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TECHNICAL REPORT - ACTION B9
FOR THE POLYGYROS LANDFILL, IN THE MUNICIPALITY OF POLYGYROS, CHALKIDIKI

SUBJECT:

TECHNICAL REPORT
FOR THE NATIONAL SURVEY

ENVECO S.A. ENVIRONMENTAL PROTECTION MANAGEMENT & ECONOMICS

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1. Executive Summary

It is widely acknowledged that landfill mining (LFM) could reverse the negative externalities of improper waste management and generate social benefits through reduced impacts, provision of secondary raw materials from recycling, job creation, etc. Nevertheless, the benefits of LFM and other improvements in waste management systems (e.g. enhanced collection systems, public awareness campaigns, etc.) can be expensive or at least more expensive than 'traditional' waste management approaches. Nevertheless, private costs and benefits alone cannot reflect the true social worth of certain improvements in waste management, principally owing to the externalities involved. Thus, in order to come up with more informed and fair social choices it is important to estimate the environmental and social costs and benefits generated and to internalize them in the decisions taken. The accuracy of economic valuation depends on the identification and quantification of the environmental change as well as the estimation of people's preferences for, or against, this change.

This report summarizes the results of a national survey conducted by means of the CV method, in order to estimate Greek society's willingness to pay for LFM projects. The survey was carried out between April and July 2015 using a national sample of 392 Greek households. Questionnaires were collected by telephone survey and the response rate was around 40%. Respondents were selected on a random basis from a phone number database including around 6.5 million records. According to the main findings of the study, more than 96% of the respondents feel that there should be a LFM program, and 47.3% said that they also feel that it is their responsibility to pay for it.

Focusing on the benefits of LFM, the responses indicate that:

- about 61% of the respondents characterize the benefits of resource and energy conservation as 'very important' and 33% as 'moderate important'
- about 58% of the respondents characterize the benefits of prevention and reduction of environmental pollution and nuisance as 'very important' and 30% as 'moderate important'
- about 55% of the respondents characterize the benefits of conservation of landfill space as 'very important' and 36% as 'moderate important'

Concerning the financial support for LFM programs, the elicited value was zero for 32% of the respondents. According to the answers given to the follow-up question, 27.6% of those who refused to pay anything said that they couldn't afford it due to low income. Around 70% of the 'zero answers' were protest bids. Significant disparities in respondents' attitude towards WTP for LFM programs were found between the local and the national samples. These differences are consistent with the differences noticed in the responses given in the social part of the surveys as regards the prioritization of the problems, the unemployment rates, etc.

The mean annual WTP (considering the parametric and non-parametric estimation methods) is of the order of 50 € per household. This amount is comparable with the lump-sum payment of 196 € of Marella and Raga (2014) assuming a social discount rate of 3% and a 5-year period of payments.

2. Introduction

It is widely acknowledged that unsuccessful waste management is commonly associated with a number of negative environmental and 'nuisance' impacts (e.g. emission of greenhouse gases and air pollutants, contamination of land and groundwater, odour, landscape deterioration, noise, disturbance of fauna and flora etc.), and threats to human health and safety (e.g. uncontrolled fires, spread of disease vectors, etc.) (Ghanbari et al., 2012). The magnitude of the impacts is influenced among other by the location and the characteristics of the facilities (e.g. size and age of the landfill), the requirements and enforcement of legislative framework, and the composition of waste (e.g. inert, municipal, hazardous, etc.) (Schollum, 2010). New technologies, which depend on legislative requirements, may lessen the environmental impacts of specific waste management practices, such as landfilling. For example, in EU, the Directive 1999/31/EC requires that landfill gas should be collected from new landfills (and existing landfills by 2007) and used to recover energy or at least flared).

The negative effects of poor waste management practices are related with a decline in the quality of life, which, in turn, generates external costs to affected population (e.g. Eshet et al., 2006). Thus, a proper waste management system could reverse these externalities and generate social benefits through reduced impacts, provision of secondary raw materials from recycling, job creation, etc. Although not considered a waste management practice in strict meaning, landfill mining (LFM) could be deemed as such. LFM helps to remediate public health and environmental quality problems associated with existing or closed facilities and may be used in order (USEPA, 1997; Lee and Jones, 1989 a&b, 1990; Hogland et al., 1997):

- Conserve landfill space.
- Reduce landfill area.
- Eliminate potential contamination source.
- Rehabilitate dump sites.
- Recover energy from mined wastes.
- Reuse of recovered materials.
- Reduce waste management costs.
- Redevelop landfill sites.

