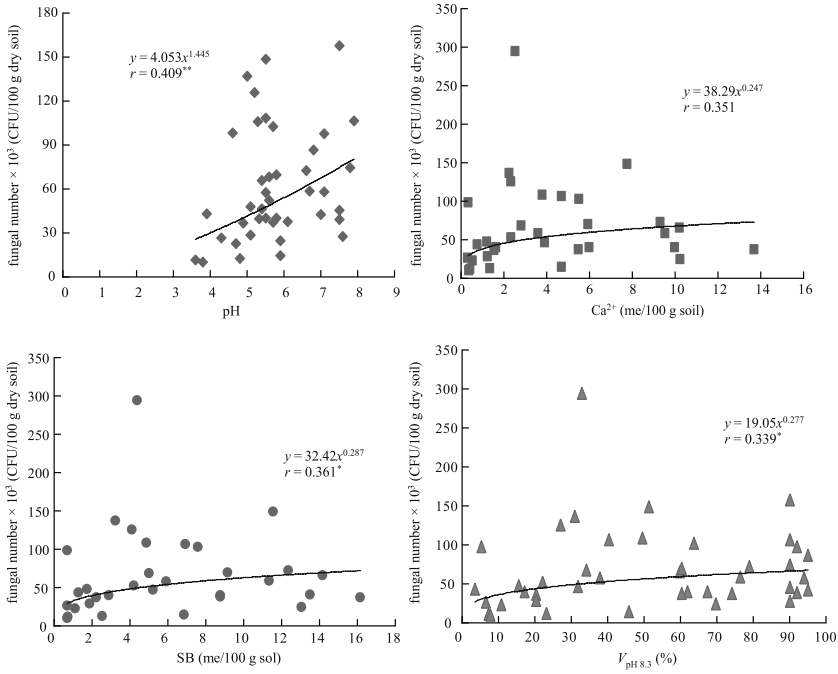


Fig. 2. Correlation between the soil properties (pH, Ca^{2+}, SB, $V_{pH\ 8.3}$) and fungal counts

Soil respiration is a characteristic of soil organic matter mineralisation and other metabolic processes in which CO_2 is released[16]. Under stress, stronger organisms respond by increasing respiratory activity, while more sensitive organisms are characterised by decreased respiration values[17].

Higher values of microbial biomass and respiration rates indicate a better state of soil microorganisms, which could not be highlighted in the area studied.

Thus, over 80% of the soil samples presented a low potential of soil respiration values and only 20% presented a medium potential of soil respiration values (Table 1).

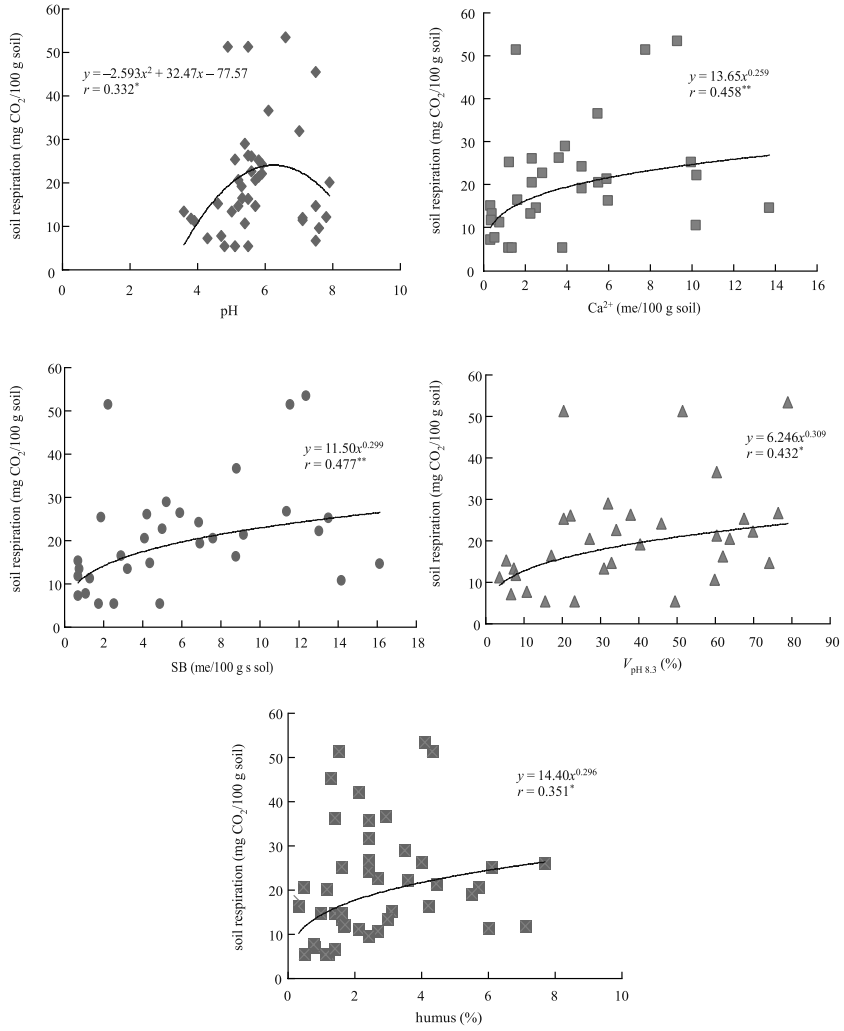


Fig. 3. Correlation between the soil properties (pH, Ca^{2+}, SB, $V_{pH\ 8.3}$, organic matter contents) and bacterial counts

In terms of soil type, average values of soil respiration can be found at Fluvisols, with neutral – slightly alkaline reaction, and medium organic matter content, allowing thus the development of a various bacterial community and a medium fungal microflora community. However, the profiles with average soil respiration values, in the least one layer, higher than the bacterial biomass may suggest a state of stress[15].

Soil respiration is positively influenced by the soil calcium content, the cation exchange capacity, the degree of base saturation and the total organic matter content (Fig. 3), establishing significant distinct or significant positive correlations.

Changes in soil respiration were found related to soil reaction, thus, in control soils, respiration was greater at pH 6.1 compared to pH 4.0 (Ref. 17). Also, soil respiration activity significantly correlated with total carbon content and total nitrogen content[18].

CONCLUSIONS

The bacteria counts are quite low in the analysed samples. The bacterial population is not completely inhibited, but only reduced to the level of bacterial species adapted to adverse soil conditions. For the same soil type, the bacteria counts were influenced by soil reaction, organic matter content, and the distance from the pollution source. The best correlation was determined between the bacteria counts and soil reaction ($r = 0.573^{***}$), followed by those with the degree of base saturation ($r = 0.525^{**}$), calcium content ($r = 0.498^{**}$), the sum of the cation exchange ($r = 0.494^{**}$), and humus content ($r = 0.423^{**}$).

The soil profiles revealed the existence of a relatively low number of microorganisms belonging to the group of fungi. Decreases of fungal populations are accompanied by a decrease in specific diversity. The correlations between soil fungal number and soil chemical properties are generally positive and significant, especially for soil reaction, the degree of soil base saturation, the sum of cation exchange and calcium contents.

As regarding the soil respiration, over 80% of the soil samples highlighted a low potential of soil respiration and only 20% highlighted a medium potential of soil respiration.

REFERENCES

1. C. RAUTA, C. CIOBANU, M. DUMITRU, E. DULVARA, B. KOVACSOVICS, L. LATIS: Case Study on Soil Pollution with Heavy Metals and Sulphur Compounds in the Zlatna Area. In: Monitoring of Soil Quality in Romania. Publistar, Bucharest, 1998, 143–154.
2. G.-A. DUMITREL, M. POPA, M. GLEVITZKY, M. VICA: Evaluation of Soils Heavy Metal Pollution in the Zlatna Region. J Environ Prot Ecol, **14** (4), 1569 (2013).

3. H. DOVLAND, A SEMB: Atmospheric Transport of Pollutants. In: Proc. of the International Conference on the Ecological Impact of Acid Precipitation, Sandefjord, 11–12 March, SNSF-project, 1980, 14–21.
4. Ghe. SMEJKAL: Forest and Industrial Pollution. Ceres Ed., Bucharest, 1982.
5. M. POPA, M. JITARU: Study on the Dynamics of Cu_2^+ Accumulation in the Polluted Vegetation from Zlatna Region. J Environ Prot Ecol, **7** (2), 326 (2006).
6. M. POPA, M. GLEVITZKY, D. POPA, S. VARVARA, G. A. DUMITREL: Study on Soil Pollution with Heavy Metals near the River Ampoi, the Alba County. J Environ Prot Ecol, **13** (4), 2123 (2012).
7. D. H.F. LIU, B. G.LIPTAK: Air Pollution. CRC Press, Boca Raton, Florida, 1999.
8. N. C. BRADY, R. R. WEIL: The Nature and Properties of Soils. 13th ed. Pearson Education, Upper Saddle River, NY, USA, 2008.
9. A. J. FRANCIS: Acid Rain Effects on Soil and Aquatic Microbial Processes. Cell Mol Life Sci, **42** (5), 455 (1986).
10. G. ZARNEA: General Microbiology. Theory of Ecology of Microorganisms: Microorganisms and Their Natural Environments. Romanian Academy Publishers, Bucharest, 1994.
11. IUSS–FAO: World Reference Base for Soil Resources 2014. International Soil Classification System for Naming Soils and Creating Legends for Soil Maps. World Soil Resources Reports No 106. FAO, Roma, 2014,
12. M. DRACEA, V. BLANARU, R. BOGACI: Determination of Soil Cation Exchange Properties. MAIA, ASAS, ICPA, Bucharest, 1986, 220–258.
13. D. DANILIUC: Determination of Organic Carbon and Estimation of Soil Humus Content. In: Soil Agrochemical Analysis Methodology in Order to Establish the Necessary Amendments and Fertilizers. MAIA, ASAS, ICPA, I (I), 1981, 125–132.
14. P. PAPACOSTEA: Soil Biology. Scientific and Encyclopedic Publishers, Bucharest, 1976.
15. Gh. STEFANIC: Assay of the Potential Level of Soil Respiration with an Oxygen-Generating Respirometer. Bull Acad Sci Agric Forest, **21**, 87 (1991).
16. I. VASILINIUC: Soil Quality: Notions and Concepts. Al. Ioan Cuza University Ed., Iasi, 2009.
17. H. SANTRUCKOVA: Soil Respiration as a Measure of Soil Biological – Activity. Crop Production, **39**, 769 (1993) (in Czech).
18. M. A. TABOR-KAPLON, J. BLOEM, P. ROMKENS, P.C. de RUITER: Functional Stability of Microbial Communities in Contaminated Soils. Oikos, **111**, 119 (2005).

Received 22 February 2016
Revised 28 April 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *512–522* (*2016*)

Industrial pollution

GEOTECHNICAL CHARACTERISTICS OF INDUSTRIAL WASTE SLAG AND SLUDGE FROM SMEDEREVO STEEL MILL, SERBIA

D. RAKIC[a]*, I. BASARIC[a], Z. BERISAVLJEVIC[b], D. BERISAVLJEVIC[c]

[a]*Department of Geotechnics, Faculty of Mining and Geology, University of Belgrade, 7 Djusina Street, 11 000 Belgrade, Serbia*
E-mail: *dragoslav.rakic@rgf.bg.ac.rs*
[b] *'Koridori Srbije' Ltd., 21 Kralja Petra Street, 11 000 Belgrade, Serbia*
[c]*Institute for Testing Materials-IMS, 43 Vojvode Misica Blvd., 11 000 Belgrade, Serbia*

Abstract. In 2011, steel mill in Smederevo has started with the construction of the first certified plant for the industrial waste management in the Republic of Serbia. The most important facility of this plant is the industrial waste landfill with independent cells: bigger – for non-hazardous waste disposal and smaller – for hazardous waste disposal. Since this is the earthfill structure with a planned height of 50 m, one of the main geotechnical problems, which is being analysed in these cases, is landfill slope stability. Geotechnical parameters, especially shear strength parameters (internal friction angle – φ′ and cohesion *c*′) as well as general physical parameters (unit weights, moisture content, particle size distribution, permeability) are used in these analysis. Their values, obtained by laboratory geomechanical tests on different samples of slag and sludge, are presented in this paper.

Keywords: industrial waste, steel slag, sludge, geotechnical parameters, shear strength.

AIMS AND BACKGROUND

In Serbia, only in manufacturing plants of the steel mill Smederevo, over 1 150 000 t of industrial waste generate each year. Almost half of it (500 000 t) is been reused, either within the steel mill or beyond. The rest of waste, which includes solid industrial waste (slag) and sludge from the industrial waste water treatment plant are been permanently disposed. Thereby, the steel mill started with the construction of the first certified plant for industrial waste management in the Republic of Serbia. The aim of this plant, from the aspect of environmental protection, is to provide the space in a rational and safe way, i.e. to build a landfill for permanent disposal of eleven types of industrial waste and for temporary storage of certain waste types which are listed as secondary raw material. The total available capacity of the landfill is 4 685 000 m³, of which 4 450 000 m³ are planned for non-hazardous waste disposal and 235 000 m³ for hazardous waste disposal.

* For correspondence.

Estimated quantities of certain waste types, which would be disposed annually, are presented in Table 1 (Ref. 1).

Besides these estimated annual quantities, at the landfill will be disposed and 900 000 m^3 of slag from the blast furnace which is located at the site (Table 2) (Ref. 2).

Waste management plant has the following functional units: landfill body (consists of two separate cells: bigger – for non-hazardous waste disposal and smaller – for hazardous waste disposal, Fig. 1), manipulative-service plateau, internal roads and system of protective boundary channels.

Table 1. Annual quantity of waste for disposal[1]

Waste types	Classification	Quantity (t/year)	Reuse (%)	Density (t/m^3)	Volume (m^3)
BF lump slag	nHZW-solid	253685	20	1.553	130681
Convertor slag	nHZW-solid	260784	40	1.553	100754
Mixer slag	nHZW-solid	78201	25	0.894	65605
BF sludge	HZW-sludge	15361	0	1.606	9565
Neutralisation sludge	HZW-sludge	8477	0	1.111	7630
Refractory waste	HZW-solid	5286	30	1.960	1888
Steel turnings	nHZW-solid	147	50	1.842	40
Roll shop machinery waste	nHZW-solid	53	50	2.400	11
Tandem mill sludge	HZW-sludge	456	0	1.111	411
Filter cake	HZW-sludge	950	0	1.111	855
Tin mill sludge	HZW-sludge	13	0	2.000	6
Total		623413			317446

Table 2. Waste volumes for disposal from 1 year till 10 years[1]

Type of cell	Present waste (m^3)	Yearly production for landfilling (m^3)	Years	Total capacity needed (m^3)
nHZW-solid	900000	297091	1–5	2385455
HZW-solid	0	1888		9440
HZW-sludge	0	18467		92335
nHZW-solid	0	297091	6–10	1485455
HZW-solid	0	1888		9440
HZW-sludge	0	18467		92335

Fig. 1. Location of the waste management plant with the final look of landfills for hazardous and non-hazardous waste

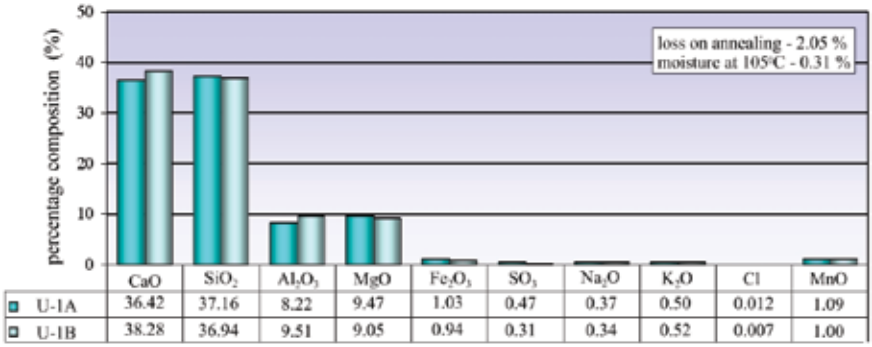
EXPERIMENTAL

There is no internationally accepted standard sampling procedure of industrial waste for the purpose of geomechanical tests. The reason for this is the extreme waste heterogeneity (by chemical and mineral composition, size and shape of fractions, different characteristics of individual waste types). Analysis of literature data showed that researchers used different sample sizes and different compositions of industrial waste for determination of physical-mechanical characteristics[2,3]. Prior mechanical preparation was mostly performed in terms of grinding (milling, crushing or simply removal of larger pieces) or tests included only small fractions of industrial slag from steel mills[4].

Results presented in this paper were obtained by tests on artificially prepared samples, taking into account moisture content, density, shape of waste particles and with respect to recommendations related to dimensions of used apparatus and size of the largest fractions in sample. For the first sample group formation non-hazardous industrial waste (nHZW) was used, which was taken from the location where it has already been disposed. The sample of hazardous waste (HZW) was taken directly from the process of industrial waste waters treatment (Fig. 2). Geomechanical laboratory tests of non-hazardous waste were carried out on 4 samples (U-1A,B and U-2A,B), and one sample of hazardous waste (U-3) was also laboratory tested. Both groups of industrial waste were treated as 'artificial soil', so the laboratory testing methods used in soil mechanics were applied for the definition of physical-mechanical parameters.

Fig. 2. Layout of hazardous waste (sludge) and non-hazardous waste (slag) which will be disposed at the landfill

The average values of chemical composition of non-hazardous waste samples (blast furnace slag – BF lump slag), on which laboratory geomechanical tests were performed, are presented in Fig. 3.



	CaO	SiO_2	Al_2O_3	MgO	Fe_2O_3	SO_3	Na_2O	K_2O	Cl	MnO
U-1A	36.42	37.16	8.22	9.47	1.03	0.47	0.37	0.50	0.012	1.09
U-1B	38.28	36.94	9.51	9.05	0.94	0.31	0.34	0.52	0.007	1.00

Fig. 3. Chemical composition of blast furnace slag

The results of performed particle size distribution analysis, without previous material preparation, for all three waste types, are presented in Fig. 4 (Ref. 5).

Shear strength is defined by direct shear test, using the direct shear apparatus. Material is previously crumbled, homogenised and mixed in order to ensure an adequate ratio of particle size distribution, i.e. ratio of characteristic apparatus dimension (L) and fraction size (d), $L/d \geq 5$. All tested samples had over 90% of particles smaller than 20 mm, and the rest (6–9%) were larger particles with maximum size of 40 mm.

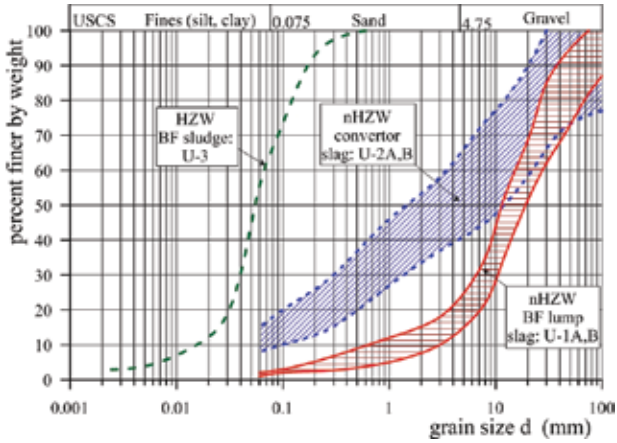


Fig. 4. Particle size distribution curves of tested industrial waste samples

RESULTS AND DISCUSSION

Industrial waste slag has quite good physical-mechanical characteristics[6]: specific gravity G_s = 3.2–3.6, dry unit weight γ_d = 16–19.2 kN/m^3, water absorption up to 3%, Los Angeles – abrasion 20–25%, hardness between 6 and 7 and California Bearing Ratio (CBR) can be over 100%. The results of performed laboratory tests showed that waste slag can be used in road construction, since it shows a good compaction characteristic and bearing capacity. Value of CBR ranged from 21.2 to 30.2%, and dry unit weight was in range γ_{dmax} = 16.4–18.9 kN/m^3 at the optimum moisture content w_{opt} = 6.6–11.1% (Fig. 5) (Ref. 5).

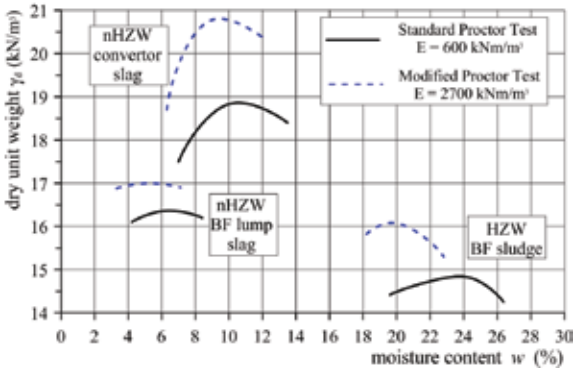


Fig. 5. Comparison of standard Proctor test and modified Proctor test of different industrial waste material

Correct design of landfill slopes implies knowledge of industrial waste shear strength, whether it refers to the contact of waste and natural soil, waste and natural

protective systems or waste and artificial (geosynthetic) materials used as protective systems[7]. Tests in the direct shear apparatus showed that stress – displacement relationship has a different character in different industrial waste types, regardless to their density. So, for non-hazardous waste samples (U-1: BF lump slag and U-2: conv. slag), with unit weights γ = 15.5–16.5 kN/m^3 and under higher normal stresses (σ'_n = 200 kPa), this relationship for initial and medium displacements (Δl < 6 mm), is the most similar to behaviour of material with deformation hardening. The peak shear strength mobilises only at horizontal displacements large enough. Under lower normal stresses (σ'_n < 100 kPa), the stress-displacement relationship was mostly indicated the behaviour of waste similar to the behaviour of material with distinct plastic failure (Fig. 6).

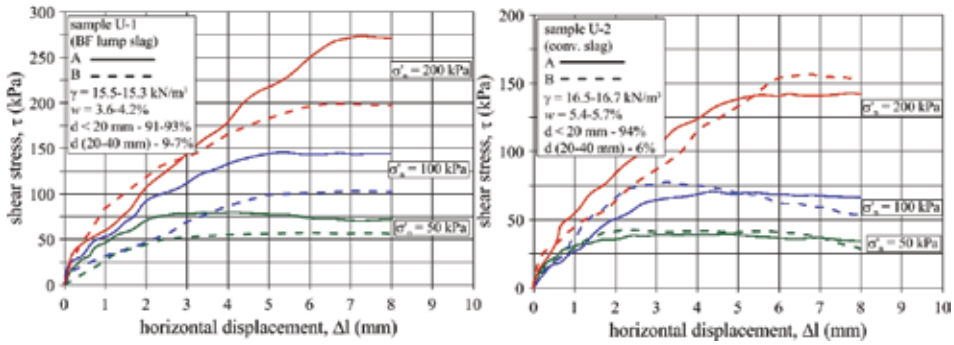


Fig. 6. Characteristic stress-displacement relationship for the non-hazardous waste samples

Stress-displacement relationship on a hazardous waste sample (U-3: BF – sludge), despite its better density (γ = 17.0 kN/m^3) and value of normal stresses, had different character. The stress-displacement behaviour of this sample is similar to the behaviour of soil with distinct plastic failure at small horizontal displacements (Δl < 3 mm, Fig. 7).

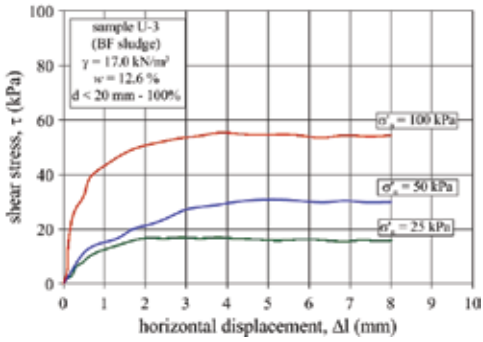


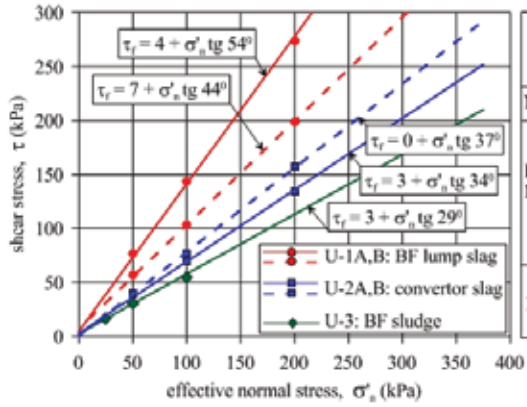
Fig. 7. Characteristic stress-displacement relationship for the hazardous waste sample

For defining the industrial waste shear strength (τ_f), a linear Coulomb-Mohr-Terzaghi equation is usually proposed[8]. This equation is a function of normal total stresses $\tau_f = f(\sigma_n)$, i.e. a function of normal effective stresses $\tau_f = f(\sigma'_n)$, using effective cohesion (c') and effective internal friction angle (φ'):

$$\tau_f = c' + \sigma'_n \operatorname{tg} \varphi' \tag{1}$$

Since that for all samples, regardless of normal stress levels, is clearly expressed failure, the peak values of shear strength were determined. The obtained values for linear form of Coulomb-Mohr-Terzaghi equation, are presented in Fig. 8, where they are compared with values of other authors that can be found in the literature[6,9]. This relationship is the simplest approximation of stress at failure, which is in reality presented with complex mechanism of interaction between grains of different sizes, shapes and even composition. Therefore, the interpretation was also performed based on the nonlinear failure envelope, using relations that correspond to the so-called hyperbolic shape[10]. Change of the effective secant shear strength angle is expressed as a function of normal stress in the following form

$$\varphi' = \varphi'_B + \frac{\Delta\varphi'}{1+\sigma'_n/p_N}; \qquad \tau_f = c' + \sigma'_n \cdot \tan\left(\varphi'_B + \frac{\Delta\varphi'}{1+\sigma'_n/p_N}\right) \tag{2}$$



Author		shear strength parameters	
		c' (kPa)	φ' (°)
Noureldin and McDaniel (1990)		-	40 - 50
I. Z. Yildirim and M. Prezzi (2009)	BOF slag R_c=95-100% w=4-8%	-	45.3-48.3
	EAF slag R_c=95-100% w=10-14%	-	40.4-40.8
Rakić et al.	BF lump slag	4 - 7	44 - 54
	Convertor slag	0 - 3	34 - 37
	BF sludge	3	29

Fig. 8. Comparative display of proposed linear failure envelopes with literature data

On the BF lump slag samples (γ = 15.3–15.5 kN/m^3), analyses were performed with cohesion of c' = 0 and 4 kPa. This way, the nonlinear envelopes were obtained, which showed good matching with linear Coulomb-Mohr-Terzaghi shear strength equation (Fig. 9).

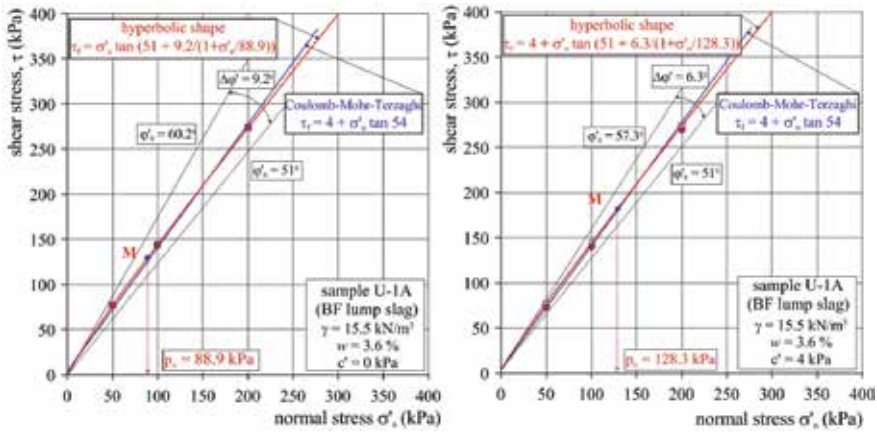


Fig. 9. Nonlinear shear strength equation of hyperbolic shape for BF lump slag

The same analyses were performed on the convertor slag samples (γ = 16.5–16.7 kN/m^3), with cohesion values c' = 0 and 3 kPa. For the convertor slag also, nonlinear envelope showed good matching with linear Coulomb-Mohr-Terzaghi shear strength equation (Fig. 10).

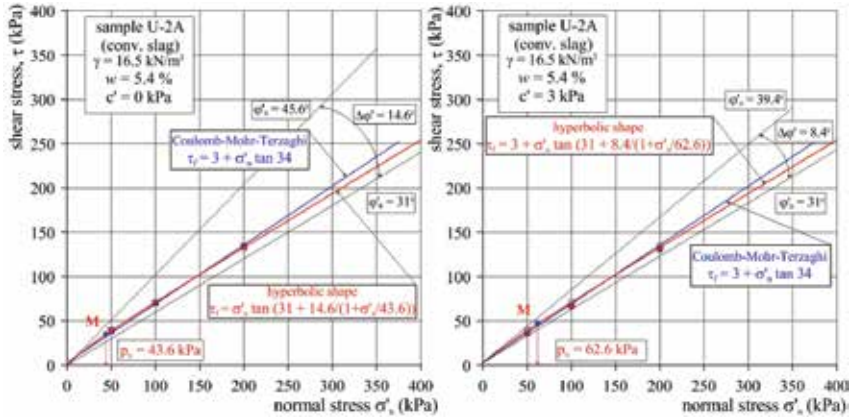


Fig. 10. Nonlinear shear strength equation of hyperbolic shape for convertor slag

Analysis with cohesion c' = 0 and 3 kPa was performed on BF sludge sample (γ = 17.0 kN/m^3), and nonlinear and linear shear strength equations for both cohesion values are presented in Fig. 11.

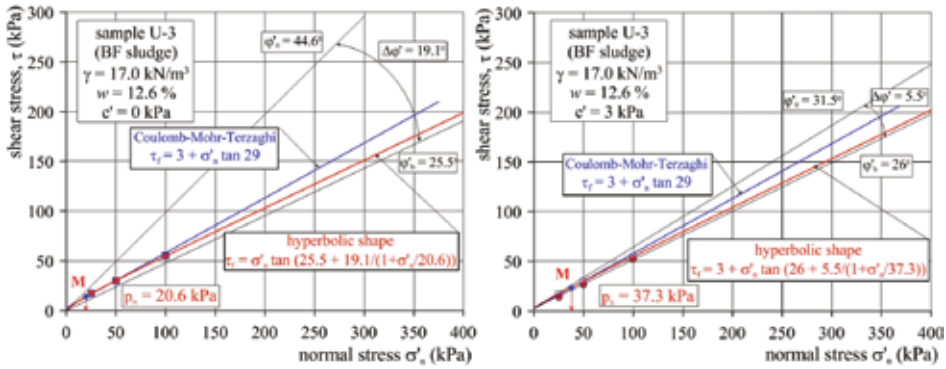


Fig. 11. Nonlinear shear strength equation of hyperbolic shape for BF sludge

Hyperbolic shape of shear strength equation has not been used so far for description of industrial waste shear strength, and therefore obtained nonlinear failure envelopes are compared with linear Coulomb-Mohr-Terzaghi equation and cumulatively presented in Fig. 12. To highlight the importance of using the nonlinear failure envelope and a significantly higher range of normal stresses, relationships for normal stresses interval from 0 to 1000 kPa are presented in Fig. 12. It can be seen that the proposed hyperbolic shape of nonlinear failure envelope showed good matching for the normal effective stresses interval σ'_n = 0–200 kPa, while for the normal effective stresses σ'_n > 200 kPa, deviation trend is expressed in terms of getting smaller values of internal friction angle, i.e. decrease of shear strength. Since the planned landfill height was 50 m, and that in these conditions the vertical effective stresses will be significantly higher than 200 kPa, for the stability analysis needs the nonlinear failure envelope of hyperbolic shape was used.

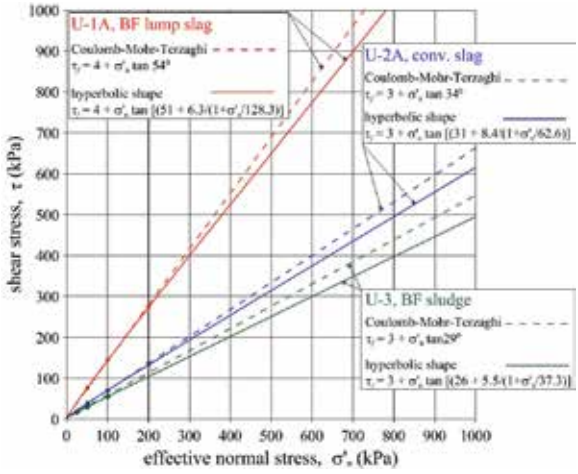


Fig. 12. Comparative review of proposed linear and nonlinear shear strength envelope of different industrial waste material

CONCLUSIONS

Problem of industrial waste disposal does not generally fall into any traditional engineering disciplines, but it is an interdisciplinary scientific area. However, despite the use of prescribed regulations, certain problems often occur because of insufficient knowledge of waste material in the landfill body. Waste material in the landfill body changes physical and mechanical characteristics over time due to constant circulation of leachate. Therefore, landfills that are more often designed are those that exceed requirements defined in the regulations in some key aspects that can endangered safety and certain technological systems and cause specific ecological consequences on the environment. One of these requirements is the analysis of the most important geotechnical aspects, primarily the landfill slope stability and prediction of size and time of waste settlement. This includes knowledge of physical-mechanical parameters of waste material (primarily the shear strength parameters). Values of the shear strength parameters, which are presented in this paper, vary depending on the industrial waste type, and therefore values that can be found in the world literature are different. The composition of steel slag varies from one region to another and from one country to another, which significantly affects the physical-mechanical properties. That is why these values cannot be directly taken from literature data without previous knowledge of chemical composition of steel slag, preparation method during the sample formation and performed procedure for their determination.

Acknowledgements. This paper was realised under project number 36014 funded by the Ministry of Education, Science and Technological Development of Republic of Serbia for the period 2011–2015.

REFERENCES

1. TAHAL-FIDECO, LDK Consultants and Planners S.A.: Report for a New Project: Waste Management Facility – WMF, for USSS at Its Steel Plant in Smederevo, Serbia, Preliminary Design, 2010.
2. N. BAGHINA, I. RADULOV, A. BERBECEA, A. MOISCUS, C. STROIA: Sewage Sludge Fertilisation Influence on Main Soil Chemical Features. J Environ Prot Ecol, **15** (1), 217 (2014).
3. R. TEODORESCU, M. ULMANU, M. GHEORGHE: Research in the Field of the Electroplating Sludge Processing. J Environ Prot Ecol, **5** (3), 519 (2004).
4. G. PERKOULIDIS, A. KARAGIANNIDIS, S. KONTOGIANNI: Solid Waste Management in Developing Countries. Present Problems and Future Perspectives. J Environ Prot Ecol, **12** (2), 570 (2011).
5. D. RAKIC, B. VOJNOVIC, D. BERISAVLJEVIC. I. BASARIC: Geotechnical Conditions of Industrial Waste Landfill Construction for U.S. Steel Serbia. In: Proc. of the XV Balkan Mineral Processing Congress, Sozopol, Bulgaria, 2013, 1056–1060.
6. A. S. NOURELDIN, R. S. McDANIEL: Evaluation of Surface Mixtures of Steel Slag and Asphalt. Transportation Research Record 1269, Transportation Research Board, National Research Council, Washington, D.C., 1999, 133–149.

7. D. RAKIC, L. CAKI, S. CORIC: Shear Strength of Municipal Waste Materials from Two Landfills in Serbia. Coupled Phenomena in Environmental Geotechnics (CPEG), from Theoretical and Experimental Research to Practical Applications, CRC Press, Taylor & Francis Group, Torino, Italy, 2013, 347–354.
8. K. VOSNIAKOS, C. PATRONIC: Risk Analysis of Influence of Several Parameters on the Shear Behavior of a Filled Rock Joint Using DEM. J Environ Prot Ecol, **10** (1), 110–120 (2009).
9. Z. YILDIRIM, M. PREZZI: Use of Steel Slag in Subgrade Applications. FHWA/IN/JTRP-2009/32, Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2009. 275 p.
10. M. MAKSIMOVIC: Nonlinear Failure Envelope for Soils. J Geotech Eng, Am Soc Civil Eng, **115** (4), 581 (1989).

Received 12 February 2016
Revised 20 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 523–531 (2016)

Industrial pollution – public health

RESPIRATORY IMPACT IN WORKERS EXPOSED TO AIR POLLUTANTS FROM PETROLEUM REFINERY

E. DANTES[a,b]*, A. P. FILDAN[a,b]*, C. L. TOMA[c,d], GH. VOICU[a], C. OANCEA[e]

[a]*Clinical Pneumology Hospital of Constanta, Constanta, Romania*
E-mail: *ariadnapetrofildan@yahoo.com*; *elena.dantes@gmail.com*
[b]*Faculty of Medicine, 'Ovidius' University, Al. Universitatii Street, Campus, Corp B, 900 470 Constanta, Romania*
[c]*Institute of Pneumology 'Marius Nasta', Bucharest, Romania*
[d]*University of Medicine and Farmacy 'Carol Davila', Bucharest, Romania*
[e]*University of Medicine and Pharmacy 'Victor Babes', Timisoara, Romania*

Abstract. The aim of the study is to examine the frequency of respiratory symptoms in a representative group of employees exposed to possible chemical pollutants, who work in the petrochemical refinery in Constanta County. We studied the exposure to environmental workplace air pollutants emitted by major sources of refinery and the prevalence of cough, expectoration, wheezing, dyspnea, chest pain or tightness in a group of 202 exposed employees and we compared this group with 121 non-exposed persons. The population of the 2 lots ($N = 323$) was investigated using a medical questionnaire and performing clinical examination. The prevalence of symptoms was calculated by sex, age, seniority at work and associated respiratory risk factors (smoking). The results reveal the most common chemical pollutants released into the atmosphere at the workplace: aliphatic and aromatic hydrocarbons, (sulphur dioxide) SO_2, carbon dioxide (CO_2), oxide of nitrogen (NO_x), volatile organic compounds (VOCs), particulate matter. The presence of these substances is systematically checked by the toxicology laboratory. 258 of the patients (pts.) (80%) age between 31–50, 132 pts. (40%) people had seniority at work between 6 and 15 years (91 pts. in the exposed group and 41 pts. in the unexposed group), and 46 pts. (14%) a higher seniority, between 21 and 30 years (24 pts. in the exposed group and 22 pts. in the non-exposed group). There was a predominance of respiratory symptoms in the exposed group, mainly cough (31.20%), expectoration (29.7%) and wheezing (29.2%). Out of 323 subjects, 205 pts. (63%) presented at least one respiratory symptom, 132 pts. (65.3%) in the exposed group versus 73 pts. (60.3%) in the non-exposed one. Symptoms were frequent in the group of smokers and in smokers exposed to toxic emissions. The study shows the importance of complying with regulations and requires ongoing monitoring of air quality in risk areas to prevent occupational exposure of employees and development of respiratory diseases.

Keywords: refinery, exposure, respiratory symptoms.

* For correspondence.

AIMS AND BACKGROUND

The petroleum refinery manufactures crude oil into gasoline, diesel fuel, kerosene, oils, feedstock for the petrochemical industry, hydrogen gas[1]. Petroleum refinery activities include storage at the refinery, all petroleum handling and refining operations starting with crude desalting (crude oil is washed with water from contaminants), fluid catalytic cracking (a process that converts fractions of petroleum into gasoline, olefinic gases and other products), catalytic reforming (chemical process that converts naphtha into higher octane liquid products known as reformates), sulphur recovery, thermal processing, delayed coking (cracks the heavy long chain hydrocarbon molecules into gas oil and petroleum coke) and terminate with distribution with loading of refined products into pipelines, tank trucks or ships[1–3]. Criteria air pollutants and other non-hazardous air pollutants that are emitted (nitrogen oxides (NO_x), particulate matter (PM), sulphur dioxide (SO_2), volatile organic compounds (VOCs), carbon monoxide (CO), greenhouse gases (GHG), total reduced sulphur) have adverse respiratory effect as irritation of the upper and lower airways or inflammations[1–5].

Asthma, chronic bronchitis and COPD are more common diseases that could be developed by workers in refinery due to occupational exposure[4,5]. Hazardous air pollutants emitted by this industry as organics (e.g. benzene, toluene, formaldehyde, acetaldehyde, phenol, ethylbenzene, xylene), inorganics (e.g. hydrogen chloride (HCl), hydrogen cyanide (HCN)), reduced sulphur compounds (carbon disulphide (CS_2)), and metals (e.g. arsenic, beryllium, cadmium, chromium, cobalt) are involved especially in leukemia or other severe blood disorders, cancer, hypersensitivity pneumonia, cardiovascular effects, depression of immune system, neurological and skin diseases[3,5,6]. The aim of our study was to evaluate the exposure to environmental workplace air pollutants emitted by major sources of refinery and identify the prevalence of cough, expectoration, wheezing, dyspnea and chest pain or chest tightness in exposed workers in petroleum refinery.

EXPERIMENTAL

The hypothesis of the study was that exposure to work in a refinery increases the risk of respiratory symptoms and lung diseases. The study design was a prospective cohort study. The study is part of a large epidemiological research, aimed to estimate the prevalence of symptoms and lung disease in a community exposed to respiratory risk factors chemical, a petrochemical sector, within Constanta County, Romania[7]. The notion of respiratory risk is defined as potential adverse effects on respiratory health resulted from exposure to hazardous agents[8], and the professional chemical noxa as substance used in the production process, under certain circumstances, could damage the body causing his illness[5].

Materials. A representative sample of the reference population was constituted, represented by the 3094 exposed employed persons, choosing a statistic step of 14, the accuracy of the sample being 95.5% and limit error of 0.1%. The study group consisting of 221 exposed employees was compared with a sample population of 145 non-exposed individuals from the administrative department. Patients in the study group (N = 323) representing 221 exposed individuals (Ex) and 145 non-exposed individuals (Non-Ex) were noted the general demographic data, respiratory chemical pollutants exposed person status, smoker status, presence of respiratory symptoms as cough, expectoration, wheezing, dyspnea, chest pain, acute episode of dyspnea or chest tightness.

Methods. We analysed the presence of exposure and respiratory symptoms in the group studied using questionnaires that included information on identifying the workplace, general information (age, sex, residence, seniority at work), workplace characteristics (lighting, ventilation, sanitary conditions, collective and individual means of protection), information about symptoms and diseases for each employee included in the study and exposure to smoking. Anamnesis, clinical examination, pulmonary function test and chest X-ray were performed. All cases were centralised in a common database in electronic format using Microsoft Office Excel 2007 program. Statistical analysis of the data has been carried out using soft GraphPad Prism and SPSS. Data were expressed as mean, percentage, standard deviation. The prevalence rate of symptoms was used to calculate the exposure risk in certain groups studied: exposed/non-exposed, women/men, smokers/non-smokers, low seniority/high seniority at work.

RESULTS

The study was conducted on 323 employees of the Petrochemical refinery from Constanta county, Romania, which were divided into 2 groups: a group of 202 people (62.5%) exposed to chemical hazards existing in their work environment and a group of 121 non-exposed people (37.5%) working in the administrative department. The general characteristics of the population studied are shown in Table 1.

Table 1. Characteristics of cohorts

	Cohort population	Exposed (Ex)	Non-exposed (Non-Ex)
Subjects No (%)	323	202 (62.5)	121 (37.5)
Ratio male:female	136 (42.1):187 (57.9)	117 (57.9):85 (42.1)	19 (15.7):102(84.3)
Mean age	39.43+–7.13 (25–56)	38.07+–6.6 (24–56)	41.70+–7.42
History of occupational exposure (years)	12.41+–7.25	12.40 +–6.7	12.41+–7.25
Smoking habits			
Actual or former	214 (66.2)	143 (70.7)	71 (58.6)
Never	109 (33)	59 (29.21)	50 (40.65)

The distribution of cohort persons depending on the Petrochemical refinery installations and the most common chemical hazards found are shown in Table 2.

Table 2. Work place characteristics

Work place	Chemical air pollution exposed (Ex)	Chemical air pollution non-exposed (Non-Ex)	Air chemical pollutants
Mixture of manufactured expedition products	78 (38.6)	0 (0)	aliphatic hydrocarbons
Coker	16 (7.9)	0 (0)	SO_2, aliphatic hydrocarbons, coke breeze
Atmospheric vacuum distillation	10 (5)	0 (0)	petroleum, gasoline, ethanol and methyl, H_2S
Gas desulphurisation and sulphur recovery	8 (4)	0 (0)	SO_2, H_2S, sulphur powder, mercaptans
Electric	7 (3.5)	0 (0)	aliphatic hydrocarbons and polycyclic aromatic hydrocarbons, CO_2, H_2S
Gasoline hydrofining	2 (1)	0 (0)	gasoline, mercaptans, gases with C3, C4, SO_2, H_2S
Hydrofining	7 (3.5)	0 (0)	petrol, diesel, gasoline, ethanol and methanol, catalyst powder SO_2, H_2S
Loading petroleum products and packaging	3 (1.5)	0 (0)	aliphatic hydrocarbons and butane
Laboratory	7 (3.5)	0 (0)	aliphatic and aromatic hydrocarbons, sulphuric acid, nitric acid, hydrochloric acid, sodium hydroxide, CO_2, CO, NO_2, SO_2, H_2S
Electronics automation Mechanical Department	0 (0)	28 (23.1)	
Petroleum and petrochemical testing Inspection Department	43 (21.3)	0 (0)	idem laboratory
Technical Department	0 (0)	5 (4.1)	
Administrative Department	0 (0)	88 (72.7)	
Others	21 (10.4)	0	miscellaneous
Total	202 (100)	121 (100)	

The main features evaluated in the workplace were lighting, ventilation, sanitary conditions and the existence of collective and individual protection means. 180 (89.1%) of the group exposed employees said they have the means of collective protection and 187 (92%) have personal protective equipment. All employees

have performed medical examination prior employment and 91.3% had regular health checks.

The prevalence of respiratory symptoms among employees in the exposed group compared to those in the unexposed group is presented in Table 3.

Table 3. Prevalence of respiratory symptoms among employees

	Chemical air pollution exposed (Ex)	Chemical air pollution non-exposed (Non-Ex)	Prevalence report of symptoms (PR)
Cough	63 (31.20)	19 (15.70)	1.99
Expectoration	60 (29.70)	27 (22.30)	1.33
Wheezing	59 (29.20)	28 (23.10)	1.26
Dyspnea	46 (22.80)	27 (22.30)	1.02
Chest tightness	22 (10.90)	17 (14)	0.78
Acute crisis of dyspnea	25 (12.40)	38 (31.40)	0.39
Total symptoms	132 (65.30)	73 (60.30)	1.08

Risk assessment of occupational exposure to chemical pollutants at work was performed by calculating the ratio of prevalence symptoms traced in different groups of people compared. Prevalence ratio (PR) represents the ratio between the prevalence of symptoms in group A and prevalence of symptoms in group B. A PR ratio above 1 indicates a greater prevalence of symptom in the numerator group. PR was calculated based on exposure vs. non exposure, sex, smoker vs. nonsmoker, seniority at work (up to 15 years vs. over 20 years) (Table 4).

Table 4. Prevalence of respiratory symptoms among employees

Respiratory Symptoms	PR exposed/ non-exposed	PR female/male (F/M)	PR smoker/ never smoker	PR under 15 years/ higher than 20 years
Cough	1.99	0.73	1.52	1.01
Expectoration	1.20	1.09	1.64	1.87
Wheezing	1.26	1.03	2.29	1.19
Dyspnea	1.02	1.24	0.71	1.88
Chest tightness	0.78	1.30	1.19	1.63
Suffocation	0.39	1.68	0.44	1.22
Total symptoms	1.08	1.05	1.03	1.20

Respiratory symptoms were more common in the exposed (PR Ex/Non-Ex = 1.08), in women (PR = 1.05 F/M), in current smokers (PR = 1.03) and in those with greater seniority (PR = 1.2). Cough was the most common symptom in the exposed group (PR = 1.99). To identify the association of smoking as a risk factor for pulmonary symptoms, we compared the prevalence of symptoms in smokers

and non-smokers in the 2 groups. It was observed that in smokers symptoms had an equal partition regardless of exposure (smokers Ex/Non-Ex 61.29% versus 67.8% – PR = 0.90); but in non-smokers the frequency of symptoms was higher in the exposed group (67.8% versus 50% – PR = 1.36). In the non-frequent exposed group the frequency of symptoms was higher in smokers (61.36% versus 50% – PR = 1.23). Seniority at work in the group of exposed patients showed a higher prevalence of symptoms than those having worked over 20 years. (75% versus 63.74% – PR = 1.17) and significantly higher than the one in the group of non-exposed patients with the same working experience (over 20 years working experience Ex/Non-Ex 75% versus 31.82% – PR = 2.36).

DISCUSSION

Both globally and in Romania, the development of the chemical industry, petrochemical industry in particular, can lead to employee exposure to risk factors for lung disease from ambient exposure in the workplace[5]. The specific pollutants are represented mainly by gas, fumes, fog, particles dispersed in air. Employees frequently report long periods with respiratory symptoms without actually being diagnosed with lung disease[9]. In the current use of chemicals, acute poisoning is very rare, accidental, so attention must be directed towards chronic disease recorded in time after moderate or low, continuous or intermittent exposure. The most common occupational diseases are pneumoconiosis, chronic bronchitis, COPD, lung cancer, extrinsic allergic alveolitis[9]. 15 to 30% of asthmatics have work-related asthma forms and 15% of COPD cases are secondary occupational exposure[9].

The study proposed to assess how much human health is affected if exposed to air pollutants of a specific chemical nature from a petrochemical plant. The results of the study show that there is a significantly higher frequency of respiratory symptoms in the occupational exposed group (PR = 1.08), especially cough, wheezing and expectoration. For this reason, the development of oil industry required application of safety procedures and safe work environment for protecting employees health. They are required to wear personal protective equipment with: glasses and goggles, safety shoes, hearing protection, respiratory protective equipment and protective fire resistant clothing[6]. Each refinery has process units controls like flares, scrubbers, steam strippers, electrostatic precipitators witch prevent emission of air pollutants.

The presence of these substances is systematically controlled by the toxicology laboratory and the refinery must permanently declare the chemical noxious emissions released into the environment. In 2000 over 3100 measurements of chemical pollutants were made in the refinery and only 35 pts. (0.9%) exceeded CMA. A health survey study published by Dales, was conducted on a rural Canadian population (n = 2157) living near refineries, exposed especially to sulphur

dioxide and hydrogen sulphide. The study reported more respiratory symptoms in the exposed group among children and youngsters (5 to 13 years of age) and among never-smokers (14 years of age) without impaired spirometric values (FEV1, FVC and FEV1/FVC) and concluded that 'the excess of respiratory symptoms in the exposed area unassociated with impaired spirometric values would be compatible with increased awareness of health or a small biologic environmental effect'[10]. However, an Italian study showed that children living near a petrochemical complex are exposed to a higher risk for developing allergic respiratory diseases[11].

To analyse the health effects of air pollutants the following phase is considered: gaseous or PM (suspension of very small particles with diameters under few micrometers that can rich the distal airways of tracheobronchial tree (PM < 10 μm), where the exposure takes place (indoors, outdoors), the source of pollutant mixture and association of other risk factors[5]. Smoking is a risk factor assumed by population inducing pulmonary symptoms. In the cohort studied it did not appear to have an additive effect (PR exposed smokers/non-exposed smokers = 0.90), occupational exposure appearing as an important risk factor. 46% of the employees who presented occupational exposure were smokers, too, suggesting that actions are needed in health education. Patients in the exposed group with greater seniority at work were symptomatic. Smoking and occupational exposure remain major risk factors for COPD appearance even if, too often, occupational exposure is underappreciated[4]. Any history of a patient with COPD should include a thorough history of his/her professional path, and recommendations target smoking and exposure to professional pollutants cessation. American Thoracic Society emphasises that occupational exposure is responsible for 15–20% of symptoms and respiratory functional impairment consistent with COPD diagnosis[12]. Wood study shows that exposure to fuel-oil ash leads to acute upper airway inflammation, by the recruitment and activation of polymorphonuclear leukocytes and IL8 increase[13], thus explaining occurrence of respiratory symptoms.

Our study did not reveal an exaggerated prevalence of respiratory symptoms as we had expected to find in the employees exposed group compared to the non-exposed. Cough was the only one that had a doubled prevalence in the exposed group. A study that examined mortality rates in petroleum and petrochemical population working in refineries for a period of 25 years found significant fewer deaths for all causes combined (different types of cancers, heart diseases, or non-malignant respiratory diseases)[14]. Kochubovski et al.[15] have registered correlations of pharyngitis and laryngitis incidence (non-specific diseases of upper respiratory tract) under high levels of the air pollution and Moga et al.[16] evaluated the environmental organic contaminants found in industrial pollution and included polycyclic aromatic hydrocarbons (PAHs) as risk factors for carcinogenesis. The present study, supported by data from literature, stresses the fact that constant

supervision of workers health in the petrochemical industry is required for the rapid identification of diseases, including respiratory ones.

CONCLUSIONS

We found that the environmental exposure represents a respiratory risk factor but a proper monitoring of technologic processes and a systematic control of toxic emissions can limit this risk close to that of non-exposed individuals, being able to say that there is no fatality that the work in a petrochemical complex be accompanied by worsening health condition. Medical education within the work place and personnel protection is an important measure in preventing illness.

REFERENCES

1. Environmental Protection Agency: Gina McCarty. Petroleum Refinery Sector Risk and Technology Review and New Source Performance Standards EPA-HQ-OAR-2010-0682. 2015, http://www3.epa.gov/ttn/atw/petrefine/20140515fr.pdf.
2. P. F. RONALD, P. E. COLWEL: Oil Refinery Processes – a Brief Overview. http://www.processengr.com/ppt_presentations/oil_refinery_processes.pdf.
3. Addressing Air Emissions from the Petroleum Refinery Sector, Risk and Technology Review and New Source Performance Standard Rulemaking. Tribal Consultation Presentation US Environmental Protection Agency Office of Air Quality Planning and Standards Research Triangle Park, NC.
4. Global Initiative for Chronic Obstructive Lung Disease. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease, Updated 2016.
5. International Agency for Research of Cancer: Monograph Outdoor Air Pollution. Lyon 2015, p. 109.
6. Occupational Safety & Health Administration: US Department of Labor. Petroleum Refining Process. https://www.osha.gov/dts/osta/otm/otm_iv/otm_iv_2.html.
7. G VOICU, A BECHIR, O. C. ARGHIR: Chemical Air Pollution and the Prevalence of Respiratory Disorders and Diseases. J Environ Prot Ecol, **13** (3), 1357 (2012).
8. V. GAVAT, G. F. PETRARIU, C. C. GAVAT, D. AZOICAI: Environmental Risk Factors and Health. DAN, Iasi, 2001.
9. Centre for Disease Control and Prevention: The National Institute of Occupational Safety and Health. Risk of Airway Diseases. 24http://www.cdc.gov/niosh/programs/resp/risks.html.
10. R. E. DALES, W. O. SPITZER, S. SUISSA, M. T. SCHECHTER, P. TOUSIGNANT, N. STEINMETZ: Respiratory Health of a Population Living Downwind from Natural Gas Refineries. Am Rev Resp Dis, **139** (3), 595 (1989).
11. F. CIBELLA, G. CUTTITTA, G. DRAGO, S. RUGGIERI, F. D'ANIELLO, S. BUCCHIERI, M. R. MELIS, S. la GRUTTA, G. VIEGI: Residence in a Urban Area Close to a Petrochemical Complex and Its Impact on Allergic Respiratory Diseases in Italian School Children. http://www.ers education.org/ media / grade.aspx?idMedia2 =226831#sthash. AG6sM75m.dpuf Annual Congress 2013.
12. J. BALMES, M. BECKLAKE, P. BLANC, P. HENNEBERGER, K. KREISS, C. MAPP, D. MILTON, D. SCHWARTZ, K. TOREN, G. VIEGI: American Thoracic Society Statement: Occupational Contribution to the Burden of Airway Disease. Am J Respir Crit Care Med, **167**, 787 (2003).

13. M. WOOD, R. HAUSER, Y. LIU, T. J. SMITH, P. D. SIEGEL, D. M. LEWIS, D. J. TALLERUD, D. C. CHRISTIANI: Molecular Markers of Acute Upper Airway Inflammation in Workers Exposed to Fuel-oil Ash. Am J Resp Crit Care Med, **158**, 182 (1998).
14. S. P. TSAI, J. K. WENDT, K. M. CARDARELLI, A. E. FRASER: A Mortality and Morbidity Study of Refinery and Petrochemical Employees in Louisiana. Occup Environ Med, **60**, 628 (2003).
15. M. KOCHUBOVSKI, B. ALEKSOSKI, M. DIMOVSKA, D. GJORGJEV: Preliminary Environmental Health Impact Assessment of Exhaust Gases from Refinery 'Okta'. J Environ Prot Ecol, **9** (1), 60 (2009).
16. M. MOGA, Gh. PREDA: Environmental Factors in Carcinogenesis. J Environ Prot Ecol, **9** (2), 323 (2008).

Received 28 March 2016
Revised 20 May 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *532–540* (*2016*)

Risk assessment

ASSESSING THE ENVIRONMENTAL IMPACT OF ACCIDENTS IN NATURAL GAS METERING-REGULATING STATIONS

S. M. GLISOVIC[a]*, D. J. PESIC[a], D. N. ZIGAR[a], I. ANGHEL[b]

[a]*Faculty of Occupational Safety in Nis, University of Nis, 10a Carnojevica Street, 18 000 Nis, Serbia*
E-mail: *srdjan.glisovic@znrfak.ni.ac.rs*
[b]*Fire Officers Faculty, Police Academy, Privighetorilor Street, Sector 1, Bucharest, Romania*

Abstract. The failure of installations and equipments for transmission and control of natural gas (NG) and its leakage may lead to many serious consequences for the people and the environment. This study assesses the risk from accidents in NG metering-regulating stations (MRS). On the basis of the hazard sources identification, the fault tree for the occurrence of accidents inside and outside the MRS facility is defined. A NG metering-regulating station in Nis is selected as a research area and the consequences of major hazardous events were investigated. The possible accident scenarios have been the explosion, the jet fire and the dispersion of NG vapour cloud. In order to determine consequence effect zones, for each identified hazard scenario the consequence analyses were performed by using advanced modelling tools. Simulation results of threat zones show influence of each hazardous event on the whole risk relative to the distance from the hazardous source. The explosion may cause window glass breakage to buildings in the endangered area, the thermal radiation from jet fire may jeopardize the people and the vapour cloud heavy pollutes the air. Obtained results have practical interest in choosing a MRS location in cities worldwide.

Keywords: natural gas, risk assessment, explosion, jet fire, vapour cloud.

AIMS AND BACKGROUND

Air quality has attracted great attention in the recent decades, due to increase in pollutants emissions and air pollution within urban areas[1]. Therefore, air quality monitoring and modelling involves surveillance of elements included in following categories: air pollutants sources and emissions; pollutants transfer into the atmosphere; concentrations level of air pollutants and their spatial and temporal distribution; air pollutants effects on human health[2]. The air pollution sources might very often be concentrated and intensive, as a consequence of the hazardous materials accidents[3].

Natural gas (NG) has been one of the fastest growing energy sources in recent decades. NG comprised 24% of the European Union primary energy consumption

* For correspondence.

in 2011, a number that is expected to grow to almost 30% by 2030 (Ref. 4). Due to the physical and chemical characteristics, the NG is a significant source of hazard accidents. The risk of this hazard could be high especially in distribution pipelines network[5,6] and metering-regulating stations (MRS).

MRS is a facility for monitoring of NG parameters. Due to equipments, installations and many joints, there is high possibility that their failure will occur. As a result of a failure inside and outside MRS building, a large quantity of gas will leak inside the building and into the atmosphere. Therefore, it is very important to assess the risk of NG accidents in order to protect the people, the property and the environment. In the field of risk assessment there are a series of acknowledged and successfully used methods and techniques for industrial hazards identification and risk assessment[7].

In the present study, the results of risk assessment of accidents in the MRS in NG transmission are presented. The procedure of hazard sources identification is carried out and the fault tree for the accidents occurrence inside and outside the MRS is defined. Since the modelling of pollution process is necessary in order to forecast the levels of pollutant substances[8], the advanced modelling tools, such as Fire Dynamics Simulator (FDS)[9] and Computer-Aided Management of Emergency Operations (CAMEO)[10] softwares have been employed to predict the consequences of NG accidents.

HAZARD SOURCES AND FAULT TREE ANALYSIS

A MRS is a facility for monitoring of NG parameters (mass flow, pressure and temperature) that is transported through pipelines. In MRS also, the pressure is reduced and the gas is odourised. Each MRS contains the following installations and equipments: pipe systems, fittings (bends, tees, reducers, flanges, screwed joints), gas filter, shut-off equipment (ball valves), regulating equipments (pressure regulator, check valve), safety equipments (block and release valves), metering equipments (mass flow meter, manometers, thermometers) and equipments for telemetry (transmitters of temperature and pressure, alarm for excessive pressure drop on the gas filter).

Hazardous accidents typically occur as a result of release and dispersion of NG in and out MRS. Typical elements that are potential sources of gas leakage in the inner space of a MRS faculty are: valves, pressure regulators, flanges and screwed joints. A significant quantity of gas can also be released through safety release valves outside the MRS building to the atmosphere. This can occur during normal operation in case of pressure fluctuations of inlet gas or failure of the pressure regulator. The pressure regulator failure can force large quantity of gas to be released continuously for longer time period through the safety release valve.

Risk assessment regarding MRS facility is therefore required for both inside and outside spaces. The fault tree for the accidents occurrence is shown in Fig. 1.

Fig. 1. Fault tree for inner and outside spaces of MRS facility

As it can be seen in Fig. 1, explosion and jet fire, as well as vapour cloud of NG represent major hazardous events in MRS facility.

Once the NG is released, it will immediately begin to disperse in MRS building. The gas will intensively mix with the surrounding air. The methane and the air can very often form the mixture with concentrations inside flammable limits. If there is ignition source, an explosion of confined vapour cloud can occur. The building structure restricts the free expansion of combustion products. As a consequence of this event a significant damaging overpressure builds up.

In case that the inner space of MRS is not yet filled with NG, the instantaneous ignition of gas at the beginning of leakage, can provoke a jet fire inside the MRS building. A jet fire will also develop in the case of immediate ignition of the leaked gas in outside space. Since the pressure regulator failure can force large quantity of gas, a jet fire can occur from its exhaust pipes. The risk of jet flame can be quantitative presented by the measure of thermal radiation. When there is not the ignition source, the NG released through safety release valves outside the MRS building, will disperse to the atmosphere. Since it is lighter than the air rapidly dissipates into it and forms vapour cloud which pollutes the atmosphere.

For each identified hazard event, consequence analysis can be performed to determine consequence effect zones. The consequences of the MRS accidents are usually: explosion in confined space, thermal radiation of the jet fire and the air pollution due vapour cloud dispersion.

EXPERIMENTAL

MRS 'Krivi Vir' facility is located at northeast side of the Nis city and at east side of manufacturing complex 'Gradska Toplana'[11] (Fig. 2). The main purpose of the MRS is the reduction of the gas pressure from 12 to 2 bar for the purposes of heating energy production process. The consumption of NG in 'Krivi Vir' boiler room compared to its total consumption in 'Gradska Toplana' is given in Table 1.

Fig. 2. Map of the study area

Table 1. Quantities of NG consumption

Consumption (m_N^3)	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015
Total	28 521 320	29 001 010	28 014 756	27 034 835	26 021 422
'Krivi Vir'	19 563 532	20 758 346	19 057 567	18 034 365	16 060 666

In this numerical study, two scenarios of NG accident were performed: the first is direct source when the duration of the gas maximum quantity releases due to equipment failure is 60 min; and the second is gas pipeline when NG escapes from broken pipe. The simulation parameters are listed in Table 2.

Table 2. Simulation settings

Class of data	Type of data	Values
Chemical data	molecular weight	16.04 g/mol
	lower explosive limit (LEL)	5%
	upper explosive limit (UEL)	15%
	ambient boiling point	–161.8°C
	vapour pressure at ambient temperature	greater than 1 atm
Atmosferic data	wind	2 m/s from NW at 2 m
	air temperature	10°C
	stability class	D
	Scenario I – direct source	
Source strength	description	max. quantity of NG releases due to equipment failure
	direct source	18 400 m^3/h
	source pressure	11.84 atm
	source temperature	10°C
	release rate	2570 kg/s
	total amount released	154 398 kg
	Scenario II – source: gas pipeline	
Source strength	pipe length	5000 m
	pipe diameter	15.0 cm
	pipe roughness	smooth
	pipe pressure	11.84 atm
	pipe temperature	10°C
	hole area	177.0 cm^2
	Scenario II.1 – burning – jet fire	
Source strength	description	flammable gas is burning as it escapes from pipe
	max flame length	13 m
	max burn rate	2040 kg/min
	total amount burned	8186 kg
	Scenario II.2 – not burning	
Source strength	description	flammable gas escapes from pipe
	max. average sustained release rate	207.0 kg/min
	total amount released	8186 kg

For each scenario, consequence analyses have been conducted to determine consequence effect zones. The NG vapour cloud explosion inside the MRS and the jet fire from the pipe were performed using FDS code (https://firemodels.github.io/fds-smv/). The accident consequences were simulated using CAMEO software (http://www2.epa.gov/cameo/cameo-software) with Areal Locations of Hazardous Atmospheres (ALOHA) which estimates hazardous chemical releases, including toxic gas clouds, fires and explosions.

RESULTS AND DISCUSSION

The simulation results show that the major risks are related to the explosion overpressure and incident heat flux radiation from the fire.

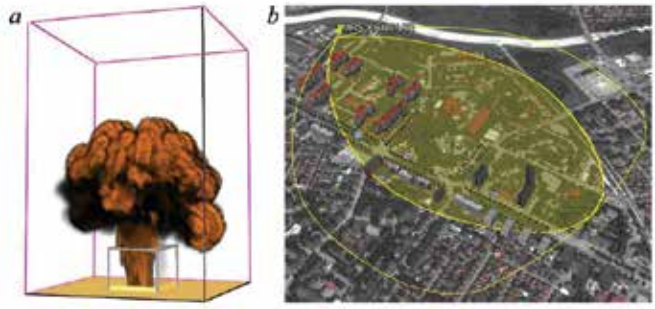


Fig. 3. Vapour cloud explosion and consequence map

The results of vapour cloud explosion inside MRS (scenario I) are shown in Fig. 3. The primary explosion hazards are overpressure and hazardous fragments. The consequence map plot for hypothetical explosion is shown in Fig. 3*b*. In case of explosion, Level of Concern (LOC) was never exceeded, i.e. there is not existed the possibility of adjacent buildings destruction and serious injury of people since the overpressure does not exceed the values of 55 158.06 and 24 131.65 Pa, respectively. Overpressure from the explosion may only cause the window glass breakage of the buildings which are located up to 1.1 km distance downwind from MRS.

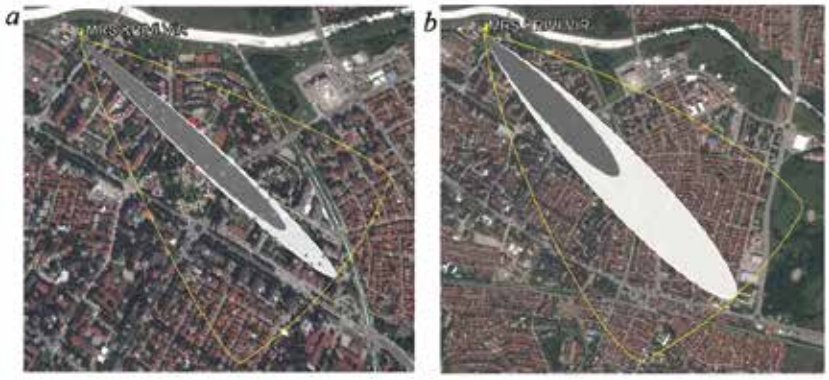


Fig. 4. Consequence maps: flammable area of vapour cloud (*a*), and vapour cloud total area (*b*)

When the NG releases into the atmosphere due to equipment failure, it forms a vapour cloud that mixes with the surrounding air and forms the flammable mixture. The flammable areas of gas vapour cloud for scenario I are shown in Fig. 4*a*. The inner, dark ellipse describes the zone of 100% Lower Explosive Limit (LEL) of

the gas and the air mixture. It extends 1 km downwind. The white, larger ellipse illustrates the zone of the vapour cloud flammable area which describes 60% of LEL that can be flammable if there is an ignition source. In this case, the flame pockets can occur at distance of 1.2 km from MRS. The vapour cloud formed due to equipment failure disperses as it travels downwind. Consequences of toxic vapour cloud areas are shown in Fig. 4*b*. There exist two zones for Protective Action Criterias (PACs). The dark ellipse that extends 1.2 km downwind indicates the life-threatening health effects because the cloud contains 17 000 ppm of toxic vapour. Under conditions of 2900 ppm of toxic vapour, the mild, transient health effects may appear till distance 2.2 km from MRS.

The jet fire outside MRS occurs when NG is ignited after release from the pipeline rupture (scenario II.1), resulting in the formation of a long stable flame (Fig. 5).

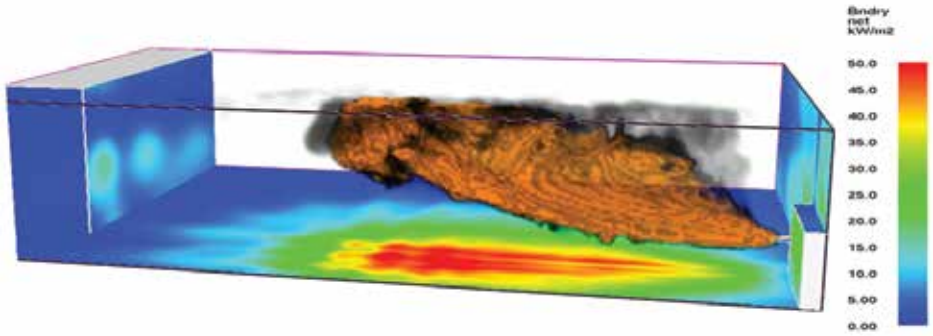


Fig. 5. Jet fire and its thermal radiation

Jet flame poses a threat to the people near the leakage source. Thermal radiation thresholds for death from jet fire, second-degree burns and first-degree burns are 10.0, 5.0 and 2.0 kW/m^2, respectively. As it can be seen in Fig. 5, the maximum value of heat radiation from jet flame of 50 kW/m^2 is much higher than the adopted threshold values.

The simulation results for scenario II.2 are shown in Fig. 6. The flammable areas of gas vapour cloud are shown in Fig. 6*a*. The area of the 100 % of LEL extends 30 m, while the area of 60% of LEL extends 47 m downwind. Consequences of toxic vapour cloud areas are shown in Fig. 6*b*. The life-threatening health effects can occur at distance of 58 m. The mild health effects may appear till distance of 141 m from pipe rupture.

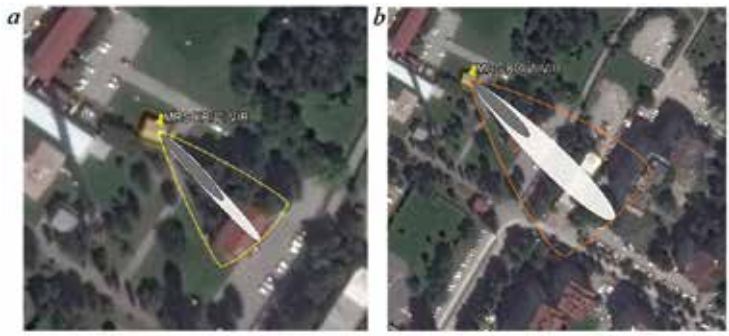


Fig. 6. Consequence maps: flammable area of vapour cloud (*a*), and vapour cloud total area (*b*)

CONCLUSIONS

The leakage of NG can lead to different scenarios and outcomes. In the paper, both inner and outer gas releases from the hazardous events inside MRS facility are considered. The results of the hazard sources identification and the accidents risk analyses are given through fault tree/event tree. The obtained results indicate that the dominant hazardous event that can be provoked by gas leakage and its subsequent ignition in the inner confined space of the MRS building is explosion. The main hazardous event outside of the MRS building can be jet fire of NG released from safety release valve and pipe rupture. In both cases of accidents, the toxic vapour cloud can be formed that may heavy pollute the air.

In order to assess the damage levels, three possible scenarios have been investigated in a MRS facility in Nis. The FDS and CAMEO software packages were employed to research the negative effects of the events on human health and environment. Simulation results show influence of each hazardous event on the whole risk relative to the distance from the hazardous source. The explosion may cause window glass breakage to buildings in the endangered area, the thermal radiation from jet fire may jeopardize the people and vapour cloud heavy pollutes the air. Obtained results have practical interest in choosing a MRS location in each city worldwide.

Acknowledgements. The research described in this article was realized as part of the scientific project 'Improvement of monitoring system and assessment of long-term population exposure to environmental pollutants using neural networks' funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

REFERENCES

1. F. VOSNIAKOS, J. TRAIANDAFYLLIS, D. PRAPAS, A. KARYDA, P. MENYZELOU, G. VASILIKIOTIS, D. KARAGIANNIS, P. LAZOU, A. PAPASTAMOU, K. VOSNIAKOS, V.

ARGIRIADIS: Urban Air Pollution due to Vehicles in Katerini City on Comparison Basis (1999–2006). J Environ Prot Ecol, **9** (3), 485 (2008).
2. G. Y. DEAK, V. DAESCU, E. HOLBAN, P. MARINESCU, G. S. TANASE, R. CSERGO, A. I. DAESCU, S. GAMAN: Health–Environment Relation: A Key Issue of Romanian Environmental Protection. J Environ Prot Ecol, **16** (1), 304 (2015).
3. D. J. PESIC, M. DJ. BLAGOJEVIC, N. V. ZIVKOVIC: Simulation of Wind-driven Dispersion of Fire Pollutants in a Street Canyon Using FDS. Environ Sci Pollut Res, **21**, 1270 (2014).
4. M. RATNER, P. BELKIN, J. NICHOL, S. WOEHREL: Europe's Energy Security: Options and Challenges to Natural Gas Supply Diversification. U.S. Congressional Research Service, 2013.
5. P. AMIR-HEIDARI, M. EBRAHEMZADIH, H. FARAHANI, J. KHOUBI: Quantitative Risk Assessment in Iran's Natural Gas Distribution Network. Open Journal of Safety Science and Technology, **4**, 59 (2014).
6. Y. ZHOU, G. HU, J. LI, C. DIAO: Risk Assessment along the Gas Pipelines and Its Application in Urban Planning. Land Use Policy, **38**, 233 (2014).
7. A. D. GHEORGHIU, Z. TOROK, A. OZUNU: How Can Existing Risk Assessment Methodologies Be Used in a Systematic Maner, in the Extractive Mining Industry? J Environ Prot Ecol, **14** (4), 1597 (2013).
8. M. POPA, I. ILEANA, F. VOSNIAKOS, D. POPA, M. GOLUMBEANU: Study on the Role of Neural Networks in Environmental Pollution Forecasts. J Environ Prot Ecol, **12** (4), 1948 (2011).
9. K. McGRATTAN, H. BAUM, R. REHM, W. MELL, R. McDERMOTT: Fire Dynamics Simulator (Version 5) Technical Reference Guide. Vol. 1: Mathematical Model, p. 108, Vol. 2: Verification, p. 75, Vol. 3: Validation, p. 298. NIST Special Publication 1018-5, Gaithersburg, MD., (2010).
10. CAMEO: ALOHA (Areal Locations of Hazardous Atmospheres) 5.4.4, National Oceanic and Atmospheric Administration, Seattle, Washington, 2013.
11. Fire Protection Plan of Metering-regulating Station 'Krivi Vir' in Nis. Faculty of Occupational Safety, Nis, 2011, p. 51.

Received 11 February 2016
Revised 16 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 541–548 (2016)

Risk assessment

EFFECT OF WIND TURBULENCE ON AEOLIAN ENERGY POTENTIAL

G. BANDOC[a]*, M. DEGERATU[b], E. DRAGOMIR[a]

[a]*Department of Meteorology and Hydrology, Centre for Coastal Research and Environmental Protection, University of Bucharest, 1 Nicolae Balcescu Blvd., District 1, 010 041 Bucharest, Romania*
E-mail: *geobandoc@yahoo.com*; *bandoc@geo.unibuc.ro*
[b]*Full Member of the Academy of Romanian Scientists, Technical University of Civil Engineering Bucharest, 124 Lacul Tei Blvd., Sector 2, 020 396 Bucharest, Romania*

Abstract. This paper aims to highlight the influence of wind turbulence on wind power potential. In order to achieve this objective the energy flow rate is computed as the ratio of the average flow to the energy flow based on average speed calculated for averaging time values that correspond to weeks, months, seasons, semesters and one year. In other words, the energy flow rate is determined on different turbulence macro-scales. The paper highlights the influence of wind turbulence on energy potential increase. The originality of this study lies in the fact that simple engineering calculations do not take into account the influence of turbulence on wind power potential. From the results we obtained, the following conclusions can be drawn: the maximum average speed depends on the averaging time, the higher the speed the lower the averaging time which is consistent with the theory; power flow coefficients C are all > 1 which leads to the conclusion that the average energy flow is greater than the energy flow computed using the average speed for the averaging times values used in the study (day, week, month, season, semester, year), i.e. turbulence macro-scales (with averaging times greater than 12 h according to as Van de Hoven) $(\overline{C})_{year}$, $[(\overline{C_{day}})_{day}$, $(\overline{C_{week}})_{year}$, $(\overline{C_{month}})_{year}$, $(\overline{C_{season}})_{year}$, $(\overline{C_{semester}})_{year}]$, the coefficients have values that range between (3.13 ... 1.93) which is consistent with the theory; it should be noted that the available measurements only allowed an analysis of the macroturbulences influence has the greatest contribution to the increase in the annual wind energy potential, much higher than the contribution of the winds microturbulence as the latter coefficients are considerably smaller.

Keywords: wind, macroturbulence, aeolian energy potential.

AIMS AND BACKGROUND

Natural wind, for a given average time of its local velocity, can be different local adimensional turbulence intensities, i.e. by different root-mean-square speed pulse values the RMS speed[1–4]. When computing wind energy potential the annual average energy flow plays a particularly important role. The sampling time is influenced by the wind speed, and consequently by averaging time[5–11].

* For correspondence.

If T is the averaging time, the time average local wind speed can be written as:

$$\overline{U} = \frac{1}{T}\int_0^T U(t)\mathrm{d}t, \tag{1}$$

where U is the instant local velocity which is equal to the sum of the average local speed and the pulsation speed as follows:

$$U = \overline{U} + U' \tag{2}$$

It should be noted that the average temporal pulse velocity is 0, i.e.:

$$\overline{U'} = \frac{1}{T}\int_0^T U'(t)\mathrm{d}t = 0 \tag{3}$$

because speed pulses are either positive or negative around the average U value.

Therefore, in order to determine the average pulse velocity in time interval T the root-mean-square is used, i.e. the RMS velocity:

$$U_{\mathrm{RMS}} = (\overline{U'^2})^{1/2} \tag{4}$$

which shows the average pulse velocity. Dividing RMS velocity by average speed, the local turbulence intensity is obtained:

$$I = U_{\mathrm{RMS}}/\overline{U} = (\overline{U'^2})^{1/2}/\overline{U} \tag{5}$$

which expresses the average value of the pulsation speeds in relation to the average speed both of which are local and computed for the same averaging time T.

Given that pulse speed is the difference between instantaneous speed and average speed:

$$U' = U - \overline{U} \tag{6}$$

and by substituting the expression (6), in equation (3) of the pulse temporal average speed $\overline{U'}$, the following relationship is obtained:

$$\overline{U} = \frac{1}{T}\int_0^T \left(U - \overline{U}\right)\mathrm{d}t = 0 \tag{7}$$

The average energy flow for the same time period T is proportional to the $\overline{U^3}$ and considering equation (2) has the expression:

$$\overline{U^3} = \frac{1}{T}\int_0^T \left(\overline{U} + U'\right)^3\mathrm{d}t = \overline{U}^3 + 3\overline{U}^2\cdot\overline{U'} + 3\overline{U}\cdot\overline{U'^2} + \overline{U'^3} \tag{8}$$

As $\overline{U'} = 0$, and because $3\overline{U}\,\overline{U'^2} \neq 0$ for $\overline{U'^2} \neq 0$ and given that $\overline{U'^3} \neq 0$ only if the probability distribution of U' is symmetrical, equation (8) becomes:

$$\overline{U^3} = \overline{U}^3 \left(1 + 3 \frac{\overline{U'^2}}{\overline{U}^2} + \frac{\overline{U'^3}}{\overline{U}^3} \right) \tag{9}$$

By determining the ratio of the average energy flux $\overline{U}^3$ and the power flow computed using the average speed $\overline{U}^3$, the following equation is obtained:

$$\frac{\overline{U^3}}{\overline{U}^3} = 1 + 3 \frac{\overline{U'^2}}{\overline{U}^2} + \frac{\overline{U'^3}}{\overline{U}^3} \tag{10}$$

where $\overline{U'^2}/\overline{U}^2$ is the turbulent intensity I.

This energy flow ratio can be noted as coefficient C, i.e.:

$$C = \overline{U^3}/\overline{U}^3 = 1 + 3I^2 + \overline{U'^3}/\overline{U}^3 \tag{11}$$

where the last two terms represent the contribution of turbulence to the size of the average energy flow. The energy flow ratio expressed as the coefficient C strongly depends on strong integration time T, i.e. on the averaging time[12].

RESULTS AND DISCUSSION

This paper used complex data that consisted of a large number of wind speed measurements made over one year, every 6 h. For a comprehensive analysis in terms of climatic characteristics it can be used remote sensing and GIS technologies.

Firstly, the distribution of the velocity U considered to be instantaneous was plotted in Fig. 1, but computed as a temporal average over a time period equal to the averaging time of the employed anemometer and with a 6-hour sampling period. The energy flow U^3 was computed and its distribution throughout the year was plotted as well (Fig. 2).

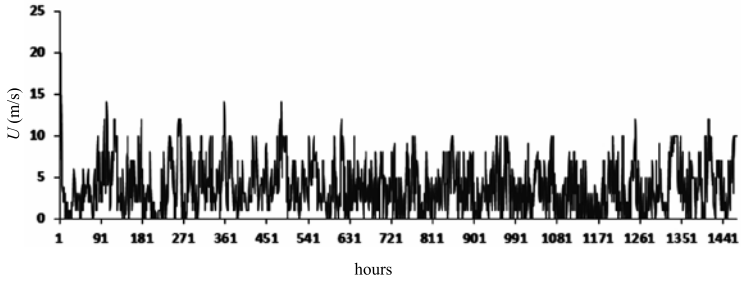


Fig. 1. Instantaneous speed distribution throughout the year

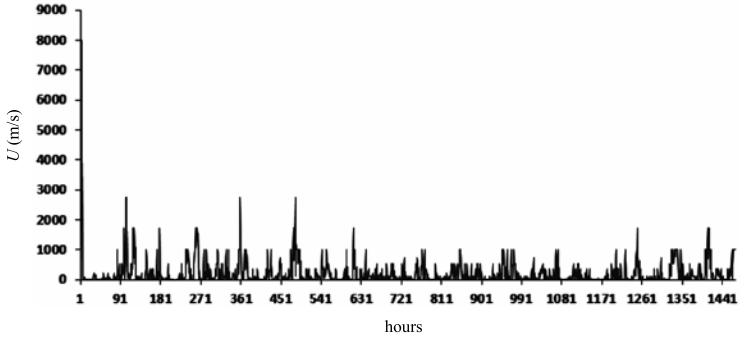


Fig. 2. Distribution of energy flow throughout the year

For the entire data set, we determined the two flows of energy $\overline{U}^3$ and $\overline{U^3}$ for different averaging times T, i.e. days ($\overline{U}_{day}{}^3$, $\overline{U_{day}^3}$) (Fig. 3), weeks ($\overline{U}_{week}{}^3$, $\overline{U_{week}^3}$) (Fig. 4), months ($\overline{U}_{month}{}^3$, $\overline{U_{month}^3}$) (Fig. 5), seasons ($\overline{U}_{season}{}^3$, $\overline{U_{season}^3}$) (Fig. 6) semesters ($\overline{U}_{semester}{}^3$, $\overline{U_{semester}^3}$) (Fig. 7) and for the whole year ($\overline{U}_{year}{}^3$, $\overline{U_{year}^3}$) (Fig. 8).

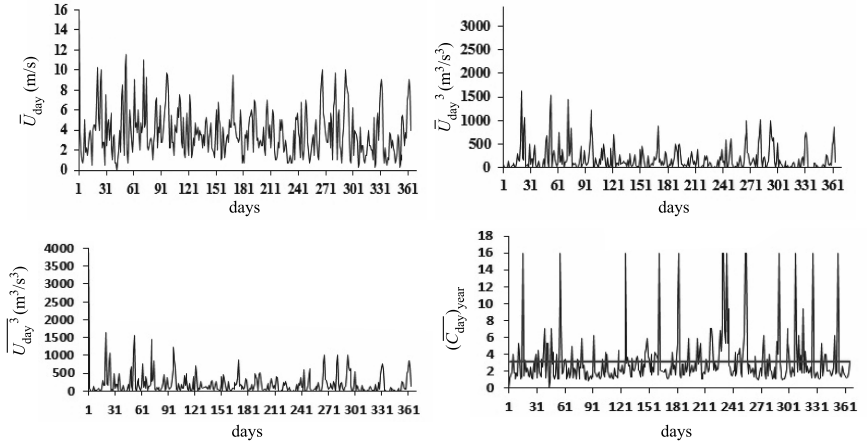


Fig. 3. Distribution of $\overline{U}_{day}$, $\overline{U}_{day}{}^3$, $\overline{U_{day}^3}$ throughout the year and the annual average value $(\overline{C}_{day})_{year}$

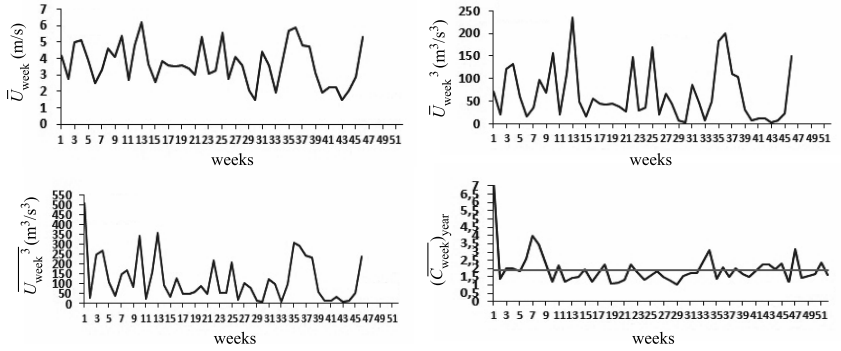


Fig. 4. Distribution of $\overline{U}_{week}$, $\overline{U}_{week}{}^3$, $\overline{U_{week}{}^3}$ throughout the year and the annual average value $(\overline{C}_{week})_{year}$

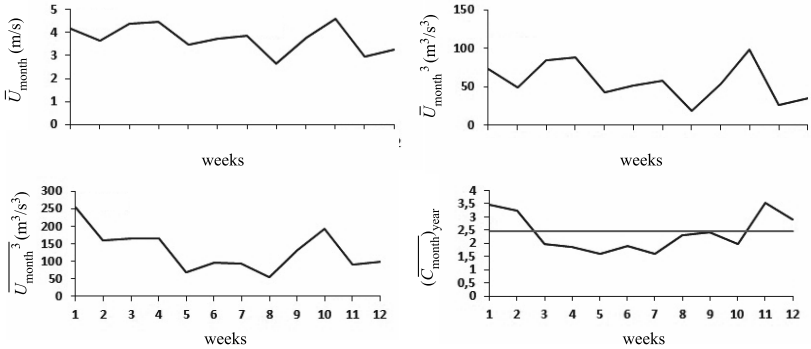


Fig. 5. Distribution of $\overline{U}_{month}$, $\overline{U}_{month}{}^3$, $\overline{U_{month}{}^3}$ throughout the year and the annual average value $(\overline{C}_{month})_{year}$

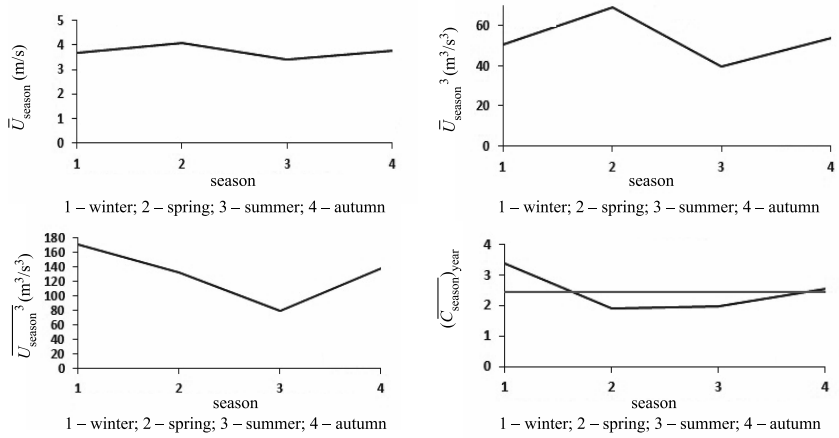


Fig. 6. Distribution of $\overline{U}_{season}$, $\overline{U}_{season}{}^3$, $\overline{U_{season}{}^3}$ throughout the year and the annual average value $(\overline{C}_{season})_{year}$

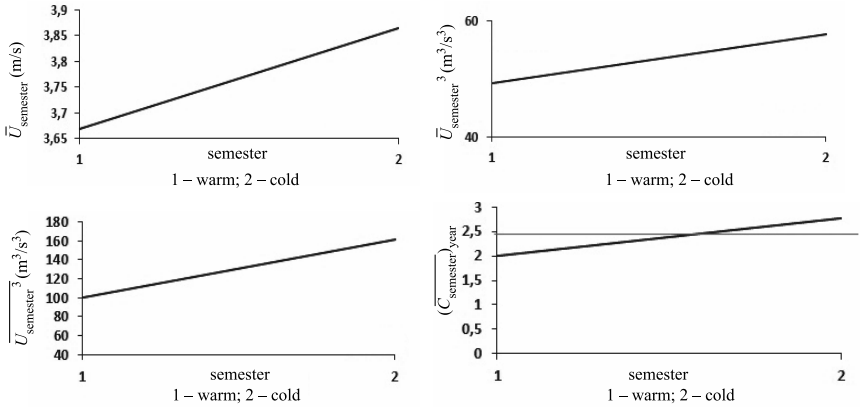


Fig. 7. Distributions of $\overline{U}_{semester}$, $\overline{U}_{semester}{}^{3}$, $\overline{U_{semester}{}^{3}}$ throughout the year and the annual average value $(\overline{C}_{semester})_{year}$

C coefficients were determined for each day, week, month, season, semester and year as the ratio of energy, after which these coefficients average value were determined for the entire year, as follows:

– for the days: $C_{day} = \overline{U_{day}{}^{3}}/\overline{U}_{day}{}^{3}$ and $(\overline{C}_{day})_{year}$;

– for weeks: $C_{week} = \overline{U_{week}{}^{3}}/\overline{U}_{week}{}^{3}$ and $(\overline{C}_{week})_{year}$;

– for months: $C_{month} = \overline{U_{month}{}^{3}}/\overline{U}_{month}{}^{3}$ and $(\overline{C}_{month})_{year}$;

– for seasons: $C_{season} = \overline{U_{season}{}^{3}}/\overline{U}_{season}{}^{3}$ and $(\overline{C}_{season})_{year}$;

– for semesters: $C_{semester} = \overline{U_{semester}{}^{3}}/\overline{U}_{semester}{}^{3}$ and $(\overline{C}_{semester})_{year}$

– for the entire year: $C_{year} = \overline{U_{year}{}^{3}}/\overline{U}_{year}{}^{3}$ and $(\overline{C}_{an})_{an} = C_{an}$.

Based on these calculations distributions over the entire year plotted, for $\overline{U}$, for $\overline{U^3}$, for $\overline{U^3}$ and for *C*, while also marking the annual average values of coefficient, $(C)_{year}$, i.e. $[\overline{U}_{day}, \overline{U}_{day}{}^{3}, \overline{U_{day}{}^{3}}, (\overline{C}_{day})_{year}]$ for days (Fig. 3), $[\overline{U}_{week}, \overline{U}_{week}{}^{3}, \overline{U_{week}{}^{3}}, (\overline{C}_{week})_{year}]$ for weeks (Fig. 4), $[\overline{U}_{month}, \overline{U}_{month}{}^{3}, \overline{U_{month}{}^{3}}, (\overline{C}_{month})_{year}]$ for months (Fig. 5), $[\overline{U}_{season}, \overline{U}_{season}{}^{3}, \overline{U_{season}{}^{3}}, (\overline{C}_{season})_{year}]$ for seasons (Fig. 6) and $[\overline{U}_{semester}, \overline{U}_{semesrer}{}^{3}, \overline{U_{semester}{}^{3}}, (\overline{C}_{semester})_{year}]$ for semesters (Fig.7).

The maximum average speed is a function of averaging time *T*, and increases as the averaging time decreases which is consistent with the theory (Fig. 8).

