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Economic Analysis of the Utilization of Disused Biomass from the Agricultural Activity in the Region of Thessaloniki

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Abstract: This paper aims to describe an environmental problem, the accumulation of waste biomass, which is a parameter of property devaluation and a reduction in the living standards of the inhabitants of the wider area of Thessaloniki. In this study, the respondents are 250 interviewees who answered the questions in the questionnaire. In the present study, the dependent WTA (Willingness to Accept) variable is determined in classes and is measured in an amount (currency units). After determining the minimum amount available to farmers (WTA) to participate in the collection and recovery of discarded biomass, averaged at € 28.3. The economic analysis of the utilization of discharged biomass involves matching the environmental to the socio-economic benefit. A solution is proposed for the optimum disposal site of the discharged biomass by multicriteria selection including alternative options to address endogenous difficulties or external factors that necessitate a change in the first optimal solution.

Key words: Biomass, WTA (Willingness to Accept), multicriteria analysis, land value, environmental cost.

1. Introduction

The decision to adopt a strategy to solve the problem of the collection and utilization of waste biomass that is a residual of agricultural activity in the wider area of Thessaloniki is a parameter for determining the value of real estate plots in the area [1]. The identification of the research objective is the economic analysis of the activity of collecting and exploiting farm residues, assessing the compensation available to farmers to participate in the activity [2]. The objective is also to minimize the environmental burden, which ecologically damages the area, decreases the incomes of residents and reduces the value of real estate [3].

The economic analysis of the utilization of discharged biomass involves matching the environmental to the socio-economic benefit [4]. By analogy, economic analysis of the principle "thinks locally, act globally" and "think globally, act locally" (now known on a theoretical and practical basis). Although these principles usually have atmospheric pollution, they can be used in solid waste [5].

2. Methodology

The analysis of the subject may include qualitative and quantitative characteristics. This is preceded by a qualitative analysis, which indicates one or more directions quantified later. The quantitative analysis follows in order to determine the WTA (Willingness to Accept) variable as well as to find the optimal site selection for depositing the discharged biomass after the rating of the specialists in a multi-criteria panel.

Considering that: (a) energy costs are critical to the cost of transporting an extremely cheap product or waste, even if it acquires (due to treatment) a relatively higher added value; and (b) the collection network/transport/transshipment plan is planned to operate over a time horizon exceeding the depreciation time of biomass treatment plants, it is

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necessary to forecast the long-term and long-term fuel prices, in particular petroleum products, natural gas and biofuels [6].

The alternative quantitative models used and their scenarios, in the form of different parameter values and associated conditions, should be studied by emphasizing the analysis of failed predictions and the investigation of the causes of this failure and the collection assumptions so that they can be reused in similar cases under a CBR (Case Based Reasoning) process [7]. These alternatives are presented hierarchically in the multicriteria Table 1.

The estimation of the compensation that farmers are willing to receive in order to participate in the activity of collecting and utilizing the disposed biomass is realized by in situ questioning and the synthesis of the alternatives of the problem is done by multi-criteria analysis. The criteria for choosing the best solution are: capital/fixed and operating/variable costs, environmental burden, residents' response, expansion barriers and hazards. The combination of these criteria in conjunction with the scoring of each alternative dumping site of the discharged biomass will result in an optimal solution [8, 9].

3. Results

In this study, the respondents are 250 interviewees who answered the questions in the questionnaire. The choice of the statistical methodology for the analysis of the data is a function of two factors: first of the question, and second, of the nature of the measurements that preceded it. Statistical data analysis methods used to investigate the relationships between dependent and independent variables and the type of the variable, i.e. whether it is a categorical, ordered, interval variable, etc. [10, 11].

This study investigates and explores the relationship between the WTA that farmers receive from the wider region of Thessaloniki in order to allow one to collect the remains of their farm and the factors that affect them this financial compensation. In particular, the dependent variable is the desire to compensate (yes/no), while independent variables are the following: the number of hectares in relation to the average, the nominal management, the participation in the process and the age. The average price of compensation to be paid by farmers in the wider region of Thessaloniki to participate in the collection and utilization of disposed biomass is EUR 28.3 ($WTA_{average}$ = 28.3 euros).

Based on statistical theory, the recommended techniques are: crosstabs, logarithmic linear models, decision trees and monotonic regression. However, in statistical analysis literature, in data analysis guides with SPSS (Statistical Package for the Social Sciences) Statistics and in cases where the dependent variable is presented as a binary, the technique proposed is the logarithmic regression ignoring the nature of the dependent variables. In the present study, the dependent WTA variable is determined in classes and is measured in an amount (currency units). The probability of financial compensation of a farmer in the wider region of Thessaloniki to collect the remains of his farm is examined with the aid of the logarithmic regression model. Table 2 shows the coefficients of the final model along with their respective induction checks and confidence intervals.