Nevertheless, the benefits of LFM and other improvements in waste management systems come at a cost. In particular, waste management infrastructure, enhanced collection systems, public awareness campaigns, etc., can be expensive or at least more expensive than 'traditional' waste management approaches. Or, more importantly, improved waste management systems may be more expensive than the society is able to afford, especially in the developing economies.

From the above-mentioned remarks, it is clear that private costs and benefits alone cannot reflect the true social worth of certain improvements in waste management, principally owing to the externalities involved. Thus, in order to come up with more informed and fair social choices it is important to estimate the environmental and social costs and benefits generated and to internalize them in the decisions taken. This means, however, that it is necessary to identify the ways in which alternative waste management solutions affect human well-being and, then, to estimate the value of these changes through a variety of appropriate valuation techniques. Consequently, the accuracy of economic valuation depends on the identification and quantification of the environmental change as well as the estimation of people's preferences for, or against, this change (Pearce & Howarth, 2000).

Considering the above-mentioned conditions, this report summarizes the results of a survey conducted at national level, in Greece, by means of a stated-preference valuation method, namely the Contingent Valuation, in order to estimate Greek society's willingness to pay for LFM projects. The rest of the report is structures, as follows. Section 2 includes background information relating to the non-market valuation theory and its methods. Section 3 provides a review of existing literature in the field of environmental valuation of waste management. Section 4 presents the design and the results of the national valuation survey. Finally, Section 5 summarizes the main conclusions drawn from this work.

3. Valuing the benefits of proper waste management

This Section provides a brief introduction to the most important theoretical and practical issues of environmental valuation. To this end, basic concepts and definitions are discussed and the most widely environmental valuation methods are presented.

3.1. Valuation of non-market goods and services

The majority of goods and services provided by the environment have no obvious market and, consequently, price. This is related to the so-called "market failures", which mean that the market place does not reflect their true social worth (Turner et al., 1994). The last three decades there is an increasing effort to incorporate monetary values in decision-making process, at different levels, in order to internalize impacts that have been traditionally considered externalities and, consequently to be directed to more informed and fair choices from a social viewpoint.

From an economic point of view, the monetary measure of the change in society's well-being resulting from a change in the quality or the availability of an environmental asset is based on its Total Economic Value (TEV), which, in turn, can be disaggregated into use values and non-use (or passive use) values.

Use values involve (Damigos, 2006):

- direct use (i.e. actual use of an environmental good or service for commercial purposes or recreation),
- indirect use (i.e. benefits from ecosystem services and functions rather than directly using them) and
- option value, i.e. the value of ensuring the option to use a resource in the future, which could be seen as an insurance premium.

Non-use values derive from the knowledge that the environment is maintained and include (DEFRA, 2007):

- altruistic values, which are related to the use of environmental goods and services from others,
- bequest values that reflect values that people may hold for ensuring that their heirs will be able to use a natural resource in the future and
- existence values which reflect the fact that people value resources for moral reasons, unrelated to current or future use