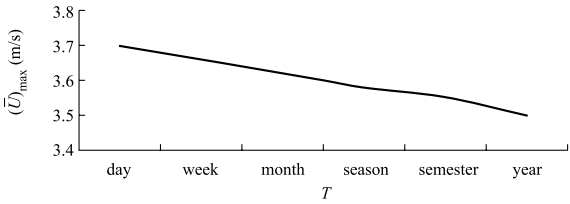


Fig. 8. Variation depending maximum average speed $(\overline{U})_{max}$ over averaging time *T*

All energy flow C coefficients are > 1 which leads to the conclusion that the average energy flow is greater than the energy flow computed using the average speed (Fig. 9).

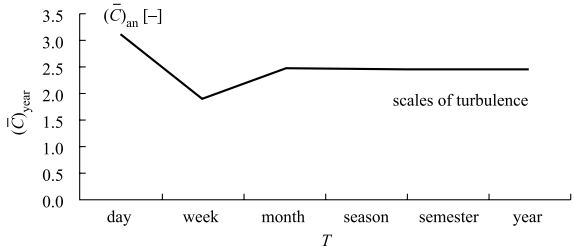


Fig. 9. Variation of energy flux coefficients annual average values $(\overline{C})_{year}$ depending on averaging time T

CONCLUSION

From the results we obtained, the following conclusions can be drawn:

– the maximum average speed $(\overline{U})_{max}$ is a function of averaging time T, and increases as the averaging time decreases whuch is consistent with the theory

– all energy flow C coefficients are > 1 which leads to the conclusion that the average energy flow is greater than the energy flow computed using the average speed ($\overline{U^3} > \overline{U}^3$; $C > 1$);

– for the considered averaging times (day, week, month, season, semester, year), i.e. turbulence macro-scales (with averaging time greater than 12 h, according to Van der Hoven), the coefficients $(\overline{C})_{year}$, $[(\overline{C_{day}})_{day}$, $(\overline{C_{week}})_{year}$, $(\overline{C_{month}})_{year}$, $(\overline{C_{season}})_{year}$, $(\overline{C_{semester}})_{year}]$ have values that range between (3.13 ... 1.93), which is consistent with the theory;

– it should be noted that the available measurements only allowed an analysis of the macroturbulence influence that has the greatest contribution to the increase of the annual wind energy potential which is much higher than the contribution of the wind microturbulence, as the latter $(\overline{C})_{year}$ coefficients are considerably smaller.

Acknowledgements. This work was performed as a part of research supported by the project COSMOMAR No 58/2013, financed by STAR Program of ROSA, and the project ECOMAGIS No 69/2012, financed by UEFISCDI PN-IIPT-PCCA-2011-3.2 1427.

REFERENCES

1. R. B. CAL, J. LEBRÓN, L. CASTILLO, H. S. KANG, C. MENEVEAU: Experimental Study of the Horizontally Averaged Flow Structure in a Model Wind-Turbine Array Boundary Layer. J Rene Sustain Energ, **2**, 013106 (2010).

2. T. MÜCKE, D. KLEINHANS, J. PEINKE: Atmospheric Turbulence and Its Influence on the Alternating Loads on Wind Turbines. Wind Energy, **14** (2), 301 (2010).
3. I. van der HOVEN: Power Spectrum of Horizontal Wind Speed in the Frequency Range from 0.0007 to 900 Cycles per Hour. J Meteorology, **14**, 160 (1957).
4. M. DEGERATU, A. M .GEORGESCU, N. I. ALBOIU, G. BANDOC, C. I. COSOIU, M. GOLUMBEANU: Turbulent Structure of the Wind Flow and Wind Tunnel Tests Achieved for Atmospheric Contamination Modelling. J Environ Prot Ecol, **14** (2), 405 (2013).
5. G. BANDOC, M. DEGERATU, A. M. S. FLORESCU, E. DRAGOMIR: Variance Analysis of Wind Characteristics for Energy Conversion**.** J Environ Prot Ecol, **14** (4), 1760 (2013).
6. G. BANDOC: Wind Potential on the Romanian Black Sea Coast. Publ. House MatrixRom, Bucharest, 2005 (in Romanian).
7. M. DEGERATU: The Atmospheric Boundary Layer. Publ. House, Orizonturi Universitare, Timisoara, 2002 (in Romanian).
8. I. FYRIPPIS, P. J.AXAOPOULOS, G. PANAYIOTOU: Wind Energy Potential Assessment in Naxos Island, Greece. Appl Energ, **87** (2), 577 (2010).
9. A. M. S. FLORESCU, G. BANDOC, M. DEGERATU: Analysis of Environmental Characteristics and Operational Reports of Small and Medium Turbines. Appl Mech Mater**, 178–181**, 973 (2012).
10. A. M. S. FLORESCU, G. BANDOC, M. DEGERATU: Energy Efficiency Evaluation of Wind Energy Based on Energy Reports. Adv Mater Res**, 1008**–**1009**, 188 (2014).
11. C. ILIE, M. LUNGU, L. PANAITESCU, M. ILIE, D. LUNGU, S. NITA: Simulating for Predicting the Hourly Dew Pont Temperature Using Artificial Neural Networks. J Environ Prot Ecol, **15** (3), 1101 (2014).
12. M. DEGERATU, A. M. GEORGESCU, G. BANDOC**,** N. I. ALBOIU, C. I. COSOIU, M. GOLUMBEANU: Atmospheric Boundary Layer Modeling as Mean Velocity Profile Used for Wind Tunnel Tests on Contaminant Dispersion in the Atmosphere. J Environ Prot Ecol, **14** (1), 22 (2013).

Received 21 January 2016
Revised 7 7 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 549–556 (2016)

Ecology

ISTANBUL UNDER PRESSURE OF SOME MEGA PROJECTS (PREDICTION OF THE EFFECTS OF SOME MEGA PLANS ON ISTANBUL)

SIMA POUYA[a]*, SAHAR POUYA[b], O. DEMIREL[a]

[a]*Department of Landscape Architecture, Karadeniz Technical University, Trabzon, Turkey*
[b]*Department of Urban and Regional Planning, Istanbul Technical University, Istanbul, Turkey*
E-mail: *sima_pouya2002@yahoo.com*; *pouya@itu.edu.tr*; *dofe01@gmail.com*

Abstract. Istanbul city as a mega city bears strong background and concepts of history, tradition, culture, and art of Turkish community. Every year, Istanbul with unique traits is able to absorb too many tourists attention all around the world. However, in the recent years, it is under pressure of some projects which are executing or planning to be performed. Construction the third bridge, Istanbul canal, and third airport are examples of those controversial schemes which are still vague and indefinite in some aspects. Even though there are various discussions on the projects from different scientific views, it seems to be necessary to make a general analysis with strict decision on the possibilities of their executions. This article tries to give an image of Istanbul future with consideration to all what the plans are following. With putting together separate comments of researches and university professors on the project, it is attempting to predict the threats and effect in the future situation of Istanbul. Therefore, with regard to differently economic, social, political, ecological surveys of project together, it is summarised the effect of them as a table. Finally this article evaluates how much those projects make sense and meet the primary need of plans.

Keywords: Istanbul, analyses, mega projects, plan, future.

AIMS AND BACKGROUND

Istanbul is one of the cultural capital cities in the world and located at a very specific region connecting Anatolia and Europe[1]. Experts predict that a devastating earthquake could hit the city within two to three decades which is to be considered in infrastructure projects. Today, Istanbul is a mega city with over 12 million inhabitants, where population density exceeds 2200 inhabitants per km. The city population nearly doubled in the 20 years between 1980 and 2000, the fastest growth period for the population. For the period between 1990 and 2000, the population growth rate of Istanbul was 29.64% for urban parts and 81% for rural parts of the city[2]. Every year, Istanbul with unique traits is able to absorb too many tourists attention all around the world. However, in the recent years, it is under pressure of some

* For correspondence.

projects which are executing or planning to be performed. An inappropriate real estate development could lead to the waste land resource, and also the declining of townscape and environment quality[3]. Construction of the third bridge, Istanbul canal, and third airport are examples of those controversial schemes which are still vague and indefinite in some aspects. Even though there are various discussions on the projects from different scientific views, it seems to be necessary to make a general analysis with strict decision on the possibilities of their executions. This article tries to give an image of Istanbul future with consideration to all what the plans are following. With putting together separate comments of researches and university professors on the project, it is attempting to predict the threats and effect in the future situation of Istanbul. Therefore, with regard to differently economic, social, political, ecological surveys of project together, it is summarised the effect of them as a table. The SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) table is made for each project and the advantages and disadvantages of each project have been researched and thus vision of the future was a head of the practitioners and authorities for their better decisions.

EXPERIMENTAL

First project: *Canal Istanbul*. The canal is a 50 km long maritime transportation canal, 150 m wide and 25 m deep, to be built between the Sea of Marmara and the Black Sea, at the European part of the province of Istanbul. This project, which is popularly known as the 'crazy project' as Prime Minister Erdogan, president of Turkey, has named it, concerns the creation of a 'new Bosporus' in Istanbul[4]. This mega project as well as having persuasive benefits, has drastic threats and various side effects which will trigger some great changes and without any doubts, it will put Istanbul under pressure over long time. As the project disrupts the ecological links existing ecosystem, it can be considered as big menace both for nature and history of Istanbul. Regarding the proposed canal project and new settlement which are planned to locate on the northern part of Istanbul are likely to cause vast environmental problems in the future[5].

Argument on effects of the project in short and long time: all benefits and reasons mentioned in favour of the project seem scientifically fallacious and actually they will sweep the problems under the carpet. For instance, it claims that the canal decreases the waiting time for vessels to pass the Bosphorus. While, in the case of the Bosphorus Strait, there is neither a shorter, nor longer alternative to connect the Black Sea to the Sea of Marmara. Another defensive reason of the project is that the canal will decrease maritime traffic in the Bosphorus Strait and increase chance for sports, leisure and tourism activities, as well as intra-city transportation. While, the Strait has always been an international maritime corridor and Istanbul was the main gateway city for incoming and outgoing products. So, increasing tourism activity puts pressure on the local government to provide more

leisure-related services[6]. Furthermore, it is claimed that current evidence suggests that the wastewater and ballast water of sea vessels traveling across different seas pose a significant threat to local habitat. However, the Black Sea already suffers such an invasion from an alien species, in the last two decades. And, canals also may facilitate such invasions, as is the case between the Mediterranean and the Red Sea, where both Lessepsian and Anti-Lessepsian migration of species is observed[7] (Table 1).

Table 1. SWOT table for Canal Istanbul

Strengths	Weakness
• The passage of vessels up to 300.000 DWT (deadweight tonnage). • Using the debris of the canal on obsolete quarries in the Northern European Istanbul for building of an airport, with a capacity of 60 million passengers per year. • A seaport. • Motorway bridges passing over the canal. • Railway bridges passing over the canal urban functions. • Residential areas. • Congress and convention centres. • Cultural facilities. • Tourism facilities. • Business districts. • Recreational functions. • Recreation areas. • Some existing lakes formed by filling up of rainwater to old quarries.	• Extremely high price of construction without any defensive plan to compensate. • Destruction inhabitants and historically drastic damage of that part. • To propagate negative impacts of development through adjacent areas. • The invasion an alien species of medus named Mnemiopsis Leidyi into the sea transmitted by vessels.
Threats	**Opportunities**
• To threaten the fertile agricultural land and crucial under-water reservoirs in the southern part of the western bank of the city. • To threaten two lagoon type lakes called Buyukcekmece and Kucukcekmece which are protected by the Master Plan of Istanbul. • To increase the populations tourist and more pressure on natural sources. • To increase the rents, buildings and business. • Reverse the balance between the cold and fresh waters of the Black Sea and the warm and salty waters flowing from the Mediterranean will change. • To dry out the Sazlidere basin, which meets 6.7% of Istanbul water needs. • Cultural shock to inhabitants who deal with the new changes, business, crowd, and so on.	• To increase recreational activities and intra-city sea transportation. • To eliminate waiting time to pass the Bosporus because it will allow a more efficient passage of vessels. • To eliminate the potential risk of discharge of wastewater from waiting vessels. • To increase the need for logistics and transportation. • To increase business districts for producer services, international tourism areas, and housing for associated workforce. • To minimise threats on population and cultural heritage that are posed by potential marine accidents.

Second project: *The new airport in Istanbul*. Transportation is the first problem that comes to mind for a metropolitan city like Istanbul with special geographical position, density of population, widespread setting areas, and historical background and also with various social, cultural, commercial activities[8]. Istanbul is a city with most important social, cultural and economic activities and expected to become one of the mega aviation cities – more than 10 000 long-haul passengers per day – in the coming years[9]. Istanbul New Airport is an airport under construction in Arnavutkoy district on the European side of Istanbul, Turkey. The existing Atatürk Airport, on the European side of Istanbul, does not meet increasing demand and there is an increasing problem of air traffic congestion. There is no space to build an additional runway as the airport is absorbed within the city of Istanbul. North of the airport is covered with industrial areas where as east and west covered with residential areas. Because of the limited capacity, the Turkish Airspace Authority does not allow additional cargo or charter flights to the airport. Airlines which want to start new routes and/or to add additional flights cannot do so.

Arguments on the long-term and short-terms effect of the project on Istanbul. The most important reasons mentioned in the articles as to the third airplane in the limitations that the two current airports have. For example, it says although the Ataturk Airport is very near to the Sea (and Istanbul is surrounded by seas) maritime transport connection and/or integration is not possible at all. The new Istanbul airport will stretch over 7659 ha of land, of which 6172 ha are forest. It is home to a rich variety of wildlife with hundreds of thousands of birds migrating over this very region and the nearby Terkos Lake and other smaller wetlands serving as birds nesting and resting grounds throughout the year. Contaminants such as lead, copper and zinc spreading from business in the third airport will contaminate the Terkos Lake with heavy metals[10] (Table 2).

Table 2. SWOT table for Istanbul New Airport

Strengths	Weakness
• Important transit point for international flights, between Europe, Asia and Africa destinations. • Reaching more than 50 destinations in different countries with less than 3.5 h flights from Istanbul with limitation of the total passenger capacity to 100 million passengers/year in Ataturk and Sabihegukcen Airports. • Attraction of passengers in the region of European part to use the airport because of limitation of the current airport for international flights. • Main metropolitan airport for passengers and cargo.	• To cut 2513341 trees in the area including pine, spruce, oak, beech, juniper, redbud, willow and poplar trees. • To damage the forest located in the airport land. • To destroy the nest of thousands of birds migrating over the region.

to be continued

Continuation of Table 2

Opportunities	Threats
• To be the major aviation centre of Turkey all the time. • Making the airport as a centre of attraction and developing surrounding areas as an airport city. • To have adequate and sufficient area for both airport and airport city development. • To develop in the vicinity of the airport, social-cultural activities, business and finance centres (with office buildings), convention centres, logistic centres (with warehouses), shopping centres, hotels, recreation and accommodation areas. • To have multimodal transportation modes, such as direct access or connection to interstate highway and railway systems, express train and metro facilities. • To have appropriate infrastructure for existing and future needs with detailed master planning studies. • The opportunity for this kind of aircraft operations which will maximise the passenger transport. • To eliminate noise problem in Ataturk Airport because of the dense settlements surrounding.	• To threat wildlife of Terkos lake • To damage the forest. • To threat the lake near and other wetlands beside the airport. • More passengers and more pressure, more pollution, and more destruction over long time. • Increase the population. • Effect on history and nature of the north.

Third project: *The third bridge of Istanbul*. The concentration of the world population in urban areas is growing at an enormously rapid rate creating megacities, currently defined by the United Nations (UN) as cities of over 10 million people. Although there are numerous examples in the developed world, megacities are primarily a phenomenon of the developing world[11]. With an official population of 13 255 685 Istanbul is the most crowded metropolitan city in Turkey. 15% of Turkey total population live in Istanbul[12]. If Kanal Istanbul is indeed built, this will be a disaster for the entire Marmara region, as it would bring the highly polluted waters of the Black Sea into the Sea of Marmara, eating away at the oxygen levels of the Marmara, and cause a new pollution problem that the authorities possibly may not be able to deal with. Salt water will leak underground, as it flows through the waterway, and affect underground water sources, and possibly the forests. The real problem, however, is the new settlement areas and the population boom that will go with it understandably the real purpose of the project[10]. The Third Bridge, which is controversially also called the Yavuz Sultan Selim Bridge, was met with protests considering that Yavuz Sultan Selim has ordered the massacre of approximately 40 000 Alevis in the 16th century. 116:002 Nazli Tumerdem budgets'[13]. The Third Bosphorus Bridge, as a part of Northern Marmara Motorway, is also

considered as a megaproject with its approximate budget of US$2.5 billion[14]. However today, a third bridge over the Bosphorus could have much more catastrophic and irreversible impacts upon the city when compared to any former structure that has transformed the geography of the city. First of all, the construction is a fait accompli one since it is not approved by the preservation council and it lacks a participatory planning medium which would ensure possibilities of opposition and dispute at local levels[15]. Its route passes directly from natural barriers of the city like ecologically sensitive forests, water reservoirs and catchments[16]. This is highly problematic since the experts point out that it has caused the deletion of 245 thousand trees so far[17]. Probably it will also have adverse effects on the areas of drinking water reserves, lead to an increase in local temperatures and cause the extinction of endemic plants and animals[18] (Table 3).

Table 3. SWOT table for Third bridge of Istanbul

Strengths	Weakness
• Support rail and sea transportation vehicle, autobuses. • Solve the problem of metropolitan such as the traffic of the two other bridges.	• Increase the vehicle passing from Asian side to European side without increasing in number of passengers. • Exhaust gases emitting vehicle. • Increasing rubber tires. • Damage lake and dam located in the North area. • Damage forest of Kocaeli and Thurace Peninsulas.
Opportunities	**Threats**
• Solving the traffic problems of Istanbul.	• Cutting blood vein of Istanbul. • To terminate water and forest sources of Istanbul. • Threaten water collection and flora-fauna of ecosystem. • Lack of water in the global drought period by using the water reservoir to build the bridge. • Harm to natural Black sea coastline by linking to the Black sea coastal highway. • To cause settlers to leave their inhabitants.

CONCLUSIONS

Cities are characterised through their urban fabrics and urban fabric can be defined as the 'artificial geography of structures and infrastructures that are superimposed over the natural geography'[19]. For centuries, cities have been developed according to their geographies and topographies, from which topologies were created that determined the social, economic, spatial and phenomenological interactions of cities. However, it is not a surprise that in the age of Anthropocene, geography is no longer considered to be the preliminary shaping agent of urbanism, but it is

urbanism that emerges through activities of humankind that shapes the geography. This could be defined with the term of geo-urbanism. The renowned urban planner Bruno Secchi claims that whenever he moves one square meter of soil from one place to another to build, he is correcting and improving natural geography. However, he also insists that these projects have to be useful and not be done just to change the world[20]. In the specific case of Istanbul, the city that has been the main focus of Turkish governance, the realisation of three projects is very questionable within the framework of geo-urbanism. The projects lack transparency in its process and is opposed by experts and NGOs (Non-Governmental Organisation). It is built on the northern regions of the city which are the most vulnerable and valuable naturally and ecologically. Moreover, the laws liability to change does not promise that these regions will be protected in the years to come. Most importantly, the previous examples show that development proceeds without being faithful to any master plan**.** It can be argued that the city of Istanbul always had a tradition of constructing mega structures and mega projects throughout its history. Whether it be a way of proving dominion of mankind over nature through artifice or another tool of visibility for the competence of the emperor and the sultan over his people; structures like Hagia Sophia, Hippodrome of Constantinople, the Valens Aqueduct, land and sea walls or Suleymaniye Mosque and many more can be considered as mega projects of former times. These man-made structures created new landscapes and territories within the city.

REFERENCES

1. S. INCECIK, E. G. BOZYAZI DAYLAN: Examination of the Air Quality of Istanbul with Geographic Information Systems. ITU Magazine, **1**, 51 (2002).
2. Y. L. CHENA, Y. H. PERNGA, H. C. LIENB: Environmental Management Utility-based Multi criteria Model for Evaluating Real Estate Development Projects. J Environ Prot Ecol, **15** (3A), 1328 (2014).
3. Y. EZBER, O. L. SEN, T. KINDAPA, M. KARACA: Climatic Effects of Urbanization in Istanbul: A Statistical and Modeling Analysis. Int J Climatol, **27**, 667 (2007).
4. A. C. SAYDAM: Why the Crazy Project Can't Be**?** Science and Future, June 2011, 16–25 (in Turkish).
5. S. KUNDAK, M. B. BAYPINAR: The Crazy Project-Canal Istanbul. Trimestrale del Laboratorio Territorio Mobilità e Ambiente – TeMALab, **4** (3), 53 (2011).
6. N. DEMIREL: Artificial Canals between Seas and the Ecosystem. Science and Future, June 2011, 26 (in Turkish).
7. A. GULER, C. Y, YILDIZCI: Measuring the Effects of the Bridges on Istanbul Green System. J Environ Prot Ecol, **10** (2), 488 (2009).
8. Airbus Company: Global Market Forecast 2012–2013, Navigating the Future. 2011. http://www.airbus.com/company/market/forecast/ 37 (Accessed 15 January 2013).
9. TOBB (The Union of Chambers and Commodity Exchange of Turkey): 2011 Sector Report of Turkish Civil Aviation Assembly TOBB Press, Ankara, Turkey, 2012.
10. S. YILDIRIM: The New Airport in Istanbul: Expectations and Opportunities. Journal of Case Research in Business and Economics, 2013.

11. G. BUGLIARELLO: Megacities and the Developing World. The Bridge, **29** (4), 19 (1999).
12. H. ESBAH, M. AKYOL, M. STEINDL: Urban Agriculture: Implications on Istanbul Cultural Heritage. J Environ Prot Ecol, **15** (4), 1793 (2014).
13. 3kopru.com (3 bridge). Available at: http://www.3kopru.com [Accessed August. 2015], 2014.
14. J. R. CAPKA: Megaprojects, They Are a Different Breed. Available at: https://www.fhwa.dot.gov/publications/publicroads/04jul/01.cfm [Accessed Sept. 2014], 2004.
15. H. GERCEK: The Case of Beyoglu, Istanbul Dimensions of Urban Development Transportation. In: Planning and Big Transportation Projects in Istanbul (Ed. G. Erkut). Technische Universitat Berlin, Endformat GmbH, Berlin, 2014.
16. M. GUVENC, E. YUCESOY: Urban Spaces in and Around Istanbul. In: Istanbul: City of Intersections (Ed. R. Burdett). Urban Age, 2009, p. 52.
17. U. ERDEM: 245 Thousand Trees Were Cut to the Bridge. Hurriyet Magazine, 13 July 2013. Available at: http://www.hurriyet.com.tr/ekonomi/23716861.asp [Accessed Sept. 2014].
18. A. FINKEL: The Bridge to Nowhere. New York Times, 16 November 2011.
19. N. KATSIKES: On the Geographical Organization of World Urbanization. MONU, Spring Istanbul, No 20, 2014, 4–11.
20. B. UPMEYER: Working with Geography – Interview with Bruno Secchi. MONU, Spring, No 20, 2014, 28–33.

Received 11 February 2016
Revised 26 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 557–565 (2016)

Ecology

POTENTIAL OF WATER PURIFICATION OF MACKA FOREST ECOSYSTEMS IN NORTHEASTERN TURKEY

L. ALTUN, U. KEZIK*, O. KARA, E. BABUR

Faculty of Forestry and Forest Engineering, Karadeniz Technical University, 61 000 Trabzon, Turkey
E-mail: *kezik@ktu.edu.tr*

Abstract. Forests are known to be critically important functions in terms of ecological, economical and social functions they serve. Forest ecosystems play a crucial role in the production of high quality and quantitiy water. Forests lands contain the necessary mechanisms to provide clean, healthy water, including the filtering effect provided by forests soils in watersheds. The objective of this study was to estimate the water filtration of forest soil in Macka Ormanustu Forest Research area, located in northeastern Turkey, which provides public drinking water supply to Trabzon province. For this purpose, the amount of filtered water which contributes to the stream flow per unit area was estimated by using water balance equation including annual precipitation, interception, surface runoff and the amount of water stored in the soil (AWHC). Soil properties such as soil depth, coarse fragment, texture, structure, pH, organic matter and avaliable water hoilding capacity (AWHC) were also determined in forest and open (grassland) area. Results from this study showed that filtered water was approximately 3751.2 $m^3\ ha^{-1}\ yr^{-1}$ in forest and 2986.1 $m^3\ ha^{-1}\ yr^{-1}$ in open area. Our results revealed that forests can reduce drinking water treatment costs by naturally filtering water through its porous soils.

Keywords: soil water, water production function, forest ecosystems, hydrological cycle.

AIMS AND BACKGROUND

Forest soils carry out essential ecosystem functions like carbon storage, nutrient uptake, water storage and filtration. In this study, we attempted to determine the ability of forest soil to filter water. This study was conducted in a small watershad area belong to Ormanustu Research Forest, located in Trabzon povinence, Turkey. The amount of filtered water was determined by using annual rainfall, interception, surface runoff and avaliable water holding capacity (Fig. 1).

Water in our ecosystems is absolutely critical. It plays a fundemental role in our healthy life, economy, agriculture, and environment. Human population growths dramatically affect water resource. Storing the water during rainy periods present on a regular and continuous manner for the benefit of life is paramount importance[1]. In this regard, forest ecosystems forming the most significant terrestrial biome play an important role in filtering water from the precipitation. It contributes to

* For correspondence.

produce high quality, regular and continuous feeding of ground water resources for public services[2–5].

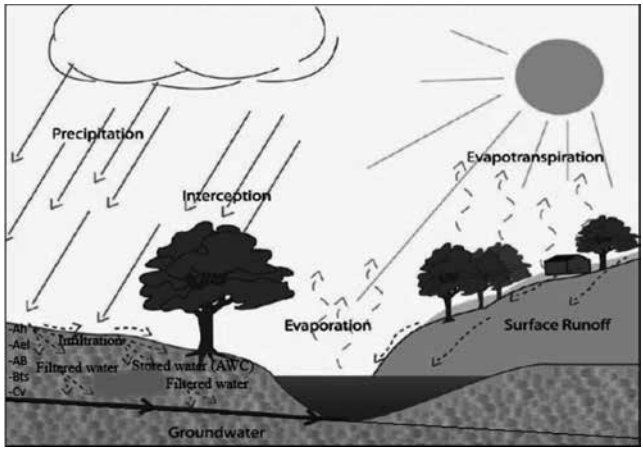


Fig. 1. Hydrological cycle in forest ecosystems[6]

Approximately 2/3 of the Earth is covered by water[7] and 97% of Earth water is contained within the oceans and seas as salt water, while remaning 3% is fresh water in lakes and frozen water in glaciers. Of that the 70% freshwater resources consist of glacier, the amount of liquid freshwater can be found underground and used for the continuation of terrestrial life, even less than 1% of the total water on earth[8].

Forests compose the world largest and most important terrestrial ecosystems[9] and represent a large part of the plant biomass[10]. Forest ecosystems, as a result of the interaction of biotic (living) and abiotic (nonliving) environment in a particular region and embodying many ecological relationships (Fig. 2), are unique systems[11]. A huge amount of organisms can be host in each gram forest soil[12,13].

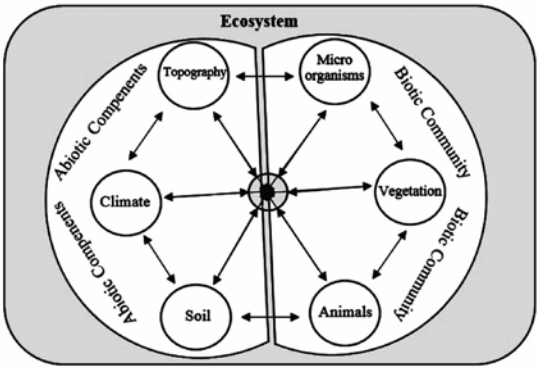


Fig. 2. Ecosystem compenents and their interrelations with each other

Forest ecosystems not only supply wooden raw material for the forest industry, but also regulate and affect the local and global climate conditions that contribute to the hydrological cycle, fresh air and water, regulating soil and water regime. They are known as an open system with ecologic, economic and social functions[2,14–16].

Soil systems in forest can perform usually several functions simultaneously[17,18]. Considering the hydrological aspect, when rainwater reaches the soil, rises to forefront of filtration function. This filtering function of the soil can be performed with its physical, chemical and bological properties (micropores, negative charges, decomposer organisms, etc.)[19].

The hydrological functions of forest ecosystem affect indirectly our urban ecosystem. The water, filtered to the forest soils after the rainfall, generates about two thirds of fresh and clean water in the United States. Forests also help to prevent waste that will be moved in many ways to the lakes, ground water and streams. Furthermore, trees and other plant roots system ensure to filter the water by tending of soil pore system in several layers before entering the groundwater. In this process, toxins, heavy metals and sediment are removed from water. Also leaves, plant waste such as branches and cones in the forest ground play an important role for water filtration. Through the process of denitrification, for example, bacteria in wet forest soils convert nitrates-a nutrient that can lead to harmful algal blooms if too much of it enters bodies of water-into nitrogen gas, releasing it into the air instead of into local streams[20–23]. Enzymatic activities in forest soils also are higher than in agricultural and cultivated lands[24].

Living filter systems as trees processing of wastewater have been identified as the best achievements in towns. The study states that in a city of 100 000 inhabitants, the daily amount of waste water is thought to be 4.5 million l. It has been demostrated that 552 ha forest area are necessary for filtering this waste water by living filter sistem[25].

EXPERIMENTAL

The study was conducted in a 645 ha (forest = 479 ha, open area = 166 ha) Ormanüstu research area located between Paparza and Camliduz streams in the Trabzon provinence in Northeast Black Sea Region of Turkey (40°47′00″–40°44′30″ N and 39°28′41′30″–39°30′00″ E) (Fig. 3). The mean elevation is 1860 m, slope – 32–70% with a west aspect. The region occupies a humid subtropical zone of oceanic climate. According to climatological data of the last 30 years, the area has mean annual temperature of 6.36°C and mean annual precipitation of 1042 mm, with about 424 mm of rainfall occuring in vegetation period between June and September. Major forest species are oriental beech (*Fagus orientalis*), oriental spruce (*Picea orientalis*) and Caucasian fir (*Abies nordmanniana subsp. nordmaniana*) and open area is grassland.

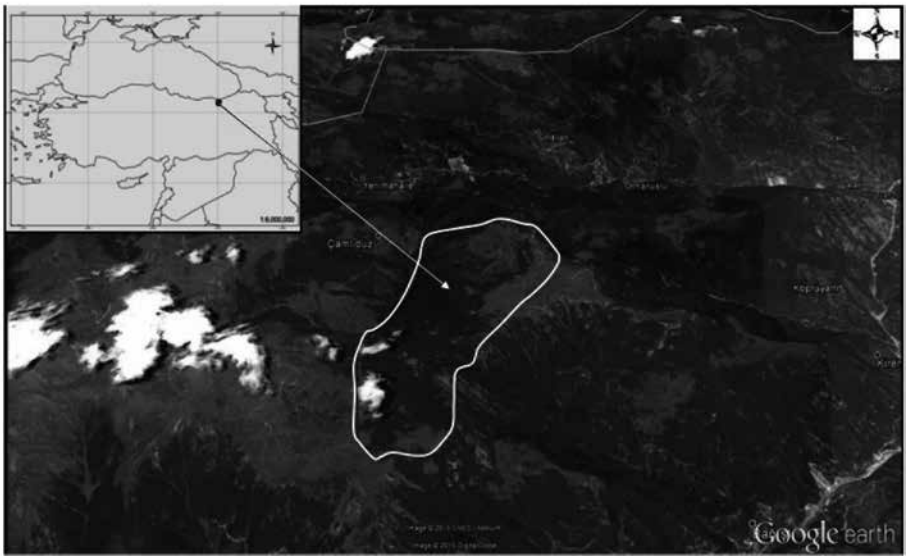


Fig. 3. Location of research area

Field working. Total 115 soil profiles, digged up to 120 cm depth, systematically distributed where on forest (82 profile) and open area (33 profile) were evaluated. Total 345 disturbed and undisturbed soil samples were taken based on soil layer (Ah, Ael, Bts and Cv horizons)[26].

Laboratory analysis. Some soil propeties such as soil texture[27], soil organic matter (walkley-black)[26,27], soil pH (H_2O) (Ref. 27), coarsa fragment (> 2 mm), fine fragment (< 2 mm), avaliable water holding capacity (AWHC) were determined.

The water holding capacity in soil is closely related to soil organic matter content, soil type, stone content and soil depth. Several formulas are used in estimating of soil water characteristics by using soil texture and organic matter[28]. In our study, we used soil texture, soil coarsa fragment (> 2 mm), soil depth and soil organic matter as soil properties in estimating AWHC per unit area for both forest and open area[29,30].

Hydrological calculations. Solum at the end of B horizon in a soil profil was used for determination of AWHC. During the calculations solum depth was taken as 100 cm because some soil depth is smaller or larger than 100 cm (AWHC values interpoleted to 100 cm).

In forest and grassland ecosystems, a certain portion of the total annual precipitation per unit area filtreted feeds to the stream flow and ground water and finally reaches the nearest reservoir. In these ecosystems, annual filtered water reaching the ground water was calculated using formula shown below.

Annual water filtration potential (*AWFP*). Numerous water balane equations developed for a watershed[31]. In our study, AWFP of soils in both forest and grassland (open area) ecosystems determined by using this equation $X = Y – (Z + T + Q)$, where X is the annual water filtration potantial (AWFP, mm); Y – the total annual rainfall (1042 mm m^{-2}); T – runoff (mixed forest: 18%, grassland: 36%) (Ref. 32); Z – annual interception ratio (mixed forest: 28% and grassland: 17%) (Ref. 32), and Q – available water holding capacity (AWHC) at 100 cm depth[33]. Water demands for evapotranspiration are met by the stored soil water[34]. Therefore, evapotranspiration parameter was not used in the water balance equation.

Statistical analysis. Soil properties according to the above formula of AWHC were analysed for comparison between forest and grasland area by One-way ANOVA at 95% confidence level. Statistical analyses were carried out using SPSS program version 15 and Microsoft Office.

RESULTS AND DISCUSSION

Forest and grassland soils in the study area are generally coarse-textured (sandy loam) and with slightly acidity reaction. One-way ANOVA demonstrated that forest soils contain significantly higher clay ratio, organic matter and AWHC than those in the open area soils (Table 1). Increased organic matter in the forests soils may be attributed to higher litter production compared to open area.

Table 1. Soil characteristics of the research area

Soil properties	Forest	Open area (grassland)
Sand (%)	69.33±10.85a*	67.88±6.49a
Silt (%)	10.21±5.68a	19.57±5.95b
Clay (%)	20.46±8.23a	12.55±4.54b
Coarsa fragment (> 2.0 mm, g l^{-1})	260.69±151.9a	241.82±134.50a
Fine fragment (< 2.0 mm, g l^{-1})	620.87±180.85a	753.11±161.97b
pH (H_2O)	5.76±0.35a	5.84±0.30a
Organic matter (%)	11.46±4.11a	10.13±2.84b
AWHC (at 100 cm depth m^{-3})	3751.2±41.31a	2986.1±49.23b

*Different letters show significant differences at $p < 0.05$ level statistically. Values in rows represent the mean standard deviation.

To estimate the filtered water in research soil, the following general steps were carried out: firstly, available water holding capacity (AWHC) (kg m^{-3}) at 1 m soil depth was determined depending on some soil properties (Table 2); secondly, annual filtrated water of per unit area (ha^{-1}) was calculated by using water balance equation mentioned above. It includes canopy interception, evapotranspiration, runoff and soil water. Our estimates reveal that water filtration potential was higher in forest

area (3751.2 m^3) than those in open area (2986.1 m^3). Our results also show that amount of filtered water in the study area was higher than previous studies may be related to soil properties, climate and stand structure[35]. Similar studies show that water quality has been affected positively by the increasing of forest area in drinking water catchments. Increasing the forest area from 10 to 60%, the cost of physical and chemical treatment of drinking water may be reduced by two to third times (Ref. 21).

Table 2. Avaliable water holding capacity of research area (AWHC, kg m^{-3})

Land use	*N*	Minimum	Maximum	Mean	Std. deviation
Forest	82	46.05	316.80	188.50	41.31
Grassland (open area)	33	92.38	396.96	191.13	49.23

AWCP in forest area was significantly higher than in open area which might be related to increased organic matter of forest soil and decreased runoff coefficient. Forest litter that covering the soil surface protects the soil from sealing and crusting by raindrop impact, thereby enhancing rainwater infiltration and reducing runoff. In forest area, litter left on the soil surface leads to improved soil aggregation and porosity, and to an increase in the number of macropores, and thus to greater infiltration rates. Studies have shown that, moder humus types developed in coniferous forest, where high amount of rainfall (150 mm h^{-1}) easily percolates to soil[34].

The high content of organic matter in forest soil is another effective factor in the production of quality water. Forest ecosystems with root, shoot, litter and soil characteristics are affecting rainfall-runoff relationship in a positive direction. Therefore, it can be interpreted that forest ecosystems have the ability to filter, trap and recycle fertilisers, herbicides, urban waste and other forms of water pollution[36].

One of the most important environmental problems of our century is climate change and the other is water scarcity[37]. The structure and function of forest ecosystems affect these issues directly. Forest dominates hydrological cycles, soil development processes and the microclimate[38]. Forest ecosystems having ecological, economical and social functions together with vegetation and soils are unique systems[39]. These systems, on the one side, supply clean and qualified water to upstream reservior established for water demand of urban[40,41] and, on the other, serve as a filter in the city wastewater treatment[23,42]. These hydrological tasks are included in the ecological function of the forest ecosystems.

In this study, assuming that water treatment cost is about 2 Turkish Liras (₺) per m^{-3}, we calculated the annual treatment cost of water as approximately ₺ 7502 per 1 ha and ₺ 3 593 458 (7502 × 479) per the total forest area (479 ha). Our finding indicated that forests soils reduced drinking water treatment costs by naturally filtering in research area. This is consistent with previous studies showing that forest area may decrease to almost 50% water treatment cost of local governments[43].

CONCLUSIONS

Forests act as a natural water filter and storage system, keeping water clear, regulating streamflow, recharging groundwater supplies and reducing runoff. Our results show that the water purification benefits of forests are economically valuable in this ecosystem. Therefore, forest land managers consider the same ecosystem services just as important in rural areas in need of clean water.

REFERENCES

1. V. EROGLU: Improvement of Hydroelectric Energy Production as the Renewable Energy in Combating of Climate Change and Other DSI Activities. Ankara, Turkey, 2006.
2. FAO: Forest and Water. International Momentum and Action. FSC (Forest Stewardship Council) Certified, Rome, Italy, 2013.
3. M. KREYE, F. J. ESCOBEDO, D. C. ADAMS, T. STEIN, T. BORISOVA: Valuing the Ecosystem Services of Florida's Forest Conservation Programs: The Economic Benefits of Protecting Water Quality. University of Florida – IFAS, EDIS, FOR 309 https://edis.ifas.ufl.edu/fr377, 2013.
4. T. STEIN, N. KIL, A. FRANK, A. E. ADAMS, D. C. ADAMS, F. J. ESCOBEDO: Public Land Management Agencies' and Nonindustrial Private Forest Landowners' Perceptions about Ecosystem Services. University of Florida – IFAS, EDIS, FOR 312 https://edis.ifas.ufl.edu/fr312, 2013.
5. F. J. ESCOBEDO, N. TIMILSINA, F. L. GAINESVILLE (Eds): Stewardship Ecosystem Services Survey Project. Gainesville, FL, University of Florida. Available at http://www.sfrc.ufl.edu/cfeor/SESS.html. October, 2012.
6. http://www.water.epa.gov, 2015.
7. M. CHANG: Forest Hydrology: An Introduction to Water and Forests. NY, USA, 2003. 373 p.
8. C. McMICHAEL: Freshwater. http://www.eoearth.org/view/article/152861, 2014.
9. FAO: http://www.fao.org/forestry/en/, 2015.
10. R. A. HOUGHTON: Aboveground Forest Biomass and the Global Carbon Balance. Glob Change Biol, **11** (6), 945 (2005).
11. H. T. ODUM: Fundamentals of Ecology. 3rd ed. W. B. Saunders Co., Toronto, Canada, 1971. 574 p.
12. K. M. MATEI, S. MATEI, I. SECELEANU, V. MOCANU, S. DUMITRU, V. COTET: Influence of Irrigation on Microbial Communities and Soil Organic Matter Evolution in the Chernozem in Marculesti. J Environ Prot Ecol, **12** (4A), 2101 (2011).
13. D. A. NEHER: Soil Community Composition and Ecosystem Processes Comparing Agricultural Ecosystems with Natural Ecosystems. Agroforestry Syst, **45** (1), 159 (1999).
14. U. KEZIK, F. KOCACINAR: Eco-physiological Functioning of Oak Coppice in Southeast Terrestrial Ecosystems in Turkey. In: Proc. of Ecology and Evoluationary Biology Symposium, Turkey, Ankara, August, 2015, p. 33.
15. G. ARABATSIZ: Development of Greek Forestry in the Framework of the European Union Policies. J Environ Prot Ecol, 1**1** (2), 682 (2010).
16. J. A. BURGER, L. D. KELTING: Using Soil Quality Indicators to Assess Forest Stand Management. For Ecol Manage, **122** (1), 155 (1999).
17. S. NORTCLIFF: Standardization of Soil Quality Attributes. Agric Ecosyst Environ, **88** (1), 161 (2002).

18. D. de la ROSA, R. SOBRAL: Soil Quality and Methods for its Assessment. Land Use Soil Res, **6** (1), 167 (2008).
19. K. SATO, T. MASUNAGA, T. WAKATSUKI: Water Movement Characteristics in a Multi-soil-layering System. Soil Sci Plant Nutr, **61** (I), 75 (2005).
20. P. K. BARTEN, C. E. ERNST: Land Conservation and Watershed Management for Source Protection. J AWWA, **96** (4), 121 (2004).
21. C. ERNST: Protecting the Source; Land Conservation and the Future of America's Drinking Water. Trust for Public Land and American Water Works Association. Water Protection Series, 2003, p. 7
22. R. A. SMAIL, D. J. LEWIS: Forest Land Conversion, Ecosystem Services, and Economic Issues for Policy: A Review. PNW-GTR-797. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, USA, Portland, OR, 2009.
23. E. SPRAGUE: The State of Chesapeake Forests. The Conservation Fund VA, USA, Arlington, VA, 2006.
24. A. D. SAMUEL, C. DOMUTA, G. CIOBANU, M. SANDORB, C. CIOBANU, R. BREJEA: Enzymological Study of the Evolution of the Technogenic Soil Submitted to Biological Recultivation in the Bauxite Mine from Padurea Craiului (Romania). J Environ Prot Ecol, **12** (2), 535 (2011).
25. W. GREY, J. GENE – DENEKE, J. FREDERIC: Urban Forestry. John Mille and Sons, Wiley, New York, 1986.
26. M. D. KANTARCI: Analytical Investigation of Some Soil Litter and Properties According to Altitude-Climate Zone In the Uludag Fir Forest of North Aladag Mountain (Bolu). Istanbul University, Faculty of Forestry, Publication No 274, Istanbul, Turkey, 1979.
27. F. GULCUR: Soil Physical and Chemical Analysis Methods. Istanbul University, Faculty of Forestry, Publication No 201, Istanbul, Turkey, 1974.
28. K. E. SAXTON, W. J. RAWLS: Soil Water Characteristic Estimates by Texture and Organic Matter for Hydrologic Solutions**.** Soil Sci Soc Am J, **70** (5), 1569 (2006).
29. M. D. KANTARCI: Investigations on Soil Types of Belgrade Forests and Mapping Principles of Forest Site Index Units. Istanbul University, Faculty of Forestry, Publication No 275, Istanbul, Turkey, 1980.
30. N. CEPEL: Soil-Water-Plant Relationships Textbook. Istanbul University, Institute of Natural Sciences, Publication No 5, Istanbul, Turkey, 1993.
31. L. ZHANG, W. R. DAWES, G. R. WALKER: Predicting the Effect of Vegetation Changes on Catchment Average Water Balance. Technical Report 99/12, Canberra, Australia, 1999.
32. N. CEPEL: Ecological Principles of Land Use Planning for the Upper Watershed of Dams. J Fac for Istanbul U*,* **B 36** (2), (1986).
33. L. ALTUN: Effects of Forest Site Factors on Distinguishing of Forest Site Unity in Trabzon-Maçka Ormanustu's Forest were Studied.Karadeniz Technical University. Institute of Natural Sciences, Ph. D. Thesis (Unpublished), Trabzon, Turkey, 1995. 176 p.
34. S. OZHAN: Watershed Management Textbook. Istanbul University, Faculty of Forestry, Publication No 481/384, Istanbul, Turkey, 2004.
35. T. R. NISBETT: Water Use by Trees. Forestry Comission Information Note, Edinburg, UK, 2005.
36. N. CEPEL: Soil Physics Textbook. Istanbul University. Faculty of Forestry, Publication No 374/281, Istanbul, Turkey, 1985.
37. R. COSTANZA, S. E. JORGENSEN: Understanding and Solving Environmental Problems in the 21st Century. 1st ed. Elsevier, 2002.

38. M. D. KANTARCI: Soil Science Textbook. Istanbul University, Faculty of Forestry, Istanbul, Turkey, 2003.
39. J. A. BLANCO, Y. H. LO: Forest Ecosystems – More Than Just Trees. Rijeka, Croatia, 2012.
40. E. ELIAS, D. LABAND, M. DOUGHERTY: Estimating the Public Water Supply Protection Value of Forests. Journal of Contemporary Water Research & Education Issue, **152** (1), 94 (2013).
41. S. GULCU, S. CELIK, N. SERIN: Effects of Forestry Activities Implemented Surrounding Water Resources on Water Quality and Water Yield. In: Proc. of the TMMOB II. Water Policies Congress, Ankara, March 2008, 61-69.
42. S. DELPHIN, F. J. ESCOBEDO, A. ABD-ELRAHMAN, A. E. ADAMS, J. MARTIN, R. CADEMUS: Stewardship Ecosystem Services Study Series: Assessing Forest Water Yield and Purification Ecosystem Services in the Lower Suwannee River Watershed, Florida. FOR317, One of a Series of the School of Forest Resources and Conservation, UF/IFAS Extension. http://edis.ifas.ufl.edu, 2014.
43. http://www.seesouthernforests.org/case-studies/role-forests-water-purification, 2015.

Received 8 January 2016
Revised 12 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 566–575 (2016)

Ecology

PEDO-GEOCHEMICAL DIFFERENCES BETWEEN YOUNG SOILS: REGOSOLS AND SPOLIC TECHNOSOLS IN NORTHERN PART OF EASTERN CARPATHIANS (ROMANIA)

D. T. JURAVLE[a]*, C. V. SECU[a], I. G. BREABAN[a], D. C. LESENCIUC[a], H. U. KASPER[b], E. D. BOBRIC[a]

[a] *'Alexandru Ioan Cuza' University Iasi, 20A Carol I Blvd., 700 505 Iasi, Romania*
E-mail: *jdorut@yahoo.com*
[b]*Department of Geology and Mineralogy, University of Cologne, 50 674 Cologne, Germany*

Abstract. Based on four young soil profiles (P), wherefrom two are situated on mining dumps (spolic technosols, P1, P3) and the other two are closely located (skeletic regosols, P2, P4) on slopes of 30°, it has been analysed the morphologic differences, the content of artefacts and the concentration of environmental relevant metals. Spolic technosols are characterised by a large content of artefacts (max. 70.9%) with profile variations while in regosols the skeleton content is slightly lower (up 65.3%), but increases steadily with depth. The high frequency of freeze-thaw cycles (88) compared with the high mountain area (70) accelerates pedogenesis, by fragmenting the anthropogenic spolic material (MAsp). The technosol formed by alteration of pyrite and chalcopyrite (P2) has maximum concentrations of following specific trace elements like Ni (158 mg kg^{-1}), Cu (696 mg kg^{-1}), in bioaccumulative horizon, and Se (43.5 mg kg^{-1}) in lower part of soil profile exceeding the benchmarks of the Romanian legislation. By weathering manganese carbonates and silicates, the second technosol (P3) has the maximum amounts for Ni (210 mg kg^{-1}), Cu (395 mg kg^{-1}), Pb (792 mg kg^{-1}), Se (74.9 mg kg^{-1}). In the topsoil of regosols, only Ni and Se are beyond the average values specified in literature. In all the studied profiles, Mn shifts to minor elements class while Fe into the major elements class. The chemical properties of the pyrite dump favoured the installation of acidophil vegetation that contrasts with the surrounding soils (regosols).

Keywords: artefacts, freeze-thaw cycles, trace elements, pedogenesis.

AIMS AND BACKGROUND

In northern part of Eastern Carpathian, the mining activities had been conducted in several stages. During 1944–1989, a period of extensive mining, the industrial system was reflected in the formation of mining dumps, some small dumps (Izvorul Giumalaului, situated at 1070 m, 0.29 ha and 8735 m^3) while others occupy large areas (Colacu, situated at 1020 m, 5.45 ha and 822 800 m^3). The bottom of

* For correspondence.

the Izvorul Giumalaului mining dump has been partially sectioned by the streams, being affected by the fluvial erosion. In addition, the slope of Colacu dump is affected by deep erosion through several rills associated in the superior part with suffusion processes[1].

Izvorul Giumalaului mining dump resulted from depositing sterile and the extracted copper ore (on Izvorul Giumalaului stream, Moldova drainage basin), being placed on epimetamorphic deposits of Tulghes 3 Formation (Tg3) from the Bucovinic Nappe[2, 3]. Colacu mining dump was formed by the exploration works for manganese ores, done on epi-metamorphic deposits of Tulghes 2 Formation (Tg2) from the Subbucovinic Nappe (on Colacu stream, Bistrita drainage basin)[2,3]. Petrographic composition of the mining dumps is conditioned by the attack mode with mining works on horizons of interest.

Tg2 contains the most important deposits of manganese ores in Romania, from where were exploited the primary (carbonates) and secondary (oxide) ones. Moreover, the lithologic substrate is constituted from sericite-chlorite-quartz schist and sericite-chlorite ± graphite schist, with intercalation of a complex black graphitic quartzite, in which holds the deposits of manganese ore[2–4].

The main accumulations of copper and polymetallic ores are into the epimetamorphic deposits of Tg3. Tg3 has a volcano-sedimentary genesis, with a strong rhyolitic character. Considering the lithostratigraphy, 3 units have been separated: Morosan, Fundu Moldovei and Basca. The Morosan unit is at the basis of the formation (consisting of sericite-chlorite schist with albite porphyroblasts, sericite quartzite, rhyolitic metavulcanites and a thin discontinuous layer of black quartzite). Fundu Moldovei is situated in the median part of the Tg3 Formation (consisting of a succession of sericite-chlorite/chlorite-sericite schist, which contains sulphides). Basca is the top unit of Tg3, being represented by a series of graphitic schist and black quartzite, white quartzite and sericite-chlorite-quartz schist and phyllites)[3,5].

Few studies had the purpose to analyse the chemical properties regarding the dump soils from the northern part of Eastern Carpathians[6], mostly being focused on topics like: water pollution from pyrite mining waste dumps[7] and iron mining waste dumps[8], environmental relevant metals load of sediments and water in central part of Apuseni Mountains, Western Carpathians[9].

The present study aims at comparing young soils formed on copper and manganese deposits with natural undisturbed soils located nearby. Izvorul Giumalaului dump (P1, Table 1) resulted from prospecting and mining exploration of copper pyrites and it was closed in 1990, while Colacu (P3) was formed by exploiting manganese deposits and closed in 1999. The objectives of this study are: (1) to identify relationships between pedogenetic factors and morphological characteristics of the soils dumps; (2) to determine the chemical differentiation of regosols and technosols formed on spolic parental materials stored at the mine entrance (waste rock).

The present paper may contribute to the database of the following edition of the Geochemical Atlas of Europe (2006), especially since data from Romania were not included in its last edition.

EXPERIMENTAL

For each dump were performed soil profiles (P1 to 47°27′45″ N – Izvorul Giumalaului and 25°30′49″ E and P3 47°30′04″ N and 25°18′29″ E – Colacu) followed by natural control profiles performed on nearby slopes (P2 the 47°27′44″ N and 25°30′48″ E and P4 to 47°30′10″ N and 25°18′24″ E) (Fig. 1). 17 horizons/layers resulted, of which 10 were for technosols and 7 for regosols, which were analysed in terms of morphological and physicochemical features.

Soil skeleton content was determined before soil sample preparation. Subsequently, 100 g dry soil passed through a 2-mm sieve, at the AS200 Retsch sieve device for 3 min. Total organic carbon (TOC) content was determined by the difference between total carbon (TC) and total inorganic carbon (TIC), measured directly with the Multi N/C 2100 analyser equipped with a module for solid samples: HT 1300 – High-temperature combustion technology.

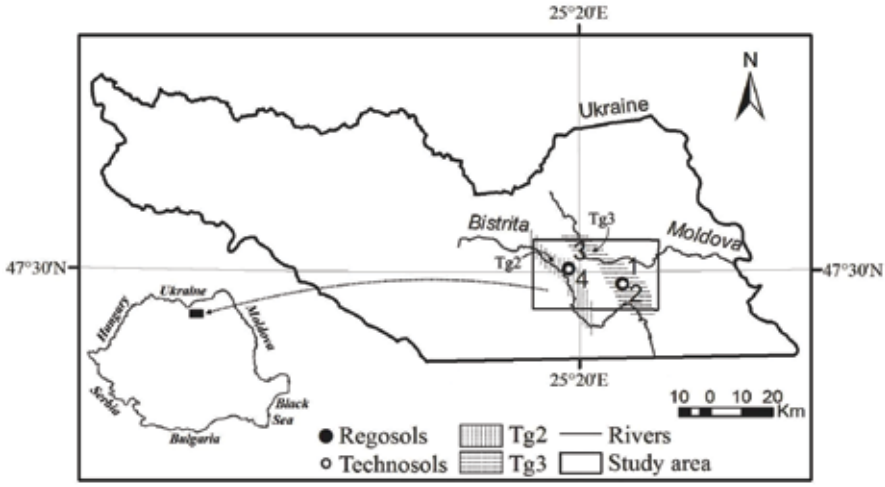


Fig. 1. Location of the soil profiles (1–4) and Tg2, Tg3 geological formations

Solid samples were treated by increasing temperature up to 950°C for TC as well as after manually acidified with HCl 2M to pH 2 and dried in an oven for TIC. The pH in water 1:5 and total dissolved solids (TDS) was analysed using a digital pH-measuring device Eijkekamp 18. For the analyses of environmental relevant metals the specimens were previously sieved to 2 mm and milled with an agate mortar, 0.2 g of the fine powder were digested according to EPA method 3051A with nitric acid, ultrapure in a closed microwave vessel system MARS 6. After

digestion, samples were filtered and filled up to 50 ml with 18 MΩ cm distilled water. For each pair of soils (technosols – regosols) mobile form major (Fe, Mg), and environmental relevant metals (As, Ba, Ce, Co, Cr, Cu, Ga, La, Li, Mo, Mn, Nb, Ni, Pb, Rb , Sc, Se, Sr, Zn, Zr, and Y) were determined by inductively coupled plasma mass spectrometry – Agilent 7700×, using Rh as internal standard. Obtained results for elements from topsoil have been checks by the Geochemical Laboratory of the University of Cologne.

Petrographic and mineralogical analyses were undertaken on thin sections, using a JENAPOL polarising microscope, the analysed images being taken with the Moticam 1000 camera.

Frequency of gelifraction cycles were measured with the LogTag Humidity and Temperature HAXO-8 Recorder with a resolution of –0.1% and 0.1°C, located near Izvorul Giumalaului dump.

RESULTS AND DISCUSSION

Izvorul Giumalaului mining dump is formed by depositing rhyolitic metavulcanites and sericite/chlorite schist in the inferior part, while in the upper part the copper ore is present (compact or impregnated), the copper-pyrite ore content being over 60–70%. From the mineralogical point of view, the ore consists mainly of pyrite (51–84%), with grain size between 0.012–0.64 mm; chalcopyrite with sizes varying from 0.011–0.11 mm; 1–5% sphalerite (0.0011–0.09 mm); sporadically, galena (0.011–0.012 mm); 0–6% tetrahedrite ($(Cu, Fe)_{12}Sb_4S_{13}$) and remaining minerals (< 1%).

Colacu mining dump consists of black quartzite and graphitic schist (70–90%), various sericite/chlorite-quartz schist (10–20%), manganese ore (5–10%) and other material resulted from the digging process (carbide, beams, metallic materials, packaging, etc. 5%). Lens shaped manganese ores occur mainly in black graphitic quartzite, with various dimensions. The mineralogical composition is relatively homogeneous: 70% manganese carbonate, 25% manganese silicate and 5% oxides and sulphides of manganese and iron, among other minerals (less than 1%). Carbonates are represented by rhodochrosite ($MnCO_3$), calcite, aragonite ($CaCO_3$), ankerite ($Ca(Mg, Fe)(CO_3)_2$) and siderite ($FeCO_3$), followed by silicate, predominantly being rhodonite ($CaMn_4Si_5O_{15}$), pyrite (FeS_2), pyrrhotite ($Fe_{1-x}S$), chalcopyrite ($CuFeS_2$), sphalerite (ZnS) and galena (PbS), oxides such as jacobsite ($MnFe_2O_4$), magnetite ($FeFe_2O_4$), hematite (Fe_2O_3) and hausmannite ($MnMn_2O_4$) (Ref. 2).

On both mining dumps the spolic technosols were formed and on slopes between 29–30° skeletic regosols[10] were present on parental materials, resulted through schist weathering. Comparable with natural materials, spolic material evolves under the influence of pedogenesis, but the mineral components of the technosols are less

affected by weathering and many of the morphological properties differ from those of the natural soils even in small areas. For both dumps, the plateau is formed by a succession of flat and wavy surfaces have been noticed. Micro-depressions and ridges resulted from the disposal of material create discontinuities in the early stages of pedogenesis. In the micro-depressions, vegetation installs faster than on ridges contributing to the formation of a very thin bioaccumulative horizon. These differences are the effect of higher water content in micro-depressions than on ridges, even if it is the case of a mining dump of relatively young age (12 years)[11]. In the early years of its existence, mining dumps had physical and/or chemical properties unfavourable cover of vegetation and soil formation. Horizontal surfaces of the two dumps are covered by natural vegetation. In 15 to 25 years of pedogenesis (Colacu respectively Izvorul Giumalaului) a thin A horizon was formed (Table 1). Rohoskova put into the evidence the role of favourable conditions[12], revealing that on a coal dump after only 10 years an initial A horizon have been developed.

Table 1. Morphological properties of technosols (P1, P3) and regosols (P2, P4)

Profile	Horizon[a]	Depth (cm)	Colour		Roots[b]		Horizon boundary[c]
			moist	dry	abundancy	diameter (mm)/ restricting depth (cm)	
1	A(u)	0–2	10YR3/1	10YR 3/2	F	2–4	
	MAsp	2–16	7.5YR 5/8	10YR 6/2	f	–/**8**	a
	MA_2sp	16–24	10YR 4/1	2.5Y 5/2	–	–	i
	MA_3sp	24–47	N3/1(70%)+10YR 3/1(30%)	2.5Y 5/2	–	–	i
	MA_4sp	>47	10YR 3/1	10YR 6/8	–	–	i
2	Ao	0–9	10YR 3/3	10YR 4/3	M	1–3	
	AC	9–31	10YR 4/4	10YR 5/8	M	0.5–1	a
	AC_2	31–52	10YR 4/2	10YR 5/2	F	1–4	a
	CR	52–61	10YR 4/1	10YR 5/2	f	3–4/**60**	a
3	A	0–2	10Y 2/1	10YR 3/1	F	1–2	
	MAsp	2–28	10YR 4/1	10YR 5/1	F	1–2	w
	MA_2sp	28–52	N2.5/1(80%)+ 2.5YR 4/5(10%)	10YR 3/2	f	1–2	w
	MA_3sp	52–64	N2.5/1(80%)+ 2.5YR 4/5(10%)	10YR 2.5/3	f	1–2/**62**	w
	MA_4sp	>64	5PB 2.5/1	N4.5/1	–	–	
4	A	0–1	10YR 3/1	10YR 3/3	F		a
	C	1–33	10YR 3.5/1	10YR 5/2	f		a
	C_2	33–65	10YR 4/1	10YR 6/2	f	/65	a
	R	>65	–	–	–	–	–

[a]MA – anthropogenic material; sp – spolic; [b]M – many, F – frequent, f – few; [c]a – abrupt, i – irregular, w – wavy

Artefact content varies within one layer to other, furthermore, it exceeds in skeleton of regosols. The reduced weight of artefacts at surface can be randomly due to the way the mining waste deposition or due to the results of freeze-thaw cycles. Monitoring done from 2012 to 2013 at the Izvorul Giumalaului dump allowed the identification of 88 diurnal cycles of freeze-thaw (Fig. 2), different from the 70 recorded cycles by the meteorological station Rarau (1651 m). In the case of dumps located in floodplains and below the thermal inversion, the higher number of gelifraction cycles lead to the fragmentation of spolic materials and pedogenesis of horizon A.

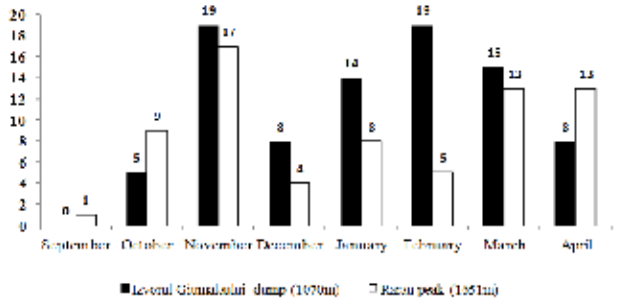


Fig. 2. Monthly distribution of the number of diurnal freeze-thaw cycles (2012–2013)

Chemical analyses highlight different values of pH for technosols. Thus, P1 ranges from strongly acidic setting in the A horizon (4.42) to extremely acidic in subsurface layers (e.g. MAsp = 3.63, MA_2sp = 3.61). In spolic technosols, pyrite, being distinguishable by straw yellow colour (Table 2) in the middle part of the profile, limiting roots penetration.

Pyrite oxidation and pH decrease are favoured by airflow due to the large spaces between pebbles of few cm in diameter in the dumped materials. Higher frequency of gelifraction phenomena induced the fragmentation of spolic material; it is a matter of course that fine material is more reactive than coarse one, especially where oxidation occurs on freshly crushed rocks. In P4, manganese carbonates are responsible for high pH values, which varied little in the profile (7.63 to 8.07). In both cases the technosol versus pH ratio displays a sharp contrast to the very low (P1) or high (P4) in relation to regosols (4.5–5.3). Donisa have been determined for dump resulted from manganese exploitation, situated on Oita valley, decreased pH values (3.8–5.7) which are different from those found in P4 (Ref. 6). Because of very low pH at the Izvorul Giumalaului dump acidophilic vegetation have been installed (*Picea abies*, *Vaccinium vitis-idaea*, *Licopodium clavatum*) which contrasts with the neighbouring, where deciduous occur (e.g. *Fagus sylvatica*).

Table 2. Spolic material and skeleton content (%) in soil profiles

Horizons	Depth (cm)	Technosols	Horizons	Depth (cm)	Regosols
		spolic material (%)			skeleton (%)
Profile 1			Profile 2		
A(u)	0–2	68.39	Ao	0–9	42.34
MAsp	2–16	44.49	AC	9–31	56.51
MA_2sp	16–24	60.39	AC_2	31–52	60.87
MA_3sp	24–47	64.17	CR	52–61	56.19
MA_4sp	>47	70.95			
Profile 3			Profile 4		
A	0–2	47.41	A	0–1	51.78
MAsp	2–28	51.62	C	1–33	65.33
MA_2sp	28–52	49.71	C_2	33–65	53.75
MA_3sp	52–64	46.96	R	>65	>95
MA_4sp	>64	60.50			

For technosols, the following nine environmental relevant metals (Cu, Pb, As, Mn, Se, Cr, Co, Ni and Ba) exceed the normal value (NV) of the Romanian legislation[13] while for regosols, only four elements (Mn, Cr, Co, and Ni) are below the benchmark. Spolic technosols are potentially contaminated with trace elements resulted from mineral oxidation that contain relatively high amounts of such elements, but these elements result for minerals oxidising. The contents of Ga, Nb, Rb, Sc, Sr, Y and rare earth elements (Ce and La) do not exceed mean values specified by A. Kabata-Pendias[14] in studied soils. In P1 and P2, Li exceed two time the mean found in the soils from USA and China (33–35 mg kg^{-1}) (Ref. 14). In the analysed profiles some changes occur in framing of some elements such as: Mn shifts from trace (< 100 mg kg^{-1}) to minor (> 100 mg kg^{-1} < 0.1%) elements. In regosols, Mn has different values in bioaccumulative horizons (2259 mg kg^{-1} in P4, respectively 886 mg kg^{-1} in P2), while at the bottom has relatively close values (P4 = 1200 to P2 = 1500 mg kg^{-1}) as a result of common origin of parent material as crystalline schist, which gives similar geochemical characteristics.

In both regosols Fe concentration increases steadily on profile (P2: Au = 62695 mg kg^{-1}, CR = 72819 mg kg^{-1}, in P4: A = 24144 mg kg^{-1}, C2 = 42320 mg kg^{-1}) with the depth. In technosols, concentrations are significantly different between the bioaccumulative horizon (P1 A(u) = 80597 mg kg^{-1}, in P3 = 52776 mg kg^{-1}) and the underlying layers (P1 MAsp = 41129 mg kg^{-1}, in P3 MAsp = 38637 mg kg^{-1}) reflecting precisely the chemical properties of the spolic material stratifications. Occasionally, soil is contaminated with high concentration of major elements such as Fe, in areas affected by sulphide mining, in the Iberian Pyrite Belt[15], but the excess amount of Mn caused the reduction in absorption and translocation of Fe resulted in a decrease of chlorophyll[14], noticeable at leaves of young *Picea*.

Distribution of trace elements (Cu, Pb, As, Sr, Mn) reveal differences in technosols depending both on parent material and profile based on stratification, but also to soils formed under natural conditions. The benchmarks from national legislation have been exceeded for the following potential toxic elements (Ni, Cu, Pb) to which Se is added, from the metalloids group. The comparative analysis of soil profiles (P1, P3) reveals that Ni, Cu and Pb with maximum values in the A horizons of the technosols are higher than the concentration of the layers below (Table 3).

Table 3. Environmental relevant metals content in soil profiles

Horizons/depth		Technosols				Horizons/depth		Regosols			
P1	(cm)	Ni	Cu	Pb	Se	P2	(cm)	Ni	Cu	Pb	Se
A(u)	0–2	152	696.8	12.4	29.4	Ao	0–9	79.0	6.7	5.7	39.0
MAsp	2–16	15.30	3.4	11.8	34.3	AC	9–31	66.3	10.6	3.8	45.1
MA_2sp	16–24	36.15	3.6	4.8	34.7	AC_2	31–52	63.0	13.9	3.1	30.2
MA_3sp	24–47	49.30	2.6	2.1	22.4	CR	52–61	78.0	12.5	3.6	39.6
MA_4sp	>47	28.58	5.4	3.0	43.5						
P3						P4					
A	0–2	210	153.8	9.9	12.9	A	0–1	39.0	7.4	10.5	12.3
MAsp	2–28	68.2	10.9	2.2	40.4	C	1–33	45.6	5.4	2.5	26.9
MA_2sp	28–52	133.3	16.0	164.5	40.0	C_2	33–65	80.1	8.3	3.5	29.2
MA_3sp	52–64	154.8	395.4	792.6	40.0	R	>65	–	–	–	–
MA_4sp	>64	99.4	9.43	1.9	74.9	Median in topsoil		18.0	13.0	22.6	0.33
NV(756/1997)		20	20	20	1	Median in subsoil[17]		21.8	13.9	17.2	–

On the one side, for P1 this can be explained by the affinity of Ni, Cu, Pb for natural organic matter and on the other side, by great mobility within oxidising, acidic condition[14,16]. However, Cu can be toxic to plants at too high concentration. Therefore, some plants have developed tolerance to high levels of Cu (Ref. 17). This can explained partially why the waste dump Izvorul Giumalaului is better covered by vegetation than Colacu. In P2, these elements have the same decreasing trend of concentration at slightly alkaline pH and different TOC content between A (0.38%) and MAsp (6.45%). In MAsp, Ni and Pb are strongly related to Fe (A = 52776 mg kg^{-1}, MAsp = 3863 mg kg^{-1}) and Mn oxides, and less with TOC that become from organic inclusions, used in mining activities. These elements seem to be controlled mainly by the geochemical signature of sulphide mineralisation, e.g. pyrite, chalcopyrite, and less by the other soil forming factors.

In regosols (P2, P4) Pb decreases steadily towards the value of the parent material, while Cu is having a concentration tendency in the same direction due to both chalcopyrite weathering and tetrahedrite. In addition to the above-mentioned elements, Mg occurs in higher concentrations in all profiles (min = 1296 mg kg^{-1},

max = 5877 mg kg^{-1}) from chlorite weathering while Na with a lower concentration (min = 74.92 mg kg^{-1}, max = 365 mg kg^{-1}), resulting from albite weathering.

CONCLUSIONS

Land micromorphology on plateau dump and geomorphological processes on the talus slopes have a major contribution in the early stages of pedogenesis of soil from mining dumps. Micro-depressions are favourable for pioneer plants while ridges expose frequently surface rock. The horizontal surfaces are generally covered with vegetation and favour the formation of a very thin bioaccumulative horizon. At slope values of approximately 30°, the bioaccumulative horizon of regosols is thicker beneath mixt vegetation (P2) and the thinner under softwood (P4). Waste mine rocks (spolic materials), through its high share, limit the penetration of roots and soil formation. The artefacts content and the land micromorphology may have a higher influence in early stages of pedogenesis on waste mining dumps than their chemical composition. More frequent cycles of gelifraction in lowlands than in highlands accelerates the disaggregation of the spolic material, resulting in a lower share in upper than in bottom layers of technosol. In regosols, the skeletal content gradually increases toward the inferior part of the profile and limits in a lesser extent the root development.

Chemical characteristics of spolic technosols are influenced mostly by the concentration of the ore. In the technosols formed by pyrites weathering, at low pH values were determined high concentrations of Ni, Cu, and Se whereas by altering the spolic material in which manganese carbonate dominates, at alkaline pH, higher concentrations were recorded for Cu, Ni, Pb and Se. Changes of concentration in the profile is directly related to the rocks chemistry that forms stratification and also to the pedogenesis, some elements being blocked in A horizon.

In regosols, Ni, Cu and Se express a normal growth trend of concentration concomitantly with the depth while higher values of Pb are enriched in the bioaccumulative horizon.

Acknowledgements. This work was financial supported by the Department of Geography from the 'Alexandru Ioan Cuza' University of Iasi, and the infrastructure was provided through the POSCCE-O 2.2.1, SMIS-CSNR 13984-901, No 257/28.09.2010 Project, CERNESIM (L4) and Geoarchaeology Laboratory.

REFERENCES

1. C. D. LESENCIUC: Giumalau Massif. A Geomorphological Study. Tehnopres Publ. House, Iasi, 2006. 268 p. (2006) (in Romanian).
2. I. PODASCA: Structural Study of Lithostratigraphy and Petrology of Crystalline Formations from Bistrita River Basin between Carlibaba and Iacobeni (Eastern Carpathians). Thesis, University Library Iasi, 2000. 114 p. (2000) (in Romanian).

3. Al. VODA, I. BALINTONI: Lithostratigraphic Correlations from the Eastern Carpathians Crystalline. Studia Univ. Babes-Bolyai, Geologia (Cluj-Napoca), **XXXIX** (1–2), 61 (1994) (in Romanian).
4. I. BERCIA, E. BERCIA, M. SANDULESCU, L. SZASZ: Geological Map of Romania 1:50 000. Vatra Dornei Sheet, Geological Institute Bucharest, 1975.
5. E. BERCIA, Gr. ALEXANDRESCU, M. STEFANESCU, J. ION: Geological Map of Romania 1:50 000. Pojorata Sheet, Geological Institute Bucharest, 1975.
6. C. DONISA, A. LUPASCU, Gh. LUPASCU: Study of Chemical Parameters Favouring Vegetation Installing on Mining Dumps in Northern Carpathians. Soil Forming Factors and Processes from the Temperate Zone, **3**, 149 (1993) (in Romanian)
7. B. BIRLICA, E. VOINEA, M. NICOLAU, M. PETRESCU, A. CUCIUREANU, M. VIDRIGHIN, I. LUCACIU, I. CIURCANU: Adverse Effects Caused by Pyrites and Sterile Dump from Central Pond Area on Environmental Factors Quality-Groundwater and Surface Water. J Environ Prot Ecol, **8** (1), 85 (2012).
8. A. GROZAV, Gh. ROGOBETE: Environmental Effects of Exploitation of Iron Ore Deposit Boul Peak – the Poiana Rusca Mountains. J Environ Prot Ecol, **13** (4), 2130 (2012).
9. E. BIRSAN, C. LUCA, G. CISNOVSCHI: Distribution of Dissolved and Particulate Heavy Metals in Surface Water from an Area Affected by Mining Activities. J Environ Prot Ecol, **13** (3), 1261 (2012).
10. IUSS Working Group WRB: World Reference Base for Soil Resources 2014. World Soil Resources Reports No 106, FAO, Rome, 2014.
11. V. KURAZ, J. FROUZ, M. KURAZ, A. MAKO, V. SHUSTR, J. CEJPEK, O. V. ROMANOV, E. V. ABAKUMOV: Change in Some Physical Properties of Soils in the Chronosequence of Self-overgrown Dumps on the Sokolov Quarry-Dump Complex, Czechia. Eurasian Soil Sci, **45** (3), 266 (2014).
12. M. ROHOSKOVA, V. PENIZEK, L. BORUVKA: Study of Anthropogenic Soils on a Reclaimed Dumpsite and Their Variability by Geostatistical Methods. Soil Water Res, **1** (2), 72 (2006).
13. R. O. M.: MAPPM Order No 756/1997, Regarding the Reference Value for Soil Chemical Elements Contents. Romanian Official Monitor, I, No 303bis/06.11.1997, (1997).
14. A. KABATA-PENDIAS, H. PENDIAS (Eds): Trace Elements in Soils and Plants. 3rd ed. CRC Press, Boca Raton, 2001, p. 331.
15. I. GONZALES, E. GALAN, A. ROMERO: Assessing Soil Quality in Areas Affected by Sulphide Mining. Application to Soils in the Iberian Pyrite Belt (SW Spain). Minerals, **1**, 73 (2011).
16. W. de VOS, T. TARVAINEN (Chief Eds): Geochemical Atlas of Europe. Part 2: Interpretation of Geochemical Maps, Additional Tables, Figures, Maps and Related Publications. EuroGeosurveys & Foregs, Espoo, Finland, 2006.
17. L. JOHANSSON, C. XYDAS, N. MESSIOS, E. STOLTZ, M. GREGER: Growth and Cu Accumulation by Plants Grown on Cu Containing Mine Tailing in Cyprus. Appl Geochem, **20**, 101 (2005).

Received 22 February 2016
Revised 18 April 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *576–583* (*2016*)

Ecology

EXAMPLE STUDY ABOUT MERYEMANA VALLEY (TRABZON/TURKEY) FOR DETERMINING THE POTENTIAL CAMPGROUND IN THE SCOPE OF NATURE TOURISM

S. S. KURT*, E. DUZGUNES, B. C. KURDOGLU , O. DEMIREL

Department of Landscape Architecture, School of Forestry, Karadeniz Technical University, 61 080 Trabzon, Turkey
E-mail: *sultansevinckurt@gmail.com*; *ertandusgunes@gmail.com*; *banukurdoglu@windowslive.com*; *odofe01@gmail.com*

Abstract. Mankind has lived in harmony with nature until the urbanisation process has led to ecosystem degradation over time. This situation has brought irreparable wounds on natural and resource values. Due to the adverse conditions experienced in urban areas, natural areas in recent years are one of the most preferred recreation areas by people fleeing the city life. Nature tourism includes adventure sports and recreational activities carried out in rural areas. Hiking, picnicking, mountaineering, orienteering, bird watching, sport fishing, nature photography and camping, come at the beginning of the events taking place in nature. Camping is one of these events, the desire to perform in the nature; more than in natural areas is preferred because of the accommodations facilities and low-cost. In this study, taking into account the needs and experiences of local people, nature tourism activities within the scope of the Meryemana Valley (Trabzon/Turkey) on the potential camp sites have been identified. In the study area, which is set by the National Camp Accreditation Programme, land use, camping area and size, terrain, vegetation, climate, water resources, security, transportation criteria, criteria within 9 ideal camping areas have been identified.

Keywords: nature tourism, camping, camp, Meryemana Valley.

AIMS AND BACKGROUND

In modern society, social, economic, cultural, technological and political developments in parallel, recreation, open green spaces and important concepts of free time and play an important role in human life. Nowadays, especially increasing trend of urbanisation and the development of transport facilities, recreation demand and diversity lead to significant changes[1]. Due to the adverse conditions experienced in urban areas, natural areas in recent years, are one of the most preferred by people fleeing the recreation area of city life.

Tourism is an exceptionally significant sector in regional development and effective use of resources. Nature tourism in general, refers to trips made to the

* For correspondence.

natural environment. It includes all forms of tourism related to the use of natural resources such as scene integrity, topography, water, vegetation and wildlife. Nature-oriented tourism was proposed at the beginning of 20th century; after the reconsideration of recreation and natural ecological conservation in the following years, ecotourism emphasised micro-tourism, different from mass tourism, focusing on local development with the activities based on local resources, economy, characteristics, and life. It includes recreational and adventure sports activities made in rural places[2–5].

The sporting events take place in nature, 'natural sports', 'open space recreation', 'adventure recreation', depending on factors including the risks that they take in and help elements used are classified by different names[6]. In recreational areas a variety of activities such as hiking, picnicking, mountaineering, orienteering, trekking, bird watching, fishing, photography, camping, cycling, canoeing, kayaking, horseback riding, water-skiing, air sports are carried out.

Camping is one of these events is an integral part of the extreme sports which creates excitement, enthusiasm or addiction on people. Camping provides the opportunity to experience the nature first hand. Camping for the purpose of having recreative and sports activities in nature, for a short time accommodation, to rest, to spend time; is a recreation way to benefit from performing vehicles such as tents, barracks, caravan[7–11].

Places where held in the camp activities are called as camping area or campings. These areas are included in the route of highways and neighbourhoods in the entrance of the city; they are established in places which have natural beauty such as sea, lake, mountain. 'Camping grounds can be found in forests and deserts, high plains and mountains, the lake shoreline and ocean beaches'[10].

According to standard measure establishing the camping area, shelter population in the area, the expansion requirement, shelter type to be used, the plot and campground shelter scheme, the rate of available space is taken into account. Shelter in the camping area, roads, including in the areas of administrative support per person (green spaces, social facilities, etc.) should not be dropped under 30 m^2. Camping grounds should have the facilities at least 30 units (tents, caravans, bungalows), should consist of no more than 1000 people[7,12].

Campgrounds are divided into four groups including transit, recreational, transit-recreational and organisation campingrounds[9,13–15].

According to National Camp Accreditation Programme (NCAP), land use, camping area and measurement, terrain, vegetation, climate, water resources, security, transportation are important factors in the selection criteria for the ideal camping ground. An ideal camp site,

- Should has a slightly sloped ground that can drain rain in an open area;
- Could endanger the lives of people in the camping area, where there is no avalanche and landslide risk;

● Is located near the area of water resources for drinking and using;

● Are coarse or medium textured areas which have low level of ground water to live on and to build facilities in order to facilitate, the ability to drain the surface water quickly;

● Are regions which has not been taken under protection in accordance with regulations or any law in terms of flora and fauna and non-sensitive in terms of plant and animal existence;

● Should be zones which have altitudes between 800–2000 m in terms of bio-climatic comfort, facing east and south, wind speed is not high degree that could affect activities and facilities in area (between 0–10 m/s), relative humidity values that will not affect the events in a negative way (between 25–75%).

The criteria which should be considered in the selection and placement of shelters in campgrounds are as follows:

● The average closed area for per person must be 3.5–4.5 m^2;

● In hot and humid climates, shelter should be ensured with adequate air flow;

● In hot and dry climates, shelter material must be high temperature resistant;

● In cold climates, shelter material should be optimally insulated;

● Shelters should be installed back to back as much as possible. Tents are portable shelters made of lightweight canvas. There are various types and sizes of tents;

● Main roads inside the camp, which will allow vehicle and pedestrian traffic should be 5 m wide;

● Access roads should be as 3 m wide to allow shipping;

● The average water use per person must be 15 l, per 250 person should fall into a water point;

● The distance between any place with water point should be a maximum of 500 m;

● 1 bath cabin should be provided for every 25 people;

● 1 toilet stall should be provided for every 20 people;

● For places to collective laundry, 1 washing pool is required for every 100 people[7,12,14–18].

EXPERIMENTAL

The main materials of study: Altindere, Bakircilar, Cayirlar, Cosandere, Kuscu, Yuzuncuyil and covering Esiroglu resort with cottage villages, constitute Macka. Macka district, with its natural and cultural features is the province of Trabzon city. The study area is located in Turkish Black Sea region, in Eastern Black Sea region (Fig. 1).

The method of the study constitutes observation, analysis, data collection, analysis and assessment. To determine the boundaries of the study area, land survey was done primarily, after taking opinions from the people who know they are well,

the regions with high tourism potential have been selected. Using the Arcgis 10.1 software, were produced maps of the area. In this context, Geographic Information System was used as a tool to produce maps and to create a database of the area.

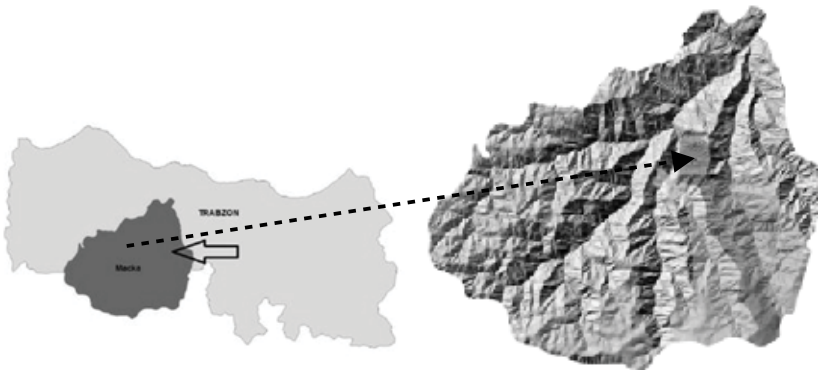


Fig. 1. Study area

RESULTS AND DISCUSSION

Eastern Black Sea unique geographic structure is described as a natural part of the district of Macka, Meryenana Valley is still today hosting many of the valley interesting, introverted traces of the cultural life. Many residential area situated in the valley, with its rich cultural heritage they contain, and the terrific harmony between man and nature reveals the most colourful examples of diversified financial environment accordingly. According to assessments made by taking into consideration the criteria set by the NCAP, 9 ideal camping areas are determined within the boundaries of the study area (see further Fig. 11).

Favaden Campground – 40°43′29.36″ north latitude – 39°39′55.78″ east longitude Favaden camping area is located at a height of 872 m (Fig. 2). The area has Black Sea climate.

Fig. 2. Present apprearence of Favaden Campground

Kebi Campground – 40°42′37.65″ north latitude – 39°40′26.11″ east longitude Kebi camping area is located at a height of 1846 m (Fig. 3). The area has Black Sea climate.

Fig. 3. Present appearance of Kebi Campground

Goflagol Campground – 40°42′21.56″ north latitude – 39°41′2.82″ east longitude Goflagol camping area is located at a height of 867 m (Fig. 4). The area has Black Sea climate.

Fig. 4. Present appearance of Goflagol Campground

Kusal Campground – 40°43′31.87″ north latitude – 39°40′20.84″ east longitude Kusal camping area is located at a height of 568 m (Fig. 5). The area has Black Sea climate.

Fig. 5. Present appearance of Kusal Campground

Lagana Campground – 40°47′49.06″ north latitude – 39°38′16.30″ east longitude Lagana camping area is located at a height of 1263 m (Fig. 6). The area has Black Sea climate.

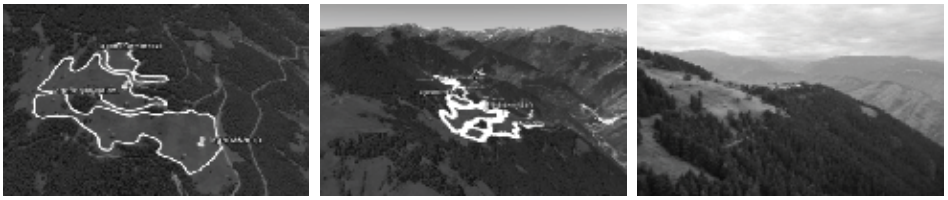


Fig. 6. Present appearance of Lagana Campground

Mezere Cayirlar Campground – 40°46′43.90″ north latitude – 39°38′16.35″ east longitude Mezera Cayirlar camping area is located at a height of 1171 m (Fig. 7). The area has Black Sea climate.

Fig. 7. Present appearance of Mezera Cayirlar Campground

Rashi Campground – 40°46′8.84″ north latitude – 39°37′53.98″ east longitude Rashi camping area is located at a height of 603 m (Fig. 8). The area has Black Sea climate.

Fig. 8. Present appearance of Rashı Campground

Severiksa Yelef Campground – 40°44′25.57″ north latitude – 39°39′6.03″ eastern longitude Severiksa Yelef camping area is located at a height of 1271 m (Fig. 9). The area has Black Sea climate.

Fig. 9. Present appearance of Severiksa Yelef Campground

Bottom of Severiksa-Kondova Campground – 40°44′2.19″ north latitude – 39°38′55.82″ east longitude Bottom of Severiksa-Kondoba camping area is located at a height of 1725 m (Fig. 10). The area has Black Sea climate.

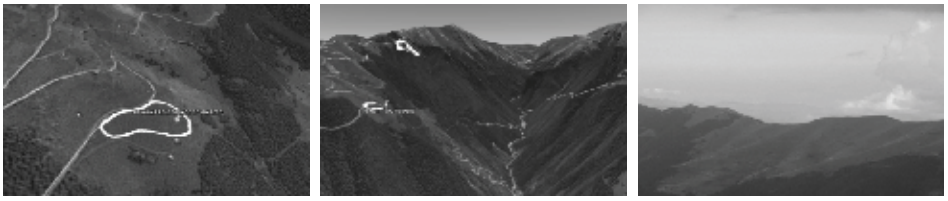


Fig. 10. Present appearance of Bottom of Severiksa-Kondoba Campground

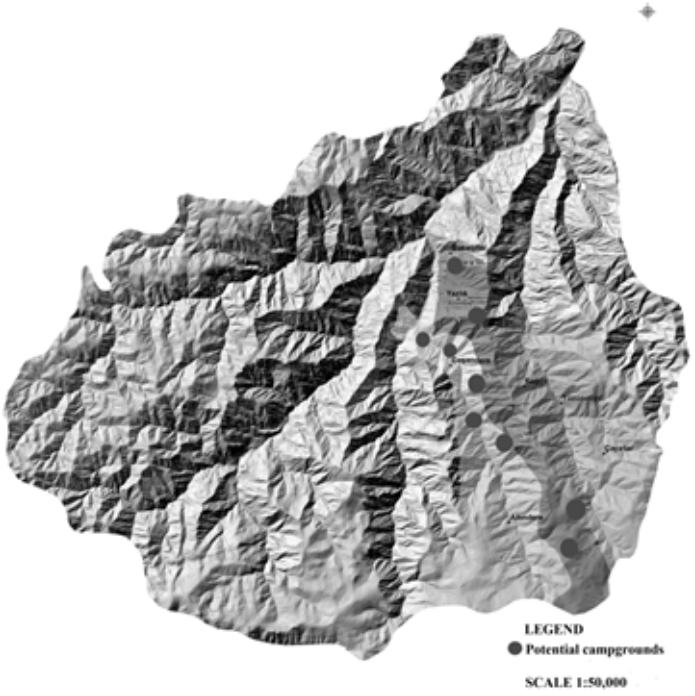


Fig. 11. Map of the potential campgrounds

CONCLUSIONS

As a result of investigations made in the study, within the boundaries of the study area, most suitable 9 areas are determined for camping activity. These areas are determined to provide the conditions that must be owned for camping activity.

Suitable areas for camping activity are usually located on south aspects. The most important reason for gaining density in this part of the camping area is the degree of curvature that is between 0–6%. Other influential factors for these areas

are having soil texture of coarse-medium bodied, being 500–1800 m above sea level, having a good soil drainage, having the ground water depth about 2 m and above. Avalanche risk in these areas is weak.

Acknowledgements. This study was a part of the Eastern Black Sea Development Agency (TR90/10/TURIZM001-A) project. We would like to thank Eastern Black Sea Development Agency for their support.

REFERENCES

1. M. AKTEN, S. AKTEN: A Model Approach on Determining the Potential Recreation: Gülez Management. 1. In: Proc. of the National Sarigol County and Values Symposium, February 2011, 17–19.
2. G. OZDEMIR, T. KIPER, B. BASARAN: Women Organisations in Turkey Rural Tourism. J Environ Prot Ecol, **13** (2), 643 (2012).
3. N. OZGUC: Tourism Geography Properties Regions. Cantay Bookstore, Istanbul, 1998.
4. T. KIPER, M. ARSLAN: Example of Determining the Nature Tourism Hiking Route in Anatolia Scope Study. Journal of Tekirdag Agricultural Faculty, **4** (2), 165 (2007).
5. C. J. SHIEH: Effects of Behavioural Norm Cognition on Tourist Satisfaction with Ecotourism. J Environ Prot Ecol, **15** (3A), 1273 (2014).
6. F. KOCAK, V. BALCI: Nature Made Environmental Sustainability in Sporting Events. Ankara University Journal of Environmental Science, **2** (2), 213 (2010).
7. Acacamps: www.acacamps.org, 2008.
8. Talkcamping: www.talkcamping.co.uk, 2008.
9. M. TOPAY, N. KOCAN: Camping/Tented Camp and Determination of Site Selection Criteria for Bartin-Uluyayla. A Case Study. Suleyman Demirel University, Faculty of Forestry, **1**, 116 (2009).
10. TKDD: Hand in Hand with Our Case Studies for Modern Campsites Entrepreneurs. Turkey Camping and Caravan Association, Turkey, 2013.
11. Tourism Dictionary: http://turizm.terimleri.com/Campsite.html, 2015.
12. CSGB: Determination and Application of Reference METIP Shelter Location. Republic of Turkey Ministry of Labour and Social Security, 2012.
13. S. GULEZ: Forest Recreation Planning House. KTU Faculty of Forestry Journal, 6 (1983).
14. F. TANRIVERDI: Basic Principles and Application Method of Landscape Architecture Garden Art. Ataturk University Publications, No 643, Erzurum, 1987.
15. N. KOC, S. SAHIN: Rural Landscape Planning. Ankara University Faculty of Agriculture, Publication No 1509, Ankara, 1999.
16. ANONYMOUS: Scout Handbook. President of the Federation of Scouting Publications, Ankara 1996.
17. N. SOZEN, S. SAHIN: Camping (Planning-Implementation-Business). Landscape Architectural Association Publications, Ankara, 1998.
18. M. TOPAY: Bartin-Uluyayla Landscape Features of Recreation and Tourism. A Research on Evaluation of User. Unpublished Ph.D. Thesis, University of Science and Technology Institute of Mainland, Ankara, 2003.

Received 11 February 2016
Revised 26 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *584–592* (*2016*)

Biology

DO EUTROPHIC WATERS PROMPT TO TOXIC CYANOBACTERIA IN TURKISH BLACK SEA COAST?

R. AKCAALAN*, L. KOKER, M. ALBAY

Fisheries Faculty, Istanbul University, No 200 Ordu Cad., Laleli, Istanbul, Turkey
E-mail: *rakcaalan@gmail.com*

Abstract. Cyanobacteria is known to form harmful blooms in fresh and brackish waters and also marine environments. Cyanobacteria blooms generally are the indicators of eutrophication in freshwaters as well as estuaries and marine ecosystems. European Environmental Agency rated the eutrophication in the Black Sea as highest concern in 1995. Since the Turkish coastline is also under the pollution risk, the present study was conducted to investigate whether toxic cyanobacteria were present and pose any risk hazard. Samples were taken in five sites along the Turkish coast between Igneada to Samsun, ca 928.5 km long between May–October 2012 to investigate the potential of toxic cyanobacteria presence. Twenty eight samples from surface waters were analysed using 16S rRNA and sixteen of them were positive. Cyanobacteria was detected every sampling date in Sakarya river vicinity both microscopically and PCR method. HEP-PCR was used to detect the toxin genes and four samples gave positive results. In contrast, no hepatotoxin was detected with ELISA.

Keywords: phytoplankton, 16SrRNA, HEP-PCR, surface waters, Black Sea.

AIMS AND BACKGROUND

The aim of this paper is to determine the potential of cyanobacteria blooms and presence of cyanotoxins in the coastal waters of Southern Black Sea using PCR.