The model therefore estimated by the sample data for the willingness or non-compensation of the farmer has the form: $Ln \cdot p/1-p = -3.195 + 0.427$ (stremmas

Table 1 Results of the Logistic Regression process in terms of interaction in the model equation.

Variables	B	S.E.	Wald	df	Sig.	Exp (B)	Lower	Upper
Stremmas	0.427	0.433	0.972	1	0.324	1.532	0.656	3.580
Volunteer	0.518	0.653	0.630	1	0.427	1.679	0.467	6.032
Age	0.407	0.499	0.666	1	0.415	1.502	0.565	3.994
Management	0.468	0.272	2.951	1	0.086	1.597	0.936	2.724
Constant	-3.195	1.238	6.667	1	0.010	0.041		

Table 2 Assessment of the adaptation of the model to the sample data.

Step	-2Log likelihood	Cox & Snell R square	Nagelkerke R square
1	63.449	0.081	0.116

average) + 0.518 (volunteer) + 0.407 (age) + 0.468 (management).

Where p is the estimated probability of the farmer's pecuniary allowance in order to allow one to pick up and transport his farm waste. On the basis of the Wald criterion, a significant effect of the variable is interpreted by the four independent variables of the model in the configuration of the dependent variable values, it has no variable since Sig > 0.05 and thus the null assumption is accepted, i.e. $H_0 : b_i = 0$.

For the assessment of the model's adaptation to the sample data, it is done with the ratio of the maximum values of the likelihood ratio statistics for the complete model (L_0) and the model containing only the fixed term (L_0). The price of speech is as follows: -2ln (L_0/L_F) = 4.875 (Model Chi – square), while the probability of a value so large for the X^2 distribution with four degrees of freedom is Sig. > 0.05. So the zero hypothesis H_0: $\beta_1 = \beta_2 = \beta_4 = 0$ is not rejected. Therefore, the four variables combined in the form of the logarithmic model do not contribute significantly to predicting the values of the dependent variable (Table 3).

In addition, Table 2 gives the value of the log-likelihood function (-2Log likelihood = 63.449) for the final model as well as the Cox & Snell determination coefficient (0.801) along with the Nagelkerke determination coefficient (0.116).

4. Roustness Analysis

The analysis of the robustness of the proposed solution for the collection of disposed biomass in the wider area of Thessaloniki leads the Local Authorities (Central Macedonia Region) to explore four sites U_1, U_2, U_3 and U_4, in order to select the most suitable storage area for the disposed biomass. The criteria taken into account are: operating or variable costs, fixed costs, environmental burden, residents' response, possible barriers to the expansion of the waste biomass collection area and risk. The weights w_i ($i = 1, 2, \ldots, 6$) and the grades α_{ij} ($j = 1,\ldots,4$) are given in Table 4, where the solution is also shown $U_4 > U_3 > U_2 > U_1$, where the symbol '>' means 'better than', because $S_4 < S_3 < S_2 < S_1$, where the smaller symbol has the usual algebraic meaning.

The technical characteristics of the Thessaloniki area include the average flow velocity of the torrents of the area, u = 36 m/h, the average flow of rivers Q = 1,000 m^3/h, the average irrigation supply is Q = 936 m^3.

Table 3 Assessment of the model's adaptation to the sample data.

Chi-square	df	Sig.
4.875	4	0.300

Table 4 Multi-criteria analysis to determine the optimal position.

F_i	Criteria	w_i	U_1 a_{i1}	U_2 a_{i2}	U_3 a_{i3}	U_4 a_{i4}	U_1 $w_i \cdot a_{i1}$	U_2 $w_i \cdot a_{i2}$	U_3 $w_i \cdot a_{i3}$	U_4 $w_i \cdot a_{i4}$
F_1	Operating cost	0.21	1.5	2.2	2.8	3.6	0.315	0.462	0.588	0.756
F_2	Fixed cost	0.27	2.5	3.2	2.9	2.1	0.675	0.864	0.783	0.567
F_3	Environmental burden	0.20	3.8	2.9	2.6	2.2	0.76	0.58	0.52	0.44
F_4	Opinion of residents	0.22	3.9	2.7	2.4	2.3	0.858	0.594	0.528	0.506
F_5	Reaction of residents	0.06	4.3	3.4	3	3.3	0.258	0.204	0.18	0.198
F_6	Danger	0.04	3.7	3	2.7	3.8	0.148	0.12	0.108	0.152
		1.00	sum S_j		3.014	2.824		2.707	2.619	

5. Conclusion

The multicriteria option of the optimal alternative is a methodological tool for the gradual implementation of the proposed solution, which can be achieved by the sequential exploitation of the disposed biomass in the four alternative sites. This study can lead to the evaluation of the results for the first years of implementation and feedback of the subsystem for the maintenance decision making for the management of that biomass. Finally, the present study achieves the determination/implementing corrective actions and completing or revising planning for the coming years with regard to the collection and recovery of waste biomass.

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