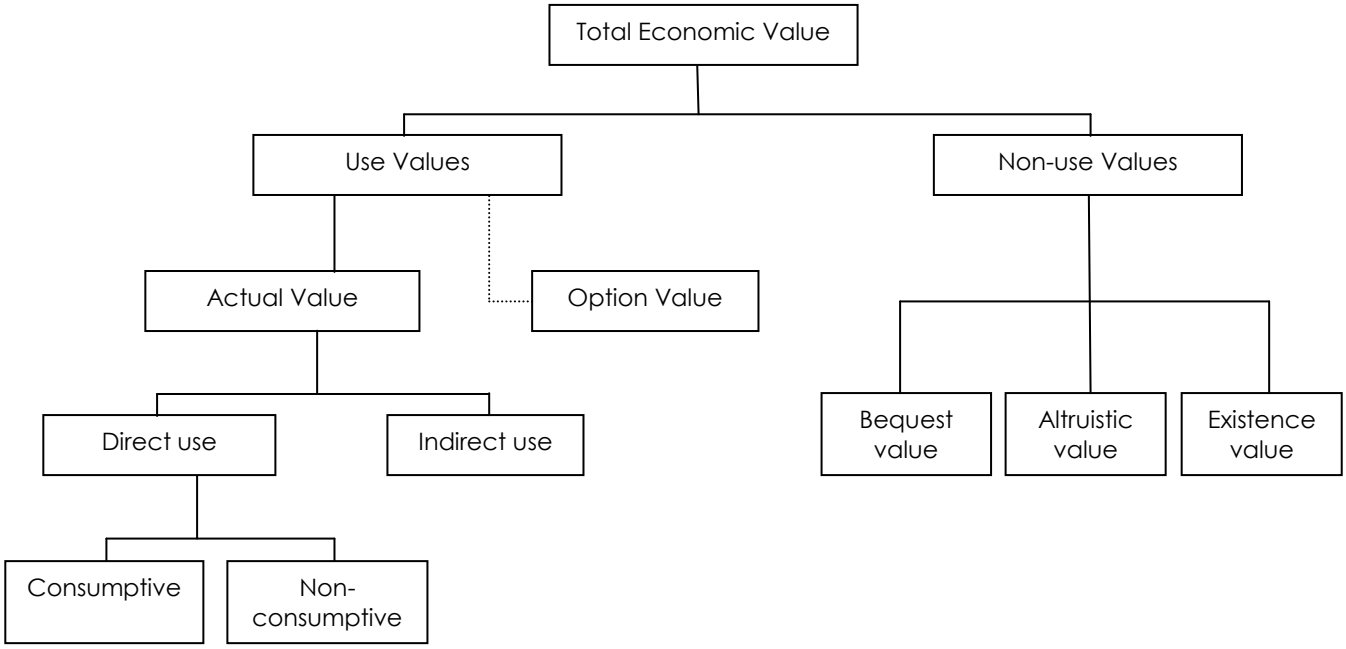

Figure 1: Values within the TEV approach

Environmental valuation is based on people's willingness to pay (WTP) an amount of money in order to avoid an environmental degradation and its consequences on health, amenity, etc. or their willingness to accept (WTA) a compensation in order to suffer the environmental impacts

incurred (Johansson, 1993; Turner et al., 1994; Freeman III, 2003). Environmental values derive from the Hicksian welfare measures of the compensating variation (CoV) and the equivalent variation (EV). More specifically, willingness to pay (WTP) is the maximum amount an individual would pay to gain an improvement in her/his quality of life (CoV) or to avoid an undesirable change (EV). Willingness to accept (WTA) is the minimum amount an individual would take as a compensation to accept an undesirable change (CoV) or to forgo an improvement in her/his quality of life (EV) (Freeman III, 2003). In principle, WTP or WTA formats could be used interchangeably to elicit individuals' preferences for change in the level of environmental goods and services (Venkatachalam, 2004). To this end, the externalities of waste management systems, both negative and positive, can be valued in either terms of WTP in order to avoid amenity losses, health risks, etc., e.g. via improved waste management, or WTA compensation for renouncing this improvement. However, stated WTA is commonly greater than stated WTP, as indicated by many empirical findings. Theoretical and experimental research efforts have explained the WTA/WTP disparity based on the 'prospect theory' (e.g. Kahneman & Tversky, 1979), the elasticity of substitution between environmental and market goods (e.g. Hanemann, 1991), the 'property rights', etc. (Venkatachalam, 2004).

Although there are several difficulties in applying environmental valuation techniques in project appraisal, there exist certain advantages that result in better decisions (Kula, 1994). According to Bonnieux & Rainelli (1999), monetization of environmental and social costs and benefit can serve four basic services:

- contribute to public debate and awareness concerning specific (environmental) problems. Money serves as a readily understandable indicator of environmental damage or potential benefits
- influence particular decisions by using a cost-benefit analysis or comparison of costs and benefits in another way
- identify the optimal alternative among competing options
- support and justify decisions (ex ante or ex post) taken by environmental agencies and other organizations.

3.2. Valuation approaches

Nowadays, there are several environmental valuation techniques, which differ in data requirements, assumptions regarding economic agents, and values that they are able to capture. Broadly speaking, valuation techniques are divided into the following three categories: (a) direct market valuation approaches, (b) revealed preference approaches and (c) stated preferences approaches (Chee, 2004; TEEB, 2010).