The Black Sea is a unique environment as a semi-enclosed system and subject to high amount of nutrient inputs via rivers, mainly Danube which is responsible of the 87% of freshwater inputs to the Black Sea[1]. Nitrogen and phosphorus enrichment in a waterbody result in eutrophication and the Black Sea coastal environment has suffer from this problem for a long time[2]. The first result of eutrophication and altered nutrient ratios is the change of phytoplankton composition in aquatic environments. There is a well-documented long-term data on the variation of phytoplankton species diversity and abundance in the western Black Sea, namely Romanian shelf and Bulgarian waters[3,4] and there is a shift between Bacillariophyta:Dinophyta ratio from 10:7 to 7:10 and intensity and frequency of algal blooms have been increased over time as indicated by chlorophyll concentrations at Northwestern Black Sea area[5]. Turkoglu[6] investigated algal blooms in

* For correspondence.

Sinop Bay and reported that 11 species, mainly diatoms, reached to the cell densities equal or higher than 1×10^6.

Red-tides which is caused by dinoflagellate blooms is a well-known phenomenon in marine systems. However, cyanobacteria could also considered other harmful species reaching high numbers in brackish waters and also Baltic Sea which toxic *Nodularia spumigena* blooms recorded historically[7]. Toxic cyanobacteria records and published data are mainly available for European freshwater systems, however, the Baltic Sea is the only marine ecosystem which have a detailed investigation on cyanobacteria blooms and toxicity. The only report of potentially toxic cyanobacteria bloom in the Black Sea was *Nodularia spumigena* detected in Ukranian coast in July 2010 (Ref. 8). Teneva et al.[9] identified seven cyanobacteria species in Bulgarian coast in the summer of 2012 with a bloom of *Romeria gracilis*, however no cyanotoxin was detected.

EXPERIMENTAL

Sampling was performed in monthly intervals between May and October in 2012. A total 5 sites were chosen in the Southern Black Sea coast from Igneada to Samsun. All sites were chosen near to main river inputs, except site 1, located in the border of Bulgaria (Fig. 1). Site 2 was located next to the Bosphorus junction and in the vicinity of a small river, namely Riva. The other sites were chosen in front of three main rivers, Sakarya, Kizilirmak and Yesilirmak rivers, respectively.

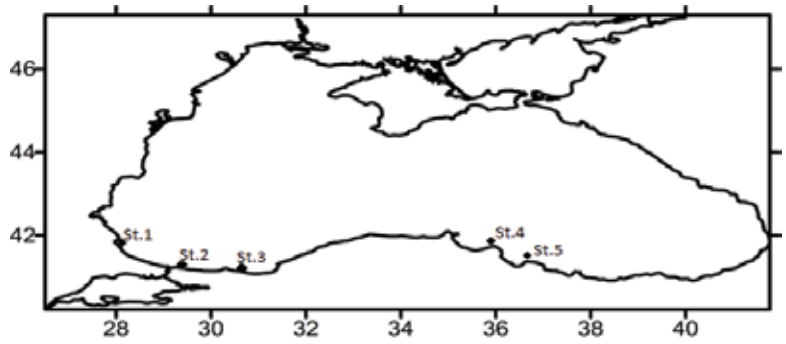


Fig. 1. Location of sampling sites

Samples were taken from surface, 5 and 10 m depths. Temperature, dissolved oxygen, pH and salinity were measured *in situ* using the YSI multiparameter (YSI 650 MDS). Water samples were collected using the Nansen bottle from the surface, 5 and 10 m depths for nutrients, phytoplankton and molecular analysis. Nutrient analysis was carried out according to APHA, AWWA and WEF (Ref. 10) and chlorophyll-*a* measurements were performed according to Nusch[11]. Phytoplank-

ton enumeration was done with a Zeiss inverted microscope using the Utermöhl method[12] and species were identified using the results of Hendey[13] and Tomas[14].

Total genomic DNA extraction from 0.2 μm membrane filters was performed using MoBio DNA isolation kits. 16s rDNA amplification was performed using forward primer (27F; 5′ AGA GTT TGA TCC TGG CTC AG 3′) and reverse primer (809R; 5′ GCT TCG GCA CGG CTC GGG TCG ATA 3′). Thermal cycling was performed at 92°C for 2 min followed by 35 cycles of 94°C for 10 s, 60°C for 20 s and 72°C for 1 min and a final extension step at 72°C for 5 min (Ref. 15). Hepatotoxin (HEP) PCR reactions were performed using primers HEP and HEPR. An initial denaturation step at 92°C for 2 min was followed by 35 cycles of 92°C for 20 s, 52°C for 30 s, and 72°C for 1 min, with a final extension step at 72°C for 5 min (Ref. 16).

To determine differences of Chl *a*, and physicochemical variables among the sites, analysis of variance (ANOVA) was used. The Tukey Honestly Significant Different (HSD) test was applied to identify sources of variation, when significant differences were determined as a result of ANOVA. These statistical analyses were performed using SPSS 19.0.

RESULTS AND DISCUSSION

During the sampling period, surface water temperatures varied between 13 and 27.4°C among the sites. Dissolved oxygen was high in all sites with a minimum 7.1 mg/l and maximum 9.3 mg/l, since sampling was done in the coastal area with a maximum depth of 10 m. Salinity did not changed between the sites and mean salinity was 17.2 $\%_o$. Lower salinity was measured in surface waters due to the higher freshwater inputs in sites 3 and 5 in May. However, any substantial variation did not detected throughout the sampling period. Secchi disc depth showed marked differences between the sites. Mean Secchi disc depth was similar in sites 1, 4 and 5 and maximum depth was detected as 7.5 m in site 2. Site 3 has the lowest Secchi disc depth among them (Table 1). As it is located in the vicinity of Sakarya river which is a long river and flow through the most industrialised cities and also agricultural areas, it carries a high amount of suspended solids. Also, the bottom of sampling area was fine sand and distributed in the water column easily with a wind action.

Mean chlorophyll-*a* concentrations changed between minimum 0.5 and maximum 1 μg/l among the sites. Lower values were detected in sites 1 and 2 and other sites have higher concentrations. However, the results are still lower when it compares with the NW Black Sea shelf area[17]. The difference between the sites is mainly because of the phytoplankton species found.

Table 1. Mean values of physochemical parameters between May and October in sites

Parameters	St. 1	St. 2	St. 3	St. 4	St. 5
Temperature (°C)	22.6 [a]	22.8 [a]	20.4 [a]	21.0 [a]	23.0 [a]
Conductivity (mS cm^{-1})	26.5 [a]	26.8 [a]	25.3 [a]	21.7 [a]	27.0 [a]
Total dissolved solids (mg l^{-1})	18.1 [a]	18.2 [a]	18.2 [a]	15.2 [a]	18.2 [a]
Salinity (g/l)	17.1 [a]	17.2 [a]	17.1 [a]	16.9 [a]	17.3 [a]
pH	8.3 [a]	83 [a]	8.2 [a]	8.2 [a]	8.3 [a]
Dissolved oxygen (mg l^{-1})	7.9 [a]	7.9 [a]	8.3 [a]	8.3 [a]	7.9 [a]
Secchi disc depth (m)	5.6 [a]	7.5 [a]	2.7 [b]	5.9 [a]	5.9 [a]
o-PO_4 (µg l^{-1})	6.8 [ac]	12.2 [ac]	24.0 [b]	4.5 [c]	15.2 [ab]
TP (µg l^{-1})	20.8 [a]	30.8 [a]	69.8 [a]	30.6 [a]	59.2 [a]
SiO_2 (mg l^{-1})	0.2 [a]	0.2 [a]	0.9 [ac]	1.4 [bcd]	0.8 [ad]
NO_3 + NO_2 (mg l^{-1})	0.2 [a]	0.6 [a]	0.7 [a]	0.4 [a]	0.4 [a]
Chl-*a* (µg l^{-1})	0.5 [a]	0.5 [a]	1.0 [a]	0.8 [a]	0.8 [a]

Similar letters indicated no statistical difference ($p \leq 0.05$).

Increased nutrient inputs have a clear negative effect on ecosystem functioning. Especially in coastal areas nutrient concentration was generally higher and under effect of urbanisation. Turkish coastline of Black Sea is about 1650 km and 14 cities, 5 of them have more than 750 000 population, were located in the coastal area. Moreover, four rivers and many streams flowing through the Black Sea carrying nutrients collected in their catchment. Therefore, the concentration of phosphorus and nitrogen is higher in site 3, which is located in front of Sakarya river mouth. Strokal and Kroeze[2] reported that the nutrient loads from the rivers in the Turkish coastline is much lower compared to the ones in Northern Black Sea with an exception of Sakarya river, however, an increase of 20 and 50% for DIN and DIP respectively is expected till 2050.

Six phytoplankton groups were detected in sampling sites. Diatoms are the dominant group in all sites, except site 3, however, subdominant groups showed differences among the sites. The contribution of dinoflagellates was substantial in site 1 and 2, on the other hand, their contribution to the total phytoplankton is lower in other sites. Uysal[18] indicated that diatoms and dinoflagellates are the main constituents of phytoplankton in Turkish Black Sea coast. Site 3, which is located in Sakarya river vicinity, separated from other sites with a dominancy of cyanobacteria which comprise 36% to the total phytoplankton and followed by diatoms and chlorophytes. Cyanobacteria were detected in every months microscopically. Sites 4 and 5 showed similarity in the percentage contribution of phytoplankton groups; diatoms were dominant, followed by chlorophytes and cryptophytes were the third group (Fig. 2).

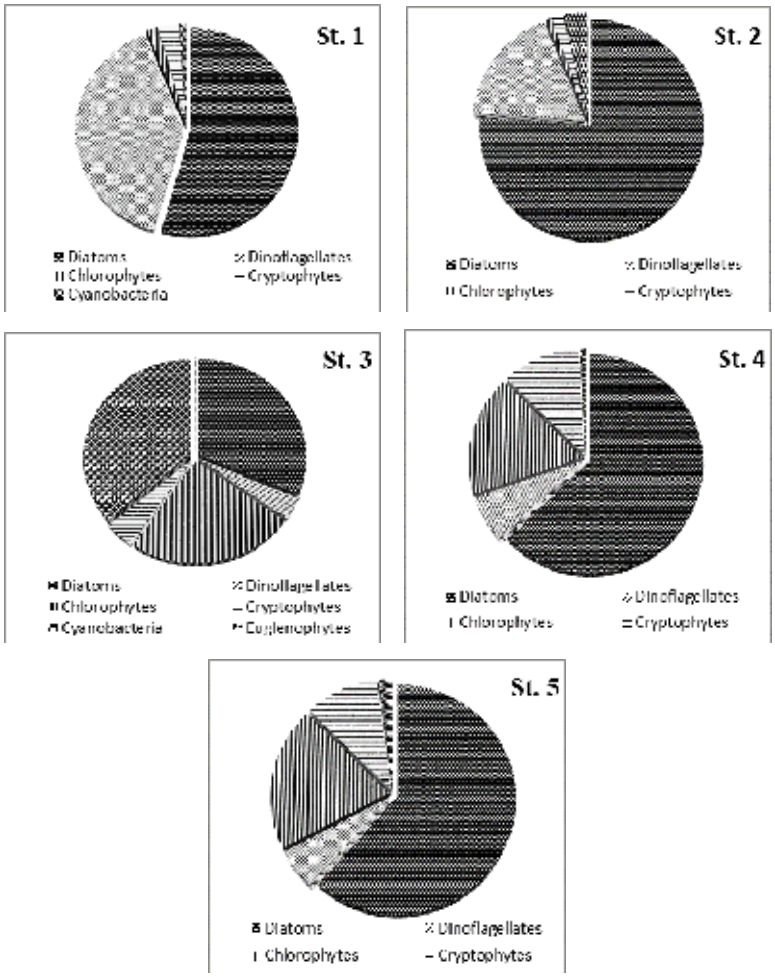


Fig. 2. Relative contribution of phytoplankton groups in the sites

Cyanobacteria abundance varied spatially and temporally. Recorded species were *Pseudoanabaena limnetica*, *Planktolyngbya limnetica*, *Merismopedia* sp., S*ynechocystis* sp., *Anabaena* sp., and *Planktothrix* sp. The latter two species only enumerated in sites 4 and 5 in very low numbers, probably drifting from freshwater lakes connected with Kizilirmak and Yesilirmak rivers. *Planktolyngbya limnetica* was recorded in site 2 in July. Maximum cyanobacteria abundance was recorded in site 3 and responsible species was *Pseudoanabaena limnetica* (Fig. 3). Marsalek et al.[19] indicated this species as toxic in a bloom in one reservoir in Czech Republic. *P. limnetica* prefers shallow, nutrient-rich, turbid waters. It is a freshwater species, however, high organic carbon concentrations drifting from freshwaters can support its presence in marine environment. It blooms also in Baltic Sea[20].

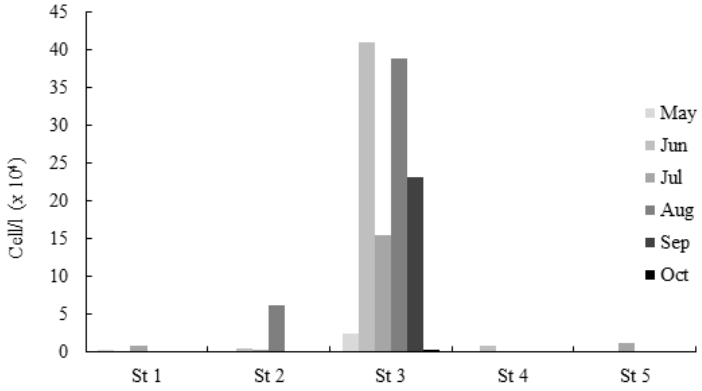


Fig. 3. Cyanobacteria abundance in surface waters in all sites

Despite the seven cyanobacteria species identified in the sites, no cyanobacteria bloom with a water discoloration was detected during the study period. One of the reasons could be salinity. Verspagen et al.[21] found that *Microcystis* blooms supressed in the salinities exceeding 14 g/l in an estuary. Similarly, *Nodularia spumigena* blooms in Baltic Sea occur rarely outside the salinity range of 3–11 g/l (Ref. 22). Alexandrov et al.[8] reported the bloom of this species in Ukranian coast with a salinity range of 12.9–14.5 g/l. In Turkish coast, the shelf is a narrow strip compared to 200 km wide area with a depth of less than 200 m in the northwestern part of Black Sea, where also affected the major freshwater discharges from Danube, Dniepr, and Dniestr[23]. Therefore, even though the samples were taken near to the main rivers, the salinity was about 17 g/l. Moreover, a unique hydrodynamic feature of the Black Sea result in three anticyclonic eddies in the areas of Bosphorus junction, Sakarya and Kizilirmak river vicinity which cause instability in water[18], in contrast to the occurrence of cyanobacteria blooms in calm waters.

Total 28 samples from surface waters of five sites were analysed for the presence of cyanobacteria with 16s rRNA and genes were detected in 16 of them. Only one sample from June has cyanobacteria in site 1 and three samples have cyanobacteria genes in sites of 2, 4 and 5. On the other hand, cyanobacteria was detected in site 3 with molecular methods in every sampling date (Fig. 4). In this study, picoplankton was overlooked microscopically, nonetheless they were included to the molecular detection since DNA isolated from filters with a 0.2 μm pore size.

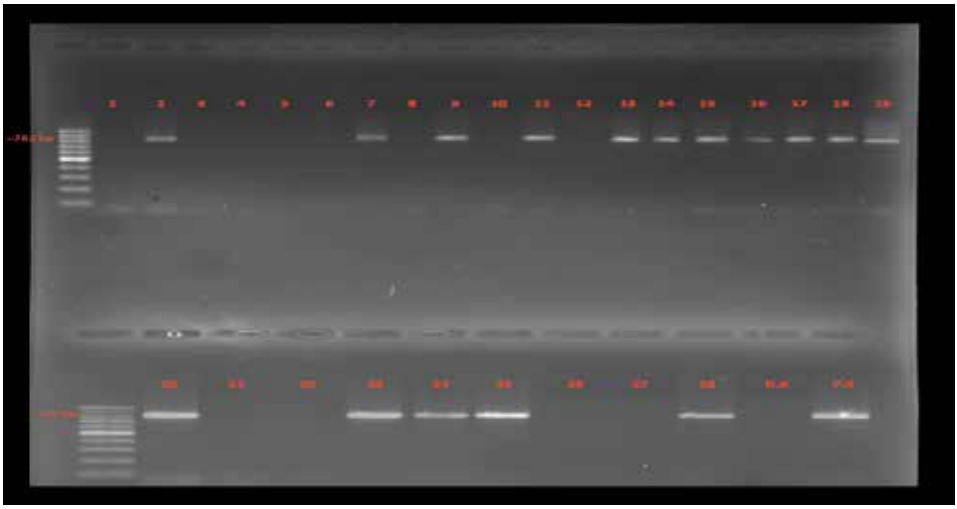


Fig. 4. Gel image of 16S rDNA (samples ranged from May to October excluded July in site 4 and June in site 5)
1–6 – Site 1; 7–12 – Site 2; 13–18 – Site 3; 19–23 – Site 4; 24–28 – Site 5; PK – positive control, NK – negative control

Only four samples were positive for HEP PCR and no toxin gene was detected in sites 1 and 2. One sample from sites 3 and 5 and two samples from site 4 have MCY/NOD genes (Fig. 5). Since presence of the genes does not mean the toxin production, positive samples from HEP-PCR were subjected to immunochemical analysis, ELISA, and no microcystin/Nodularin was detected.

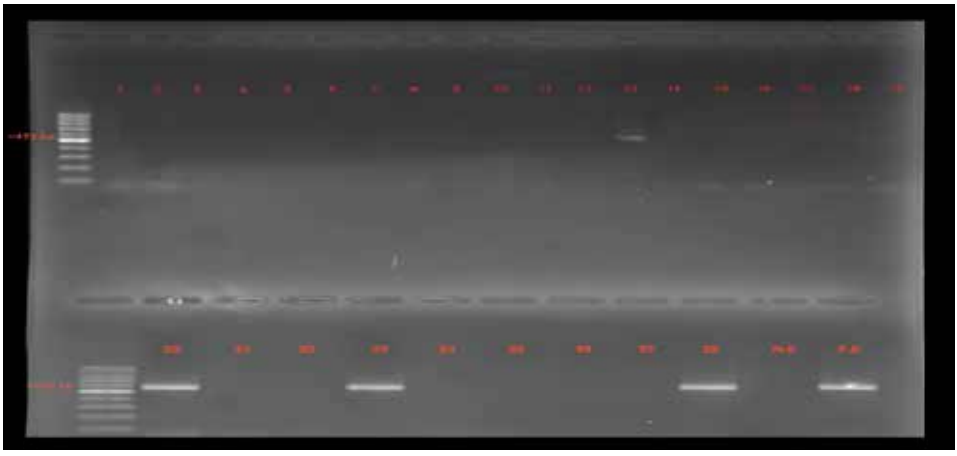


Fig. 5. Gel image of Hep-PCR
1–6 – Site 1; 7–12 – Site 2; 13–18 – Site 3; 19–23 – Site 4; 24–28 – Site 5; PK – positive control; NK – negative control

CONCLUSIONS

Black Sea suffers from eutrophication since 1970, because of increased nitrogen and phosphorus inputs through rivers derived from anthropogenic sources[3,24]. According to our results, despite the differences among the sites, coastal waters could be regarded as eutrophic based on nutrient concentrations. Cyanobacteria represented in low numbers and generally found in the main freshwater inputs, however, species diversity remained very poor. Some potentially toxic species *Planktothrix* sp. and *Anabaena* sp. were detected in very low numbers in the Southern Black Sea coast. On the other hand, *Pseudoanabaena limnetica* reached relatively high numbers. The detection of potentially toxic cyanobacteria with MCY/NOD genes indicated the possibility of risk based on cyanobacteria in Southern Black Sea. With a scenario of increased nutrient load in Turkish coastline[24], the risk of harmful algal blooms should be monitored closely and necessary measures has to be taken.

Acknowledgements. This work was supported by research grants BS ERA- NET (MARCY-019) and TUBITAK 132T211. The authors are grateful to Onur Saglam, Cenk Gurevin and Zeynep Dorak for their help in sampling, chemical analysis and data evaluation.

REFERENCES

1. L. BAT, F. SAHIN, F. USTUN, A.E. KIDEYS Kideys, H. H SATILMIS: The Qualitative and Quantitative Distribution in Phytoplankton and Zooplankton of Southern Black Sea of Cape Sinop, Turkey in 1999–2000. IEEE Oceans'07-1-4244-0635-8 (2007).
2. M. STROKAL, C. KROEZE: Nitrogen and Phosphorus Inputs to the Black Sea in 1970–2050. Regional Environmental Change, **13** (1), 179 (2012).
3. O. A. YUNEV, J. CARSTENSEN, S. MONCHEVA, A. KHALIULIN, G. ÆRTEBJERG, S. NIXON: Nutrient and Phytoplankton Trends on the Western Black Sea Shelf in Response to Cultural Eutrophication and Climate Changes. Estuarine, Coastal and Shelf Science, **74** (1), 63 (2007).
4. D. PETROVA, D. GERDZHIKOV: The Changes of Phytoplankton Community. J Environ Prot Ecol, **10** (2), 365 (2008).
5. T. OGUZ, A.G. DESHPANDE, P. MALANOTTE-RIZZOLI: The Role of Mesoscale Processes Controlling Biological Variability in the Black Sea Coastal Waters: Inferences from SeaWIFS-derived Surface Chlorophyll Field. Continental Shelf Research, **22** (10), 1477 (2002).
6. M. TURKOGLU, T. KORAY: Algal Blooms in Surface Waters of the Sinop Bay in the Black Sea, Turkey. Pak J Biol Sci, **7**, 1577 (2004).
7. T. FINNI, K. KONONEN, R. OLSONEN, K. WALLSTROM: The History of Cyanobacterial Blooms in the Baltic Sea. Ambio: A Journal of the Human Environment, **30** (4), 172 (2001).
8. B. G. ALEXANDROV, L. M. TERENKO, D. A. NESTEROVA: The First Case of a Bloom of Nodularia spumigena Mert. ex Born. et Flah.(Cyanophyta) in the Black Sea. International Journal on Algae, **14** (1) (2012).
9. I. TENEVA, P. STOYANOV, B. DZHAMBAZOV, R. MLADENOV, D. BELKINOVA: What is Known about Cyanoprokaryota and the Algal Blooms along the Bulgarian Black Sea Coast: an Overview. J BioSci Biotechnol, **4** (3), 239 (2015).
10. APHA, AWWA & WEF: Standard Methods for the Examination of Water and Wastewater. 17th ed. American Public Health Association, Washington, 1989.

11. E. NUSCH: Comparison of Different Methods for Chlorophyll and Phaeopigment Determination. Arch Hydrobiol Beih Ergebn Limnol, **14**,14 (1980).
12. H. UTERMOHL: Zur Vervollkommung der Quantitativen Phytoplankton-methodik. Mitt Int Ver Theor Angewan Limnol, **9**, 1 (1958).
13. N. I. HENDEY: An Introductory Account of the Smaller Algae of British Coastal Waters. Part 5, Bacillariophyceae. H.M. Stationary Office, London, 1964, p. 317.
14. C. TOMAS: Identifying Marine Diatoms and Dinoflagellates. Academic Press, Inc., 1997, p. 598.
15. B. A. NEILAN: Identification and Phylogenetic Analysis of Toxigenic Cyanobacteria by Multiplex Randomly Amplified Polymorphic DNA PCR. Appl Environ Microbiol, **61**, 2286 (1995).
16. A. D. JUNGBLUT, B. A. NEILAN: Molecular Identification and Evolution of the Cyclic Peptide Hepatotoxins, Microcystin and Nodularin, Synthetase Genes in Three Orders of Cyanobacteria. Arch Microbiol. **185**, 107 (2006).
17. A. E. KIDEYS: Fall and Rise of the Black Sea Ecosystem. Science, **297** (5586), 1482 (2002).
18. Z. UYSAL: On the Formation of Net Phytoplankton Patches in the Southern Black Sea during the Spring. Hydrobiologia, **485** (1), 173 (2002).
19. B. MARSALEK, L. BLAHA, P. BABICA: Analyses of Microcystins in the Biomass of Pseudanabaena limnetica Collected in the Znojmo Reservoir. Czech Phycology, Olomouc, **3**, 195 (2003).
20. L. RIEMANN, C. LEITET, T. POMMIER, K. SIMU, K. HOLMFELDT, U. LARSSON, A. HAGSTRÖM: The Native Bacterioplankton Community in the Central Baltic Sea Is Influenced by Freshwater Bacterial Species. Appl Environ Microbiol, **74** (2), 503 (2008).
21. J. M. VERSPAGEN, J. PASSARGE, K. D. JOHNK, P.M. VISSER, L. PEPERZAK, P. BOERS, H. J. LAANBROEK, J. HUISMAN: Water Management Strategies against Toxic Microcystis Blooms in the Dutch Delta. Ecological Applications, **16** (1), 313 (2006).
22. J. LEHTIMAKI, K. SIVONEN, R. LUUKKAINEN, S. I. NIEMELA: The Effect of Incubation Time, Light, Salinity, and Phosphorus on Growth and Hepatotoxin Production by Nodularia Strains. Arch Hydrobiol, **130**, 269 (1994).
23. O. BORYSOVA, A. KONDAKOV, S. PALEARI, E. RAUTALAHTI-MIETTINEN, F. STOLBERG, D. DALER: Eutrophication in the Black Sea Region; Impact Assessment and Casual Chain Analysis. Global International Waters Assessment, 91-89584-50-3, University of Kalmar, Kalmar, Sweden, 2005.
24. M. STROKAL, C. KROEZE: Nitrogen and Phosphorus Inputs to the Black Sea in 1970–2050. Reg Environ Change, **1**,179 (2013).

Received 8 January 2016
Revised 5 February 2016

Journal of Environmental Protection and Ecology 17, No 2, 593–602 (2016)

Solid waste management

CARBON FOOTPRINT IMPORTANCE FOR AN INTEGRATED WASTE MANAGEMENT SYSTEM

E. GRECU[a], D. C. PETRILEAN[b], I. IONEL[a]*

[a]*Politehnica University of Timisoara, 2 Victoriei Square, 300 006 Timisoara, Romania*
E-mail: *ioana.ionel@upt.ro*; *ionel_monica@hotmail.com*
[b]*University of Petrosani, 20 Universitatii Street, 332 006 Petrosani, Romania*

Abstract. The main difficulty in choosing a preferential site of a number of possible sites is the fact that the environmental impact and transport cost of each location cannot always be quantified easily. This paper analyses the environmental impact by evaluating the carbon footprint and transport cost of such a waste collection system which can be implemented in Timis County. In order to minimise handling costs, the location of waste landfills should be as close to the source of waste generation as possible. Expected to be achieved initially near the largest town in Timis (the village Covaci), the project was met with opposition from the neighbourhood population; another option is the location situated 50 km from Timisoara, in Ghizela village, operating with 4 transfer stations (Timisoara, Deta, Jimbolia, Faget). In particular, this paper offers a carbon foot analysis to establish a comparison between the variation of the carbon footprint and the waste transport cost, using trucks from 4 different areas of the county to 3 possible landfills.

Keywords: footprint, cost of transport, environmental impact of waste land filling, study case Timis County.

AIMS AND BACKGROUND

In order to justify the importance of the assessment, it must be therefore highlighted that the open air or even the dedicated special waste landfills are an important soil, water and air pollution generator, the environmental impact being a significant and a long term one, landfills being considered possible pest holes. Ecological landfills are final waste deposits, set up in areas which cannot be used for economic-social purposes, located outside the cities, built and fitted with installations which do not allow in any way the pollution of the environment.

Currently, many EU countries (such as Germany, Austria, Netherlands, Belgium, Denmark and Sweden) have complex systems of waste collection. They deposited to landfill less than 5% of the waste they produce[1]. In addition, these countries have outstanding performance in terms of biodegradable waste recovery (waste to energy concept). Regional Waste Management Plan for the West 5 regions

* For correspondence.

(comprising Timis, Arad, Caras Severin and Hunedoara counties) is presumed to apply the concept of effective solutions in terms of waste management costs[2]. For this purpose, the use of modern technologies focused on creating deposits within the meaning to be environmentally friendly and safer. Through effective awareness of selective waste collection process was intended to make possible the selection of many waste fractions.

In recent decades, due to the general increase in living standards and increasingly extensive use of packaging technologies, the quantities of organic waste and packaging increased and changed considerably. To counter over this situation, specific objectives have been defined: selective waste collection, recycling reusable resources and reducing the quantity of biodegradable waste landfilled. An optimistic approach regards the selective collection of waste: paper and tar boards, glass, plastics, metals, leather and rubber, wood, textiles, food garbage. Therefore, several approaches regarding waste management are imposed, considering the perspective brought forward in Fig. 1.

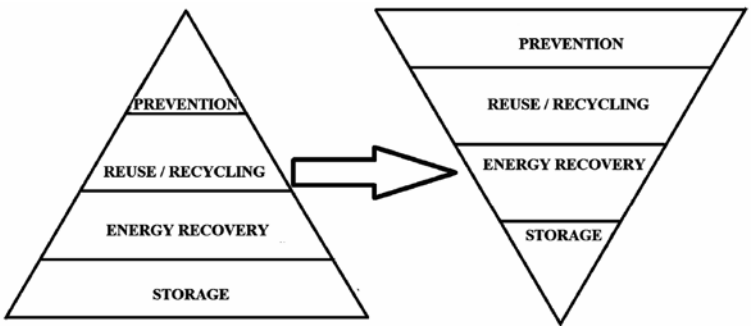


Fig. 1. Priorities regarding the waste management approach

The following aspects need to be taken into account when choosing the location of the integrated waste management system:

– Eliminating the risk of pollution of underground and surface waters;

– Reducing the effects the flow of polluted water, resulted from rain water which goes through the waste, has on the soil;

– Reducing the pollution of soil with plastic, paper or other light waste, which may be taken by wind and spread on the adjacent surfaces;

– Eliminating the discomfort of citizens by reducing the unpleasant and non-hygienic aspect of the points of collection and specific landfill;

– Eliminating possible pest holes;

– Reducing the amount of waste which can be stored by increasing the collection rate of recyclable waste (glass, metal, plastic, paper, organic waste);

– Improving the quality of waste collection services, which leads to the improvement of citizens comfort and quality of life[3];

– Creating new jobs;

– Reducing environmental pollution by reducing the carbon footprint;

– Reducing transport expenses considering the location, i.e. the landfill should be as close as possible to the waste generating source.

The assessment deals with the last two aspects regarding the location of the ecologic landfill, namely:

– The comparative study regarding the variation of the carbon print through the change of the location of the ecologic landfill in 3 possible locations (i.e. Covaci, Cheveresu Mare and Ghizela). The transport is ensured by a fleet of 4 types of trucks, with different emission factors (Euro 2, Euro 3, Euro 4, Euro 5) the transport capacity being comprised between 30–40 t/truck;

– The comparative study regarding the variation of cost generated with the transport of waste to the 3 locations (Covaci, Cheveresu Mare and Ghizela), taking into account the transport for 3 different tariffs foreseen by the transport legislation in force (in Timisoara, Jimbolia, Deta and Faget).

EXPERIMENTAL

Materials and method. Storing waste in ecologic landfills is considered to be the most popular waste management methods. Correctly choosing the site of the landfill, adequately designing the landfills as well as the necessary studies to be carried out represents an essential element of any waste management programme[4].

The main difficulty in choosing a preferential site of a number of possible sites is the fact that the environmental impact and transport cost of each location cannot always be quantified easily. The impact of a site can be linked to costs, footprint, but also the visual aspects and the effect on human health[5].

The harmful effects of waste (pollution, contamination), but especially those determined by inappropriately set-up landfills are determined by:

(1) Harmful gas emissions generated by the decomposition process of organic waste (produced by fermentation), with effects on air quality;

(2) Leaks and infiltrations from rainwater and infiltrations of substances, dissolved and diluted, transported with this type of waters as well as the humidity degree of solid components, the effect of which is the pollution of surface waters, ground waters and soil of the adjacent areas and the soil of the site of the landfill[6].

The main conditions for the site of the landfill regard the following[7]:

– Intensive use of the allocated space as simultaneously it should bring forward stability regarding environmental conditions;

– The ground should correspond from a geotechnical point of view and it should also present stability considering seismic phenomena;

– It should exclude the danger of flooding or rain water flushing and the creation of water planes or mud slides;

– The zone must be isolated from all communication ways, utility networks (energy, water, wastewater, telephone networks, etc.), human settlements, industrial areas and protected areas such as reservations, archaeological sites, parks, and others, as much as possible, but must have an appropriate access route as well.

For depleted quarries, natural depressions, slums, totally degraded fields the recovery means investing a large amount of money, efforts and planning and it is hardly recommended to be use waste deposit sites. The implementation plan must demonstrate that it is possible to obtain cost effective to achieve the objectives in terms of collection, treatment and disposal of Romania and proposed targets for packaging waste and reducing biodegradable waste deposits[4].

Table 1 presents the constituents in solid wastes of Timisoara area[6].

Table 1. Constituents in solid wastes of Timisoara area

No	Components	Average (mass.%)	Variation frames (%)
1	paper and tar boards	8.2	4–23.9
2	glass	13.1	1.8–14.3
3	plastics	6.2	1.6–9.0
4	metals	1.1	0.71–5.9
5	leather and rubber	1.8	0.24–2.6
6	wood	0.3	1.6–3.0
7	textiles	4.9	1.29–11.0
8	food garbage	37.0	25.5–39.6
9	no identified with prevailing biological origin	27.4	3.8–71.94

Figure 2 brings the evolution in the composition of waste for the past few years.

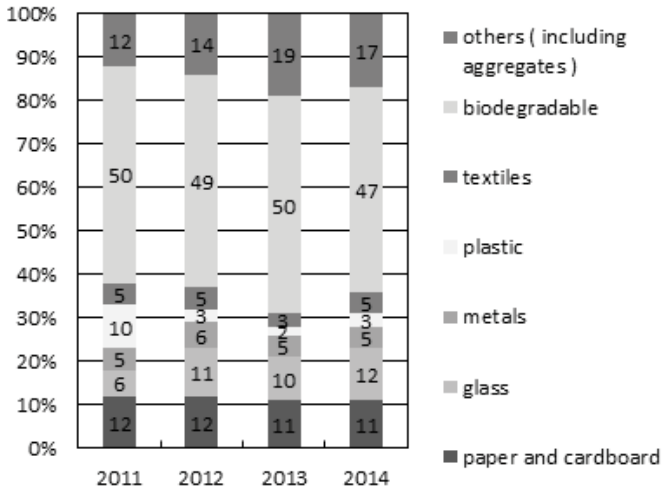


Fig. 2. Evolution of the composition of waste during 2011–2014

In order to determine the carbon footprint generated by waste transportation using trucks to all three possible sites/locations of deposits/ during a year, the following relation is used:

$$\mathrm{FP} = f_{\mathrm{CO}_2} \times L \times 10^{-6} \times 365 \text{ t/year} \quad (1)$$

where f_{CO_2} is the footprint resulted from the train manufacturer, g/km; L – distance covered, km.

The comparative determination of transport costs to all possible sites is realised using the following relation:

$$\text{price} = L \times S_{\mathrm{c}} \text{ Euro} \quad (2)$$

where L is the distance covered, km; S_{c} – specific cost, €/km.

Case study. The project 'Ecological Zone Landfill Timisoara' began by late 1996. The initiator of this project (Timisoara-City Hall) wanted to achieve, in accordance with European environmental standards, a modern landfill. It would have to replace the landfill near Timisoara (from the side Parta) which needs to be closed. First solution was an ecological land filling site in the locality Covaci, about 10 km from Timisoara. Against this project there was a strong opposition from the civil society[4]. Therefore, because of protests against the location of Covaci, the European Union blocked the funding. By 2006, a new location was established for landfill: a land in the commune Cheveresu Mare, 25 km from Timisoara. The project was not completed because the inhabitants rebelled against its location on their locality, as well. After further negotiations and delays, it was decided to build an ecological landfill in Gisela, a village located 50 km from Timisoara. Concerning this location acceptance from citizens occurred, as they associated this project with the hope of creating jobs (in an area otherwise disadvantaged and with a significant level of unemployment) and the creation of a transport infrastructure and utilities was as well expected. Ghizela landfill is part of the Integrated Waste Management in Timis County and involves three waste collection and transfer centres in the county (Jimbolia, Deta, Faget) and a transfer station in Timisoara. The deposit is one of the largest in the country (a total capacity of 5 131 300 m^3). The number of people to be served by the landfill covers up to 700 000 inhabitants.

In order to minimise transporting costs, the location of landfill should be as close to the source of waste generation. If handling costs would be the only criterion for placement, the optimum location of the landfill would be centred around a point whose coordinates should be equal to the weighted average of the corresponding values of waste generation points, depending on the quantities of waste generated[1].

Table 2. Waste area and possible and selected storage (Regional Waste Management Plan)

Area	Total population served (thousands inhabitants)	Possible storage Covaci (km)	Possible storage Cheversu Mare (km)	Storage selected Ghizela (km)
Area 1 Timisoara	399970	10.9	24.1	50.4
Area 2 Jimbolia	70673	51.3	66.9	93.4
Area 3 Deta	27070	55.1	51.9	94.7
Area 4 Faget	27689	92.7	69.6	56.0
Area 0 Ghizela	98056	55.4	45.0	0.0

According to this criterion, including possible alternatives, the solution chosen was less favourable in terms of handling costs. The largest quantity of waste is generated by the Area 1 Timisoara (which serves about 60% of the total population) and must be transported to landfill Ghizela covering a distance of over 50 km. This is a double distance than if the site should have been selected near Cheveresu Mare and nearly five times higher than if the site had been chosen to be Covaci. It should be noted that the Regional Waste Management Plan was developed at a moment, when the feasible landfill was still proposed to be located near Timisoara.

Also, it is notable to mention that the amounts corresponding to Area 2 Jimbolia and Area 3 Deta (corresponding to a population that is 15% of the population served) are transported over a distance of more than 90 km to the landfill Ghizela. All these wastes are transported by road and cause damage to the environment in terms of pollutants emitted from exhaust gases, not mentioning the damaging of the routes for transport and noise/vibrations generated (as all routes are traversing villages). Moreover, between operators of transfer stations are found marked differences in the activity of sorting, recycling and transportation; The operator station transfer 1 Timisoara performs sorting waste at a rate of about 40%, of which about 20–30% of waste is recycled (providing a final recovery rate of 8–12% by recycling), after which the waste is packaged in wrapping pallets of 1.5–1.8 t and transported by trucks with a capacity of 35–40 t to landfill from Ghizela. In addition, even unsorted waste is transported over 90 km, because only the landfill Ghizela is prepared/equipped to achieve sorting. A more advantageous solution for the environment could be railway transport; but the location chosen for the landfill, Gisela has no access to rail.

RESULTS AND DISCUSSION

The relocation of the waste deposit site leads to significant changes concerning the distances from the main waste generating source enhancing, therefore the environmental impact of the carbon footprint. Moreover, the waste transport expenses

will increase for the decades to come, aspect leading to the main aspect involved in the correct managerial decision[8].

Waste transport is ensured by a fleet of different trucks, the carbon emissions declared by the manufacturer being presented in Table 3 (fleet functioning on fossil fuel):

Table 3. Carbon emissions according to Euro type

No	Euro 2	Euro 3	Euro 4	Euro 5
Value (g/km)	600	550	500	450

The transport is carried out once a day with each type of truck (with different emissions, as analysed). The determination of carbon emissions is considering the distances from the waste generating sources to the three possible sites as indicated in Table 2. The comparative determination is carried out for the determination of the carbon footprint as well as for the determination of transport costs from the waste generating source to the 3 possible sites (Covaci, Chervesu Mare and Ghizela). (Timisoara-Covaci; Jimbolia-Covaci; Deta-Covaci; Faget-Covaci). The transport tariff is considered to be comprised between 0.6 and 0.7 Euro/km.

Figures 3, 4 and 5 present the variation of the carbon footprint depending on the variables, namely the distance and the carbon emissions.

Figures 6, 7 and 8 bring forward the dependencies of the cost of transport considering the 2 variables: distance and transport.

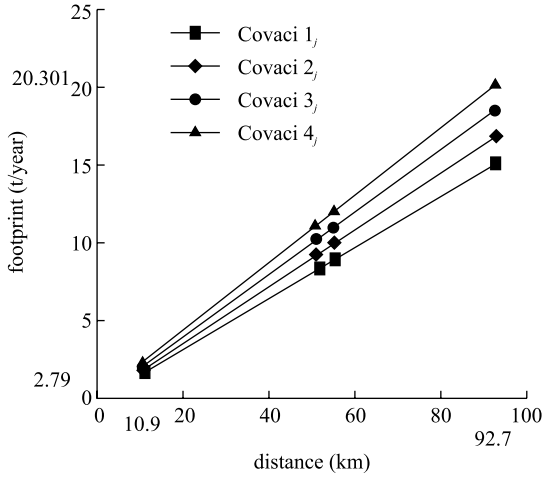


Fig. 3. Linear dependence of the footprint on the following routes: Timisoara-Covaci; Jimbolia-Covaci; Deta-Covaci; Faget-Covaci, if the waste deposit site is located in Covaci (f_{CO_2} =450, 500, 550, 600 g/km)

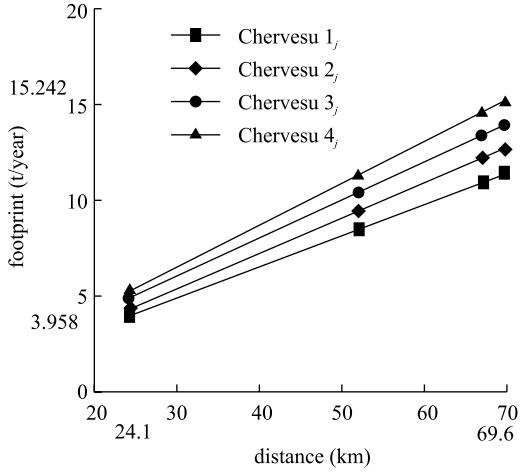


Fig. 4. Linear dependence of the footprint on the following routes: Timisoara-Chervesu Mare; Jimbolia-Chervesu Mare; Deta-Chervesu Mare; Faget-Chervesu Mare (f_{CO_2} = 450, 500, 550, 600 g/km.)

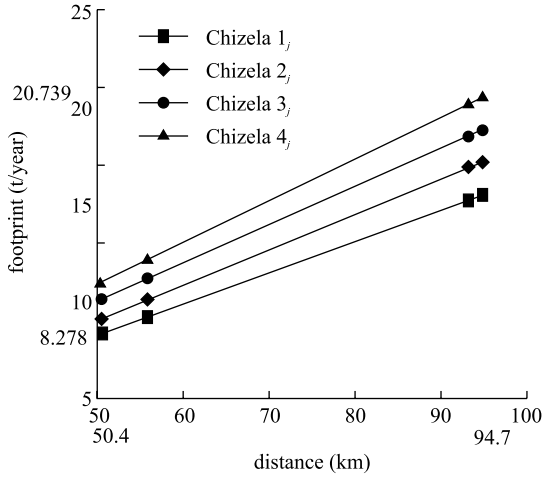


Fig. 5. Linear dependence of the footprint on the following routes: Timisoara-Ghizela; Jimbolia-Ghizela; Deta-Ghizela; Faget-Ghizela, if the waste site is located in Covaci (f_{CO_2} = 450, 500, 550, 600 g/km)

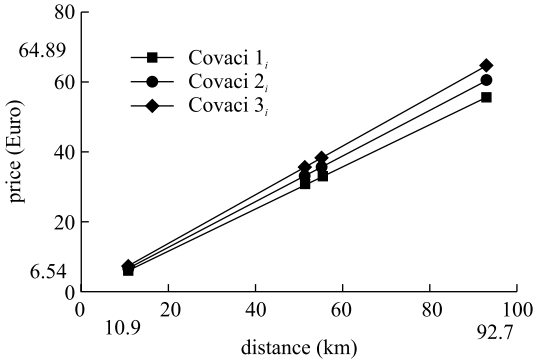


Fig. 6. Variation of waste transport expenses/truck on the four routes considering the positioning of the waste site in Covaci, the transport tariff varies between 0.6, 0.65 and respectively 0.7 Euro/km

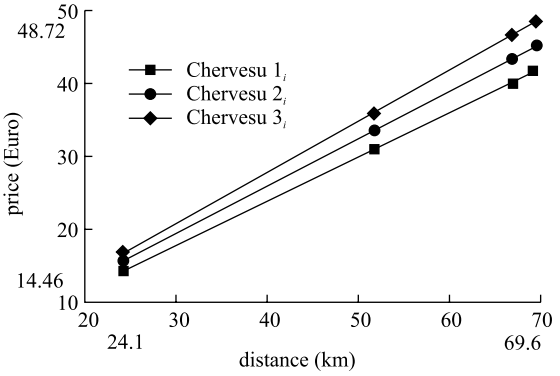


Fig. 7. Variation of waste transport expenses/truck on the four routes if the waste site is located in Chervesu Mare, the transport tariff varies between 0.6, 0.65 and 0.7 Euro/km

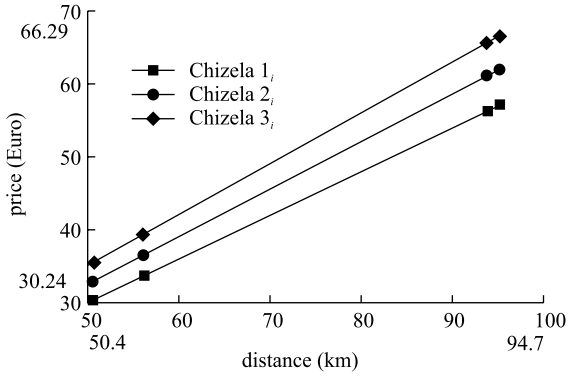


Fig. 8. Variation of waste transport expenses/truck on the four routes if the waste site is located in Ghizela, the tariff varies between 0.6, 0.65 and 0.7 Euro/km

The lines in Figs 3–8 form a divergent bunch as the distance ran through by the trucks increases. Also, from Figs 3–8 it may be observed a linear increase both

of the carbon footprint, as well as of the waste transport expenses, the f_{CO_2} and the transport tariff, according to the distance. The results calculated for the study case are specific, but still can be used as a model of a professional, logic analysis that should be run/achieved before establishing locations for landfills. By all means ecological support and social acceptance must be correctly taken into account.

CONCLUSIONS

The determination of the carbon footprint and of the waste transport expenses are determining factors in taking decisions. They are required and fluctuating in the quantification of the environmental impact, which is an important condition when choosing the final waste deposit site/location for a future landfill.

It is therefore considered that the carbon footprint and the waste transport expenses are variable parameters with significant implications upon the environment, the other conditions brought forward by the paper being *státu-quó* conditions.

When one intends to take a decision concerning the location of a landfill, the method and diagrams as proposed can be used as a model to generate a database for making estimates on the carbon footprint and cost of transport, and leading finally to a conclusion and scientific decision, even with accepted risks.

REFERENCES

1. M. R. WÄCHTER, I. IONEL, A. NEGREA: New Concept for Landfill Disposal of Municipal Solid Waste Incineration Residue. J Environ Prot Ecol, **14** (3), 947 (2013).
2. M. GOLUMBEANU, S. NICOLAEV, T. ZAHARIA, F. K. VOSNIAKOS: Tool of Training as an Important Component of the Environmental Education and Public Awareness. J Environ Prot Ecol, **13** (2A), 1139 (2012).
3. E. GRECU: The Selection of a Landfill Site Timisoara Case. In: Proc. of the 11th International Multidisciplinary Scientific GeoConference SGEM2011, Albena, Vol. 3, 2011, 731–738.
4. E. GRECU, C. E. TUREAC, M. L. EPURE-STAN: The Evaluation of the Environmental Policy. In: Proc. of the 11th International Multidisciplinary Scientific GeoConference SGEM2011, Albena, Vol. 3, 2011, 677–684.
5. F. K. VOSNIAKOS, G. VASILIKIOTIS, P. MENTZELOU, M. KATSANTONI, M. LIAKOS: The Impact of Hospital Wastes in the Environment. Fresen Environ Bull, **12** (10), 1233 (2003).
6. O. FALUP, I. MIRCEA, R. IVAN, I. IONEL: Novel Approach for the Current State of Greenhouse Gases Emissions. Romanian Case Study. J Environ Prot Ecol, **15** (3), 807 (2014).
7. O. V. BOLD, R. F. MORARU, J. GRABARA, U. ASGHER: Environmental Impact Assessment for an Industrial Solid Waste Deposit Located in Constanta Harbour. Annals of Faculty Engineering Hunedoara – International Journal of Engineering, **2**, 61 (2015).
8. F. NICOLAE, M. GOLUMBEANU: Environmentally Acceptable Sea Transportation. The Human and Technical Measures. J Environ Prot Ecol, **8** (1), 146 (2007).

Received 11 February 2016
Revised 16 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 603–598 (2016)

Solid waste management

CELLULASE-MEDIATED HYDROLYSIS APPLIED ON SEVERAL DANUBE DELTA BIORESOURCES

M. PARASCHIV[a,b]*, C. MANOLE[a], I. TUSA[a], M. PAUN[a], L. TCACENCO[a]

[a]*National Institute of Research and Development for Biological Sciences, 296 Spl. Independentei, 060 031 Bucharest, Romania*
[b]*Research Centre for Advanced Materials, Products and Processes (CAMPUS), University Politehnica of Bucharest, 313 Spl. Independentei, 060 042 Bucharest, Romania*
E-mail: *maria.paraschiv@incdsb.ro*

Abstract. The paper deals with the cellulase-mediated hydrolysis applied to several residual biomass resulting after extraction of biologically active principles from three medicinal plants: *Melissa officinalis* L., *Melilotus officinalis* L., *Viola tricolor* L. The yield of hydrolysis to hexoses was determined based on the amount of free glucose in the reaction mixture identified by spectrophotometric analysis, and total conversion of biomass residues was calculated. It was found that biomass resulted from *Viola tricolor* L. exhibits best glucose amount (10.35%) after 1 h of enzymatic hydrolysis, while that sourced from *Melissa officinalis* L. gives the highest total conversion of solid biomass (82.13%).

Keywords: bioresources, enzymatic hydrolysis, medicinal plants.

AIMS AND BACKGROUND

The aim of this work is to identify improved pathways for efficient use of biomass resources. Enzymatic hydrolysis of other sugar-based biopolymers resulted from industrial biotechnologies appears to offer a promising way to obtain glucose and short-chain oligosaccharides used in different fields.

For bio-ethanol production by alcoholic fermentation, sugar and starch still remain the main sources of raw materials[1]. This first generation of fuels, with the origin in raw materials similar to those used for food and feed has to be limited. Obviously advancing research directions are focused on obtaining hexoses using sources that do not come into competition with human nutrition. One followed pathway is the enzymatic hydrolysis of cellulosic biomass, process conducted by cellulase of different origins. This is related to the carbon cycle in nature, showing very high percentages calculations to reduce the emission of greenhouse gases when using cellulosic biomass, as we can see in Fig. 1 (Refs 2 and 3).

* For correspondence.

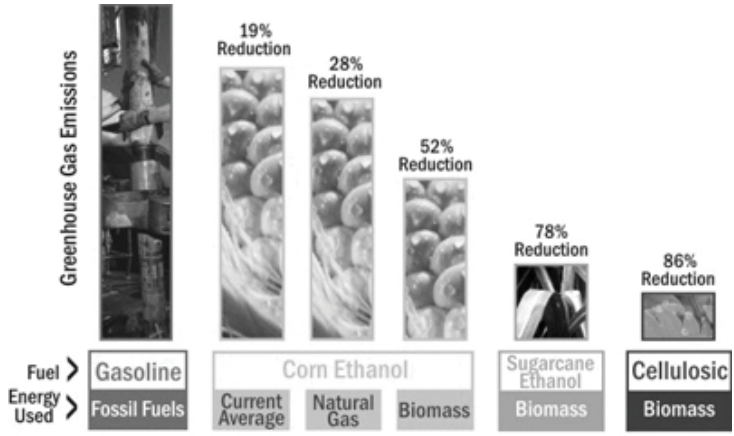


Fig. 1. Evolution of greenhouse gas emissions with raw material nature used for fuel production[2]

Biomass saccharification is the biggest obstacle for technical and economic production of biofuels and bio-refining. To address this challenge there are different approaches or combinations thereof: pre-treatments for biomass fractioning and then enzymatic hydrolysis of these fractions; cellulase engineering focused on increasing its activity and stability; enhancing cellulase activity toward real crystalline biomass[4–6].

Thus, lignocellulosic biomass can be utilised to produce bio-alcohols, a promising alternative energy source for the limited crude oil. For that, cellulose is hydrolysed through enzymatic way to produce reducing sugars, and fermentation of the sugars to ethanol.

The cost of bio-alcohol production from lignocellulosic materials is relatively high based on current technologies, and the main challenges are the low yield and high cost of the hydrolysis process[7]. Considerable research efforts have been made to improve the hydrolysis of lignocellulosic materials. Pre-treatment of lignocellulosic materials to remove lignin and hemicellulose can significantly enhance the hydrolysis of cellulose. Optimisation of the cellulase enzymes and the enzyme loading can also improve the hydrolysis. Simultaneous saccharification and fermentation effectively remove glucose, which is an inhibitor to cellulase activity, thus increasing the yield and rate of cellulose hydrolysis and, respectively, the ethanol production rate[8].

Reducing sugars are not used only in renewable energy field. Sustained studies on alternative carbon sources are developed in major biotechnological industries since the main enzyme synthesis pathway is microbiological one. Thus, different renewable-based sources for media and carbon sources needed in microorganism growth are tested and evaluated from efficiency in enzyme production point of view[9,10].

In Romania about 300 species of medicinal plants are collected and recovered, some of which are used as raw materials for drugs factories, pharmacies, for external or internal use. The presence of biologically active substances (such as free amino acids, volatile oils, antioxidants, etc.) of different plant species gives them therapeutic properties. An important zone with specific bioresources is represented by Danube-Delta[11], this region being declared a protected area (Biosphere Reserve).

Nearly a third of the total number of plant species that live in Romania is found in the Danube-Delta Reserve, meaning over 1830 species. There are mostly herbs species (195) but the largest world areas covered with reeds and two unique forests in Europe, consisting of centuries-old oaks and Mediterranean lianas (source: http://www.info-delta.ro/).

The residual biomass remained after extraction of biologically active substances is often pelleted and burned. This biomass contain large amounts of cellulose (from 40 to 50%), the polysaccharide that can play an important role in alternative source of glucose for different biotechnologies[12].

Moreover, cellulose is associated with other substances such as lignin, pectin, hemicellulose, various resins, lipids, glycosides, tannins, etc. Thus, chemical composition of lignocellulosic feedstock becomes a key factor affecting the efficiency of biomass conversion process[4]. From this point of view, low lignin biomasses such as agricultural wastes are excellent biomass resources for cellulose hydrolysis or fermentation pathways[13,14].

EXPERIMENTAL

The paper aims to use the waste biomass as alternative sources of monosaccharides required in the production of biofuels or other bio-based products. The work is related to the wastes resulted after the extraction of biologically active compounds from medicinal plants.

In this respect, three type of medicinal plants where used famous for their antioxidant, antimicrobial and anti-proliferative activities[15–17]: *Melissa officinalis* L., known as lemon balm, of that different extracts were tested for their activity in the treatment of various disorders; *Melilotus officinalis* L., known as yellow sweet clover, of which the flower extract has anti-inflammatory and anti-spasmodic properties; *Viola tricolor* L., known as heartsease contains, as many viola plants, small chain peptides used in drug development. It is known that extracts from *Viola tricolor* L. have antimicrobial and anti-inflammatory effects due to their complex flavonoids content.

The extractions of active molecules were performed in bi-distilled water and the extraction biomass: solvent ratio was 1:13. The aqueous extracts were obtained by maceration of cleaned and dried herbs, under slow agitation. The extraction process lasted 72 h.

The aqueous extract was subjected to thin layer chromatography (TLC) analysis, the objective being to separate and identify the amino-acids in a mixture of compounds.

Materials used for TLC:

– Stationary phase: silica gel plate ALUGRAM SIL GEL (Macherey-NAGEL), G / UV 254, 20 × 20 cm.

– Mobile phase: mixture of butanol, acetic acid and water (ratio 4:1:1);

– Amount applied: 10 µl standard amino acid, 50 µl aqueous extract sample;

– Migration distance: 15 cm;

– Revealing solution: 0.3% ninhydrin solution dissolved in acetone.

The waste biomass resulted after active biomolecules extraction was subjected to enzymatic hydrolysis with cellulase. The enzyme solution (0.2% in sodium citrate buffer 0.05 M, pH 4.8) was prepared with cellulase produced by *Aspergillus niger* from Fluka. The reactions were carried out in a parallel reaction station (RS600 STEM Reaction Blocks with 6 positions from Electrothermal), which allows the work at the same temperature and stirring rate simultaneously and ensures the repeatability of reaction parameters. The temperature and pH were kept at 50°C and 4.7–4.9, respectively.

The reaction time was set to 2 h and from 60 to 120 min, samples of 2 ml of reaction mixture have been taken and analysed every 20 min by UV-vis. spectroscopy.

For comparison, other cellulosic biomass (crops residues) has been processing at the same conditions.

RESULTS AND DISCUSSION

The amino acids identified by TLC analysis in the aqueous extract are presented in Table 1. It can be seen that the extracts have five common amino acids (L-hydroxyproline, L-histidine, Valine, L-proline and Glutamic acid). L-arginine and L-alanine were found only in the extracts obtained from *Melissa officinalis* L. and *Viola tricolor* L., while Tryptophan, L-lysine and L-tyrosine in *Melilotus officinalis* L. and *Viola tricolor* L. On the other hand, L-serine and Aspartic acid have been identified only in *Melissa officinalis* L. extract, and L-methionine in *Viola tricolor* L.

Table 1. Water-soluble amino acids present in the extract of tested medicinal plants

No crt	Identified amino-acid	Chemical formula	Aqueous extracts from medicinal plants		
			Melissa officinalis L.	*Melilotus officinalis* L.	*Viola tricolor* L.
1	L-hydroxyproline	$C_5H_9NO_3$	+	+	+
2	L-arginine	$C_6H_{14}N_4O_2$	+	–	+
3	L-histidine	$C_6H_9N_3O_2$	+	+	+
4	L-alanine	$C_3H_7NO_2$	+	–	+
5	Valine	$C_5H_{11}NO_2$	+	+	+
6	L-proline	$C_5H_9NO_2$	+	+	+
7	Glutamic acid	$C_5H_9NO_4$	+	+	+
8	Tryptophan	$C_{11}H_{12}N_2O_2$	–	+	+
9	L-lysine	$C_6H_{14}N_2O_2$	–	+	+
10	L-asparagine	$C_4H_8N_2O_3$	–	–	–
11	L-serine	$C_3H_7NO_3$	+	–	–
12	Aspartic acid	$C_4H_7NO_4$	+	–	–
13	L-phenylalanine	$C_9H_{11}NO_2$	–	–	–
14	L-tyrosine	$C_9H_{11}NO_3$	–	+	+
15	L-leucine	$C_6H_{13}NO_2$	–	–	–
16	L-methionine	$C_5H_{11}NO_2S$	–	–	+
17	L-glycine	$C_2H_5NO_2$	–	–	–

The cellulase-mediated hydrolysis performed on the biomass residues resulted after biomolecules extraction generated different amount of glucose in the reaction mixture. The results (Table 2) allowed a distinct placement of *Viola tricolor* L. residue as the most susceptible biomass source to produce glucose by enzymatic hydrolysis. Moreover, the cellulase shows a good activity even at one hour of reaction.

On the other hand, by determining the total biomass conversion during enzymatic hydrolysis it was found that, in addition to glucose, an important amount of other water soluble sugar fragments are formed. The results of the investigated samples are shown in Fig. 2, where it can be see that *Melissa officinalis* L. residue was very well degraded in the described conditions.

Table 2. Glucose concentration obtained during cellulase-mediated hydrolysis

Nr Crt	Biomass substrate	Enzymatic hydrolysis time (min)	Glucose concentration (mg/ml)	Glucose yield (%) (g/g) reported to biomass
1	*Melissa officinalis* L.	60	0.409	4.91
2	*Melissa officinalis* L.	80	0.452	4.97
3	*Melissa officinalis* L.	100	0.455	5.00
4	*Melissa officinalis* L.	120	0.457	5.03
5	*Melilotus officinalis* L.	60	0.433	5.19
6	*Melilotus officinalis* L.	80	0.444	5.33
7	*Melilotus officinalis* L.	100	0.450	5.40
8	*Melilotus officinalis* L.	120	0.452	5.43
9	*Viola tricolor* L.	60	0.862	10.35
10	*Viola tricolor* L.	80	0.928	11.14
11	*Viola tricolor* L.	100	0.926	11.12
12	*Viola tricolor* L.	120	0.945	11.34
13	Straw*	60	0.409	4.91
14	Straw *	80	0.423	4.65
15	Straw *	100	0.441	5.29
16	Straw *	120	0.429	3.94
17	Straw **	60	0.437	5.24
18	Straw **	80	0.458	5.49
19	Straw **	100	0.522	6.26
20	Straw **	120	0.531	6.37

* – without aqueous extraction; ** – with aqueous extraction before enzymatic hydrolysis.

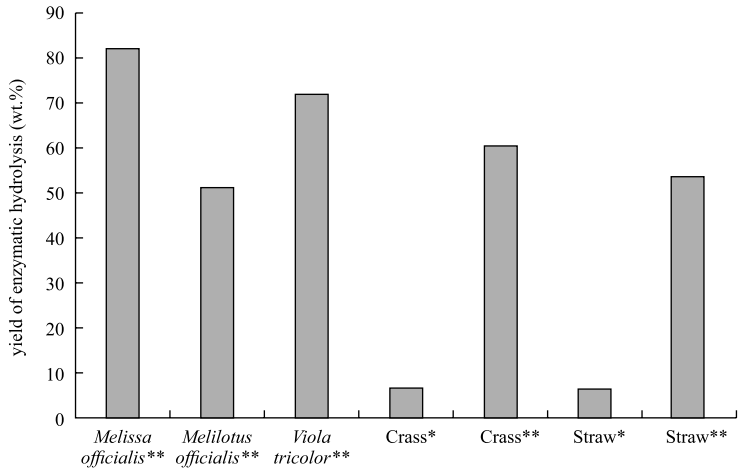


Fig. 2. Biomass conversion after 2 h of enzymatic hydrolysis of biomass with cellulase

Furthermore, the work performed in this paper highlights the importance of biomass pre-treatment before enzymatic hydrolysis. Thus, the cellulase-mediated hydrolysis applied on dried grass or straw led to a low degree of conversion (only 6–7%). Using water hydrolysing as pre-treatment method, the biomass structure exhibits a much higher capacity to respond to the cellulase attack. Thus, the total conversion increased drastically to 60% for grass and 53% for straw. On the other hand, the pre-treatment did not bring an enhancement of glucose concentration, as the obtained values show (Table 2).

CONCLUSIONS

This paper evaluates the possibility of biomass residues integration into valuable chain pathways. Through the experimental work it was proved that during enzymatic hydrolysis with cellulase obtained from *Aspergillus niger* different amount of glucose is released in the reaction mixture. The total conversion of biomass depends on the nature of the substrate, but it is most depended of substrate pre-treatment before adding the enzyme.

The best results were obtained by enzymatic hydrolysis of *Viola tricolor* L. residues (10.35 $g_{glucose}/g_{biomass}$ at 60 min, and 11.14 $g_{glucose}/g_{biomass}$ at 80 min). For the rest of tested substrates, cellulase-mediated hydrolysis occurred at different level in the used reaction conditions, but not until the final compound (glucose). Thus, even if the total conversion reaches more than 80% (i.g. *Melissa officinalis* L.), the yield of glucose remains below 5.5%.

As for crop samples, it was found that preliminary treatment does not significantly influenced the conversion to glucose, which is around 6.37% even after 2 h of reaction but the total conversion can be significantly increased.

Acknowledgements. This work has been developed and was financially supported through the National Core Program: BIODIVERS Project.

REFERENCES

1. M. PEDERSEN, M. HOLLENSTED, L. LANGE, B. ANDERSEN: Screening for Cellulose and Hemicellulose Degrading Enzymes from the Fungal Genus Ulocladium. Int Biodeter Biodegr, **63**, 484 (2009).
2. M. WANG, M. WU, H. HUO: Life-cycle Energy and Greenhouse Gas Emission Impacts of Different Corn Ethanol Plant. Environ Res Lett, **2** (2), 024001 (2007).
3. M. Q. WANG, J. HAN, Z. HAQ, W.E. TYNER, M. WU, A. ELGOWAINY: Energy and Greenhouse Gas Emission Effects of Corn and Cellulosic Ethanol with Technology Improvements and Land Use Changes. Biomass Bioenergy, **35** (5), 1885 (2011).
4. A. AMARASEKARA: Handbook of Cellulosic Ethanol. John Wiley & Sons, Massachusetts, USA, 2014.
5. B. A. SIMMONS: Chemical and Biochemical Catalysis for Next Generation Biofuels. RSC Publishing, 2011.

6. C. WAN, Y. ZHOU, Y. LI: Liquid Hot Water and Alkaline Pretreatment of Soybean Straw for Improving Cellulose Digestibility. Bioresource Technol, **102**, 6254 (2011).
7. M. KEROLLI-MUSTAFA, V. LAJQI-MAKOLLI, S. BERISHA-SHALA, L. LATIFI, I. MALOLLARI, I. MORINA: Biomass and Biofuel Overview. A Global Sustainability Challenge. J Environ Prot Ecol, **16** (1), 222 (2015).
8. C. BUMBAC, E. PENA-LEONTE, C. DUMITRESCU, C. TEODORESCU, I. GHITA: Alternative Biotechnological Solutions for Paper and Mill Plants Solid Wastes Reusing. J Environ Prot Ecol, **11** (1), 209 (2010).
9. A. SORENSEN, J. J. ANDERSEN, K. B. AHRING, J. P. TELLER, M. LUBECK: Screening of Carbon Sources for Beta-glucosidase Production by *Aspergillus saccharolyticus*. Int Biodet Biodegr, **93**, 78 (2014).
10. Y. WILLY: Feasibility of Various Carbon Sources and Plant Materials in Enhancing the Growth and Biomass Productivity of the Freshwater Microalgae *Monoraphidium griffithii* NS16. Bioresources Technol, **196**, 1 (2015).
11. M. E. SIDOROFF, S. LITESCU: Biodiversity Issue on Danube River-Danube Delta- Black Sea System. J Environ Prot Ecol, **13** (3A), 1768 (2012).
12. M. A. MEYERS, P. Y. CHEN: Biological Materials Science. Cambridge University Press, Cambridge, United Kingdom, 2014.
13. S. KIM, B. E. DALE: Global Potential Bioethanol Production from Wasted Crops and Crop Residues. Biomass Bioenergy, **26** (4), 361 (2004).
14. S. KIM, B. E. DALE: Life Cycle Assessment of Various Cropping Systems Utilized for Producing Biofuels: Bioethanol and Biodiesel. Biomass Bioenergy, **29** (6), 426 (2005).
15. L. BRAUN, M. COHEN: Herbs and Natural Supplements. 4th ed. Vol. 2, Elsevier Australia, Chatswood, New South Wales, 2015.
16. N. CASSETTARI CARVALHO, M. J. FRYDBERG CORREA-ANGELONI, D. D. LEFFA, J. MOREIRA, V. NICOLAU, P. AGUIAR AMARAL, A. E. ROSSATTO, V. MORAES de ANDRADE: Evaluation of the Genotoxic and Antigenotoxic Potential of *Melissa officinalis* in Mice. Genetic Molecular Biology, **34** (2), 290 (2011).
17. A. ZAREI, S. C. ASHTIYANI, S. TAHERI, F. RASEKH: Comparison between Effects of Different Doses of *Melissa officinalis* and Atorvastatin on the Activity of Liver Enzymes in Hypercholesterolemia Rats. Avicenna Journal of Phytomedicine, **4** (1), 15 (2014).

Received 27 January 2016
Revised 20 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 611–620 (2016)

Environmental protection and sustainable development

GREENWAY PLANNING PROCESS IN THE EXAMPLE OF TOKLU VALLEY

B. C. KURDOGLU[a]*, S. S. KURT[a], K. T. CELIK[a], T. USTIN TOPAL[b]

[a]*School of Forestry, Department of Landscape Architecture, Karadeniz Technical University, 61 080 Trabzon, Turkey*
E-mail: *banukurdoglu@windowslive.com*; *sultansevinckurt@gmail.com*; *kadirtolgaacelik@gmail.com*
[b]*School of Arts, Design and Architecture, Department of Landscape Architecture, Namik Kemal University, 59 000 Tekirdag, Turkey*
E-mail: *tugbaustun61@gmail.com*

Abstract. In today cities the ecological framework requires the creation of sustainable landscape. For this purpose the protection of the green corridor established relationships with existing and development of new tissue is important. In this context greenway planning approach is the preferred planning model in cities. 'Toklu Valley', passing through the city of Trabzon and yet has not been distorted by yearling settlement and connecting the city to rural and other types of land, was selected as the study site. This area is evaluated in terms of greenway planning criteria for the determination of appropriate land use decisions and may undertake functions were analysed. After analyses of the valley, suggestions were given for appropriate goals for greenway planning strategy and functions. Study includes the following steps: Literature Research, Analyses, Data Integrity and Statistical Results, Assessments and Presentation. As a result, suitable areas in respect to recreational and scenery functions are presented in the study area. The area is evaluated in 3 zones. In the proposed scenarios for these zones, the opportunities of the area as recreational, ecology and education corridors are presented through illustrations. The 1st zone is evaluated as recreational and education corridors, the 2nd zone is evaluated as recreational, ecology and education corridors and the 3rd zone is evaluated as recreational, ecology, education and scenery corridors.

Keywords: greenway planning, planning of urban corridors, sustainable cities, Trabzon.

AIMS AND BACKGROUND

Sustainable cities are ecologically planned and require obtaining, interpretation and using all the ecological data with ecological land planning principles which called urban landscape planning[1]. Deniz et al.[2] state that in fragmented landscapes, to minimise the negative impact of isolation, increasing the effectiveness of the natural cycle and providing of type mobility are based on the establishment of corridors to enable the connection of the field. In this sense, the most effective way in improving the connection status of a landscape, protection of the natural

* For correspondence.

and artificial corridor development or strengthening and creating new artificial corridors. Corridor functions are described in 6 items:

(1) Help to increase on the continuity of species diversity and richness;

(2) Prepare an environment to ensure the recolonisation for extinct species, due to the formation of suitable habitat matrix again;

(3) Provide genetic variation between isolated habitats,

(4) Provide alternative transitions to the species which need different habitats periodically;

(5) Bring together different shelter and hunting areas;

(6) Provide recreational, visual and climatic benefits by creating a green belt that borders the city[3].

Greenways have played a significant role in the development of urban areas. There are significant benefits from greenways[4]. According to Ahern[5], the greenway planning have linearity, binding, sustainability, a lot of functionality and features to be integrated into landscape planning. When the greenways are assessed in terms of these features, they will be able to play a very important role for sustainable urbanisation.

On greenways, hiking, bike riding, skating, picnicking, horse riding, ski walking, etc. outdoor recreation activities are carried out. These are generally active and passive activities including social, cultural and sporting events. When performing daily activities on greenways, facilities and opportunities are available to perform several days activities at the same time[6]. After the greenway movement started with Frederick Law Olmsted Boston Park System referred to by name of 'Emerald Necklace', 'Greenways for America' book written by Charles Little in 1990 (Ref. 7), was an important step towards the concept. Yet very few literature about the concept found, by Flink and Searns in 1993 (Ref. 8) that described greenway history and planning principles have been published.

By Journal Landscape and Urban Planning (Fabos and Ryan Publishers)[9] in 1995, 'greenway' was discussed in a special subject and about this topic 26 issues were published. Searns[10] described the greenways processes from past to now, also provided information about their current status, meanings and functions on urban landscapes. Starting from axis, boulevards, following the recreation path along rivers, creeks, ridges, stages were described until today multi-purpose greenways. Ahern[5] describes Greenway planning strategies, concepts and plans, discusses the properties and benefits by definition of greenway. The greenway classification made in the study and was discussed in three sample areas. Turner[11] has published an article that contains the history of the greenway planning in England, development proposals for the current state and future state.

The study of Ndbusi et al.[12] describes the method for performing source analysis and planning strategies for a greenway corridor application that will be carried out in an example ecologically sensitive area. In an article published in

2004, Asakwa et al.[13] defined five river corridors as example areas evaluating the city river corridor in the greenway system, described the area as recreational use, nature and views. Riberio and Barao[14], compare five example greenway areas which feature ensuring the continuity of recreational and landscape quality and emphasise the importance of this planning. The article published for the rural greenway planning by Conine et al.[15] in Konkord city, North Karolayna, in the direction of planning multi-purpose greenway system, the works they created could be given as example for the purpose of recreational, environmental protection and alternative transportation. Likewise, Lindsey[16], in the article, by explaining the aims and planning strategies of Indianapolis Greenway System, reveals visitors profiles and the status of three roads used by visitors which belongs to the greenway system. Mugavin[17], besides the Tonnes River Linear Park, with the work made about Adelaide Greenways Planning application and assessment, introduces a 50 km-long riverside greenway. Haren and Reich[18], providing information about the greenway network and habitats in Germany, discuss the rewards of a multi-purpose greenways and the advantages of the way to create habitat networks. In their published article, Yokohari et al.[19] report their views on the history of greenways and their situation in the future in modern cities of Japan. Arslan[20] defines the greenway concept and function, focuses on the need to apply this model for our cities and our rural areas. Again, in Turkey, a research project was performed by Arslan et al.[21] in Ankara University, Turkey. A study of decisions taken towards Greenway Planning in Ankara occurs as a completed study in 2004. Kurdoglu[6] in his thesis work called 'A Research on Planning Hamsikoy-Zigana Village Road that Owns Trabzon-Gumushane Old State Highway as Greenway', also with the number of 102Y067 CAYDAG-TUBITAK research project, has examined the feasibility of Trabzon-Gumushane Old State Highway as greenway and in terms of recreation-scenery-historical/cultural functions, he has assessed the suitability of the area by using the 'Suitability Analysis' method. He has revealed a Greenway Planning Model as the result of evaluation carried out in GIS environment.

Toklu Valley that passes through the city of Trabzon and has not been distorted by construction yet, and connects the city to the countryside and to many areas with special characteristics, has been selected as the study are. This field has been analysed to determine the decisions about the undertaken functions and appropriate land use in terms of greenway planning criteria. Then, recommendations have been presented about strategies, aims and functions for a greenway planning in the area that could contribute the sustainable urbanisation. The study has been performed through the following steps: Literature research, Analyses, Data integrity and Statistical results, Assessments and Presentation.

Geographic Information System (GIS) has been benefited for data and route studies of the parameters and stage assessments in the study area. GIS support has been taken again for the visualisation of data, mapping and data analysis steps of

concerned valley. At the last step, according to the statistics and analysis results, assessments have been made and the results have been discussed.

In the research, the urban corridors of Trabzon Toklu Valley have been analysed in terms of undertaken functions and possibility greenway planning. In this context:

- To provide a contribution to the planning of landscape by creating qualified green areas with the evaluation of Toklu Valley Corridor potential to be greenway;
- Through this corridor, to provide the routes that offer the opportunities for recreational activities like cycling, hiking, running, examination of nature, horse riding, watching the village life, etc. for city people;
- With planning this corridor as a greenway to create the routes (corridors) for providing socialisation and offering the opportunity to watch the view of the city for people and local-foreign tourists coming to the city;
- With planning this corridor as a greenway to create the routes (corridors) offering the opportunity to increase awareness of city people about the natural, historical, cultural and semantic values of city;
- With planning this corridor as a greenway to connect with important focus in terms of the city historic, cultural and natural values;
- With planning this corridor as a greenway, beside ensuring the knowledge about the natural, historical and cultural resources to the visitors of all ages, to contribute to education by making organisations for the natural and cultural sciences in cooperation with primary and secondary schools, universities, other institutions that give nature and environment education that near the greenway;
- Through this corridor, to create routes (corridors) that people with disabilities could use;
- To ensure increasing the amount of qualified green area per capita in the city;
- To manipulate a greenway linking urban areas to rural areas;
- With planning this corridor as a greenway to break the heat island by providing the air circulation which is important for the city climate;
- To contribute to the sustainable urbanisation phenomenon with planning this corridor as a greenway.

EXPERIMENTAL

Study purposes and scopes were carried out using the following steps:

STEP 1: LITERATURE RESEARCH

Many articles, projects, reports related with subject and workspaces were examined within the country and abroad in scope of the research.

STEP 2: ANALYSES

Area survey. The transport status, property status, recreational status, aesthetic status, etc. of the field were examined by determining the value of current natural and cultural resources, observations, photos, land patterns that belong the current situation of area.

Mapping in Geographical Information Systems. Inventory of area has been mapped in the GIS environment.

Survey studies. A survey will be achieved in order to identify the possibility of being greenway and the functions that area could have by reference of the views of local people and the people who visit the area. Overall, the survey was administered over 84 people. Trabzon Toklu Valley corridor is designated as study area. Toklu Valley connects Trabzon seaside to the residental area and rural area in the city. This area has opportunities in terms of potentials like recreation, education, alternative transportation, etc. for city people.

Present condition analysis. In this step, according to the studies carried out in step 2, the possibilities of corridor were discussed according the current situation. The analysis of area was carried out in the GIS environment.

Planning strategies, determination of goals and functions. Planning strategies, purposes and greenway functions of corridor identified as an area of research have been revealed in line with 1st and 2nd working steps and current situation analysis that carried out in 3rd step.

- In this step, in line with data obtained from the result of 1st, 2nd and 3rd working steps and literature assisted assessments of area, the Ahern planning strategy stated in 1995 (Ref. 5) has been decided as appropriate combination for Toklu Valley. In this step, protectionist, fighting, defensive and assessed opportunities four different strategies have been discussed; a combination of appropriate strategies has been determined by considering one or more of the most suitable combination together.
- In addition, with data obtained from the result of 1st, 2nd and 3rd working steps and literature assisted assessments, environmental, humanitarian, economic, application, development and management goals have been created for planning Toklu Valley with greenway system.
- Again, with data obtained from the result of 1st, 2nd and 3rd working steps and literature assisted assessments, convenient functions for greenway system of the said valley (to be a corridor to protect natural and historical-cultural values, to be a recreation corridor, to be an alternative transportation corridor, to be a tourism corridor, to be a scenic corridor, to be an educational purposes corridor, etc.) have been determined.

STEP 3: DATA INTEGRITY AND STATISTICAL RESULTS

Determination of percentage and relations of survey data. In this step some results of the survey are given. In the evaluation of the survey results the average values of statistical results are given by using SPSS 16.0 software and determining frequency values.

Determination of land use rules. All previous assessments of this step, as a result of GIS analysis to be performed later determining land use decisions for corridor have been shown on the maps.

STEP 4: ASSESSMENTS AND PRESENTATION:

In this step, some results of the survey, maps prepared in GIS environment and presentations prepared in other visualisation programs were given. Statistical evaluations of the survey conducted have been presented with tables and graphs. By discussing the findings of the research, recommendations are presented for planning, implementation and management purposes with greenway model of urban valleys.

RESULTS AND DISCUSSION

Results of Toklu Valley. Toklu (Karsiyaka) Valley that is the working area is a valley that opens to the state coast road between Karsiyaka District in west and Toklu and Aydinlikevler Districts in east. This valley as well as other valleys that have unspoiled constructions in Trabzon, that can be reached from the beach directly and has an uncut the connection with environment, has a quiet and calm ambience; between the areas of life and education; is home to a rich countryside tissue in an urban tissue.

1st Stage; the area between State Coast Road and Yavuz Selim Avenue has been identified. Particularly the relation with activity areas in coast road is high.

2nd Stage limit starts from Yavuz Selim Avenue and proceeds to the bridge located in the area. There are two entrances to this area. First one is the 5 m secondary road located in the southwestern of the avenue and second one is 5 m secondary road that opens 800 m from the sea through Toklu District. Along the way, the landscape accompanies to valley floor with a wooded route. This route provides the urban-rural linkages.

3rd Stage which is our last stage begins with the southern border of passive activity area and extends along the greenhouse terrain. The location and terrain that found in allows the activities like greenhouse cultivation and stockbreeding (beekeeping and sponging of small ruminants-bovine animals).

Determination of percentage and relations of survey data. 61.90% of respondents participating in the survey were female and 38.10% were male.

67.8% of respondents participating in the survey were between 15–25 years, 16.67% were 26–35 years, 7.1% were between 56–65 years, 4.76% were between 36–45 years, 2.38% were between 46–55 years and 1.19 % were 66 years and above.

65.48% of respondents participating in the survey were students, 8.33 % were officers, 5.95% were housewives, 3.57% were retired, and 16.67% were among other professions.

70.24% of respondents participating in the survey were graduated from university, 20.24% were graduated from postgraduate, 4.76% were graduated from high school, 3.57% were graduated from primary school and 1.19% were graduated from secondary school.

When the average results were analysed, it was observed to fulfill the several listed functions. Especially it is considered to be a very major contribution in the subjects of 'Urban-Rural-Natural Areas Connection (4.7500)', 'Recreation Facility (4.5476)', 'Identity Addition (4.5238)' and 'Socialisation (4.5119)'. 'Subtransportation (3.7976)', 'Accessibility (3.8214)' and 'Education (3.9048)' will contribute less in the study area.

When the stages are analysed separately, for 1st stage 'Recreation (4.4286)', for 2nd stage 'Recreation (4.4762)' and for 3rd stage 'Ecological (4.2857) and Education (4.2619)' functions come forward (Table 1).

Table 1. Average values of given points of awarded functions as planning Toklu Valley a greenway within separately stages

	Average statistics				
	N	minimum	maximum	average	std. deviation
A-recreation	84	2.00	5.00	4.4286	0.69915
A-scenic	84	1.00	5.00	3.0595	1.19589
A-historical cultural	84	1.00	5.00	2.8452	1.26581
A-ecological	84	1.00	5.00	3.3690	1.30596
A-education	84	1.00	5.00	3.6667	1.14422
B-recreation	84	3.00	5.00	4.4762	0.68506
B-scenic	84	1.00	5.00	3.5952	1.13136
B-historical cultural	84	1.00	5.00	2.9881	1.24662
B-ecological	84	1.00	5.00	3.8810	0.96199
B-education	84	1.00	5.00	3.7976	1.00336
C-recreation	84	2.00	5.00	4.3690	0.83276
C-scenic	84	1.00	5.00	3.8810	0.94938
C-historical cultural	84	1.00	5.00	3.0000	1.31717
C-ecological	84	1.00	5.00	4.2857	0.85829
C-education	84	1.00	5.00	4.2619	1.00743
Valid N (listwise)	84				

Note: absolutely disagree – 1, disagree – 2, neutral – 3, agree – 4, absolutely agree – 5.

Planning strategies, determination of goals and functions. As a result of the inventory and land analysis carried out in Toklu Valley, an approach that was defined by Ahern in 1995 which assesses the opportunities and protects the planning strategies which has been followed for the area and the area has dealt with a planning approach to ensure the sustainability of the existing natural and cultural values, primarily for the people of Trabzon city and targeting the masses of tourist visiting the city. As a result of survey application given in Table 1 assessment of area analyses; the corridor has found suitable for recreation, scenic, ecological and educational functions. Then, suggestion function map and sections are presented in Fig. 1.

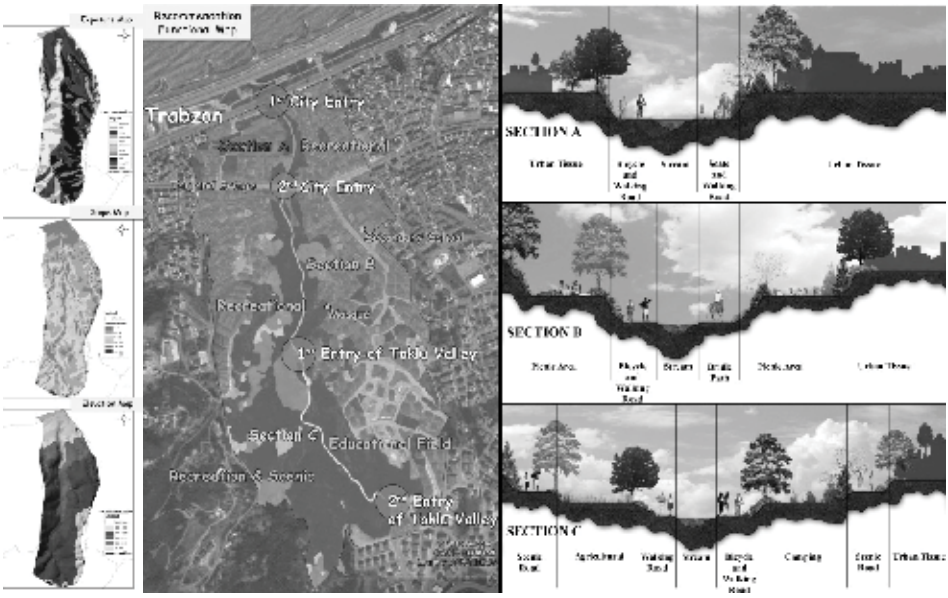


Fig. 1. Suggestion function map and sections

CONCLUSIONS

This project work that is not found in the city of our country is a planning model revealing a planning approach and dealing with landscape planning approaches. Such a model may be an example for other cities. In this way, examples can be formed by creating a model that deals with landscape planning approaches in the lack of zoning plan. It is among the original values of the research to present concrete proposals for a multi-functional planning approach that will improve the quality of life of the city people, will protect the natural and cultural values of the city, will improve the city climate, will offer alternative transportation opportuni-

ties, will reveal the urban-rural connection, will allow people the opportunity to make recreational activities:

● Natural valleys in urban areas, are the corridors that needed to protect ecologically. At this point, there are important functions in terms of urban ecosystem. A landscape planning approach will be presented by emphasising on this topic with such a work.

● Such valleys are areas that should be left as corridors that used as green area and allowed air circulation. In this sense, the research project will reveal a planning approach model for other cities.

● Because of transportation that has become a major problem in our cities every day, drivers provided to use other routes by creating alternative roads.

● Reducing effect can be created for environmental pollution (visual pollution, noise pollution, air pollution, etc.) by making the pedestrian or non-motorised vehicle transportation possible.

● Survival effect can be created in the city by creating recreational areas for people that can spend their free time.

● Qualified green spaces in the city and the amount of green space for per person can be increased.

● The awareness of locals and foreign tourists about the city can be increased, in historical-cultural and natural resource values with semantic values of rich routes.

This study on the lack of zoning plans in landscape planning approaches while planning the urban open green space systems reveals an approach for the planning of the valleys. This approach can be an example for many other urban valley.

Natural and cultural resource values of said valley may be integrated into the system and may be loaded many different functions with this planning approach that can access to large scale between urban-rural areas, a basic may be created for a large greenway system.

This study is an example work that demonstrates the functions by taking a holistic approach to urban green space, not the solution of point but the solution of whole, in the meaning of the whole area to be planned in this line. This is an approach that increases the green area per capita by increasing the qualified green spaces. It takes attention to the concept of sustainable urbanisation and the greenway.

Acknowledgements. This study make use of 'Greenway Planning Approach on Urban Corridors: Toklu Valley and Trabzon-Golcayir Village Route Example' titled which was a part of the KTU BAP (10741) project. We would like to thank KTU BAP for their support.

REFERENCES

1. B. GULGUN, M. A. GUNEY, E. AKTAS, K. YAZICI: Role of The Landscape Architecture in Interdisciplinary Planning of Sustainable Cities. J Environ Prot Ecol, **15** (4), 1877 (2014).

2. B. DENIZ, E. V. KUCUKERBAS, H. ESBAH TUNCAY: Overview of Landscape Ecology. Adnan Menderes University Journal of the Faculty of Agriculture, **3** (2), 5 (2006).
3. R. F. NOSS: Corridors in Real Landscape: A Reply to Simberloff and Cox. Conserv Biol, **1** (2), 159 (1987).
4. E. E. SISMAN, E. BOLU: An Ecological Approach for the Planning of Urban River Greenways. A Meric River Case Study, Turkey. J Environ Prot Ecol, **16** (1), 372 (2015).
5. J. AHERN: Greenways as a Planning Strategy. J Landscape Urban Plan, **33** (1–3), 131 (1995).
6. B. C. KURDOGLU: A Research on Planning of Hamsikoy-Zigana Village Route in Former Trabzon-Gümüşhane State Highway as a Greenway. Ph.D. Thesis, Karadeniz Technical University Natural Science Institute, Trabzon, Turkey, 2005.
7. C. LITTLE: Greenways for America. The John Hopkins University Press, Baltimore, 1990.
8. C. A. FLINK, R. M. SEARNS: Greenways a Guide to Planning, Design, and Development. The Conservation Fund, Washington D.C., 1993.
9. J. G. FABOS, R. L. RYAN: International Greenway Planning: An Introduction. Journal of Landscape and Urban Planning, **68** (2–3), 143 (2004).
10. R. M. SEARNS: The Evolution of Greenways as an Adaptive Urban Landscape Form. Journal of Landscape Urban Planning, **33** (1–3), 65 (1995).
11. T. TURNER: Greenway Planning in Britain: Recent Work and Future Plans. Journal of Landscape Urban Planning, **76** (1–4), 240 (2006).
12. F. NDBUSI, T. DEMEO, N. D. DITTO: Environmentally Sensitive Areas: a Template for Developing Greenway Corridors. Journal of Landscape Urban Planning, **33** (1–3), 159 (1995).
13. S. ASAKAWA, K. YOSHIDA, K. YABE: Perceptions of Urban Stream Corridors within the Greenway System of Sapporo Japan. Journal of Landscape Urban Planning, **68** (2–3), 167 (2004).
14. L. RIBEIRO, T. BARAO: Greenways for Recreation and Maintenance of Landscape Quality: Five Case Studies in Portugal. Journal of Landscape Urban Planning, **76** (1–4), 79 (2006).
15. A. CONINE, W. XIANG, J. YOUNG, D. WHITLEY: Planning for Multi-purpose Greenways in Concord, North Carolina. Journal of Landscape Urban Planning, **68** (2–3), 271 (2004).
16. G. LINDSEY: Use of Urban Greenways: Insights from Indianapolis. Journal of Landscape Urban Planning, **45** (2–3), 145 (1999).
17. D. MUGAVIN: Adelaide's Greenway: River Torrens Linear Park. Journal of Landscape Urban Planning, **68** (2–3), 223 (2004).
18. C. HAREN, M. REICH: The German Way to Greenways and Habitat Networks. Journal of Landscape Urban Planning, **76** (1–4), 7 (2006).
19. M. YOKOHARI, M. AMEMIYA, M. AMATI: The History and Future Directions of Greenways in Japanese New Towns. Journal of Landscape Urban Planning, **76** (1–4), 201 (2006).
20. M. ARSLAN: Greenway Planning: The Case of Ankara City. In: Proc. of Symposium on Intagrated Approaches to Environmental Planning and Design, November 26–28, Ankara, 1996.
21. M. ARSLAN, E. BARIS, E. ERDOGAN, Z. DILAVER: Greenway Planning: Sample of Ankara. Ankara University, Scientific Research Projects, 2004.

Received 11 February 2016
Revised 10 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 621–628 (2016)

Environmental protection and sustainable development

URBAN PARKS AND THEIR ROLE ON SUSTAINABLE URBAN WATER CYCLE

D. D. KUSULUOGLU*, G. AYTAC

Faculty of Architecture, Istanbul Technical University (ITU), Taskisla Street, 34 437 Taksim, Istanbul, Turkey
E-mail: ddinemis@gmail.com

Abstract. From building scale to metropolitan, urban green areas vary in size and functions. One of these green areas is urban parks, which have environmental, economic and social benefits for the cities. Besides having recreational opportunities for the urban dwellers, they host rich bio-diversity with diverse flora and fauna with respect their size and they contribute to the sustainability of the city. Transformation of old hunting lands to public greens brings out the concept of urban parks. In historical process, the main reason behind the designation of urban park is mostly to improve life quality after the industrial revolution and rapid urbanisation. Urban green areas can also play an important role in sustaining urban water cycle. Designing and planning of urban green areas are critical to improve hydrological cycle and manage the water in site. From 19th century, Olmsted designed urban parks as a part of the urban infrastructure as in Central Park and Emerald Necklace, and he designed the parks to function as the natural drainage and reservoir systems. These two epic urban parks not only bring rural to urban with aesthetical concerns, but also provide the resilience and sustainability for city systems. Today, contemporary urban park designs deal with environmental incidents more than ever because of the rising global ecological challenges. In this paper, how can urban parks contribute to improve urban hydrological systems will be examined through projects from the world.

Keywords: urban parks, urban water systems, hydrological cycle, Olmsted.

AIMS AND BACKGROUND

From the first examples of designed landscape in Mesopotamia to Hanging Gardens of Babylon in 600 BC (Ref. 1), landscape has always been a part of human art and life. Greeks and Romans conceived urban landscape in political and social ways, while medieval gardens had influenced future with being pioneer for 18th century romanticism and asymmetric composition, until Renaissance were made to pacify men[1].

From the beginning of the history, civilisations were settled in coastal lands and water was the important matter for humanity. Water ecosystems provide many ecosystem services such as water for consumption use, for food and generating power, transportation and recreational activities for human; and also ecological

* For correspondence.

services such as regulating water quality and maintaining sustainability of water ecosystems[2]. However, one of the agreed results of Industrial Revolution is the climate change as a critical global issue, threatening world systems.

The breaking point in late 18th century, the Industrial Revolution, had changed entirely the social and economic world. The serious migration from rural end up with rapid urbanisation bring with new concerns about cities. Starting from then, many urban formation theories evolved to deal with fundamental changes in city history especially for sanitary problems. After the change in water based land uses along with the uncontrolled rapid urbanisation and impervious pavements caused urban water runoff; loss of water quality and even water scarcity in the 21st century. According to Lal[3], the number of countries who suffer from water scarcity will be 34 in 2025 while the number was 20 in 1995 and 7 in 1955. This rapid urbanisation drove planners to find new design objectives to restore the hydrological cycle naturally[4]. At this point the urban landscape planning comes seeing ecologic and social benefits for both urban environment and human psychology. This is where urban parks design arose, first in Europe from old hunting lands, then in America with F. L. Olmsted.

URBAN PARK CONCEPT

Urban parks are considerably greater areas in urban scale and have many ecologic, economic and social functions. Once being hunting lands for royals, such as Hyde Park designed in 1536 (Ref. 5), now represent important examples of urban parks especially in Europe. Having influences of them, Olmsted presented the concept of urban parks for America. Urban parks are mainly designed to increase life quality; they provide healthy recreational activities for human, and also help cities for their sustainability with biodiversity, water cycle, air quality and many other ecosystem services.

In historical process, from royal hunting land to other functioning greens opened to public and considered urban public green areas. In 15th century, the end of Medieval Era came along with major events affecting history such as end of feudalism and new beginning of renaissance. After this century, green areas in urban boundaries began to transform from royal hunting lands to public parks. One of the London biggest parks, Hyde Park was opened to public by Charles I in 1637 (Ref. 6). Once being a hunting land known as Marylebone Park until 1649, Regent Park first opened to the public in 1835 for limited days a week[7]. Paris has many urban parks which was transformed from varied green spaces. One of the most important public park of Paris, Tuileries Park was built as palace garden and redesigned and opened to public by Le Notre in 17th century. Bois de Boulogne, once designed for Napoleon as hunting land between 1852–1858 (Ref. 8), is the second biggest public green space in Paris (Fig. 1).

Fig. 1. Hyde Park, London[9] and Bois de Boulogne, Paris[10]

New technological improvements following Industrial Revolution changed 19th century urban formation and landscape design. 1899 City Beautiful Movement is the beautification act of the unhealthy cities for better aesthetic sense and sanitary conditions. Along with bringing new identity with new architectural style and orders, green areas were also planned for physical and social improvements. As one of the pioneer of the movement, Olmsted visited Europe many times and had great influences from London and Paris urban parks.

URBAN PARKS AND WATER CYCLE

Central Park and Emerald Necklace are two important urban park examples where Olmsted took water as a design tool and created these parks to improve urban hydrologic cycle. After experiencing urban life with great open green areas in European cities, Olmsted returned to America with ideas of creating a national park system and meets the clean air and green space need of the city. His first remarkable design with Vaux, Central Park, is planned to serve ecologically, socially and culturally to both city and people and be accessible for everyone to reduce the negative effects of urban life and improve life quality. After winning the competition with Greensward Plan which is a rural and picturesque design in Manhattan grid, Olmsted and Vaux created the public urban park between 1857 and 1873, which still gives New York its identity. Olmsted stated that he created the park so that working class can go after work to spend their leisure time away from urban noise[11].

Built in the 1862 as a temporary water supply for New York City regarding the design of Central Park, the reservoir is a good example of guiding the city water to the urban park as a natural drainage and replaced the Receiving Reservoir as an important fresh water source[12]. The Reservoir, today called as Jacqueline Kennedy Onassis Reservoir, is still used to water other green places in the park. The reservoir today is one of the main ecological sanctuary in park with more than 20 water bird species and is an attractive point for bird watchers[12] (Fig. 2).

Fig. 2. Central Park Reservoir[13]

Another important project of Olmsted which he took water as the basic design tool is Boston Emerald Necklace. It was a very problematic area with a contaminated river flooding every heavy rain and threatening user health. In the second half of the 19th century, Muddy River in Boston became much polluted as the urbanisation reduced infiltration and increased flooding to the point of danger to public health. In 1896, Olmsted and Charles Eliot came with propose of open green space system which connects neighbourhood into an integrated network[14]. Boston Emerald Necklace is planned as Boston natural drainage and is created as a green system with a linkage of public green spaces. It is planned as an urban infrastructural part which regulates Boston hydrological cycle. Olmsted first started the necklace with a large pond to provide wetland habitat and continue with ponds and free-flowing channels which all act ecologically functional as an ecotone[15]. He planted the streambeds with native and nonnative plants for recreational activities and designed multiple pathways for social promenades from different economic class[16]. After designing separate parks, an arboretum and Back Bay Fences where he rehabilitated the river and the marshlands, he was asked to link these green spaces and to create a system. He connected these green spaces with parkways (Fig. 3).

The most important water related problem of the Emerald Necklace was the Back Bay Fences, which were a tidal swamp with shallow salt water. The swamp water of Muddy River flooded when heavily rained and caused serious health problems. Olmsted designed tidal gates between Fens and Charles River to control the water flow and placed a sewage interceptor to reduce health problems, this is how he made the Fens act as a temporary storage basin for run-off water[19] (Fig. 4), and turned the Fens a freshwater marsh again. The section of Muddy River was changed with terraces to control flood and widened with two freshwater ponds in

two different places. One of them, Jamaican Pond was the first drinking reservoir of Boston. Emerald Necklace project works as a constructed storm water wetland which appears as a natural landscape.

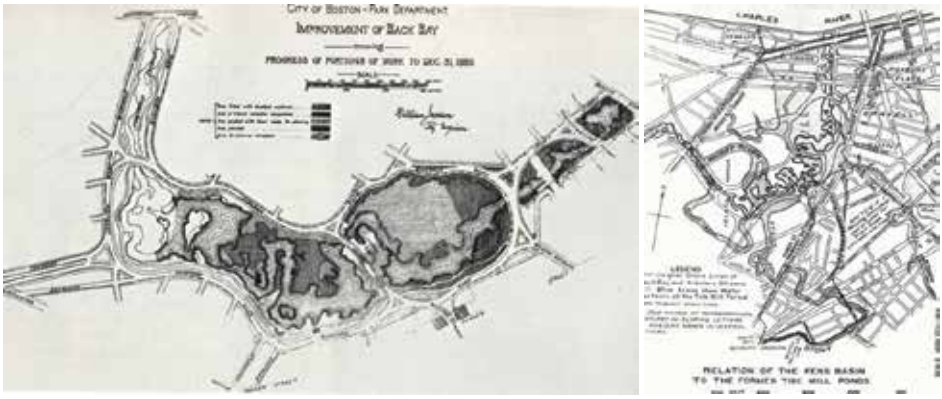


Fig. 3. Topographic manipulation of Back Bay Fences in 1888 (Ref. 17), and 1903 drawing of streets and Fens over original estuary[18]

Fig. 4. Storage basin of the Fens in 1882 (Ref. 20), and Back Bay Fens in 2013 (Ref. 13)

RESULTS

CONTEMPORARY DESIGNS WITH ECOLOGICAL APPROACH TO URBAN WATER CYCLE

In the beginning of the 21st century, world faced natural disaster more often and became aware of global problems more than ever. One of the common disasters are water based, such as floods, tsunami and sea level rise; however there are other water based disaster that we will face more seriously such as water scarcity and loss of water quality. Urban areas are covered with impervious pavements more than rural areas, which causes urban storm water run-off. Storm water run-off causes loss of urban water, negative environmental effects on aquatic ecosystems with

pollutants, and urban floods in heavy rains. The main struggle today is to eliminate the effects of global warming and to take water under control in an ecologic way, and on site constructed as a natural drainage to minimise the surface run-off and restore urban hydrological cycle. Water is a naturally regenerating medium, however the qualitative characteristics are undefended against polluters such as waste, urban agglomeration and intensive agriculture with lack of useful management, and a compatible water management is a primacy for the local strategies due to social and economical development[21]. There is increasing number of water based park designs in different scale to provide a healthier urban hydrological cycle.

Tanner Springs Park is a city park in downtown Portland designed by Atelier Dreiseitl in 2005. The area was formerly a wetland and Tanner Creek ran through the area. The drained land transformed into a natural water feature and fed by storm water runoff from the park (Fig. 5). The park offers many recreational activities to Portland with historic industrial rails and water based landscape solution. Another important point is that Portland park system is mainly guided by 1903 Olmsted Portland Park Plan, which was proposed by Olmsted Brothers Company who was the son of F. L. Olmsted.

Fig. 5. Hydrological cycle of Tanner Springs Park[22]

Another urban hydrology project of Atelier Dreiseitl is Potsdamer Plaza in Berlin, designed in 1998. Created as an urban waterscape, the main idea behind Potsdamer Plaza is using rainwater where it falls with a green and non-green roof harvesting the annual rain[23]. The water is used in buildings and canals as recreational opportunities to plaza users (Fig. 6).

Fig. 6. Potsdamer Plaza, Berlin[23]

A plaza design or a city park, landscape design has diverse scale and forms in history. From nineteenth century until today, water became a different design element rather than historical feature. It is now an infrastructural problem to deal with, especially after the problems caused by global warming. Urban hydrological systems are now very critical for sustainable and resilient cities. As human life depends on water and 2/3 of world population live coastal lands[24], water scarcity and decreasing quality is a very important issue for urban ecosystems. Now that more than half of world population will live in urban areas in near future, in a site scale or an urban scale, understanding the nature, as Olmsted did in nineteenth century, may be the best way to achieve a sustainable design and to collaborate with nature.

CONCLUSIONS

A plaza design or a city park, landscape design has diverse scale and forms in history. From nineteenth century until today, water has become a different design element rather than historical feature. It is now an infrastructural problem to deal with, especially after the problems caused by global warming. Urban hydrological systems are now very critical for sustainable and resilient cities. As human life depends on water and 2/3 of world population live coastal lands[24], water scarcity and decreasing quality are very important issues for urban ecosystems. Now that more than half of world population will live in urban areas in near future, in a site scale or an urban scale, understanding the nature, as Olmsted did in nineteenth

century, may be the best way to achieve a sustainable design and to collaborate with nature.

REFERENCES

1. G. A. JELLICOE, S. JELLICOE: The Landscape of Man, Shaping the Environment from Prehistory to the Present Day. Thames and Hudson, London, 1975.
2. B. AYLWARD, J. BANDYOPADHYAY, J. C. BELAUSTEGUIGOTIA: Ecosystems and Human Well-being: Policy Responses: Findings of the Responses Working Group. Millennium Ecosystem Assessment Series, 2005, 215–255.
3. R. LAL: Integrated Watershed Management in The Global Ecosystem, Ch. 1, CRC Press Boca Raton London New York Washington, D.C., 2000, p. 16.
4. D. D. KUSULUOGLU, G.AYTAC: Water as a Design Strategy: Case Study of Kurbagalidere Istanbul. J Environ Prot Ecol, **15** (4), 1536 (2014).
5. A. SELF: The Birds of London. A&C Black, 2014.
6. R. PORTER: London, a Social History. Penguin Books, 2000.
7. https://en.m.wikipedia.org/wiki/Regent%27s_Park. Retrieved in 20.08.2015.
8. D. JARRASSE: Grammaire des jardins parisiens : De l'héritage des rois aux créations contemporaines. Parigramme, 2007.
9. https://www.flickr.com/photos/31363949@N02/6885510005. Retrieved in 12.08.2015.
10. http://www2u.biglobe.ne.jp/~MCFW-jm/paris2008.htm. Retrieved in 12.08.2015.
11. F. L. OLMSTED: Public Parks and the Enlargement of Towns. Cambridge, MA: Printed for the American Social Science Association, 1870. pdf: http://isites.harvard.edu/fs/docs/icb.topic753413.files/11_Landscape%20Architecture%20City%20Planning/Olmsted_Parks.pdf.
12. https://en.m.wikipedia.org/wiki/Jacqueline_Kennedy_Onassis_Reservoir. Retrieved in 22.08.2015.
13. D. D. KUSULUOGLU: New York and Boston Visit (photos), 2013.
14. G. B. WATSON, I. BENTLEY: Identity by Design. Elsevier Ltd., Oxford, 2007.
15. V. NOVOTNY, J. AHERN, P. BROWN: Water Centric Sustainable Communities: Planning, Retrofitting and Building the Next Urban Environment. John Wiley & Sons, 2010.
16. K. HILL: Urban Design and Urban Water Ecosystems. In: The Water Environment of Cities (Ed. L. A. Baker). Springer Science+Business Media, 2009, 141–170.
17. http://www.landscapeandurbanism.com/category/resources/. Retrieved in 26.08.2015.
18. http://www.olmsted.org/storage/documents/Reprints_Fall_2010_vol_12_no2.pdf. Retrieved in 26.08.2015.
19. C. ZAITZEVSKY: Frederick Law Olmsted and the Boston Park System. Harvard University Press, Cambridge, 1982.
20. http://www.muddyrivermmoc.org/restoring-olmsteds-vision/. Retrieved in 10.08.2015.
21. O. V. NISTOR, E. BOTEZ, D. G. ANDRONOIU, G. D. MOCANU: Water Quality in the Galati District. J Environ Prot Ecol, 13 (2A), 862 (2012).
22. http://www.landezine.com/index.php/2013/03/tanner-springs-park-by-atelier-dreiseitl/. Retrieved in 25.08.2015.
23. http://www.dreiseitl.com/index.php?id=82&lang=en. Retrieved in 25.08.2015.
24. OSIB: Wetlands. Ministry of Water Affairs and Forestry, Nature Conservation and National Parks General Directorate, Department of Sensitive Areas, Wetlands Branch, 2013.

Received 11 February 2016
Revised 21 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 629–637 (2016)

Environmental protection and sustainable development

RESEARCH OF GENOTOXIC EFFECT OF OLIVE MILL WASTEWATER WITH ALLIUM TEST SYSTEM

S. KOCA[a]*, S. TURKOGLU[b], L. GENCER[b], M. OZDEMIR[a]

[a]*Department of Biology, Science and Arts Faculty, Adnan Menderes University, Aydin, Turkey*
E-mail: *skoca@adu.edu.tr*
[b]*Department of Biology, Science Faculty, Cumhuriyet University, Sivas, Turkey*

Abstract. Wastewater of the olive oil factory or olive olive mill wastewater occurs at the time of olive oil production and shows an important environmental contaminating feature due to the organic substances inside them and the toxicities of these substances to various biological systems. The toxicity of olive mill wastewater stems from the phenolic compounds which are included in olive mill wastewater. In our study, genotoxic effects of the olive mill wastewater on the *Allium cepa* root tip meristem cells have been examined. The onions were rooted at 0.1, 0.3 and 0.5% concentrations of the olive mill wastewater. It was observed that concentrations decreased the mitotic index compared to the control and only the decrease at 0.5% group was statistically significant. In the study, the abnormalities such as anaphase bridge, laggard chromosome, C-metaphase, stickness, irregular distribution and polar deviation, etc. were observed. In the study done with 1, 3 and 5% concentrations of the olive olive mill wastewater, was concluded that root extension was too little and even 5% concentration showed a toxic effect.

Keywords: olive mill wastewater, *Allium cepa*, chromosome aberrations, mitotic index.

AIMS AND BACKGROUND

Aydin Province takes place on the top with 2 million da olive cropland, around 22 million olive trees and approximately 20 000 t olive oil production at 2014–1015 season in Turkey[1]. As a result of 200 000 t olive processing at the campaign term of the olive (approximately 100 days) in nearly 200 olive oil enterprises located in Aydin, 2 byproducts as pomace oil and olive mill wastewater were produced except olive oil. While pomace oil is generally used as fuel in terms of economy, olive mill wastewater is left to the environment randomly and imposes a big organic load. Olive mill wastewater includes high organic susbstances (sugar, nitrogen, volatile acids, polyalcohols, pectine, tannins) and phenolic compounds and metals that have a sharp smell and show toxic features[2–6]. The olive mill wastewater occurring at the olive oil production was poured to the vaporisation pools and left to the streams or expanded to the soil. Due to that natural waters acquire a dark

* For correspondence.

colour by leaving the oilve mill wastewater randomly to the streams and environment, luminous transmittance decreases and as aquatic plants are not able to take enough light, their life is imperiled. As well as that the oil included in the olive mill wastewater covering the water surface may lead to that fish and other aquatic organisms living in these waters are asphyxiated and die, the substances available in the olive mill wastewater such as phenolic compunds and metals may show toxic and genotoxic effect at fishes and other aquatic organisms. It was reported at different species subjected to these compounds that phenolic compunds may lead to toxic, genotoxic, carcinogenic, immunotoxic, physiological and histopathologic effects[5,7–11].

There are very limited histopathologic and genotoxic studies that may be resulted from that olive olive mill wastewater of which annual production in the world is assumed to be 30 million t and annual production in the Aegean Region is assumed to be approximately 670 000 t. So many physical and chemical analyses have been done with the aim of detecting the contamination at the water and soil. But these analysis are not sufficient solely. Cytogenetic, histologic, biochemical, etc. studies are required to be done with the aim of detecting the effects of these living creatures. In these studies, various animal, plant and bacterial test systems were used. With the aim of detecting the genotoxicity in the water, micronucleus test was done on aquatic livings such as fish[12–16], amphibian[17], mussel[18]. *Allium cepa* and *Vicia faba* choromosome aberation and micronucleus tests were used to detect the genotoxicty at contaminated water and soil[19–22]. In this study, *A. cepa* choromose aberration test was used to test the genotoxicty stimulated at three different dosages (0.1, 0.3 and 0.5%) of raw olive mill wastewater.

EXPERIMENTAL

The olive mill wastewater was diluted in 0.1, 0.3 and 0.5% dosages and then put into test tubes and onions were placed inside them. Stabilised tap water was used for the control group. The roots were cut when they became 1.5–2 cm and then fixed at the ethyl alcohol–glacial acetic acid (3:1) mixture. After the fixation procedure, the roots were hydrolysed in 0.2 HCI for 2–3 min and then stained with aceto orcein. The peparates were prepared with squashed methods and inspected under microscope. During the examinations, photos of observed cellular and chromosomal abnormalities were taken. At the trials done with 1, 3 and 5% dosages of the olive mill wastewater, the onions were not adequately rooted (Fig. 1).

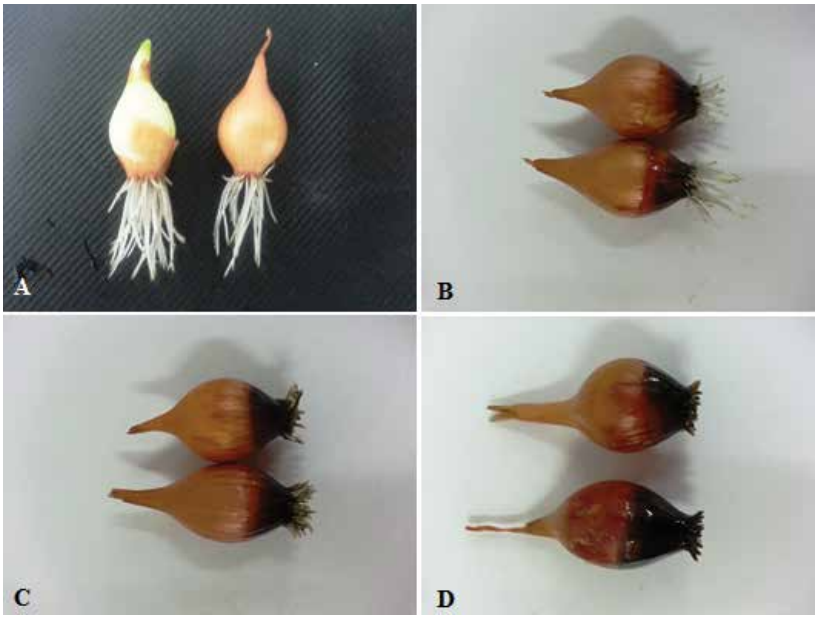


Fig. 1. Root length of *Allium cepa* after treatment with three different dosages
A – **c**ontrol; B – 1% dose; C – 3% dose, and D – 5% dose

RESULTS AND DISCUSSION

Effect of olive mill wastewater on mitotic index. As a result of the examinations, it was observed that mitotic index of olive mill wastewater at *Allium cepa* decreased at a significant ratio at only 0.5% dosage. The decrease at 0.1 and 0.3% dosage was not statistically significant (Table 1).

Table 1. Effect of 0.1, 0.3 and 0.5% concentrations of olive mill wastewater on mitotic index

Dose (%)	ETC	Pro-phase	Meta-phase	Ana-phase	Telo-phase	TM	Mitotic index Ort±SH*	TA	TA (%)
Control	2496	58	27	19	18	122	4.88±0.18a	5	0.20
0.1	2639	47	26	17	16	106	4.01±1.95a	55	2.08
0.3	2458	40	29	23	16	108	4.39±1.37a	58	2.35
0.5	2110	27	18	13	4	36	1.70±1.46b	10	0.47

*The differences between the ones marked with different letters were statistically significant (ETC – examined total cell, TM – total mitosis, TA – total abnormalities).

Effect of olive mill wastewater on choromosomes. The effects of olive mill wastewater on mitotic division and chromosomes have also been researched except for mitotix index. It was detected that it leads to chromosomal abnormalities such as

anaphase bridge, stickness, C-metaphase, irregular distribution, polar deviation, etc. at the examinations. Abnormalities ratio was very high at 0.1 and 0.3% dosages compared to the control group. Altough the abnormalities slightly increased at 0.5% group, it was not significant (Table 1, Figs 2A–H).

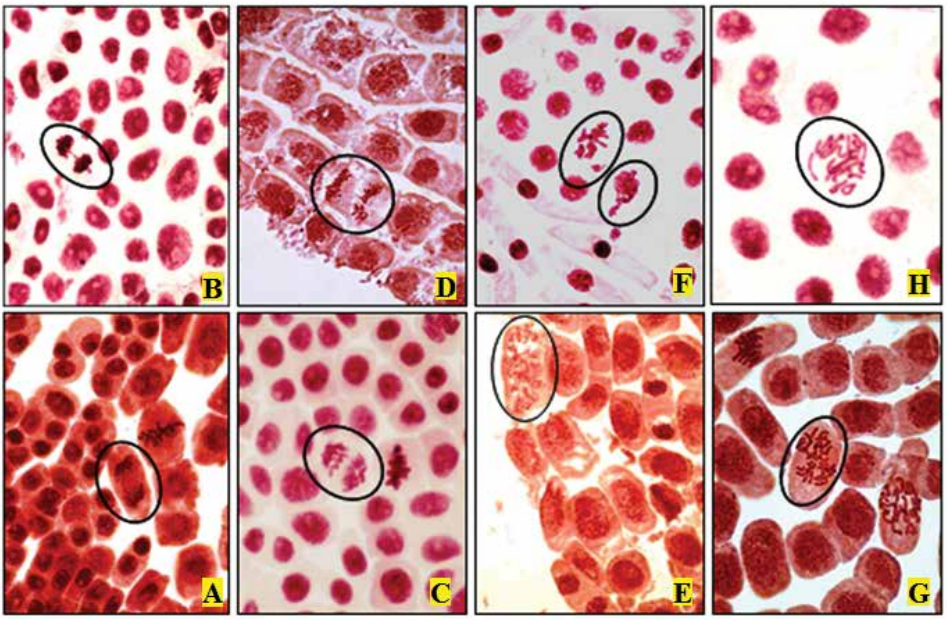


Fig. 2. Different types of aberrations induced by the olive mill wastewater in *Allium cepa* root-tips. A – Anaphase bridge, B – Telophase bridge, C – Laggard chromosomes, D – Multipolar division, E – Disturbed prophase, F – Sticky chromosomes and unequal distribution, G – Poliploid cell, H – C-metafaz

Allium cepa chromosome aberration test was used with the aim of detecting the genotoxic potential of olive mill wastewater. It is known that olive mill wastewater is toxic for aquatic organisms such as fish and mussel and bacteria, plants[23]. In the study done with 1, 3 and 5% dosages of the olive mill wastewater, it was observed that the onions were not adequately rooted and root tip were get darkened and even roots did not grow at 5% dosage (Fig. 1). Similar results were obtained from application of 1/10 and 1/100 concentrations of olive mill wastewater done by Aybeke et al.[7] for 7.5 and 15 h to *Triticum aestivum* seeds and the study done by El Hajjoui et al.[5] with *Vicia faba* at 20% concentration of olive mill wastewater. The reserachers stated that they observed darkening and mitosis loss at the root tips and this may be related with the damage at necrotic cell and root tip tissue damage. This may be an evidence that olive mill wastewater showed toxic effect on a definite concentration of olive mill wastewater. Olive mill wastewater contains various metals[6], nitrogen compounds, polyphenols, volatile acid

and polyalcohols[5,24]. El Hajjoui et al.[5] stated that when concentratiosn of phenols reached 900 mg/l, this leads to high toxicity of olive mill wastewater.

Onion root meristem cells are very sensitive to genetic damage that chemicals and environmental contaminators lead to and Allium test includes root extension and chromosome aberrations[25]. *A. cepa* is an important bioindicator for environmetal damages that affect mitosis and damage at metaphase chromosomes.

Mitotix index is an acceptable criteria for all living organisms[26]. Cytotoxic level may be determined with the decrease on mitotic index ratio. Generally cytotoxic substances show their effects on mitosis by inhibiting microtubul formation.The effects of three different concentrations of olive mill wastewater on mitosis division are given in Table 1. When compared with the control group, decreases at 0.1% and 0.3% dosages were not statistically significant. The decrease at 05.% dosage was detected as statiscally significant. Aybeke et al.[7] obtained smiliar results with the study done with olive mill wastewater at *Triticum aestivum*, El Hajjoui et al.[5] – at *V. faba*, Samuel et al.[27] at *A. cepa* and Aksoy[6] – at *Elodea canadensis.* The decrease of the mitotic index may be mitotic inhibition. A chemical susbstance contacts with the cells for a time and may form an active form that leads to disorder between the cell cycles if they stay in the cell at critic concentrations. This negative effect may gradually increase depending on extenions of the period. Schreiderman et al.[28] put forth that the decrease of mitotic activity may occur with inhibition of DNA synthesis. Van't Hof [29] stated that mitosis of the cell is prevented or delayed with blockage or extension of G_2 phase at cell cycle and this decreases mitotic index.

In our study, the abnormalities as well as the effect on the mitotic index were detected and are shown in Table 1. These were abnormalities such as C-metaphase, stickness, irregular distribution, laggard chromosome, multipolar division and anaphase bridge. According to many researchers, the abnormalities such as C-metaphase, multipolar anaphase and stickness depend on spindle apparatus formation[26,30–32]. It is called as C-metaphase that the chromosomes at the metaphase are available as distributed and this is revealed out by the factors that affect the spindle apparatus smiliar to colchicine and then damages them. Depending on that, centromere division delayed and chromosomes were replicated but stayed distributed in the cell as separated from each others. These kinds of abnormalities at the metaphase may lead to decrease of mitotic index. C-metaphase cells were obtained at the studies done with different chemical substances[33–35]. C-metaphaes were obtained from the studies of Aybeke et al.[7] and Aksoy[6] with olive mill wastewater. This may be an indiciator that some sucbtances in the olive mill wastewater had adverse effects on spindle apparatus.

Other abnormality type that we observed in our study was chromosomal stickness. Patil and Bhat[36] defined the chromosome stickness as a physiological adhesion type that mostly includes protein matrix of chromatine material. Valle and Ulmer[37] stated that stickness may be accepted as the effect of chemical substances

on stickness at DNA and formation of complexes. It was stated that choromosome stickness is an abnormality type that leads to irreverseble cell death[38].

The laggard chromosomes are resulted from the chromosomes that got late moving to different polars. Patil and Bhat[36] put forth that residual chromosomes may resulted from disorders at organisation and function of spindle apparatus. It is accepted as residual chromosome at acentric fragments. The substances in the olive mill wastewater in the study that we applied may have an adverse effect on spindle apparatus and may lead to laggard chromosome.

The chemical substances that lead to choromosome fractures are known as clastogenic agents and it is stated that they exhibit their effects on chromosomes by affecting DNA[39]. Molecular mechanism of DNA fractures has not been clearly understood. It was defined that oxidative stress played an important role at DNA damage induction, because phenolic compounds are important componets of olive mill wastewater and these support oxidative stress.

There are studies done on various organisms that showed cytotoxic and genotoxic effect of phenolic compunds and their derivatives on human, animal and plants[5,6,40–42]. El Hajjoui et al.[5] detected that 10% dosage of olive mill wastewater and gallic acid (GA) and oleuropeinin (Ol) among phenolic compounds obtained from olive mill wastewater significantly increase the micronucleus frequency at *Vicia faba* and showed genotoxic effect. The abnormalities such as laggard chromosom and wrong polarisation that we observed in our study are the disorders that may lead to micronucleus formation. This is an indicator that there are genotoxic substances in the olive mill wastewater.

In our study the decrease in the mitotic index at 0.1 and 0.3% dosages (4.01 and 4.39) was not statistically significant compared to the control (4.88), while the decrease at 0.5% dosage (1.70) was significant. While the abnormality ratios (2.08 and 2.35) at 0.1 and 0.3% dosages were detected as higher than control (0.2), the abnormality ratio at 0.5% dosage was closer to control (0.47). The reason is that heavy metals and phenolic compunds available in the olive mill wastewater decreased the mitotic index. According to De Marco et al.[40], the decrease of the mitotic index may resulted from the DNA synthesis of olive mill wastewater at mitotic cycle and negative effects on enzymatic reactions at repair mechanism. They stated that genotoxic effect of phenolic compounds depend on: (i) their concentreations; (ii) pH of culture environment and (iii) existence of metal ions especially such as Fe and Cu (Ref. 5).

CONCLUSIONS

The findings that we obtained from this study showed that olive mill wastewater may have citotoxic and genotoxic effect on *A. cepa* root tip cells. As olive mill wastewater decreased the mitotoxic index at 0.5% dosage, it is accepted that it has

citotoxic activity. It may be accepted as genotoxic due to its effects on heredity material as well as cytotoxic effect. The results showed that olive mill wastewater may be dangerous for environment without appropriate dilution and also may lead to distinct adverse effects on the living organisms.

REFERENCES

1. www.uzzk.org/Belgeler/Turkiye_2014_2015_Zeytin_Rekolte_Tahmin_Tablosu).
2. A. ROZZI, F. MALPEI: Treatment and Disposal of Olive Mill Effluents. Int Biodeterior Bioegrad, **38**, 135 (1996).
3. F. SENGUL, E. OKTAY, E. COKAY: Evaluation of Olive Mill Wastewater and Its By-products. In: Proc. of the GAP-Environmental Congress, 16-18 October 2000, Sanlıurfa, 2000.
4. A. MEKKI, A. DHOUIB, S. SAYADI: Changes in Microbial and Soil Properties Following Amendment with Treated and Untreated Olive Mill Wastewater. Microbiol Res, **161**, 93 (2006).
5. E. El HAJJOUJI, B. PINELLI, M. GUIRESSE, G. MERLINA, J. C. REVEL, M. HAFIDI: Assessment of the Genotoxicity of Olive Mill Waste Water (OMWW) with the *Vicia faba* Micronucleus Test. Mutat Res, **634**, 25 (2007).
6. O. AKSOY: The Phytoxic and Genotoxic Effects Olive Oil and Milk Industry Wastewater on *Elodea canadensis*. J Func Environ Botany, **3** (1), 43 (2013).
7. M. AYBEKE, G. OLGUN, U. SIDAL, D. KOLONKAYA: The Effect of Olive Oil Mill Effluent on the Mitotic Cell Division and Total Protein Amount of the Root Tips of *Triticum aestivum* L. Turkish J Biol, **24**, 127 (2000).
8. S. AZIRAK: The *in vivo* Genotoxic Effects of Thymol and Carvacrol. Ph. D. Thesis, Institute of Natural and Applied Sciences, Unıversity of Cukurova, 2007.
9. N. A. H. ABDEL HAMEID: Physiological and Histopathological Alterations İnduced by Phenol Exposure in *Oreochromis aureus* Juveniles. Turk J Fish Aquat Sci, **7**, 131 (2007).
10. M. S. BUTCHIRAM, M. VIJAYA KUMAR, K. S. TILAK: Studies on the Histopathological Changes in Selected Tissues of Fish *Labeo rohita* Exposed to Phenol. J Environ Biol, **34**, 247 (2013).
11. R. VARADARAJAN, H. S. HARI SANKAR, J. JOSE, B. PHILIP: Sublethal Effects of Phenolic Compounds on Biochemical, Histological and Ionoregulatory Parameters in a Tropical Teleost Fish *Oreochromis mossambicus* (Peters). Int J Sci Res Pub, **4** (3), 1, (2014).
12. S. SANCHEZ-GALÁN, A. R. LINDE, E. IZQUIERDO, E. GARCÍA-VÁSQUEZ: Micronuclei and Fluctuating Asymmetry in Brown Trout (*Salmo trutta*): Complementary Methods to Biomonitor Freshwater Ecosystems. Mutat Res, **412**, 219 (1998).
13. A. RODRIGUEZ-CEA, F., AYLLON, E. GARCIA-VAZQUEZ: Micronucleus Test in Freshwater Fish Species: an Evaluation of Its Sensitivity for Application in Field Surveys. Ecotoxicol Environ Safety, **56**, 442 (2003).
14. J. I. R. PORTO, C. S. O. ARAUJO, E. FELDBERG: Mutagenic Effects of Mercury Pollution as Revealed by Micronucleus Test on Three Amazonian Fish Species. Environ Res, **97**, 287 (2005).
15. Y. BASIMOGLU KOCA, S. KOCA, S. YILDIZ, B. GURCU, E. OSANC, O. TUNCBAS, G. AKSOY: Investigation of Histopathological and Cytogenetic Effects on *Lepomis gibbosus* (Pisces: Perciformes) in the Cine Stream (Aydin/Turkey) with Determination of Water Pollution. Environ Toxicol, **20** (6), 560 (2005).
16. S. KOCA, Y. BASIMOGLU KOCA, S. YILDIZ, B. GURCU: Genotoxic and Histopathological Effects of Water Pollution in the Buyuk Menderes River (Aydin/Turkey) on Two Fish Species (*Barbus capito pectoralis* and *Chondrostoma nasus*-Pisces: Perciformes) with Determination of Water Pollution. Biol Trace El Res, **122** (3), 276 (2008).

17. M. L. FERNANDEZ, J. HARIDON, L. GAUTHIER, C. ZOLL-MREREUX: Amphibian Micronucleus Test (s): a Simple and Reliable Method for Evaluating *in vivo* Genotoxic Effects of Freshwater Pollutants and Radiations, Initial Assessment. Mutat Res, **292**, 83 (1993).
18. J. MERSCH, M. N. BEAUVAIS: The Micronucleus Assay in the Zebra Mussel, *Dreissena polymorpha*, to *in situ* Monitor Genotoxicity in Freshwater Environments. Mutat Res, **393**, 141 (1997).
19. S. MINISSI, D. CACCESE, F. PASSAFIUME, E. CICCOTTI, M. RIZZONI: Mutagenicity (Micronucleus Test in *Vicia faba* Root Tips), Polycyclic Aromatic Hydrocarbons and Heavy Metal Content of Sediments Collected in Tiber River and Its Tributaries within the Urban Area of Rome. Mutat Res, **420**, 77 (1998).
20. M. S. KONG, T. H. MA: Genotoxixity of Contaminated Soil and Shallow Well Water Detected by Plant Bioassays. Mutat Res, **426**, 221 (1999).
21. S. MONARCA, D. FERETTI, C. COLLIVIGNARELLI, L. GUZZELLA, I. ZEBRIBI, G. BERTANZA, R. PEDRAZZANI: The Influence of Different Disinfectants on Mutagenicity and Toxicity of Urban Wastewater. Water Res, **17**, 4261 (2000).
22. A. MESI (DIZDARI), D. KOPLIKU: Seasonal Phyto- and Genotoxicity Monitoring of Municipal Landfill Leachate on *Allium cepa* Roots. J Environ Prot Ecol, **15** (4), 1671 (2014).
23. A. FIORENTINO, A. GENTILI, M. ISIDORI, P. MONACO, A. NARDELLI, A. PARRELA, F. TEMUSSI: Environmental Effects Caused by Olive Mill Wastewaters:Toxicity Comparison of Low-molecular-weight Phenol Components. J Agric Food Chem. **51**, 1005 (2003).
24. E. MORENO, J. PEREZ, A. RAMOS CORMENZANA, J. MARTINEZ: Antimicrobial Effect of Waste Water from Olive Oil Extraction Plants Selecting Soil Bacteria after Incubation with Diluted Waste. Mikrobios, **51**, 169 (1987).
25. P. FIRBAS, T. AMON: Chromosomes Damage Studies in Onion Plant *Allium cepa* L. Caryologia, **67** (1), 25 (2014).
26. S. M. AMER, E. M. ALI: Cytological Effects of Pesticides V. Effects of Some Herbicides on *Vicia faba.* Cytologia, **39**, 633 (1974).
27. O. B. SAMUEL, F. OSUALA, P. G. C. ODEIGAH: Cytogenotoxicity Evaluation of Two Industrial Effluents Using *Allium cepa* Assay. African J Environ Sci Technol, **4** (1), 21 (2010).
28. M. H. SCHNEIDERMAN, W. C. DEWEY, D. P. HIGHFIELD: Inhibition of DNA Synthesis in Synchronized Chinise Hamster Cell Treated in G1 with Cycloheleximide. Exp Cell Res, **67**, 147 (1971).
29. J. VAN'T HOF: The Action of IAA and Kinetin on the Mitotic Cycle of Proliferative and Stationary Phase Excised Root Meristem. Exp Cell Res, **51**, 167 (1968).
30. A. S. HALIEM: Cytological Effects of the Herbicide Sencor on Mitosis of *Allium cepa.* Egyptian J Botany, **33**, 93 (1990).
31. W. F. GRANT: Higher Plant Assays for the Detection of Chromosomal Aberrations and Gene Mutations-a Brief Historical Background on Their Use for Screening and Monitoring Environmental Chemicals. Mutat Res, **426**, 107 (1999).
32. E. M. LAZAREVE, V. Y. POLYAKOV, Y. S. CHENTSOV, E. A. SMIRNOVA: Time and Cell Dependent Formation of Heterogeneous Tubulin Arrays Induced by Colchicines in *Triticum aestivum* Root Meristem. Cell Biol Int, **27**, 633 (2003).
33. A. A. El-GHAMERY, M. A. El-KHOLY, M. A. ABOU El-YOUSSER: Evaluation of Cytological Effects of Zn^{2+} in Relation to Germination and Root Growth of *Nigella sativa* L. and *Triticum aestivum* L.. Mutat Res, **537**, 29 (2003).
34. A. N. GOMURGEN: Cytological Effect of the Potassium Metabisulphite and Potssium Nitrate Food Preservative on Root Tips of *Allium cepa* L. Cytologia, **70**, 119 (2005).
35. Z. FINDIKLI, S. TURKOGLU: The Effects of Glyphos and DDVP on Mitotic Division and Chromosomes in *Allium cepa* L. Cumhuriyet Sci J, **31** (2), 49 (2010).

36. B. C. PATIL, T. G. I. BHAT: A Comparative Study of MH and EMS in the Induction of Chromosomal Aberrations on Lateral Root Meristem in *Clitoria termata* L. Cytologia, **57**, 259 (1992).
37. B. L. VALLE, D. D. ULMER: Biochemical Effects of Mercury, Cadmium and Lead. Ann Rev Biochem, **41**, 92 (1972).
38. D. H. LIU, W. S. JIANG, C. L. WANG: Effect of Zn^{+2} on Root Growth, Cell Divisions and Nucleoli of *Allium cepa* L. Environ Sci, **8**, 21 (1996).
39. L. K. S. CHAUHAN, P. N. SAXENA, S. K. GRUPTA: Cytogenetic Effects of Cypermethrin and Fenvlerate on the Root Meristems Cells of *Allium cepa*. Environ Exp Botany, **42**, 181 (1999).
40. A. de MARCO, M. ROMANELLI, M. A. STAZZI, E. VITAGLIANO: Induction of Micronucleated Cells in *Vicia faba* and *Allium cepa* Root Tips Treated with NTA. Mutat Res, **171**, 145 (1986).
41. G. M. WILLIAMS: Methods for Evaluating Chemical Genotoxicity. Ann Rev Pharmocol Toxicol, **29**, 189 (1989).
42. L. MIGLIORE, E. BARALER BOSCO, F. GIORGELLI, M. MINNUNNI, R. SCARPATO, N. LOPRIENO: Genotoxicity of Emthyglyoxal: Cytogenetic Damage in Human Lymhocytes *in vitro* and Intestinal Cells of Mice. Carcin, **11** (9), 1503 (1990).

Received 8 January 2016
Revised 12 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *638–647* (*2016*)

Environmental protection and sustainable development

MEASURING FUNDED RESEARCH PERFORMANCE FOR MULTIDISCIPLINARY RESEARCH IN THE DANUBE BASIN

M. SIDOROFF, M. PARASCHIV, A. AMARIOAREI, M. PAUN*

National Institute for Research and Development of Biological Sciences,
296 Splaiul Independentei Street, 060 031 Bucharest, Romania
E-mail: *mihaela.paun@incdsb.ro*

Abstract. Evaluation of funded research, by measuring the outcomes of the grants – publications, journals, and citations – is not always done comparatively and publicised. Bibliometric indicators were employed and applied to the 2009–2014 publications authored by academicians funded by European research grants that are indexed in the Web of Science. Citation based approaches, such as the h-index or the impact factor, have been widely used to evaluate researchers or journals. In this study we use the aforementioned H-index to evaluate the funded research grants and to provide a ranking in terms of the most successful ones. The ranking results can be used by evaluators in determining how successful an applicant has potential to be, but also by researchers to choose their publication outlets, or to pursue future collaborations.

Keywords: bibliometrics, research evaluation, citations, funded grants, highly cited papers.

AIMS AND BACKGROUND

Bibliometric analysis is an attempt to quantitative analysis, statistical properties and behaviour of recorded knowledge. Through bibliometric analysis one can measure the recorded information and statistically identify patterns within a given field or area of the literature. Most frequently researchers use bibliometric methods of evaluation to determine the influence on one single entity or to find the relationship among two or more entities (such as researchers, institutions, are of research or publications).

The present study intends to investigate funded research excellence and what a successful project means in the Environmental Science area. Obviously, the first step is to define what do one means by a 'successful' project. How do one measures success. Is success quantified in a unidimensional way or what factors are to be considered? So far there is a lack of consensus in the literature in what one means by success or excellence in research evaluation. Once the above definitions are set, the scientific community has to agree on the common criteria and metrics to be used in evaluating research performance uniformly. As in any instance when one intends to use metrics for evaluation, there is not a single choice that is universally

* For correspondence.

applicable and not one metric that is indisputably better, hence several metrics should be used complementary and analysed together.

Several studies in the literature are investigating the impact of research grants on academic output[1,2], the citation counts[3], as well as evaluating funded research in different areas, such as medicine[4,5], socio-economy[6], oceanography[7,8] or bioenergy[9].

DATA SOURCE AND METHODOLOGICAL FRAMEWORK

The present work is based on the metadata collected through the efforts of the project 'Danube macroregion: Capacity Building and Excellence in River Systems (Basin, delta and sea) – DANCERS', financed under the FP7- Environment programme of the European Commission, in 2013. The data set contains projects funded in the period 1993–2013 performing research with focus on Danube Basin and Coastal Black Sea, from national, European and international funds. The analysis in this paper is focused on the sample consisting of all projects accepted for funding during the interval 2009–2013. There are 31 projects funded to perform research in the Danube Basin in this timeframe that have been entered into the database. The performance of the projects was based on the evaluation of the number of publications produced, the citations generated, impact factor, ranking of the journal based on quartiles. The performance considered also the degree of collaboration in the paper authorships, the research productivity of the authors, as well as the budget and number of partners in the projects and the geographic location of the coordinating country. A nonparametric analysis was carried out to answer the following hypothesis that we intended to test.

Hence the study has undertaken the examination of several aspects in order to produce a ranking of funded research, by measuring publication performance, by addressing the following questions:

1. Collaborative research dominates in research grant output? The percentages for single authorships contributions, two authors contributions, are significantly different?

2. An increasing trend on quantitative and qualitative contributions is present?

3. Citation evaluation does not produce different project ranking?

The paper assesses the degree of collaboration at the level of partnership in the project versus the degree of the collaboration expressed through the authorship of the publications. In the literature there are arguments in both directions[10,11] – on how adequate is to measure collaboration only through paper 'co-authorship'?

We are supporting the claim that collaboration in research is an advantage and should be stimulated at all levels: institutional and individual. There are various ways in which collaboration among individual researchers can be developed – centres of excellence, interdisciplinary research groups, participation in research grants, especially those that funds interdisciplinary research since this leads to

collaboration within thematic areas, as well as between thematic areas. Some funding agencies are encouraging international collaboration between institutions through specific calls design specifically to boost researchers interaction, such as National Science Foundation (NSF) – Catalysing New International Collaborations (CNIC) NSF wide call for proposals, Australian Academy of Science – Australia – European Union Collaboration Program 2014, European JPI Climate Joint Call for Transnational Collaborative Research Projects.

The metadatabase contains projects funded in the last two decades, and the funding behaviour reflects the geopolitical events in the region, over the specified period of time. The analysis is performed on a sample consisting of all projects that were accepted for financing in the timeframe 2009–2013. There is one exception, FP7 project EARTH2OBSERVE, that formally started in January 2014 and was also included in the dataset. The dataset consists of 31 funded projects. The goal of the analysis is to either support or reject the hypothesis stated above and to highlight best practices and outcomes of projects funded research with focus on the Danube Basin, as well as identify the strengths and weaknesses of the scientific outcomes. Additional data about these projects, related to the number of publications, citations, authorship, was collected from the Thomson Web of Knowledge, by search on the acronym, funding agency and grant number search. The results were validated to the information on the official webpage of the projects, when current and updated information was available. One should note that there is not a standardised manner in which various partners in a project are acknowledging either the grant number or agency, or even affiliation, fact mentioned in the literature for the format in which authors write the same affiliation on different papers[12–14] which leads to inconsistencies in rankings.

RESULTS AND DISCUSSION

Table 1 presents a ranking of the top 10 projects in the sample in terms of the number of papers published and recorded on Thomson Web of Science, as of September 2014. One can note that although the project PERSEUS is ongoing and half-way through the funded period, it is ranked on the 4th position by the number of papers published up to the investigation date. This project can move up several positions by the end of the implementation period.

Table 1. Projects ranking by publication count

Rank	Acronym of the project	Coordi-nating country	Number of papers	Starting year	Duration in months	Number of partners	Status
1	WISER	Germany	149	2009	36	25	completed
2	REFRESH	UK	111	2010	48	25	completed
3	THESEUS	Italy	78	2009	48	31	completed
4	PERSEUS	Greece	63	2012	48	53	ongoing
5	BIOFRESH	Germany	56	2009	54	19	completed
6	CoCoNet	Italy	55	2012	48	39	ongoing
7	HYPOX	Germany	44	2009	36	17	completed
8	KNOWSEAS	UK	31	2009	51	32	completed
9	KULTURISK	France	22	2011	36	11	completed
10	EPI_WATER	Italy	19	2011	36	11	completed

There are various reasons while some countries coordinate more projects than others in Environmental research, but it is no real surprise that the most active countries in environmental and water research are Germany and Italy. The study identified that there is no significant correlation between the number of papers produced and the number of partners in the project (p-value=0.5098) and in what follows the study will evaluate the quality of the authors and collaboration to identify if the hypotheses made are supported or not. The study revealed that the top 10 ranked projects produced about 85% of the total number of publications produced by the projects in the analysed sample. The distribution of papers by year produced by the projects in the sample is presented in Table 2.

Table 2. Papers distribution by year

Year	2009	2010	2011	2012	2013	2014
Papers	5	21	58	195	274	188

There is an ascendant trend in the number of publications by year. The total number of publications collected for the projects in the sample was 741 papers. One should note that in 2014 the papers were collected from ISI Web of Knowledge in September 2014, having July as the last month of publication recorded in the database, hence 2014 only presents the number of publication for half a year and there are 12 projects ongoing among the sampled 31 projects, that will continue to produce papers, possible even some of the projects that have recently completed.

Investigating the sample with respect to other variables, such as quartile of the journal, impact factor, number of citations, number of authors for the papers, the study revealed that 56.8% of the papers are published in journals of quartile I, 28.9% of the papers in journals of quartile II, 8.7% of the papers in journals of quartile III and the remaining 5.6% of the papers in journals of quartile IV. One should

note that the three projects ranked on top (WISER, REFRESH and THESEUS) are keeping their ranking when the ranking is done by quartiles, these being the projects that produced the highest number of quartile I, as well as quartile II papers.

Testing the qualitative growth, by testing if the journal quartile is increasing yearly, confirms with 95% confidence that the journal quality increases by year, hence there is an observed qualitative growth, as well as a quantitative increase in number of publications, hence supporting the hypothesis stated above. Study also reveals that multiple authorship is higher for the papers in the upper quartile, than the lower quartiles. The claim is supported by testing and rejecting ($p = 0.0208$) the hypothesis that the average number of papers is the same for each quartile. Multiple comparison of the means identifies that in average the number of authors on papers is different in each quartile, and the higher the quartile, the higher the collaboration characteristic. For the quartile I papers the highest numbers of papers are produced having 4 co-authors. The Degree of Collaboration (DC) is derived in Ref. 15 as:

$$\mathrm{DC} = P_{\mathrm{m}}/(P_{\mathrm{m}} + P_{\mathrm{s}}'),$$

where P_{m} is the number of papers multi authored and P_{s} – the number of papers single authored, while the Collaborative Coefficient (CC) derived in Ref. 16 is calculated using the following formula:

$$\mathrm{CC} = 1 - (1/N) \sum_{i=1}^{A} (p_i/i),$$

where p_i is the number of papers with i authors in the given quartile over the defined period of time; N – the total number of papers published in a given quartile during a defined period of time, and A – the highest number of authors per paper in the quartile. Using the above formulas, the DC measure calculated for the quartile I papers is 0.97, and the CC measure for the papers in quartile I are 0.76. The CC is higher with higher quartile and the analysis shows the qualitative and quantitative increase in the joint authored papers, reflecting that the nature of collaboration is very high, dominating the contributions in top journals (quartile I).

Investigating the journals of choice for the top three projects, the study identified that the authors producing papers under the WISER and REFRESH projects have comparable choices, while the authors disseminating under the THESEUS project are choosing different journals. The top five journals for each of these three projects are presented in Table 3.

The findings in Table 3, agree with our hypothesis that the citation counts does not produce a different ranking. The papers published by the projects in the study are producing, as of September 2014, 3259 citations, with project WISER gathering 1221 citations, REFRESH gathering 431 citations and THESEUS gathering 251 citations, followed by BIOFRESH with 231 citations, PERSEUS with 156

citations and CoCoNet with 106 citations. The top 5 journals presented in Table 3 for each project are accounting for 67% of the total citations of WISER, 63.3% of the total citations of REFRESH and 45.8% of the total citations of THESEUS.

Table 3. Top 5 journals selected for publication and citations gathered

Project	Journal name	Quartile	5-year Impact factor	Article influence score	Citations count from papers
WISER	Ecological indicators	Q1	3.384	0.817	260
	Freshwater biology	Q1	3.857	1.217	91
	Marine pollution bulletin	Q1	3.118	0.769	79
	Hydrobiologia	Q2	2.350	0.679	315
	Fundamental and applied limnology	Q2	1.297	0.403	73
REFRESH	Freshwater biology	Q1	3.857	1.217	68
	Global change biology	Q1	8.595	3.124	82
	Journal of hydrology	Q1	2.693	1.141	2
	Hydrobiologia	Q2	2.350	0.679	115
	Hydrology research	Q2	1.810	0.555	6
THESEUS	Coastal engineering	Q1	2.343	0.864	77
	Environmental science & policy	Q1	3.948	1.204	17
	Plos one	Q1	4.015	1.370	13
	Estuarine coastal and shelf science	Q2	2.782	0.873	1
	Natural hazards and earth system sciences	Q2	2.075	0.619	7

Table 4 presents the ranking of the projects based on the highest number of citations the 741 papers produced. In the top 3 highest ranked projects, project HYPOX has the most cited paper, followed by WISER and REFRESH. HYPOS project also has another paper in the top 5 most highly cited papers. We were investigating if the authors of these high cited papers are also highly productive. The highest cited paper in HYPOX has 2 authors that have authored over 342 papers that have gathered over 14299 citations, and have an H-index of 56 and 36, respectively in ISI Thomson Web of Science. The distribution of citations for the three papers presented in Table 4 is presented in Fig. 1.

Table 4. Top 3 highest cited papers produced

Rank	Project	Paper	Journal quartile	Citation
1	HYPOX	Coastal hypoxia and sediment biogeochemistry, By: Middelburg, J. J.; Levin, L. A., BIOGEOSCIENCES Volume: 6 Issue: 7 Pages: 1273–1293 Published: 2009	Q1	97
2	WISER	Three hundred ways to assess Europe's surface waters: An almost complete overview of biological methods to implement the Water Framework Directive, By: Birk, Sebastian; Bonne, Wendy; Borja, Angel; et al., ECOLOGICAL INDICATORS Volume: 18 Pages: 31–41 Published: JUL 2012	Q1	70
3	REFRESH	Warmer climates boost cyanobacterial dominance in shallow lakes, By: Kosten, Sarian; Huszar, Vera L. M.; Becares, Eloy; et al., GLOBAL CHANGE BIOLOGY Volume: 18 Issue: 1 Pages: 118–126 Published: JAN 2012	Q1	63

One can see that the paper published in BIOGEOSCIENCES has an ascendant citation trend, having an impact in the literature since it was published in 2009. The second and the third ranked papers exhibit a similar trend, and have the potential that 6 years after publication (as is the case with the HYPOX paper) to have gather a significantly larger number of citations, especially the WISER paper since in both in 2013 and 2014 gathering more citations than the other two papers. This reconfirms the fact that by measuring publications performance for output produced by funded environmental research in the period 2009–2014, project WISER could be considered as the most successful one.

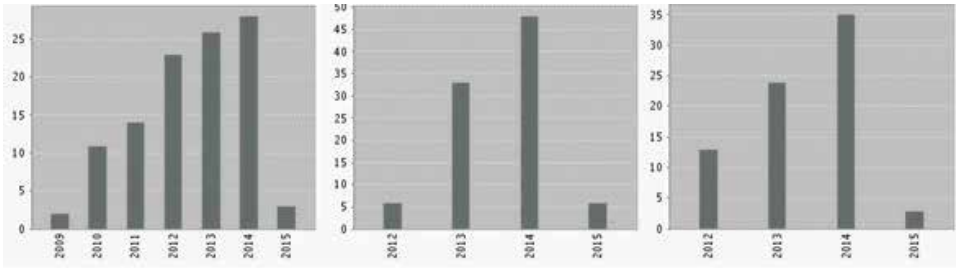


Fig. 1. Citations distributions by year for the highest cited papers presented in Table 4

We have categorised the projects in terms of the budget size as it follows: small budget projects (if budget is less than 1 mil Euro), mid-size budged projects (if budget is between 1 to 5 mil Euros) and large size budget (if budget is greater than 5 mil Euro). The budgets of the projects were all converted to Euro, considering the conversion rating at the time of funding. The results of the analysis show that

the number of papers in each budget category is significantly different for each category. Projects in the large size budget category have published more papers, with project WISER standing as an outlier even for the large size budget projects. Although project WISER is not the project with the largest number of partners, the number of partners of this project is larger than the median number of partners for the projects in the dataset.

The published papers were categorised under 26 different research areas in Thomson Web of Science. The highest number of papers 197, where categorised under the 'Environmental Sciences & Ecology area', followed by 170 papers under the area of 'Marine & Freshwater Biology' and 68 papers under the area of 'Biodiversity & Conservation'. The largest contributions for all these area came from papers published under the projects WISER and REFRESH, that were also funded under the Life and Earth Science areas.

To validate that our assessment and the produced ranking of top projects is accurate, we will employ the well-known H-index, introduced by Hirsch[17]. In this study the index will be used to characterise the scientific output of the grant, not the researcher. We agree in employing this index, that citation impact is a very important metric. Having papers that are highly cited is very important, as is having many papers and having a high total number of citations.

Table 5. Ranking by H-index

Rank	Acronym of the project	H-index	g-index
1	WISER	16	25
2	REFRESH	10	15
3	BIOFRESH	8	12
4	HYPOX	8	17
5	KNOWSEAS	8	12
6	KULTURISK	6	8
7	PERSEUS	6	10
8	THESEUS	6	11
9	CoCoNet	5	8
10	EXPEER	5	6

The ranking in Table 4 is consistent with the findings of this study, presented in Tables 1 and 3. If one is interested in identifying top projects counting the citations from the highly cited articles, the g-index should be considered. The g-index is quantifying scientific productivity based on publications and calculated based on the distribution of citations received by a given grant publications. Evaluating the results provided by the g-index, one can see that project HYPOX is raising in ranking, the results agreeing more to the finding from Table 4. All the rankings employed are identifying the top 3 most successful projects as being: WISER, REFRESH consistently, the third one being HYPOX, BIOREFRESH or THE-

SEUS – depending on the metric used. The g-index also differentiates between projects ranked equally by the H-index, by attaching more weight to the highly cited papers, hence differencing between the projects by highlighting the ones that have papers that are more widely recognised in the scientific community.

Overall, the study provides a ranking of the funded research, by quantifying the performance in terms of number of publications, journal category, degree of collaboration and especially measuring the research impact, by number of citations.

CONCLUSIONS

Analysing the projects with respect to the allocated budged, one can note that projects with larger budget are producing more papers and also papers with highest number of citations. These projects have more than the median number of partners. The research outcomes are highly interdisciplinary spanning over Engineering, Biodiversity, Environmental and Marine Sciences. It will be interesting to see if partners of these projects are creating consortium in the future and if the projects are as successful as the ones we investigated. The study provides a realistic glimpse into the research in the fields of Environmental Sciences, Marine and Fresh Biology and Biodiversity, using the top European funded projects in the time interval 2009–2013. Based on the findings, the quantitative and qualitative characteristics of the output, the investment in these grants can be considered justified, the grants being considered successful.

The results suggest that a potential evaluator can use the information provided by the ranking of past projects in which the applicants (institutions or researchers) were partner, evaluate the quality of research and the success of former collaborations in predicting the outcomes of projects under review.

Acknowledgements. This work was financially supported by the Institutional Core Program BIODIVERS-105 Project.

REFERENCES

1. D. CHUDNOVSKY, A. LOPEZ, M. A. ROSSI, D. UBFAL: Money for Science? The Impact of Research Grants on Academic Output. Fisc Stud, **29** (1), 75 (2008).
2. D. C. DANULETIU, A. TAMAS-SZORA, A. SOCOL: Affordability and Sustainability of Water Services Investments Financed by EU Funds. J Environ Prot Ecol, **16** (1), 154 (2015).
3. K. W. BOYACK, K. BORNER: Indicator-assisted Evaluation and Funding of Research: Visualizing the Influence of Grants on the Number and Citation Counts of Research Papers. J Am Soc Inf Sci Tech, **54** (5), 447 (2003).
4. J. BAWDEN, N. MANOUCHEHRI, C. VILLA-ROEL, E. GRAFSTEIN, B.H. ROWE: Important Returns on Investment: an Evaluation of a National Research Grants Competition in Emergency Medicine. Can J Emerg Med Care, **12** (1), 33 (2010).
5. P. J. ZED, M. H. ENSOM, R. S. SLAVIK, K. WILBUR, S. KANJI, S. L. KOSHMAN, J. IRVINE-MEEK, M. PERREAULT, S. ZELENITSKY: Evaluation of the Research Grant Program of the

Foundation of the Canadian Society of Hospital Pharmacists, 1995–2008. The Canadian Journal of Hospital Pharmacy, **64** (6), 399 (2011).
6. C. DONOVAN: The Australian Research Quality Framework: a Live Experiment in Capturing the Social, Economic, Environmental, and Cultural Returns of Publicly Funded Research, New Directions for Evaluation. Special Issue: Reforming the Evaluation of Research, **118**, 47 (2008).
7. C. W. BELTER: Measuring the Value of Research Data: A Citation Analysis of Oceanographic Data Sets. PLoS One, **9** (3), (2014).
8. M. GOLUMBEANU, A. OROS, M. NENCIU, M. ZAVATARELLI, A. DRAGO: Contribution of Environmental Indices in Meeting the Objectives and Principles of the Marine Strategy Framework Directive (MSFD). J Environ Prot Ecol, **15** (3), 1130 (2014).
9. Y. XU, W. J. BOEING: Mapping Biofuel Field: A Bibliometric Evaluation of Research Output. Renew Sust Energ Rev, **28**, 82 (2013).
10. J. S. KATZ, B. R. MARTIN: What Is Research Collaboration? Res Policy, **26** (1), 1 (1997).
11. T. VELDEN, A. HAQUE, C. LAGOZE: A New Approach to Analyzing Patterns of Collaboration in Co-authorship Networks – Mesoscopic Analysis and Interpretation. Scientometrics, **85** (1), 219 (2010).
12. Z. TASKIN, U. AL: Standardization Problem of Author Affiliations in Citation Indexes. Scientometrics, **98** (1), 347 (2014).
13. M. R. FALAHATI, Q. FUMANI, M. GOLTAJI, P. PARTO: Inconsistent Transliteration of Iranian University Names: A Hazard to Iran's Ranking in ISI Web of Science. Scientometrics, **95** (1), 371 (2013).
14. J. BAR-ILAN: A Closer Look at the Sources of Informetric Research. International Journal of Scientometrics, Informetrics and Bibliometrics, **13** (1), (2009)
15. K. SUBRAMANYAM: Bibliometric Studies of Research Collaboration. J Inf Sci, **6** (1), 33 (1983).
16. I. S. AJIFERUKE, Q. BURREL, J. TAGUE: Collaborative Coefficient: a Single Measure of the Degrees of Co-authorship in Research. Scientometrics, **15** (6), 421 (1988).
17. J. E. HIRSCH: An Index to Quantify an Individual's Scientific Research Output. Proc Nat Acad Sci, **102** (46), 16569 (2005).

Received 27 January 2016
Revised 4 April 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *648–655* (*2016*)

Environmental protection and sustainable development

COMPARISON OF CROP CLASSIFICATION METHODS FOR THE SUSTAINABLE AGRICULTURE MANAGEMENT

M. USTUNER[a]*, M. T. ESETLILI[b], F. B. SANLI[a], S. ABDIKAN[c], Y. KURUCU[b]

[a]*Department of Geomatic Engineering, Yildiz Technical University, 34 220 Esenler, Istanbul, Turkey*
E-mail: *mustuner@yildiz.edu.tr*
[b]*Department of Soil Science and Plant Nutrition, Ege University, 35 100 Bornova, Izmir, Turkey*
[c]*Department of Geomatics Engineering, Bulent Ecevit University, 67 100 Zonguldak, Turkey*

Abstract. Accurate and reliable information regarding crop yields and soil conditions of agricultural fields are essential for the sustainable management of agricultural areas. The increasing necessity of the food due to the high population, global climate change and rapid urbanisation, the sustainable management of the agricultural resources is becoming more crucial for countries. Remote sensing technology offers a feasible solution for gathering the cost-effective, reliable and up-to-date information about crop monitoring by using high-resolution remote sensing data. Image classification is the one of most common method to obtain information from the remotely sensed images. Despite machine learning based classifiers such as Support Vector Machines (SVM) could provide high classification accuracy, the researchers have been still working to improve the classification accuracy. Recently, the utilisation of ensemble learning approaches in remote sensing classification is the research of interest for this purpose. In this study, we implemented six different supervised classification techniques and a classifier ensemble: Maximum Likelihood, Mahalanobis Distance, Minimum Distance, Spectral Angle Mapper, Parallelepiped, Support Vector Machines and Winner-takes-all (WTA) classification which is an ensemble based classifier. In this study, we investigated the comparative performance of the classifiers within overall and corn-class category for the study area located in Aydin, Turkey. Radial Basis Function (RBF) kernel was used here for the SVM classification. Results demonstrate that WTA classification outperformed other classification methods whilst the Parallelepiped obtained the lowest classification accuracy 13.24%. Moreover SVM gave the second highest overall classification accuracy of 89.90%.

Keywords: remote sensing, image classification, RapidEye, agriculture management.

AIMS AND BACKGROUND

Over the years, food demand in the world has been increasing and global food security have been crucial due to the global climate change, high population growth and extreme weather events. These changes reduce the agriculture productivity

* For correspondence.

and hence push the countries whose economy is mostly based upon the agriculture to enhance the efficiency, productivity, and performance of their sustainable agriculture system. The extreme weather events damage the crops thus cause the agflation[1–3]. In FAO (Food and Agriculture Organisation of the United Nations) report in 2013, it is estimated that global population will be over nine billion by 2050 and the food production will have to increase by 60% to meet the expected demand for food of the world[4]. Therefore, sustainable agriculture management is pretty essential and crucial for global food security.

Recent advances in earth observation satellites have been making remote sensing very important and essential tool for the environmental monitoring and assessment as well as the agricultural applications since it could provide up-to-date and cost-effective information of land use/cover types at different spatial and temporal domain[5–8]. Remote sensing could provide many important information such as spatio-temporal distribution of crops or yield estimation for the agricultural decision support systems[3,6,9]. Classification of remotely sensed data is one of the most common method for obtaining the land use/cover information[10]. The accuracy and reliability of the information gathered by the imagery is much depending on the classification. Despite there are some advanced classification methods in remote sensing such as support vector machines, random forest, rotation forest etc., scientists and researchers have been still working to improve the classification accuracy because classified images provide many important base information for GIS application and analysis on decision making process. Several methods have been used to increase the image classification accuracy such as combination of spectral and texture features, multi-sensor image fusion or ensembles of classifiers[11–13]. Data fusion in remote sensing can be categorised into three different levels: pixel-level, feature-level and decision level[14,15]. In this study, we implemented six different supervised classification methods: Maximum Likelihood, Mahalanobis Distance, Minimum Distance, Spectral Angle Mapper, Parallelepiped, Support Vector Machines and an ensemble of classifiers or multiple classifiers, is based on decision level fusion strategy, that is called Winner Takes All (WTA) for the classification of RapidEye imagery of our study area.

This study examined the applicability and comparative performance of supervised classification techniques and classifier ensemble technique for crop mapping using RapidEye in Aydin Province. Moreover classification accuracy for corn-class category has been investigated as a specific task.

EXPERIMENTAL

Study area and data. The study area is located in Aydin Province, Aegean region of Turkey and comprised of approximately 17.3 km^2 of agricultural areas (Fig. 1). Besides favourable climate and soil conditions of Aegean region, most of the ag-

ricultural lands in Aydin province are fed by Great Meander River, which enables to intensive agriculture for the area. Study area covers nine land use classes which are corn (first crop, second crop), cotton (well developed, moderate developed, weak developed), soil (wet, moist, dry) and water surface (Fig. 2). The acquisition date of the RapidEye imagery was August 23rd 2012.

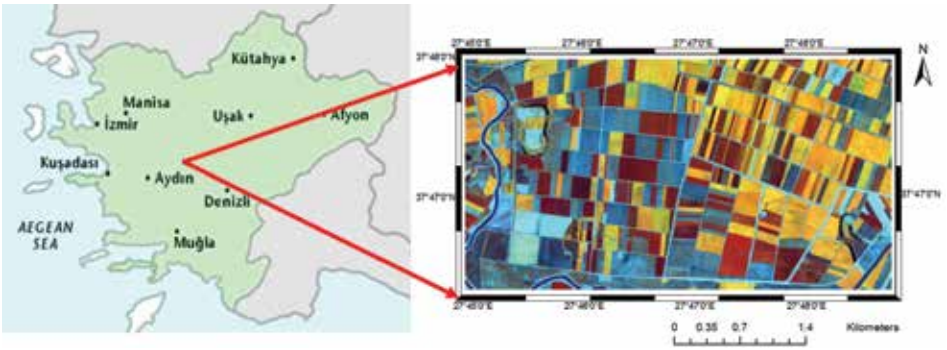


Fig. 1. Study area

Fig. 2. Crop types

RapidEye was launched in 2008 with a primary focus of agricultural, environmental and cartographic applications[16,17]. Blackbridge, the provider of RapidEye imagery, offers RapidEye data at three different processing levels. The imagery was obtained in Level 3A (RapidEye Ortho product) processing level in which radiometric, geometric and sensor corrections were applied. The RapidEye data provides five spectral bands which are blue (440–510 nm), green (520–590 nm), red (630–685 nm), rededge (690–730 nm) and near-infrared (760–850 nm) (Ref. 18).

Methods. Each method will be briefly described here however reader could reach the further details and theoretical background for each method at remote sensing textbooks such as Tso and Mather[19], Mather and Koch[20], and Richards[21].

Maximum likelihood classification is the most common method in remote sensing image classification. In this method, a pixel is assigned to the class of highest probability of belonging[19,22,23]. Minimum distance and Mahalanobis distance classification uses the euclidean distance and mahalanobis distance, respectively. Both methods assign the pixel to the corresponding class in which distance between class centre[19,21,22]. Spectral Angle Mapper classification compares the image spectra and a known spectrum (or endmember) and calculates the spectral angle

between them to determine the spectral similarity[24,25]. Paralelpiped classification uses maximum and minimum pixel values for each class, which is the boundaries of paralelpiped. If a given pixel in features space is within class limits, the pixel is assigned to the corresponding class[19,20]. SVM is a supervised machine learning algorithm. It was initially developed for the binary classification by defining the optimum hyperplane separating the two classes. SVM uses the kernels to contruct the optimum hyperplane for the complex data that can not be linearly separated[26–28]. Kernel based SVMs are commonly used in remote sensing for classification and need parameters for kernel functions. The optimum parameters of cost (C) and kernel width (σ) which are required for the Radial Basis Function (RBF) kernel have been determined by using grid search method as 100 and 0.125, respectively. Further details of SVM algorithms were given by Huang et al.[27] and Melgani and Bruzzone[28] in the context of remote sensing.

The ensemble based approaches or multiple classifiers have been utilised in order to improve the classification accuracy by combining the outputs of several classifiers[11,29,30]. Some strategies have been developed for the ensemble learning approaches such as majority voting, fuzzy integral, Dempster-Shafer evidence theory[11,31]. Majority voting is the most common method that collects label outputs of each classifiers for a given pixel then assign the pixel to the majority label[19,31]. We performed the classifier ensemble based upon WTA method in which majority voting was used. WTA classification assign each pixel to the corresponding class that has the majority for all classification methods implemented[32]. Readers requiring more and comprehensive detail for classifier ensembles should refer to Briem et al.[33], Foody et al.[29] and Du et al.[11]

RESULTS AND DISCUSSION

In this section, comparative performance of the classifiers will be analysed by means of overall accuracy and kappa coefficients (Table 1). Moreover the individual class accuracies for most accurate three methods will be assessed by producer accuracy for in-depth analysis of comparison (Table 2).

Minimum distance, SVM and WTA are the most accurate three classification methods as their overall accuracy were obtained as 89.20, 89.90 and 90.94%, respectively. Since the accuracies of these three methods close to each other especially minimum distance and SVM, we will compare the individual class-based accuracy for comprehensive analysis by using producer accuracy. Among all methods performed here, Parallelepiped had the lowest classification performance as 13.25% of overall accuracy while WTA had the highest one as 90.94% for this study. In general, SVM performs better than single classifiers if the optimum parameters have been used for kernel.

Table 1. Classification accuracy

Method	Overall kappa	Overall accuracy (%)
Parallelepiped	0.1202	13.25
Mahalanobis distance	0.7276	76.31
Maximum likelihood	0.8010	82.58
Spectral angle mapper	0.8179	83.97
Minimum distance	**0.8762**	**89.20**
Support vector machines	**0.8845**	**89.90**
Winner-takes-all	**0.8964**	**90.94**

Table 2. Producer and user accuracy

Classes	Classification methods (most accurate three ones)					
	minimum distance		support vector machines		winner takes all	
	prod. acc.	user acc.	prod. acc.	user acc.	prod. acc.	user acc.
First crop corn	**100.00**	84.13	*88.68*	97.92	*94.34*	98.04
Second crop corn	82.93	100.00	100.00	87.23	**100.00**	93.18
Wet soil	85.00	62.96	90.00	60.00	**90.00**	60.00
Moist soil	100.00	100.00	100.00	100.00	**100.00**	100.00
Dry soil	**70.59**	96.00	64.71	91.67	64.71	91.67
Well-developed cotton	**97.06**	89.19	91.18	100.00	91.18	100.00
Moderate developed cotton	90.00	85.71	100.00	83.33	**100.00**	83.33
Weak developed cotton	66.67	100.00	66.67	100.00	**66.67**	100.00
Water body	97.74	100.00	94.74	100.00	**94.74**	100.00

Even though the overall accuracies of minimum distance and SVM are close to each other and the difference is 0.70%, we will check the benefits of each classifier for individual class classification and compare the performances. The highest accuracies for individual class category (producer accuracy) are given in bold in Table 2 for each classification method. While minimum distance classify most accurately only three classes (first crop corn, dry soil and well developed cotton), WTA classified the remaining classes within producer accuracy. When we check the results in Table 2, we can not find any method that classify the all classes on highest accuracy. Producer accuracies of SVM and WTA are pretty close to each other however WTA outperformed SVM 5.7% (Italic) of producer accuracy for the first crop corn class as it is one of our investigation on this study.This 5.7% increase on the producer accuracy for first crop corn enables the WTA had higher overall accuracy than SVM as 1.74% (Table 2). Classification maps for the most accurate three methods are given in Fig. 3.

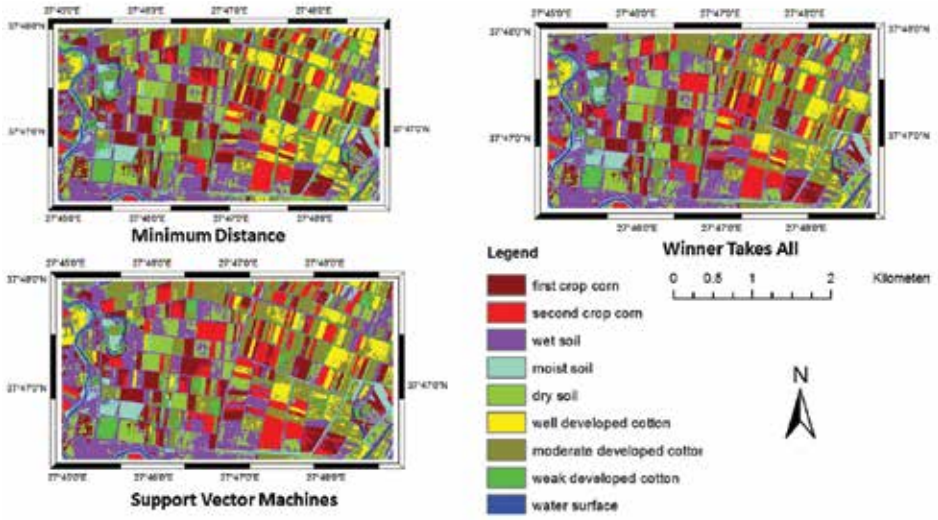


Fig. 3. Classification maps

CONCLUSIONS

In this study, we examined the sensitivity, applicability and comparative performance of six different supervised classification techniques and a classifier ensemble for the classification of crop types in Aydin Province, Turkey. Also the suitability of Rapideye imagery for crop mapping has been investigated.

It can be concluded that each type of classification method has different sensitivity and benefits on classes and classifier ensembles could increase the overall classification accuracy as well as individual class-based accuracy for this study area. Results demonstrate that WTA classification outperformed other classification methods whilst the Parallelepiped obtained the lowest classification accuracy 13.24%. Moreover SVM gave the second highest overall classification accuracy of 89.90%. Most accurate classification method (WTA in our study) can not have the highest accuracy (producer accuracy) for all classes. Results indicate that since the sensitivity of each classification method is different, it is possible to obtain high classification accuracy as well as low classification accuracy for crop classification even though same imagery and input data were used.

In future work, we are planning to assess the comparative classification performance of other advanced techniques such as rotation forest, relevance vector machines and object based SVM for our study area. We also plan to integrate the information by RapidEye and Sentinel-1 sensor that will be freely available and provide C-band that is commonly used in agricultural applications in remote sensing.

REFERENCES

1. D. R. EASTERLING, G. A. MEEHL, C. PARMESAN, S. A. CHANGNON, T. R. KARL, L. O. MEARNS: Climate Extremes: Observations, Modeling, and Impacts. Science, **289**, 2068 (2000).
2. Y. KANG, S. KHAN, X. MA: Climate Change Impacts on Crop Yield, Crop Water Productivity and Food Security – A Review. Prog Nat Sci, **19**, 1665 (2009).
3. H.-O. KIM, J.-M. YEOM: Sensitivity of Vegetation Indices to Spatial Degradation of RapidEye Imagery for Paddy Rice Detection: A Case Study of South Korea. GISci Remote Sens, **52**, 1 (2015).
4. FAO: Climate-smart Agriculture Sourcebook. 2013. http://www.fao.org/3/a-i3325e.pdf (Accessed: 15.08.2015).
5. E. TOK, Y. KURUCU: Using High-resolution Satellite Imagery to Determine Hazelnut Planted Areas in Istanbul Province. J Environ Prot Ecol, **12** (1), 215 (2011).
6. J. U. H. EITEL, L. A. VIERLING, M. E. LITVAK, D. S. LONG, U. SCHULTHESS, A. A. AGER, D. J. KROFCHECK, L. STOSCHECK: Broadband, Red-edge Information from Satellites Improves Early Stress Detection in a New Mexico Conifer Woodland. Remote Sensing of Environment, **115**, 3640 (2011).
7. G. DROJ: GIS and Remote Sensing in Environmental Management. J Environ Prot Ecol, **13** (1), 361 (2012).
8. M. T. ESETLILI, F. OZEN, Y. KURUCU, U. KAYA: Agroecological Aspect of Olive Cultivation. J Environ Prot Ecol, **15** (4), 1810 (2014).
9. C. CONRAD, S. DECH, O. DUBOVYK, S. FRITSCH, D. KLEIN, F. LOW, G. SCHORCHT, J. ZEIDLER: Derivation of Temporal Windows for Accurate Crop Discrimination in Heterogeneous Croplands of Uzbekistan Using Multitemporal RapidEye Images. Computers and Electronics in Agriculture, **103**, 63 (2014).
10. G. M. FOODY: Thematic Map Comparison: Evaluating the Statistical Significance of Differences in Classification Accurac.' Photogrammetric Engineering and Remote Sensing, **70** (5), 627 (2004).
11. P. DU, J. XIA, W. ZHANG, K. TAN, Y. LIU, S. LIU: Multiple Classifier System for Remote Sensing Image Classification: A Review. Sensors, **12**, 4764 (2012).
12. Y. JIANGYE, W. DELIANG, L. RONGXING: Remote Sensing Image Segmentation by Combining Spectral and Texture Features. Geosci Remote Sens IEEE Transactions, **52**, 16 (2014).
13. G. FORKUOR, C. CONRAD, M. THIEL, T. ULLMANN, E. ZOUNGRANA: Integration of Optical and Synthetic Aperture Radar Imagery for Improving Crop Mapping in Northwestern Benin, West Africa. Remote Sensing, **6**, 6472 (2014).
14. C. POHL, J. L. van GENDEREN: Multisensor Image Fusion in Remote Sensing: Concepts, Methods and Applications. Int J Remote Sens, **19** (5), 823 (1998).
15. J. ZHANG: Multi-source Remote Sensing Data Fusion: Status and Trends. International Journal of Image and Data Fusion, **1**, 5 (2010).
16. G. TYC, J. TULIP, D. SCHULTEN, M. KRISCHKE, M. OXFORT: The RapidEye Mission Design. Acta Astronautica, **56**, 213 (2005).
17. J. WEEBER: RapidEye Satellite Imaging System, Defense/Intelligence Capabilities. 2010. http://usgif.org/system/uploads/1009/original/John_Weeber.pdf (Accessed: 13.08.2015).
18. BlackBridge: RapidEye Satellite Imagery Product Specifications. Version 6, 2013. http://www.blackbridge.com/rapideye/upload/RE_Product_Specifications_ENG.pdf
19. B. TSO, P. M. MATHER: Classification Methods for Remotely Sensed Data. 2nd ed. CRC Press, Boca Raton, 2009.
20. P. M. MATHER, M. KOCH: Computer Processing of Remotely-sensed Images: an Introduction. 4th ed. Wiley-Blackwell, Chichester, UK, 2011. 504 p.
21. J. A. RICHARDS: Remote Sensing Digital Image Analysis. Springer, Berlin, 2013, p. 494.

22. P. GONG: Remote Sensing and Image Analysis. 1997. http://nature.berkeley.edu/~penggong/textbook/ (accessed: 14.08.2015).
23. T. KAVZOGLU, I. COLKESEN: A Kernel Functions Analysis for Support Vector Machines for Land Cover Classification. International Journal of Applied Earth Observation and Geoinformation, **11**, 352 (2009).
24. F. A. KRUSE, A. B. LEFKOFF, J. W. BOARDMAN, K. B. HEIDEBRECHT, A. T. SHAPIRO, P. J. BARLOON, A. F. H. GOETZ: The Spectral Image Processing System (SIPS) – Interactive Visualization and Analysis of Imaging Spectrometer Data. Remote Sens Environ, **44**, 145 (1993).
25. G. P. PETROPOULOS, K. P. VADREVU, G. XANTHOPOULOS, G. KARANTOUNIAS, M. SCHOLZE: A Comparison of Spectral Angle Mapper and Artificial Neural Network Classifiers Combined with Landsat TM Imagery Analysis for Obtaining Burnt Area Mapping. Sensors, **10**, 1967 (2010).
26. C. CORTES, V. VAPNIK: Support-Vector Networks. Machine Learning, **20**, 273 (1995).
27. C. HUANG, L. S. DAVIS, J. R. G. TOWNSHEND: An Assessment of Support Vector Machines for Land Cover Classification. Int J Remote Sens, **23**, 725 (2002).
28. F. MELGANI, L. BRUZZONE: Classification of Hyperspectral Remote Sensing Images with Support Vector Machines. Geosci Remote Sens, IEEE Transactions, **42** (8), 1778 (2004).
29. G. M. FOODY, D. S. BOYD, C. SANCHEZ-HERNANDEZ: Mapping a Specific Class with an Ensemble of Classifiers. Int J Remote Sens, **28**, 1733 (2007).
30. S. D. JAWAK, A. J. LUIS: Very High-resolution Satellite Data for Improved Land Cover Extraction of Larsemann Hills, Eastern Antarctica. J Appl Remote Sens, **7**, 073460 (2013).
31. C. ZHANG, Z. XIE: Data Fusion and Classifier Ensemble Techniques for Vegetation Mapping in the Coastal Everglades. Geocarto International, **29**, 228 (2012).
32. Exelis VIS Online Documentation Center, 2015, "TERCAT" http://www.exelisvis.com/docs/TERCAT.html (Accessed: 14.08.2015).
33. G. J. BRIEM, J. A. BENEDIKTSSON, J. R. SVEINSSON: Multiple Classifiers Applied to Multisource Remote Sensing Data. Geoscience and Remote Sensing, IEEE Transactions, **40**, 2291 (2002).

Received 11 February 2016
Revised 16 April 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *656–665* (*2016*)

Environmental protection and sustainable development

ENOTOURISM AS AN INSTRUMENT FOR PROMOTING RURAL DEVELOPMENT IN THRACE REGION (TURKEY)

A. P. BEKDEMIR*, N. K. AKTAS

Department of Landscape Planning and Design, Faculty of Forestry, Istanbul University, Istanbul, Turkey
E-mail: *alevbk@istanbul.edu.tr*; *niluferk@istanbul.edu.tr*

Abstract. Anatolia, which has hosted many civilisations for centuries, has great tourism potential with its natural and cultural resource values. Not only as a general destination for tourism but also as an alternative tourism destination, Anatolia is attracting the attention of local and foreign tourists. In recent years enotourism has been developing in Turkey and by popularising new destinations it has become an important sector for tourism. Turkey is located in the Earth most conducive climate zone for viticulture. The history of viticulture in whole Anatolia goes back to 3500 years B.C. Turkey consists of seven regions which have different geographic and climatic characteristics. In almost every region, various grape species are cultivated and wine production is made. In Turkey, 49% of the land are used for agricultural purposes and 1.2% of agricultural land are used for grape cultivation. According to FAO 2012 database, Turkey is ranked 6th out of all world countries in the grape production but only 2% of grapes are used for wine production. With implementation of wrong policies, prohibitions and obstructions for wine production and consumption, the benefits of enotourism to Anatolia can not be adequately assessed. Within the context of this study, economic contribution of enotourism, the changes in the employment opportunities of local communities and changes in the tourism movements are examined in the Thrace region where 40% of Turkey wine production is carried out.

Keywords: enotourism, alternative tourism destinations, viticulture, Thrace region, wine.

AIMS AND BACKGROUND

Over the decades, tourism has experienced continued growth and deepening diversification to become one of the fastest growing economic sectors in the world. Modern tourism is closely linked to development and encompasses a growing number of new destinations. These dynamics have turned tourism into a key driver for socio-economic progress[1].

Evolving tourist trends have, over the last decade, led to a shift from standardised mass tourism to more individualistic patterns, in which greater flexibility and a more meaningful experience have gained prominence[2]. These changing demand trends have forced tourism practitioners to develop different products or alternatives. Smith and Eadington[3] have mentioned that the birth of alternative tourism

* For correspondence.

was due to high criticism for mass tourism and its negative effects on destination areas[4]. Alternative tourism is sometimes referred to as 'special interest tourism' or 'responsible tourism' and is usually taken to mean alternative forms of tourism which give emphasis on the contact and understanding of inhabitants way of living and the local natural environment[5]. The specific forms of alternative tourism were identified by Mieczkowski[6] as cultural, educational, scientific, adventure and agri-tourism, with rural, ranch and farm subsets[5].

Actually rural tourism seems to be a subset of agritourism among the alternative tourism types but in fact agritourism is one of the major form of rural tourism[7]. While rural tourism is a more generic term, agritourism refers to specific sets of leisure activities organised by farmers to cater for visitors[8]. Also rural tourism and agritourism are terms which differ by their spatial range and form of area management. Rural tourism has placed special emphasis on the role of agro-tourism in protecting and promoting cultural heritage of rural areas[9]. Agrotourism is a kind of alternative tourism which is respectful and sensitive to people and the environment, has a minimum impact to the local rights and environment, also it helps to create job opportunities and generate income. It is based on local residents and the region geographic, cultural and traditional features. With agrotourism, it is aimed the preservation, introduction and exploitation of the country cultural inheritance[10].

Rural tourism can be defined as the country experience which encompasses a wide range of attractions and activities that take place in agricultural or non-urban areas. Its essential characteristics include wide-open spaces, low levels of tourism development, and opportunities for visitors to directly experience agricultural and/or natural environments[11].

Rural tourism may, as its components and in principle, involve agrotourism, outdoor activities, ecotourism, cultural tourism, adventure tourism, excursion tourism and enotourism (wine tourism)[12].

ENOTOURISM

Enotourism as an integral part of rural tourism and alternative tourism is widely recognised as having a strong connection with in the rural landscape[12,13]. Nowadays, wine-related tourism is becoming increasingly important to a number of rural areas around the world[14].

Enotourism has been recognised as a significant component of both the wine and tourism industries[15]. Enotourism is travel based on the desire to visit wine producing regions, or in which travellers are enticed to visit wine producing regions, and wineries in particular, while travelling for other reasons[16]. As Brown and Getz[17] mentioned, enotourism has become an important form of tourism since the mid 90s when one could observe a steady growth of tourists interested in wine who displayed relatively high spending power[18].

Most popular enotourism destinations worldwide can be sorted as Italy (Tuscany), France (Bordeaux), Spain (La Rioja), USA (Napa Valley), Portugal (Douro Valley), Germany (Mosel), South Africa (Cape Town), Argentina and Chile, New Zealand (Otago), Australia (Barossa Valley). Analysing wine tourism development worldwide, it can be determined that the most of the wine-producing countries are European representing over 70% of the world production. Europe has a significant history in comparison with countries in the new world; the vineyard is a very important component of European heritage and enotourism in Europe rests on the development of rural tourism which has experienced growth in the form of wine roads[19].

Anatolia, which has hosted many civilisations for centuries, has great tourism potential with its natural and cultural resource values. Anatolia is attracting the attention of local and foreign tourists not only for general destination tourism but also for alternative tourism. In recent years enotourism is not developed in Turkey but by creating new destinations it has become a new trend for our tourism sector.

The Turkish wine industry lags well behind that of other wine-producing countries around the world despite being in such a productive climate[20]. The history of viticulture in Anatolia goes back to 3500 years B.C. The most important indicators of viticulture in Anatolia are historical artifacts with grape related shapes and reliefs, amphoras used for drinking and storage of wine which are extracted from archaeological excavations at different parts of our country[21].

In Turkey, 49% of the land are used for agricultural purposes and 1.2% of agricultural land – for grape cultivation[22]. Despite this, according to FAO (Food and Agriculture Organisation of the United Nations)[23] 2012 database, Turkey is ranked 6th out of all world countries in the grape production (still maintains this position in 2015) but only 2% of grapes are used for wine production. The contrast between the high grape production results and low wine production is indeed remarkable. Most of the countries use 90% of their total grape production for wine-producing but the Turkish grape crop is used mainly as table grapes or dried as raisins[20].

Turkey consists of seven regions and each of them has their own geographic and climatic characteristics. In almost every region, a total of 18 provinces, various grape species are cultivated and wine production occurs. Turkey has more than 1200–1500 named grape varities of which 800 are genetically different and there are around 30 outstanding wine grape varieties among all these types[24].

The major vineyards of Turkey by regions are: Denizli, Manisa and Izmir in the Aegean region;Tekirdag, Edirne and Canakkale in the Thrace region; Cappadocia in the Central Anatolia region, Diyarbakir in the Southeastern Anatolia region and Elazig in the Eastern Anatolia region. These are followed by Bozcaada, Bursa, Ankara, Malatya, Antalya, Konya, Adapazari and Tokat counties.

In terms of vineyard surface area, the Aegean region is ranked first in Turkey in having 28% of the country total vineyard area. Due to the grape quality and high

value added raisins, the proportion of grapes used in wine production is lower in this region. On the other hand, the Thrace region, which has only 5% of country total vineyard area, is ranked first place in wine production in Turkey. This region can be described as the wine capital of our country because 40% of Turkey wine production occurs here[25].

ENOTOURISM IN THE THRACE REGION

The Thrace region, known as the wine capital of Turkey, constitutes our border with Europe in the far West of our country. Besides having geo-strategic importance, this region has also a wide range of natural and cultural values. Thrace can be defined as a peninsula bounded by three seas: the Black, Marmara and Aegean. Along with the coastline, southern and northern parts of the region have a significant presence of forest. The Black Sea coast in the north, Gulf of Saros in the south and Ganos Mountain stand out as an eco-tourism area.

As well as ecotourism and coastal tourism potential of the area, the Thrace Region has a very rich diversity of tourism facilities like cultural heritage tourism, rural tourism, extreme sports tourism, agrotourism and festival tourism (Kirkpinar Oil Wrestling), etc.

The Thrace region also has a very important agricultural potential and the main source of income is agriculture. This region has major agricultural areas that can grow variety of products due to the variable climate, soil and topographic features. 75% of agricultural income come from crop production[26,27]. Today, the main agricultural products of the region are sunflower, wheat, grapes (for wine-producing), rice and sugar beet. As for the wine grapes which have a significant place among the agricultural products, especially in the province of Tekirdag, production is carried out in an area of 2470 ha (Ref. 28).

Though there is tourism potential in Thrace in addition to the industry and agriculture, tourism in the region has not become a sector as yet. In order to constitute the basis for tourism development in the Thrace region, a Tourism Master Plan was prepared by Trakya development agency. The main purpose of the plan is to provide benefits to rural development of the region by planning different types of tourism. Thus, some strategies and actions have been established for the development of tourism in the region. An Action Plan has been prepared for the region towards the determined goals and strategies. As a result of the review, the attraction components of the region and the types of tourism were determined. Enotourism has emerged as one of them[29].

Basic objectives and strategies established for the medium term development of enotourism with high priority are as follows[29]:

– Establishment of an enotourism platform;
– Determination of ancient wine routes;

– Introducing new wine routes by determining the boutique wineries;

– Development of grape harvesting and wine tasting activities;

– Establishment of wineries and restaurants offering local wines in addition to authentic dishes which cater to the top income group;

– Collaborating with the travel agencies for attracting foreign tourists to the region;

– Effective advertising and information activities.

The Thrace region is trying to come to the fore in enotourism by using its status of wine capital along with its geography and tourism opportunities. Just like the Aegean region, the Thrace region is also an extremely important area for wine producers. Viticulture in Thrace appears mainly in three regions: Kirklareli and its environs, the Tekirdag vineyards between Ucmakdere and Sarkoy, and finally Edirne-Uzunkopru[29].

Thracian wine producers have developed a solution to enhance enotourism activities in the region. Twelve boutique wine producers from Tekirdag, Sarkoy, Kirklareli and Gelibolu gathered together in 2013 to promote a new 'Vineyard Routes Project' with the support of the Thrace Development Agency (TDA) and The Thrace Tourism Association (TTID) (Ref. 30).

The route is an opportunity to visit the wine producers, experience the territory, discover new tastes, and live the natural local village life. The surrounding historical sites, cultural events and the rich nature add another dimension to the Thrace Wine Route. Within the scope of the project the distribution of wineries by region is as follows: 4 wineries from Tekirdag, 3 wineries from Sarkoy, 3 wineries from Kirklareli, and 2 wineries from Galipoli.