The first category involves market price-based, cost-based, and production functions approaches. The most commonly used techniques are: the replacement cost, the damage avoided cost, the substitute (or alternative) cost, and the productivity change cost (TEEB, 2010). These methods are

based on the cost of replacing environmental services, or the cost of avoiding damages, the cost of providing substitute services, and the cost incurred due to changes in productivity. The principal assumption of these methods is that if people incur costs to avoid damages caused by lost environmental services or to replace the services of ecosystems, then those services are worth at least what people have paid to replace them and their main advantage is that they use data from actual markets, and thus reflect actual preferences or costs to individuals (TEEB, 2010). However, the marginal value (market price) does not reflect the total value of the good due to the difference between the market price and people's WTP, which is known as Consumer Surplus (CS). Furthermore, given that many of the environmental services are provided at no cost (i.e. have no price) but hold a positive value, it is necessary to obtain their demand curve in order to reveal this value (which, in the case of zero price, will consist entirely of consumer surplus) (Damigos, 2006).

The revealed preference methods elicit preferences from the actual behavior of individuals based on market information. Generally, two types of procedures have been applied to this type of valuation (Damigos, 2006):

(a) Household production function methods based on the demand for complements and substitutes.

(b) Hedonic price analysis of decomposing prices for market goods to extract embedded values for related environmental attributes.

The two main methods within this approach are the Travel Cost Method (TCM) and the Hedonic Pricing Method (HPM).

The TCM is commonly used to measure the demand for recreational activities and can be interpreted as a special case of the household production function method. It is based on the rationale that the time and travel cost expenses that people incur to visit a site (direct expenses and opportunity costs of time) represent in some way the recreational value of the site. The idea is attributed to Hotelling, but the method was developed principally in papers by Clawson (1959) and Clawson and Knetsch (1966). In the context of TCM, the economic value derives from a trip generating function (which is the 'demand' function of the site under investigation) which is statistically determined by means of multiple regression analysis from zonal or individual travel cost models. The type of the model determines the dependent variable, which is either the number of trips made by inhabitants of a given geographical zone, or the number of trips made by individuals. The independent variables describe the cost of travel, (e.g. on-site costs, fuel, tolls, etc.), socio-economic characteristics of visitors (income, education, age, gender, etc.), characteristics of the site, substitute sites, travel time and others, depending on the selection of the model (Damigos, 2006). The method raises serious debates as far as the treatment of travel time is concerned (e.g. Garrod and Willis, 1992; Lockwood and Tracy, 1995), the allocation of travel costs in the case of multipurpose trips (Heyes and Heyes, 1999), the treatment of "zero cost" visitors (e.g. Kula, 1994), etc.

The HPM is based on the assumption that changes in environmental quality are capitalized into property values, since environmental attributes influence individuals' decision on the consumption of the commodity (Lancaster, 1966). The theoretical framework of the method is simple. Dwelling

prices differ with respect to: (a) housing characteristics (square footage of the home, number of rooms, quality of accommodation, etc.), (b) neighborhood characteristics (level and quality of social infrastructure, housing density, traffic, and presence of other facilities) and (c) the quality of the environment (air pollution, noise level, view, etc.)(Damigos, 2006). In other words, hedonic price analysis decomposes prices for market goods (i.e. either built-up properties or land) to extract embedded values for related environmental attributes (Rosen, 1974). Hedonic models have been used in a variety of applications, such as: clean air, proximity to green areas, proximity to waste disposal site, effects of view etc. (e.g. Bleich et al., 1991; Tyrväinen, 1996; Bouvier et al., 2000 ; Luttik, 2000 ; Du Preez et al., 2009). Although the principal concept is simple, there are serious difficulties and limitations with putting the method into practice (Damigos and Anyfantis, 2011). For example, it is referred that the results may be highly sensitive to model specification and level of disaggregation (e.g. Tyrväinen, 1996; Tyrväinen & Miettinen, 2000), to multicollinearity effects (e.g. Palmquist, 1991), to market shocks over the time period covered by the dataset, (ibid.), etc.

Stated preference approaches attempt to elicit individuals' preferences directly by means of social surveys on hypothetical changes in the quantity or quality of environmental and/or social goods and services. The main types of stated preference techniques are: the Contingent Valuation method (CVM) and the Choice Modelling (CM). Furthermore, Group Valuation (GV) approaches are also considered in this category (TEEB, 2010).

The most important of these techniques is the CVM, which is in use for over 40 years in over 50 countries by government agencies and international organizations and is perhaps the most frequently and widely applied stated preference valuation technique (Carson, 2004). While the most known applications are those for natural resource damage assessments (e.g. the Exxon Valdez oil spill), the vast majority of CV studies have been undertaken for assisting in decision-making procedures (Damigos, 2006). CVM is a survey-style approach that relies on a hypothetical market. It asks a sample of individuals to state their hypothetical maximum WTP for preserving an environmental asset or their minimum WTA for suffering the loss of that asset via a questionnaire. The method has two advantages over indirect methods, i.e. it is capable of capturing non-use values and, in principle, CVM answers go directly to the theoretically corrected measures of utility changes (Pearce & Turner, 1990; Perman et al. 2003). In addition, it is very flexible, and can be used in estimating the economic value of variety of environmental assets. On the other hand, due to the hypothetical character of the method and the fact that a social survey by means of questionnaire must take place, there is considerable controversy over whether it adequately measures people's WTP for environmental quality (e.g. Diamond & Hausmann 1994; Navrud & Pruckner 1997; Ajzen et al. 2004, Damigos, 2006). The debate over the use of CVM has two major points (Carson, 2000). The first one is whether or not non-use values should be included in an economic analysis. The whole subject gained considerable notoriety, apart from pure scientific interest, after the D.C. Circuit Court of Appeals in its Ohio v. U.S. Department of Interior ruling that allowed the inclusion of non-use values in natural resource damage assessments (US District Court of Appeals, 1989). The second point concerns mainly some technical problems involved in CV studies, including (Damigos, 2006):

- Information bias, since it is assumed that people understand the good in question and reveal their preferences as they would in a real market.
- Strategic bias that is related to Individuals' efforts to direct the survey at specific results.

- Hypothetical bias, since respondents do not actually pay for the proposed actions and, thus, it is possible to overestimate the amount that they would pay in a real situation.
- Payment bias that refers to the influences posed by the proposed method of payment.
- Part-Whole bias (also mentioned as embedding effect), which is related to the effect of the scale or the scope of the environmental good or the information provided via the hypothetical scenario.
- WTP vs. WTA, which leads to observed differences in the estimates. Yet, the utility theory predicts that for commodities where there are limited possibilities for substitution WTA could be much greater than WTP.

It should be mentioned, however, that the abovementioned biases could be reduced at a great extent or even eliminated by a proper survey design and that the overall process has significantly improved as other relative scientific fields have shown considerable improvements (Tentes & Damigos, 2012).

CM refers to a family of survey-based methods for modeling preferences for goods, where goods are described in terms of their attributes and the levels that they take (Hanley et al., 2001). The main CM variants are (Bateman et al., 2002):

- Choice Experiments (CE)
- Contingent Ranking (CRank)
- Contingent Rating (CRat)
- Paired Comparisons (PC)

From the abovementioned variants, only CE can provide WTP estimates consistent with the usual measures of welfare changes, under the prerequisite that a status quo option is included in the choice set (Hanley et al., 2001). The theoretical basis of CE can be found in Lancaster's (1966) characteristics theory of value, welfare theory and consumer theory and its differentiating characteristic is that it provides respondents with the opportunity to make a hypothetical economic choice concerning a good that is described in terms of the good's attributes and their importance. When choice alternatives include cost or a cost proxy as an attribute, DCE is able to capture respondents' willingness to pay for choice attributes, revealing trade-offs among alternatives (Bateman et al., 2002). Following the utility maximization theory, the utility that the consumer obtains from one good or service is equal to the sum of part-utilities deriving from the attributes of the good or service. Thus, the respondent weights the attributes of every alternative choice and opts for the one that offers the highest utility. In practice, however, individuals may make choices that do not maximize their utility due to lack of information, market failure, non-observable features or secondary characteristics of alternative choices that are not included (Louviere et al., 2002).