EXPERIMENTAL

In the scope of this study, a representative face-to-face survey was done with 'Thrace Tourism Operators Association' member companies at one of their stated meetings in July 2014. The Thrace Wine Route Project aims to merge gastronomy and tourism by determining a route including the vineyards of 12 wine producers. The distribution of the companies of the wine route by counties is as follows: in Tekirdag, there is Umurbey, Chateau Nuzun, Barel and Barbare; in Sarkoy, there is Melen, Gulor and Chateau Kalpak; in Kirklareli, there is Arcadia, Chamlija and Vino Dessera, and in Gelibolu, there is the Gali and Suvla. Beside these, there are an additional 32 companies in the Thrace region.

According to the information obtained from personal interview surveys conducted with the 12 companies, 67% of these companies (3 companies from Tekirdag, 3 from Sarkoy, 1 from Kirklareli and 1 from Gelibolu) have 11–25 ha of vineyards, 17% (Gelibolu (1), Kirklareli (1)] have 51–75 ha, 8% (Kırklareli (1))

have 26–50 ha and 8% (Tekirdag (1)) have less than 10 ha of vineyards. None of these companies that we interviewed have more than 75 ha vineyards.

Cabernet Sauvignon and Merlot are the grapes grown in all of these vineyards. This is followed by Sauvignon Blanc, which is the second type of grape grown 67% of these vineyards and Okuzgozu, Shiraz and Syrah are the third grape types grown in 45% of these vineyards.

Almost all of these companies press 1–250 t of grapes annually with one company pressing 251–1000 t annually. Considering the annual wine production only one company produces 550 t of wine, 4 companies produce 50–100 t and the others produce 25–50 t wine annually. Only three of these companies are making an annual average export of 10 000 Euro, mostly though red, then rose and then white wine production.

According to the information received about the products and services in the area of vineyards, all vineyards have wine sales shops, in 88% of vineyards there are wine tasting opportunities, guided tours in the vineyards, outdoor restaurants which need a special reservation and opportunity of to meet with vineyard owners. In 38% of vineyards there are picnics, various social events, conference facilities and festivals. In 25% of vineyards there are accommodation and educational tours in 13%.

In these companies, an average of 10 people are full-time employed, 3 people are part-time and 15 people are seasonal or temporarily employed. For grape production the average number of full-time employees is 3 people, for wine production the average 3 people, for tourism/accomodation the average is 2 people and for sales the average is 2 people.

Part-time workers are few withan average of 2 workers for the grape production and 1 worker for wine production. Seasonal or temporarily workers are more numerous with for grape production employing anaverage of 12 people and for wine production 3 people.

In some companies, there are employees working part-time or seasonally for tourism/accommodation, working part-time for sales and working full-time or part time as restaurant/cafe staff.

In 78% of the companies, employees are predominantly from the local comminities (76–100%) and the remaining companies (22%) have their employees from the local people with a rate of 51–75%.

The most popular month for tourists to visit the vineyard is August-September-October period with 89% visitation. May-June-July period also experience as small spike in visitor numbers. The lowest number of visitors is in February, March, April (56%) and then November, December January (44%).

Eversole and Martin[31] thought that globalisation progressively threatens traditional agriculture and tourism may become a necessity to support the continuation of traditional production in rural areas[32].

People who tire of daily city life show tendency to visit natural sites. This kind of tourism enables people living in big cities to witness the rural life, to reflect on natural life in their life style, to get to know new customs and local cultures. This type of tourism is known as rural tourism and agro-tourism is a branch of rural tourism[33].

Rural tourism as a selective form of tourism includes a number of activities, primarily various services and additional facilities which are provided by rural population for the purpose of attracting tourists, generating extra revenue on behalf of relating family businesses, raising the standard of living, decreasing the outflow of rural households, all on the principles of sustainable development and preservation of the existing natural resources[12].

Wine tourism has been identified as a particularly appropriate rural tourism product by Van Ausdle[34]. Wine production can help rural areas redesign their economies through job creation for both wine production and the hospitality associated with fine dining[32].

Wine tourism, generally plays a pivotal role in attracting visitors to rural areas which, in turn, benefit local economies and communities[35]. Wine tourism can consist of visits to wineries, vineyards, and restaurants known to offer unique grapeharvesting events, as well as organised wine tours, wine festivals or other special events.

Wine trails have been part of the German tourism industry since the 1920s (Ref. 15). The oldest wine route in the world, the Deutsche Weinstrasse, opened on 19 October 1935 (German Wine Route). Today, Europe (which includes countries such as Spain, Italy, France and Germany) has a large number of wine trails that are organised by various profit and non-profit organisations[36].

In Turkey, the Thrace region is one of the most important region of vineyards. 'The Thrace Wine Route Project' organised by the Thrace Tourism Operators Association is the first one of its kind in Turkey and supported by 12 boutique wine producers. It is an important project to promote vineyards and rural economies. If these type of projects can be completed across the country, it would be an important step in the promotion of other major vine routes of our country and ultimately the development of a thriving enotourism intensity.

The European Union supports wine production in Europe with a budget of EUR 1.3 billion per year, which is about 3% of the total for agriculture[37]. However, our Ministry of Food, Agriculture and Livestock does not currently give any support to the production of wine grapes from its TL 5.4 billion annual support budget.

While wine production in Turkey has been neglected for years for various reasons (primarily religious ones) it can provide a significant contribution to our national economies as it has done in European countries. This can be clearly seen when considering the share of the wine sector in the gross domestic products of major wine producing countries such as Italy, France, Germany, Australia.

France, as one of the biggest wine producers of the World, is a top tourist destination attracting 83 million foreign tourists. 29% of all tourists visit the wine regions of France[38]. The Thrace region is mostly preferred for sea-sun-sand tourism during the high season of summer. Promoting wine tourism sector investments and enotourism opportunities will boost the rural development by making the region much more attractive to tourists throughout the year.

CONCLUSIONS

Enotourism events are seen to assist with social and economic development because it can increase business, income and employment in the region. Enotourism plays an important role to impede migration from the country side by establishing facilities like boutique hotels and restaurants. Regional touristic initiatives will make an important contribution to the solution of social problems associated with workforce development in the region.

Promoting enotourism in our country allows for the demonstration of multiple other local activities. While visiting the vineyards, wine producers allow people to walk through the vineyards, learn about the production process, harvest the grapes, taste wines, attend wine festivals, educational tours and cultural activities and discover the regional delicacies and gastronomy of Turkey. Thus, enotourism is important for the economical development of our country.

All the wine producers that we interviewed, work with local people and communities. This shows the importance of enotourism for regional employment. The development of enotourism is a very important opputunity in terms of the promotion of our cultural values (local architecture, regional foods, pension, agro-tourism, handicrafts, grapeharvesting tours, etc.) and allows local communities not only to earn money but also to exhibit other cultural traditions.

Today, the wine-producing sector in Turkey is troubled because of new regulations and the increase in excise duties on alcoholic drinks. Entrepreneurs who have come into this sector with huge investments can not sell their wines, which they have produced with high effort. It is not permitted to advertise and publicize these products over the internet either. Even those wines that have won medals at international competitions cannot be offered for tasting. Organising grapeharvesting tours has also been banned which had recently become quite popular.

Rural development related to the enotourism in Thrace Region depends on new regulations in development plans, master plans, legislations and an increase in sales and marketing opportunities.

REFERENCES

1. UNWTO (World Tourism Organisation): Why Tourism? Tourism – An Economic and Social Phenomenon. 2015. http://www2.unwto.org/content/why-tourism.
2. J. BRIEDENHANN, E. WICKENS: Tourism Routes as a Tool for the Economic Development of Rural Areas – Vibrant Hope or Impossible Dream? Tourism Manage, **25**, 71 (2004).
3. V. SMITH, W. EADINGTON: Tourism Alternatives: Potentials and Problems in the Development of Tourism. University of Pennsylvania Press, Philadelphia, 1992.
4. L. CHRISTOU: Is It Possible to Combine Mass Tourism with Alternative Forms of Tourism: the Case of Spain, Greece, Slovenia and Croatia. Journal of Business Administration Online, **11** (1), 1 (2012).
5. K. SILLIGNAKIS: Rural Tourism: An Opportunity for Sustainable Development of Rural Areas. 2001. www.sillignakis.com/PDF/Rural_Tourism_Finall_ALL.pdf.
6. Z. MIECZKOWSKI: Environmental Issues of Tourism and Recreation. University Press of America, Lanham, Maryland, 1995, p. 552.
7. R. LOBO: Helpful Agricultural Tourism (Agri-tourism) Definitions. 2001. http://www.sfc.ucdavis.edu/agritourism/definition.html.
8. E. P. LOPEZ, F. J. C. GARCIA: Agrotourism, Sustainable Tourism and Ultraperipheral Areas: the Case of Canary Islands, Pasos. Revista De Turismo Y Patrimonio Cultural, **4** (1), 85 (2006).
9. M. KUBAL, B. PIZIAK: Wine Tourism on Rural Areas – Polish Conditions after the Transformation. Journal of Settlements and Spatial Planning, **1** (2), 135 (2010).
10. M. TSANTOUKA, D. GEROMOSHOS, M. GOLUMBEANU: Agrotouristic Development in the Area of 'Nymfeo' – Florina, Greece. J Environ Prot Ecol, **4** (1), 160 (2003).
11. L. ROBERTS, D. HALL: Rural Tourism and Recreation: Principles to Practice. CABI Publishing, Cambridge, 2001.
12. M. MELER: Wine Tourism as a Centripetal Force in the Development of Rural Tourism. In: Proc. of the 3rd International Scientific Conference Tourism in Southern and Eastern Europe, Crotia, Vol. 3, 197–209, 2015.
13. R. MITCHELL, S. CHARTERS, J. ALBRECHT: Cultural Systems and the Wine Tourism Product. Annals of Tourism Research (Pergamon Press, UK), **39** (1), 311 (2012).
14. C. M. HALL, R. MITCHELL: Wine Tourism in the Mediterranean: a Tool for Restructuring and Development. Thunderbird International Business Review, **42 (**4), 445 (2000).
15. C. M. HALL, G. JOHNSON, B. CAMBOURNE, N. MACIONIS, R. MITCHELL, L. SHARPLES: Wine Tourism: an Introduction. In: Wine Tourism around the World: Development, Management and Markets (Eds C. M. Hall, L. Sharples, B. Cambourne, N. Macionis). Elsevier Science Ltd, Oxford, 2000.
16. D. GETZ: Explore Wine Tourism: Management, Development & Destinations, Cognizant Communication Corporation, New York, 2000.
17. G. BROWN, D. GETZ: Critical Success Factors for Wine Tourism Regions: a Demand Analysis. Tourism Manage, **27**, 146 (2006).
18. N. ORSOLINI, P. BOKSBERGER: Wine and Tourism – How can a Tourist Experience be Created? Bacchus Goes Green, Fourth Interdisciplinary and International Wine Conference, France, July, 2009.
19. M. MANILA: Wine Tourism – a Great Tourism Offer to Face New Challenges. Revista De Turism (Journal of Tourism), **13** (13), 54 (2012).

20. O. AZABAGAOGLU, A. AKYOL, A. OZAY: Examining the Turkish Wine Industry: Marketing Effectiveness and Recommendations for Increasing Its Competitive Performance. New Zealand Journal Crop and Horticultural Science, **34** (3), 257 (2006).
21. M. TOSUN: Wine Industry Research. Development Bank of Turkey Co., Directorate of Research, Ankara, Turkey, 2005.
22. TUIK (Turkish Statistical Institute): Basic Statistical Data of Agricultural Products. 2015. http://www.turkstat.gov.tr/UstMenu.do?metod=temelist**.**
23. FAO (Food and Agriculture Organization of the United Nations): 2012. http://faostat.fao.org/site/339/default.aspx.
24. WOT: Wines of Turkey Catalog, 2014. http://www.winesofturkey.org/wp-content/uploads/2012/10/Prowein2014Katalog.pdf.
25. VINOTOLIA: 2014; http://www.vinotolia.com/old_version/iframe/bolgeler.html.
26. A. SEMERCI: Thrace Region's Agricultural Structure, Productivity and Its Development Level. Journal of Agriculture and Engineering, TMMOB The Chamber of Agricultural Engineers Publications, 2006, 76–77.
27. S. KONYALI, T. KIPER: Effect of Climate Changes on Agricultural Product Quantity and Yield and Its Reflection on Sustainable Development. The Case of the Thrace Region. J Environ Prot Ecol, **13** (1), 392 (2012).
28. Tekirdag Directorate of Provincial Food Agriculture and Livestock: 2013, http://tekirdag.tarim.gov.tr/Sayfalar/Detay.aspx?SayfaId=47.
29. TDA (Thrace Development Agency): Master Plan. 2013–2023, 2013.
30. TTID (The Thrace Tourism Association): Thrace Wine Route Guidebook, 2013.
31. R. EVERSOLE, J. MARTIN: Jobs in the Bush: Global Industries and Inclusive Rural Development. Social Policy & Administration, **40** (6), 692 (2006).
32. L. SHERIDAN, A. D. ALONSO, P. SCHERRER: Wine Tourism as a Development Initiative in Rural Canary Island Communities. Journal of Enterprising Communities: People and Places in the Global Economy, **3** (3), 291 (2009).
33. C. TURKBEN, F. GUL, Y. UZAR: Importance of Viticulture in the Agricultural Tourism in Turkey. KMU Journal of Social and Economic Research, **14** (23), 47 (2012).
34. S. L. VANAUSDLE: Changing Times for Rural Prosperity through Wine, Food and Art. Community College Journal, **75** (6), 10 (2005).
35. D. DAWSON, J. FOUNTAIN, D. COHEN: Seasonality and the Lifestyle "Conundrum": an Analysis of Lifestyle Entrepreneurship in Wine Tourism Regions. Asia Pacific J Tourism Res, **16** (5), 551 (2011).
36. A. KIRKMAN: The Role of Wine Tourism in the Marketing of Wineries in the Stellenbosch Wine Route of South Africa. Master of Commerce, University of South Africa, 2010.
37. Commission of the European Communities, 2007. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52007PC0372.
38. France Diplomatie: 2013. http://www.diplomatie.gouv.fr/en/french-foreign-policy/economic-diplomacy-foreign-trade/facts-about-france/one-figure-one-fact/article/france-the-world-s-leading-tourist.

Received 11 February 2016
Revised 10 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *666–674* (*2016*)

Environmental protection and sustainable development

REGIONAL ACUPUNCTURE FOR IZMIR PENINSULA: CREATING CAPITAL WEB FOR CREATIVE ECO-TOURISM

K. VELIBEYOGLU

Department of City and Regional Planning, Faculty of Architecture, Izmir Institute of Technology, Izmir, Turkey
E-mail: *korayvelibeyoglu@iyte.edu.tr*

Abstract. Rural socio-economic development has gained utmost importance in Turkish Metropolitan Municipalities within the frame of recent legal changes extending the boundary of such municipalities towards their larger rural hinterland. Beforehand, Izmir Metropolitan Municipality had been started 'Izmir Peninsula Sustainable Development Strategy' in 2013 as a model of their local development agenda based on the principles of 'Urla-Cesme-Karaburun Peninsula Local Development Idea Competition' held in 2008. Izmir Peninsula region is the nature reserve for Izmir with its specific flora and fauna always considered as perfect location for eco-tourism activities. This paper aims to illustrate the development and implementation mechanisms of creative eco-tourism strategies for the region with concrete examples including thematic tourism routes based on green transportation, local production and consumption networks (i.e. local bazaars, family pensions) and special events aim to create local buzz and global pipelines. The major contribution of this study is to illustrate a model of networked integration strategy by using 'creative' eco-tourism opportunities of Izmir Peninsula Region. It exemplifies the key implementation mechanisms of regional acupuncture and capital web approach derived from the idea of network of local micro-projects working in synergy.

Keywords: creative eco-tourism, capital web, regional acupuncture, Izmir Peninsula.

AIMS AND BACKGROUND

Izmir Peninsula Region (IPR) lies on the western end of Izmir city (Fig. 1). IPR covers five county municipalities and 49 rural settlements approximately a population of 150.000 people lives in the region (out of 4 million in Metropolitan region). The region is considered as the nature reserve of Izmir metropolitan city which has preserved its natural and cultural landscapes and properties, historical references as well as traditional-rural lifestyle. Characterising typical Mediterranean transitional zone, IPR hosts remarkable/outstanding landscapes such as historic, traditional-rural settlements, coastal regions, microbasins, forests and wetlands. However, some ecological and socio-economic challenges stemmed from fish farms, wind energy plants, highway (cutting IPR into two and damaging wildlife), open cast mining, aging and youth migration, and misuse of agricultural fields and coastal environments[1].

The urban change in IPR can be described with consecutive waves in conjunction with the changes in big Turkish metropolitan cities and global changes affecting consumer behaviour and habits. In Izmir, IPR has experienced the emergence of suburban developments started from 1970s via massive amount of middle-class summer houses by housing cooperatives alongside with ecologically sensitive coastal areas. Therefore, rural-urban continuum harmed and this movement created many vacant houses for the time being.

Second wave, affecting the future development of region, started after 1990s due to changing global economic relations that have created new upper income groups and new consumption habits. Those upper-middle income groups in Turkey prefer new living environments at the peripheries of metropolitan cities[2]. Parallel to this, the construction sector in Turkey has become major economic sector, therefore, changing habits of urban elites have resulted in the suburban housing developments in Turkey and IPR as well. The construction boom in IPR strongly related with the Izmir-Cesme Highway that connects IPR to Izmir central area in 1992. Alongside with luxurious consumption and new infrastructure investments, this uneven development also brought greater accessibility to the region and permanent dwellings, commuters from Izmir central business districts to IPR. In this decade, in relation to tourism development, small town identity has gained great popularity, Alacati and Seferihisar (joined Citta Slow Network in 2010) brought flagship of rebranding of IPR 'small is beautiful'[3].

Third wave brought two main development agenda to IPR:

● Reorganisation of Turkish metropolitan municipalities: In 2013, Act on New Metropolitan Municipality (No 6360) incorporates all existing town municipalities, villages and rural territory were merged. Therefore, once known as villages (köy), rural administrations have been abolished and connected to the metropolitan district municipalities (ilce belediye) and renamed as neighbourhood (mahalle) of those districts. Five district municipalities covered 49 villages in IPR try to figure out newly connected settlements peculiar needs and administrative necessities. The law also defines those new responsibilities of Metropolitan Municipality and metropolitan district-municipalities to fulfill the former rural settlements major economic necessities such as agriculture and animal husbandry. To support rural economies, creating new agricultural projects, producing regular activities for farmers well-being, and constituting partnerships with local economic and social actors are encouraged with the new law.

● Urla-Cesme-Karaburun Peninsula Local Development Idea Competition: Long before the recent legal arrangements, Izmir Metropolitan Municipality held a local development idea competition in 2008. The aim was to provide local sustainable development of the region with excessive care to their natural and cultural assets. Then, it took six years to realise and renew original competition ideas into strategic documents via 'Urla-Cesme-Karaburun Peninsula Sustainable

Development Strategy 2014–2023', as a subsequent part of Izmir Regional Plan produced by Izmir Regional Development Agency[4]. In sum, Izmir Metropolitan Municipality has decided to implement key actions of this strategy document as a model example of local economic developments.

The main idea asserted here is that rural or suburban regions are not places of isolation and deprivation, by innovative asset-based approaches, it can restore the healthy continuum between urban and rural. Therefore, the aim of the paper is to illustrate creative eco-tourism implementation efforts in order to exemplify the process of creating synergy management derived from various theoretical approaches including 'capital web' and 'regional acupuncture'.

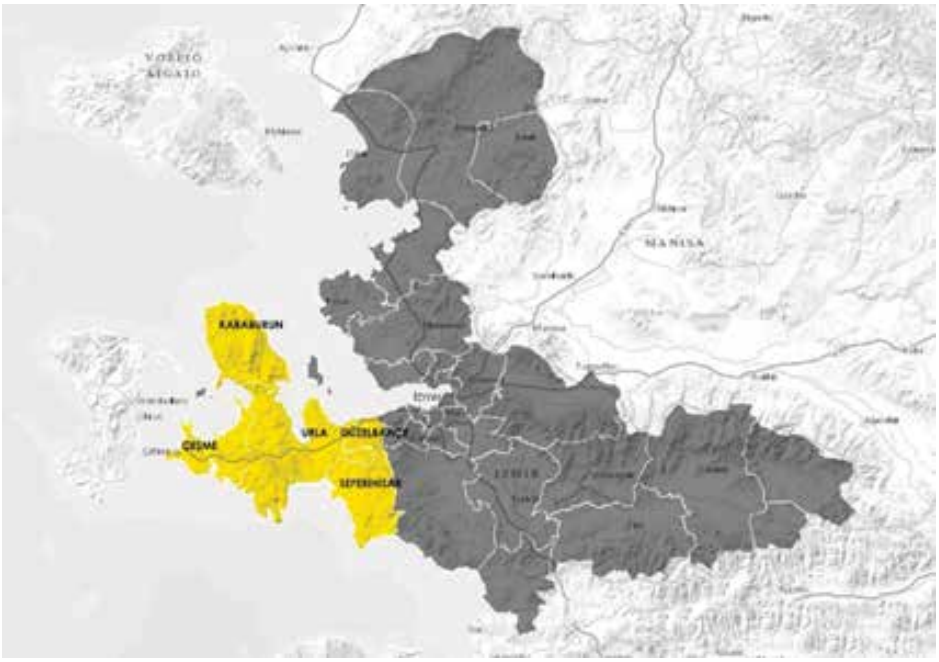


Fig. 1. Location of IPR in Izmir

CREATIVE ECO-TOURISM

Today local development agendas meet creative economy, experience economy and sharing economy that imply users attitude towards consuming to collaborating the surrounding environment. The terms 'creative class'[5] and 'creative tourism'[6] have brought new possibilities to various fields including eco-tourism that need to be expanded beyond the commonly agreed borders.

According to Florida[5], members of the creative class prefer more active, authentic and participatory experiences such as rock climbing or cycling. They

prefer an authentic place when travelling offering unique and original experiences. Many increasingly define the quality of their lives by the quality of experiences they consume. The typical tourist attractions such as theme parks, sport stadiums are irrelevant to many creative class people: 'What they look for in communities are abundant high-quality amenities and experiences, an openness to diversity of all kinds, and above all else the opportunity to validate their identities as creative people'[5]. Florida depiction of creative class implies so-called creative tourists whose values celebrate the new experience landscape mainly based on respectful and sustainable use of natural resources and cultural assets[7].

UNESCO[8] defines creative tourism as 'travel directed toward an engaged and authentic experience, with participative learning in the arts, heritage, or special character of a place, and it provides a connection with those who reside in this place and create this living culture'. Similarly, Richards[6] describes four distinct elements implied within the frame of creative tourism: creative potential, active involvement, characteristic experiences and co-creation. The path of experience, as Richard[6] outlines, follows the isolated experiences of individuals towards the supporting networks necessary for successful experience production as a part of communities of practice largely via social media and other open source and crowd-sourced platforms. Therefore, networks are increasingly necessary for the creation and distribution of products and experiences[9].

Aside from demand side, creative/responsible tourist mentality may reduce and help to renovate the fragile natural and local cultural systems which is utmost important in the creative understanding of eco-tourism. As highlighted in the definition of eco-tourism 'responsible travel to natural areas that conserves the environment, sustains the well-being of the local people'[10] requires innovative way of seeing natural environment as creative ecosystem (an active entity not the passive one). Sustainable tourism covers all this human interaction with nature based on environment preservation goals[11]. On the contrary, the global development of mass tourism activities has brought negative impacts to host cities and regions that cause degradation of natural reserves, commercialisation of culture, noise, pollution and waste and rising cost of services. These adverse effects on natural and cultural assets are no exception occurs in IPR as summarised in its development trajectory.

CREATIVE ECO-TOURISM EXPERIENCE IN IPR

IPR has no industrial or agricultural character. Cesme is the top national and international tourism destination in IPR. Karaburun has known as potential eco-tourism destination due to its unique natural assets in the region (i.e. Mediterranean monk seal). Seferihisar became famous because of its Citta Slow (Slow City) label. Guzelbahce locates various private colleges and special education institutions. Urla

is a growth pole in IPR and is mixed with housing, tourism, health, and education. Therefore, IPR is expected to rise in services industry, especially in education, tourism and health[12].

This section covers specific strategic actions of 'Urla-Cesme-Karaburun Peninsula Sustainable Development Strategy 2014–2023'. Izmir Metropolitan Municipality and associated metropolitan-district municipalities in IPR have coped with the implementation process of prioritised asset-based local development ideas mainly at the intersection of agriculture and tourism.

In terms of eco-tourism potential, Urla, Cesme and specifically Karaburun in IPR have gifted by valuable natural and environmental assets. There are micro-regions fit for potential organic farming areas requiring suitability analysis to uncover this reserve (for systematic study in this field see Ref. 13).

For the physical networks, thematic routes designed to connect various natural and cultural assets in a network:

● Cultural route: It connects historical and cultural sites throughout IPR that is considered as the backbone of all thematic routes.

● Wine route: It covers the cluster of wine producers mainly in Urla region (as flourishing wine region) and extended to other parts of IPR.

● Olive route: Olive trees have been cultivated throughout the region. Like wine production olive trees and olive oil are characteristic symbols of Mediterranean Basin. In IPR, one of the earliest olive oil production facilities can be found in ancient Klazomenai. Olive route connects ancient olive oil workshop to olive oil production sites as a part of region industrial heritage, olive museum to listed olive trees.

For the purposes of local development strategy aims of these routes are threefold (3E):

● Providing additional income (Economy): Establishing these thematic routes, elder population of IPR may find opportunities to sell relatively small scale but authentic agricultural and local cultural products to eco-tourists without searching costly and high end promotional efforts.

● Reducing ecological footprint (Environment): All thematic routes have been designed according to environmentally sustainable modes of transportation including hiking, cycling and sailing, each of which considered as integral part of regional and international networks. To this end, Izmir Metropolitan Municipality has applied to European Cycling Federation for Eurovelo Routes connecting whole European region to each other as a part of cycling tourism.

● Enriching local knowledge (Experience): Non-motorised transportation choice in IPR may have increased contacts to the local culture, local cuisine, local economy, local interaction, and natural environment that basically leads to enhanced social learning and more enriching experiences.

At the functional networks, namely as production and consumption networks, culture of local bazaars in IPR and potential old houses as family pensions in villages are aimed to mobilised. Local bazaars based on local farmers market, antiques and night bazaars are carefully mapped for promotion. Also the establishment opportunities of new ones are explored, rules and regulations are defined based on readily experiences in IPR and near vicinity such as Foca Slow Food Earth Market. These efforts are celebrated in Europe within the frame of multifunctional farming in which young and women farmers are given utmost priority. At the same time, building inventory is created and municipality supported courses are arranged for volunteer villagers to exploit opportunities in various thematic routes specifically designed for IPR.

Individual networks are subjective in nature and based on their preferences. Choices of creative tourist or eco-tourist have influenced by re-arrangement of events or creation of totally new ones adjusted to strengths of local natural and cultural assets. For instance, wine route is suggested to connect with an international network such as European Wine Cities. Recently, Izmir has joined DELICE Network of Gourmet Cities including 23 cities leading in gastronomy worldwide. Urla, one of the central cities in IPR arranged a local food event this year by using the strength of this network and more on the way. Seferihisar has already the part of Citta Slow (Slow City) network and gateway to other cities in Turkey. Karaburun, economically the least developed settlement in IPR, wants to protect its natural assets and Karaburun City Council (formerly Local Agenda 21) published a report clarifying why Karaburun is eligible for UNESCO Biosphere Reserve Network. Despite its strong claim Karaburun is tackling with massive wind energy investments that have paid no attention to local decision making mechanisms. Above all, this layer can be best incorporated with soft networks such as social media, national and international events and ecological communities that creates 'visibility' to promote and protect valuable natural and cultural assets.

RESULTS AND DISCUSSION

Synergy management is the key to integrate all these networks to produce catalytic effect in the development of creative eco-tourism development opportunities in the region. Since the main strategy is to connect local assets into a network, David Crane concept of the 'capital web' and related idea of 'regional acupuncture' may help to improve the synergy management framework.

The original idea of capital web comes from urban design indicating all movement channels (i.e. public transport systems), the public realm (streets, squares, parks) and public buildings as the manipulator, controller and guiding influence on city form[14]. The primary focus of the capital web is on the richly configured movement and green space networks interwoven to create as many qualitatively

different places and locations as possible. Chosen infrastructure is in fact a key to future development of eco-tourism opportunities in IPR. For instance, the conscious choice of sustainable and green transportation modes is the solid proof of this idea. Therefore, capital web can be seen as backbone, a major determinant of various local asset-based projects and applications.

Capital web approach could be operational whether the identification and selection of structurally and symbolically significant locations can be found. It creates an infrastructure that paves the way for different micro-scaled, asset-based local development projects. This resembles to operating rule of networks (nodes and links) that if there are good and plenty of links, the node is powerful. These nodes can be accepted as points of intensity suited to functional, experiential and symbolical meanings although each of which might be suited to specialised or a relatively limited range of uses. Those conscious investment of capital web brought legibility, identity and choice to its underlying geographical places. Creating capital web link local natural and cultural assets more effectively, facilitating new connections, supporting idea development and providing small, catalytic micro-projects.

Individual networks should not be fully managed but influenced like acupuncture hot spots securing to total wellness of the system and hence the creation of synergy. Therefore, one alternative implementation strategy could be regional acupuncture, involves small-scale and low-impact development harmonious with the local asset base. When we think of regional acupuncture in IPR, there are rural settlements with specialties, authentic products and experiential services to develop, as the structurally significant nodes in a capital web of 'small-scaled settlements' (Fig. 2). The promise of small-scaled settlements is their distinctive character such as accessible places, identity, sociable and tasteful way of life[3]. Via regional acupuncture approach these small-scaled settlements might be resistance to change agents against the rapid and uncontrolled tourism development depended on globalisation process.

So, where will be start? How a capital web of local micro-projects working in synergy? If you have accepted regional acupuncture based on small, sparingly and speedy interventions, their management becomes important. One alternative is called the 'Stepping Stones' approach, of starting with the easy and simple ones instead of the tough problems involving many actors. If it is useful, then you increase the capacity. If that is also successful, then you widen the scale to a whole capital web. Of course, there can be similar and widely known strategies. One is to 'Keep It Small and Simple' (KISS), which advises one step at a time. Another similarly bottom-up approach is the rather popular 'Snowball', 'Domino' or 'Butterfly' effect. This small scale and reversible strategy could be much more effective if extended, creates snowball effect or what might called here is synergy.

Creativity needs its own ecosystem: creative ideas and creative environments to emerge, develop and progress. Therefore, to extend creative eco-tourism activities

in IPR its capital web should carefully be structured within the guidelines of active involvement, characteristic experiences and co-creation. Each small or micro-scale projects should be the source of social innovation. This implies bottom-up structure based on a network of creative hot spots that is organic and that can be developed at a time by local people with adequate social capital.

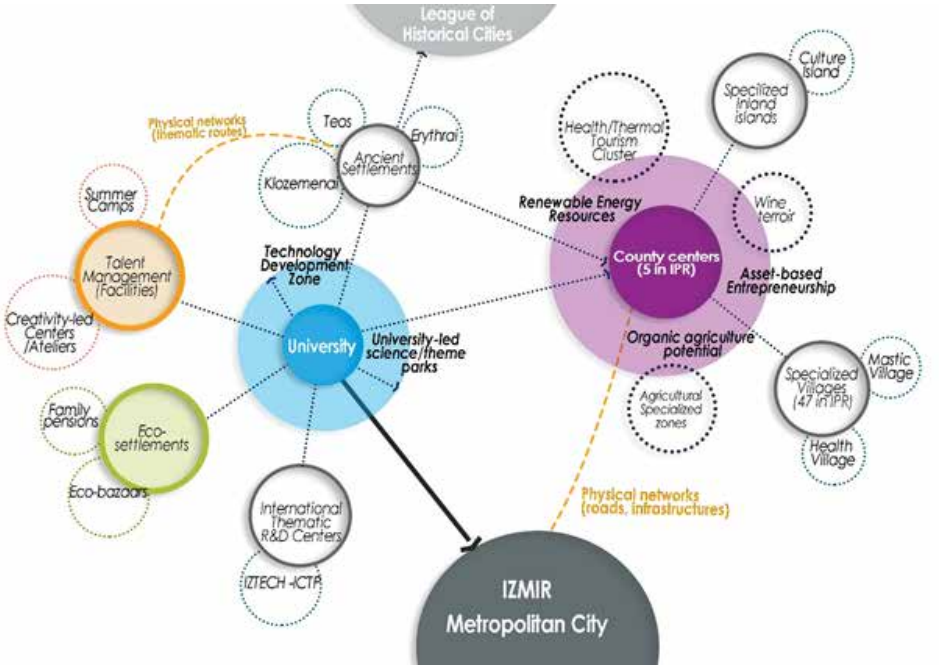


Fig. 2. Structurally significant nodes as regional acupuncture points in a capital web

CONCLUSIONS

In this study, opportunities of the creative eco-tourism development within the case of IPR. Operating in such a multilayered network Crane capital web and concept of regional acupuncture were employed as alternative bottom-up strategies to extend the influence of efforts exemplified in IPR.

The capital web here delivers a backbone that supports activities in functional network (social and community facilities, trading and manufacturing facilities, etc.) and individual network that enables visibility of the region; and providing a regional acupuncture hot spots it creates an environment that offers pride of place to its inhabitants.

Synergy management has become valuable in terms of stocking valuable local assets, developing complementary products and services and sharing additional possibilities throughout the region. To foster sustainable development, the power of

an interrelated 'quad' of actors (public, private, civil, and academic) needs to draw on synergy management. Within this frame, civil society is important. NGOs or local development cooperatives are the most familiar with conditions on the ground in rural and urban communities. Therefore, further research should be to focus on in-depth understanding of civil society inclusion mechanisms (i.e. place-based leaders) in order to mobilise valuable local assets into the value-added capital web.

REFERENCES

1. A. KAPLAN: Urla-Cesme-Karaburun Peninsula Sustainable Development Strategy 2014–2023: Asset-based Local Development with a Focus on 'Sustainable Landscape – Rural Life and Economy' Equilibrium. Council of Europe, European Landscape Convention, Fifteenth Council of Europe Meeting of the Workshops for the Implementation of the European Landscape Convention, Nevsehir, Turkey, 2014.
2. I. SONMEZ: Re-emergence of Suburbia: The Case of Izmir Turkey. Eur Plan Stud, **17** (5), 741 (2009).
3. I. INCE, K. VELIBEYOGLU: Creative-based Tourism Development in Small Scale Towns: A Case of Alacati. In: Proc. of the AESOP Annual Congress, July 13–16 2015, Prague, Czech Republic, 2015.
4. K. VELIBEYOGLU, S. OZDEMIR, A. BABA, Z. D. ARSAN, H. YAZDANI, D. HAZAR, A. KAPLAN, M. BOYACI, Y. KURUCU, N. ERDOGAN, O. YILDIZ, H. ERKAN, E. AFSAR, S. ERSIN, S. C. OGUZ, F. M. INELER, H. ULUSOY: Urla-Cesme-Karaburun Peninsula Sustainable Development Strategy 2014–2023. IZKA (Izmir Development Agency) Publication, Izmir, 2014.
5. R. FLORİDA: The Rise of the Creative Class. Basic Books, New York, 2002.
6. G. RİCHARDS: Tourism Development Trajectories – from Culture to Creativity? In: Proc. of the Asia-Pacific Creativity Forum on Culture and Tourism, Jeju Island, Republic of Korea, 2009.
7. R. KOREZ-VİDE: Promoting Sustainability of Tourism by Creative Tourism Development: How Far is Slovenia? Innovative Issues and Approaches in Social Sciences, **6** (1), 77 (2013).
8. UNESCO: Creative Cities Network, 2006.
9. G. RICHARDS: Creative Tourism: Development, Trends and Opportunities. Barcelona, 2010.
10. TIES: What is Ecotourism?, The International Ecotourism Society, Accessed at: http://www.ecotourism.org/what-is-ecotourism, 2015.
11. E. SHKIRA, D. HORANLLI: Sustainable Tourism Development in Albania. Environmental Damages of Some Tourists Places in the Korca Region. J Environ Prot Ecol, **12** (3), 1068 (2011).
12. K. VELİBEYOGLU: The Potential Values of Eryhtrai/Ildiri: An Introduction to the Regional Framework of the Intensive Programme. Lecture was held at ERASMUS IP Archaeological Landscapes, Izmir Institute of Technology, Urla, 2013.
13. E. TOK, F. PEKER, Y. KURUCU, H. H. TOK, E. SAYGİLİ: Determining and Mapping the Potential Organic Farming Areas in Istanbul. J Environ Prot Ecol, **14** (2), 675 (2013).
14. M. CARMONA, T. HEATH, T. OC, S. TiESDELL: Public Places Urban Spaces. Architectural Press, 2003.

Received 11 February 2016
Revised 12 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 675–680 (2016)

Environmental protection and sustainable development

IMPORTANCE OF VISITOR MANAGEMENT IN NATIONAL PARK PLANNING

E. DUZGUNES*, O. DEMIREL

School of Forestry, Department of Landscape Architecture, Karadeniz Technical University, 61 080 Trabzon, Turkey
E-mail: *ertanduzgunes@gmail.com*; *odofe01@gmail.com*

Abstract. With the increasing attention in the natural areas in recent years, especially the national parks have become focus of interest thanks to natural, cultural and historical resource values they embrace. These areas, which enable various forms of recreational and touristic activities, are under threat because of uncontrolled flow of visitors. Although they have been under protection through enacted laws, the continuous destruction on the resource values of the areas that lack visitor management plans is indispensable. The effects of recreational and touristic activities conducted especially in national parks can be biophysical, social and economic in nature. Therefore, visitor management is crucial in these areas for the sake of the continuity of sustainable utilisation. In the current study, the importance and effects of visitor management in the scale of the national parks of our country is stated, and suggestions are made in terms of relevant legislation.

Keywords: visitor management, national parks, national park planning, recreation, tourism.

AIMS AND BACKGROUND

National parks, which constitute an important place among protected areas, serve as a source of information for ecology, geology, biology, medicine, chemistry and behavioural sciences. They especially play a key role in preservation of biological diversity. In our present day, unfortunately, damages and deteriorations caused by the utilisation of visitors are increasing in national parks, which have become the focus of interest for both domestic and foreign visitors along with the rise of alternative tourism trend. Soil compaction, loss of vegetation, extinction of wild life or being under threat of extinction, and impairment of the balance of water and food are some examples of the destruction taking place in national parks[1–8].

National parks, which enable various types of recreational and tourism activities thanks to natural and cultural resource values they have, do contribute both to local and country economy by hosting a great number of visitors. However, uncontrolled visitor flow can cause irreparable damages on the resource values. Thus, environmental protection plays an importance role in sustainable development[9], local and country economy.

* For correspondence.

There is a delicate balance between touristic return and the sustainability of the resource values. In other words, the existence of the resource values ensures the continuity of economic gains. Aggressive tourism practices have various irremediable effects to these resources because of lack of protective plans[10]. Therefore, various management strategies have been developed, beginning from 1964, to maintain the sustainability of the resource values and to protect the biological diversity.

Management is defined as the collaboration of the related people in order to attain the goal of efficient use of the resources against the changing environmental conditions[11]. Protected area management, on the other hand, can be perceived as the management of the resource values in the protected areas in an efficient and sustainable way through certain strategies and action plans[12]. The notion of management in the protected areas was first mentioned in 1972, in the 2nd World Parks Congress. During the congress, it was advised to draft an annual park environmental report that would examine the internal and external environmental factors affecting national parks and reveal the actions to improve the conditions[13]. The following are the basic principles in management planning of the protected areas[14]:

- To maintain the sustainability of resource values by protecting them;
- To efficiently use the scientific data in any sort of investment and utilisation;
- To generate the institutional structure that will enable sector-specific coordination;
- To minimise or eliminate the pressure and impact on the resource values;
- To maintain public involvement in the planning and decision-making processes.

One of the new methods and approaches developed peculiar for the protected areas is the visitor management. In the current study, the importance and effects of visitor management in the scale of national parks is explained and further suggestions are made in respect to legal regulations.

VISITOR MANAGEMENT AND ITS IMPORTANCE

Visitor management is a management plan that lets visitors gain quality experiences with a sustainable environmental attitude, and that tries to realise visitor satisfaction about different experiences along with sustaining the qualities of the environment[15]. Impacts caused by utilisation of visitors can be minimised through this management strategy, which has been developed based on carrying capacity.

Basic goals of visitor management are[16]:

- To increase the consciousness of the visitors and ensure the acknowledgement of the values of natural areas or regional resources;

● To spread the messages that contain natural and historical processes, ecological interactions and human activities;

● To enable people to spend time in natural places where they can have personal experiences with natural and cultural environments;

● To ensure elaborate use of natural resources, protect cultural and natural heritage and minimise negative effects while increasing positive ones;

● To decrease seasonality;

● To include the experiences of the local people in the application;

● To provide meaningful experiences for visitors and make them feel that they are actually in a special environment;

● To increase governmental support and understanding for management issues and for peculiar policies.

The following are the major ways in visitor management as stated in the report on the interaction between visitors and the environment published by UK Ministry of Environment, the Department of Employment and the English Tourist Board (ETB) in 1991 (Ref. 17):

● Limiting the visitor capacity and distribution;

● Maintaining compatibility of the visitors with the resources and minimising the harms;

● Changing the behaviours of visitors.

Impacts of visitors may be biophysical or social in protected areas, especially in national parks[18]. Intensity of visitors, traffic and parking lot problems in parallel with that, deterioration of the vegetation caused by over-treading, accompanied with soil compaction, threats and pressure on wild life, spoilage of water sources, erosion and negative impacts on the local people can be mentioned as examples of the pressure factors on the carrying capacity.

Many parks around the world are under threat due to over-utilisation and inadequacies in management. Though not being in our country, many studies done abroad revealed that models that have been developed for visitor management resulted in very desirable yields[19–22]. All of those models aim at protecting and improving the resource values, and they have been shaped by the legislative, social and cultural conditions of the USA and Europe[23].

In order that a visitor management model is successful, it must follow a visitor-oriented approach, considering the balance between protection and utilisation, having an infrastructure supported by legislative regulations. In this scope, a flexible and transparent decision making process which includes various information and precautions like complex and dynamic structure of natural resources, environmental, economic, ecologic, technologic and social factors is required[24].

DISCUSSION AND CONCLUSIONS

One of the new methods and approaches developed for the sake of eliminating the visitor-induced damages caused in protected areas is the visitor management method. In this visitor-oriented method, different types of people coming from different cultural backgrounds must leave well-satisfied when they come to visit such protected areas. Therefore, a management model taking the differences into account needs to be formed. Arrangements must be made with great care and preciseness in this management model.

Management planning is generally made through such classical planning approaches as Long Term Development Plan, and Environment Planning and Development Plan. The authorised bodies in these are the Ministry of Forestry and Water Affairs, and Ministry of Culture and Tourism. However, scrutinising the planning processes reveal that centralist structure could not be truly broken in all 40 national parks announced, except for Kure Mountains National Park, as long term development plans implemented are not user-oriented and they did not include visitor management. It is observed that principles were identified and decisions were taken merely for the sake of determining the areas where the visitors would conduct their touristic activities and the ways in which they should be directed.

The new management understanding in the developed countries embraces the participatory approach that considers the utilisation-protection balance. Nevertheless, there is not a consensus across the world about the level of participation, the qualities of the participants, and the time when they should be realised. Yet, according to Ref. 25, the list of participants include the local people living in or nearby the protected area, visitors, persons, institutions or companies that are affected by the management, special interest groups, local, national and international institutions and associations that deal with nature protection, governmental bodies, local authorities and other relevant entities. As a result of all these, it is a must to define the objectives of management clearly, to determine the relevant parties to be included in the decision making process and accordingly reflect their opinions to the planning decisions.

Turkey, too, is pushing hard to keep up with the new ideas and opinions arising in the new globalising world order. Therefore, numerous legislative and administrative regulations have been introduced. However, it is clear that the proposed management models would vary depending on the legal, social and cultural conditions of every country in respect to actual implementation. So, in order to be able to make efficient and applicable management plans, the legislation – both laws and administrative decisions – should be revised, and efficient and an actually applicable visitor management plan, which is compliant with the legal, social and cultural conditions of our country, being participant-oriented and considering the balance of utilisation-protection, should be put into practice.

REFERENCES

1. D. J. PARSONS, S. A. MACLEOD: Measuring Impacts of Wilderness Use. Parks, **5** (3), 8 (1980).
2. B. SHELBY, J. J. VASKE, T. A. HEBERLEIN: Comparative Analysis of Crowding in Multiple Locations: Results from Fifteen Years of Research. Leisure Sci, **11**, 269 (1989).
3. J. BELNAP: Soil Surface Disturbances: Their Role in Accelerating Desertification. Environ Monit Assess, **37**, 39 (1995).
4. J. BELNAP: Soil Surface Disturbances in Cold Deserts: Effects on Nitrogenase Activity in Cyanobacterial-Lichen Soil Crusts. Biol Fert Soils, **23**, 362 (1996).
5. J. BELNAP: Choosing Indicators of Natural Resource Condition: A Case Study in Arches National Park, Utah, USA. Environ Manage, **22** (4), 635 (1998).
6. J. L. MARION, T. A. FARRELL: Managing Ecotourism Visitation in Protected Areas, Ecotourism: a Guide for Planners and Managers. Ecotourism Society, North Bennington, Vermont, 1998.
7. Y. F. LEUNG, J. L. MARION: Spatial Strategies for Managing Visitor Impacts in National Parks. Journal of Park and Recreation Administration, **17** (4), 20 (1999).
8. A. FARRELL, J. L. MARION: The Protected Area Visitor Impact Management (PAVIM) Framework: A Simplified Process for Making Management Decisions. J Sust Tour, **10** (1), 31 (2002).
9. G. ORZAN, L. A. BOBOC, I. BURGHELEA, L. D. STUPU: The Power of Interconnectivity in Intelligent Technologies as a Way to Increase Environmental Protection Awareness and Implication. J Environ Prot Ecol, **16** (3), 1070 (2015).
10. O. KURDOGLU: Effect of Traditional Highland Settlement Texture on Visual Carrying Capacity: Kackar Mountains National Park Case. J Environ Prot Ecol, **16** (2), 771 (2015).
11. M. YUCEL: Protected Areas and Management, Landscape Management. Institute of Turkey Middle East Public Administration Publication 35, Local Government Center Publications 27, Ankara, 2009.
12. E. DUZGUNES: A New Model Proposal for Visitor Management in Planning National Parks: Case of Altindere Valley National Park (Macka/Trabzon). Ph.D. Thesis, Institute of Natural Sciences, Karadeniz Technical University, Trabzon, 2015.
13. M. HOCKINGS, S. STOLTON, N. DUDLEY: Management Effectiveness: Assessing Managements of Protected Areas. J Environ Policy Plan, **6** (2), 157 (2004).
14. F. DEMIRAYAK: A New Approach for Protected Areas in Turkey: Collective Management. Ph.D. Thesis, Institute of Social Sciences, Ankara University, Ankara, 2006.
15. S. AKTEN: Visitor Impact Management in Protected Natural Areas (Case of Golcuk Nature Park), M.Sc. Thesis, Institute of Natural Sciences, Süleyman Demirel University, Isparta, 2009.
16. S. AKTEN, A. GUL. M. AKTEN: Visitor Impact Management Approach Model in Protected Natural Areas' Participant Management Plan. International Davraz. Congress on Social and Economic Issues Shaping the World's Future: New Global Dialogue, Isparta, 2009, 1577–1590.
17. P. MASON: Visitor Management in Protected Areas of the Periphery: Polar Perspectives, Tourism and Hospitality. Plan Develop, **2** (3), 171 (2005).
18. F. GIONGO, J. BOSCO NIZEYYE, N. WALLACE: A Study of Visitor Management in the World's National Parks and Protected Areas. Ecotourism Society, 1994.
19. J. ABSHER: Applying the Limits of Acceptable Change Model to National Park Service Wilderness: an Example from Cumberland Island National Seashore. In: Proc. of the 1988 Southeastern Recreation Conference, 1989, 143–152.
20. A. R. GRAEFE, F. R. KUSS, J. J. VASKE: Visitor Impact Management: the Planning Framework. National Parks and Conservation Association, Washington, DC, 1990.

21. R. MANNING, D. LIME, M. HOF: Social Carrying Capacity of Natural Areas: Theory and Application in the US National Parks. Nat Area J, **16**, 118 (1996).
22. J. VASKE, M. DONNELLY, B. SHELBY: Establishing Management Standards: Selected Examples of the Normative Approach. Environ Manage, **17**, 629 (1993).
23. S. AKTEN, A. GUL. M. AKTEN: Visitor Management Models and Their Comparison Used in Protected Natural Areas. Suleyman Demirel University Journal of Forestry Faculty, **13**, 57 (2012).
24. C. F. DADASER, U. OZESMI: Method of Participant Management Plan for the Salt Lake Ecosystem: Fuzzy Cognitive Mapping Approach. In: Proc. of the 4th National Environmental Engineering Congress, 7–10 November, Mersin, 2001, 10–15.
25. ANONYMOUS: Landscape Character Assessment, Guidance for England and Scotland. Edinburgh, England, 2002.

Received 11 February 2016
Revised 18 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 681–686 (2016)

Environmental protection and sustainable development

IgG AVIDITY TEST FOR DIAGNOSIS OF ACUTE *Toxoplasma gondii* IN PREGNANT WOMEN

E. ABAZAJ*, E. FERATAJ DELIU, O. PETRI, L. SHUNDI, B. HYSAJ (VILA), E. ALI, S. XINXO, M. TANKA, S. QYRA

Control of Infection Disease and Epidemiology Department, Institute of Public Health, Tirana, Albania
E-mail: *abazajerjona@gmail.com*

Abstract. *Toxoplasma gondii* is an obligate intracellular parasite with a worldwide distribution. Toxoplasmosis is well known as an important infection in pregnant women. Detection of *T. gondii*-specific antibodies is the most common approach used to identify toxoplasmosis. The aim of the study was to detect the Toxoplasma IgG antibodies developed at the early stage of infection in pregnant women for distinguishing recent from past toxoplasmosis. Anti-toxoplasma IgM, IgG and IgG avidity were evaluated by ELISA method (Bio Rad kits). In total 152 pregnant women, who were in first months of their pregnancy (3–12 weeks), enrolled in this study. In the total the prevalence for Toxoplasma infection for IgG antibody were 31.6%. And for IgM antibody, 5.9% of them resulted positive. Average age was 27 years (min < 17year, max 43 years). All pregnant women which resulted with IgG+, IgM+, 5.9% in total were tested for IgG avidity. 3.3% of them had low avidity that revealed an active infection in the pregnant women. All other cases presented high avidity. The presence of high avidity IgG essentially excludes the possibility that infection occurred within the previous five months. This is an indication that in our population the level of toxoplasmosis infection is high and most women have had contacts with this parasite before pregnancy. Application of IgG avidity is a significant test in diagnosis of acute infection especially in cases of pregnant women.

Keywords: Toxoplasmosis, IgG avidity, pregnant women.

AIMS AND BACKGROUND

Toxoplasma gondii is an obligate intracellular protozoan parasite. Toxoplasmosis infection caused by this protozoan is one of the most prevalent chronic infections in humans. More than 10^9 people having chronic infection[1,2]. Acquired of Toxoplasmosis in immunocompetent patients are generally asymptomatic infections, but in some patients this infection can be associated with self-limited symptoms like: cervical lymphadenopathy, fever, malaise or ocular disease[3]. For some other patients diagnosis of Toxoplasmosis was more critical. Four groups can be mention: (a) pregnant women: an acute *T. gondii* infection in early pregnancy carries the risk of transmitting the infection to the foetus with serious consequence; (b) foetus and newborns who are congenitally infected by their mother during the

* For correspondence.

gestation; (c) immunocompromised patients, and (d) those with chorioretinitis[3–6]. Infection occurred during the period of pregnancy and its transmission to the foetus through placenta continues to be the cause of tragic yet preventable disease in the offspring[7]. The majority of infants infected by toxoplasmosis (congenital transmission) appear to be healthy at birth, but significant long-term consequence may become evident after birth, the first year of life ore adolescence. Some of the severe consequences of congenital transmission are mental retardion, epilepsy and most of cases cause blindness. As reason of this infection unfortunate outcome for infants and children are the emotional and economic burden faced by the parents, governments and society.

France applies a National Program for detection and treatment of this infection. This program has reduced the rate and consequence of congenital infections[8,9].

In recent years a number of new methods are proved to be a great value in diagnosis of *T. gondii* as infection in pregnant women, foetus and newborn. The first diagnosis is based to the serological test (detection of antibodies IgM and IgG)[10,11] and after that IgG avidity, PCR and western blots help in laboratory diagnosis of infection. The development of IgG avidity assays has revolutionised serological diagnosis of Toxoplasma infections. The measurement of IgG avidity has shown its power in various clinical settings, especially in situations where timing and differentiation of primary and secondary infections is crucial. The impact of IgG avidity measurement will be helped clinicians for diagnosis of 5 clinical scenarios: acute acquired infection, primary infection during pregnancy, congenital toxoplasmosis, ocular toxoplasmosis and toxoplasma infection in immunocompromised patients. The aim of the study was to detect the Toxoplasma IgG antibodies developed at the early stage of infection in pregnant women for distinguishing recent from past toxoplasmosis.

EXPERIMENTAL

For each pregnant woman were collected 5 ml blood in one vacutainer during two years (January 2011–December 2012). In total 152 pregnant women, were tested for anti-toxoplasma IgG and IgM. This study samples enrolled pregnant women at first months of their pregnancy (3–12 weeks). Also we have enrolled in this study and pregnant women that presented clinical signs and symptoms suggestive for toxoplasmosis during their pregnancy. A questioner was filled for each participant in the study. Sera initially were analysed for the presence of toxoplasma specific IgG antibodies for determinate the immune state of each participant. After that all pregnant women were tested for the presence of toxoplasma specific IgM to determine if one of them present an acute infection. Pregnant woman with toxoplasma specific IgG and IgM positive were evaluated for IgG avidity. ELISA method (Bio Rad kits) was used during this study.

RESULTS AND DISCUSSION

Out of 152 pregnant women participate in this study, average age resulted 27 years. Min age was < 17 years old and max 43 years old) were enrolled in this study. They were at first months of their pregnancy range 3 to 12 weeks at time of specimen collection. The mean length of pregnancy was 8.2 weeks. From calculate of questioners about socio-demographic characteristics, 118/152 pregnant women live in urban area and other 34/152 in rural area. Single women resulted only 5/152 and other was married 147/152. In our study were enrolled and 14 pregnant women with clinical manifestation for *T. gondii*, other women were without clinical manifestation. Most of pregnant women have done Secondary and Higher education. Toxoplasmosis disease is caused by drinking water or eating food, contaminated with excrements of an infected animal; the cats, eating contaminated rodents are an important reservoir of the disease[12]. Majority of them have contact with the pets like cat and dog (Table 1).

Table 1. Socio-demographic characteristics and seroprevalence of *T. gondii* among study participants

Characteristics of pregnant women	Number (=152)	IgG positive (%)	Statistics data odds ratio CI 95%, p-value < 0.05
Residence			
Urban	118	22.4	1
Rural	34	9.2	OR 0.58 (0.26 to 1.27) $p = 0.17$
Marital status			
Single	5	1.3	1
Married	147	30.3	OR 1.4 (0.23 to 9.06) $p = 0.68$
Clinical manifestation			
Without clinical manifestation	138	24.3	1
With clinical manifestation	14	7.3	OR 0.01 (0.026 to 0.37) $p = 0.80$
Educational status			
Illiterate	3	0.0	1
Primary educational	6	1.3	OR 0.25 (0.009 to 7.27) $p = 0.4$
8-years	21	7.35	OR 0.13 (0.006 to 2.83) $p = 0.19$
Secondary	65	15.8	OR 0.24 (0.012 to 4.88) $p = 0.3$
Higher education	57	7.35	OR 0.57 (0.028 to 11.98) $p = 0.72$
Do you have contact with the cat?			
No	115	19.8	1
Yes	37	11.8	OR 0.4 (0.18 to 0.80) $p = 0.011$
Do you have contact with dog?			
No	131	27.6	1
Yes	21	4.0	OR 1.17 (0.42 to 3.25) $p = 0.7$

All women were screened for Toxoplasma infection with ELISA for antibodies IgG, IgM and also for IgG avidity. In the total the prevalence for Toxoplasma

infection for IgG antibody was 31.8%, and for IgM antibody, 5.8% of them resulted positive. In Table 2 is presented the positivity of IgM and IgG for each age groups.

Table 2. Positivitity for anti-Toxoplasma IgM and IgG divided by the age groups

Age groups	Total number	IgM negative	IgM positive	IgG negative	IgG positive
17–25	43	42	1	31	12
26–35	89	84	5	79	20
36–43	20	17	3	2	18
Total	**152**	**143**	**9**	**104**	**48**

Measurement of *T. gondii*-specific IgG avidity has proven to be a powerful tool for distinguishing recent from past toxoplasmosis[13–15]. Unlike most other infections, primary toxoplasmosis cannot be reliably identified by detection of *T. gondii*-specific IgM. For reasons not clearly understood, *T. gondii*-specific IgM remains detectable as long as 2 years following primary infection[15]. Diagnosis of primary toxoplasmosis in pregnant women early in the first trimester of pregnancy is of most important in order to offer them early therapy or to do interventions for prevention of congenital infection to the foetus[16–18].

This study aimed to determine the usefulness of toxoplasma specific IgG avidity (ELISA) as a tool to separate between recent and acute toxoplasma infection. Routine serological diagnosis of this infection provides high sensitivity, but specificity varies depending on the test used. In this study 9 (5.9%) women in their early pregnancy had antibody IgM for Toxoplasma. To those cases diagnosis of primary infection with *T. gondii* in early pregnancy were improved by determination with IgG avidity. On avidity test only three of nine IgM positive women had low antibody IgG avidity. This result suggests an acute infection to these women. Four of nine pregnant women with IgM positive had high antibody IgG avidity; this suggests that infection was acquired before gestation (Table 3). This apparent disagreement in detection of IgM and IgG avidity antibodies by ELISA serology may be due to the fact that IgM antibody may persist for months or even years following the acute phase of an infection to some patients. So the presence of IgM antibody is not always an indication of an acute infection[15]. This study showed that there was no association between the level of the Toxoplasma – specific IgM, IgG and IgG-avidity.

Table 3. Comparison of IgG avidity and IgM

IgG avidity (results)	Number of specimens with ELISA IgM positive (n = 9)
Low	3 (33.33%)
Borderline	2 (22.22%)
High	4 (44.44%)

CONCLUSIONS

Measurement of *T. gondii*-specific IgG avidity has proven to be a powerful tool to distinguish recent from past toxoplasmosis. The presence of high avidity IgG essentially excludes the possibility that infection occurred within the previous five months. This is an indication that in our population the level of Toxoplasmosis infection is high and most women have had contacts with this parasite before pregnancy. Application of IgG avidity is a significant test in diagnosis of acute infection especially in cases of pregnant women.

REFERENCES

1. J. S. REMINGTON, G. DESMONTS: *Toxoplasmosis*: Infectious Diseases of the Foetus and Newborn Infants. 4th ed. WB Saunders, Philadelphia, 1995.
2. J. L. JONES, D. KRUSZON-MORAN, M. WILSON, G. McQUILLAN, T. NAVIN, J. B. McAULEY: *Toxoplasma gondii* Infection in the United States: Seroprevalence and Risk Factors. Am J Epidemiol, 154, (4), 357 (2001).
3. J. G. MONTOYA, O. LIESENFELD: Toxoplasmosis. Lancet, **363** (9425), 1965 (2004).
4. J. G. MONTOYA: Laboratory Diagnosis of *Toxoplasma gondii* Infection and Toxoplasmosis. J Infect Dis, **185** (Suppl 1), S7 (2002).
5. J. S. REMINGTON, R. McLEOD, P. THULLIEZ, G. DESMONTS: Toxoplasmosis. Infectious Diseases of the Fetus and Newborn Infant. 5th ed. W. B. Saunders, Philadelphia, 2001.
6. P. THULLIEZ, F. DAFFOS, F. FORESTIER: Diagnosis of Toxoplasma Infection in the Pregnant Woman and the Unborn Child: Current Problems. Scand J Infect Dis Suppl, **84** (18-22), (1992).
7. J. S. REMINGTON, R. McLEOD, P. THUILLIEZ, G. DESMONTS: Toxoplasmosis. Infectious Diseases of the Foetus and Newborn Infant. 6th ed. Philadelphia, 2006.
8. J. COUVREUR: Congenital Toxoplasmosis. Vie Med, **43**, 1839 (1962).
9. W. FOULON, J. M. PINON, B. STRAY-PEDERSEN, A. POLLAK, M. LAPPALAINEN, A. DECOSTER, I. VILLENA, P. A. JENUM, M. HAYDE, A. NAESSENS: Prenatal Diagnosis of Congenital Toxoplasmosis: a Multicenter Evaluation of Different Diagnostic Parameters. Am J Obstet Gynecol, **181**, 843 (1999).
10. J. C. MONTOYA, J. S. REMINGTON: Management of *Toxoplasma gondii* Infection during Pregnancy. Clin Infect Dis, **47**, 554 (2008).
11. O. VILLARD, J. JUNG-ETIENNE, B. CIMON, J. FRANCK, H. FRICKER-HIDALGO, N. GODINEAU, S. HOUZE, L. PARIS, H. PELLOUX, I. VILLENA, E. CANDOLFI: Le Reseau du Centre National de Référence de la Toxoplasmose. Sérodiagnostic de la toxoplasmose en 2010: conduite à tenir et interprétation en fonction des profils sérologiques obtenus par les méthodes de dépistage. Feuillets Biol, **52**, 1 (2011).
12. S. D. PETROV, T. N. BILEVA: Economical and Public Health Importance of Rodents**.** J Environ Prot Ecol, **11** (2), 529 (2010).
13. C. L. ROSSI: A Simple Rapid Enzyme-linked Immunosorbent Assay for Evaluating Immunoglobulin G Avidity in Toxoplasmosis. Diag Microbiol Infect Dis, **30**, 25 (1998).
14. M. PAUL: Immunoglobulin G Avidity in Diagnosis of Toxoplasmic Lymphadenopathy and Ocular Toxoplasmosis. Clin Diag Lab Immuno, **6**, 514 (1999).

15. J. C. MONTOYA, O. LIESENFELD, S. KINNEY, C. PRESS, J. S. REMINGTON: VIDAS Test for Avidity of Toxoplasma-specific Immunoglobulin G for Confirmatory Testing of Pregnant Women. Clin Microbiol, **40** (7), 2504 (2002).
16. B. S. AKOIJAM, S. SHASHIKANT, S. SINGH, S. K. KAPOOR: Seroprevalence of Toxoplasma Infection among Primigravid Women Attending Antenatal Clinic at a Secondary Level Hospital in North India. J Indian Med Assoc, **100**, 591 (2002).
17. S. SINGH: Mother-to-child Transmission and Diagnosis of *Toxoplasma gondii* Infection during Pregnancy. Indian J Med Microbiol, **21**, 69 (2003).
18. S. EMNA, A. KARIM, K. MOHAMMED, B. AIDA: Difficulty in Dating Primary Infections by *Toxoplasma gondii* in Pregnant Women in Tunisia. Tunis Med, **84**, 85 (2006).

Received15 December 2015
Revised 6 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 687–695 (2016)

Environmental protection and sustainable development

ATTITUDES AND PRACTICES CONCERNING SUSTAINABILITY. A RESEARCH CASE ON ROMANIAN TOURISM VENTURES

I. MESTER, D. BADULESCU*, A. BADULESCU, D.-P. BAC, R. SIMUT, M. SEHLEANU

University of Oradea, 1 Universitatii Street, 410 087 Oradea, Romania
E-mail: *daniel.badulescu@gmail.com*

Abstract. Tourism industry presents a special relationship with the environment and sustainability requirements, as a clean environment is the primary resource of this industry. The literature indicates that the entrepreneurs and managers involved in responsible touristic ventures are expected to be more aware of the importance of sustainability and more interested to possess advanced knowledge on sustainability issues. On other side, customers are also assumed to be more sensitive to touristic suppliers attitudes and practices regarding sustainability. Based on a survey research, in this paper we investigate the sustainability-oriented attitudes and practices among ventures operating in tourism and hospitality industry, in Bihor County, Romania. Our research revealed a consistent interest for an effective sustainable tourism, but also some barriers and limits in understanding the problems of sustainability, a short term focusing and a prevalence of conventional and low efficacy actions. The undoubted interest in meeting the required standards and obtaining the relevant certificates is shadowed by the fact that many of these certificates do not say too much to tourists concerning operators practices towards promoting an effective sustainable tourism. As a result, many touristic ventures are reluctant to assign a significant economic effect to holding and implementing sustainability standards.

Keywords: sustainability attitudes and practices, sustainable tourism, certification.

AIMS AND BACKGROUND

Sustainability and environmental impact of human actions are widely considered as major issues both in theoretical approaches and in specific empirical researches. This concern raises numerous questions related to the activity of the ventures operating in tourism and hospitality industry, especially due to the fact that tourism is inseparably related and even dependent on the quality of the natural environment of tourist destinations. However, the various forms of tourism, the various sizes of tourism ventures, the composite nature of the tourism product, all make it difficult to implement a single policy, especially when business interests, performance and profitability requirements are threatened[1]. The present paper, based on a research among representatives of ventures operating in tourism and hospitality industry, aims at examining how they do understand and practice sustainability actions,

* For correspondence.

how they perceive benefits and barriers associated with sustainability practices. The results allow us to point out some conclusions regarding the involvement in sustainability actions, and to suggest policies to improve sustainable practices in tourism.

The sustainable tourism development became important not only due to ecological reasons at touristic destination, 'but also for improving its competitiveness'[2]. Indeed, tourism has a complex impact on the environment, related to both environmental degradation as a result of the increasing number of visitors, and to the effects of business activity on tourism. Hence, sustainable tourism induces responsibilities for both consumers and companies operating in tourism.

The fact that sustainable tourism combines various conceptual, moral, and social elements with practical reasons, determines some researchers to doubt about the sincere involvement in these actions, considered to be as a simple trick, a marketing approach[3], or new destinations promotion, instead of environmental conservation[1,4]. On the other hand, it is very difficult to ask to an entire sector to contribute to a cleaner world, as long as its links with the rest of the economy are made through activities (such as transportation or construction) which consume non-renewable resources, or represent major polluters.

However, sustainable tourism supports and respects the social, economic and environmental concerns of host communities, strongly considering the local particularities and requirements, but it also involves rational consumption allowing a natural regeneration of resources[5]. Finally, tourism as an economic activity is able to provide consumers with comprehensive, satisfying and meaningful experiences[1,6].

These goals can be implemented through various forms, e.g. encouraging energy saving (lighting and heating), waste collection, purchasing from local ventures, re-dimensioning tourist flows, preventing degradation of natural and cultural sites, etc. These actions could lead mainly to environmental gains, but also to monetary benefits (savings), increasing reputation, and providing pleasant experiences to visitors, attracting influential customers and investors, and a positive response from local community[1,7].

There is a consistent and diverse literature on the results of implementing sustainability principles in tourist ventures and their effects on customers (i.e. tourists). Kirk[8] finds that major hotel chains have assimilated relatively quickly and on large scale sustainability and environmental issues, among employees, suppliers and business partners. On the other hand, for small tourism companies the results were less visible and the actions proved to be more difficult to implement, as these small firms 'do not have the interest, resources or time required to introduce environmental management practices'[1].

Some researchers found out an effective availability of hoteliers for sustainable tourism, but also a limited understanding of tourism – environment relation. Sustainable practices were dominated by conventional and low efficiency actions,

i.e. recycling, low energy consumption devices, lead free vehicles or double glazing. Horobin and Long and Stabler and Goodall consider that this inaction is caused by 'a high degree of complacency amongst the businesses, with satisfactory current environmental performance'[9], insatisfaction related to the excessive time spent carrying out these actions or even a plan to return to some classic products, non-environmentally friendly but more efficient and, probably, cheaper[10]. Geerts[11], when interviewing a group of 21 London hotels managers, found out that certification schemes provide knowledge to hoteliers and help against claims of 'greenwash'. However, the effect of certifications on profitability is unclear. Moreover, certification schemes are very limited in providing guests with more accurate information about the hotel efforts on sustainability. Brown[12] analysing the behaviour of large hotel groups managers, indicated that main incentives for environmental initiatives are, firstly, cost savings, and then, the environmental protection. In some cases, luxury hotels managers were reluctant to engage in sustainability policies, considering that this could affect their image or even 'the enjoyment of a guest stay'. Horobin and Long[10] suggested that, although there is a lot of affinity for the general principles of sustainability, there is general confusion around the concept of sustainability and even the environmental concern. Although 76% of the respondents are prepared to accept the link between the environment and their businesses, however, many of them mention they did not find the occasion, incentive or time to put these beliefs into practice, do not see the chance to turn 'their own business practices *green* as a *business opportunity*, and between 59% and 80% are not aware of any information sources about sustainability' [10].

Another aspect of the implementation of sustainable tourism practices is given by the customers requirements and behaviour[13]. According to Martens and Spaargaren[14], or Budeanu[15], the tourists are far less motivated to practice sustainable lifestyles or support responsible tourism products, reducing or even ignoring industry's sustainability goals, considering the active protection of the environment and the support of local communities is a part of hotel responsibility[16]. Hjalager[17] studies on tourist attitudes in Denmark indicate that two thirds of the visitors in metropolitan area said that the environment has no importance for their choice of destination, and this percentage reaches 80% if the travel motivation is business or studies. Only rural locations tend to host vacationers with a high focus on environmental issues. While some tourists are willing to pay more for environmentally less damaging products, around 71% of them prefer lodging in hotels that show concern for the environment, but they are not willing to pay more for them[8,17], and one in three British travelers surveyed said they would pay more for an international trip if their money went to preserving the local environment[16].

EXPERIMENTAL

Our survey-based research aims at investigating some issues concerning the sustainability-oriented attitudes and practices among tourism and hospitality ventures. We are particularly interested on the real concern about sustainability and the impact on the environment of touristic ventures, about the factors driving to sustainability, about the perception of tourism ventures managers on the benefices and gains associated with sustainability practices. The research is based on surveying 83 ventures operating in tourism and hospitality industry in Bihor County (North Western Romania), the sampling being made by using the random stratified proportional procedure.

The questionnaire consisted of 23 questions: the general questions are related to the profile of the respondents, while the specific questions evaluate the awareness, attitudes and behaviours related to the environmental impact of the ventures operating in tourism and hospitality industry. For the confirmation of the survey reliability, we grouped the questions referring to the perception on the protection of the environment, and by using the Cronbach alpha method we found that the alpha coefficient is equal to 0.804, which indicates a reliable scale. The elimination of any item leads to a lower alpha.

The sample consisted of guest houses (39%), clubs and restaurants (42%), and hotels (19%). Small size companies, with less than 49 employees, were 86% from total, the rest being medium or large companies. 61% of companies had an annual turnover under 35 000 EUR, while the rest had an annual turnover between 35 000 and 7 300 000 EUR.

The actions reported by firm representatives as already undertaken in order to protect the environment were as follows: the use of energy saving light bulbs (100% of the firms), water saving devices (90.69%), the use of environmental friendly products (74.4%), recycling glass (69.76%), recycling plastic recipients (53.48%), the use of movement light sensors (7%), towel policy (4.65%), renewable energy source (i.e. solar panels: 2.3%), recycling paper and/or aluminium wastes. Most of the respondents considered that the most important advantage associated with their sustainability practices had been the lowering of the electricity (58.1%) and water consumption (46.5%) costs. The percentage of representatives considering that protecting the environment brought some advantages or benefits for the businesses is 81.6%. However, 16.27% of the respondents argued that high prices restricted them to take any action to protect the environment.

RESULTS AND DISCUSSION

Research hypothesis H1. The managers perception regarding the impact of hospitality industry on the environment is correlated with the number and type of their actions undertaken to protect the environment.

In Table 1 we have highlighted, starting for the sample, the number of actions undertaken to protect the environment, and we have constructed the cross tabulation between the answers of the respondents. A majority of 62.79% of the respondents consider that ventures operating in tourism and hospitality have a medium impact on the environment, whilst only 18.6% believe that their impact is significant.

Table 1. Correlation between managers' perception regarding the impact of hospitality industry on the environment and the number of their actions undertaken to protect the environment

Environmental impact of the hospitality industry		Number of actions undertaken to protect the environment									Total
		1	3	4	5	6	7	8	9	10	
Insignificant	observed frequency	0.0	0.0	2.0	2.0	4.0	4.0	0.0	4.0	0.0	16
	expected frequency	0.4	0.4	4.8	2.2	3.5	2.8	0.4	1.1	0.4	
	adjusted residual	–0.7	–0.7	–1.7	–0.2	0.3	0.9	–0.7	**3.1**	–0.7	
Medium	observed frequency	0.0	2.0	22.0	6.0	13.0	7.0	2.0	2.0	0.0	54
	expected frequency	1.3	1.3	16.3	7.5	11.9	9.4	1.3	3.8	1.3	
	adjusted residual	–1.9	1.1	**2.8**	–1.0	0.6	–1.4	1.1	–1.5	–1.9	
Significant	observed frequency	2.0	0.0	2.0	4.0	2.0	4.0	0.0	0.0	2.0	16
	expected frequency	0.4	0.4	4.8	2.2	3.5	2.8	0.4	1.1	0.4	
	adjusted residual	**3.0**	–0.7	–1.7	1.4	–1.0	0.9	–0.7	–1.2	**3.0**	
Total		2.0	2.0	26.0	12.0	19.0	15.0	2.0	6.0	2.0	86

Note: Adjusted residuals in bold are those that exceed +/– 2.

The calculated χ^2 is 38.76, reflecting a strong correlation between the above mentioned variables. To determine if this correlation is maintained also for the total population, we need to compare the calculated value with the critical one. In our case the critical value for 16 degrees of freedom and a 95% of probability is 23.6, and therefore the strong correlation stands also for the total population.

To investigate the statistically significant omnibus Chi-square test results, we used also the procedure that calculates the residuals[18]. In Table 1, four cells had the adjusted residuals greater than +/– 2, all of them being positive, thus indicating that the observed frequencies were bigger than the expected ones. For example, more managers than expected evaluated the environmental impact of the hospitality industry as insignificant, for a number of 9 out of 10 possible actions to protect the environment, and more managers than expected evaluated the environmental impact of the hospitality industry as medium, for a number of 4 actions to protect the environment. The more values (in absolute value) are bigger than 2, the stronger is the correlation between the two variables. All of them had positive adjusted residual values, which indicates there were more managers than expected by chance who consider the environmental impact of the hospitality industry as: insignificant for a number of the actions undertaken to protect the environment

equal with 9, medium for a number of actions equal with 4, and significant for a number of action equal with 1 and 10.

Therefore, research hypothesis H1 is validated at the sample level, and the total population level.

Research hypothesis H2. The level of the market targeted by the ventures is positively correlated with the existence and the number of environmental standard certifications they own.

The companies were investigated in order to assess whether they had environmental certificates and in what number. Following the investigation, scores ranging from 1 to 3 were associated to each target market. For example, for luxury consumers it was assigned 3, for average consumers it was assigned 2, for economy class it was assigned 1. The next step was to determine the average score. Table 2 contains the cross tabulation between the respondents answers.

Table 2. Correlation between the level of the market targeted by the ventures and the number of environmental standard certifications they own

Number of environment certificates		Target market – average score					Total
		1	1.5	2	2.5	3	
0	observed frequency	4	0	34	6	0	44
	expected frequency	3.1	5.1	30.7	4.1	1.0	
	adjusted residual	0.8	**–3.4**	1.6	1.4	–1.5	
1	observed frequency	2	10	24	0	2	38
	expected frequency	2.7	4.4	26.5	3.5	0.9	
	adjusted residual	–0.6	**3.8**	–1.2	**–2.6**	1.6	
2	observed frequency	0	0	2	2	0	4
	expected frequency	0.3	0.5	2.8	0.4	0.1	
	Adjusted residual	–0.6	–0.7	–0.9	**2.9**	–0.3	
Total		6	10	60	8	2	86

Note: Adjusted residuals in bold are those that exceed +/– 2.

The average consumer is targeted by a significant proportion of the companies (i.e. 70.76%), while no environmental certificates were owned by more than half of the ventures (i.e. 51.16%). There was a weak correlation between the two variables, because of the distribution of the frequencies, at a sample level (calculated χ^2 = 28.29, higher than the critical value of 15.51, for 5% significance level and 8 degrees of freedom). Therefore, we can conclude that there is a correlation between the two variables, valid for the sample and the total population. Regarding the adjusted residual, four cells were associated with values greater than +/– 2. Two of the cells have positive adjusted residual values, while the other two have negative adjusted residual values. The positive values indicate that there were more companies than expected by chance which have a target market 1.5 and one certificate, and a level

of the market targeted by the ventures 2.5 and two certificates. Conversely, the two cells with negative values indicate that there were fewer companies than expected by chance which have a target market 1.5 and no certificate, and a 2.5 target market for one certificate. Consequently, research hypothesis H2 is validated.

Research hypothesis H3. The managers perception regarding the environmental impact of the hospitality industry is correlated with the possession of an environmental certificate, with the accomplishment of certain actions to protect the environment or the evidence of some interest to protect it.

The assumption is that between the awareness of the environmental impact of the tourism and hospitality industry and the actions implemented to protect it, there is a positive correlation.

A score from 0 to 5 was assigned to show the extent to which the ventures in the sample got involved in environmental protection. The respondents who gave negative answers to the questions related to research hypothesis RH3 were given 0 points, and for each positive answer they got 1 point. By summing up the three scores mentioned above, we were able to determine the score of the company. Table 3 presents the cross tabulation between the responses and the assigned scores.

Table 3. Correlation between the managers perception regarding the environmental impact of hospitality industry and the possession of an environmental certificate

Environmental impact of the hospitality industry on the environment	Possession of an environmental certificate					Total
	0	1	2	3	5	
Insignificant	0	6	10	0	0	16
Medium	8	14	22	8	2	54
Significant	0	2	8	6	0	16
Total	8	22	40	14	2	86

A medium intensity is shown by the distribution of the frequencies, while between the two variables there is a direct correlation. Because the calculated $\chi^2 = 16.36$, which is higher than the critical value 15.51 determined for 8 degrees of freedom and a 95% of probability, the null hypothesis is rejected. Therefore, research hypothesis H3 is validated. There is a correlation between the two variables, valid for the sample and the total population, even if at the level of the total population the correlation is weak.

CONCLUSIONS

Our research on attitudes and behaviours related to sustainability-oriented business practices, among touristic ventures in Bihor County, Romania, revealed a consistent interest for an effective sustainable tourism, but also some barriers and

limits in understanding the problems of sustainability. After testing the research hypotheses, we found out that surveyed managers/representatives understand that hospitality industry has a significant environmental impact and they undertake a series of actions in order to protect the environment. However, these actions are scaled, limited and reduced as effectiveness. The managers operating in tourism consider that achieving and maintaining a target market is fostered by possessing quality certificates which cover also environmental issues, even if those certificates do not say much on the concern to practice an effective sustainable tourism. However, an important share of them are aware of the importance of practicing sustainable tourism, and try to obtain those certificates, meet the requirements, and act accordingly[19]. For other companies, obtaining such a certificate appears as a waste of time and money with no tangible advantages. However, further research is needed to more carefully address the research questions, mainly by extending the sample and also the research hypotheses.

REFERENCES

1. K. HOBSON, S. ESSEX: Sustainable Tourism: a View from Accommodation Businesses. The Service Industries Journal, **21** (4), 144 (2001).
2. M. CUCCULELLI, M. GOFFI: Does Sustainability Enhance Tourism Destination Competitiveness? Evidence from Italian Destinations of Excellence. J Clean Prod, **111**, 379 (2016).
3. S. BERRY, A. LADKIN: Sustainable Tourism: A Regional Perspective. Tourism Manage, **18** (7), 433 (1997).
4. B. WHEELLER: Alternative Tourism: A Deceptive Ploy. Progress in Tourism. Recreation and Hospitality Management (Ed. C. Cooper), 4, Belhaven, London, 1992, 140–145.
5. I. MESTER, D. BADULESCU: Sustainability among Tourism and Hospitality Industry's Ventures: from Awareness to Specific Practices. In: Proc. of the 8th European Conference on Innovation and Entrepreneurship, Brussels, 2, 2013, p. 434.
6. T. ANGELKOVA, C. KOTESKI, Z. JAKOVLEV, E. MITREVSKA: Sustainability and Competitiveness of Tourism. Procedia – Social and Behavioral Sciences, **44**, 221 (2012).
7. J. SWARBROOKE: Greening and Competitive Advantage. Insights, **5**, 43 (1994).
8. D. KIRK: Environmental Management for Hotels. Butterworth-Heinemann, Oxford, 1996.
9. M. STABLER, B. GOODALL: Environmental Awareness. Action and Performance in the Guernsey Hospitality Sector. Tourism Manage, **18** (1), 19 (1997).
10. H. HOROBIN, J. LONG: Sustainable Tourism: the Role of the Small Firm. International Journal of Contemporary Hospitality Management, **8** (5), 15 (1996).
11. W. GEERTS: Environmental Certification Schemes: Hotel Managers' Views and Perceptions. International Journal of Hospitality Management, **39**, 87 (2012).
12. M. BROWN: Environmental Auditing and the Hotel Industry: An Accountant's View. In: Tourism: The State of the Art (Eds A.V. Seaton et al.). Wiley, Chichester, 1994, 675–681.
13. M. GOLUMBEANU, S. NICOLAEV, T. ZAHARIA, F. K. VOSNIAKOS: Tool of Training as an Important Component of the Environmental Education and Public Awareness. J Environ Prot Ecol, **13** (2A), 1139 (2012).

14. S. MARTENS, G. SPAARGAREN: The Politics of Sustainable Consumption: the Case of the Netherlands. Sustainability: Science, Practice and Policy, **1**, 29 (2005).
15. A. BUDEANU: Sustainable Tourist Behaviour – a Discussion of Opportunities for Change. Int J Consumer Stud, **31** (5), 499 (2007).
16. Z. CHAFE: Consumer Demand and Operator Support for Socially and Environmentally Responsible Tourism. CESD/TIES Working Paper, **104,** 2005.
17. A. M. HJALAGER: Consumerism and Sustainable Tourism Journal of Travel & Tourism Marketing, **8** (3), 1 (2000).
18. D. SHARPE: Your Chi-square Test is Statistically Significant: Now What? Practical Assessment, Research and Evaluation, **20** (8), 1 (2015).
19. H. BAKAS, F. VOSNIAKOS: Building Virtual Environments for Environmental Education. J Environ Prot Ecol, **9** (4), 946 (2008).

Received 26 February 2016
Revised 18 April 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *696–702* (*2016*)

Environmental protection and sustainable development – landscape planning

LAND DEGRADATION DUE TO COASTAL URBANISATION

M. T. ESETLILI[a]*, Y. KURUCU[a], T. TURK[b], F. OZEN[a]

[a]*Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Ege University, 35 100 Bornova, Izmir, Turkey*
E-mail: *tolga.esetlili@ege.edu.tr*; *mustolga@gmail.com*
[b]*Verim Harita Company, Izmir, Turkey*

Abstract. Recently, rapid urbanisation has been triggered by a population increase in coastal areas caused especially by migration, commercial development and tourism. Sever damage to natural resources, particularly in the agricultural soils have resulted in a rise in rural unemployment, as well as creating economic and ecological problems. The original population, farmers working the land, have been replaced by a population which consists of those employed in tourism, and people who have retired to areas of natural beauty. The new population structure demands the improvement of urban requirements and more housing, with no particular regard nature. This study focuses on land use changes in the coastal regions of the Izmir region, which are subjected to rapid growth. Aerial photographs and satellite images from the period 1984 and 2011 have been used. A significant expansion of the urban areas, up to 552, 481 and 439% increase have been determined for the coastal districts of Cesme, Karaburun, Foca, respectively, due to tourism and secondary residences. When losses in the agricultural land of this region were investigated, results showed that 14 974 ha of land are in the I and II land use capability class (LUCC) and 10597 ha – in the III and IV LUCC.

Keywords: remote sensing, GIS, urbanisation, Izmir, degradation, environment.

AIMS AND BACKGROUND

Important changes have affected cities and urbanisation, particularly in the last fifty years. The first change is the rapid urbanisation parallel to an increase in the population and the changes in production methods. This has brought a dense population accumulation in cities. In the 1900s, 9% of world population lived in cities, and this rate has increased to 40% by 1980 and to 50% by 2000. It is estimated that this rate will increase to 66% by the year 2025 (Ref. 1). The second factor that effects urbanisation is the improvement in transportation and construction sectors due to technological advances. These developments have caused the cities to greatly expand, and most cities globally have experienced a tendency to encroach on their surroundings. When the urban expansion rates are evaluated within this process, it has been determined that the greatest intensity was on and adjacent to coastal regions. The attractiveness of the shores in terms of economic and aesthetical concerns has brought a higher density population and an increase

* For correspondence.

in associated activities, creating greater pressure on the environment. Intensification of activities such as industrialisation, urbanisation, infrastructure, defense, tourism, mining, sporting events, transportation and housing within these regions are the main causes of stress on the loading capacity in the region, and eventually create an intense pressure on the natural areas[2–6].

Loss of the natural structure in agricultural lands has economic and ecological effects, decreasing agricultural employment. The soil, the source of agricultural production that meets people basic requirements, is destroyed, either conscious or unconsciously, with no possibility of recovery. Rapid urbanisation not only causes the loss of natural structure, but also air, water and soil pollution[7]. Urban diffusion causes an increase in greenhouse gas emission. Greenhouses gases cause global warming and it is estimated that 55% emissions will originate from vehicles in the next 10 years[8]. As a result of transforming the forest lands, which are sources of fresh water, into residential areas, water resources and quality have also deteriorated. The distorted structuring within the cities deteriorates the hydraulic pattern of water and the uncontrolled discharge of waste water causes the pollution of water sources. In addition, the disproportionate and unplanned growth of urbanisation and industrialisation have caused the soil to become more vulnerable to erosion; and as a result of the release of increasing amounts of city waste (e.g. from sewers) into the soil with the rapid increase of population, natural resources are irrevocably damaged.

The existence of forests, rivers and marshy land is necessary for the continuation of human life. But, urban diffusion not only creates pollution and threatens biological diversity; it also degrades natural areas, and decreases the filtration characteristic of water and air, and the capacity to absorb carbon dioxide[9].

This study examined the changes in the use of space in coastal regions in the province of Izmir, which has experienced a period of intense urbanisation from 1984.

EXPERIMENTAL

Study area. The study area consists of thirty districts within the borders of Izmir province. The study is particularly intensified in the shore regions, which experienced the most intense urban development, and therefore the greatest increase in pressure on natural structure (Fig. 1).

This study focuses on the pressure on natural resources and in particular, on agricultural lands, within the 30 districts of Izmir province as a result of development or urban residential growth. Of particular interest were the shore regions, where urban development is most intensely experienced. The sources of numerical and visual data were the Izmir Province Field Assets inventory of 1984, and the updated Izmir Province Field Assets of 2010, with additional data from high

resolution aerial photographs and satellite images. The remote sensing technique and geographical information systems were combined in this study to examine the environmental effects of urban development in Izmir within the last 26 years. First, high resolution aerial photographs were used in conjunction with 1/25.000 scale maps, representing a detailed record of the field assets of Izmir province in 1984. These maps were transferred to the digital environment using ArcGIS software and a digital database was established. The external borders of residential areas were determined in this database of 1984. In the second stage, the digital data of Izmir Province Field Assets were created and updated, using the high resolution orto-photographs and satellite images from 2010, and these were transferred to the database as a separate layer. This database was used to determine the external borders of residential areas in 2010. The urban development which occurred in the 26 year period, and the resulting pressure on natural structure was digitally determined and mapped with the investigation models developed in the GIS environment.

Fig. 1. Study area

RESULTS AND DISCUSSION

The Aegean region and Izmir province is under intense threat from migration and population increase, both due to the attractiveness of its climate and the richness of its natural resources (Fig. 2). This demographic change simultaneously triggers the urbanisation process and a rapid urban diffusion. This causes the irrevocable loss of rich natural assets and valuable agricultural lands in the region. When we consider that a large proportion of Izmir economy depends on agricultural sector, it is clear that this situation has the potential to create problems in the future.

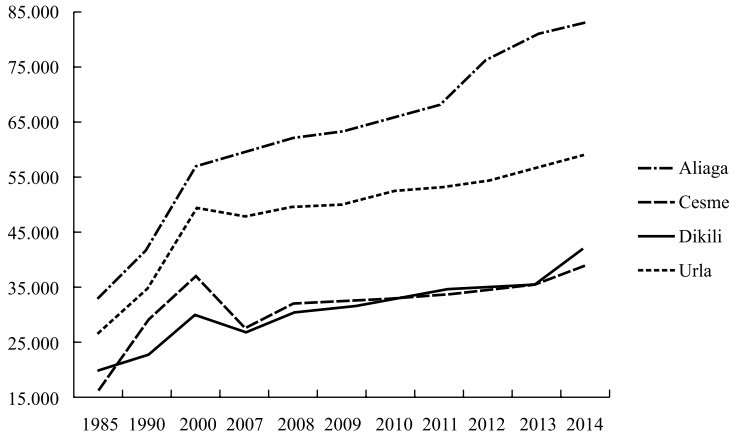


Fig. 2. Population data of districts by years

This study examined the agricultural lands lost in the last 26 years as a result of urban diffusion. 1/25 000 scale digital Izmir province asset, revised in 1984, constitutes the basic support database, and was integrated with the external boundaries of residential areas, which were recorded and digitalised in 2010 using the high resolution ortho-photo and satellite images. As a result of this examination, it was found that a total of 39 000 ha of land were lost as a result of restructuring in the last 26 years (Table 1, Fig. 3). An examination of the land use capability of these areas shows the irrevocable destruction of 14 974 ha of the most valuable class I, and II, and 10 597 ha of class III and IV land.

Table 1. Distribution of total increase in residence and industry with respect to land use capability classes (LUCC) in Izmir province

LUCC	Area (ha)
I	7914
II	7060
III	4732
IV	5865
VI	7080
VII	6197
VIII	203
Total	39052

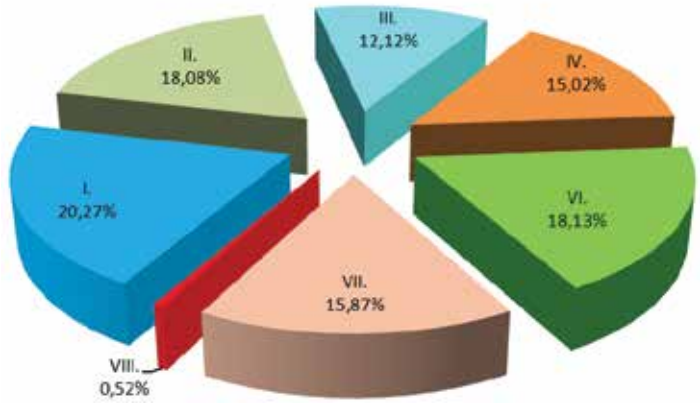


Fig. 3. Distribution of lost area in terms of land use capability class

Within this process, when the losses are examined in terms of land usage types, it is seen that 26.8% is rain-fed agricultural lands and 8.2% is irrigated agricultural lands. In addition, it has been determined that forage lands make up 23.2%, and olive groves, 20%. When generally reviewed, it is understood that 85.4% of the land under threat was characterised as agricultural (rainfed/irrigated agricultural lands, pasture, olive grove, orchards, vineyards) (Fig. 4).

It has also been determined that in the province of Izmir, and in particular, the coastal districts of Cesme, Karaburun and Foca have experienced an urban area expansion of 552, 481 and 439%, respectively. The shore regions were not only affected by tourism, the establishment of new industrial regions and growth in marine transportation facilities has led to the expansion of Aliaga district from 780 to 3580 ha, a total increase of 459%.

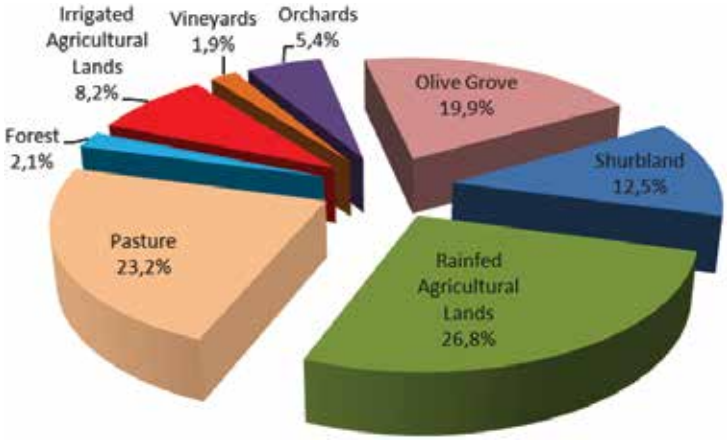


Fig. 4. Distribution of lost land in terms of land usage types

CONCLUSIONS

As a result of a rapid population increase and technological advances in the coastal regions of Izmir within the last 26 years, forest, agriculture and forage areas have become increasingly pressurised by elements such as industry, residential growth and tourism. As a result of these pressures, these mainly valuable agricultural lands have been irrevocably lost.