According to Hoyos (2010), the first application of DCE in the context of environmental resources dates back to 1990s (Adamowicz et al., 1994). In a CM study, respondents within the survey are given a choice between several options, each consisting of various attributes. In order to capture respondents' WTP, choice alternatives should include cost or a cost proxy as an attribute so as to reveal trade-offs among alternatives (Bateman et al., 2002). The CV method is considered to be less complicated to design and implement; yet, the CE is more capable of providing value estimates for changes in specific characteristics (or attributes) of an environmental resource (TEEB, 2010). Nevertheless, like CVM, the contingent character of the CE has been criticized (Sayadi et al., 2009). In addition, as mentioned by Andreopoulos et al. (2015), biases have been reported related to payment vehicles, strategic behavior, interviewing, and difficulty to link choices to the real world (Louviere et al., 2000).

GV combine stated preference techniques with elements of deliberative processes from political science (TEEB, 2010). They are being increasingly used as a means to capture value types that may escape individual based surveys (Spash, 2008). Thus, it is argued that GV may tackle shortcomings of traditional monetary valuation methods (de Groot et al., 2006).

Table 1 summarizes the valuation methods, the elements of TEV captured and the main advantages and limitations (DEFRA, 2007).

Table 1: Typology of valuation methods

Valuation method	Element of TEV captured	Advantages	Limitations
Market prices	Direct and indirect use	Market data readily available and robust	Limited to those ecosystem services for which a market exists.
Cost-based approaches	Direct and indirect use	Market data readily available and robust	Can potentially overestimate actual value
Production function approach	Indirect use	Market data readily available and robust	Data-intensive and data on changes in services and the impact on production often missing
Hedonic pricing	Direct and indirect use	Based on market data, so relatively robust figures	Very data-intensive and limited mainly to services related to property
Travel cost	Direct and indirect use	Based on observed behavior	Generally limited to recreational benefits. Difficulties arise when trips are made to multiple destinations.
Contingent valuation	Use and non-use	Able to capture use and non-use values	Bias in responses, resource-intensive method, hypothetical nature of the market
Choice modeling	Use and non-use	Able to capture use and non-use values	Similar to contingent valuation above

Source: Adopted by DEFRA (2007), after modifications

Undertaking original environmental valuation studies, especially revealed or stated-preference, is expensive and time-consuming and, in many cases, impractical. The latter has resulted in adopting the use of the "Benefit Transfer (BT)" (or "Value Transfer") method, which refers to the application of the results obtained from a particular case to another area. The site of the original research from

which the value estimate is borrowed is called 'study site', while the site to which the value is transferred is called 'policy site'. Primary research is always the "first-best" strategy but in the face of budget constraints and/or time limitations, BT provides useful information for decision-making, especially in cases where a high degree of precision is not critical (Rosenberger & Loomis, 2001).

In general, there are two broad approaches to BT, namely 'value transfer' and 'function transfer'.

Value transfers encompass the adjusted or unadjusted transfer of a single (point) estimate from a study site, or a measure of central tendency of the estimates from several study sites (such as an average value). The transfer is relatively simple when the sites are located in the same country and are similar in all characteristics (Eshet et al., 2007). International benefit transfers are not that different from those encountered between regions within a country. Nevertheless, factors, such as income differentials, commodity price levels, cultural and socioeconomic differences, etc., should be considered. In order to offset influences concerning income differences, assuming that income is the most important factor that influences WTP, values from 'study' sites are proposed to be adjusted according to the following formula (Bateman et al., 2002):

$$WTP_p = WTP_s(Y_p/Y_s)^e$$

where *p* is a character for the policy site and *s* for the study site, *Y* is the income per capita and *e* is the income elasticity of WTP.

Furthermore, in order to offset influences concerning differences of income, price level and time, Pattanayak et al. (2002) have proposed the following equation:

$$WTP_{p,pt} = WTP_{s,st} * \frac{PPPI_{p,st}}{PPPI_{s,st}} * \frac{CPI_{p,pt}}{CPI_{p,st}}$$

where *p* is a character for the policy site and *s* for the study site, *pt* refers to the year that the BT study is conducted and *st* refers to the year that the original study was conducted, *PPPI* is the Purchasing Power Parity Index and *CPI* is the Consumer Price Index.