Ironically, the loss of agricultural lands as a result of rapid population and urban diffusion reduces the possibility of meeting the increased demand for food to feed this new population. Therefore, in order to reduce the loss rate in the coming years, precautions need to be taken to ensure the sustainability of existing agricultural lands.

Agriculture remains the main economic sector in our country, as it is in much of the world. Therefore, it is essential to recognise the strategic importance of agricultural lands, and to develop effective protection policies and programs accordingly.

REFERENCES

1. N. McINTYRE, K. KNOWLES-YANEZ, D. HOPE: Urban Ecology as an Interdisciplinary Field: Differences in the Use of 'Urban' between the Social and Natural Sciences (Ed. J. M. Marzluff). Urban Ecology, Washington. 2008.
2. B. DURU: Coastal Policy. Mulkiyeliler Association Publishing, Ankara, 2003.
3. F. OZEN, M. T. ESETLILI, M. BOLCA, Y. KURUCU: Impact of Land Use Changes on Agricultural Ecosystem: A Case Study of Kemalpasa-Izmir. J Environ Prot Ecol, **15** (4), 1801 (2014).
4. B. K. ATAK, N. ERDOGAN, E. ERSOY, E. NURLU: Analyzing The Spatial Urban Growth Pattern by Using Logistic Regression in Didim District. J Environ Prot Ecol, **15** (4), 1866 (2014).

5. B. ATAOGLU, E. TOK: Peripherial Ecological Degradation in Istanbul. J Environ Prot Ecol, **12** (3), 952 (2011).
6. I. MALOLLARI, M. BAKALLI, L. XHANGOLLI: Environmental Impact on the Albanian Coastal Region and the Relevant Strategies. J Environ Prot Ecol, **3** (4), 979 (2002).
7. R. W. G. CARTER: Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of Coastlines. 3rd ed. Academic Press, London, 1991.
8. D. J. CIESLEWICZ: The Environmental Impacts of Sprawl, Urban Sprawl: Causes, Consequences & Policy Responses. The Urban Institute Press, Washington, USA, 2002.
9. S. GARDNER: The Impact of Sprawl on the Environment and Human Health, Urban Sprawl a Comprehensive Reference Guide. Greenwood Press, USA, 2006.

Received 11 February 2016
Revised 13 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 703–710 (2016)

Environmental protection and sustainable development – landscape planning

REVEALING LANDSCAPE STRATEGIES FOR THE WATER BASINS – CASE OF BUYUKCEKMECE LAKE, ISTANBUL

F. A. TURER BASKAYA*, E. TEKELI

Department of Landscape Architecture, Faculty of Architecture, Istanbul Technical University, Taskisla Building, 34 437 Taksim, Istanbul, Turkey
E-mail: *turerfat@itu.edu.tr*; *tekilies@itu.edu.tr*

Abstract. Today, existence of expanding megacities brings about a concern about how sustainable their attitudes toward the natural resources. This study handles one of the major drinking water basins of Istanbul megacity called the Buyukcekmece Lake which examines conflicting urban dynamics. Benefiting from the GIS technology, this study aims to reveal landscape strategies for the Buyukcekmece Lake and concerns a two-phased evaluation process ranging from the overall water basin scale to the scale of stream impact area. For the water basin scale, 4 main parameters are defined as 'proximity to urban transformation areas', 'assigned functions within the Istanbul environmental plan', 'urban stream network' and 'dispersion of major land uses'. For the studies on the scale of stream impact area, two major streams examining different urban dynamics are selected as Karasu and Kesliciftligi. To reveal multi-scale landscape strategies, these streams and their impact areas are evaluated by two major parameters as 'green infrastructure capacity', and 'openness to intervention'. This study is an attempt to highlight the importance of developing multi-scale landscape strategies for the benefit of urban streams and water basins existing inside the ever-changing megacities.

Keywords: multi-scale landscape strategies, urban water basins, Buyukcekmece Lake, Istanbul.

AIMS AND BACKGROUND

With its more than 14 million population, Istanbul is the most populated megacity of Turkey. Although Istanbul comes into prominence with its cultural and economical values, its natural values are actually important. Following the 1950s, the world has experienced a breakthrough in the industry along with the urbanisation movement. Urbanisation has appeared to be a nodal point for environmental issues[1]. In Turkey, Istanbul is a case in point. Due to an extreme increase in domestic migration and economics, the 1980s appeared to be a touchstone of the uncontrolled development of Istanbul.

Today, existence of expanding megacities brings about a concern about how sustainable their attitudes toward the natural resources[2,3]. This study handles Istanbul as one of these megacities. This dynamic city is both facing an urban expansion that is bringing about mega infrastructure projects and a decaying urban fabric vulnerable to earthquake risk that is bringing about urban transformation projects.

* For correspondence.

Within the last two decades, rapid spatial expansion and transformation supported by the nonintegrated plans have put pressure on the natural resources of Istanbul. Regarding the scope of this pressure, this study focuses on the Buyukcekmece Lake as one of the major drinking water basins of Istanbul, which examines conflicting urban dynamics.

Istanbul provides its daily water demand from 18 surface water resources[4] (Fig. 1). The Buyukcekmece Lake is the third largest water resource of Istanbul with its annual water production of 100 million m^3 (Ref. 5). It was transformed into a lake from a lagoon by the construction of a dyke to provide water for Istanbul in 1987 (Ref. 6)**.** Capturing a drainage area of 621 km^2, the Buyukcekmece Lake is under a great risk of contamination in recent years.

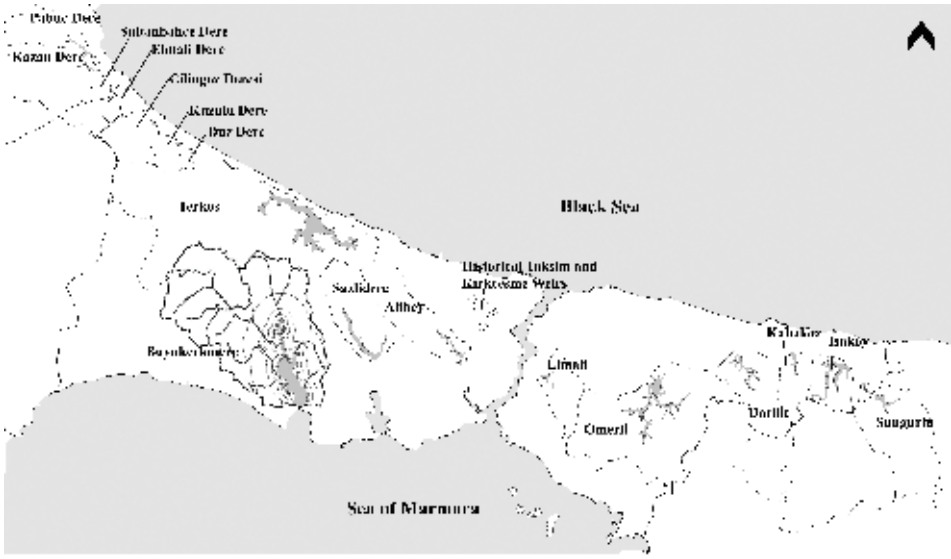


Fig. 1. Water basins of Istanbul[4] and the Buyukcekmece water basin with its protection areas and major streams

Despite its ecological importance, Buyukcekmece Lake has no more protection than the one defined by the Drinking Water Basin Regulation of Istanbul Water and Sewage Administration[7]. This regulation defines several protection areas that are strict (0–300 m), short-distance (300–1000 m), middle-distance (1000–2000 m), and long-distance (2000 m-water basin boundary) ones[8]. Buyukcekmece Water Basin captures several major streams which are Ahlat, Akalan, Ayus, Ayva, Beylikcayi, Cekmece, Damlidere, Delice, Eskidere, Hamza, Inter, Karasu, Karamurat, Keslicifligi, Kiladine, Kizildere, Koy, Orcunlu, Seytan, Tahtakopru, and Tavsan[8,9].

Although it is experiencing some adverse impacts of nonintegrated plans and rapid urban alterations, The Buyukcekmece Water Basin has got a capacity to have

a sustainable future in this ever changing megacity. Regarding this capacity, this study is focusing on it to develop multi-scale landscape strategies.

EXPERIMENTAL

Benefiting from the GIS technology and ArcGIS 10.0 software, this study aims to reveal landscape strategies for the Buyukcekmece Lake and concerns a two-phased evaluation process ranging from the overall water basin scale to the scale of stream impact area. Within this study, 1/5.000 digital based maps are obtained from Directorate of Cartography of Istanbul Metropolitan Municipality and current aerial photographs from the online map service of Yandex. Aerial photographs are rectified according to the digital base maps. GIS based stream network map is created by benefitting from the maps of Istanbul Water and Sewage Administration and field studies. 1/100.000 Environmental Plan of Istanbul[10] is rectified to determine assigned functions to the study area. Within this study, GIS-based data are registered to Universal Transverse Mercator 3 Degree coordinate system with European Datum 1950 as it is the coordinate system preferred by the Istanbul Metropolitan Municipality for landscape planning studies.

In this study, two evaluation phases with different scales are developed. For the first phase that concerns the water basin scale, four main parameters are defined as 'proximity to urban alteration areas', 'assigned functions within the Istanbul Environmental Plan', 'urban stream network', and 'dispersion of the current major land uses'. For the studies on the scale of stream impact area, two major streams examining different urban dynamics are selected as Karasu and Kesliciftligi. To reveal multi-scale landscape strategies, these streams and their impact areas are evaluated through the second phase by two major parameters as 'green infrastructure capacity', and 'openness to intervention'.

RESULTS AND DISCUSSION

Istanbul is a dynamic city open to spatial alterations. Mapping studies for the urban macroform alteration of Istanbul[11] and the Environmental Plan Report of Istanbul[12] highlight that Buyukcekmece Lake and its surrounding area had been out of the urban macroform boundary prior to the year of 1970. In between the years of 1970 and 1994, the southern areas of the water basin had appeared to be inside the urban macroform boundary. Throughout the years, these southern areas have experienced the impact of altering macroform more.

Urban alteration projects have several adverse impacts on the water basins of Istanbul. Environmental Plan Report criticises the Formula 1 Area standing on the Omerli Water Basin and the golf tourism facilities current trend to select sites for themselves on the water basins[13]. A quite new mega project declared by the

government at 2011 is called Canal Istanbul, and it passes through the Sazlidere Water Basin just standing at the north of the Buyukcekmece Lake.

It is evident that there is a conflict between 2009 dated Environmental Plan of Istanbul and the current partial plans. Environmental Plan Report defines Buyukcekmece Lake as a natural area capturing strategic ecological importance. Therefore, it forwards planning decisions for the water basin as assigning areas for the rehabilitation, agricultural protection, ecological agriculture, forest, environmental sustainability, and the protection of natural – rural character[14].

Figure 2 illustrates the major assigned functions within the Istanbul Environmental Plan for the water basin[10]. Besides the plan decisions, this figure also illustrates the dispersion of major streams and current land uses of the water basin. In addition to a large number of factories and residential areas, there are quarries, greenhouses, barns and an airport in study area. Residential areas with high to medium and low density exist both on the geologically problematic and natural threshold areas of the Buyukcekmece Water Basin[12]. Southern areas of the water basin appear to be more problematic as they hold majority of the high density residential areas. Figure 2 reveals that high density residential areas locate on or close to natural-rural protection areas declared by the Environmental Plan of Istanbul. Increasing industrial facilities is the biggest problem of the water basin. Figure 2 illustrates how they stand on the plan based defined areas for rehabilitation, agricultural and natural–rural protection.

For the studies on the scale of stream impact area, two major streams examining different urban dynamics are selected from the stream network as Karasu and Kesliciftligi. Stream buffer and stream front terms are adapted from a study on urban streams existing outside the drinking water basins of Istanbul[15]. Regarding the difference between the streams existing inside and outside the water basins, this study enlarges the buffer radius from 250 to 500 m. The term of stream front is defined as ‘the direct contact area between the stream and the first line of buildings together with the transportation lines’[15]. Figure 3 illustrates the 500-m buffer areas and stream fronts of the two selected streams.

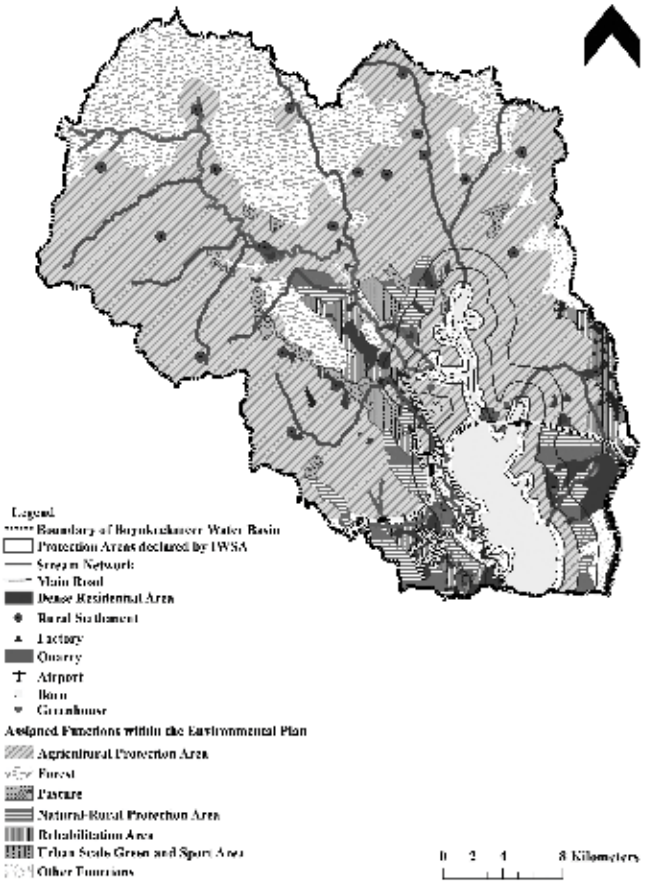


Fig. 2. Buyukcekmece Water Basin with its major streams, protection areas of Istanbul Water and Sewage Administration[4], current land uses, and assigned functions within the Istanbul Environmental Plan[10]

This study defines two sub-parameters for the green infrastructure capacity. The first sub-parameter is the ratio between the buffer area and stream front. The second sub-parameter regards the stream front existing on the natural-rural protection areas, forests and agricultural protection areas. Hence, it is essential to consider the stream fronts existing on the protection areas and not.

Openness to intervention is related to the interplay between rehabilitation area, natural threshold area, protection areas of Istanbul Water and Sewage Administration, and the stream buffer. Stream buffers standing on the rehabilitation areas, natural–rural protection areas, and the strict – short – middle distance protection areas are more open to landscape interventions than the others.

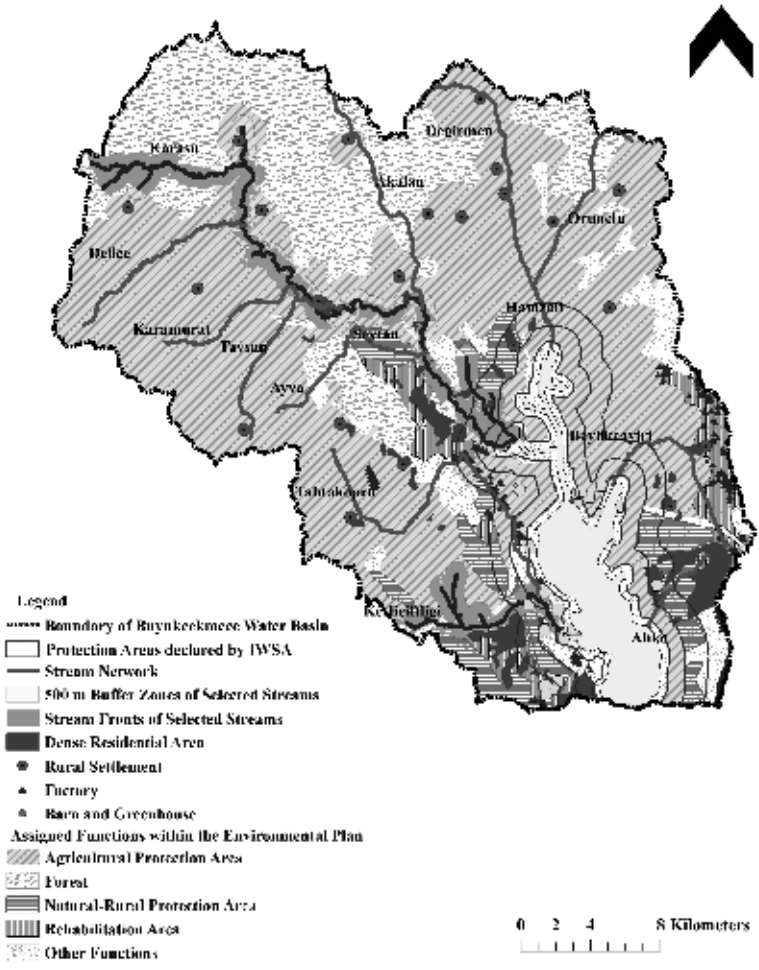


Fig. 3. Stream buffers and stream fronts of the selected streams and their interplay with the protection areas of Istanbul Water and Sewage Administration[4], current major land uses, and assigned functions within the Istanbul Environmental Plan[10]

The ratio between the buffer area and stream front of selected streams is an indicator of green network capacity. These ratios are calculated as 54.43% for Karasu Stream and 50.27% for Kesliciftligi Stream. Due to the first sub-parameter of green infrastructure capacity, Karasu Stream that is three times longer than the Kesliciftligi has a slightly stronger capacity than the other. The second sub-parameter of green infrastructure capacity regards the interplay between the stream front and the areas involving protection based plan decisions. GIS-based studies indicate that stream front area of Karasu Stream is 27 224 664 m^2 and Kesliciftligi is 9 884 194 m^2. According to these mapping studies, 93.04% of the Karasu stream front exists on the natural-rural protection areas, forests and agricultural protec-

tion areas while only 54.95% of the Kesliciftligi stream front exists on such areas. This significant difference remarks the higher green infrastructure capacity of the Karasu Stream.

Figure 3 illustrates the location of these streams and closeness of the barns, factories, greenhouses, and residential areas. All of these urban dynamics affect the ratios and ecological potential of streams. Extending to the northwest, Karasu Stream is located in a more rural area but experiencing a fragmented landscape due to dispersed settlements. Standing at the south, Kesliciftligi Stream is under the risk of urban development.

Openness to intervention parameter considers the amount of rehabilitation, natural-rural protection and IWSA strict to middle protection areas within the stream buffer zone. These areas constitute 76.54% of the Kesliciftligi and 30.42% of the Karasu Stream buffers. Hence, the Kesliciftligi stream appears to be more open to landscape interventions.

All these GIS-based studies reveal that although they have got differing characteristics both of the streams can be responsive to multi-scale landscape strategies.

CONCLUSIONS

Today, water basins are under the adverse impacts of rapid urbanisation and nonintegrated plans in the majority of megacities. By considering the complex dynamics and problematic landscapes of Istanbul megacity, this study forwards a two-phased evaluation process to develop multi-scale landscape strategies for the urban streams and water basin of Buyukcekmece Lake. In order to cope with the challenges of 21st century, cities should provide themselves with the multi-scale studies. There is an urgent need for developing landscape strategies for the urban streams and water basins. Regarding the benefit of megacities, this study constitutes an initial step for further studies.

REFERENCES

1. S. SENGUR, O. ATABEYOGLU, N. ERDOGAN, U. ERDEM: Climate Change and Effective Factors and Evaluation of Edremit Coastal Areas. J Environ Prot Ecol, **16** (2), 764 (2015).
2. K. T. DERICIOGLU, S. GUNDUZ: Evaluation of Ecological Belts and Corridors in Terms of Sustainable Spatial Planning with Specific Reference to the Istanbul Case. J Environ Prot Ecol, **12** (4), 1791 (2011).
3. D. KUSULUOGLU, G. AYTAC: Sustainability of Urban Fringes. Case Study of Arnavutkoy, Istanbul. J Environ Prot Ecol, **15** (2), 779 (2014).
4. IBB-Map: Online City Map Service of Istanbul Metropolitan Municipality. (http://sehirharitasi.ibb.gov.tr) (Accessed 05.07.2015) (2015).
5. ISKI-Map: Online Map Service of Istanbul Water and Sewage Administration. (http://harita.iski.gov.tr) (05.07.2015) (2015).

6. IPDEU: Istanbul Provincial Directorate of Environment and Urbanisation Environmental Impact Assessment Department, State of Environment Report 2012 Istanbul. (http://www.csb.gov.tr/db/ced/editordosya/ Istanbul_icdr2012%20(2).pdf) (Accessed 08.07. 2015) **(**2013).
7. B. ERGEN, Y. S. ERGEN, M. ERGEN: An Implementation and Investigation of Buyukcekmece Coastal Line According to Ecological Planning Approach. (http://webdeyim.net/tr/e_dergi/mimarlar-odasi-bursa-subesi/21-uluslararasi-yapi-ve-yasam-kongresi/2009/200) (Accessed 03.07. 2015) (2009).
8. IWSA: Istanbul Water and Sewage Administration Regulation for Drinking Water Basins (http://www.iski.gov.tr/Web/UserFiles/File/mevzuat/pdf/ISKI_Icmesuyu_Havzalari_Yonetmeligi.pdf) (Accessed 01.08.2015) (2011).
9. IDEF: Istanbul Directorate of Environment and Forestry- State of Environment Report 2005 Istanbul. (http://cdr.cevre.gov.tr/icd_raporlari/istanbul2005.pdf) (Accessed 01.07.2015) (2006).
10. Environmental Plan: 1/100 000 Istanbul Environmental Plan. (http://www.planlama.org/images/stories/ Dokuman/istanbul_cdp/CDP_13_02_2009_.gif) (Accessed 10.12.2014) (2009).
11. F. A. TURER BASKAYA, E. TEKELI: Coastline Changes and Istanbul Coastal Landscape. In: Proc. of the 12th International Conference on the Mediterranean Coastal Environment, Vol. 1, 2015, 171–182.
12. Environmental Plan Report Part 3: 1/100.000 Istanbul Environmental Plan Report Part 3. (http://www.planlama.org/images/stories/Dokuman/istanbul_cdp/3-b_il_butunu_aras_bulgulari.pdf) (Accessed 10.12.2014) (2009).
13. Environmental Plan Report Part 4: 1/100.000 Istanbul Environmental Plan Report Part 4. (http://www. planlama.org/new/images/stories/Dokuman/istanbul_cdp/4_swot_analizi.pdf) (Accessed10.12.2014) (2009).
14. Environmental Plan Report Part 7: 1/100.000 Istanbul Environmental Plan Report Part 7. (http://www.planlama.org/new/images/stories/Dokuman/istanbul_cdp/7_plan_kararlari_ve_gerekceleri.pdf) (Accessed 10.12.2014) (2009).
15. F. A. TURER BASKAYA: Urban Stream Enhancement – Revisiting Urban Streams of Istanbul. ITU AIZ Journal, **10** (2), 148 (2013).

Received 11 February 2016
Revised 15 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 711–718 (2016)

Environmental protection and sustainable development – landscape planning

INTERACTION BETWEEN URBAN DESIGN AND ERGONOMICS OF FITTINGS. CASE STUDY OF TRABZON COASTAL AREA

E. BAYRAMOGLU*, Y. CINDIK AKINCI, O. DEMIREL

Department of Landscape Architecture, Faculty of Forestry, Karadeniz Technical University, 61 040 Trabzon, Turkey
E-mail: *elifsol_@hotmail.com*

Abstract. Human beings are among the main components of the environment that they live in. Cities, on the other hand, are not just places where people conduct their daily activities, but the combination of spaces where people deal with such activities as resting and entertainment. Habitability of the urban areas can only be possible in an environment which is compatible with its users. From this perspective, the interaction of people with the urban fittings placed in the city is a key factor in increasing the quality of life of people sharing the urban life. Elements of urban fittings maintain a physical interaction between the users and the area, being in harmony with the environment they are placed in and gaining function and an identity for the given area. Elements of urban fittings that enable different activities for different users should be suitable for the measurements of human body. As a result, elements of urban fittings should comply with ergonomic–anthropometric principles in the evaluation of the physical environment. The current study has been conducted in order to reveal the importance of ergonomics with the approach of increasing the quality of life of the users of urban areas that benefit from the open green spaces within the city. In this sense, the ergonomic compliance of the elements of landscape fittings placed on the Trabzon Shoreline recreational area, which is intensively utilised especially during the summer months and constitute the only access point to the sea for the community, will be assessed. Trabzon shoreline will be evaluated in terms of purpose of utilisation and access to the city. By applying an interview to the users, the interaction of human-fittings-ergonomics will be investigated. At the end of the study, suggestions will be made especially to adjust the physical environment to the optimum level for its users.

Keywords: urban design, ergonomics, elements of fittings, Trabzon coastal area.

AIMS AND BACKGROUND

Urban green has a positive impact to the microclimate and air texture updates humans quality of life, also improves both architectural and aesthetics view of cities[1,2]. Cities are not only considered for their buildings, but for open spaces outside the buildings as well. Therefore, exteriors of the buildings should be 'habitable' as well as their interiors. Main components of the spaces that are outside the buildings include urban areas like streets and squares. Being means of communication, streets, avenues and squares play a crucial role in the interaction between man –

* For correspondence.

environment and creative power of mankind[3]. The ones that really make the urban open spaces more habitable and perceivable are the landscape elements, which are made up of live (botanical elements) and inorganic materials (elements of fittings). Elements of fittings that are called inorganic landscape elements enable visual and physical interaction between the city and users[4]. Elements of urban fittings, the user of which is the mankind, should be designed in compliance with human beings in terms of colour, form and style. The discipline of anthropometry has been developed as a result of this. Anthropometry is the field of science that deals with the measurements of human body and its common factor with landscape architecture is 'human'[5]. Anthropometrical dimensions may vary depending on nation, region, age, sex, physical activity and even vary according to the economic and social status. Therefore, there are certain standards.

The current study has been conducted on the Trabzon Shoreline pathway, which is intensively utilised especially during the summer months. In the study, the compliance of benches, rubbish bins, illuminating elements, signboards and land markers with anthropometric and ergonomic criteria has been assessed. Apart from that, a questionnaire was implemented to the users during busy hours of the day, aiming at evaluating the elements of fittings.

Landscape architecture-ergonomic-anthropometry. The term 'ergonomics' derives from the Greek words 'Ergon' and 'Nomic'[3]. According to Heng (1987), ergonomics is the implementation of engineering disciplines in connection with the fields that study the biological structure of human beings[6]. Ergonomics, in fact, aims at enabling all creatures live in harmony and maintaining healthy relationships with the environment they are surrounded by. Anthropometry is the branch of science that analyses the human and dimensions of human body metrically and socially, depicting peculiar differences of human beings[5,7]. In other words, anthropometry is the branch of science that defines the differences across individuals and groups by measuring the human body[8]. Anthropometry is not a result-oriented branch, yet it serves as a means to attain results[9]. It was first introduced by the Belgian mathematician Quetlet in the second half of the 19th century, so as to identify the similarities and differences across individuals and groups[8].

While meeting their daily needs, human beings need some materials, devices, machinery and equipment. These are classified as elements of fittings in the field of landscape architecture[10]. Elements of fittings are the objects that facilitate the lives of people in the urban texture, maintain interaction among individuals, make the environment more functional, define and complete its surroundings[11]. Elements of fittings in urban areas can vary depending on the purposes of use. In literature[12], the elements of fittings are classified in the following groups: floor elements (concrete, stone, asphalt, stone, brick, etc.); sitting elements (benches, chair, group elements); lighting elements; sign and information boards (routers, locators, traffic barriers); surrounding elements (pedestrian barriers, traffic barriers); water element (ponds,

fountains, canals, etc.); cover elements (pauses, canopies, pergolas), sales elements (buffets); art objects (sculptures), and other items (flag poles, trash cans, mailboxes, flower beds, bike parking, watches, planting elements).

Design criteria of urban fittings: they should be evaluated in functional, psychological and technological terms. Functional criteria: it is the compatibility of urban objects with the physical features and action characteristics of human beings. Psychological criteria: these are the criteria that maintain the environmental measurement in accordance with the socio-cultural features of the society based on perception and evaluation. Technological criteria; they are the combination of all the criteria regarding materials, products and economy[13]. Designs compatible with the measurements of human beings are usually preferred in the implementations of landscape architecture. The required standards for landscape elements located in urban spaces are explained in Table 1 according to Refs 14–18.

Table 1. Standards for landscape elements

Sidewalks	*Height: 12–15 cm *Width: 150 cm	*Covering material should not be slippery *Should not be reflect light
Pedestrian way	*Slope: 1–3% *Width: 150 cm	*Covering material should not be slippery *Should not be reflect light *Some cases slope can be increased up to 5% *Short distance paths max slope 10%
Lighting elements	*Pedestrian way: 3–4 m *Street: 4.5–6 m *Main street: 7.5–9 m *Highway: 10–12 m	*To provide visual access in proper position and illumination level *It must support the structural and plant design *It must ensure colour surrounding structure
Sign and information boards	*Height: 210–250 cm	*It must be located in appropriate visual access in the space
Dustbin	*Height: 60–120 cm	*According to different materials used and the user space
Sitting elements	*Height: 40–50 cm *Width: 40–50 cm *21.5 to 22.8 cm above the armrest seating surface	*Back should be 50 cm height *It must be able to sit back slightly inclined and curved for comfort *Material must be appropriate to the weather conditions, vandalism and corrosion
Cycle ways	Slope: lengthwise max 3% transverse min. 2% One way 100 cm, double way 200 cm	*It must be hinder to the pedestrian and vehicle traffic *It should not be bumps and pit on the road *It should be asphalt coating *It can be used of blue ground path

'Human being' is the shared factor by anthropometry and landscape architecture. Only with the knowledge provided by anthropometry is it possible to create places suitable for human beings[3]. The common goal of landscape architecture – ergonomics-anthropometry implementations is to regulate the open spaces in the most suitable way in terms of health, safety and comfort, so as to be able to ensure the harmony in the human-machinery-work place[19]. The means that users of the urban open spaces utilise for their daily activities are called the elements of fitting. The measures of all types of elements of fittings placed in the urban area are evaluated in a unity. The common goal is to ensure that the user of these areas, human beings, can use and move their body organs (hand, face, arms, feet, etc.) as they wish. Therefore, the elements of fittings placed in urban open spaces should be designed suitable for the measurements of human body, and elements of urban fittings should be made ergonomic by designing them according to the features of individuals.

EXPERIMENTAL

The current study has been conducted on the Trabzon Shoreline recreational area, which is intensively utilised especially during the summer months and constitutes the only access point to the sea for the community, in order to reveal the importance of ergonomics with the approach of increasing the quality of life of the users of urban areas that benefit from the open green spaces within the city. Covering an area of 6685 km^2, the province of Trabzon is located in the eastern part of the region. Thanks to its shoreline, urban texture and peculiar cultural values, Trabzon embraces various different beauties. The shoreline of the province of Trabzon is 135 km along the Black Sea. The area of study covers the strip between Trabzon Ayasofya junction and the junction located at the end of Besirli area. All types of elements of fittings placed along the shoreline pedestrian pathway have been accounted for study material.

Landscape research methods based on data collection, analysis and synthesis were implemented in the current study. The area of study was observed, photographed and analysed at different times of day. A questionnaire was implemented in the scope of the study at evening hours of weekdays, when the area is most crowded. The questionnaire was applied to 80 individuals in August 2015. Randomly selected participants were used in the study through face-to-face meeting method. In the survey, socio-demographic characteristics of participants were determined and they were asked whether the elements of fittings (rubbish bins, benches, signboards, and illuminating elements) were ergonomically suitable for use. Existing elements of fittings were identified in the area, and they were assessed in terms of compliance with ergonomic standards in the light of the obtained information. Assessed elements of fittings were evaluated in comparison

with the anthropometric measurements according to Ref. 14, required standards for landscape elements (Ref. 15), and data provided[16–20].

RESULTS AND DISCUSSION

The findings acquired in the study were evaluated in two groups in accordance with the implemented questionnaire: I. Socio-demographic status of users, and II. Suitability of the elements of fittings placed in the area in terms of ergonomics of study for use.

Socio-demographic status of users. Socio-demographic characteristics of users were identified in the first part of the questionnaire. 56% were female participants while 44% – male, 39% were in the 15–20 age group, 42% – in the 21–35 age groups, and 19% – in the 35–50 age groups. Considering the occupational groups of the participants of the survey, it was found out that 28% worked in the private sector, 18% – retired, and 34% – students, 10% worked for the state sector and 10% were unemployed. Participants were asked with which purpose they used the shoreline pathway and it was found out that 24% used it for sightseeing, 27% used it for walking and hiking, 11% for exercise on apparatus, 18% for eating, 14% for sitting and relaxing and 6% used it for fishing.

In the second part of the questionnaire, participants were asked about the frequency of their use of the elements of fittings placed along the shoreline pathway; 65% used them quite frequently, 13% used them randomly and 12% indicated that they never used those elements of fittings. 65% of the participants responded that they most frequently used the shoreline pathway and the fittings on it during summer, 20% during spring, 10% during fall and 5% during winter. Regarding the question about the sufficiency of the number of elements of fittings on the shoreline pathway, 68% assumed benches were sufficient while 86% thought the illuminating elements were enough; 75% of the participants believed rubbish bins were insufficient while 89% were content with the number of signboards; 65% thought limiting elements were insufficient while 88% were happy with the sculptures.

Regarding the question about the whether they approved of the proper ergonomically equipment components 28% were not appropriate while 72% were appropriate. They stated that the approval only of those annoying the living unit. They also stated that there were insufficient places in the lighting fixtures.

Suitability of the elements of fittings placed in terms of ergonomics. Sitting elements are wooden material and fixed on concrete in the study area. According to Ref. 21, sitting units must be in order to satisfy to user requirements and structure. In the study area sitting settlements are intervals along the walkways: 200, 180, 60 and 30 cm. Sitting elements widths are different sizes to be desired in terms of users. Because people sitting with groups at a different number in the coast road. Sitting elements depth of 110 cm is not suitable for standards. However, it appears to be

an appropriate seating equipment designed to be used as doubled-sided. High from the ground of sitting elements vary from place to place: 20, 30, 40, and 58 cm. The height of sitting clement is supposed to be 37–45 cm. In this case people are at ergonomically uncomfortable level. In addition, the absence of a certain period of time the user clicks the back after sitting element is caused to pull back pain.

Walking and jogging paths along the coastal strip of discrimination is separated by floor covering and floral elements. This is very suitable for people who are not disturbed for sports. This value is the width of the runway 180 cm anthropometric (not less than 150 cm) was viable. Seating elements of the material because it directly affects physical comfort, ergonomics and design directly affect the user physical comfort[22]. Similarly, it was recorded that the room for two pedestrians to walk side-by-side should be about 110–130 cm (Ref. 14). Dustbin is fixed and standard. In the study area bears the signs provide users with quality information and directions. Also provide the information at regular km interval. Lighting elements in coastal road area are high quality and two. Such lighting components are not suitable for areas of activity in terms of spread and the nature of light. Lighting elements in place to be used and should be used selectively to function in compliance with the environmental organisation[23]. More should be included on the sea floor near the lower and lighting fixtures.

CONCLUSIONS

The profession of landscape architecture aims at creating aesthetic, functional and, at the same time, useful spaces for human beings in accordance with the principles of planning and design. Needs of these spaces, whose users are human beings, can only be met and their harmony with their surroundings can only be maintained by designing them ergonomically suitable. While creating functional spaces harmonious with nature, all types of materials and measurements used must comply with anthropometrical values so that comfort is ensured. As a result, elements of fittings used in such spaces should be correlated directly with the measurements of human body. While considering the elements of fittings as per international standards, such criteria as age and gender of the users and the characteristics of the region they are placed should also be taken into account. Urban fittings should be perceived as a component of the human-tool-environment system during the design process. With the purpose of meeting the needs of individuals, urban fittings should be designed compliant to physiological, psychological characteristics of human beings, analysing the relationship with their perceptional and behavioural features. Accordingly, elements of fittings should be functional, permanent, fit for purpose, and feasible for the users. Hence, the sitting height of the benches, which are the most frequently used elements of fittings, their leaning parts and inclinations, the height of rubbish bins and their arm-reach distance, illuminating

angle of illuminating elements and the distance between them, height and stance of signboards, height and width of limiting elements should all be identified taking into consideration the anthropometric measurements. It must be provided psychological and technological criteria for urban furniture design. Based on the observations made on the shoreline of Trabzon, limited with the area of study, it was determined that the frequency of use was higher during evening hours. Users mostly prefer using this area with the purpose of cooling off during hot summer days, sightseeing, walking, eating and exercising on apparatus.

Urban fittings elements are suitable for ergonomics standards. In addition to this serious problems have been observed. In particular more of width and the lack of seating recline share is a big problem for the users. Furthermore, no differences of height of the seating elements are not a desirable situation. It must bring the appropriate standard of lighting fixtures along the coastal belt. According to the low lighting should be included in ergonomic standards along the coastal zone. Instead of using uniform lighting elements there should be use according to vary. Dustbins are general standard size and stable, but it is insufficient. It is achieved by not disturb people, both physically and in terms of health, social, cultural, economic and psychological aspects of providing a high efficiency by the use of appropriate anthropometric measurements. This is an unavoidable reality as work in landscape architecture at every stage of our lives.

REFERENCES

1. T. YILMAZ, F. SAVKLI: Effects of the Use of Water Features in Antalya Urban Parks. J Environ Prot Ecol, **15** (4), 1603 (2014).
2. P. KARANIKOLA, S. TAMPAKIS, E. RANTZOUDI: Evaluation of the Problems Created by Trees and Bushes to the Urban Environment. J Environ Prot Ecol, **9** (3), 698 (2008).
3. S. ONER BILEN: The Investigation of Landscape Staff Given in Ankara Example Depending on Anthropometric Data in Designing Urban Outdoor Areas. Ph.D. Thesis, Ankara University Graduate School of Natural and Applied Sciences Department of Landscape Architecture, Ankara, 2004.
4. N. BAYRAKTAR, A. TEKEL, O. ERCOSKUN YALCINER: An Evaluation and Classification of Urban Furniture on Ankara Ataturk Boulevard and Relation with Urban Identity. J Fac Eng Arch Gazi Univ, **23** (1), 105 (2008) (in Turkish).
5. A. KARTAY, A. B. KORKUT: Landscape Architecture-Anthropometry Relationship: The Case of Istanbul. Journal of Tekirdag Agricultural Faculty, **6** (3), 245 (2009) (in Turkish).
6. S. GUNEY: Psychological Structure and Ergonomics for People. In: Proc. of the 1st System Engineering and Defense Applications Symposium. I. Military Academy, a Former Presidency of the Department of System Management Sciences, Ankara, 1995 (in Turkish).
7. Y. KORKMAZ: The Effect of a Summer Camp on Social Anthropological Improvement of the Kids in Turkey. Anthropologist, **19** (1), 65 (2015).
8. J. PANERO, M. ZELNIK: Human Dimensions and Interior Space. A Source Book of Design Reference Standards. The Architectural Press Ltd., London, 1979.
9. E. GULEC: Antropometric Dimension of Anatolian People. Ankara University Scientific Research Project, Final Report, 2006.

10. B. GULGUN, B. TURKYILMAZ: Zusammenfassung Untersuchungen Über Umweltsplanung smoglich keiten in Objectsebene und Die Ergonomic Als Bzw. Ihre Bedectung Awf Das Manschensleben Als Beipsiel in Bornova. Ege Uni J of Agr Fac, **38** (2–3), 127 (2001).
11. A. GUNEY, U. ERDEM, B. ZAFER, S. HEPCAN: Landscape Construction. Ege Uni J Agr Fac, 514 (1996).
12. P. KUSKUN: A Research on the Use of Outdoor Furniture in the Case of Erzurum, Master Thesis, Ataturk University, Institute of Science, Erzurum, 2002.
13. C. ZULFIKAR: Use Relationship of Urban Furniture. Master Thesis, Istanbul Technical University, Institute of Science, Istanbul, 1998.
14. L. R. AUSTIN, R. T. DUNBAR, J. P. HULVERSAN: Graphics Standards for Landscape Architecture. New York, USA, 1986.
15. E. P. NEUFERT: Architects' Data (Eds B. Baiche, N. Walliman). 3rd ed. Willey-Blackwell, UK, 2002. 636 p.
16. C. W. HARRIS, N. T. DINES: Time-saver Standards for Landscape Architecture. McGraw-Hill Education, New York, 1997, 928 p.
17. B. GULGUN, I. ALTUG: A Research on Evaluating the Izmir Promenade Applications' Appropriateness due to Ergonomic Standards. Ege University Journal of Agricultural Faculty, **43** (1), 145 (2006).
18. S. ONDER, A. T. POLAT, A. OZTURK: The Evaluation of Ergonomic Situations of the Equipment Elements in Selcuk University Campus, Konya. Journal of Selcuk University Natural and Applied Science, **1** (1), 30 (2012).
19. I. YORUK, B. GULGUN, M. SAYMAN, F. U. ANKAYA: Examining the Ege University Campus by the Concept of Ergonomy and Anthropometry in the Embrace of Landscape Architecture Applications. Ege University Journal of Agricultural Faculty, **43** (1), 157 (2006) (in Turkish).
20. E. BAYRAMOGLU, B. OZDEMIR: The Evaluation of the Urban Furniture Through Uzun Sokak in Trabzon City in Front of Urban Identity. Kastamonu University Journal of Forestry Faculty, **12** (2), 182 (2010).
21. J. GEHL: Life between Buildings. Van Nostrand Reinhold, New York, 1987.
22. B. KARAKAYA, T. KIPER: Investigation of Hospital Outer Space Design in Edirne City. Journal of Tekirdag Agricultural Faculty, **8** (2), 49 (2011).
23. L. GUREMEN: A Research about Urban Furniture in the Aspect if Urban Identity and Aesthetics within the Example of Amasya Province. e-Journal of New World Sciences Academy, **6** (2), 254 (2011) (in Turkish).

Received 11 February 2016
Revised 13 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 719–726 (2016)

Environmental protection and sustainable development – landscape planning

MARINE AND COASTAL AREAS INFORMATION SYSTEM WITH GEOGRAPHIC INFORMATION SYSTEM (GIS) BASED ON CLOUD COMPUTING. TRABZON EXPERIENCE

Y. S. ERBAS*, R. NISANCI, S. BEDIROGLU, G. YILMAZ

Department of Geomatics Engineering, Karadeniz Technical University, 61 080 Trabzon, Turkey
E-mail: *yselcukerbas@hotmail.com*; *rnisanci@gmail.com*; *sevketbediroglu@gmail.com*; *gmzeyilmaz08@gmail.com*

Abstract. Marine and coastal areas take an important place in Turkey, especially, the coastal provinces. Marine areas have intensive information sets including sea bed, sea surface and coastal areas. So the spatial data are needed for a sustainable management of marine and coastal areas in Turkey. It is very easy accessibility these collected spatial data with internet technology. Cloud Computing (CC) which it is internet technology phenomena is rising fast, with its data centres growing at an unprecedented rate. One can easily store data, data view or data processes on internet with this system (CC). Cloud-based system is not only accessible computers, it can be used with phones, tablets, etc. and it is a system based on GIS. In this study we have prepared a 'Marine Area Information System' with cloud computing based on GIS for Trabzon province at the Black Sea region of Turkey.

Keywords: marine area, cadastre, cloud computing, GIS.

AIMS AND BACKGROUND

The management of the national marine ecological resources depends on the constant improvement of scientific methods and information resources among the researchers of the marine community. These improvements must come in the form of better information and better access to information. To this end, the marine community must develop standard methods of data management and analysis, which provide rapid dissemination of data, easy comparability of research findings, and simple means to carry out complex analysis[1]. Coastal and marine areas have a great value for the welfare of the country, communities and the regions. These areas contribute a great deal for improving the living standards of social, economic and natural functions[2]. In the world marine cadastre are applied in various countries with GIS. Usually GIS is used in sustainable studies and projects all over the world[3], for example, in the United State, National Oceanic and Atmospheric Administration (NOAA) at the Department of Commerce and Ocean Planning Information System (OPIS). Within Australia, the Australian and New Zealand

* For correspondence.

Land Information Council (ANZLIC, the nations peak spatial information body) has recommended that the Australian SDI (ASDI) incorporate spatial information relating to all of Australia, including the marine environment. In New Zeland, Land Information New Zealand (LINZ) is produced. It is a New Zealand government department responsible for land titles, geodetic and cadastral survey systems and variety of other functions. And also studies of marine cadastre continue in Canada, Holland and South Korea[4].

Cloud Computing (CC) whose internet technology phenomena are rising fast, with its data centres growing at an unprecedented rate (Fig. 1). Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimum management effort or service provider interaction[5]. Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in third-party data centres[6]. Cloud computing, or in simpler shorthand just 'the cloud', also focuses on maximising the effectiveness of the shared resources. Cloud resources are usually not only shared by multiple users but are also dynamically reallocated per demand. This can work for allocating resources to users. For example, a cloud computer facility that serves European users during European business hours with a specific application (e.g. email) may reallocate the same resources to serve North American users during North America business hours with a different application (e.g. a web server). This approach helps maximise the use of computing power while reducing the overall cost of resources by using less power, air conditioning, rack space, etc. to maintain the system. With cloud computing, multiple users can access a single server to retrieve and update their data without purchasing licenses for different applications (Fig. 1).

Proponents claim that cloud computing allows companies to avoid upfront infrastructure costs, and focus on projects that differentiate their businesses instead of on infrastructure[7]. Proponents also claim that cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and enables IT to more rapidly adjust resources to meet fluctuating and unpredictable business demand[8,9]. The present availability of high-capacity networks, low-cost computers and storage devices as well as the widespread adoption of hardware virtualisation, service-oriented architecture, and autonomic and utility computing have led to a growth in cloud computing[10,11]. Cloud computing is a super computing paradigm based on internet, which makes use of computer nodes in the cloud cluster through a network to complete a computing task in parallel[12]. The technology and architecture that cloud service and deployment models offer are the key areas of research and development for geographic information system (GIS) technology[13]. Cloud technology capabilities make it possible to combine data services from various data providers and distribute geospatial processing to

other processing service providers[14]. This capability can be as simple as running a GIS on a cloud platform[15]. Geographic Information Systems (GIS) have gained popularity in recent years because they provide spatial data management and access through[16], so that in this study the marine and coastal areas information system is built with cloud computing.

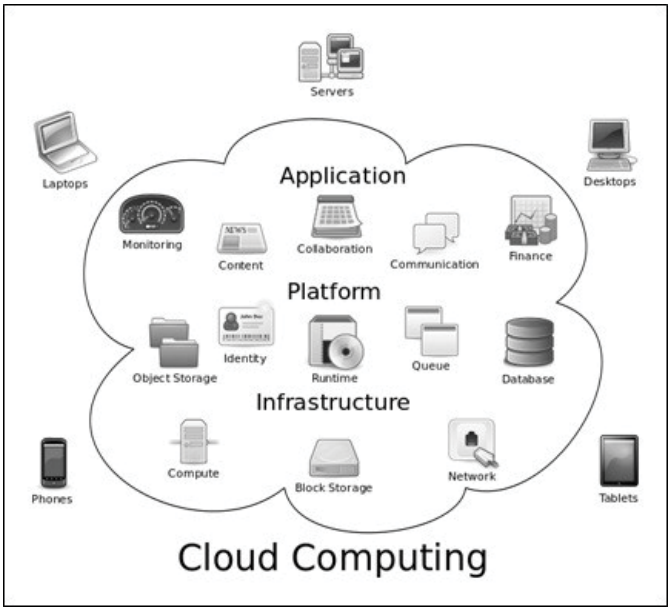


Fig. 1. Cloud computing application

EXPERIMENTAL

In these days tourism and industrialisation initiatives increase on the marine and coastal areas. So marine and coastal areas information system is needed for sustainability and protection of marine and coastal areas. In this study as the research area was selected the city of Trabzon marine and coastal area (Fig. 2). Total coastal length of Trabzon is 161.5 km. Study aim was ensuring the management of marine and coastal areas for planning marine area with support of information technologies for sustainable management.

Marine and coastal information system enables the boundaries of maritime rights and interests to be recorded, spatially managed and physically defined in relationship to the boundaries of other neighbouring or underlying rights and interests.

Fig. 2. Study area (Trabzon)

Firstly, Trabzon Environmental Master Plan and fish farms from satellite images were analysed. Coordinates required for spins, which are currently obtained from municipalities are obtained from the map for using satellite images (Fig. 3).

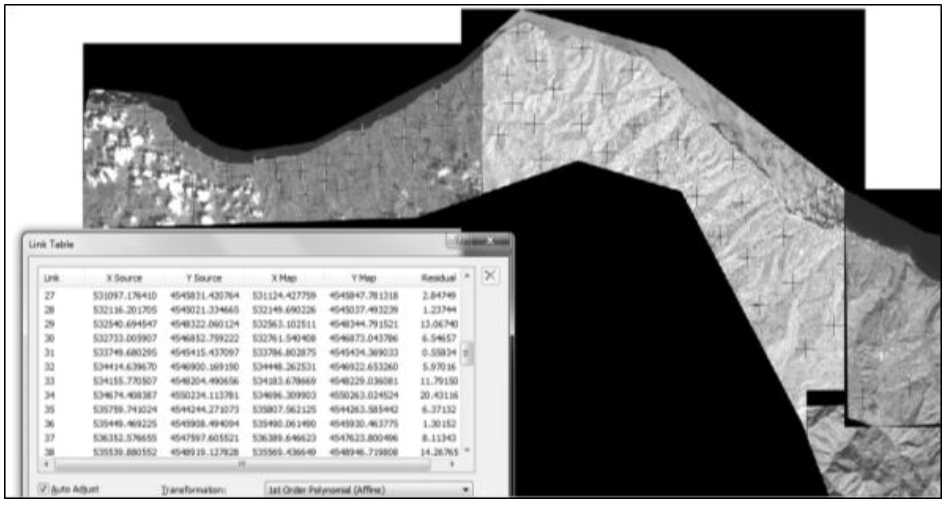


Fig. 3. Checkpoints and theirs entering

The others spatial data related to marine and coastal areas such as anchorage areas, sand exraction areas, shoreline, harbours, lighthouses, shipyards, discharge lines, marine military zones and restricted zones, port authority boundaries were collected (Fig. 4). All these data were collected in ArcGIS software.

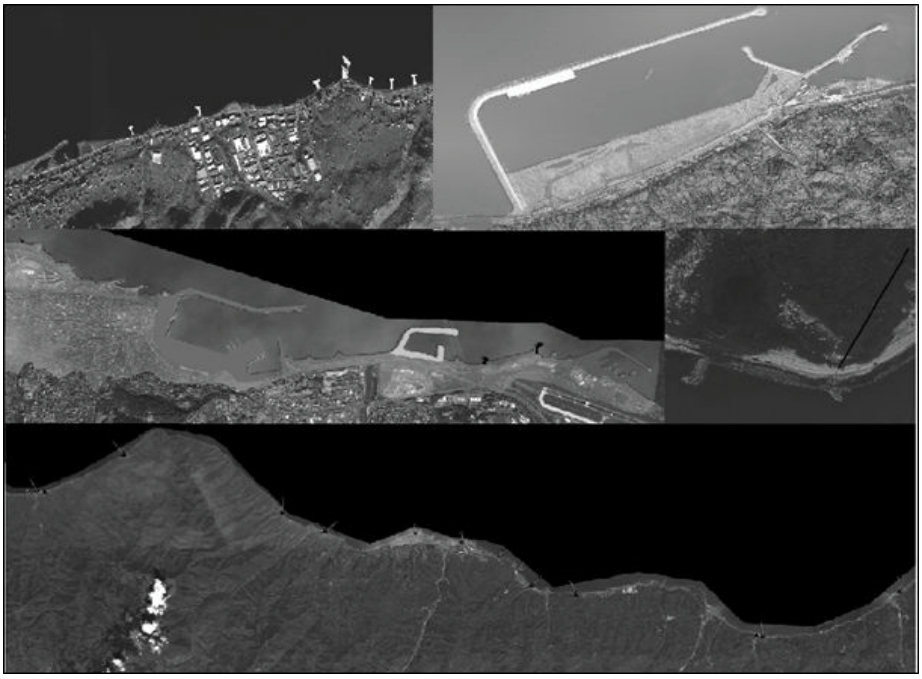


Fig. 4. Collected spatial data on marine and coastal areas

All collected spatial data and their information are presented by CC technology (Fig. 5). Flexibility and speed in making spatial analysis problems are available in the Classic WebGIS application. This problem is eliminated with CC technology and so the cost is reduced.

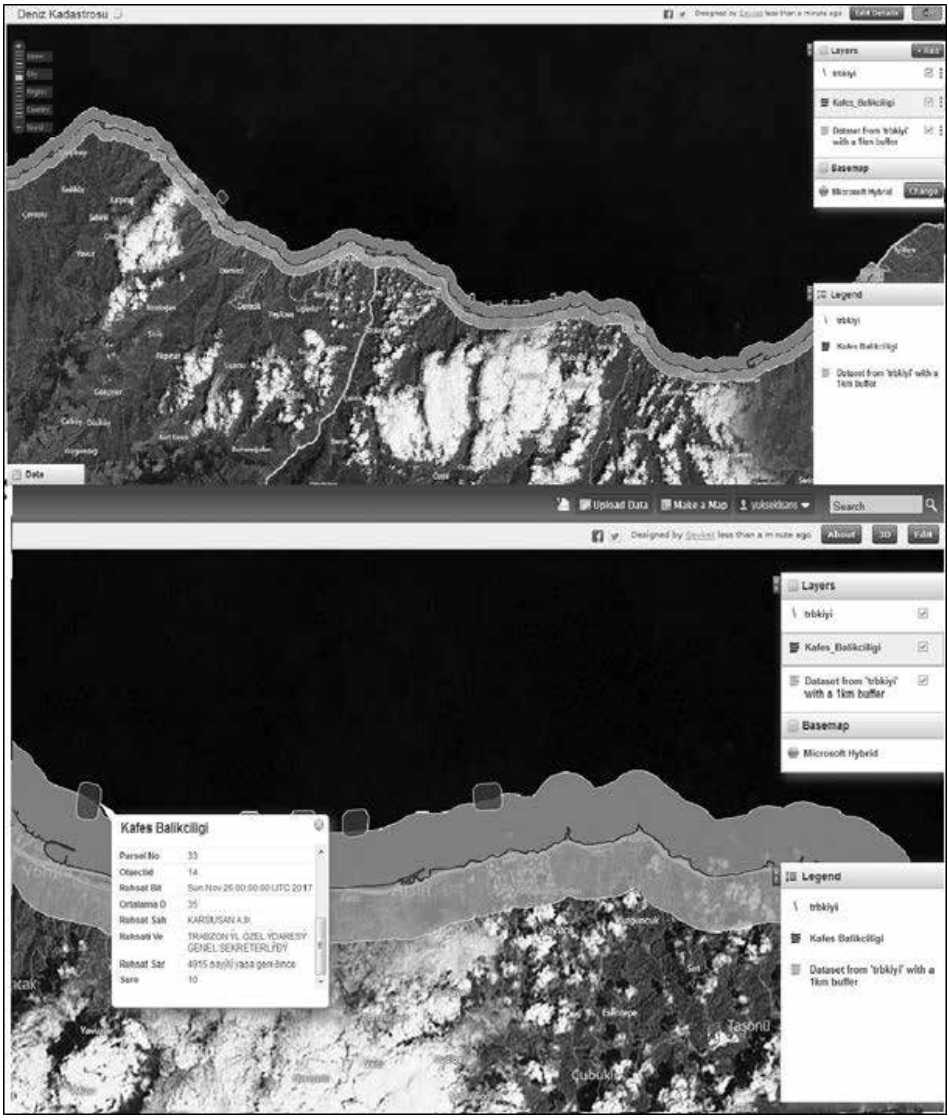


Fig. 5. Collected spatial data are presented by CC technology

DISCUSSION AND CONCLUSIONS

In these days marine and coastal areas must be protected because these areas are disappering day by day. Thus, a spatial information system is an improtant need about marine and coastal areas. Geographic information system (GIS) softwares are the most suitable programs for spatial information systems. In this study, ArcGIS 10 (one of the GIS softwares) is used because it constitutes an useful tool

for protection of coastal and marine areas, as well as in management projects. It is used in defining, recording, analysing the rights and benefits on the coastal and marine areas with defining their relationships. It will provide an extensive spatial data information that includes rights, boundries and responsibilities to be managed around the marine and coastal areas. In this way the managers will have a good information system to the best knowledge that exists for the purposes of management and applications. Besides ArcGIS software is compatible with cloud computing. Their data formats are suitable for easy presentations with CC.

Presentation of marine and coastal areas information system based on CC provides too many adventageous criterias for GIS such as flexibility, cheapness, sustainability, etc. Classic WebGIS applications are very complex, slow and very expensive. There is no data loss with CC technology because all spatial and non-spatial data are stored in the internet. CC is useful and easily applicable in client or developer side. Through CC spatial data users can easily access their spatial data from everywhere with their mobile phones, tablets, personel computers or another device regardless of installing any GIS programs. So that in this study, a marine and coastal areas information system model based on CC is suggested for coastal and marine areas of Trabzon province with GIS.

Acknowledgements. The authors would like to thank the Scientific and Technological Research Council of Turkey (TUBITAK; project number: 109Y304) for its financial support.

REFERENCES

1. B. K. LORD-CASTILLO, B. R. MATE, D. W. WRIGHT, T. FOLLET: A Customization of the Arc Marine Data Model to Support Whale Tracking via Satellite Telemetry, Transactions in GIS, **13** (S1), 63 (2009).
2. M. S. WIDODO: The Needs for Marine Cadastre and Supports of Spatial Data Infrastructures in Marine Environment – A Case Study. Paris, France, April 13–17, 2003.
3. E. TOK, F. PEKER, Y. KURUCU, H. H. TOK, E. SAYGILI:. Determining and Mapping the Potential Organic Farming Areas in Istanbul. J Environ Prot Ecol, **14** (2), 675 (2013).
4. R. NISANCI, Y. S. ERBAS, V. YILDIRIM, H. E. COLAK: Management of Marine Cadastre with Geographic Information System: a Case Study of Trabzon. J Environ Prot Ecol, **16** (1), 126 (2015).
5. P. MELL, P. GRANCE: The NIST Definition of Cloud. Computing Computer Security Division Information Technology Laboratory, National Institute of Standards and Technology, Gaithersburg, 2011.
6. M. HAGHIGHAT, S. ZONOUZ, M. ABDEL-MOTTALEB:.CloudID: Trustworthy Cloud-based and Cross-enterprise Biometric Identification. Expert Systems with Applications, **42** (21), 7905 (2015).
7. URL-1: What Is Cloud Computing? 2015. http://aws.amazon.com/what-is-cloud-computing/, Final Access date: 01.09.2015.
8. URL-2: The Rising Cloud Storage Market Opportunity Strengthens Vendors. 2015. http://technews.tmcnet.com/channels/cloud-storage/articles/211183-rising-cloud-storage-market-opportunity-strengthens-vendors.htm. Final Access date:02.09.2015.

9. URL-2: The Rising Cloud Storage Market Opportunity Strengthens Vendors. 2015. http://technews.tmcnet.com/channels/cloud-storage/articles/211183-rising-cloud-storage-market-opportunity-strengthens-vendors.htm Final Access date:02.09.2015.
10. URL-3: Cloud Computing Clash of the Clouds. 2015. http://www.economist.com/node/14637206, Final Access date:31.08.2015.
11. E. KNORR: What Cloud Computing Really Means? InfoWorld, 2008. http://www.infoworld.com/article/2683784/cloud-computing/what-cloud-computing-really-means.html. Final Access date:01.09.2015.
12. R. BUYYA, G. S. YEO, S. VENUGOPAL, J. BROBERG, I. BRANDIC: Cloud Computing and Emerging IT Platforms: Vision, Hype, and Reality for Delivering Computing as the 5th Utility. Future Generation Computer Systems, **25** (6), 599 (2009).
13. V. KOUYOUMJIAN: GIS in the Cloud: the New Age of Cloud Computing and Geographic Information Systems. ArcNewsmagazine, 2010, 1–31.
14. K. EVANGELIDIS, K. NTOUROS, S. MAKRIDIS, C. PAPATHEODOROU: Geospatial Services in the Cloud. Computers & Geosciences, **63**, 116 (2014).
15. H. WILLIAMS: A New Paradigm For Geographic Information Services. Spatial Cloud Computing (SC2) White Paper, 2010, 1–9.
16. D. FUSTES, D. CANTORNA, C. DAFONTE, B. ARCAY, A. IGLESIAS, M. MANTEIGA: A Cloud-integrated Web Platform for Marine Monitoring Using GIS and Remote Sensing. Application to Oil Spill Detection through SAR Images. Future Generation Computer Systems, **34**, 155 (2014).

Received 11 February 2016
Revised 20 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 727–736 (2016)

Environmental protection and sustainable development – landscape planning

DETERMINATION OF THE ENVIRONMENTAL STATUS OF AKCAKOCA COASTAL AREAS THROUGH HIERARCHICAL ANALYSIS

P. K. AYDEMIR, G. F. GOKCE*, O. DEMIREL, M. OZBAY

Environmental Protection and Control Department, Kaynasli Vocational College, Duzce University, Duzce, Turkey
E-mail: *dr_gumusfunda@hotmail.com*

Abstract. The fact that urban development plans, which are the main tool of physical planning endeavors, consider coastal areas just as potential urban settlement zones can cause deterioration of the coastline and irreversible ecological damages. Therefore, redesigning efforts of the coastal areas started in the 1970s, and legal regulations were introduced regarding the coasts and utilisation of coastal areas. This approach aims at re-maintaining the harmony of coasts and cities, which has been lost due to unplanned utilisation. The purpose of this study is to determine the current status of utilisation in the coastal areas located in Akcakoca district, and evaluate the environmental effect of the coastal areas, which were deemed as 'area for public use' on Akcakoca district, accompanied with coastal definitions, legal and administrative approach to coasts and Environmental Consciousness movement of post 1970. In this perspective, the utilisation forms of coastal areas in Akcakoca-Duzce will be identified, and SWOT (Strengths–Weeknesses–Opportunities–Threats) and AHP (Analytical Hierarchy Process) methods will be applied for the analysis of environmental status.

Keywords: utilisation of coastal areas, 1970 environmental consciousness, analysis of ecological and environmental status, Akcakoca.

AIMS AND BACKGROUND

AREA OF STUDY

The area of study is located in the Western Black Sea Region of Turkey. It starts at the point where Melen stream disembogue into the sea in the North, and ends at the point where Melen meets with Karataş stream in the South[1]. It covers a surface area of 463 km^2. It is composed of 8 neighbourhoods namely, Osmaniye, Ayazli, Yali, Orhangazi, Cumhuriyet, Haci Yusuflar, Yukari and Yeni Mahalle[2] .

In the study, Application Development Plan scaled 1/1000, documents containing notes on Application Development Plan scaled 1/1000 and Master Development Plan scaled 1/5000 were used as the main materials. Environmental Plan Decisions scaled 1/25 000, and current and potential development decisions of

* For correspondence.

the area were also analysed. On-site observations, aerial photographs and digital images were used in the field study. In order to identify the forms of utilisation and current status of the coastal areas located within the border of the adjacent area of Akcakoca Municipality, Analytical Hierarchy Process (AHP) method based on a survey implemented to a group of specialists was employed, and the environmental status was evaluated through the method of SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis.

COASTS OF AKCAKOCA AND FORMS OF UTILISATION

The coasts of Akcakoca are about 30 km in length. It has the beaches of Geneose Fortress, Edilli, Degirmenagzi, Akevler, Cinar, Cayagzi, Cuhalli, Kalkin, Limoncuk and Karaburun. Tourism in Akcakoca, which is mainly based on recreational facilities, dates back to 1948.

It has a significant potential for being close to Ankara and Istanbul. Buildings standing along the shore are (in accordance with Law of Tourism Promotion Law) the touristic buildings, namely secondary residences, hotels and recreational areas.

There are currently 28 tourism facilities offered for accommodation, 4 of which bear the license given by the Ministry of Tourism . As per Law of Tourism Promotion Law No 2634, planning decision approved the construction of open and daily tourism facilities in the second section on the coastline, on condition that they are offered for public use as indicated in articles 13 and 14 of the relating Communiqué, not exceeding 5.5 m in height with a floor area ratio of 0.20 and h_{max} of 4.5 (Ref. 3). Nevertheless, as there was not a development plan in force at the time of their construction and because of inadequacy of inspections, Akcakoca Sky-tower and Teachers Guest House were built up to h_{max} 12.5, clearly violating the current requirements of the Communiqué, and they are currently used for touristic purposes. The lack of such a communiqué at the time of sky-tower encouraged the construction of private apartment hotels and similar buildings.

In accordance with the Tourism Promotion Law enacted in 1982, no fences, walls, bars, etc., that will hinder the access can be built on the coast, and wastes like debris, dirt, slag etc. that have a deteriorating effect on the nature can be dumped in the coastal areas[3]. Yet, the walls built by sky-tower to mark their borders portray contradiction between privatisation and public use. Akcakoca Municipality and District Governorship tried to stop construction but they could not attain a significant success because of the legal process (Table 1).

When the structural area is analysed in terms of utilisation, it is observed that secondary residences are generally built in Karaburun Village and towards Melen Stream, which are located outside the municipal adjacent area (Table 1). In terms of the port and pier, we can see that the port and fishing port located in Yali neighbourhood contributed to the development and growth of the town. However,

we observed that the busy days of the current port are now over, and it is used as a fishing port only. A scattered and irregular development took place in the port (pier) by fishers who use it.

As the elevation increases as you go further west of the city, the road construction had to be stopped. The existence of vertical cliffs along the coast in certain distances enabled the utilisation of these areas as recreational green areas and meadows. Recently, a road has been planned leading down to Edilli beach, but it was detected in the field visits that it has been cancelled due to high number of potential curves and dangerous inclination (Table 1).

It will be necessary to evaluate in details how the sand on the beaches will be affected by the construction of a road, whether it will cause coastal erosion, whether it will change the wave movements and therefore how the ecosystems will be affected; so the construction should start after the completion of all the requirements and analyses. Settlements like Akcakoca, which have unique natural and cultural characteristics, are very valuable in terms of cultural publicity and tourism, and consequently for economic development.

The fact that there is a mosque (Central Mosque) and a clock tower on the road located parallel to the coast, and they have close links with the commercial units, gained relative reliability for the area and turned it into a focal point. This avenue (Cinar Av.) is not currently fully pedestrianised, and it is partly closed for vehicular traffic only in summer. It was observed that it is mainly used for transportation and parking purposes. This situation is a factor that limits the mobility in terms of pedestrian circulation, thus negatively affecting the space perception.

Regarding utilisation, the differences in altitude in the coastal area made it necessary to meet the recreational needs on slope lands (Table 1). The rising cliffs located in parallel with the cost do not allow such recreational activities as hiking and cycling along the shore. In order to gain functionality and mobility, hanging access routes, wooden bridges, playgrounds, banks, enlarged pavements etc. would be an efficient approach for better public utilisation and the silhouette of the town. Introducing the teahouses and kiosks compatible with the communiqué increases the recreational demand in utilisation of the area.

Table 1. Images of the costal sceneries in Akcakoca

TRANSPORTATION	SETTLEMENT	TOURISM	RECREATION
			
1- The road located parallel to the coast and current status of use (Çınar Av.) 2- The road leading down to Edilli, which is currently not used because of high curves.	Settlements of Melen–Karaburun secondary residences	The Sky Tower Hotel built for touristic purposes and efforts of Municipality to stop construction of borders.	Recreational use of coastal areas in Akcakoca

EXPERIMENTAL

IDENTIFICATION OF THE ENVIRONMENTAL STATUS OF AKCAKOCA COASTS THROUGH AHP (ANALYTIC HIERARCHY PROCESS) METHOD AND SWOT ANALYSIS

In order to analyse the forms of utilisation in the coastal areas of Akcakoca and their interactions, a survey study was conducted on 5 specialists (the landscape architect of Akcakoca Municipality, the director of Directorate of Development and Technical Works of Akcakoca Municipality, a graduate of Department of Public Administration, a journalist from the local newspaper of Duzce province, a faculty member of Faculty of Forestry in Istanbul University and a faculty member of Faculty of Civil Engineering – Department of Geomatic Engineering in Istanbul Technical University) taking into consideration the resources and capabilities of the district.

Implementing the method of Analytical Hierarchy Process, one of the methods extensively used in various areas to analyse decision-making problems with multiple criteria, we processed the multiple criteria and goals relating the given area[4]. The data acquired through Analytical Hierarchy Process (AHP) method are explained step by step:

Step 1 – Identification of the Problem: In this phase, the criteria are determined in accordance with the goals (Fig. 1).

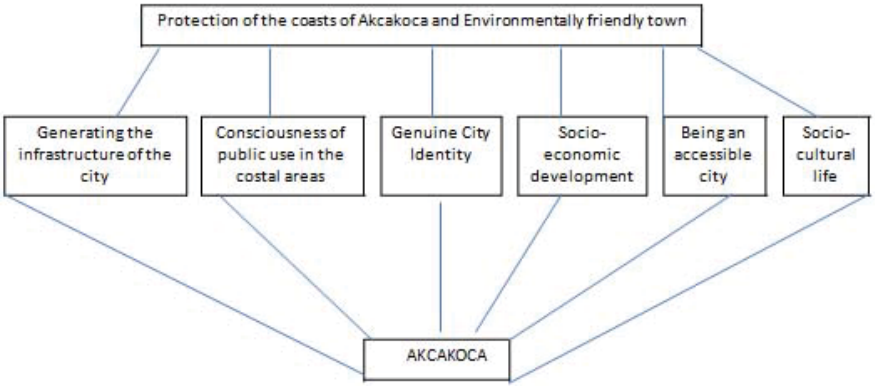


Fig. 1. AHP analysis of environmental status of Akcakoca

As indicated in Fig. 1, as per the conducted survey, the goal of 'Protection of the coasts of Akcakoca and environmentally friendly town' was taken as the reference in Akcakoca. According to the findings revealed from the questions asked in the survey, the criteria such as 'Generating the infrastructure of the city, Consciousness of public use in the costal areas, genuine city identity, socio-economic development, being an accessible city and rehabilitating socio-cultural life', etc. were determined, and their priority levels were assessed for the coasts and current status of Akcakoca, implementing the method of Analytical Hierarchy Process.

Step 2 – It is based on the comparison of the criteria according to their priority levels. For this purpose, scoring is conducted based on priorities (Table 2).

Table 2. Priority ranking

1	3	4	7	9
Equal importance	medium importance	high importance	veri high importance	extremelly high importance

Priority estimation is made through scoring according to pre-determined criteria. As a survey was implemented on 5 specialists in the scope of the study, the 'consensus' was identified by taking the geometric averages of their responses (Table 3).

Dividing the consensus into the total number and taking the arithmetical average of the 6 criteria, 'priority' was determined.

Table 3. Consensus of the assessment and identification of priority

	Infrastructure of the city	Consciousness of public use	Gennuine city identity	Socio-economic development	Being an accessible city	Rehabilitating socio-cultural life	Priority
Infrastructure of the city	1	0.999980	0.724780	0.581799	1.245706	0.762140	0.139863
Consciousness of public use	1	0.802726	0.271725	0.724780	0.644381	0.802725	0.107329
Gennuine city identity	0.889071	3.680110	1	2.290126	1.551815	1.551815	0.268462
Socio-economic development	1.718772	1.379702	0.436648	1	1.379702	0.802741	0.165910
Being an accessible city	0.802741	1.551846	0.644394	0.902880	1	0.644381	0.139747
Rehabilitating socio-cultural life	1.312094	1.245706	0.644394	1.245706	1.551845	1	0.178690
Total	6.722679	9.660069	3.721941	6.745291	7.373448	5.563802	

Step 3 – The consistency/inconsistency rate of the survey assessment was identified. In the AHP analysis conducted with the opinions of 5 specialists, we resolved that the data acquired in the survey were consistent as the inconsistency rate was found to be 1.75%. After the survey, in order to be able to detect a common problem and suggest solutions, a SWOT analysis was conducted along with the AHP method implemented to identify the environmental status of Akcakoca coasts; in this way, strengths, weaknesses, opportunities and threats of the study area were evaluated (Tables 4 and 5).

Table 4. Positive and negative aspects detected in Akcakoca (strengths and weaknesses)[5]

POSİTİVE ASPECTS	NEGATİVE ASPECTS
•The area of study hosts many natural and cultural features. •With its soil and climate characteristics, the area has the potential of organized agriculture. •Feasible for coastal tourism in terms of economic development. •Portrays a holistic urban structure with its architectural texture. •Regarding infrastructure, the town has a sewerage system of 55 km that covers ¾ of the settlement, secondary residences not connected to the sewerage system has cesspools. •It has a waste water purification system. •It has a rain water piping system of about 11 km, alongside the sewerage system. •An additional biological treatment facility with a capacity of 3000 people was founded in 2007 in Akevler neighborhood. •The coastal areas partially provide public utilization opportunities. •Along the shoe there exist the remains of archeological sites like the Genoese Fortress, the protection zones are getting larger.	•The naturality of the coasts is partially damaged due to residential constructions. •Because of the natural beauties, people desire to be nearer to the seaside, and this increases the number of secondary residences. •Buildings constructed along the coast earlier became legal after the adoption development decisions of 1/1000 and 1/5000. •Prices of property have increased too much due to the efforts to encourage local and international tourism. •Tourism facilities like hotels create overbuilding in the coastal areas, which is encouraged by inefficiency of legal and administrative inspection. •To enable access, roads are partially built in parallel with the coastline. •The surface waters of Akcakoca, constituted by streams that shape the development of the town, flow without any control. •The huts of fishers located at and around the old port, currently used as fishing port, are irregularly constructed. •Decision making and implementation processes with the perspective of multiple management is usually delayed. •Number of reports and decisions reflecting the texture and architectural culture of coastal settlement is very low for management purposes. •In terms of the natural structure of the area of study, high cliffs rise in parallel with the coast.

Table 5. Opportunities and threats detected in Akcakoca[5]

OPPORTUNITIES	THREATS
•The pier can be enlarged after getting the opinions of several experts from different areas and as per the results of Environmental Impact Analysis (EIA). This construction can contribute to economical development of the district enabling better fishing opportunities and boost tourism. •Akcakoca has the potential of development in terms of tourism, fishing and organized production. •Maintaining the sustainability of the current texture and culture of the town, they can be announced as Natural and Cultural World Heritage Site by UNESCO. •Open space activities like a festival can be organized to support recreational utilization and publicizing Akcakoca.	•Black Sea has a "rip tide" style flow. Therefore, buildings may affect the coastal currents. The sedimentation on the coast may trigger coastal erosion. •In case of rise in sea level, the coastline may recede. •Buildings may affect wave movements and sea ecosystems may therefore deteriorate. •Seal levels may rise •If the construction is not planned across the district, it may suffer from inadequacy of the sewerage system.

RESULTS AND DISCUSSION

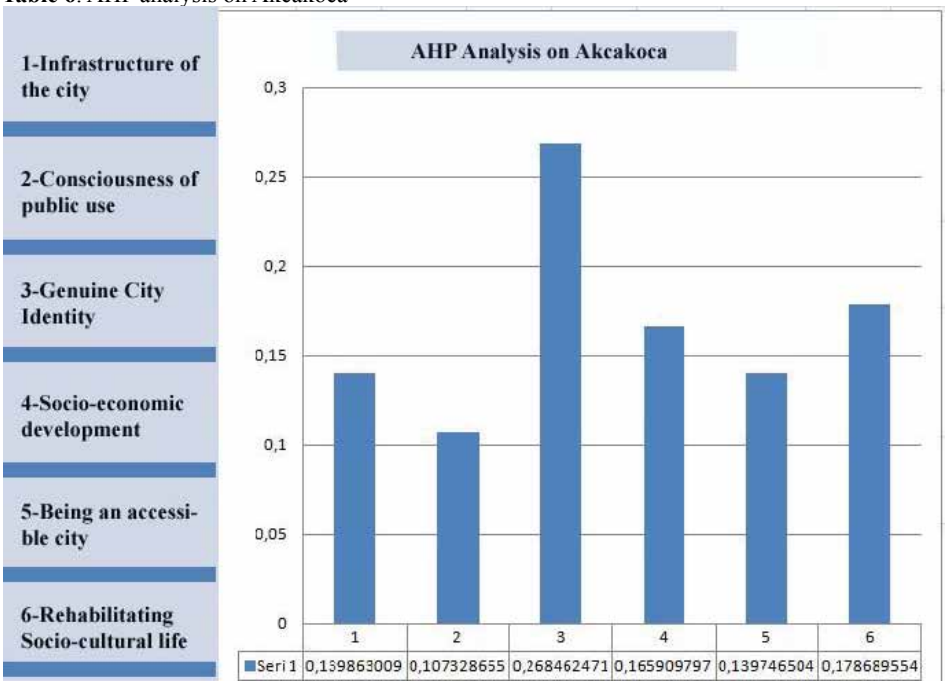
Governance and management of natural ecosystem, forests, lakes, wetlands, rivers, natural resources and agricultures have to face the increased diversity of connections between different environmental characteristics and decisions of local, regional, national, and supra-national relevance, with high coordination and exchange between administrative entities and actors in the public/private and the expert/stakeholder different sectors[6].

However, it is observed that there are buildings constructed on the coasts of Akcakoca violating the terms of Coast Law. Urbanisation, immigration, uncontrolled development structure and lack of sustainable tourism decisions resulted in the increase in the number of hotels, secondary residences, etc. built on the coastal areas. This situation creates a contradiction between public use and privatisation. The road constructed in parallel with the coastline thanks to topographical structure creates a split between the sea and the town, thus causing breakdowns in the sustainable holistic structure of the town. Such facilities as green areas and similar recreational places are the factors that positively affect the public utilisation of the coastal areas, and they should be improved so as to support the publicising and the cultural structure of the city.

Akcakoca is a cultural mosaic that embodies archeological, natural and historical characteristics. Therefore, it should be protected and transferred to future generations. A sustainable understanding of administration is necessary for that. The phenomena of fishing and tourism are very essential in the economic development of Akcakoca. In terms of tourism, it will have a sustainable development potential with Integrated Coastal Zone Management (ICZM) decisions, and its economy will be stronger. In the AHP analysis conducted, it is observed that importance must be placed on the genuine urban texture of the town and having an environmentally friendly city (with a priority rate of 26%) in accordance with the goals of protection of Akcakoca coasts. This is followed by rehabilitating the socio-economic life with a rate of 18% (Table 6).

Akcakoca is a settlement prominent for its historical and cultural characteristics. Tourism is very essential for the district to develop in socio-economic terms. The decisions of Development Plan scaled 1/1000 and Master Development Plan scaled 1/5000 should be prepared in a way that they will support touristic development while protecting the holistic identity of the town. As is known, the main cause of the environmental problems in our country and around the world are the economic development strategies based merely on construction and investment. Even if this is perceived as profitability in the short run, such an understanding definitely causes serious problems damaging the infrastructure, physical and social environment of a given city in the long run[7,8].

Table 6. AHP analysis on Akcakoca



CONCLUSIONS

For being such areas where land-sea interaction is on the highest level, coastal cities are experiencing an intensive and unorganised utilisation impact, along with the rapid population growth and the present lifestyle that deems economic development as the ultimate goal. The fact that local administrations lack the required personnel, equipment and opportunities in inspecting the construction activities that are conducted as per efficient development regulations and without authorisation alike directly contradicts with the understanding that requires upmost public utilisation on the coasts[7,9,10].

Keeping a balance between the economical development and the environment is one of the most serios current problems[11]. Therefore, any interference taking place on the coasts does affect the ecological balance, life forms of coastal ecosystems, as well as the urban silhouette. The district of Akcakoca, too, is a coastal town that has a 'rip tide' style flow for being located in the Black Sea Region. Uncontrolled construction to take place in the coastal areas can cause several damaging results like erosion, calcification, rise in the sea level, etc.

REFERENCES

1. D. SEKER, A. TANIK, I. OZTURK, T. LEVET, S. OVEZ: Testing of Methodology on Spatial Planning for ICZM. Akcakoca District Pilot Project, Istanbul Technical University, Environmental Engineering, Urban and Regional Planning, Geodesic Surveying and Photogrammetry Department, Istanbul, 2007.
2. Akcakoca District Governorship: http://www.akcakoca.gov.tr/menu.php?id=7. 2015.
3. Regulation of Coastal Law Application. Turkey Chamber of Engineering and Architects, Journal of Map and Cadastre Engineering, (86), 101 (1992).
4. H. BASLIGIL: The Fuzzy Analytic Hierarchy Process for Software Selection Problems. Journal of Engineering and Science (Yildiz Technical University, Istanbul), **3**, (2005).
5. Akcakoca Municipality Protection Council: 1\5000 and 1\1000 Akcakoca District. Planning Approach for Urban Protected Area, Akcakoca, 2008.
6. Z. S. ANDREOPOULOU, A. K. KOKKINAKIS: Sustainable Fishery Management of Coastal Wetlands Using Data Bases. J Environ Prot Ecol, **15** (2), 643 (2014).
7. P. OZDEN: The Importance of Environmental Fact of Zoning Area. Journal of Political Science Department (Istanbul Technical University), (16-19), (1997).
8. Z. YENEN, Y. UNAL, Z. M. ENLIL: The Change of Istanbul's Identity, from Water City to Land City. Istanbul Metropolitan Planning, http://www.metropolistanbul.com. (2009).
9. A. SAGLIK, A. KELKIT, E. SAGLIK: Environmental Problems as a Result of Settlement Pressure at Urban Coastal Areas: Canakkale as an Example. Journal of Biological Science Research, (2), 145 (2012).
10. P. OZDEN: The Consideration about the Role of Local Administration at Urban Renewal Application and Istanbul as an Example. Journal of Political Science Department (Istanbul Technical University), (23-24), 1 (2001).
11. D. PLESOIANU: Current Situation of the Environment in the Midia-Navodari Area. J Environ Prot Ecol, **12** (1), 1 (2011).

Received 11 February 2016
Revised 19 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 737–746 (2016)

Environmental protection and sustainable development – landscape planning

LANDSCAPE ASSESSMENTS IN BARTIN (TR) VIA GREEN INFRASTRUCTURE APPROACH

M. ARTAR[a]*, S. GORMUS[a], S. CENGIZ[b]

[a]*Department of Landscape Architecture, Faculty of Forestry, Bartin University, 74 200 Bartin, Turkey*
E-mail: *mustafa.artar@gmail.com*
[b]*Department of Landscape Architecture, Faculty of Fine Arts, Inonu University, Malatya, Turkey*

Abstract. Recent researches on a sustainable relationship especially in urban areas have been focusing on ecosystem services. Green infrastructure approach together with green networks, green roofs and storm water management systems offers benefits for ecological, socio-cultural and economical functions. Natural areas including rivers, coasts or forest that located in and around cities are valuable assets for the unity and sustainability of urban landscapes. According to European Commission, waterfront cities which rivers pass through are ecologically valuable and those rivers are important components of green infrastructure that providing ecosystem services for urban areas. The aim of this study was to evaluate Bartin River and vicinity with regard to green infrastructure potential and the role and benefits of Bartin River in urban ecosystem as a natural ecological corridor. Study was carried out within 18 neighbourhoods in Bartin Municipality and covering 92 city parks on and around Bartin River.

Keywords: green infrastructure, Bartin, parks, European Landscape Convention, riverscape.

AIMS AND BACKGROUND

Due to rapid increase in population and construction for urbanisation, cities of 21st century change rapid and dynamically. When the cities change, different characters of the cities also eventually change. On the other hand, rivers, green spaces and natural areas in the cities limit the change of urban texture and urban development and often function as important natural characters of the cities.

Recently, the climate change has become an important topic and brought more emphasis on the urban water management and green infrastructure connections. Due to the large hard surfaces, heavily built urban texture and the lack of water management systems the number of natural disasters like flooding increased enormously. Recently, Green infrastructure (GI) approach has become a critical issue for experts for good urban development, landscape management and urban health.

* For correspondence.

The enhancement of green areas has the potential to mitigate the negative impacts of urbanisation on natural environment in a sustainable way, making cities more attractive to live in and buffering urban sprawl. Nowadays, there is an increasing societal support for more green space in and around cities[1].

Urban green spaces provide essential ecosystem services and improve environmental quality of life. But open space networks are often fragmented by urban development, and therefore, it is difficult to reclaim natural lands after they have been built up[2].

Benedict and McMahon[3] discussed that green infrastructure contributes greatly to the health and quality of life for America communities and people as a strategically planned and managed network of wilderness, parks, greenways, conservation easements and working lands with conservation value that supports native species, maintains natural ecological processes, sustains air and water resources.

Rouse and Bunster-Ossa[4] suggested that GI is more than just implementing measures at various scales, from green roofs and rain gardens to regional greenways and open space.

Literally, GI refers to an interconnected green space network including natural areas and features, public and private conservation lands, working lands with conservation values, and other protected open spaces that is planned and managed for its natural resource values and for the associated benefits it confers to human populations. Term of green infrastructure describes a process that promotes a systematic and strategic approach to land conservation at the national, state, regional, and local scales, encouraging sustainable land-use planning and practices[3].

Benedict and McMahon[3] claimed that GI helps to sustain forests, farms, and other working lands and allows natural systems to function as intended, saving communities millions of dollars in flood mitigation, water purification. GI also provides mental and physical health benefits as well as outdoor recreation, for the inhabitants of the cities. It helps to protect valuable natural amenities by attracting also tourists and visitors to the city.

A key question for planners and designers is how can we measure these benefits to demonstrate the value of green infrastructure brings to society? Besides environmental and economic indicators, there are social (community) indicators which include parks and open space access (typically measured in terms of walking distance to the nearest resource), parks and open space equity (typically measured in terms of distribution relative to demographics), public health outcomes, etc.[4]

Landscape Institute-UK stated that the role of GI in addressing the challenges of the 21st century cannot be underestimated. GI is defined here as the network of natural and semi-natural features, green spaces, rivers and lakes that intersperse and connect villages, towns and cities. It is a natural, service-providing infrastructure that is often more cost-effective, more resilient and more capable of meeting social, environmental and economic objectives than 'grey' infrastructure[5].

There is a clear need that GI should be designed and managed as a multifunctional resource capable of delivering those ecological services and quality of life benefits required by the communities that it serves and needed to underpin sustainability. Design and management of GI should also respect and enhance the character and distinctiveness of an area with regard to habitats and landscape types.

The European Landscape Convention (ELC) brings a holistic approach to the landscape by the definition as '…an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors'. The ELC recognises the multifunctional value of our landscapes, which is fully consistent with the green infrastructure approach. Recognition of landscape character is a core part of Natural England Landscape Policy underpinning that retrofitting and creation of green infrastructure elements can contribute to the landscape strategies. Other elements of green infrastructure planning, such as education and public participation, are also consistent with the aims of the ELC (Ref. 6).

GI can be broadly defined as a strategically planned network of high quality natural and semi-natural areas. More specifically, being a spatial structure GI can foster a better quality of life and human well-being, enhance environmental quality, improve biodiversity by reconnecting isolated nature areas and increasing the mobility of wildlife across the wider landscape, prevent environmental disasters by alleviating floods, storing carbon or preventing soil erosion, encourage a smarter, more integrated approach to development in as efficient and coherent a way as possible[7].

The types of physical features that contribute to GI are diverse, specific to each location or place and very scale-dependent. On the local scale, biodiversity-rich parks, gardens, green roofs, ponds, streams, woods, hedgerows, meadows, restored brownfield sites and coastal sand-dunes can all contribute to GI if they deliver multiple ecosystem services. They have an important function: to deliver multiple benefits, or connect ecosystems, so that they can deliver their services[8].

A green infrastructure typology covers:

- Parks and gardens – urban parks, country and regional parks, formal gardens;
- Amenity greenspace – informal recreation spaces, housing green spaces, domestic gardens, village greens, urban commons, other incidental space, green roofs;
- Natural and semi-natural urban greenspaces – woodland and scrub, grassland, heath or moor, wetlands, open and running water, wastelands and disturbed ground), bare rock habitats (e.g. cliffs and quarries);
- Green corridors – rivers and canals including their banks, road and rail corridors, cycling routes, pedestrian paths, and rights of way;
- Other – allotments, community gardens, city farms, cemeteries and churchyards[6].

Demiroglu et al.[9] articulated that green infrastructures in Kilis city, Turkey, are not planned as an integrated system and their contributions to sustainable

development of the city are quite weak. They found that as of 2013, with a total population of 89 442 the city has a ratio of 3.65 m^2 of active green areas per capita.

The 2nd International Conference 'The New Generation of Green Infrastructure' concludes that the green sustainable development is the only way for the prudent use of natural resources and the environment for future generations. Each state should encourage the Green Business and GI in order: (1) to promote the development; (2) to reduce social inequality; (3) to limit the effects of climate change; (4) to reduce environmental degradation; (5) to better manage the problems of the growing scarcity of raw materials; (6) to secure funding that will yield long-term gains, and (7) to face the pressures of population growth[10].

The focus of this research is to evaluate benefits and values of ecological corridors of Bartin River and vicinity, using GI approach and its contributions to urban ecosystem based on parks and garden within Bartin Municipality. Resilience to flooding and economic outcomes with regard to proposed management system of Bartin River is also discussed. Bartin River has been a passive recreation area as well as an ecologically important site with biological richness of flora and fauna. As the requested connection with active recreational areas has not been supplied with corridors, the parks and open public spaces of the city could not serve as an input of green infrastructure element[11]. Bartin River has a character of a network connecting rural and urban landscape which surrounds the city and accordingly more emphasis will be given to 'parks and gardens' and 'green corridors' in this paper.

EXPERIMENTAL

This research was held within the borders of 18 neighbourhoods covering the given list of parks by the Bartin Municipality (Fig. 1). Ninety-two parks are examined for the study located in different neighbourhoods. Some sites, those double written or parks and children playgrounds on military ground were eliminated from the study. As a data set 1:25 000 scale Environmental Plan, beside 1:5000 and 1:1000 scales Construction Plans were used.

The methodology of our study covered 4 stages of analytical approach: (1) fieldworks and visualisation; (2) green/grey surface relation and density; (3) identification of park typology, and (4) proposals for green infrastructure.

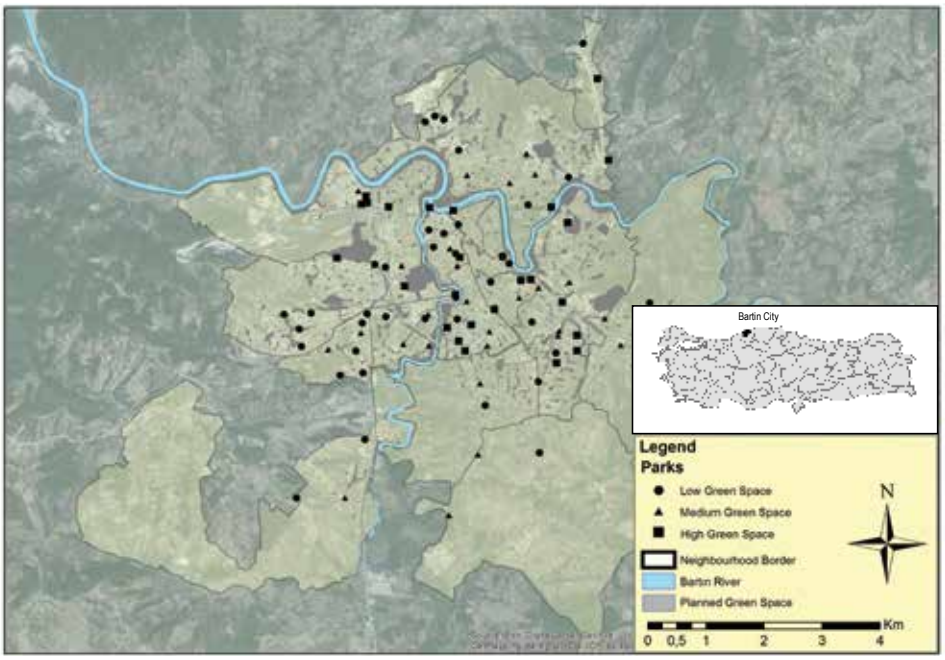


Fig. 1. Location of the study area

Fieldworks and visualisation. All 92 parks listed by the Municipality had been visited and evaluated on site. The location and the borders of the parks were recorded by Global Positioning System (GPS). Urban furniture and green-grey interaction had been recorded via taking photos. Borders of the parks and the area were controlled via overlay analysis with Arcview Geographical Information System (GIS) 10.1 version and the Basemap of the software and the actual areas of the parks were obtained.

Green space density. Park borders were overlaid with the neighbourhood so the number of parks located in concerning neighbourhoods was obtained. Areas were compared with the population living along the neighbourhood and green space per capita was calculated.

Identification of park typology. Green space and impermeable land of each park was calculated. Due to this the ratios of green to grey were classified by less than 40, 40–70, more than 70% were classified as low-medium and high green spaces, respectively.

Proposals for green infrastructure. In order to offer proposals for green corridors, physical layout and data sets of 1:25 000 scaled Environmental Plan, 1:5000, 1:1000 scaled Construction Plans and Digital Elevation Model (DEM) and current Landuse-Landcover (LULC) map were used. Possible corridors were proposed

between actual parks and planned green spaces with reclassified DEM and the data obtained had been overlaid with LULC.

RESULTS AND DISCUSSION

Actual situation of the parks in Bartin. Relating to green infrastructure and user density of public parks, population statistics in Bartin Municipality are given in Table 1 and Fig. 2. According to the Address Based Population Registration System (ADNKS) in 2014, the population of 18 neighbourhoods in Bartin is 63 253 people (Ref.12). The table reveals that the number of population below and over +18 years of ages, number of parks and green spaces per capita along the neighbourhoods (Table1).

Table 1. Neighbourhoods of Bartin, population and distribution of parks[12,13]

No	Neighbourhood	Population			No of parks	Area of total green space (m^2)	Green space per capita (m^2)
		total	over +18	below +18			
1	Agdaci	2622	2356	266	3	2459.73	0.94
2	Aladag	4714	3363	1351	7	3611.78	0.77
3	Cumhuriyet	2920	2131	789	7	3990.13	1.37
4	Cayduzu	3314	2413	901	4	1871.53	0.56
5	Demirciler	3336	2452	884	3	713.33	0.21
6	Esentepe	2283	1613	670	7	6261.89	2.74
7	Golbucagi	7660	5762	1898	7	10162.93	1.33
8	Hurriyet	2688	1785	903	0	0.00	0.00
9	Karacay	323	256	67	2	16948.40	52.47
10	Karakoy	2412	1756	656	2	1210.76	0.50
11	Kemerkopru	9692	7231	2461	15	16955.25	1.75
12	Kirtepe	3780	2982	798	8	22138.62	5.86
13	Koyortasi	1664	1399	265	3	26262.70	15.78
14	Okulak	1584	1263	321	0	0.00	0.00
15	Orduyeri	6560	4909	1651	12	9561.12	1.46
16	Orta	1881	1491	390	2	2601.33	1.38
17	Siremircavus	904	721	183	3	821.07	0.91
18	Tuna	4916	3589	1327	7	9493.07	1.93
Total		63.253	47472	15781	92	135063.65	2.14

Green infrastructure assessment of Bartin City. According to the green/grey assessments in parks of Bartin city, it can be said that most of the parks are lack of plant material, some of them have little amount of plant cover. There are 92 parks listed by the municipality of which 37 have low green space, 29 medium and 26 high amount of green space with plant materials. Those are evaluated within the

fieldworks and measured on field due to the density of vegetation and hard landscapes. Parks with low level vegetation cover mostly related to children playground basketball or volleyball areas. Some of them have outdoor fitness equipments. This fact is open to discussion about what are the benefits for green infrastructure. For those parks just have hard surfaces without no plant material the other discussion is that the use of the areas in all different seasons. As most of the playgrounds with no green space locate close or in private residential sites most of them cannot be used under hot climate conditions in the daytime of summer season. When evaluated in means of urban equipment quality, cleanness, health and security it can be said that most of the parks are lack of clean areas with broken banks and rubbish boxes. Figure 2 shows the distribution of parks in Kemerkopru neighbourhood which has low-medium and high density of vegetation with planned green spaces.

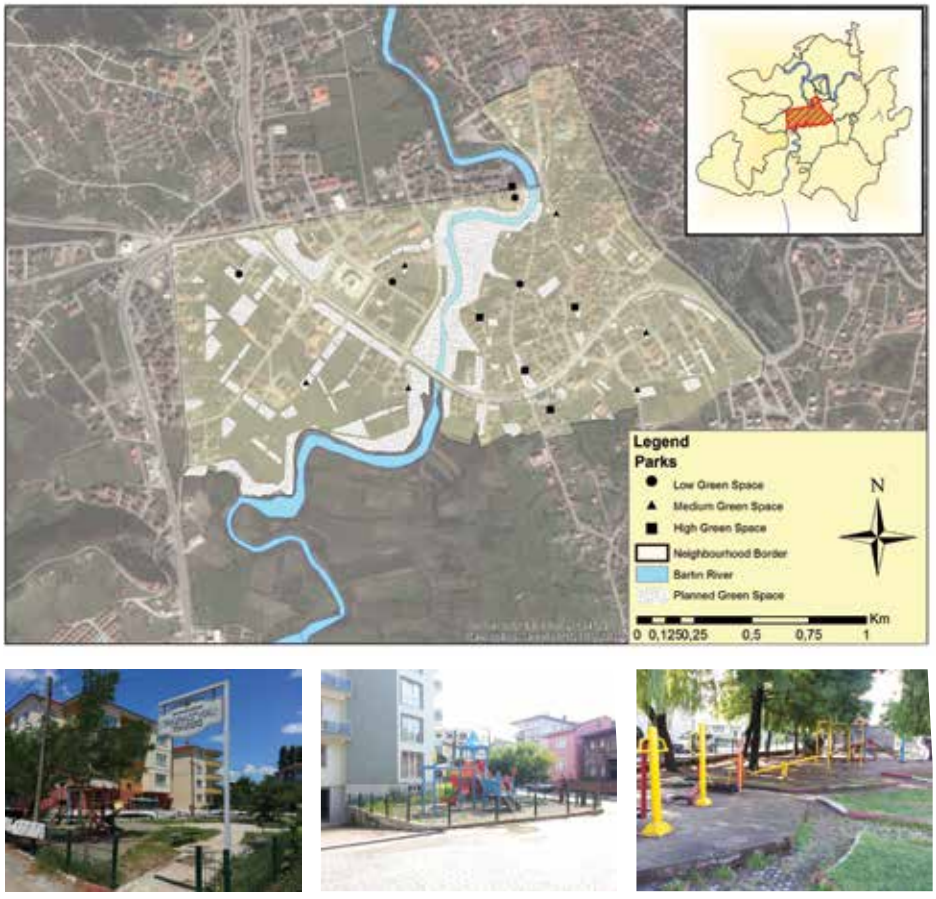


Fig. 2. Distribution of parks in Kemerkopru neighbourhood of Bartin Municipality

Most of the parks are not accessible for disabled people and many of them have dangerous electricity transformer stations so close to children playgrounds. Some are located under electricity power lines. Most of the parks fall into conditions that could not be evaluated as part of a GI system as they are totally located under dangerous and unhealthy circumstances. Those areas might be evaluated as a part of the system just only after revitalisation.

As seen in the construction plans, Bartin River forms an important ecological corridor in the city. Most of the parts of this corridor cannot be reached by the people living around. This might be important for ecosystem services of the river itself for flora and fauna but as seen from Table 1, green space per capita is only 2.14 m^2 in Bartin even though the Construction Law describes it to be 10 m^2 per capita. Because of this fact the river banks and the corridor should be designed via connections with other recreational areas of the city. Aladag neighbourhood has the lowest green area per capita while Karacay neighbourhood with new landscape design areas has the highest. Even though it has the highest amount per capita, that does not cover the amount of 10 m^2 of standard of the Construction Law.

Ecological corridor proposal. As described in the introduction excluding the Bartin river itself, the green system of Bartin do not form an ecological corridor which will feed the green infrastructure. So the methodology used in this paper tried to form ecological network between planned green spaces and the actual parks. Land use and land cover data which had been classified by twenty classes had been used as a base. The corridor had been formed via appropriate features such as actual roads, agricultural areas, residential landscapes, the river corridor, etc. Destinations are described due to appropriate slopes and actual parks had been connected to planned green spaces.

There are many possibilities for green infrastructure applications in Bartin city. Beginning from state buildings green roofs might bring an enormous solution for the rainwater investment. Most of the residential areas are covered by high grey walls and green wall applications might also be solutions for many parts of the city. Bartin city along the Western Black Sea is famous for its flood during all seasons. Little amount of rain in a short period might also cause flood problems. The rainwater line which is connected to sewage should be evaluated in a different manner. So as to use the rain water effectively rain gardens might be solution especially close to low attitudes. As the river rises which meant flood for the city design techniques via thinking sustainable use of water should be considered. The ponds after rain might be temporary wetlands and designed with natural vegetation which will mitigate the unexpected results of the flood.

CONCLUSIONS

Bartin city is well known with its floods. A vast flood in the Western Black Sea region of Turkey in May 1998 caused great loss and caused significant damage. Communication network, transportation, and construction cost of the disaster was estimated around US $500 million. Rainwater management is an important issue for the city. The flood exists in a very short and limited time as recent years brought more alluvial material from highlands and the construction industry developed more than expected. Green infrastructure approach is more important on such cases and if GI is accepted as an approach, Bartin River might be not a problematic issue than an important feature for recreation and tourism.

As the river in the past covered most of the characteristics of GI approach which meant multifunctionality, connectivity, habitability, resiliency, identity, return on investment, it has a great potential. The river had been used for transport, connected different aspects of the city, gave birth to ecosystem and gave its name to the city. It is well known that GI offers cheaper solutions than traditional civil engineering activities.

Even with just the pollination effect, green roofs and greenways have significant contribution to urban health. Green systems let energy save, water treatment and better infrastructure planning capability.

The findings and comparisons with many case studies within Europe show actual green spaces which are called parks by the local authorities do not cover permeable pavements and roads, rain gardens, green roofs and roof gardens, rain harvesting systems, road plantations, maintenance of landscape designs and wetland formations. There is also misuse of plant material especially at some of the parks designed. GI approach is an important solution for cities living with floods such as Bartin.

Landscape planning and design due to the characteristics of the cities themselves is an important approach. Regulations for secure life, healthy cityscapes and happy nations might be supplied with interdisciplinary studies of green infrastructure approach. Grey infrastructure is assumed to be planned effectively if only thought with interaction with the green infrastructure. Bartin River shows an important ecological network feature and an important landscape character for the region. The river with the ecosystem services might only be carried to further generations with a common understanding of common understanding with stakeholders. GI approach which offers for all actors of city management to come together and plan the city might also bring effective results of increasing total income for residents.

Acknowledgements. Authors wish to acknowledge Bartin University Scientific Research Projects Commission for support given to the Project coded 2013.2.102 and master students who have been involved during the field and office works.

REFERENCES

1. K. de RIDDER, V. ADAMEC, A. BANUELOS, M. BRUSE, M. BURGER, O. DAMSGAARD, J. DUFEK, J. HIRSCH, F. LEFEBRE, JM. PÉREZ-LACORZANA, A. THIERRY, C. WEBER: An Integrated Methodology to Assess the Benefits of Urban Green Space. Sci Total Environ, **334–335**, 489 (2004).
2. A. E. FRAZIER, S. BAGCHI-SEN: Developing Open Space Networks in Shrinking Cities. Appl Geogr, **59**, 1 (2015).
3. M. A. BENEDICT, E. T. MCMAHON: Green Infrastructure: Linking Landscapes and Communities. Island Press, Washington, DC, 2006.
4. D. C.ROUSE, I. F. BUNSTER-OSSA: Green Infrastructure: A Landscape Approach. PAS Report No 571. American Planning Association, Chicago, 2013.
5. Landscape Institute: Green Infrastructure. An Integrated Approach to Land Use. Landscape Institute Position Statement. London, 2013. 32 p.
6. Natural England: Green Infrastructure Guidance. Catalogue Code: NE176. www.naturalengland.org.uk, UK. 2009. 107 p.
7. European Commission: Building a Green Infrastructure for Europe. Luxembourg: Publications Office of the European Union, 2013. 24 p.
8. European Commission: Commission Staff Working Document. Technical Information on Green Infrastructure (GI). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Green Infrastructure (GI). Enhancing Europe's Natural Capital. {COM(2013) 249 final}, Brussels, 2013.
9. D. DEMIROGLU, M. YUCEKAYA, A. COBAN, D. GOKCE: Investigation of Green Infrastructure for Sustainable Cities: the Kilis Case. J Environ Prot Ecol, **15** (3), 1199 (2014).
10. BENA: Conclusions of the 2nd International Conference on 'The New Generation of Green Infrastructure'. J Environ Prot Ecol, **13** (3A), 2050 (2012).
11. M. ARTAR: Regaining of Bartin River and Vicinity for Tourism via Landscape Planning Focus. Fifteenth Council of Europe Meeting of the Workshops for the Implementation of the European Landscape Convention; Sustainable Landscapes and Economy', 30 September–2 October, 2014, Urgup, Nevsehir, Turkey, 2014.
12. TUIK: Neighborhoods of Bartin, Population and Distribution. Address Based Population Registration System Results 2014. Turkish Statistical Institute, 2015.
13. Bartin Municipality: The List of Parks according to the Neighborhoods in Bartin. Worksheet from Parks and Gardens Administration, Bartin, 2015.

Received 11 February 2016
Revised 16 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 747–753 (2016)

Environmental protection and sustainable development – landscape planning

SUSTAINABILITY OF LANDSCAPE IN THE PORTALS OF HIGHWAY TUNNELS

Y. CINDIK AKINCI*, O. DEMIREL, E. BAYRAMOGLU

Department of Landscape Architecture, Faculty of Forestry, Karadeniz Technical University, 61 080 Trabzon, Turkey
E-mail: *yasemincindik@gmail.com*

Abstract. Today, road construction which works as a natural consequence of extending the transport network and concordantly making tunnels and viaducts have brought change and differences in general appearance of the landscape. Roads, bridges, viaducts and tunnels, as elements of the transport network are straight corridors that solve the flow of traffic. They also play an effective role in creating beautiful landscape. So simultaneously they have various functions in city structure. The design of highway tunnel portals includes the structure entrances design, hillside stabilisation, greenery systems, and landscape design effects. This paper reveals the importance of the tunnel portals in terms of landscape design and how they must be addressed with respect to design principles. Moreover, the architectural and landscape aspects of design applied to tunnel portals was analysed and compared with alternative architectural solutions.

Keywords: tunnel portal, landscape, sustainability, city structure.

AIMS AND BACKGROUND

Highways are the most common form of transportation in Turkey. The rapid increase in urbanisation and technological advances led to increased road building, and certain parts of cities are more intensely used to provide urban services. The number of tunnels also increased to make transportation more economical.

Right now, highways provide access to almost every human settlement in Turkey. Tunnels are used for connections where different and mountainous land morphologies make road building difficult.

Highway alignment, highway structural design, road materials, side slopes, the highway cross-section and the organisation of their space constitute the 'scenery of highway construction'. The alignment of the highway can give a pleasant impression to road users, and what is more, the rise and fall of the alignment also influence road users to appreciate the landscape. Highway alignment therefore has a basic function in highway landscaping. Furthermore, the whole usage of space in the highway has a pivotal effect on the highway landscape[1].

* For correspondence.

In recent years, tunnel portals are playing an important role in landscape design. This study will consider essential problems related to tunnel development and tunnel portals and examine what needs to be done about their effect on the landscape. It also aims to provide the most appropriate landscape design alternatives for the existing natural landscape of the site, creating contemporary designs that offer environmental protection. Finally, it aims to determine landscaping principles for the variety of tunnel portal landscape designs.

IMPACT OF TUNNEL PORTALS ON USERS

Integration between tunnel portals and their environments is an important aspect of road building and design. A detailed urban design study can offer opportunities for integrated visual quality. The impact of tunnel portals on users are relieve tiredness, create a landmark, lighting and visual adaptation, environmental protection[2–5].

ELEMENTS OF HIGHWAY TUNNEL PORTAL LANDSCAPES

A variety of landscape elements, including land grading, water elements, vegetation, plants functions, buildings and other structures, slope, vehicle traffic and traffic volume, should be considered for highway tunnel portals.

PRINCIPLES OF HIGHWAY TUNNEL PORTAL DESIGN IN LANDSCAPE

There are specific principles that need to be considered in the landscape design and maintenance of highway tunnel portals. Context of design; the project needs to be appropriate for the natural and structural characteristics of the site. Strategic plans should be developed to improve the quality of the natural and the built environment. Context of safety; negative impressions should be minimised at tunnel portals. Scarp stabilisation and vegetation should be reassuring. Negative aesthetic impressions should be eliminated. Road safety should be considered in design solutions. Identity and distinctiveness; design and maintenance approaches should reflect local identity. Landscape designs for tunnel portals should emphasise distinguishing characteristics of the site. Panoramic images should be created, emphasising the landmark features of the natural landscape. Minimum impact for the natural environment; sensitive approaches with minimum impact on the natural environment should be adopted. The most favourable ecological conditions should be achieved. Existing vegetation is damaged in tunnel portal construction. Restoring the vegetation after construction takes a long time. Technical scarp stabilisation should be done in this period. Context of physiological; for drivers to feel safe and comfortable, landscape design should keep the human scale in mind. Physiologically, the beauty and diversity of nature should be embraced. The colour green has an especially calming and soothing effect. Context of value

for money to economic; landscape architects have to do their best visually with low costs. Design and maintenance proposals should be cost-effective. Solutions should be long term and practical. Context of district impression; tunnels can be built in different locations with different climatic conditions. People culture and life styles differ from place to place. These particularities need to be considered in the aesthetics of the design. Tunnel portals should give an impression of the locale to their users, creating identity and spatial awareness.

TUNNEL PORTAL LANDSCAPE

There are some negative environmental impacts of highways increasing day by day. Because of that there is a growing awareness for road projects in the World[6]. The real cause of environmental problems is human-induced disturbance of ecological systems. Damaged landscapes take years to recover and renew themselves. Principles and techniques are needed to restore these landscapes. Sustainable landscape design has the potential to heal unhealthy sites and regenerate many of the services of damaged ecosystems[7].

Landscape maintenance has been a human activity since the first time people turned natural landscapes into cultural landscapes. Landscape maintenance studies are becoming more common in our country. Some examples in this field are described in Refs 8–17.

Landscape design for tunnel portals have been a popular field of study in China in recent years. It is necessary to identify the most important problems in landscape maintenance for tunnel portals. The surrounding landscape suffers serious damage because tunnel portal construction used a large amount of concrete and damages nature. These kinds of sites (tunnel portals and their surroundings) can be rehabilitated using landscape design.

There are original implementations that inteded for design at tunnel portal landscape in China. According to Ref. 5, original implementations at tunnel portal are: (1) Variety of geometric types of tunnel portals; (2) Integration with local cultures (anthropological aspects, regional culture, historical culture); (3) Environmental conservation; (4) Giving prominence to light transition at tunnel portal; (5) Blending into the surrounding environment; (6) Nonrepresentational tunnel portal landscape, and (7) Special decoration.

EASTERN BLACK SEA HIGHWAY TUNNEL APPLICATIONS

Mountains run parallel to the coast in the Eastern Black Sea Region. This region has a mountainous terrain. The highest mountains are found in the eastern section of the region. The layout of the mountains in this region slows down commercial and economic development in coastal cities.

The flora of the Eastern Black Sea region varies according to climate and altitude. Vegetation is lush on the northern side due to copious precipitation. The natural flora of the Black Sea Region consists of dense forests of deciduous trees due to high humidity and precipitation. The Black Sea Region contains 25% of Turkey forests, and it is the region with the largest amount of land covered with forests.

The coastal road project in the Eastern Black Sea started in 1960s. The ground was broken in 1987. After a 10 year halt, construction began again in 1997 with the filling the shoreline with rocks and damaging the natural beauty of the clean shores and bays. The project caused ecological and visual pollution (Fig. 1).

Fig. 1. Ecological and visual pollution (green extinction with concretion)

Tunnels are a part of a comprehensive road system. Tunnels were needed in the coastal road system in the Eastern Black Sea due to the mountainous landscape and topographical obstacles. The number of tunnels increased with the construction of the Black Sea coastal road.

The number of tunnels in the Eastern Black Sea is 68 and counting, with 30 tunnels in the coastal road system (Fig. 2). The longest tunnel ever built in Turkey is the 3825 m long double tube Nefise Akcelik Tunnel on the Persembe-Bolaman Road (Fig. 3) (Ref. 18).

Fig. 2. A number of tunnels in the Eastern Black Sea

Fig. 3. Nefise Akcelik Tunnel on the Persembe-Bolaman Road

The longest tunnel in the planning stage in Turkey is Ovit Mountain Tunnel. It will be a 12.6 km long double tube tunnel. When the Ovit Tunnel is completed, it will also be the longest double tube tunnel in Europe and the second longest double tube tunnel in the world[19].

CONCLUSIONS

Highway landscape design is an essential component of highway landscaping. Tunnel portals can be designed to leave a positive impression that highway users will appreciate. The designs and perspectives on tunnel portals can actually display elements of artistic composition.

Highway tunnels and their entrances can change a landscape and affect the visual quality of the area. Damage to highway tunnel portals is considered landscape deterioration.

Visual damage to the landscape should be minimised. Maintenance (rehabilitation, restoration and reclamation) work is very important for ameliorating damaged

landscapes at highway tunnel portals. Landscape design and maintenance work is important for creating livable spaces and use the natural environment sustainably.

Landscape maintenance is mentioned in the European Landscape Convention, to which Turkey is a signatory. The Convention (October 20, 2000, Florence) focuses on the protection, planning (development, restoration and rehabilitation) and management of landscapes. It also includes deteriorated areas and their landscapes.

The tunnels of the Black Sea Coastal Road project required the pouring of much concrete for tunnel portals and damaged the vegetation on the side scarps. Aesthetic and ecological values were not considered, and damaged ecosystems were not repaired. No maintenance work took place around the tunnel portals, leaving them to natural processes, which take a long time. Landscape planning and maintenance work is needed for highway tunnel portals, which would make it possible to restore the ecological, economical and aesthetic values of the damaged area around the tunnel portal.

There are various landscape design methods for tunnel portals. Each design is a result of the combination of the natural environment, topography, culture, stabilisation factors, the designers aesthetics and the elements used in the design.

In conclusion, environmental, architectural and engineering needs should be considered in highway tunnel portal design. Landscape design aims to create landmarks, prevent driver fatigue, have visual quality, communication and culture and protect the environment at highway tunnel portals.

REFERENCES

1. D. GONG, H. XIE, X. XU, X. FU, H. LI: A New Concept of Landscape Design in Highway Construction. In: Proc. of the 24th Southern African Transport Conference (SATC 2005), 11–13 July, Pretoria, South Africa, 2005.
2. M. N. ZEDENO, D. AUSTIN, R. STOFFLE: Landmark and Landscape: A Contextual Approach to the Management of American Indian Resources. Culture & Agriculture, **19** (3), (1997).
3. NPRA (Norwegian Public Roads Administration): Road Tunnels. Norwegian Public Roads Administration Handbooks, 2004.
4. L. A. GELDERMALSEN: Environmental Aspects in Tunnel Design. Safe & Reliable Tunnels. Innovative European Achievements, 1st International Symposium, Prague, 2004.
5. Y. FEI, H. CHUAN, W. SHI-MIN, Z. JIN-LONG: Landscape Design of Mountain Highway Tunnel Portals in China. Tunnelling and Underground Space Technology, **52–68**, 29 (2012).
6. S. MANSUROGLUA, P. KINIKLIA , R. YILMAZ: Impacts of Highways on Land Uses: the Case of Antalya–Alanya Highway. J Environ Prot Ecol, **14** (1), 293 (2013).
7. Z. DEMIROZ KIRAY, A. C. YILDIZCI: Impact of Landscape Architectural Practices on the Environment. J Environ Prot Ecol, **15** (2), 565 (2014).
8. N. AKPINAR: Enverimental Impact Assesment for Strip Coal Mining and Land Reclamation Case Study: Milas-Sekkoy Strip Coal Mine. Ph.D. Thesis, Ankara University, Science Institute, Ankara, 1994 (in Turkish).
9. E. F. DILEK: Landspace Planning on the Solid Waste Disposal Areas of the City of Ankara. Master Thesis, Ankara University, Science Institute, Landscape Architecture Department, Ankara, 2000 (in Turkish).

10. S. URGENC: Rural Landscape (Conservation-Restoration-Regulation). Yildiz Technical University, Architecture Faculty, Urban and Regional Planning Department. Istanbul, YTU-2000.004, 2000, p. 244.
11. E. GORCELIOGLU: Landscape Maintenance Technique. Istanbul University, Forestry Faculty Publication: 4351, Istanbul, XXI+320, 2002 (in Turkish).
12. Y. YAVUZSEFIK, O. UZUN: Landscape Maintenance Technique. Abant Izzet Baysal University, Duzce Forestry Faculty Publication, Duzce, 2005 (in Turkish).
13. Y. ULUSOY: Studies on the Reclamation and Rehabilitation of the Surface Mining Areas of the Region: Sile-Avcikoru. Master Thesis,Yildiz Technical University, Science Institute, Urban and Regional Planning Department, Landscape Planning Programme, Istanbul, 2006 (in Turkish).
14. H. SAHIN: Explore of the Planting after Open Pit Mining Activities: Example of Istanbul-Sile-Yesilvadi Village. Master Thesis, Bartin University, Science Institute, Bartin, 2011 (in Turkish).
15. A. G. OZTURK: Evaluatin of the Degraded Forest Lands in Terms of Lanscape Restoration Technique: Case of Edirne. Master Thesis, Namik Kemal University, Science Institute, Landscape Architecture Department, Tekirdag, 2012 (in Turkish).
16. S. SAHIN, H. PERCIN, E. KURUM, O. UZUN, C. BILGILI: PEYZAJ-44: Landscape Character Analysis in City Scale and Evaluation of Tourism/Recreation. (Landscape-44), No 109G074,TUBITAK KAMAG Project, Final Report, 2013 (in Turkish).
17. S. ERASLAN: The Landscape Restoration and Development Planning Approach after Facilities of Marble Quarries. Ph.D. Thesis, Suleyman Demirel University, Science Institute, Environmental Engineering Department, Isparta, 2014 (in Turkish).
18. ANONYMOUS: Republic of Turkey General Directorate of Highways. URL: http://www.kgm.gov.tr/SiteCollectionDocuments/KGMdocuments/MerkezBirimler/TesislerveBakimDairesiBaskanligi/sanatyapilari.pdf Retrieved on 08.12.2015.
19. URL: http://www.zaman.com.tr/ekonomi_karayollari-ferhat-gibi-daglari-deliyor_1223130.html Retrieved on 08.12.2015.

Received 11 Februaryy 2016
Revised 10 April 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *754–762* (*2016*)

Environmental protection and sustainable development – landscape planning

EFFECT OF URBAN PLANNING DECISIONS ON THE CONSERVATION AND SUSTAINABILITY OF AGRICULTURAL LANDS IN URLA, IZMIR

L. UNVERDI*, N. K. UNVERDI

Department of City and Regional Planning, Faculty of Architecture, University of Dokuz Eylul, Izmir, Turkey
E-mail: *levent.unverdi@deu.edu.tr*; *neslihan.karatas@deu.edu.tr*

Abstract. The rapid course of urbanisation triggered by massive migration since the 1950s has resulted in the rapid development of small peripheral settlements. This pressure for land development has caused the loss of fertile agricultural land. The main tendency of urban planning regarded land development as obligatory for growth, while agricultural areas were deemed inappropriate for planned areas. The last two decades, however, witnessed the rise of ecological approaches in planning, the consideration of natural and ecological thresholds for land development plans and a focus on sustainable land use decisions based on proper balance of the use and protection of resources. New restrictions have been introduced to protect agricultural lands in planning decisions. Urla is an important coastal settlement under the pressure of rapid urbanisation and particularly secondary housing trends due to its proximity to Izmir. Fertile agricultural lands have recently been transformed into urban areas. Despite regulations against urban sprawl, urban plans fail to resist the increasing pressure. Secondary housing emerges as the major component of rapid urban sprawl. Coastal areas are increasingly dominated by the living spaces of higher income groups. This study intends to scrutinise the extent to which conservation-based urban planning decisions guide the ongoing spatial transformation of agricultural lands into residential areas.

Keywords: sustainability, agricultural lands, urban planning, Urla, urban sprawl.

AIMS AND BACKGROUND

The primary goal in preparing development plans is: 'to protect and develop physical, natural, historical, and cultural values and ensure that land use is balanced, and establish healthy and safe environments with high living quality'. Although development plans are prepared according to these aim and goals, urban area capital accumulation, the basic driver of the neoliberal policy framework that has been in effect since the 1980s, has increased the pressure to develop specifically in metropolitan cities. This pressure for development triggered urban growth towards city peripheries, which created disjointed sprawl of low density form of settlements dispersed within a setting of vacant lands. This new growth form is called 'urban sprawl'[1]. These areas are dynamic intersecting areas where both rural and urban

* For correspondence.

qualities are seen together and play an important role for the sustainability of the balance between the urban and the rural[2]. With urban sprawl, agricultural lands are functionally changed by development where the basic land uses include non-urban, low density, work, housing, education, and shopping areas that are situated separately[3]. In the 1990s, with the development of technology and transportation the amount of urban sprawl increased[4]. Specially in the coastal areas, while tourism policies are indexed on foreign tourism and the lack of alternative tourism have changed the form of sprawl phenomenon in the coastal areas, urban growth in these areas has developed in the form of summer homes (secondary homes), country cottages, farm houses and so forth[5,6], since the 1980s, there has been a large increase in the quantity and quality of these areas. While increases in economic activity in coastal areas led to conflict and the depletion of natural resources[7], especially with houses being built on rich and fertile agricultural lands, the profitability of these areas was reduced[8]. Also, the lack of an extensive coastal management tool has permitted investors to use coastal laws for their own benefits[9].

On the western axis and within a distance of 38 km from the city of Izmir, the Urla district appears to be the best case for such development in urban development. While it holds the potentials for becoming a coastal touristic city as well as an urban development centre, Urla still displays characteristics of a rural settlement where the traditional agricultural facilities dominate the spatial settings[10]. Yet, Urla is one of the districts of Izmir metropolitan city most affected by rapid urbanisation, flows of migration and disjointed growth of urban sprawl towards peripheries. The purpose of this study is to show how, in reality, the agricultural areas in Urla could not be protected, despite decisions to protect them as part of a 55-year planning process and how much these agricultural areas have been subject to development.

EXPERIMENTAL

Urla was a coastal settlement that made a living off of agriculture, fishing, and commerce. Today with the development of agricultural areas into urban lands, agriculture has taken a downfall, and with the increasing population in the summer with the rise of tourism and commercial activities, Urla has begun to seem like a city united with Izmir both spatially and socio-economically. In the course of time, the agricultural lands appear to be subject to urban development despite the related conservation decisions.

In this study, Turkey Fundamental Soil Map (1984), the Land Use Classification Map (2013), this officially defines the legend and the master plan on scale 1/5000 that was approved in 2003 and is still valid, was superposed in ArcGIS. Then, current settlement areas in the land use classification map of 2013 and existing settlements in the planned areas of 1984 were removed to determine the areas open

for development between these dates. In the next step, the identified areas were separated according to their land use classification and type of land use. Finally, the results of the research helped to determine the amount of agricultural lands, which were originally designated as protected farming land within the planning process, but which lost their agricultural characteristics in reality.

RESULTS AND DISCUSSION

Urla previous development plans within the related planning area boundaries reveal that, there are different development plans approved on different dates for different areas in Urla. The first development plan approved by the Bank of Provinces in 1960 comprised the Urla settlement centre and only a small part the coastal areas. During the period of 1967–1968, the plan boundaries were extended to include the entire municipal boundaries[11]. Today, the existing land use of Urla appears to have been shaped after approval of the land use plans in 1984.

In the plans of 1984, the city centre of Urla appears to develop towards the agricultural lands on the northern and eastern parts, while the disjointed sprawl on the coastal areas continue their growth along the waterfront and towards the agricultural lands on the south both. Spatially, these settlement areas are disconnected; however, the agricultural areas between them were meant to be protected for agricultural purposes. However, neither the municipal boundaries of these development plans did include the entire agricultural areas, nor did they consider the effects of the Izmir-Cesme highway, and a wide area was left out of the development plan approved boundaries. Given all of these developments and increasing urbanisation demands due to the opening of the highway, in 1995 a new master plan was deemed necessary. The plan approved in 2003 is still in effect and has determined today planning boundaries**.**

In 1995 the approved master plan was evaluated in four different categories by the planner observational evaluations: Agricultural Land to be Preserved, Agricultural Land that can be Preserved, Green House Areas and Woodland Character to be Preserved. The plan, in addition to establishing a road connection to the areas classified as agricultural land to be preserved, contained no plan decision. The zoning plans aimed to create an agricultural housing development (TK I) where permission would be granted for the construction of farm houses or country cottages. In agricultural lands that can be protected, in addition to establishing similar roads and lacking plan decisions, zoning plans for agricultural housing (TK II) areas were permitted[12]. With the exception of allocation conditions between TK II agricultural areas and TK I agricultural areas, the most important difference is that in TK II agricultural areas more than one structure is permitted. Thus large scale housing estates began to be built in agricultural areas. However, partial urbanisation was foreseen in the plan where agricultural qualities are protected or to be

protected, and while the agricultural lands in the planned area were presumed to be under protection, they were in fact destroyed.

In the 2003 plans, I, II and III class (land use capability class) agricultural areas were placed under absolute protection and defined as 1st degree Agricultural Lands to be Preserved and IV, V, VI, and VII class agricultural areas were defined as 2nd degree Agricultural Lands to be Preserved. Olive groves were defined as special product areas. However, by this definition, in the 1995 master plan, TK I and TK II development areas and conditions were preserved identically.

Fig. 1. Existing settlement and planned areas (2003 Plan)

Fig. 2. Built areas in 1984 and the distribution of built and planned areas in 2013

Table 1. Land use capability class (LUCC)

LUCC	Area (m²)	Percentage (%)
I	1146985	10.53
II	2973797	27.31
III	4415332	40.55
IV	638049	5.86
VI	1399281	12.85
VII	315887	2.90
Total	10889331	100.00

Reference: Prepared from the 2013 land use classification study developed earlier.

Based on this, the total area of the current Urla settlement to be developed by planning is 1 5236 899 m² (1523.6 ha). 4 347 568 m² (434.7 ha) of this area was opened to development by the 1984 plan or the remaining 10 889 331 m² (1088.9 ha) area was developed after 1984 or developed according to the 2003 plan (Figs 1 and 2). In two decades, approximately an additional 1089 ha within the boundaries of the Urla development plan area were included. In the process, 78% of the post-1984 developed or opened for development area are 1088.9 ha and includes class I, II and III agricultural lands (Table 1).

Table 2. Land use (LU)

Land use	Area (m²)	Percentage (%)
Grassland	503802	4.63
Shurbland	1618374.5	14.86
Irrigated agriculture lands	3821132	35.09
Pasture	657250	6.04
Forest	209287	1.92
Rainfeed	350661	3.22
Vineyard	674643	6.20
Olive grove	3054181	28.05
Total	10889330	100.00

Reference: Prepared from the 2013 land use classification study developed earlier.

Table 2 shows developed areas and areas to be developed areas according to plan decisions. While dry agricultural lands top the list with 35%, olive areas are in second place with 28%. In both of these areas, but especially olive groves, TK II conditions apply and gated housing developments emerge in the guise of agricultural housing. When the land use capability classification is examined, 49% of 1st degree agricultural land opened to development is dry agriculture, 19% are wet agriculture, and 32% – olive groves. Of the 2nd degree agricultural lands, 35% are dry agricultural areas, 18% are vineyards, and 47% – olive groves. Of the 3rd degree agricultural lands, 20% are brushwood, 3% – meadows, 47% – dry agriculture, 3% – vineyards, and 27% – olive groves (Figs 3 and 4).

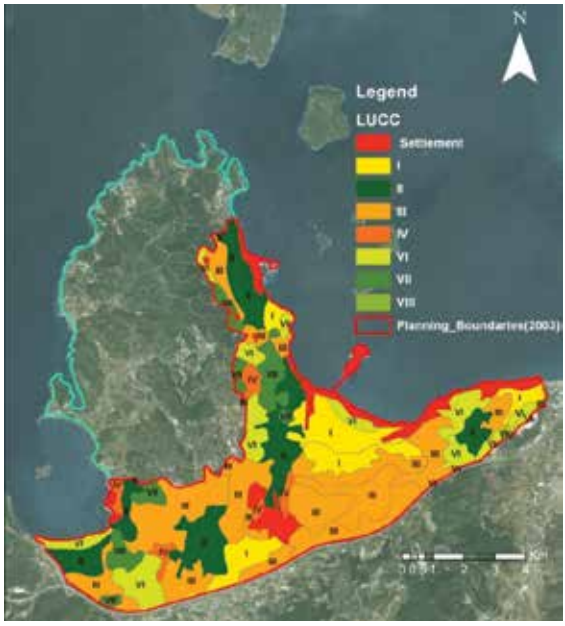


Fig. 3. Land classification in the 2003 Urla development plan boundaries

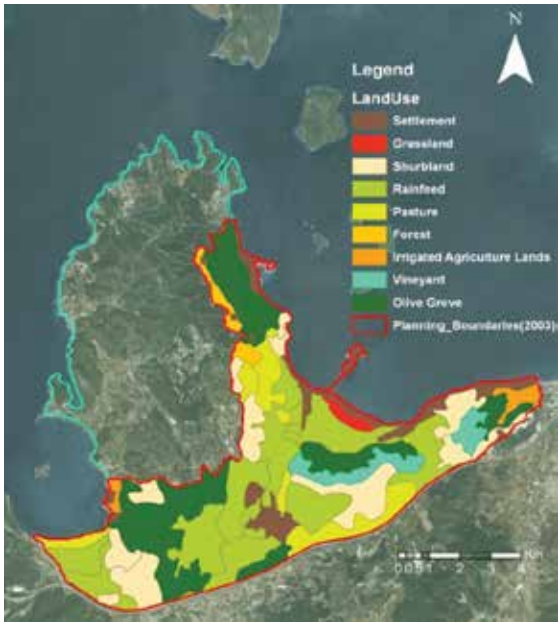


Fig. 4. Land use in the 2003 Urla development plan boundaries

The 2013 development plan decisions and legal legend for the land use classification map show that in the agricultural lands north of Downtown Urla there

is a single structure on each TK I parcel. East of Downtown Urla, despite being a 3rd degree agricultural area on a slope and a large part of the areas classified as marginal, there are more than one structure on each parcel. This development, which is disconnected and piecemeal, seriously threatens the agricultural areas integrity. These areas, regardless of their classification as marginal agricultural land, are in need of absolute protection (Fig. 5).

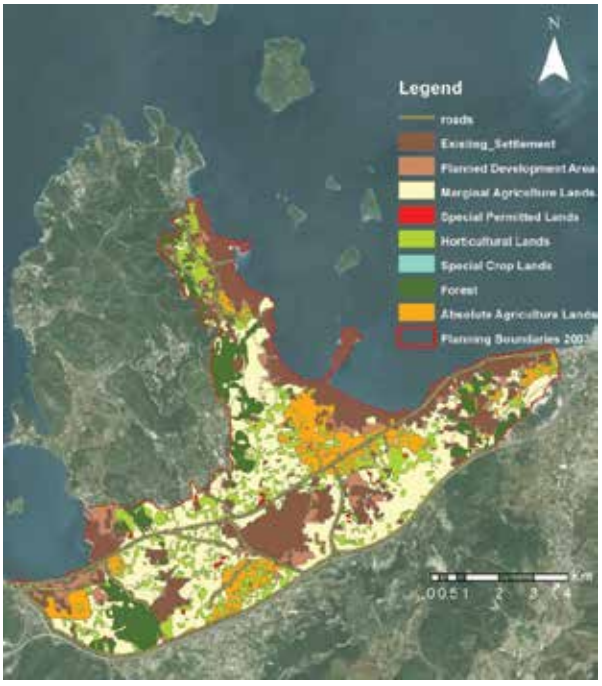


Fig. 5. Land use classification

All of these findings and evaluations show that although the development plan decisions permit 7% building in 1st and 2nd class agricultural areas, fertile agricultural areas are being diminished piece by piece, and agricultural areas are being transformed into low density residential areas. Again, in a similar way, with the exception of roads passing through developed areas along parcel borders, the master plan decisions, approved zoning development plans, and TK II land parcels, no technical or social infrastructural areas were left the public, and with agricultural allotments and plans for urban development, agricultural areas have inevitably been lost. For this reason, social development, urban planning and land management play an important role in ensuring the environmental sustainability of agricultural lands, wetlands and natural areas that are under the pressure of uncontrolled urban expansion[13].

CONCLUSIONS

Coastal settlements along the boundaries of especially large metropolitan cities where urban sprawl is seen in the perimeters entered a rapid transformation process under great pressure for urbanisation. Urla is located on the west axis of Izmir and is a coastal settlement along the perimeter where this transformation process can clearly be seen. Natural and agricultural areas are affected by this transformation the most. Regardless of how plan decisions are devised to protect agricultural areas, they have backfired and caused these areas to be transformed into housing areas due to the increasing demands, pressures and the building of secondary housing. Over time, the development of secondary housing in coastal areas, as one goes towards Downtown Urla, has given way to the development of specifically agricultural areas as primary housing areas. The most important factor triggering this process are the conditions stipulated for the structures needed for agricultural activities. In Urla, from 1984 to the present, 1089 ha are developed or are planned to be developed as urban lands. This study determined that 78% of these areas fell within class I, II, and II agricultural lands, and 63%, within dry agriculture and olive groves. No matter how much plan decisions are brought to protect agricultural areas, they fail to do so.

Today in Turkey, it is possible to see this type of transformation, as in Urla, in many settlements. With this in mind, special protection measures must be implemented during the planning process, especially for agricultural areas whose natural character requires protection. While the need to identify and regulate agricultural quality areas as protected areas constitutes an important part of land use planning[14], socio-economic factors and agro-economic models need to be handled together to plan and protect the nature[15]. Creating alternative planning scenarios with new planning and management policies, not ignoring the contribution of dynamic spatial urban models and researching the potential effects of decisions on the environment became a necessity[16]. Of course, one of the important conditions for providing the necessary incentives is for this process to be conducted in the country political framework in a way that is suitable for agricultural areas to be used. For providing a protective understanding within a holistic framework in agricultural areas, first the implementation of long term regional plans incorporating protective measures is required. At the same time, this process needs to be part of a more comprehensive developmental policy for rural development planning[17]. At the regional scale where agricultural areas to be protected require the establishment of 'holistic agricultural area management' so that regions can protect planned agricultural areas with a holistic understanding and develop an important sustainability policy. Lower scale plans should include a special protective legend, plan notes and decisions from the regional scale. Thus, special measures preventing inappropriate development in agricultural areas will be implemented and enforced. When needed, especially in fertile agricultural areas that have been

defined as special, such as archeological sites or nature reserves, developing special conditions to be enforced in 'agricultural protected areas' will effectively protect them. This will not only simplify the protection of agricultural area planning, but also act as a deterrent to inappropriate development.

REFERENCES

1. N. KARATAS: Impact of Urban Sprawl upon Landovner Property Ownership in Ayrancilar-Torbali, Izmir (1968–2000). Union of Turkish Engineers and Architects, Chamber of City Planners Publication (Ankara), **40** (2), 3 (2007) (in Turkish).
2. D. KUSULUOGLU, G. AYTAC: Sustainability of Urban Fringes. Case Study of Arnavutkoy, Istanbul. J Environ Prot Ecol, **15** (2), 779 (2014).
3. R. E. HEIMLICH, W. D. ANDERSON: Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural. Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No 803, 2001.
4. A. KALPAKCI: Integration of Paratransit Systems with Innercity Bus Systems, Case of Izmir. Master Thesis, Dokuz Eylul University, Izmir, 2013 (in Turkish).
5. N. KARATAS: Effects of Land-Ownership Transformation in Metropolitan Fringe Areas on Existing Urban Pattern (a Case Study of Ayrancilar–Torbali). Unpublished Master Thesis, Izmir Institute of High Technology, Izmir, 2000 (in Turkish).
6. E. O. TORE, Z. O. EREN, G. CEVIK, Z. KORKMAZ, M. GOKDEMIR: Evaluation of Settlements on the Coastal Regions of Thrace Regarding Current Laws and Regulations. J Environ Prot Ecol, **13** (2), 710 (2012).
7. E. OZHAN: Coastal Zone Management in Turkey. Ocean Coast Manage, **30** (2-3), 153 (1996).
8. D. BAYEZIT: Statistical Analysis of Impact of Secondary (Summer) Housing upon Tourism Economy in Turkey. http://dspace.trakya.edu.tr:8080/jspui/bitstream/1/66/1/Bayezit%2c%20Dil%C5%9Fat.pdf, 2003 (in Turkish).
9. S. BURAK, E. DOGAN, C. GAZIOGLU: Impact of Urbanization and Tourism on Coastal Environment. Ocean Coast Manage, **47**, 515 (2004).
10. G. EMEKLI: Evaluation of Urban Development of Urla in Terms of Urban Geography. Ege University, Research Projects Final Report, Project No 2001-EDB-004, Faculty of Literature, Department of Geography, Izmir, 2004 (in Turkish).
11. Dokuz Eylul University, Faculty of Architecture, Department of City and Regional Planning: Urla Analytical Survey Report, Izmir, 1992 (in Turkish).
12. EGEPLAN: Urla Master Plan Revision Report. Plan Codes. Municipality of Urla, Izmir, 2003 (in Turkish).
13. U. AKIN: Urban Agriculture: An Instrument for Sustainable Urban Development in the Metropolitan City of Istanbul. J Environ Prot Ecol, **12** (4A), 2245 (2011).
14. N. AKPINAR, I. TALAY, S. GUN: Priority Setting in Agricultural Land-Use Types for Sustainable Development. Renew Agr Food Syst, **20** (3), 136 (2014).
15. M. LÜTZ, O. BASTIAN: Implementation of Landscape Planning and Nature Conservation in the Agricultural Landscape – a Case Study from Saxony. Agr Ecosyst Environ, **92**, 159 (2002).
16. B. K. ATAK, N. ERDOGAN, E. ERSOY, E. NURLU: Analysing the Spatial Urban Growth Pattern by Using Logistic Regression in Didim District. J Environ Prot Ecol, **15** (4), 1866 (2014).
17. H. AHRENS, J. KANTELHARDT: Accounting Forfarmers' Production Responses to Environmental Restrictions within Landscape Planning. Land Use Policy, **26** (4), 925 (2009).

Received 11 February 2016
Revised 16 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 763–771 (2016)

Environmental management

ASSESSMENT OF COASTAL AREA USES OF ORDU PROVINCE WITH AN INTEGRATED COASTAL AREAS PERSPECTIVE

E. AKYOL SATIROGLU, P. YESIL

Architecture Department, Faculty of Agriculture Landscape, Ordu University, 52 200 Ordu, Turkey
E-mail: *elifakyol78@hotmail.com*

Abstract. Coastal regions with their natural, social, cultural and economic potentials have become the mostly preferred places and consequently such places have become the centre of intense human activities. Rapidly increasing population and public right to use coasts gradually increased the pressures exerted over those coastal regions. Then, the limited resource, the coasts, destroyed in time and started to lose their natural assets. Integrated coastal management plans have been implemented in Turkey to bring a new perspective in coastal planning and implementation works, to provide compatible and balanced preservation of coastal regions and decision-making process considering entire sectors. These plans are expected to be a tool to meet the international obligations, to orient local expectations and demands, to arrange conflicting responsibilities over coastal regions and to provide a balance between economic development and environmental health. Along with these objectives, integrated coastal management plans were prepared for Sinop, Samsun, Trabzon, Artvin and Rize provinces along the Blak Sea coastal line, but there are not any works done for Ordu province. In this study, current status of coastal sections of Ordu province was assessed and zoning decisions and strategy recommendations were provided along with the principles of integrated coastal management planning.

Keywords: integrated coastal area management, Ordu, coastal areas.

AIMS AND BACKGROUND

Coastal zone has been the most attractive and popular area for every time and for all the populations and cultures[1]. Such sites have become the most preferred sites economically and culturally. Natural resources, transportation opportunities and convenient safe environments have made the coastal sections essential attraction centres for human settlements rather than being only riparian sites[2]. Urbanisation has been an important component of land use and land cover change, and its significance will undoubtedly continue to increase with the majority of the world population swarming into cities. Coastal areas are the most variable units on earth. Especially for the last 30 years, coastal areas of Turkey have been under tremendous repression mainly because of population explosion arising from the

* For correspondence.

domestic and foreign tourism demands, and also settlements by holiday dwellers and industrial companies, highways constructed to overcome traffic problems, intentions to convert beaches to sand supplying quarries and the other applications[3].

Just because of rich natural resources, coastal sections have intense human activities, thus, they need a management plan because of conflicts in resource utilisations[4]. Coastline has effects both on land and sea ecosystem[5]. Coast preservation is possible only with an official management system and coastal zone management constitutes the uppermost significant part of such a management system. Coastal zone management is an administrative and resource management process targeting a balanced utilisation of coastal resources for a sustainable development of such areas, designating the position of coast in economic and social life and arranging the interactions with surrounding environments. 'The objective of coastal zone management are to create integrated policy and strategy-based management process allowing compatible and altogether activities of public and local groups through taking sensitive, limited and under-pressure nature of such sites into consideration'[6].

Coastal and marine areas have a great importance for countries. Turkey has a wealth of coastal areas and an abundance of their coastal resources[7]. Several attempts have been made and pilot implementations were performed in Turkey for integrated shore management. Recently, the Ministry of Environment and Urbanisation have been implementing Integrated Coastal Management and Design Projects in different cities. These works are considered as the documents of integrated spatial preservation and development strategies for coastal sites.

Integrated Coastal Management is a course of action for all planning and implementations to be made in coastal region and terrestrial site of coastal section. It should be assessed as a physical plan. Integrated Coastal Management Plan grounds on sustainability of coastal area which is a limited resource; targets the management of utilisations, demands and conflicts of different sectors; aims to develop planning process, principles and strategies of the shore and cooperation among institutions and organisations. The concept of 'Management Plan' is a process design and Integrated Costal Management can then be defined as a set of strategies[8].

Within the scope of this study, current status of coastal uses of Ordu province was assessed and along with basic principles of Coastal Management Planning works, zoning decisions and resultant strategy recommendations were provided and the need for the development of a new planning approach was brought forward to point out the problems of urbanisation, industrialisation, tourism and second-home construction over coastal regions and the deficiencies of current planning implementations in solving such problems.

Shores are the conjunction sites between land and sea. Since these sites are limited sources, cannot be increased and have sensitive ecosystems, preservation priorities should be taken into consideration while benefiting from these sites. A

sustainable approach should be employed and preservation-utilisation balance should always be taken into consideration in management of these areas.

Coastal regions of Turkey should be planned within the frame of a new approach and model; the coastal sites should not be considered as sites composed only of coast and beach, they should be considered as a region covering the entire areas with which coasts have interactions; and they should be planned with a regional planning perception. Within this framework, integrated coastal management approach is envisaged as a significant tool for balanced resource use in coastal regions.

EXPERIMENTAL

The research site, Ordu province, is located on the north of Turkey in Central and Eastern Black Sea region between 40˚18′–41˚09′ north latitudes and 38˚40′–38˚07′ East longitudes. The province is surrounded with Black Sea on the north (Fig. 1).

Surface area of the province is 5963 km^2 and it covers about 0.8% of country soils. The province is neighboring with Black Sea on the north, Samsun on the West, Giresun on the east, Tokat and Sivas on the south.

Fig. 1. Research site

Ordu province has 19 towns including central town (Fig. 2). The province has 107 km shore line and respectively from west to east the province has Black Sea coasts in Unye, Fatsa, Persembe, Ordu Centre and Gulyali towns. The other towns do not have a coast.

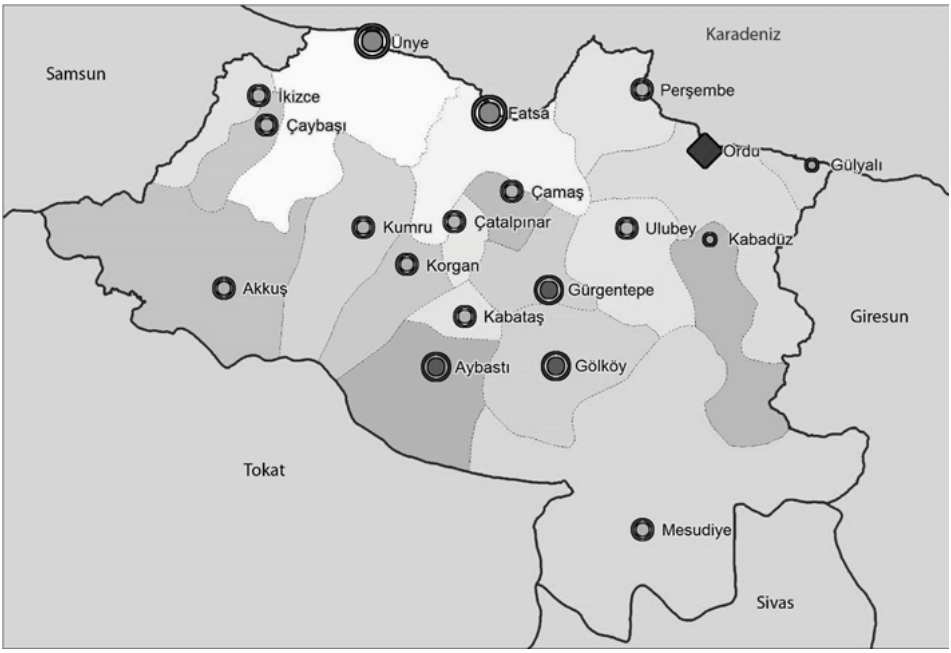


Fig. 2. Administrative division of Ordu province

The research site was divided into 5 sub-regions composed of coastal towns (Fig. 3). Beside similar characteristics of each region, they have also different characteristics. Strong and week points of each region were assessed and strategic decisions set forth for each region.

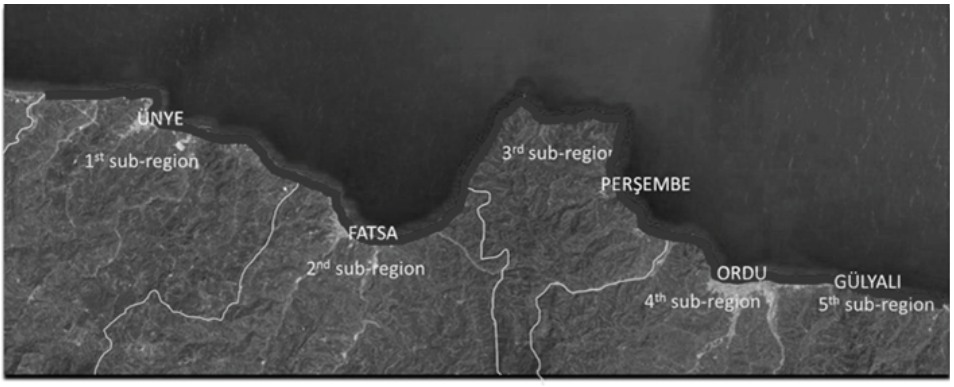


Fig. 3. Zoning decisions for the research site

RESULTS

1st SUB-REGION: UNYE AND CLOSE VICINITY

Unye is neighbouring with Fatsa and Terme along the shoreline and with Akkus, Ikizce and Caybasi through the inner sections. The town was established over a smooth terrain with almost zero slope and such characteristic totally distinguish the town from Eastern Black Sea. Unye town centre is located over a large crescent-shaped bay. The Tabakhane stream passing through the town separated the town as 1/3–2/3 in each side. Akcay at western side constitutes the border of the town with Terme. Unye is the most densely populated town of Ordu. Uzunkum, Incekum, Inciralti, Cinarsuyu beaches extend kilometers along the coast.

Strengths

- Large and clean natural beaches.
- Rich flora and fauna.
- Coastal road and parks providing day and night recreation opportunities.
- Unye castle, historical houses, Ottoman bazaar, church and fountain-like several historical structures.
- The most intense accommodation facilities in the city and thus more intense tourism mobility.
- Convenient connection and transportation with surrounding settlements and resultant commercial life.

Weaknesses

- Insufficient facility and infrastructure.
- Insufficient lodging facilities for eco-tourism and thus not meeting the needs.
- Insufficient qualified stuff for eco-tourism activities.
- Insufficient tour organisations.
- Insufficient publicity.

The strategies forecasted for the 1st sub-region of the research site: The town has the luckiest position with regard to eco-tourism of Ordu province. These assets should be preserved and alternative tourism can be developed. Number of tourism facilities and boutique hotels can be increased and existing ones can be developed. Beaches along the cost can be preserved and significant contributions can be provided to tourism potential of the province.

2nd SUB-REGION: FATSA AND CLOSE VICINITY

Fatsa is neighbouring with Persembe on the east, Unye on the west, Korgan, Camas, Catalpinar and Kumru on the south and Black Sea on the north. There are smooth fields around the close sections of Bolaman and Elekci Streams to the coast.

Strengths

- Highly mobile commerce because of Fatsa port.

● Existence of valuable eco-tourism assets like Gaga lake, Cingirt rock tombs, Sarmasik hot springs.

● Diverse local income sources with development potential like agriculture, livestock, aquaculture, carper business.

● Coastal road and parks providing day and night recreation opportunities.

● Rich flora and fauna.

Weaknesses

● Increasing intensive structuring.

● Insufficient facility and infrastructure.

● Insufficient lodging facilities for eco-tourism and thus not meeting the needs.

● Insufficient qualified stuff for eco-tourism activities.

● Insufficient tour organisations.

The strategies forecasted for the 2nd sub-region of the research site: Existing port can be developed and capacity can be increased. Daily touristic use of the port can be provided. Natural and cultural assets can sustainably be managed in a preservation-utilization balance.

3rd SUB-REGION: PERSEMBE AND CLOSE VICINITY

Persembe town is a natural bay over Ordu-Samsun highway. It is a coastal town. The town is neighbouring with Black Sea on the north, Ordu central town on the east, Fatsa on the west and Ulubey on the south. The town was founded at the skirts of small steep hill called Kordon Tepe. Persembe port is the second largest and natural port of Black Sea.

Strengths

● Undisturbed nature and natural resources.

● Clean sea and beach and available places for water sports.

● Although providing highly proper and diverse places for tourism, the town has not completed the development in this respect. Therefore, it is open for sustainable tourism planning works.

● The town received the title of calm city (cittaslow) in 2012. It is one of 9 calm cities of Turkey and the only one in Black Sea region. Works have been done to reduce the noise levels on highway to meet the criteria for calm cities and calm settlements have established along the coast line.

● Located in close vicinity of Ordu central town (14 km) and having convenient transportation opportunities.

● Existence of Akkus (Hoynat) island, a significant bird place, within the borders of the town.

● Yason cape with natural and historical assets.

● Rocky sites, bays and under-water caves along the coast.

● Existence of nice beaches already decreased in Black Sea region, in town.

● Passage of Black Sea coastal highway from the south of the town without following the coast line.

Weaknesses

● Insufficiently developed industry and trade because of close vicinity to centrum.

● Negative pressures exerted by fish farms along the Persembe port on coasts.

● Insufficient publicity and marketing about eco-tourism.

● Insufficient facility and infrastructure.

● Insufficient lodging facilities for eco-tourism and thus not meeting the needs.

● Insufficient qualified stuff for eco-tourism activities.

● Insufficient tour organisations.

The strategies forecasted for the 3rd sub-region of the research site: Current status of archeological and natural protection sites, sensitive natural and cultural heritages can be preserved and tourism opportunities can be increased. The title of calm city can be used to improve daily tourism activities. The beaches along the coast line can be preserved and improved for public use.

4th SUB-REGION: ORDU CENTER AND CLOSE VICINITY

The region has an intense use because of beach parks and Boztepe telpher station. Back side of coastal line, transportation connections and spatial arrangements are relatively more complex than the other towns.

Strengths

● Existence of rich scenery watch points for province and surrounding assets.

● Natural resources and undisturbed natural environment.

● The beaches in centrum and along the large part of coastal line.

● Diverse plant cover and existence of site-specific endemic flora.

● Potential for water-related and various recreational activities.

● Local foods, cuisines and hand crafts.

● Stream passing through centrum and with untouched recreational potentials.

Weaknesses

● Oil factory and solid waste repository in coastal line.

● Discharge of domestic wastes to the sea through Melet River.

● Intense and unplanned urbanisation especially in centrum.

● Insufficient facility and infrastructure.

● Insufficient lodging facilities for tourism and thus not meeting the needs.

The strategies forecasted for the 4th sub-region of the research site: The pressures exerted by intense use of Boztepe telpher station, which has a great significance for the tourism of Ordu centrum, should be minimised. Transportation connections and traffic arrangements should be made in centrum and equipment needs of current parks should be met. The solid waste repository sites located

within the borders of the region should be designed, solid wastes should be put under control, negative impacts on natural resources and ecological balance should be prevented.

5th SUB-REGION: GULYALI AND CLOSE VICINITY

The town is located at 8th km along the route from Ordu to Giresun. It is a unique place with blue-flagged beaches in Ordu province. The Ordu-Giresun airport opened in 2015 is the only airport of Turkey constructed over the sea.

Strengths

- Existence of an active airport.
- Close vicinity to Ordu central town.
- Being a unique place with blue-flagged beaches in Ordu province.

Weaknesses

- Insufficient publicity and marketing.
- Insufficient facility and infrastructure.
- Insufficient lodging facilities for tourism and thus not meeting the needs.

The strategies forecasted for the 5th sub-region of the research site: The Ordu-Giresun airport opened in the region is the first airport of Turkey constructed over the sea. Runway was designed as 3000 m along the cost. The blue-flagged beaches of the region should be preserved and improved. Considering the intensive use of the airport, number of facilities should be increased to serve the region. Tourism mobility will increase with the operation of the airport. Therefore, negative effects of such mobility on natural assets and agricultural lands should be prevented.

DISCUSSION AND CONCLUSIONS

Ordu province and close vicinity with coasts and natural beauties have great tourism potential. In this study, current status and potential structure of coastal sections were assessed together with natural and cultural assets and urban life and strategic forecasts were provided for further development and improvement of coastal sections. The research site was divided into 5 sub-regions including coastal towns. Strengths and weaknesses of the regions were put forth. In the 1st sub-region covering Unye and close vicinity, preservation and eco-tourism development measures can be taken. In the 2nd sub-region covering Fatsa and close vicinity, measures can be taken to improve existing port and efficiency of port can be increased. In the 3rd sub-region covering Persembe and close vicinity, public should be encouraged to use the beaches and arrangements should be made for beach and facility utilisations to improve coastal uses. In the 4th sub-region covering Ordu centrum and close vicinity, arrangements should be made to minimise the pressured exerted by intensive use of telpher station and park equipment should be improved. Solid

wastes around the centrum should be put under control and negative impacts on environment should be prevented. Finally, in the 5th sub-region covering Gulyali and close vicinity, considering the potential improvements in regional tourism with the operation of Ordu-Giresun airport, ground transport should be improved. Also in coastal sections of the region, arrangements should be made for the public use of coasts. Within this scope, recreative uses should be supported and developed.

In all works and implementation to be made in the region, entire natural resources of coastal sections should be planned and managed by taking preservation-utilisation balance and bearing capacities into consideration. Sensitive ecosystems should be identified and preservative measures should be taken over such sites. Already protected sites should be managed in accordance with management plans. Domestic and industrial wastewater discharges into sea should urgently be terminated. In all planning activities, pressures exerted by potential uses should be taken into consideration and efficient and sustainable use of coastal sections should be supported.

REFERENCES

1. S. SAZAK: Legal and Administrative Issues on Pollution of Turkish Coasts. J Environ Prot Ecol, **10** (4), 1170 (2009).
2. S. UCLAR: Integrated Coastal Zone Management and a Case Study of Istanbul. MSc Thesis, Graduate School of Science Engineering and Technology, Istanbul Technical University, Urban Planning Program, Istanbul, 2012.
3. M. OZYAVUZ, Y. D. ONMEZ: Monitoring the Changing Position of Coastlines Using Information Technologies, an Example of Tekirdag. J Environ Prot Ecol, **15** (3), 1051 (2014).
4. O. BAHAR: The Value of Integrated Coastal Zone Management and Marine Spatial Data Infrastructure for Turkey. MSc Thesis, Institute of Natural Sciences, Karadeniz Technical University, Trabzon, 2007.
5. G. GULER: Possible Conflicts between the Recreation and Ecology in the Coastal Region of the Black Sea. The Cilingoz Case. J Environ Prot Ecol, **12** (2), 543 (2011).
6. F. A. SESLI, A. C. AYDINOGLU, N. AKYOL: Management of Coastal Areas. Union of Chambers of Turkish Engineers and Architects, Chambers of Map and Cadastral Engineers, Turkey Scientific and Technical Conference, Notification Book, Ankara, 2003, 757–768.
7. R. NISANCI, Y. S. ERBAS, V. YILDIRIM, H. E. COLAK: Management of Marine Cadastre with Geographic Information System: A Case Study of Trabzon. J Environ Prot Ecol, **16** (1), 126 (2015).
8. BIB, Antalya Report: The Ministry of Public Work and Housing, General Directorate of Technical Research and Implementatiton, Antalya Integrated Coastal Zone Management Plan Project Report, Ankara, 2010.

Received 11 February 2016
Revised 16 April 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *772–780* (*2016*)

Environmental management

WATER MANAGEMENT IN THE HOSPITALS IN TRABZON PROVINCE

M. TOPBAS*, N. E. BEYHUN, G. CAN, S. Y. UCUNCU, C. C. KOLAYLI, S. KARAKULLUKCU, S. CANKAYA

Department of Public Health, Faculty of Medicine, Karadeniz Technical University, Trabzon, Turkey
E-mail: *murattopbas@yahoo.com*

Abstract. There is a high demand of water in hospitals and wastewater can pose danger. However, water should be provided without interruption. In other words, water should be professionally managed in hospitals. Survey methodology was used to collect data for this study in which the knowledge and opinions of the managers of 23 private and public hospitals in Trabzon province of Turkey on water management were analysed. It was found out that the managers do not know either the daily water requirement of water in hospitals or the exact number of the items and places related to water consumption such as faucets, toilets, urinals and shower stalls; many of the documents that show in-building water supply networks are not available; there are not any technical staff for water-related problems in 8 hospitals; there have been water cuts in 13 hospitals in the last year and problems in providing water in the time of water cuts. It turned out that the hospital managers in Trabzon should be informed about water management and awareness should be raised in this regard. Moreover, water management issue should be tackled in green hospital context and relevant statutory obligations should be imposed.

Keywords: hospital, water management, Trabzon, drinking water, waste water.

AIMS AND BACKGROUND

Water is of vital importance for both clinical and other areas in hospitals. In hospitals, water is used for drinking, general cleaning, sterilisation and gardening and in operating rooms, diagnosis and treatment units, kitchens and laundries in the form of cold water, hot water and vapour[1].

Healthcare systems are among a community largest consumers of water[2]. Especially, hospital and pharmaceutical wastes are those that include serums and vaccines which exceeded validity terms, expired drugs, chemotherapy substance residues, which can be cytotoxic, genotoxic, mutagenic, teratogenic or carcinogenic[3]. In addition, healthcare institutions pose a risk on the water requirement of the public especially in settlements in arid regions because of the obligation to provide water to hospitals without interruption.

* For correspondence.

The amount of the consumed water varies according to the geographic location of the hospital, water resources, water supply network of the city and in-building water systems, type and age of the building, total size of the hospital premises, the type and number of the healthcare services, bed and polyclinic capacity and the number of the patients who receive daily care, the number of the staff, etc. Water consumption per patient ranges from 150 to 1500 l in hospitals[1].

Hospitals need clean and safe water, on the other hand, major part of the wastewater is dangerous since it is chemically, pharmaceutically, microbiologically and radioactively contaminated as a result of hospital processes[4]. Additionally, there should be in advance planning in order to meet clean and safe water requirements of hospitals in extraordinary situation and remove sewage water[5]. Moreover, there is a high demand of water in hospitals; however, water saving/limitation of water use is not possible in hospitals by its nature. Necessary amount of water should be used in the necessary areas. Therefore, water resources should be protected, water should not be wasted, contamination should be prevented, wastewater should not pose a threat on environment and public; in other words, water should be efficiently and environment friendly utilised. This means that water should be professionally managed in hospitals[1,6].

Recently, the concept of 'green hospital' is on the global agenda[7,8]. Careful and efficient use of water and water resources and reducing contaminative effect of wastewater are the top priorities in green hospitals[9]. Therefore, it is of great importance to develop strategies that aim to identify the areas where water is consumed, determine the daily and monthly amount of consumed water in units and reduce the unnecessary use of water in order to render the use of water in hospital efficient[4,9,10].

Chief physicians are the most authorised persons in hospitals in Turkey. Hospital managers are in charge of several issues such as providing food and beverage for the hospitals, repair and maintenance of the building, taking precautions to protect the surrounding, taking and implementing measures for extraordinary situations[8,11,12]. Therefore, there is not a specific person in charge of water management but it seems that hospital managers are responsible for this issue.

With its 1000–3000 m^3 water per capita in terms of water opulence ranking, Turkey is one of the countries with 'water problem' and that may be adversely affected by climate change[13–15]. Therefore, effective and efficient use of water is highly important. But, what do the hospital managers in Turkey know about water management? What is the knowledge and awareness level in terms of the procedures of water management in their hospitals? In other words, do the hospital managers have a good knowledge of water management? Seeking the answers of these questions, this study is one of its kinds in Turkey, one of the few studies in this field in the world and aims to set forth the knowledge and opinions of the hospital managers in Trabzon on water management.

EXPERIMENTAL

We received approval from the Karadeniz Technical University (KTU), Faculty of Medicine Scientific Research Ethics Committee (date of the meeting: 01.06.2015; decision No 9) and necessary permissions from Trabzon Provincial Directorate of Health and Trabzon General Secretariat of the Public Hospitals Union. After obtaining oral permission from KTU Farabi Hospital Chief Physician and Chief Physicians of Private Hospitals (since Trabzon Provincial Directorate of Health is in charge of inspecting private hospitals, we received permission from the Directorate), we started to conduct our study.

23 hospitals in Trabzon province including KTU Faculty of Medicine Farabi hospital, 3 training and research hospitals (Kanuni training and research hospital, Numune training and research hospital, Ahi Evren training and research hospital), 10 state hospitals (Fatih state hospital, Yavuz Selim osteopathic and rehabilitation hospital, Akcaabat Hackali Baba state hospital, Vakfikebir state hospital, Tonya state hospital, Of state hospital, Surmene state hospital, Macka Omer Burhanoglu physical therapy and rehabilitation hospital, Arakli Bayram Halil state hospital, Atakoy psychiatric hospital), 4 private hospitals (Medicalpark Karadeniz hospital, Medicalpark Trabzon hospital, Private imperial hospital, Private Clinart international hospital), 5 district hospitals (Salpazari district hospital, Arsin district state hospital, Caykara Dr. M. Ilhan Durgun district hospital, Koprubasi Vali Recep Yazicioglu district hospital, Duzkoy district hospital) were chosen as the research population and all of the private and state hospitals participated in the study.

In face-to-face meetings with Directors of Patient Services and Healthcare Hotel Management or Hospital Managers, research data were collected by using the survey form that was prepared by the researchers between 01.06.2015–15.06.2015. The questions of survey were about the daily and monthly water requirements of hospitals, water resources, use of water and information on the use of water (the number of faucets, toilets, shower stalls and urinals), water control, disposal of wastewater, inclusion of water in emergency action plans.

Data collected from 23 hospitals were analysed as a whole. However, in terms of data, no comparison was made among hospitals in order to prevent the emergence of a potential problem in terms of ethics and health service provision.

RESULTS

Certain descriptive data of 23 hospitals in Trabzon are presented in Table 1.

Eight hospitals do not have trained personnel on sanitary systems and hydraulics. The number of bathrooms in 2 and the number of restrooms in 4 hospitals were not even known. In order to be able to present current or closely concerning situation about water management and water consumption in hospitals the number of faucets, sensor faucets and urinals were demanded. However, during the surveys

due to the contradictory statements and the answers provided as 'I do not know' these data could not be presented accurately.

Table 1. Some of the descriptive features of hospitals in Trabzon

Features	Median	Min.–Max.
Number of beds	88	(10–780)
Daily average number of polyclinic patients	550	(10–4000)
Number of personnel	300	(28–2492)
Sanitary system – number of educated personnel about sanitary structure	1	(0–5)
Number of restrooms	78	(10–205)
Number of bathrooms	18	(1–168)

It was detected that water source of 20 hospitals were city water, 2 were well water and 1 was spring water.

The water consumption of the hospitals was questioned and the bills were evaluated for this data. According to that, the average monthly water consumption of hospitals was 1962 t of water (min. 9 – max. 7500) However, 3 of the hospitals that were not using city water did not have information about their water consumption.

21 hospitals had their own drinking water tanks, 1 had a utility water tank and 1 did not have any. 4 of these drinking water tanks are cleaned once a month, 4 of them once every 3 months, 8 of them once every 6 months and 5 of them once a year.

It was determined that there is a project for indoor water system in 4 of the hospitals. However, there have been leaking/cracking problems in indoor water systems before.

It was determined that 4 of the hospitals had water purification devices and that they were being used in kitchens and 13 had water dispensers to provide drinking water in public areas. Moreover, drinking water consumed by the personnel in polyclinics and services was researched and it was detected that 6 hospitals used city water, 1 was using well water, and others used dispenser-sized packaged water.

It was questioned whether there were any water cuts in the last year in hospitals and 13 of the hospitals that use city water responded this question as 'there was water cut'. 11 of these hospitals indicated that water cut happened more than once. During the water cut 9 hospitals supplied their water from the auxiliary tank, 4 hospitals used dispenser-sized water and 1 hospital supplied water through the municipality water trucks.

When the water reports were examined, water samples were taken by the Public Community Health Directorate except for one hospital. However, according to water checks it was detected that samples were collected every 15 days from 2 hospitals, once a month from 7 hospitals and that in 12 hospitals these checks were carried out less frequently.

Ways of removal of waste water from qualified areas can be found in Table 2.

Table 2. Ways of removal of waste water from qualified areas

Qualified areas	General sewer system	Private containers	Private sewage system
Laboratory (n = 23)	15	7	1
Radiology (n = 11)	2	8	1
Chemotherapy unit (n = 4)	2	2	
Nuclear medicine (n = 3)	2		1

It was detected that emergency action plans of 21 hospitals tackled the issue of drinking water, 2 hospitals were preparing it. Only one hospital had waste water plan in case of emergency. However, the study was not able to receive details on this issue.

The question of 'What should be the order of priority of drinking water supply in hospital management?' was asked. 14 hospital managers responded that it should be top priority whereas 13 hospital managers expressed that they already set drinking-utility water as top priority.

DISCUSSION

Water must be delivered from its source to consumption areas and after that consumption waste water must be disposed in a way that it does not constitute a health risk for the environment or the society. In other words, water must be managed professionally. In this study, which is one of the firsts on this field in literature, knowledge and awareness of managers of all hospitals in Trabzon province, in the Eastern Black Sea region on water management were evaluated. Due to its geographical location and climate conditions, Trabzon receives over 800–850 kg/m^2 of precipitation every year[16]. The city water demand is met by Atasu Dam, built in the Trabzon city centre. Even though some districts do have smaller dams, the fundamental water sources in districts are caisson wells that are located around surface waters that originate from the mountains and flow into the Black Sea. The water collected from these wells is transferred into tanks. And after chlorination, it is distributed through the network system. Since Trabzon receives high level of precipitation, water scarcity and water cuts are not familiar concepts to the society. In case of a cut, water can be supplied from villages and mountains. The perception of hospital managers on water management may be originating from the high level of precipitation and abundance of water sources in the province.

A successful hospital by-product management demands strict maintenance policies for avoiding diseases spread out and leaching of hazardous chemicals on soil and in ground water[17]. However, we have to know the source of water con-

sumed in hospitals. Study demonstrates that managers are aware of the source of the water they use in their hospitals.

Study also examined monthly and daily water consumption. However, this issue was replied by looking at their monthly bill and they set their daily consumption by dividing the monthly bill by 30. Managers of hospitals that do not receive network water were not informed regarding this issue. However, based on the nature of the processes in the hospital the water demand on each area and unit is different. Water consumed in hospitals may vary depending on the area/unit, hours within the day, days, months and seasons. These demands must be recognised in case of cuts or emergency situations/disasters and water must be supplied accordingly. In literature it is emphasised that water meters must be placed in strategic locations in hospitals in order to manage water in a more healthy and planned fashion and that daily, weekly, monthly and yearly water consumption data acquired from these meters must be monitored. However, our study demonstrated that hospital managers were not sensitive towards and well-informed regarding this issue.

When it comes to water management in developed countries, the emphasis is on the preservation of water sources that are also important for the society, saving on water and preservation of water-water resources. Aim here is not to decrease water consumption or water saving. Quite the contrary, the objective is to make an effort in not wasting the water that exists and needs to be benefited from. Therefore, low-flow fixtures must be installed onto all shower stalls, bathrooms and faucets. If equipment used in the hospital is old, the new ones must be of the water-saving kind. It is also important to have the related project plans on in-house water network systems for maintenance and repair works for possible leaks and bursts. However, only 4 out of 23 hospitals have such plans. Our study showed that hospital managers are not aware of the number of water structures and fixtures such as bathrooms, toilets, urinals and faucets, that there were not any inventory works in respect to this and that they do not have good knowledge on in-house network systems.

Alongside with clean and safe water supply, it is also important to provide water in a continuous way. It goes without saying that water is of vital importance in hospitals for corporate and personal hygiene. In settlement areas and societies, hospitals are one of the most adversely affected institutions by water cuts. In this study, we see that this is the case for 13 out of 20 hospitals that are supplied with network water. Nine of these hospitals use their auxiliary tanks in case of a cut. There are two aspects here: First of all, water cuts are highly common in hospitals that meet their water demands from the city water network. Therefore, it is important to have an auxiliary water tank. Second aspect is the maintenance and cleaning of the auxiliary tanks. Systems and staff that will clean these tanks will be needed. However, it is a serious disadvantage that most of the hospitals do not have staff that would carry out this task.

According to the Regulation Concerning Water Intended for Human Consumption, the monitoring and inspection of drinking-utility waters in terms of health is carried out by Provincial Directorates of Public Health, which are the provincial organisations of the Turkish Public Health Agency affiliated to the Ministry of Health[18]. In this vein, water quality checks in hospitals must be carried out more regularly and taking samples from various spots. However, the interviews showed that hospital managers are not informed about and sensitive towards these monitoring and inspections. Twenty-two hospital managers stated that the water in their hospitals were inspected, however the frequencies were different. Our study is somewhat limited in this regard. It did not question the results of the inspections or what kinds of arrangements are being made when unfavorable situations emerge.

It is necessary and vital for the hospitals to be prepared for extraordinary situations/disasters both to ensure the sustainability of the services provided and to keep the society/environment away from problems that may arise out of health care services. Therefore, emergency plans must be drawn up and its relative sections must be shared with all personnel. Researchers of the study also work in a hospital and stated that no such documents were shared with them. However, after receiving the statement that hospital managers did have disaster plans for their hospitals, we thought that this was solely because of plans are required by legislation. This created a concern that health care service organisation and risk management may not be well-management in case of a disaster.

In literature information on the features of hospital waste water is quite scarce and detailed studies are rather limited[19]. Hospital waste water may be hazardous. Particularly waste water from laboratories, chemotherapy units and nuclear medicine units must be collected through separate systems. However, only a few hospitals collect such waste water though separate systems and containers.

An important finding of this study is that 14 out of 23 hospital managers stated that water was the top priority among the hospital services they provide. Considering the findings of the study, it can be seen that managers lack information and training in terms of water management in hospitals even though 13 of them stated that they deem it top priority.

CONCLUSIONS

According to the results of the study on hospital managers, which is a first both in Turkey and in medical literature, it was recognised that managers of 4 different hospital groups in Trabzon need to be aware of, interested in and informed on management of drinking-utility water in hospitals. Especially because of the growing popularity of the green-hospital concept, many countries and institutions have been publishing guidebooks on water management in hospitals. All hospital managers must be aware of and sensitive towards green hospitals and water man-

agement. In this sense, we are sorry to see that Turkey and Trabzon is not familiar with the concept of water management in hospitals. In every aspect, management of drinking and utility water in hospitals must be carried out in a professional way. Ministry of Health must assume the leading role and regulate the related legislation. We also have to organise trainings for all hospital managers.

REFERENCES

1. O. OZKAN, G. BAYIN, G. T. YESILAYDIN: Sustainable Approach in Hospital Management: Green Management. In: Proc. of the 8th Health and Hospital Management Congress, Nicosia, September 2014.
2. K. TADDONIO: Hospitals Save Costs with Water Efficiency. http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/hea_water_efficiency_fs.pdf (connecting date 21.11.2015).
3. S. BUNGAU, C. BUNGAU, D. M. TIT: Studies on the Last Stage of Product Lifecycle Management for a Pharmaceutical Product. J Environ Prot Ecol, **16** (1), 56 (2015).
4. ANONYMOUS: Managing Hospital Water and Wastewater Minimizing Health Risks and Environmental Impact. http://www.dhigroup.com/upload/publications/scribd/161586304-Managing-Hospital-Water-and-Wastewater-DHI-Solution.pdf (connecting date 20.11.2015).
5. Centres for Disease Control and Prevention and American Water Works Association: Emergency Water Supply Planning Guide for Hospitals and Health Care Facilities, Atlanta, U.S. Department of Health and Human Services, 2012.
6. G. TEREKLI, O. OZKAN, G. BAYIN: Environment Friendly Hospitals: From a Hospital to a Green Hospital. Ankara Health Care Services Journal, **12** (2), 37 (2013).
7. ANONYMOUS: Siemens Green+ Hospital System: An Understanding beyond Being Eco-friendly. http://www.ekoyapidergisi.org/970-siemens-yesil-hastane-sistemi-cevre-dostu-olmanin-otesinde-bir-anlayis.html (connecting date 20.11.2015).
8. Regulation on Implementation of Hospital Disaster and Emergency Plans. Date of the Official Journal, 20.03.2015, Number of the Official Journal, 29301.
9. ANONYMOUS: Global Green and Healthy Hospitals Agenda. A Comprehensive Environmental Health Agenda for Hospitals and Health Systems around the World. https://noharm-global.org/issues/global/global-green-and-healthy-hospitals-agenda (connecting date 20.11.2015).
10. A. RELLER: Greener Hospitals Improving Environmental Performance, Environment Science Center, Wissenschaftszentrum Umwelt University Augsburg, Germany. http://www.bms.com/Documents/sustainability/downloads/greenh.pdf (connecting date 20.11.2015).
11. Regulation on the Management of Inpatient Treatment Facilities. Date of the Official Journal, 13.1.1983, Number of the Official Journal, 17927.
12. Circular on Rules and Procedures of Operation of the Provincial Organization of Turkish Institution of Public Hospitals. Date of Publishing 31.10.2012, Ministry of Health, No 3131.
13. O. F. TEKBAS: Environmental Health, Drinking and Utility Waters with the Aspect of Public Health. Gulhane Military Medical Academy Print. House, 2010, 49–126 (in Turkish).
14. ANONYMOUS: Renewable Internal Freshwater Resources per Capita (cubic meters). http://data.worldbank.org/indicator/ER.H2O.INTR.PC (connecting date 21.11.2015).
15. S. P. ESTHER, K. EVAN, S. KARSTEN, R. G. AUROOP: Estimating Future Global per Capita Water Availability Based on Changes in Climate and Population. Comput Geosci, **42**, 79 (2012).

16. Geography and Climate Conditions, Trabzon Provincial Directorate of Culture and Tourism. http://www.trabzonkulturturizm.gov.tr/TR,126647/cografi-yapi-ve-iklimsel-ozellikler.html (connecting date 20.11.2015).
17. P. MENTZELOUA, F. VOSNIAKOS, Th. DARDAVESIS, N. PAPADAKIS, K. NIKOLAOU, Ch. ATHANSIADOU: An Information System for Hospital Waste Management. J Environ Prot Ecol, **10** (1), 285 (2009).
18. Regulation Concerning Water Intended for Human Consumption. Date of the Official Journal, 17.02.2005, Number of the Official Journal 25730.
19. A. ALTIN, M. DEGIRMENCI, S. ALTIN: Determination of Amount and Characteristics of Hospital Wastewater in Sivas City. DEU Journal of Science and Engineering, **1** (2), 33 (1999).

Received 8 January 2016
Revised 18 February 2016

Journal of Environmental Protection and Ecology 17, No 2, 781–788 (2016)

Environmental management

SEMANTIC EVALUATION OF WATERFALLS AS TOURISM DESTINATIONS

O. KURDOGLU*, B. C. KURDOGLU

Faculty of Forestry, Karadeniz Technical University, Trabzon, Turkey
E-mail: *oguzkurdoglu@gmail.com*

Abstract. In recent years, undisturbed nature and clean environment have become two factors that define the competitive power in tourism. Waterfalls have enchanted people since ancient times and have higher priority in the list of must-see places. However, few waterfalls can be described as tourism destinations since many of them are attractions. Accessibility and being well known are affecting this. In many countries, including Turkey, waterfalls play important roles in tourism. Heavy demand and mismanagement of destinations have a damaging effect on these natural monuments. In this study, 9 important adjective pairs were used for 17 waterfalls located in different (various) regions of Turkey, mostly along the Eastern Blacksea region. These adjective pairs were evaluated by 69 experts (32 forest engineers and 37 landscape architects) according to septet semantic differential scale. Consequently, waterfalls were evaluated in terms of sustainable tourism management and suggestions were given for conservation strategies.

Keywords: semantic differential, waterfalls, tourism destination, Turkey.

AIMS AND BACKGROUND

The last quarter of a century can specifically be considered as a period of more intense interest in the unspoiled natural areas. The current developments in tourism are specifically in close relationship with environmental protection which also means the protection of basic values of tourism destinations[1]. Currently, tourism is closely related to the environment and especially to the climate change. It is highly sensitive to the climate change as an economic sector since climate change can directly or indirectly affect tourism destinations in various ways. The most important expectation in a visit to a natural destination is a comforting atmosphere and an unspoiled natural environment[2]. Numerous factors play a role on the orientation towards tourism. One of these factors is without doubt landscapes created by water. That seas, lakes and rivers are among the most preferred locations has never been a surprise. Water ecosystems create benefits for humanity for consumption, energy, transport and recreational activities in addition to their ecological role. In a sense, water is a basic element of recreation[3,4]. In numerous studies carried out since the beginning of the last century; it has been emphasised that water is one

* For correspondence.

of the most important and enchanting elements of natural and built landscape[5]. Indeed, water has been accepted as an attractive and enchanting phenomenon and an indispensable element of landscape[3]. According to environmental ethics, while natural environment ethics is a matter of moral concern, nature is a matter of aesthetical taste. From this perspective, waterfalls are considered as magnificent presences flowing over special reliefs[6]. For this reason, waterfalls are among the most visited locations at tourism destinations. Whether big or small, high or low, natural or built, narrow or wide, waterfalls face visiting demand at various densities. The answer for the question, 'What is it that makes waterfalls so popular actually?' has not been found by neither waterfall lovers nor scientists. According to a theory expressed in some studies, formations like waterfalls create negative ions due to the downfall of water which has stimulating effect on people. However, this is a view not largely supported by scientists who study rivers and streams. Nevertheless, it is clear that something in waterfalls affect people mood positively[7].

Clearly, various natural and cultural assets are evaluated by their different attributed meanings. The effective power of these assets is reflected in people preferences and positive or negative attitudes emerge towards the related assets. These attitudes find their correspondence in tourism and create preferences for destinations and travel plans. Waterfalls have kept their popularity as visual attractions and areas for recreation for a long time. For this reason, waterfalls play an important role in tourism for countries[8]. The purpose of this study is to determine how waterfalls which face a dense touristic demand have semantically been evaluated by experts. In this respect, it has been aimed at determining which waterfalls, evaluated by means of 9 adjective pairs, are most preferred and proposing suggestions for a better protection and management of those which take priority in terms of preference.

EXPERIMENTAL

The material of the research includes 17 waterfall photographs from different rural areas in Turkey (Fig. 1). The photographs have been evaluated according to a septet semantic differential scale (in this 7-point scale 1 point was the lowest and 7 was the highest) by a total of 69 experts comprised of 32 forest engineers and 37 landscape architects by using 9 adjective pairs seen in the table and graphics. In addition, each waterfall was given a 'worth seeing' score. As a result, the average scores of photographs were determined through descriptive analysis. Then, in accordance with the purpose of the study, the scores of three waterfalls which received the highest and lowest 'worth seeing' scores were tested through non-parametric correlation analysis. The purpose of this test was to find out the relationship between the adjective pairs and the 'worth seeing' condition.

Fig. 1. Waterfalls evaluated in the study and the cities they are located

RESULTS AND DISCUSSION

The results reveal that all waterfalls were given a specific average score. It is possible to interpret this as such: waterfalls affect people in any case with their attractive value. In the evaluation, all waterfalls received a high score for the 'built/natural' adjective pair. That all waterfalls were natural caused the result to be high for each waterfall. This result shows that especially 'naturalness' is always effective on preferences (Table 1).

Table 1. Average scores received by the waterfall photographs

Photo No	Monoto-nous / active	Illegible / legible	Built / natural	Simplicity / divercity	Not clear / clear	Not interest-ing /interest-ing	No-unity / unity	Ordinary / unique	Low visual value /high visual value	Not worth seeing / worth see-ing
1	5.0290	5.5507	6.3188	4.8696	5.6957	4.5217	5.2899	4.3913	5.3478	5.4493
2	4.5507	4.9420	6.0000	4.6667	5.2029	4.0870	4.8406	4.5072	4.8406	4.6667
3	5.6232	5.4348	6.3623	5.7391	5.6522	5.3478	5.5362	5.4203	5.6667	5.6087
4	5.5507	5.6812	6.2754	5.3188	5.8986	5.2899	5.7246	5.7391	5.9130	5.9420
5	5.5652	5.7246	6.2609	5.2319	5.6667	5.2319	5.5217	5.4348	5.6667	5.7971
6	5.0870	5.2174	5.4928	5.1449	5.2319	4.7971	4.8406	4.7536	4.8406	4.8551
7	5.8116	5.6232	5.8406	5.3188	5.7391	5.5507	5.6377	5.6232	5.7536	5.7536
8	4.5797	4.8406	5.0870	4.7971	5.0725	4.7246	4.8406	4.7391	4.7101	4.6812
9	5.6812	5.7101	6.2319	5.3043	5.8406	5.5072	5.3913	5.5652	5.8986	5.7391
10	4.6232	4.8406	5.2319	4.3768	5.0870	4.2609	4.4203	4.3043	4.4203	4.5797
11	4.7101	5.1449	5.5652	4.4928	5.3188	4.6667	4.8986	4.7101	4.9275	4.8696
12	4.8841	5.0145	5.5507	4.9420	5.1594	4.5217	5.0725	4.6087	4.8551	4.8261
13	5.7391	5.2754	6.1014	5.5507	5.3913	5.4928	5.3043	5.5362	5.6087	5.5507
14	5.6957	5.6812	6.0435	5.4638	5.6667	5.6232	5.3333	5.6377	5.8986	5.9565
15	5.3188	5.1014	5.7536	5.3623	5.1884	5.2319	5.4638	5.2029	5.4203	5.4058
16	5.1884	5.2754	5.6377	4.5797	5.2029	5.2899	5.0870	5.3623	5.2319	5.2029
17	5.1449	4.9710	5.7391	4.7826	5.0580	4.7826	5.1594	4.7971	5.1594	5.0145

In a study on visual quality by Gul and Kurdoglu[9], it was observed that highest scores were received by rivers and waterfalls located in unspoiled natural areas. Although Waterfall 2 (W2) received the lowest score (4.5507) for the 'monotonous/active' adjective pair, it was not found to be very monotonous. In other words, it was found to be moderately active. The photograph receiving the highest score was W7 (5.8116). The lowest score for being 'legible/illegible' was received by W8 (4.8406). The highest score for this condition was received by W5 (5.7246). The lowest score for the condition of 'simplicity/diversity' was received by W10 (4.3768). The highest score for this condition was received by W3 (5.7391). For the condition 'clear/not clear', the lowest score was received by W17 (5.0580), and the highest score was received by W4 (5.8986). For the 'interesting/not interesting' condition the lowest score was received by W2 (4.0870), and the highest score was received by W14 (5.6232). When we consider the condition of 'unity/no unity' lowest score was given to W10 (4.4203) and the highest score was given to W4 (5.7246). The highest score for being 'ordinary/unique' was given to W10 (4.3043) and the highest score was given to W14 (5.6377).

Waterfall 10 received the lowest score for the condition 'low visual value/high visual value' (4.4203), and W4 received the highest value (5.9130) for this condition. When the condition of 'worth seeing' was examined in isolation, the lowest score (4.5797) was received by W10 and the highest score (5.9565) was received by W14. 2nd highest score (5.9420), was given to W4 and the 3rd highest score (5.7971) was given to W5. The waterfalls which received the lowest scores for 'worth seeing' condition were respectively W10 (4.5797), W2 (4.6667) and W8 (4.6812). In addition, the relationship of the lowest scored waterfalls with the other adjectives was tested (Table 2). This test revealed that all adjective pairs are in significant relationship with each other. In other words, a significant relationship in the positive direction was found between the adjective pairs and the 'worth seeing' condition. Here, for the 6 waterfalls which received the highest and lowest scores in respect to the 'worth seeing' condition, the highest correlation was found among the scores given for the landscape value. On the other hand, although a significant relationship was found between the Waterfalls 4 and 5 and the conditions 'simplicity/diversity' and 'worth seeing', the correlation coefficient was low (0.365 for W4 and 0.385 for W5). Similarly, despite the significant relationship between the conditions 'legible/illegible' and 'worth seeing', the correlation coefficient was low (0.271 for W5). Although there is a significant relationship between the conditions 'clear/unclear' and 'worth seeing', the correlation coefficient is low (0.287 for W4). An overview of the results shows that waterfalls receive admiration under every condition although at different levels.