Function transfers encompass the transfer of a benefit or demand function from a study site, or a meta-regression analysis function derived from several study sites (Navrud & Ready, 2007). The simple function transfer uses the coefficients from the selected study site combined with the values of the explanatory variables (e.g. socio-economic characteristics, environmental characteristics, etc.) of the policy site (Rosenberger & Loomis, 2001; Bateman et al., 2002). If suitable functional relations and parameters are available, then the functional transfer is more sophisticated and is assumed to produce more accurate results (Eshet et al., 2007). However, as the functions obtained from TCM, HPM and CVM studies often have low coefficients, the transfer of such functions can lead to further uncertainties. In this case, the transfer of unit value can be more manageable, as it can be adjusted as necessary (Damigos, 2006).

Meta-analysis WTP functions derive from a collection of studies treating each study site as one observation (Bateman et al., 2002; Barton, 2002). Meta-analysis is commonly used to analyze the variations in welfare measures due to differences in methodological assumptions of valuation studies in order to identify causal relationships between explanatory variables and benefit estimates and, thus, to improve the transfer of values (Eshet et al., 2007).

Several necessary conditions should be met to perform effective and efficient BTs, regardless of the approach adopted. For instance, it is mentioned that the environmental resource and the change in its quality (or quantity) should be similar for the study and the policy sites, the type of measure (e.g. unit, average, marginal value) and the kind of value (i.e. use, non-use, or total) elicited at the study site should correspond to the value needed for the policy site, the extent of the population affected and its demographic characteristics in the policy site should closely match those of the study sites, etc. (e.g. Rosenberger & Loomis, 2001; Loomis & Rosenberger, 2006; Spash & Vatn, 2006; Boyle et al., 2009). Although the study and the policy sites should be perfect substitutes, practically, 'sufficiently similar' sites are acceptable (Rozan, 2004; Eshet et al., 2007). In some cases, the transfer errors could be considered acceptable, but in other cases, the disparity between the estimates was quite large (Damigos, 2006).

4. Literature review

A review of scientific and gray literature, including journal articles, conference proceedings, books, agency reports, etc., reveals that there exist several studies monetizing disamenity impacts arising from treatment and disposal facilities, as well as studies examining society's WTP for improved municipal solid waste (MSW) management, recycling schemes, etc. The review also found only one research paper dedicated to the valuation of LFM benefits. The results of the review are presented following sections. The emphasis of this survey is on LF benefits and, secondary, on people's WTP for improvements in MSW management. Nevertheless, for completeness studies dealing with the external costs of MSW management disamenity are also mentioned. For uniformity and comparison reasons all values are expressed in €(2014), using the equation proposed by Pattanayak et al. (2002). The PPPI and CPI values were obtained by the World Bank (2015a & b).

4.1. Valuing externalities of landfilling

This section emphasizes the landfilling externalities and illustrates the social costs of waste disposal facilities. The analysis is based on existing studies on economic evaluation of externalities arising from landfill disposal and incineration of waste, using as a basis previous study of the authors (Damigos and Kaliampakos, 2012).

There are a number of studies that have estimated the external costs of waste treatment and disposal facilities by means of one or more of the valuation methods described in previous section. For example, the European Commission (2000) launched a study to consider the externalities from incineration and landfill disposal of municipal solid waste reviewing existing studies on economic evaluation of externalities from landfill disposal and incineration of waste. Sasao (2004) examined

public preferences in order to estimate the social costs of landfill siting using a choice experiment in Morioka City, Japan. Eshet et al. (2006) reviewed 12 studies that investigate externalities from landfills, 17 studies that analyze externalities from incinerators (some deal with both), and 5 studies that deal with air pollution from other sources and could be applied to waste management. The Resource Recovery and Recycling Authority of Southwest Oakland (2007) adopted a policy brief that explores the theory and the available data associated with the externalities of landfilling based on 8 studies. Schollum (2010) estimated the value of landfill externalities in the Perth Metropolitan Region, Australia. The analysis was carried out by means of the Benefit Transfer method after examining about 20 international and Australian studies. Ferreira and Gallagher (2010) investigated attitudes held regarding compensation in communities in Ireland, directly impacted upon by final waste disposal infrastructure projects (landfill and incineration) using the CVM.