Table 2. Relationships between the adjective pairs and the 'worth seeing' (*N*= 69)

Photo No	Monoto-nous / active	Illegible / legible	Built/ natu-ral	Simplicity / divercity	Not clear / clear	Not interest-ing / interesting	No-unity / Unity	Ordinary / Unique	Low visual value / high visual value	Not worth seeing / worth see-ing
2	0.755**	0.685**	0.638**	0.480**	0.628**	0.616**	0.760**	0.636**	0.852**	1.000
8	0.709**	0.733**	0.685**	0.763**	0.880**	0.764**	0.714**	0.830**	0.938**	1.000
10	0.761**	0.591**	0.675**	0.582**	0.521**	0.782**	0.655**	0.709**	0.908**	1.000
4	0.523**	0.558**	0.533**	0.365**	0.287*	0.625**	0.560**	0.596**	0.784**	1.000
5	0.497**	0.271*	0.523**	0.385**	0.358**	0.630**	0.481**	0.711**	0.755**	1.000
14	0.655**	0.603**	0.579**	0.634**	0.603**	0.686**	0.544**	0.676**	0.869**	1.000

** Correlation is significant at the 0.01 level (2-tailed); * correlation is significant at the 0.05 level (2-tailed).

For this reason, at tourism destinations, waterfalls, monuments, temples and museums are met with high density of tourists[10]. For example, in Turkey Maral (No 1), Palovit (No 4), Muradiye (No 7), Mencuna (No 9) and Tortum waterfalls (No 14) are met with high demand as important destinations. This is due to the fact that from the beginning of the 20th century, waterfalls have been almost identified as an object of art, thus transforming them into a touristic geomorphosite[6]. Accordingly, visual and various semantic evaluative data of attractions which have become a subject of tourism help the making of sustainable planning and the protection of landscape[11].

RECOMMENDATIONS

High slope and steep topography which cause the formation of waterfalls, creates a visually attractive view. However, high sloped water flow creates a high demand not only for tourism but also for the construction of hydroelectric power plants (HEPP). The constructions of HEPPs are damaging many tourist destinations especially in the Black Sea region. Specifically, waterfalls with high attractiveness and an unspoiled naturalness should be kept away from all investment activities. Especially in semi-arid regions, the use of waterfall waters for irrigation causes them to dry out at the dense tourism season. This means the area can not be utilised for tourism. For this reason, the irrigation planning should be done so that other resources are used for this purpose. Ekinci[12] emphasises that the starting point for all kinds of planning should be 'protection' and that any compromise from this principle would mean orienting towards 'non-sustainable tourism' at the long run. He also reminds that resources are facing immense pressure with the high scale that international tourism activities have reached, and that in order to sustain economies which rely on tourism the destinations have to be specifically protected. Sustainability in tourism is only possible through the sustainability of the resources. If the water is being polluted and/or diminished, forests are being destroyed or natural resources are being transformed into constructed environment in a tourism area, this means that the end is near for tourism.

CONCLUSIONS

In terms of adjective pairs, all waterfalls have received high scores, which show that waterfalls have priority in preferences in regard to being worth seeing. According to the results, the condition 'worth seeing' has a high level relationship to 'landscape value'. All adjective pairs support this result. The fact that all adjective pairs are in a significant relationship with the condition 'worth seeing' shows that the adjective pairs have been correctly selected. As expressed in the literature widely waterfalls are water elements which are preferred with priority in Turkey. Although a number of the 17 waterfalls which have been evaluated here have not

yet been established as a tourist destination, almost all have received at least an average score for all adjective pairs. The most important result of this study has emerged from the evaluation of the condition 'worth seeing'. According to these evaluation results, it could be said that the waterfalls receiving the highest scores are indeed the most important destinations for their regions and they are especially featured in numerous tourism brochures. On the other hand, the waterfalls with low scores do not meet a high tourism demand.

REFERENCES

1. E. KUSHI: Sustainable Tourism and Environment Protection in Albania. J Environ Prot Ecol, **12** (1), 251 (2011).
2. L. CURCIC, J. STEPANOV, D. PROKIC: Interaction between Tourism and Climate Change. J Environ Prot Ecol, **13** (2), 620 (2012).
3. Z. BULUT, H.YILMAZ: Determination of Waterscape Beauties through Visual Quality Assessment Method. Environ Monit Assess, **154**, 459 (2009).
4. G. AYTAC, D. KUSULUOGLU: Water as a Design Strategy: Case Study of Kurbagalidere, Istanbul. J Environ Prot Ecol, **15** (4), 1536 (2014).
5. A. FAGGI, J. BREUSTE, N. MADANES, C. GROPPER, P. PERELMAN: Water as an Appreciated Feature in the Landscape: A Comparison of Residents' and Visitors' Preferences in Buenos Aires. J Clean Prod, **60**, 182 (2013).
6. J. P. HAGHE: Do Waterfalls Have Value in Themselves? A Metamorphosis in the Values of the Gimel Waterfall in France. Policy and Society, **30**, 249 (2011).
7. K. ADAMS: North Carolina Waterfalls: A Hiking and Photography Guide. 4th ed. John F. Blair Publisher, North Carolina, 2005. 590 p.
8. B. J. HUDSON: Waterfalls Resources for Tourism. Ann Tourism Res, **25** (4), 958 (1998).
9. A. U. GUL, O. KURDOGLU: To Determine Biodiversity and Visual Quality Numerically. In: Proc. of the Symposium on Conceptual Expansions and New Targets on Forest Management, 18–19 April, Istanbul, 2002, 212–219.
10. G.WALL: Tourism Attractions: Points, Lines, and Areas. Ann Tourism Res, **24** (1), 240 (1997).
11. C. L. KRAUSE: Our Visual Landscape: Managing the Landscape under Special Consideration of Visual Aspects. Landscape Urban Plan, **54** (1–2), 239 (2001).
12. S. EKINCI: Planning and Local Identity on Tourism Planning. Symposium on Tourism Policies in 21st Century. Semra Atabay, 17–18 December, Istanbul, 1998, 105–110.

Received 11 February 2016
Revised 15 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 789–795 (2016)

Environmental management

SUSTAINABLE RAFTING TOURISM PLANNING AND MANAGEMENT. AN EXAMPLE OF ANTALYA-KOPRUCAY RAFTING AREA

E. POLAT*, E. KELES, F. UZUN, A. GUL

Faculty of Architecture, Department of City and Region Planning, Suleyman Demirel University, Isparta, Turkey
E-mail: *erkanpolat@sdu.edu.tr*

Abstract. The river tourism, which is very important for nature tourism, does not require big investments and constitutes a whole together with environmental, historical, archaeological, cultural, authentic values and other types of tourism. Turkey, which has rich natural resources, offers a significant potential with a variety of sporting activities (especially rafting, canoeing and river kayaking, etc.). In this context, the rafting activities are done intensively on some rivers (such as Koprucay, Manavgat, Dim, Adana Feke, Goksu and Zamat) of Turkey. The Koprucay Rafting Area (KRA) which is located in the Koprulu Kanyon National Park (KKNP) of Antalya City is one of the most important nature tourism destinations of Turkey. There are many environmental, social, economic, political, spatial, administrative problems and so on in the KRA. The most important issues are overcrowding with higher capacity utilisation, environmental pollution, irregular constructions, lack of spatial organisation, failing of transportation, accommodation and restrictive legislation, etc. As a result, there are some planning, management and economic suggestions for sustainable protection and utilisation of tourism areas and within rafting tourism.

Keywords: rivers tourism, rafting, Antalya, Koprulu Kanyon National Park (KKNP), Koprucay.

AIMS AND BACKGROUND

Tourism is one of the world largest industries. It is not so easy to provide a clear and all-encompassing definition of the tourism, particularly when one considers that it is so closely interrelated with all other sectors of life: economic, social, cultural, environmental, and political[1]. Today, sustainable tourism is about re-focusing and adapting[2] and can be threatened in two ways[3]; firstly, overcrowding can reduce the enjoyment received from the tourism experience and deter some tourists from a particular area since enjoyment and environmental quality are closely aligned[4], and secondly, tourist pressures and facilities designed to service tourists may partially or completely degrade the tourist attraction that drew tourists in the first place. The sustainable use of most nature-based resources is threatened because of their 'open access' nature, which the owners or the managing agencies do not

* For correspondence.

appropriate the economic rent accruing from these sites. Economic rent can be defined as the economic surplus over and above normal profits earned from the exploitation of resources[5].

Today, sustainable tourism is diversified, socio-economic and cultural conditions vary as a result of the parallel rise in living standards[6]. These are referred to as sports tourism, mountain tourism, ecotourism, health tourism, conference tourism, nature tourism, cultural tourism and river tourism[7]. Today, protected areas management, besides the ecological and scientific values, economic, political and social considerations are also taken into account for aesthetic and recreational enjoyment[8]. One of the major problems faced by managers in the natural protected areas is the protection of natural ecosystems, on the other hand, in this complexity is to use oriented to tourism and recreation[9]. Especially, it is difficult to make together these two opposing tasks increasing in recreational demand[10]. Today, scientific and technical sense are the main reasons for the protection of natural areas getting under protected by law, which is especially in contradiction with recreation and tourism purposes and can not compete[11]. The river tourism, which is very important for nature-based tourism, one of the most dynamic sectors of the tourism industry, provides significant potential for economic development in regional areas[12] and recreational users can cause significant ecosystem damage in natural areas[13].

Turkey, which has rich natural resources, offers a significant potential with a variety of sporting activities (especially rafting, canoeing and river kayaking, etc.). In this context, the rafting activities are done intensively on some important rivers (Koprucay, Manavgat, Dim, Adana Feke, Goksu and Zamat) of Turkey. The KRA is located in the KKNP in Antalya, which is one of the most important nature tourism destinations in Turkey. It has rich and important natural, social, cultural and aesthetic values and there are a variety of problems about environmental, social, economic, political, spatial and administrative dimensions.

The main aim of this paper is determine to current problems in the KRA and make proposals for sustainable planning, management and economical instruments and consists of a framework for solving of related problems.

One of the most common types of tourism is the river tourism. It is based on a unique resource combination at the interface of land and sea offering amenities such as water, scenic beauty, rich terrestrial and biodiversity, diversified cultural and historic heritage, healthy food and, usually, good infrastructure. It includes a diversity of activities that take place both in river zones and river waters, which involve the development of tourism capacities (rafting, canoeing and river kayaking, etc.). River tourism, rafting performed on streams, stream sports like canoeing and kayaking comes to mind. Rafting is a sport made on high rivers the flow rate. In Turkey, Coruh River, Manavgat River and Canyonlands are considered among the major rafting spots (Table 1) (Ref. 14).

Table 1. River tourism areas in Turkey

Regions	Rivers for tourism
Mediterranean region	Antalya-Koprucay, Alara and Dim Streams, Manavgat Stream, Anamur (Dragon Stream), Adana-Feke-Goksu River
Central Anatolian region	Zamanti River
Aegean region	Mugla Dalaman Stream
Blacksea region	Altiparmak- Barhal Stream, Firtina Stream
East Anatolian region	Coruh River
Southeast Anatolian region	Firat Stream

EXPERIMENTAL

In order to benefit from the current literature, by Keles[15] conducted to survey and SWOT analysis results were considered and evaluated. With local people, national park managers, rafting operators and visitors in this area have been made opposed interviews and also was detected identified common problems. For these problems, some predictions for operational planning and management have been developed.

The KKNP was declared as a National Park in 1973 due to has rich flora and fauna, biodiversity, archeological, cultural, jeomorfological, recreational, aesthetics values and others. It has 35 777 ha areas, which are located 85 km away from Antalya, and is one of the important tourism destination areas of Turkey. It is estimated almost 700 thousands visitors came to the area per year in KKNP and also 90% preferred the KRA (Ref. 16).

Commercial rafting activity on the Koprucay River had begun at the end of 1992. On both sides are located some recreational facilities and sites for visitors. The services to visitors include picnicking, trekking and other recreational activities. Visitors are usually accessed to the river by bus or car. There are a lot of settlements (Beskonak, Karabuk, Altinkaya, Gaziler and others) in its surroundings and some facilities for rafting are located on all sides of the river[16]. However, approximately 10% of these visitors prefer the rafting outside. A great number of tourists visit the ancient city of Selge, i. e. around 20 000 visitors per year[17]. There are 40 rafting services and catering service facilities as well as rafting. It is estimated that about 25 million US dollars of the total annual income come from rafting, and only around 6 million US dollars remain for the local rafting companies. The remaining large amount remains for the tour operator[18]. These areas provide suitable environment for many activities such as plant observation and camping besides rafting, canyoning, trekking, climbing, bird-watching, etc. Rafting industry is also creating seasonal jobs, but it can not benefit local people and growing pollution on the river is a serious problem[17].

DISCUSSION

Based on the studies about these areas, the general problems were determined[17,18], local people were still continuing their habits of casually land use and the activities were as in the past in the KKNP. Management of the National Park is not effective, efficient and perfect. It has not restrictive legislation in planning and management of these areas and respectively, different conservation regulations (National Park and Natural Sit Area). Thus, it is quite difficult to control and monitor all activities in this field. Other main problems are overcrowding and overuse per daily for rafting activities; increasing environmental and visual pollutions during rafting activities; building on the river sides in unplanned way and illegal; insufficient recreation sites, facilities, pensions, sales places, car parks for visitors; the lack of spatial planning and design projects of areas; no cooperation and coordination between stakeholders; no participation of all stakeholders to processes of planning and management of areas; lack of quality and number of personal trainers and guides for rafting activities; damaging of flora and fauna in area; eradicating of natural and cultural values; lack of knowledge of stakeholders about nature conservation and nature-based tourism; insufficient quality of services and safety of rafting operators; lack of transportation and accessibility in areas and non controlled entrance and exit to areas; not realised rational land use and no multiple benefits from areas to decrease satisfied level of visitors.

Basic aims of the sustainable planning and management should be conservation of river water (spring point sources, river base, etc.) and its surroundings (flora, fauna, ecosystem, etc.). It should also be increased local development and multiple using levels. A complementary objective is the promotion of users awareness and appreciation of the values of the river and its natural and cultural values. However, the participation of all stakeholders (local people, visitors, rafting operators, etc.) is very important in order to realise these aims. Sustainable using of the KRA should be directly related to its planning, managerial and economic instruments.

Planning instruments. They should be related and integrated to master planning of the KKNP. Koprucay River should be evaluated for rafting activities in first and prepared to inventory of natural and cultural values of areas and taken into consideration in entirely rafting route from the first point of Koprucay to the finishing point of rafting activities. It should be surely protected areas which are located endangerous, rare or endemic flora and fauna species or ecosystem of the river and its surroundings and suggested appropriate to new recreation areas, facilities and types of recreation activities. Preparation of planning decisions and principles (and also managerial and economic instruments) should be guided for managers, operators and others and must be efficient, flexible, applicable and equitable. Recreation sites should be designed according to spatial carrying capacities. It should be

suitable and accessible for vehicle, bikes and pedestrians. Materials and formation of buildings should be harmonious with natural characteristics and local identity.

Managerial and economic instruments. They should be an effective management and/or local tourism organisations should be coordinated by tourism and business investment. The new Koprucay Rafting Management Department in the KKN has a lot of persons and volunteers and also stakeholders (local people, rafting operators, NGOs, other relevant government authorities, academician and others). They should use appropriate recreational types and levels to determine and attribute to zones of protection, organised and controlled an entrance and exit points, and priority to local people for rafting operators and recreation sites keeping. Rafting operators should do licenses and fee by the department. Some measures should be taken for monitoring and control of the activities for visitors daily capacity and environmental and visual pollutions. Local production and marketing by local people should be encouraged. Recreational activity or compounds should increasingly be diversified. The importance and local values of tourism should be explained and communicate to visitors, local people, management personals, operators, researches and others.

CONCLUSIONS

Today, nature-based tourism is rapidly expanding in the world unless sustainable management and planning strategies, the natural and cultural values will become degraded. Sustainable resource use, however, will ensure the maintenance of tourism assets and the provision of the tourism service into the future[19]. Degradation of these values will also reduce their amenity and landmark value. Amenity value can also be reduced through overcrowding and overuse. Various planning instruments or tools have been adopted to ensure that environmental and amenity values are maintained at recreational sites[20]. In addition to planning instruments, there are a wide variety of economic instruments that can be used to control environmental impacts[19,20]. Economic instruments can affect the environmentally damaging, that is, via price or quantity controls for environmental goods or services[20].

For developing an appropriate planning and management strategy for KRA, it should be aimed to provide protecting and using levels balance with the carrying capacity approaches, establish an effective destination organisation and stakeholder cooperation. These aims can be realised with planning, management and economic instruments or action programmes. The planning instruments should have protecting and using zones, spatial arrangement (landscape design project and application) for recreation sites or facilities and activities, spatial carrying capacity, number of commercial operators and others. Administrative and economic instruments should be effective, efficient and equitable. They should have a management organisation, monitoring and checking of all activities, safety and

security tools. Fees should be checked, commercial and financial benefits should be gained from the use, and licenses should be allocated to real operators. It is also becoming increasingly important for resource managers to appropriate some of the financial benefits gained from the use of the natural resources for recreation. Criteria of development for sustainable nature-based tourism are biodiversity conservation, economic consistently, controlled marketing, cultural wealth, local people prosperity, work and services quality, social equality, visitors pleased levels, to spread to local of authorizes, community happiness, effective using of sources and healthy environmental.

REFERENCES

1. The Economist: Travel and Tourism: The Pleasure Principle. The Economist, 3 (1991).
2. C. BARBU, L. STEFANESCU, L. UNGUREANU, M. A. CONSTANTINESCU, M. NEGULESCU, I. V. MATEI, M. GHIT: Natural and Anthropic Resources Used in Sustainable Tourism Development in Oltenia. J Environ Prot Ecol, **14** (1), 303 (2013).
3. C. TISDELL: Economics of Environmental Conservation: Economics for Environmental and Ecological Management. Aildershot, Edward Elgar, Melbourne, 1991.
4. L. H. PENDLETON: Environmental Quality and Recreation Demand in a Caribbean Coral Reef. Coast Manage, **22**, 399 (1994).
5. World Bank: Pacific Island Economies: Building a Resilient Economic Base for the Twenty-first Century. World Bank, Washington, D.C., 1996.
6. E. KUSHI: Sustainable Tourism and Environment Protection in Albania. J Environ Prot Ecol, **12** (1), 251 (2011).
7. A. GUL, O. OZALTIN: Ecotourism and Isparta. Rose-environment, Isparta Directorate of Environment and Forestry, **1307** (2), 22 (2007).
8. Y. KUVAN: Management of Forest Recreation Resources in Balikesir Region, Problems and Solutions. IU Faculty of Forestry, Institute of Science and Technololgy, Istanbul, 1997.
9. R. F. KUSS, A. R. GRAFE: Effects of Recreation Trampling on Natural Area Vegetation. Journal of Leisure Research, **17**, 165 (1985).
10. A. D. KLISKEY: A Comperative Analysis of Approaches to Wilderness Perception Mapping. J Environ Manage, **41** (33), 199 (1994).
11. A. GUL, M. AKTEN: Recreational Carrying Capacity in Protected Natural Areas and Theoretical Perspectives. In: Proc. of Protected Natural Areas Symposium, Isparta, 2005, 485–494.
12. Northern Rivers Regional Development Board (NRRDB): Northern Rivers Tourism Masterplan. Lismore, 1994.
13. D. ALDEN: Recreational User Management of Parks: An Ecological Economic Framework. Ecol Econ, **23**, 225 (1997).
14. M. YAVUZ: Evaluation of Ecotourism Potential of Akdag Natural Park in Afyon-Sandikli County. Afyonkarahisar, Afyon Kocatepe University, 2011.
15. E. KELES: Current Situation Analysis and Proposed Solutions of Antalya-Koprucay Rafting Center. SDU Institute of Science, Department of Landscape Architecture, Isparta, 2015.
16. DKMPGM: Koprulu Canyon National Park Management Plan (2007–2011). General Directorate of Nature Protection and National Parks, Antalya, 2007.
17. E. KELES, A. GUL, M. TUGLUER, O.F. UZUN: Current Situation Analysis and Tourism and Recreational Aspects of Antalya-Koprucay Rafting Center. In: Proc. of the III International Symposium on Non-wood Forest Products, Kahramanmaras, 2014, 809–819.

18. B. McKERCHER: Some Fundamental Truths about Tourism: Understanding Tourism's Social and Environmental Impacts. Journal of Sustainable Tourism, **1** (1), 6 (1993).
19. C. TISDELL: Environmental Economics: Policies for Environmental Management and Sustainable Development. Aildershot, Edward Elgar, Melbourne, 1993.
20. D. JAMES: Using Economic Instruments for Meeting Environmental Objectives: Australia's Experience. Environmental Economics Paper No 1, Department of the Environment, Sport and Territories, Canberra, 1993.

Received 11 February 2016
Revised 12 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *796–804* (*2016*)

Environmental management

INVESTIGATING THE WILLINGNESS TO PARTICIPATE WITHIN A TARGET POPULATION WITH LOW OPPORTUNITY COST AS A CONTRIBUTION TO HISTORIC MONUMENTS PRESERVATION

O. KOPSIDAS[a]*, L. FRAGKOS-LIVANIOS[b]*

[a]*Department of Civil Engineering, Alexander Technological Educational Institute of Thessaloniki, 17th km Thessaloniki-Sindos, 57 400 Thessaloniki, Greece*
E-mail: *odykopsi@yahoo.com*
[b]*Division of Natural Sciences and Applications, Hellenic Army Academy, 16 673 Vari, Attiki, Greece*
E-mail: *leonfragos@yahoo.co.uk*

Abstract. We present the results of a survey on a population of 200 conscript soldiers, probing their willingness to participate (WTP) voluntarily to the maintenance and beautification of an archaeological site – the Heraion of Samos – during their military service. The evaluation of this good is impossible in market terms; consequently, a modified version of the Contingent Valuation Method (CVM) was applied. The population was divided in two equal groups. The first group received a questionnaire and were asked to reply without any information on the significance of the particular site. The other half were given informative material. Subsequently, the first group was divided in two equal subgroups. One subgroup was asked to re-fill the same questionnaire following an update in the form of the same informative material (post-questionnaire update). The results indicate strong positive correlation between willingness to participate (WTP) and information. Further, WTP shows positive correlation against age, level of education and locality.

Keywords: ancient monument restoration, parametric approach, willingness to participate (WTP).

AIMS AND BACKGROUND

The Contingent Valuation Method (CVM) is an important tool for the evaluation of abstract non-marketable goods. This technique is basically subjective, attempting to acquire objectivity by extracting opinion/attitude and information/knowledge from a stratified representative sample of interviewees, who are asked by means of a questionnaire to assign a value on a non-marketable (e.g. cultural or environmental) good or an externality (considered as transaction spillover by *laissez-faire* economists like Milton Friedman and Friedrich von Hayek), meaning a benefit or cost not related to market values[1–3]. The main objective of the questionnaire is

* For correspondence.

to ‘measure’ the willingness of interviewees (i) to pay for a positive and/or (ii) to be paid in order to accept a negative externality (WTP and WTA, respectively)[2,4]. More precisely, WTP reflects the maximum amount in monetary units an individual would pay to acquire the non-marketable good or service under examination, while WTA corresponds to the minimum amount an individual would demand as compensation in order to relinquish this good or service. Conceptually, the CVM might be extended to (or considered to be part of) a corresponding cost-benefit method by relating expenditure (implying capital and operating cost) to benefit, including (but not limited to) externalities[5].

Archaeological sites on a tourist destination such as an island on the Aegean sea present potential both as a cultural as well as socio-cultural resource[6]. Such is the case of the Heraion of Samos, a place of cultural significance on a tourist destination. Cultural tourism can sustain the development of locations through the outlining of the material and immaterial cultural patrimony, emphasising at a superior level the natural potential of the given regions[7]. The Heraion was a large sanctuary dedicated to the goddess Hera, in the southern region of Samos, Greece, 6 km southwest of the ancient city, in a low, marshy river basin near the sea. The Late Archaic Heraion of Samos was the first of the gigantic free-standing Ionic temples, but its predecessors at this site reached back to the Geometric Period of the 8th century BC, or earlier. The site of the temple ruins, with its sole standing column, was designated a joint UNESCO World Heritage Site, along with the nearby Pythagoreion in 1992.

Regarding the opportunity cost of a soldier, in the case of conscripts, the individual soldier is forced to dedicate his time during his military service. By not receiving a salary for this service – or receiving a small, mostly symbolic compensation – he is actually ‘paying’ in terms of opportunity cost and time. Ignoring other parameters (their contribution to national defense, the acquirement of skills during their military training, opportunities to visit in remote locations, etc.) the conscripts lose the ability to pursue professional or other economic opportunities or to further their education during their service (by Greek law, it is allowed to study while in service but it is rarely the case, being taxing and unpractical). In this sense, conscripts can be considered a low opportunity cost population.

EXPERIMENTAL

The respondents were soldiers in the area of Samos, serving mandatory military service. Conscripts cannot have professional activity. To them, the participation in the restoration of the archaeological site of the Heraion had no opportunity cost in terms of working hours. As the opportunity cost for labour is zero, the production possibility frontier of each soldier is stable and indicates their availability to participate in the redevelopment of the site with corresponding zero hours of

participation in terms of work. Graphically, on a Cartesian plane, this would be represented by a line parallel to the axis of the WTP. In this case WTP is the time allocated to the soldier involved in voluntary work and L – the working time of a soldier. The antiquities are treated as public and non-market goods. Conceptually, it is assumed that the demand function for volunteering tends to infinity in the requested units, with voluntary work measured in time. The consent or non-consent of the interviewees in the activity does not involve a cost and the cost of transporting troops is zero as research is conducted *in situ*. The dependent variable WTP is the time dedicated in this activity by the respondents. All other variables are independent. This participation was not motivated. The evaluation of WTP is done *ceteris paribus* for alternatives and parameters that could affect this evaluation. The weather conditions as well as catering for the soldiers are postulated.

Due to the specificity of the responding population – conscript soldiers – the hypothetical appraisal method is applied to a hypothetical economy without money. Time is what was offered and spent. With WTP, the individual willingness for participation is measured, by means of personal work for the restoration of the site. The soldiers have to choose between standard military activities and participation in this voluntary activity.

The research was conducted on people aged between 18–30 years old, of the same sex and of the same nationality. The apparent homogeneity of the population is a systemic characteristic. All Greek male citizens that have completed their 18th year of age are obligated by law to enlist as conscripts. The military service may be delayed on the excuse of educational responsibilities, undergraduate and postgraduate studies. This leads to a male population aged between 18 and 30. Further, in terms of sampling, all the soldiers in the barracks took part in the survey. Consequently, there was no sampling, the whole population was surveyed. The population was divided in two equal groups. The first group received a questionnaire and were asked to reply without any information on the significance of the particular site. The other half was given informative material ('informed' group).

The effect each factor has to WTP was analysed by means of analysis of variance (ANOVA). To examine the role of information, the Independent-Samples T-Test procedure was applied, comparing the means for two groups[8,9].

To further investigate the correlation of WTP and information, the first group of interviewees was divided into two subgroups, after filling the questionnaires. One subgroup was given informative material on the monument (post-questionnaire update, the same package as the 'informed' group). Then they were asked to refill the same questionnaire. The other subgroup was a control, with no information and no further action whatsoever. The willingness to participate between the two subgroups was analysed by means of the Paired-Samples T-test procedure.

RESULTS AND DISCUSSION

To probe the opinion the interviewees have regarding the actual location of the archaeological site of site Heraion of Samos, they were asked on the adverse effects caused by the surroundings of the site, the measures taken by the authorities for the protection and maintenance of the site and their preference on the necessary intensity of intervention on the site (Fig. 1). The profile of the population was generated by means of descriptive statistics. The results are shown in Fig. 2. It is worth noting the substantially high percentage – 52% – of respondents that have previous experience as volunteers to similar voluntary activity. Another interesting point is the notably high educational level of the population, with 22% having a university degree and 21.5% a postgraduate degree.

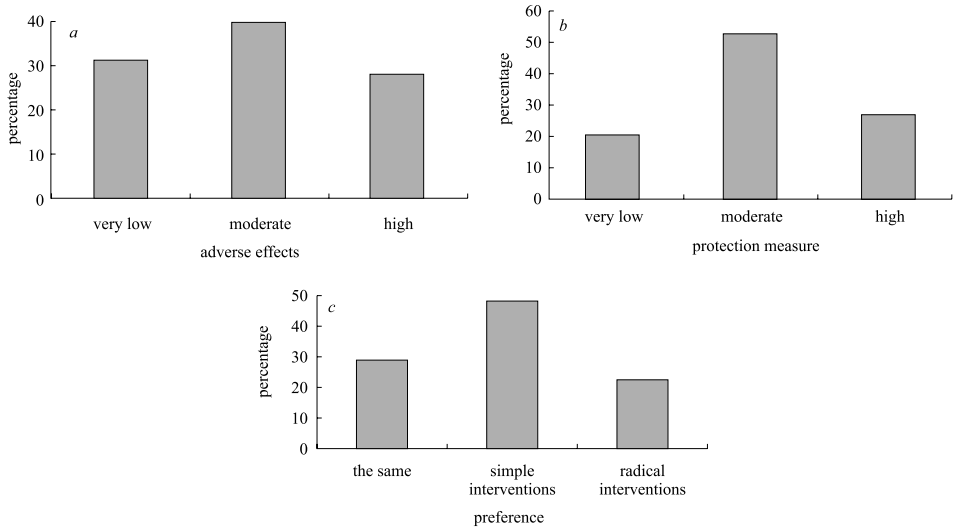


Fig. 1. Opinions regarding the archaeological site Heraion of Samos
a – bar chart for interviewees answers regarding the adverse effects on the monument due to the surrounding environment, natural and anthropogenic (land and buildings): 31.5% of the interviewees believe that the adverse effects are very low, 40% moderate, 28.5% believe they are high; *b* – bar chart for interviewees answers about the measures taken by the authorities for the protection and maintenance of the site: 20, 53, 27% of the interviewees feel that the measures taken by the authorities for the protection and maintenance of the site are negligible, moderate, and high, respectively; *c* – bar chart on preference of intervention on the site: 29% of the interviewees prefer negligible, 48.5% simple/low, 22.5% radical (including further excavation and restoration with expropriations of surrounding properties) intervention

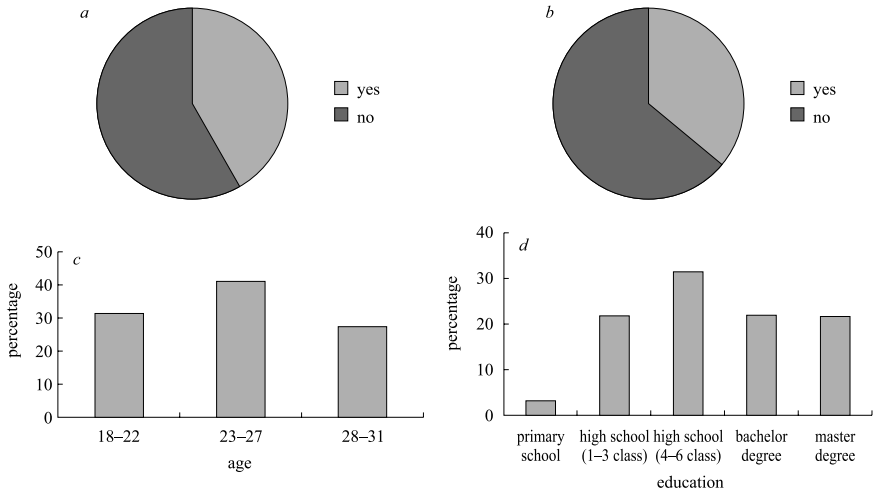


Fig. 2. Interviewees profile
a – pie chart for previous volunteering; *b* – pie chart for previous visits on the site; *c* – age classes. Interviewees answers regarding their age; *d* – bar chart for interviewees answers regarding education level

In Table 1, the effect of examined factors on WTP is reported, namely, adverse effects (p-value = 0.000 < a = 0.05), visit events (p-value = 0.000 < a = 0.05), age (p-value = 0.001 < a = 0.05), the educational level (p-value = 0.014 < a = 0.05), and information (p-value = 0.000 < a = 0.05) at 5% significance level. The effect each factor has to WTP was analysed by means of analysis of variance.

Table 1. Analysis of variance with the dependent variable WTP

Dependent variable: willingness to participate			
Source	*df*	*F*	Sig.
Corrected model	15	51.14	0.000
Intercept	1	336.000	0.000
Protection measure	2	0.534	0.587
Preference	2	0.853	0.428
Adverse effects	2	24.82	0.000
Previous volunteering	1	2.494	0.116
Visit	1	7.598	0.006
Age	2	7.798	0.001
Education	4	3.208	0.014
Information	1	95.050	0.000
Error	184		
Total	200		
Corrected total	199		
R^2 = 0.807 (adjusted R^2 = 0.791)			

To examine the role of information, the WTP between those who received informative material and those who did not was compared. The Independent-Samples *t*-test procedure was applied. The results of the analysis are shown in Tables 2 and 3. In Table 2, Group statistics is presented by means of descriptive statistical indicators: the size (*N*) of each group, the average (Mean), the standard deviation (Std. Deviation) and the standard error of the mean (Std. Error Mean). The WTP correlation on information is shown in Table 3. In particular, the updated soldiers (M = 5.9, SD = 3.329) show a greater willingness to participate compared to the soldiers, who were not updated (M = 0.88, SD = 1.241), t (126.013) = 14.130, p = 0.000 < a = 0.05.

Table 2. Averages desire to participate per team update

WTP		*N*	Mean	SD	SE Mean
Level	yes	100	5.9	3.329	0.333
	no	100	0.8	1.241	0.124

Table 3. Independent samples *t*-test of WTP by comparing information on whether they have been informed

WTP	*t*	d*f*	*p*-value	Mean difference	SE difference
	14.130	126.013	0.000	5.020	0.355

At that stage, the *t*-test compares the means of two variables for a single group. The procedure computes the differences between values of the two variables for each case and tests whether the average differs from 0 (Table 5). As indicated by the *t*-test for dependent samples, WTP increased when the participants were educated on the significance of the site (M = 3.74, SD = 1.807), compared with when they were ignorant (M = 1.00, SD = 0.000), t (99) = –15.164, p = 0.000 < a = 0.05. In essence, the update caused a shift in opinion, positively affecting WTP (Table 4).

Table 4. Averages participation desire per information (before and after)

		Mean	*N*	SD	SE mean
WTP	before information	1.00	100	0.000	0.000
	after information	3.74	100	1.807	0.181

Table 5. Paired samples *t*-test of WTP before and after information

WTP	Mean	SD	SE Mean	*t*	d*f*	*p*-value
Before information – after Information	–2.74	1.807	0.181	–15.164	99	0

Summarising, the soldiers updated on the history and significance of the archaeological site show a greater willingness to participate than soldiers who do not have the same information (Tables 2 and 4 and Fig. 3*c*).

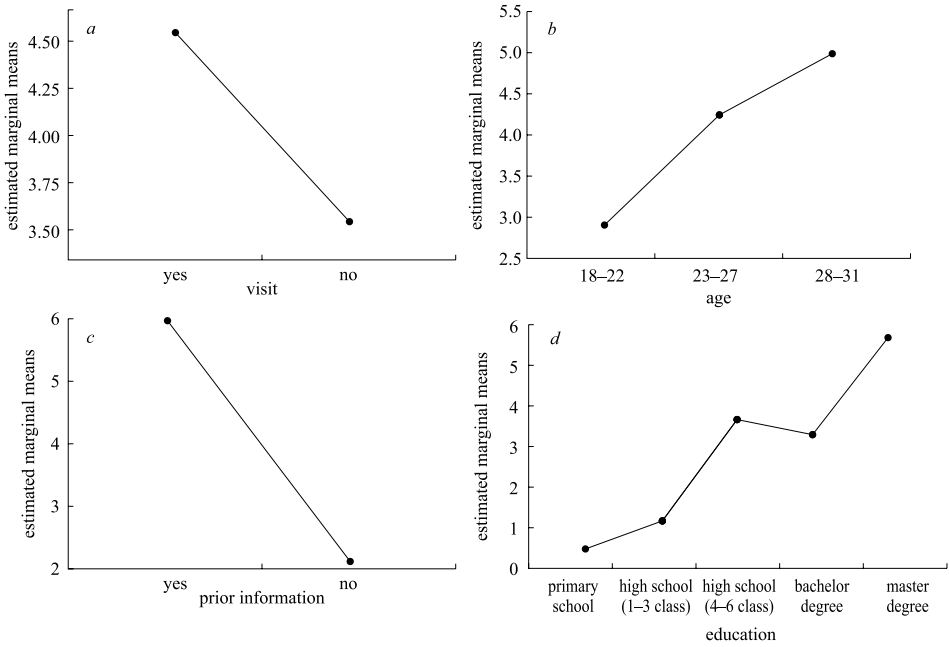


Fig. 3. WTP as a function of population factors (WTP is expressed in time units, namely days) *a* – means plot for interviewees WTP per visit level; *b* – means plot for interviewees WTP per age level; *c* – means plot for interviewees WTP before and after information; *d* – means plot for interviewees WTP per education level

Educational level and age affect the variable WTP. Respondents with higher education show a greater willingness to participate than those of lower education (Fig. 3*d*). Older respondents show a greater willingness to participate than younger ones (Fig. 3*b*). Locality also plays a role. Interviewees originating from Samos and surrounding islands show a greater willingness to participate than others. The effect of locality on willingness to pay when environmental or cultural preservation is at stake has been shown in previous studies as well[10]. Further, respondents who have previous experience as volunteers are more willing to participate than those, who have not participated.

CONCLUSIONS

The willingness to participate of interviewees in volunteer activity for the redevelopment of the site of the Heraion of Samos verifies an optimum socioeconomic status. The Pareto condition is satisfied and everyone involved in the activity optimize their position without reducing the position of anyone else. The reconstruction of a monument of world cultural heritage is aided. The local community, with the advantage of a restored archaeological site strategically promoted benefits with additional revenue from tourism. The army enhances the acceptance enjoyed by

the local community, demonstrates social and cultural sensitivity and strengthens the morale of the soldiers. Local authorities profit from savings and reputation from the end result. Such activities encourage companies to assist – for example by means of food provisions for the volunteers – thus demonstrating Corporate Social Responsibility. Downstream results include educational enhancement of those involved or the residents and visitors on the fields of history and archaeology. In conclusion, the end result constitutes an excellent social solution according to Pareto.

The findings are encouraging for meta-analysis and comparison with other regions. WTP shows a positive correlation against information, age, level of education and locality.

In previous studies, on the evaluation of WTP in monetary units for the redevelopment of the ancient walls of Piraeus[11], respondents showed significantly less willing to participate in voluntary activity, which was restricted from zero to two days with a strong preference for the one day. The two monuments – for the sake of comparison – are of equal cultural significance. Respondents of that previous survey belong to the country workforce. Consequently, any voluntary activity has an opportunity cost in terms of working days (time) for the respondent.

Voluntary activity includes renovation, cleaning and optimisation of the archaeological site. The economic value of the monument is measurable, although no insurance company undertakes insurance responsibilities on archaeological monuments. The positive externalities generated by the reformation of an archaeological monument, even though abstract, are recognised by the public. They are an incentive that keeps the marginal propensity to WTP positive. The WTP is the only variable input in terms of volunteer labour. Capital and other factors are considered stable and exogenously defined. The interest and value that society attach to heritage sites depend on the information the public receives, mainly by means of education and secondly by the media.

REFERENCES

1. A. BEDATE, L.C. HERRERO, J. A. SANZ: Economic Valuation of the Cultural Heritage: Application to Four Case Studies in Spain. J Cult Herit, **5**, 101 (2004).
2. W. M. HANEMANN: Testing and Calibrating the Measurement of Nonmarket Values for Oil Spills via the Contingent Valuation Method. Am Econ Rev, **81**, 635 (1991).
3. I. BATEMAN, A. MUNRO, B. RHODES, C. STARMER, R. SUGDEN: A Test of the Theory of Reference-dependent Preferences. Q J Econ, **112**, 479 (1997).
4. J. K. HOROWITZ, K. E. MCCONNELL: Willingness to Accept, Willingness to Pay and the Income Effect. J Econ Behav Organ, **51**, 537 (2003).
5. T. C. BROWN: Loss Aversion without the Endowment Effect, and Other Explanations for the WTA–WTP Disparity. J Econ Behav Organ, **57**, 367 (2005).
6. G. ARABATZIS, S. POLYZOS: Contribution of Natural and Socio-cultural Resources in Tourism Development of Mainland Greek Prefectures: a Typology. J Environ Prot Ecol, **9** (2), 446 (2008).

7. G. TIGUA, C. D. FURTUNAB, G. GHEORGHEB: Environmental Management Promotion of the Immaterial Cultural Patrimony for a Lasting Local Development. J Environ Prot Ecol, **14** (4), 1803 (2013).
8. T. F. LIAO: Interpreting Probability Models: Logit, Probit, and Other Generalized Linear Models. SAGE Publications Inc., 1994.
9. S. MENARD: Applied Logistic Regression Analysis, 2nd ed., SAGE Publications Inc., 2001.
10. A. KUBAS, I. H. INAN, H. HURMA, E. R. ERBAY: An Important Role of Local People to Joining Wetland Protection and Analysis of Contingent Valuation Methods. J Environ Prot Ecol, **8** (2), 352 (2007).
11. O. KOPSIDAS, F. BATZIAS: Improvement of Urban Environment and Preservation of Cultural Heritage through Experimental Economics by a Modified Contingent Valuation Method (CVM). In: Recent Research in Energy, Environment, Devices, Systems, Communications and Computers (Eds S. Chen, N. Mastorakis). WSEAS Press, 2011, 157–162.

Received 18 February 2016
Revised 15 April 2016

Journal of Environmental Protection and Ecology 17, No 2, 805–812 (2016)

MEDICAL WASTE INCINERATION IN SKOPJE. REGULATION AND STANDARDS

Z. SAPURIC[a], D. DIMITROVSKI[b]*, M. DIMITROVSKI[b], F. IVANOVSKI[a]

[a]*University American College, 60 Treta Makedonska Brigada, 1000 Skopje, FYR Macedonia*
[b]*Faculty of Mechanical Engineering, University St. Cyril and Methodius, Karpos 2, b.b. 1000 Skopje, FYR Macedonia*
E-mail: *dame.dimitrovski@mf.edu.mk*

Abstract. Treatment of medical waste is one of the most complex parts of waste management. Despites the opposite views incineration of medical waste is one of the most favourable methods of treatment, mainly because of waste volume reduction. But also incineration produces a number of environmental risks. Incineration in FYR Macedonia covers only a part of hazardous medical waste which is about 18% of the total volume of medical waste and the rest is deposited in the landfills which do not meet any EU and national standard. Incineration of medical waste in the state is performing in an incineration plant which has an old fashion technology and creates a high level of pollution. This causes the urgent measures for modernisation of incineration. It has to be followed by acceleration of the implementation of EU legislation and standards in the state. The aim of this paper is to analyse the regulation and standards in FYR Macedonia and in city of Skopje in the sphere of medical waste incineration and to give recommendations for the future activities.

Keywords: medical waste, incineration, regulation, standard.

AIMS AND BACKGROUND

Medical waste sector is an important part of waste management. Medical waste often is referred as health care waste. This waste type is generated from various sources such as medical care institutions, laboratories, medical and animal research, blood banks, pharmacy, etc. Hospital and medical waste are unavoidable outcomes of health care[1]. A significant part of medical waste belongs to the hazardous waste. Medical waste as a particular type of waste due its specific characteristics requires a special treatment. This applies particularly to the hazardous medical waste. There are different methods of medical waste treatment, like steam treatment, or autoclaving, chemical disinfection, dry heat sterilisation, land filing, incineration, etc. Even there are notable different attitudes waste incineration is one of the most favourable methods of medical waste treatment. Incineration of medical waste enables a significant reduction of waste volume and destroying hazardous substances. The

* For correspondence.

technology of waste incineration has considerably improved in the last 20 years, but the incineration still produces a number of risks. Medical waste incinerators are currently at the top of the list of contributors of dioxins to the environment[2]. This produces the need of comprehensive and precise regulations and standards.

FYR Macedonia faces with a number of problems in the waste area, especially in the hazardous waste sphere. Despite some positive results in the implementation of EU legislation in other waste spheres, the implementation of legislation concerning the medical waste incineration into national legislation has been performing very slowly. In the state has operated an incineration plant since 2000, which is located at the landfill 'Drisla', 14 km southeast of the city of Skopje (Latitude 41°55′35.95″N/Longitude 21°27′20.37″E). The plant has a very old technology and does not meet any EU and national standards, which produces the significant risks for the environment and human health. As a candidate state for the EU, FYR Macedonia has to completely implement EU legislation and standards relating to the waste incineration.

The overall goal of this paper is to analyse the conditions of medical waste incineration in Macedonia and in the city of Skopje, particularly in the sphere of regulation and standards. This paper highlights the risks which appear from medical waste and underlines the urgent need for the improvement of medical waste incineration.

EXPERIMENTAL

Within the research there were analysed the main EU and national strategic documents and regulation referring to the medical waste and its incineration. The national legislation is compared with the EU legislation. Also there were studied the permits issued from competent authorities, documentation, reports and technical details related to the current incineration in the state and the studies of environmental impact assessment for the construction of a new incineration plant which content the new data. It was visited the existing incineration plant in the landfill 'Drisla'. There were used statistical data both of the EU and FYR Macedonia. It was reviewed relevant published literature.

EUROPEAN UNION AND NATIONAL LEGAL FRAMEWORK

The EU has built a comprehensive legislation which regulates treatment of medical waste. This legislation determines the high standards of medical waste incineration. The EU policies have been promoted though the EU directives and strategies[3]. Directive 2008/98/EC regulates the basic principles on waste management including waste incineration. This Directive determines that hazardous waste should be labelled in accordance with international and EU standards. It prohibits mixing of

hazardous medical waste with other waste types and creates a list of waste including hazardous waste[4]. Directive 2000/76 stipulates operating, technical conditions and setting emission limit values for waste incineration[5]. The procedures of handling and incineration of all of hazardous waste types are regulated in details. This Directive promotes prevention and limitation of negative effects on the environment, from incineration. It sets the strict technical requirements. The minimum temperature of waste incineration process has to be 850°C and if the waste content more than 1% of halogenated organic substances, minimum temperature is 1100°C which has to be reached for at least 2 s. Furthermore Directive 2001/80/ EC creates the standards for combustion plants with thermal input which is equal to or greater than 50 MW. The member states are obliged to adopt national plans for reduction of total emissions of NO_x, SO_2 and dust from combustion plants[6]. Directive 2010/75/ EU promotes best available techniques and integrated approach for prevention and control of emissions into air, water and soil in the process of incineration. The need of strict conditions of the permits for waste incineration is particularly stressed[7]. In the annexes of the Directive are defined air emission limit values in different periods for various hazardous substances. Emission limit values are defined as the mass, expressed in terms of certain parameters, concentration and/or level of an emission, which may not, exceeded one or more period of time. Environmental quality standard is determined a set of requirements which must be fulfilled. This Directive establishes a framework for the integrated approach and emission prevention into, air water and soil from the industrial activities including waste incineration. It determines that infectious medical waste shall be placed directly in the furnace without being mixed with other waste categories. The Directive promotes gradually replacement the provisions from the Directive 2000/76.

From the above mentioned, it can be concluded that the EU legislation sets the high standards of medical waste incineration and provides conditions for sustainable medical waste management. It regulates the medical waste management in a very complex way. Effective waste management requires substantial legislative and organisation actions[8].

RESULTS

In the process of the harmonisation of its legislation with the EU legislation, Macedonia has transposed only a part of this legislation, which refers to the medical waste incineration. According to the Law on environment[9] and Regulation for IPPC licenses[10], operator of the installation for hazardous waste incineration must obtain A IPPC license, issued from Ministry of Environment and Physical Planning. Law on waste management determines classification of hazardous waste, the sources and types of medical waste. This law also regulates segregation procedures, packaging, labelling, transport, disposal and incineration of medical

waste[11]. Regulation of handling, packaging and labelling of medical waste, specifies different methods of medical waste treatment including incineration[12]. The List of waste types classifies waste types in 20 groups and appropriate subgroups. Medical waste is classified in eighteenth group with twenty particular subgroups[13]. Finally Regulation on limit values for incineration plants, regulates air and water emission limits in the process of waste incineration. It determines designing and working conditions, dynamic of measurement of the emissions and physical and chemical analysis of waste samples. The minimum temperature for medical waste incineration is 1100°C (Ref. 14).

A fact that Macedonia has transposed only a part of the EU legislation concerning to the medical waste incineration, produces a need for the future efforts to accelerate transposition of Directive 2001/80/ EC and Directive 2010/75/ EU.

The medical waste incineration in Macedonia started in 2000 in a plant which is placed in landfill 'Drisla'. From 18 January 2013 the landfill started to be operated by a company 'Drisla Skopje' LLC, which is established by 'FCL Ambiente' MK DOOEL (a daughter company of the consortium from Italy). This consortium is 80% owner of 'Drisla Skopje' LLC and the city of Skopje is 20% owner[15].The foreign partner has undertaken the obligations to invest in the modernisation of the landfill, especially in building of a new ground floor infrastructure, a composting plant, and a new incineration plant. But the realisation of these obligations has performed very slowly by prolonging the specified time limits. Building a new incineration plant still is in a preparatory phase. According to the National Waste Management Strategy, the volume of generated medical waste in the country is 6.670 t per year, from which approximately 1200 t or 18% are hazardous waste[16]. Hazardous medical waste for incineration is collected from the city of Skopje and a partially from Kumanovo and Tetovo, the cities near Skopje. The other areas from the country are not covered and hazardous medical waste is disposed in the landfills which do not meet any environmental standard. Every health care institution, which is covered by a system of medical waste incineration, has to sign a contract for collecting of the hazardous medical waste. This waste has to be separated in the process of its generation, disposal, and transport from other waste categories. The collection and transport is performed with 5 special vehicles. The input of medical waste is carried out manually, which produces the numerous of risks. Improper management of medical waste can pose a great health risk to the waste workers[17]. The incinerator is produced by INCINO Ltd. and has a very old technology. It has one main purpose to incinerate medical waste and expired medicines. The capacity of the incinerator is 100 kg/h or 500 t annually and can operate maximum 12 h per day. Table 1 displays the amount of collected and incinerated medical waste for the period 2004–2014. It shows significant increasing of incineration since 2004.

Table 1. Collected and incinerated medical waste, 2000–2014 (t)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
114	231	248	255	322	375	327.	327	358	416	458	469	501	748	725

The incineration plant consists of two chambers, primary and secondary. The primary is for waste burning and the second is for oxidation of exhaust gases and smoke. Air supply in the primary and secondary chamber is carried out from a centrifugal fan. Exhaust gases are discharging into the atmosphere through a metal chimney without any purification. It is required an hour to reach a working temperature of 850°C, which is very far from the EU and national standards. The measurement of air emission is performed monthly and according to the Report of operating of the landfill in 2014, all results show that the emissions of dust, CO, SO_2 and NO_x are above the maximum permitted limits. The report does not present the accurate results of measurement which is inconsistent with the EU and national regulation. This shows a lack of transparency. The inert ash as a residue of combusting is disposed into the landfill. The plant is combusting medical waste from researching, diagnosis, expired medicines, medical treatment or prevention of diseases, including animals according to the list from the national and EU classification: 180 101 sharp objects;180 104 waste from single use (disposable clothes, bandages, plasters and nappies); 180 106 chemicals containing the hazardous substances; 180 108 cytostatics and chemotherapy drugs; 180 109 other medical drugs; 180 110 waste from dental protection and 108 202 waste which has an infections threat.

The last study of environmental impact assessment on the environment of the project for building a plant for hazardous waste incineration within the landfill 'Drisla', which is performed in 2012, determines construction and working conditions of a new planned incineration plant. The plant should operate with a high level of automation with equipment for emission measurement. The plant will be consisted of two chambers primary and secondary. In the primary chamber will be a burner with a power of 800 kW. The secondary chamber will be consisted of two burners with thermal power of 1500 kW. This chamber has a system for providing a minimum temperature of 1100°C and permanent concentration of oxygen higher than 6%. According to this study, the incinerator has equipment which could stop the incineration process in case of drop the prescribed temperature. That will meet the EU and the national standards. The waste will be loaded in the plant automatically by hydraulic equipment for the containers of 200 and 1100 l. The plant will have equipment for continuous monitoring of the operation process and for air emission monitoring and a system for ash separation. The whole space of a new incineration plant will cover a surface of 630 m^2 and it will be primary aimed for incinerating of medical waste. The projected dimension of the incinerator is 37.10 ×

16.6 m with a height of 10 m. At the beginning heating will be with diesel oil and in the future should use the gas captured from deposited waste in the landfill. It is planned to use the thermal energy of the incinerator for heating the indoor space in the landfill. The plant will have a capacity of 1600 t per year, which will be significantly higher than existing and could meet collecting the hazardous medical waste from all medical institutions in the country. The existing plant will be immediately closed after the start of operating a new incineration plant. In Table 2 are presented the main technical characteristics of the planned incineration plant, which should significantly improve medical waste incineration.

Table 2. Main characteristics of planned incineration plant

Title	Unit	Value
Duration of the operation	h	24/24
Maximum power	kg/h	250
Minimum caloric power	kJ/ kg	15000
Average waste density	kg/ m^3	80
Maximum humidity	%	25
Minimum temperature	^oC	1100
Operability of the plant	h/year	8000
Thermal power that can be renewed	kcal/h	1130000

In February 2013 the landfill 'Drisla' received an A permit for the harmonisation of the operational plan, which besides the other conditions determines the conditions for medical waste incineration. The permit establishes the conditions for medical waste incineration in a new incineration plan. The measurement of emissions of furans, dioxins and heavy metals should be performed at least every three months and the measurement of TOC, HCL, HF and SO_2 will be continuously. In Table 3 are presented air emission limits from the A permit. These limits should enable the incineration of medical waste in line of the EU standards.

Table 3. Determined limit of air emission values for the planed incineration plant

Parameters	Concentration (mg/m^3)	Frequency of monitoring
CO	50	continuously
SO_2	50	continuously
NO and NO_2	200	continuously
Total dust	10	continuously
HCl	1	every three months
Dioxins and furans	0.1	every three months
Tl	0.1	every three months
Hg	0.1	every three months

CONCLUSIONS

Treatment of medical waste is an important part of waste management. Incineration is one of the most favourable methods of medical waste treatment. Medical waste incineration in FYR Macedonia and in the city of Skopje faces with a number of problems that are produced by a very old technology. The existing process of incineration of medical waste does not meet any EU and national standard and the level of emissions is significantly above the determined values. FYR Macedonia has to finish completely the implementation of the EU legislation and standards, concerning to the medical waste incineration. The situation could be improved by acceleration of the planed investments in a new incineration plant. If the planned new incineration plant will not start to operate by the end of 2016, the working of an existing plant has to be forbidden, because of high level of pollution. This means future treatment of medical waste by depositing in the landfill after sterilisation and autoclaving. However, the whole treatment of medical waste in the country must be significantly improved.

REFERENCES

1. P. MENTZELOU, F. VOSNIAKOS, Th. DARDAVESIS, N. PAPADAKIS, K. NIKOLAOU, Ch. ATHANSIADOU: An Information System for Hospital Waste Management. J Environ Prot Ecol, **10** (1), 285 (2009).
2. D. THEOFANIDIS, A. FOUNTOUKI, F. VOSNIAKOS, N. PAPADAKIS, K. NIKOALOU: Sustainable Waste Management of Hospital Waste: The View of Greek Nurses. J Environ Prot Ecol, **9** (2), 391 (2008).
3. K. PAPATHEDOROU, N. KLIMIS, B. MARGARIS, K. NTOUROS, E. EVANGELIDIS, A. KONSTANTINIDIS: An Overview of the EU Actions Towards Natural Hazard Prevention and Management: Current Status and Future Trends. J Environ Prot Ecol, **15**(2), 433 (2014).
4. Directive 2008/ 98 EC on Waste and Repealing Certain Directives. Official J of the EU, L313/2008.
5. Directive 2000/76/EC on the Incineration of Waste. Official J of the EU, L 332/ 2000.
6. Directive 2001/ 80/ EC on the Limitation of Certain Pollutants into the Air from Combustion Plants. Official J of the EU, L 309/ 2001.
7. Directive 2010/75/ EU on Industrial Emissions (Integrated Pollution Prevention and Control). Official J of the EU, L 334/2010.
8. E. ZEBEK, M. SZWEJKOVSKA, M. RACZKOWSKI: Legal and Organisational Solutions of Municipal Waste Management in Poland in Compliance with Waste Directive 2008/98 EC. J Environ Prot Ecol, **16** (2), 652 (2015).
9. Law on Environment. Official J of the RM, No 53/2005, 81/05, 24/07, 159/2008, 83/2009, 48/2010, 124/2010, 51/2011, 123/2012, 93/2013 and 44/2015.
10. Regulation on Determining the Activities for the Installation for which Is Issued Integrated Environmental License and License for the Harmonization of the Operational Plan. Official J of the RM, No 89/2005.
11. Law on Waste Management. Official J of the RM No 68/2004, 71/2004, 107/2007, 102/2008, 134/08, 9/2011, 123/ 2012, 132/2012, 147/2013 and 163/2013.

12. Regulation on Handling, Packaging and Labelling of Medical Waste. Official J of the RM, No 146/2007.
13. List of Waste Types. Official J of the RM, No 100/2005.
14. Regulation on Limit Values of Emissions from Waste Incineration and Conditions on Incineration Plant Operating. Official J of the RM, No 123/2009.
15. Decision for the Transformation of the Public Company for Waste Disposal 'Drisla' in Limited Trade Corporation. Official J of City of Skopje 11/2012.
16. Waste Management Strategy 2008 – 2020 of FYR Macedonia. Official J of the RM, No 39/2008
17. S. GOREN: Evaluation of Medical Waste Treatment Systems in Turkey. Environ Prot Ecol, **12** (2), 621 (2011).

Received 13 January 2016
Revised 15 March 2016

Journal of Environmental Protection and Ecology 17, No 2, 813–821 (2016)

Environmental legislation

AGRI-TOURISM: A RURAL PLANNING INSTRUMENT FOR SUSTAINABILITY OF AGRICULTURAL LANDS

E. D. TOPCU

City and Regional Planning Department of Middle East Technical University, Ankara, Turkey
E-mail: *odofe01@yahoo.com*

Abstract. Agri-tourism is seen as an increasing tendency for providing the sustainability of especially the agricultural areas/regions that are lost their productiveness through the way of adding value by touristic activities. In Turkey, especially in the last 15 years, there is an observable increase in the amount of agri-tourism initiatives. However, agri-tourism concept is still not a planning instrument in the rural planning approach of Turkey. It is a certainty that, agri-tourism concept should have a significant role in providing the sustainability of agricultural areas due to the reason of serious agricultural land loss problem in Turkey. In this study, agri-tourism concept is aimed to present as an alternative rural planning instrument for providing the sustainability of agricultural lands. Through this aim, after the definition of agri-tourism concept, the required mechanisms for agri-tourism planning approach are exposed through examining the examples of agri-tourism initiatives of Tuscany Region of Italy and Lublin Region of Poland. Finally, some suggestions are proposed for agri-tourism development in Turkey.

Keywords: agri-tourism, agri-tourism planning, sustainability of agricultural areas.

AIMS AND BACKGROUND

In the world, agri-tourism planning concept is benefitted as a way of sustaining agricultural areas for the agricultural lands those are under the threat of urbanisation. Agricultural areas are the unique ones of the rural areas with the properties of agricultural economy (agricultural production + agricultural employment + marketing), soil, agricultural landscape elements (both natural and artificial elements) and socio-cultural identity (socio-cultural character of rural people + agricultural settlements + living styles).

'In rural areas, tourism has become an important public policy issue because of limited development options, increased public expenditures for promotion, increased local pressures for resultant public services, increased conflict among user groups, and general concerns over societal costs and benefits of public support for tourism development'[1]. Conserving the agricultural areas need specific planning acts in both national and local rural planning approaches. This study asks for 'How agri-tourism concept should be benefitted for conserving the agricultural areas'. Through this aim, agri-tourism concept is reviewed for determining the planning

mechanisms to present the agri-tourism concept as being a planning instrument for the solution way of agricultural land loss problem in Turkey.

In this study, interpretative-textual-comparative research method is used to demonstrate the planning mechanisms of agri-tourism sector through two comparative examples those are the Lublin Region of Poland and Tuscany Region of Italy. These cases are examined through their distinct governmental approaches those are up-to-bottom approach of Polish and bottom-to-up approaches of Italian governments. As the result, this interpretative- textual-comparative method allows exposing the required mechanisms of agri-tourism planning approach for Turkey.

DEFINITION OF AGRI-TOURISM CONCEPT IN LITERATURE

Essentially, agri-tourism is defined as a branch of rural tourism in the related literature and there are several definitions of the term according to the aim of benefitting from agri-tourism in practice. Agri-tourism as a word is constituted of uniting the words of *agriculture* and *tourism*; thus it is a type of tourism activity incorporating the agriculture and tourism activities. 'First of all it is essential to explain about the confussion on the usage of the several terms, which are taking place in the literature for describing the notion; before examining the various definitions of agri-tourism. In the literature, there are several terms utilising for each other instead of agri-tourism'[2]. The terms such as agrotourism/agro-tourism, farm-based tourism, tourism on the farm and agriteinment/agri-teinment all have the same meanings that mean agri-tourism.

'Agri-tourism refers to an enterprise at a working farm, ranch or agricultural plant conducted for the enjoyment of visitors that generates income for the owner. Agricultural tourism refers to the act of visiting a working farm or any horticultural or agricultural operation for the purpose of enjoyment, education or active involvement in the activities of the farm or operation that also adds to economic viability'[3].

According to the 'A Guide for Local Governments and Indiana Farmers' document, Indiana State Department of Agriculture, agri-tourism 'is generally understood to be a business model that links agricultural production/processing with tourism in order to attract visitors onto a farm, forest, or the agricultural business for the purposes of entertaining and/or educating the visitors and generating income for the farm, forest, or business owner. Durydiwka[4] presents both the agri-tourism and rural tourism as a factor of the activation the rural areas in Poland. Nowadays, there are various definitions of rural development programs of the governments by the verified approaches to this agricultural and touristic activity. One of these approaches, a sustainable way of economic survival in agricultural regions, is the mostly accepted one in the literature. It is the approach of integration among sustainable development, sustainable tourism and sustainable agriculture principals[2]. According to Ivona[5], 'Rural tourism should be seen as a potential tool for conservation and sustainability, rather than as an urbanising and development

tool'. 'Agri-tourism includes any income-generating activity conducted on a working farm or ranch for the enjoyment and education of visitors. It includes the interpretation of the natural, cultural, historical, and environmental assets of the land and people working on it[6].

AGRI-TOURISM PLANNING AND AGRICULTURAL LAND CONSERVATION

Agricultural land is a category of 'resource land' in every sense of that term[7]. In other words, agricultural lands are multidimensional resources those embracing social, spatial, economic, ecologic and cultural aspects. Conserving agricultural land is mostly the seen as the conservation of arable lands through the classical point of view. However, in the world there are large amounts of agricultural lands those are under the threats of deficiencies such as unproductiveness, disadvantageous locational reasons and/or income profits.

Rural tourism is one of the sectors benefitting for sustainability of rural areas through rural development policies. 'Well-developed agri-tourism systems in rural areas have the potential to reverse negative economic trends by bringing in visitors and creating new jobs and local business ventures for rural residents. For those unfamiliar with the concept, agri-tourism is a hybrid concept that merges elements of two complex industries – agriculture and travel/tourism – to open up new, profitable markets for farm products and services and provide travel experience for a large regional market'[8]. Agri-tourism includes the planning instruments of sustainable agriculture and sustainable tourism those are the elements of sustainable rural development. Figure 1 shows the relationship between sustainable rural development, sustainable agriculture, sustainable tourism and agri-tourism planning.

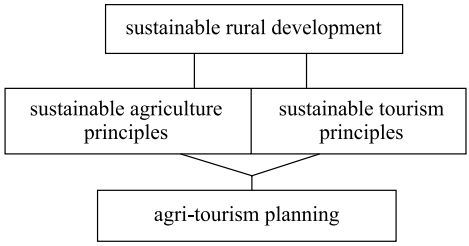


Fig. 1. Sustainable agriculture and sustainable tourism components of sustainable rural development constitute the main principles of agri-tourism planning

Not only in Europe, almost in all developed countries of the world, rural solutions are produced to solve the problems through the local potentials of the area or region. In the recent European approaches of rural development issue, rural traditions and all type of rural materials are noticed and accepted as the tourism goods. The development process of rural tourism in EU developed in a parallel way to the development process of rural development approach and presented the

supplementary role of rural tourism as on decreasing the regional inequalities and increasing the employment in the disadvantageous areas.

In Table 1, Knickel and Renting[9] identify the rural development issue according to two elements those are categorised through cultural landscapes and regional identity and bio-energy production. Table 1 demonstrates the multi-functional characteristics of rural economy that presents development and diversification of non-agricultural sectors as one of the non-agricultural element of rural development. It is seen that natural resources maintenance is presented as the environmental element of rural development approach that also contains conservation of land as being one of the crucial components of natural resources.

Table 1. Rural development issue[9]

Rural development elements	Environment	Agriculture	Rural development
1. Cultural landscapes and regional identity	– Maintenance of natural resources and the diversity of cultural landscapes	– Marketing of agricultural products with a regional image – Processing and marketing at regional level	– Regional business marketing – Short food chains from producer to consumer – High quality food products – Development of rural (green) tourism
2. Bio-energy production	– Reduction of air pollution in conjunction with the production of energy crops – Increasing crop diversity	– Diversification of agricultural production into non-food crops – Product innovations – New secondary products and farm-based processing technologies	– Development and diversification of non-agricultural sectors – Spin-off (multiplier) effects in rural business – 'Seedbed capacity' of farming for new economic activities

Data source: Ref. 3.

METHOD

Agri-tourism planning in Lublin region of Poland. 'Lublin region locates at the east of Poland with a dominant agriculture sector. 57% of the total lands of Lublin region are agricultural, 23% are forest areas and 20% are the other lands'[2]. 'According to the 2007 year of Polish Ministry of Agriculture and Rural Development, there are about 246 000 small farms with the average land area of 6.9 ha per farm and sector is in the tendency of development with the encouragements of EU financial support programmes and 75% of the agri-tourism farms are operated by rural women'[2]. According to Szymoniuk[10], in Lublin Region there are 11 associations and 300 agri-tourism farms offer 2500 beds for tourists per year.

In Poland, not only the rural tourism, each type of tourism is planned and managed by the national administration, therefore the role of the regional institutions is not regulative; they are just the informative units for local people. The Regional Chamber of Tourism and Consortium of the Tourist Organisation act as the responsible institutions for the development of rural tourism in the region. Lublin region agri-tourism planning practice model is an example for up-to-bottom governmental management.

Demirbas Topcu[2] determined 5 main planning mechanisms of developing agri-tourism in an agricultural region through the Lublin Region case those are:

1. *Legislative- regulative support mechanism*: Polish Ministry of Sport and Tourism (UKFIT) and European Union PHARE Programme constitute the legislative-regulative mechanism of Lublin region agri-tourism development planning;

2. *Financial support mechanism*: European Union is the financial supporter of Polish government agri-tourism projects in Lublin Region;

3. *Monitoring mechanism*: National administrative monitoring units;

4. *Action mechanism*: Agri-tourism clusters;

5. *Human resources mechanism*: Owners of agri-tourism farms, land owners.

In Fig. 2 Topcu analyses the roles and relations of planning mechanisms of agri-tourism sector in Poland[2].

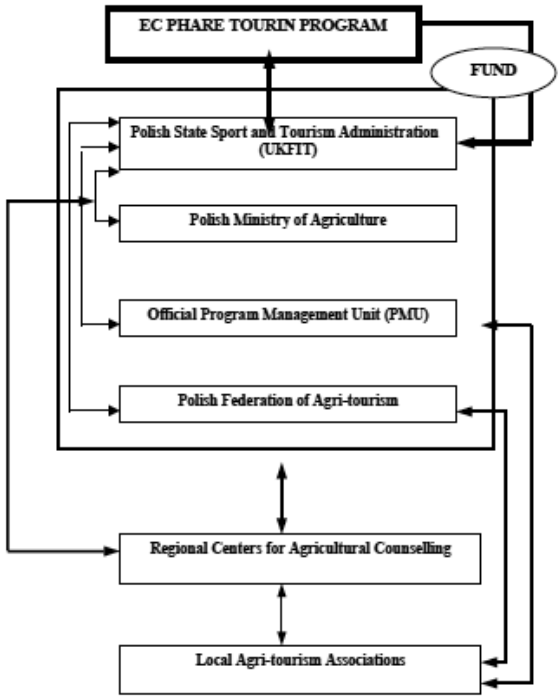


Fig. 2. Role and relations of planning mechanisms of agri-tourism sector in Poland[2]

Agri-tourism planning in Tuscany region of Italy. According to the OECD (Organisation for Economic Co-operation and Development) (2005) data, 'the numbers of farms offering some kind of tourist services has doubled to 12 500 units in 2003 with a turnover of 750 000 million Euro, 100 000 units of accommodation, 7500 units of restaurants, 930 units of camping facilities and 1 520 units of horse riding'[11]. According to Sonnino (2004), 'agri-tourism is developed in the Tuscany region as a complementary element for the income. Agricultural product diversification, adding value to the products and direct marketing constitutes the cores of agri-tourism in Tuscany and the regional law introduces the notion as an opportunity and a challenge for rural areas'.

In Italy, agri-tourism sector is decided to benefit for disadvantageous regions by the decisions of national and regional administrations and EU financial supports. Italian agri-tourism model is based on an agricultural production that is not just a tourism activity, but an agricultural event due to aim of protecting the agricultural lands according to the Italian national law. However, it is seen the diversification of tourism activities in Italian rural regions[2]. In Fig. 3, Topcu[2] analyses the Tuscany region agri-tourism planning process through the levels of the mechanisms.

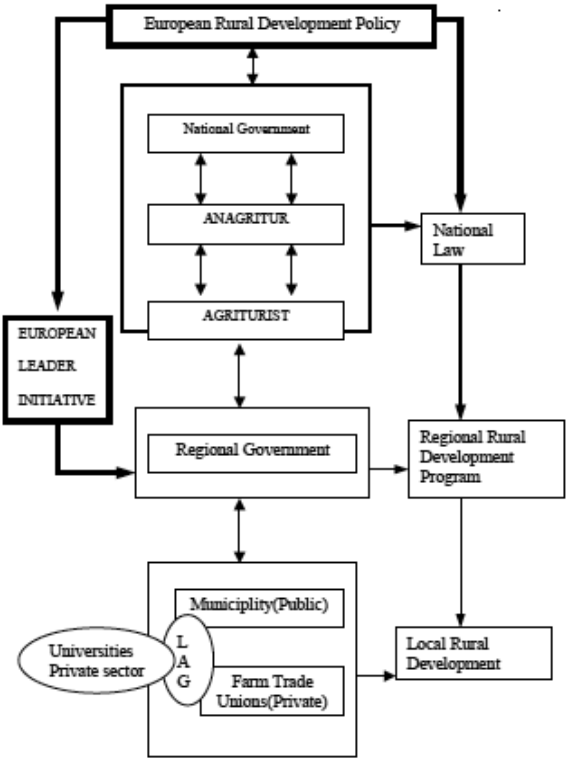


Fig. 3. Analysis of the Tuscany region agri-tourism planning process through the levels of the planning mechanisms

Tuscany region is a success example for bottom-to-up planning approaches. Regional administration has the key role within all the levels of the planning process. There are three legislative-regulative mechanisms those are EU LEADER Programme, related Italian national laws and regional laws. EU LEADER Programme provides financial resources to local projects and directs the regional administration for distribution of the financial resources. Also, a national law regulates the fiscal regime for the agri-tourism farms through not reducing but simplification of the taxes[2].

RESULTS

In this study, agri-tourism development process is reviewed through two comparative examples for determining the planning mechanisms of agri-tourism. By the study, it is exposed that there are five main planning mechanisms those have different roles in agri-tourism planning process. It is also seen that by the same planning mechanisms agri-tourism should be planned through different approaches. Topcu[2] defined these mechanisms as:

1. Legislative-Regulative Support Mechanism;
2. Financial Support Mechanism;
3. Monitoring Mechanism;
4. Action Mechanism;
5. Human Resources Mechanism.

These mechanisms have the same roles in both up-to-bottom or bottom-to-up governmental approaches. However, according to the Tuscany case, it is seen that bottom to up approach is more effective in providing a strong agri-tourism planning sector. Because of the identity of being local initiative, stronger local governments have more effective roles in agri-tourism planning by serving the necessary services.

In Table 2, Lublin and Tuscany regions agri-tourism planning practices are compared for exposing the differences and similarities of the two different planning approaches of agri-tourism planning.

Table 2. Differences and similarities between Lublin and Tuscany Regions agri-tourism planning approaches

Criteria/Differences	Lublin region	Tuscany region
Bottom-up approach	weak	strong
Relationship between tourism and agriculture	weak	stromg
Regional image	weak	strong
Diversification in tourism product	low	high
Share of agricultural tourism in overall tourism sector	very low	moderate/ increasing
Legislative-regulative mechanism	specialised for tourism sector	specialised for rural land conservation
Financing mechanism	EU PHARE programme+ national government	EU LEADER programme + national government
Monitoring mechanism	central monitoring	local monitoring
Action mechanism	weak	strong
Human resources mechanism	weak	strong
Criteria/Similarities		
Size of agri-tourism farms	small	small
Tradition of rural tourism	long time	long time

CONCLUSIONS

According to Topcu[2], it should be generally said that 'agri-tourism development is based on four related groups that are the public sector, private sector, NGOs and the local people. These four actors are complementary elements of the system by supporting each other through the cooperative studies of these groups to achieve five main planning mechanisms examined in this study'. It is a certainty that, establishment of these planning mechanisms is not adequate by itself for the establishment of a strong agri-tourism sector. Entrepreneurship behaviour of local societies, having the skills of being a tourism enterpreneur and acting together of local people are the other three effective functions for the establishment of the sector. However, it is the significant responsibilty of both the local and central governments of acquiring the five main planning mechanisms. Establishment of such an alternative sector is possible through the common work and policies of both Turkish Ministries of Culture and Tourism and Food, Agriculture and Livestock. These ministries have to be act with local governments in the processes of preparation of the agri-tourism projects.

Today, a few primary agri-toursim initiatives in Turkey are weak steps due to weak rural tourism comprehension and strong up to bottom governmental approach. On the other hand, providing sustainability of agricultural lands is one of

the vital problems in Turkey. Agricultural lands are especailly face to face with unproductiveness, constraints of urban land speculation and rapid decrease in agricultural labour force. Therefore, especially for the economically unproductive agricultural lands, alternative solution ways such as agri-tourism have to be researched. In other words, it has to be benefitted from the adding value methods for the agricultural areas those are under the weak conditions with regard to agricultural production in Turkey.

REFERENCES

1. D. MARCAUILLER: Toward Integrative Tourism Planning in Rural America. J Plan Lit, (11), 337 (1997).
2. D. TOPCU: Agri-tourism as a New Element of Country Planning. Master Thesis, Middle East Technical University, Ankara, Turkey, 2007.
3. American Farm Bureau Federation Web Page, 2004. Annual Meeting Highlights, http: //www.fb.org, last visited: 10.12.2015.
4. M. DURYDIWKA: Tourism as a Factor of the Activation in the Rural Areas in Poland. ACTA Universitatis Carolinae Geographica, (1), 53 (2003).
5. A. IVONA: Farm Toursim and Rural Development, a Successful Combination? A Local Experience. 2003. https://www.openstarts.units.it/dspace/bitstream/10077/867/1/f6ivona.pdf., last visited: 11.10.2015.
6. H. GEORGE, E. RILLA: Agri-tourism Enterprises on Your Farm or Ranch: Where to Start. University of California, Division of Agriculture and Natural Resources Publication, (8334), (2008). http://anrcatalog.ucanr.edu/pdf/8334.pdf, last visited: 14.01.2015.
7. D. P. WHEELER: The Conservation of Agricultural Land Resources. 1982. http://www.georgewright.org/021wheeler.pdf, last visited: 27.08.2015.
8. M. RAMSEY, N. A. SCHAUMLEFFEL: Agri-tourism and Rural Economic Development. Indiana Business Review, 6 (2006).
9. K. KNICKEL, H. RENTING: Methodical and Conceptual Issues in the Study of Multifunctionality and Rural Development. Sociologica Ruralis, **40** (4), 512 (2000).
10. B. SZYMONIUK: Rural Clusters in the Lublin Region (Eastern Poland) Good Solution for a Young Democracy. In: Proc. of the 43rd Congress of the European Regional Science Association, Finland, August 27–31, 2003, http://www-sre.wu-wien.ac.at/ersa/ersaconfs/ersa03/cdrom/papers/410.pdf., last visited: 16.01.2016.
11. OECD: New Approaches to Rural Policy, Lessons from around the World. OECD Publishing, Paris, 2005.

Received 11 February 2016
Revised 18 March 2016

Journal of Environmental Protection and Ecology 17, *No 2*, *822–824* (*2016*)

Information

B.EN.A.
Balkan Environmental Association

CONCLUSIONS
1st INTERNATIONAL WORKSHOP ON ENVIRONMENTAL PROTECTION AND SUSTAINABILITY

28–29 May 2016, Tulcea, Romania

The *1st International Workshop on Environmental Protection and Sustainability*, organised by Balkan Environmental Association (B.EN.A.) and Danube Delta National Institute for Research and Development, under the auspices of the National Authority for the Scientific Research and Innovation, was held during 28–29 May 2016, in Tulcea, Romania.

The workshop sessions were attended by more than 80 scientists and experts from Bulgaria, Czech Republic, Germany, Greece, Iceland, Italy, Portugal, Romania, Turkey and USA, presenting the results of their recent research work on workshop-relevant topics.

The workshop was honoured by the president of Tulcea County Council, followed by the Governor of Danube Delta, the representative of the Balkan Environmental Association Executive Board and the Danube Delta National Institute for Research and Development, that hosted the workshop.

The technical content of the meeting was introduced by Dr. Marian Tudor, the General Director of Danube Delta National Institute for Research and Development, and Dr. Mariana Golumbeanu, on behalf of the Executive Board of B.EN.A. which introduced to the participants the event hosted by the National Institute for Marine Research and Development 'Grigore Antipa', Constanta on 27th of May 2016, during which the room where many of the B.EN.A. activities were held, was named 'Prof. Dr. Fokion K. Vosniakos', in a public ceremony. In addition, Dr. Evangelos Papathanassiou, the Scientific Director of the Hellenic

Centre for Marine Research of Athens, Greece dedicated the Proceedings of the FP7 PERSEUS Project Closing Conference – *Integrated Marine Research in the Mediterranean and Black Sea* – to the memory of Prof. Vosniakos, chair of the PERSEUS Advisory Board. Further opening remarks, addressing the participants with talks relating the workshop thematic and expressing gratitude to the late Prof. Dr. Fokion Vosniakos, were given by: Prof. Timothy Ehlinger from Wisconsin University, USA; Prof. Dr. Massimiliano Fenice from the University of Tuscia, Viterbo, Italy and Dr. Tania Zaharia, scientific director of the National Institute for Marine Research and Development 'Grigore Antipa' Romania.

The workshop was structured in two parts – one dedicated to communications covering a large range a research fields: biodiversity assessment, aquatic ecology, natural resources, ecological restoration, sustainable fundamental and applied research on physics, chemistry, etc. in the management of environmental concerns through planning and implementation/utilisation of environment-friendly technologies in much needed sustainable infrastructures by the researchers and experts in environmental sciences and management practices; and one field application in the Danube Delta.

The scientific program of the Workshop consisted of three sections, with a total of 22 oral presentations, with extensive interdisciplinary approaches, followed by wide discussions and comments by the audience.

During the **first session**, 6 presentations were given, dealing with different scientific arguments, were well focused regarding the workshop topics and were accompanied by interesting comments and discussions by the participants. The presentations included an outline of the EU FP7 project 'Perseus', that was devoted to investigating the selection and application of appropriate tools to assess the state of South European marine environments.

In addition, other topics regarded: the complexity of social-ecological systems for sustainable development, a new system to improve surface water quality by aeration, criteria for differentiating patterns of natural resources management, the problem of energy storage from solar and wind power plants and case studies investigating the potentia of microorganisms from transition zones.

During the **second session**, 7 papers were presented, dealing with water management issues, economy and innovation. The world needs a safer water supply to continue human life and water management programmes should provide the necessary steps and plans to decision makers. These steps can be organised as follows: determine, analyse, assessment, monitoring, rise awareness, select priorities and also give chances, funds, support to new innovative ideas. The participants gave much feedback to the e-waste pollution, innovation platforms for environmental and health decision makers, water management and ecohydrological approach, assessment of industrial processing impacts on water bodies, innovative management tool for sustainable Marine Protecd Areas (MPAs) conservation. These reactions

show that future topics of BENA could be focused also on urban mining and innovation platforms on environmental and health collaboration.

The **third session** comprised 9 oral presentations, focusing mainly on marine and freshwater environments. The first two presentations covered the application of Ecosystem-based Responsive Fisheries Management System (RFMS) in the frame of several European research projects (FP7 EcoFishMan, WhiteFish, MareFrame, PrimeFish, ClimeFish and SAF21). This approach entails including socio-economics and policy aspects in the process of managing fisheries in European seas, in a dynamic co-creation process. Additionally, talks covered the following topics: abnormalities/malformations recorded in turbot specimens caught in Bulgarian and Crimean Black Sea waters; summary of the current state of the main components of the marine environment of the Romanian Black Sea in 2015, an alternative in controlling invasive species in wetlands, which is of great importance due to their potential impact on the native flora and fauna, ways towards a sustainable sturgeon fishery in the Lower Danube Region, scientific contributions of the Danube Floodrisk to the H2020 Floodserve project, which aims to enhance ecosystem services for flood mitigation, assessing the genetic diversity of endangered species in the Danube Delta area, ways of strengthening the Natura 2000 network in Romania, using the advantages of the GIS.

The scientific knowledge and technical competence of BENA experts in all aspects of environmental management issues are always available to provide support to the authorities and stakeholders involved in the decision-making process in environmental protection in our region, without imposing economic burdens.

During the workshop it was possible to interact freely and exchange ideas among the participants. It represented an excellent opportunity for discussing newly developed tools for environmental management supporting environmental and sustainability directions.

In conclusion, all the oral presentations fulfilled the goals of the workshop very succesfully and increased the visibility of BENA members, and related Institutions, to connect research activities at the European and international levels.

The worksop activities concluded with a field day on the Danube Delta having the possibilitilty to understand the peculiar Delta environment; its integration with local population and anthropogenic activities; problems and development perspectives of a unique and wide geographic area showing a paramount importance within European natural resources.

30th of May 2016, Tulcea, Romania

Journal of Environmental Protection and Ecology 17, No 2, 825–827 (2016)

Information

CONCLUSIONS INTERNATIONAL CONFERENCE GREDIT2016 – GREEN DEVELOPMENT, INFRASTRUCTURE, TECHNOLOGY

Skopje, 31 March – 2 April 2016

The International Conference, '*GREDIT2016 – Green Development, Infrastructure, Technology*' co-organised by the Balkan Environmental Association (B.EN.A.) and the Faculty of Technology and Metallurgy of St. Cyril and Methodius University in Skopje was held during 30 March–2 April 2016.

The conference sessions were attended by more than 200 scientists and experts from Albania, Bosnia, Bulgaria, Croatia, Greece, Italy, Montenegro, Romania, Serbia, Turkey and the host country FYR Macedonia, presenting the results of their recent research work on conference-relevant topics.

The conference was honoured with the presence of the Mayor of Skopje, followed by the State Secretary of the National Ministry of Environment and the Vice-rector of St. Cyril and Methodius University in Skopje that hosted the conference.

The technical content of the meeting was introduced by Dr. Caner Zanbak of BENA Executive Board while Prof. Dr. Mihail Kochubovski, head of the B.EN.A. National Office and Dr. Mariana Golumbeanu of the Executive Board of B.EN.A. addressed the participants with talks about life, science, achievements and heritage of late Dr. Josif Tanevski and late Prof.Dr. Fokion Vosniakos. All the participants paid their homage to the late Prof. Dr. Fokion Vosniakos, founding President of B.EN.A., who suddenly passed away on March 16th, 2016 who has been the driving force for scientific and social endeavour in the Balkan Region for almost two decades, with a minute of silence.

The objective of the Conference was to emphasize the importance of green approaches in management of environmental concerns through planning and

implementation/utilisation of environment-friendly technologies in much needed sustainable infrastructures by the researchers and experts in environmental sciences and management practices. The scientific program of the conference consisted of six sections with a significant number of papers and posters, proceeded with four invited lectures at the Plenary Session.

The Plenary Lectures, delivered at the onset of the Conference, on *World Energy Issues and Advanced Nuclear Fusion, Green Infrastructure – Ecological Networks, Integration of Environmental Values in Land Use Planning, Air Pollution from Transport in Urban Areas – Case Study Skopje, Urban Zones and Toxic Waste* carried special messages to the conference audience.

In the Oral Presentation Sessions, 12 keynote lectures and around 100 papers with extensive interdisciplinary approaches were presented and opened to discussion under six specific thematic sessions below:

- Air – Water – Soil Pollution, Risk Assessment – Sustainable Development
- Renewable Energy Resources, and Management of Natural Resources
- Green Smart Cities / Societies – Green Architecture, and Landscape Design
- Agricultural Ecology, Food Quality Safety, Public Health Environmental Medicine
- Management of Urban and Industrial Waste
- Climate Change – Biodiversity – Energy Efficiency.

During the six oral sessions, a total of 13 keynote presentations were made on topics emphasising some of the most relevant aspects of the discussed topics. Important in the same way, around 144 poster papers were presented on the conference topics, mainly jointly authored by young researchers and scholars of the Balkan area, which revealed the importance of young researchers training and involvement, following once again the tradition of B.EN.A and of B.EN.A. conferences for the last fifteen years.

A round table on Higher Education and Industrial Environment also took place, while the coverage by local and national media was quite wide; especially, despite the fact that – on the same days – national politics issues were driving the attention of the public opinion and media in Skopje.

Remarks about the different sessions are as follows: Oral Session 1 (Air – Water – Soil Pollution, Risk Assessment – Sustainable Development) consisted of 14 oral papers which delivered a wealth of information about current development in that important research area in the Balkans and in Europe. Oral Session 2 consisted in 11 presentations, concerning Renewable Energy Resources, and Management of Natural Resources, while Oral Session 3 (Green Smart Cities / Societies – Green Architecture, and Landscape Design) provided a medium for the participants to listen to the 11 presentations on the main theme of the Conference.

The second day of the Conference on April 1st, Session 4, covered Agricultural Ecology, Food Quality Safety, Public Health Environmental Medicine with 12

presentations, while Session 5, concerning Management of Urban and Industrial Waste, again included 12 oral presentations. Likewise, Session 6 concluded the technical sessions of the conference, with 13 presentations regarding Climate Change – Biodiversity – Energy Efficiency topics.

Another specific topic emphasised at the conference was the application of landscape architecture, which nowadays is more and more necessary for the sustainable development of the cities in the appropriate way in order to respect the environment and to be more friendly to the people.

The Environmental Education and Training and raising Public Awareness on Public Health, Climate Changes, Environmental Economics with the Urban Planning and the Land Use matters should be the current and future trends and targets of our societies for a better life on this planet. B.EN.A. should contribute positively to the above topics. In this regard, the inclusion of Landscape Architecture within the key indicator topics proves the enhancement of B.EN.A. efforts to improve long-range cooperation in the Balkan area.

As a conclusionary remark of the conference, it should be born in mind that the economic crisis should not be used as a justification to let the environment unprotected and without sustainable management. Therefore, emergencies of different kinds must be taken into account and countermeasures must be put in force in a quite short time. The scientific knowledge and technical competence of B.EN.A. experts in all aspects of environmental health issues are always available to provide support to the authorities and stakeholders involved in the decision-making process in environmental protection in the Balkan area, without imposing economic burdens.

The GREDIT2016 conference was a great success in terms of the large number of paper submittals with a negligible amount of no-shows and commendable flawless organisation. All the presenters did cope with the limited time allocations given to them to present their findings of research projects followed with fruitful discussions either during the sessions or at the coffee breaks and also at the social events during the conference.

Selected papers of the conference will be published in the Journal of Environmental Protection and Ecology (JEPE), the official journal of B.EN.A. and the remaining papers will be published by a select publication of the Faculty of Technology and Metallurgy of St. Cyril and Methodius University and five other international publications managed by the B.EN.A. member institutions.

3 April 2016

Call for papers
Rapid Publication Journal

INSTRUCTION FOR AUTHORS

The language of the Journal is exclusively English. Contributions will be considered only if they have not been previously published or been submitted elsewhere. The manuscripts must be submitted only by active B.EN.A. members (at least one-year old member) and should be submitted only in electronic form. Receipt of a contribution for consideration will be acknowledged immediately by the Editorial Office. The acknowledgement will indicate the paper reference number assigned to the contribution. Authors are particularly asked to quote this number on all subsequent correspondence. The manuscripts are subjected to preliminary evaluation by the Editorial Board, and after selecting and receiving the referees consent they are forwarded to the appointed referees. The period of evaluation is 2–4 months. In case of negative report, the manuscripts are processed to other referees.

MANUSCRIPT PREPARATION

Authors are requested to prepare the manuscripts considering the following options: double-space, 2.5-cm margins on all sides, Times New Roman font, and ca. 60 characters per line and 30 lines per page or about 1800 characters per page (standard page). Use an English keyboard layout and the Symbol Font for Greek letters and mathematical symbols. All tables, figures, with their legends must be inserted within the text following their citation.

The **length of manuscripts** should be as follows: articles – max. 7 pages (not more than 13 standard pages including references, tables and figures), for review articles – max. 10 pages (not more than 18 standard pages), and for short communications – max. 3 pages (not more than 7 standard pages).

ORGANISATION

The title page should include the title, authors and their affiliations, complete address of the author to whom correspondence should be sent and an Abstract.

Abstract – should not exceed 200 words and should give the subjects and conclusions of the article and all results of general interest. References and compound numbers should not be mentioned in the Abstract. Maximum five keywords should follow the Abstract.

Aims – should include brief and clear remarks outlining the specific purpose of the work.

Background – a short summary of the background material including numbered references.

Experimental – should be sufficiently detailed (but concise) to guarantee reproducibility.

Results and Discussion – should indicate the logic used for the interpretation of data without lengthy speculations. Authors submitting material on purely theoretical problems or on a new experimental technique might unite the sections Experimental, Results and Discussion into one section under the heading Discussion.

Conclusions – short summary of the main achievements of the research.

References – should be typed at the end of the manuscript sheet and numbered in the order of their first mention in the text. They should be indicated by superscript Arabic numerical in the text. Abbreviations of journal titles should follow the style used in Chemical Abstracts Service Source Index, 1970 edition and supplements. Sequence and punctuation of references should be:

1. F. K. VOSNIAKOS, K. S. FARMAKIS: Radioactive Releases from Nuclear and Thermoelectric Power Plant Operation and Their Effect to the Environment of Northern Greece. J Environ Prot Ecol, **1** (2), 255 (2000).
2. E. P. PAPANIKOLAU, P. KRITIDIS: Contamination of the Agricultural Land of Greece with Cs-137 and Its Effect on Crops. In: Intern. Conf. on Radioactivity in the Mediterranean Areas, Barcelona, May 1988, 457–466.
3. K. TASCHNER: Environmental Management and Audit Scheme. EEB Industry Handbook (Eds C. Key, K. Tashner). Brussels, Belgium, 1998.

   In preparing the list of References attention must be drawn to the following points:
   (a) Names of all authors of cited publications should be given;
   (b) Only the initials of first and middle names should be given.

Tables – each bearing a brief title should be numbered in Arabic numerals and placed in order of their mention in the text. Tables must be created using table format feature.

Figures and captions – figures must be numbered consecutively together with captions. Illustrations must fit the format of the Journal and should not exceed 12×18 cm. For best results, illustrations are to be black and white, and submitted in the actual size at which they will appear in the Journal.

Chemical structures should be produced with the use of a drawing program such as ChemDraw or ChemWindows, and other graphics in Microsoft Excell or Microsoft PowerPoint format. Particular attention is drawn to the use of SI system of units, and IUPAC recommendations regarding symbols, units, and terminology.

Chemical equations must be supplied using equation editor.

ELECTRONIC SUBMISSION OF MANUSCRIPTS

Manuscripts should be submitted only in electronic form. Submission not in electronic form may face a delay in publication. All text (including the title page, abstract,

keywords, all sections of the manuscript, figure captions, and references) and tabular material should be in one file. The manuscript must be prepared using MS Word 6.0 and above. Manuscripts in PDF are not accepted.

SUBMISSION OF MANUSCRIPTS

Manuscripts should be sent to the following address:

Prof. Dr. G. Vasilikiotis
BALKAN ENVIRONMENTAL ASSOCIATION (B.EN.A.)
Alexander Technological Educational Institution, P.O. Box 141, 57 400 Sindos, Thessaloniki, GREECE
E-mail: bena@gen.teithe.gr
http://www.jepe.gr; http://www.ge.teithe.gr/~bena

All manuscripts are subject to critical review and the names of referees will not be disclosed to the authors. The manuscript sent back to the author for revision should be returned within 2 months. Otherwise it will be considered withdrawn. Revised manuscripts are generally sent back to the original referees for comments, unless (in case of minor revisions) the editors accept them without seeking further opinions. Proofs should be corrected and returned as soon as possible.