Based on the referenced studies, Damigos and Kalimpakos (2012) estimated the total external costs for a tonne of waste. According to Table 2, the total externalities per tonne of waste range between 2 and 76 €(2014) when considered as a whole and between 4.2 and 78.3 €(2014) when estimated separately. The central tendency of the 'as a whole' and of the 'aggregated' datasets were estimated discarding the minimum and maximum values (i.e. using a 5% trimmed mean) and were found equal to 24.8 and 11.7 €(2014) per tonne, respectively. The values vary significantly, mainly due to the uncertainties involved in estimation of damages caused by greenhouse gas emissions and disamenities. Furthermore, the disparity in the estimates comes also from the different methods applied (e.g. damage cost functions, contingent valuation, etc.) in the original studies (Damigos and Kaliampakos, 2012).

Focusing on the effect of landfill sites on property values, Brisson and Pearce (1995) reviewed studies conducted by means of HP and CV methods. The results indicated that the expected maximum decline in house prices is 12.8%, which occurs at the site of the waste disposal facility. House prices increase by 2.34% per km away from the site and beyond 5.44 km from the facility there is no negative effect. Cambridge Econometrics et al. (2003) found that the total cost of disamenity due to landfills in Great Britain (at end of 1995) was £2,483 million, at 2003 prices, conducting a primary HP study by means of a database of 11,300 landfills that were associated with 592,000 housing transactions between 1991 and 2000. In addition, it was found that there was a reduction of over £5,500 in the average value of a house lying within the zone of 0.4 km (about 7%) from an operational landfill site and about £1,600 for those in the zone of 0.4 to 0.8 km (2%). Beyond the distance of 0.8 km there was no evidence of a statistically significant disamenity impact. Eshet et al. (2006) using a meta-analysis of hedonic pricing studies found that the overall range of disamenity damages is reflected in 1.06–6.25% reduction in housing price per km, resulting in an average of 3.6%/km. The maximum range of influence varies between 4 and 6.4 km, with an average of 5.2 km.

Table 2: External costs of landfill sites per tonne of landfilled waste (€2014)

	Low estimate	High estimate	Comments
Externalities 'as a whole'			
Stone and Ashford (1991)	75.7		
The Tellus Institute (1991)	67.7		
Powell and Brisson (1994)	2.1	14.3	Urban landfill without energy recovery
Enosh (1996)	6		
EMC (1996)	2.8		With energy recovery
European Commission (2000)	7.2	53	
Porter (2002)	2.8	14.1	
Fullerton (2002)	11.6	72.2	
Eunomia (2002)	6.8	10	
Dijkgraaf and Vollebergh (2004)	24.3		
Bartelings et al. (2005)	6.3	79.3	
Rabl et al. (2008)	10.2	14.4	
Gorecki et al. (2010)	36.7	45.7	
Greenhouse gases			
Powell and Brisson (2004)	1.7	11.6	
European Commission (2000)	1.4	19.5	
Eunomia (2002)	6.7	7.3	
Davies and Doble (2004)	2.9		Without energy recovery
Davies and Doble (2004)	2		With energy recovery
Disamenity			
European Commission (2000)	8.3	26.4	
Defra (2004)	3.7	5.4	
Transportation cost			
Powell and Brisson (2004)	0.5	1.4	
Davies and Doble (2004)	0.5	1.5	
Leachate			
Powell and Brisson (2004)	0	1.7	
Electricity generation benefits			
European Commission (2000)	1.4	14	
Dijkgraaf and Vollebergh (2004)	4.8		

Source: Damigos and Kaliampakos (2012) after modification by the authors

4.2. Valuing the benefits of improved waste management practices

This section focuses solely on studies examining society's WTP for improved MSW management, recycling schemes, etc. In total, 44 studies were gathered, which provided 55 point estimates (Table 3). Whenever data were available, original estimates that were expressed in terms of WTP per capita or per household (HH) per month etc., were converted to values per HH per year, for uniformity reasons.

As shown in Fig. 2, the majority of the observations come from Asia (n=21 or 38.2%), followed by North America (n=14 or 25.5%), Africa (n=9 or 14.5%), Europe (7=4 or 12.7%), Oceania (n=4 or 7.3%) and Middle East (n=1 or 1.8%). Furthermore, almost 45.5% of the studies were conducted in developing countries (as specified by the World Bank) and the rest (i.e. 54.5%) in developed countries. Around 58% of the studies were conducted between 2000 and 2009, 18% prior to 2000 and the rest 24% between 2010 and 2014.

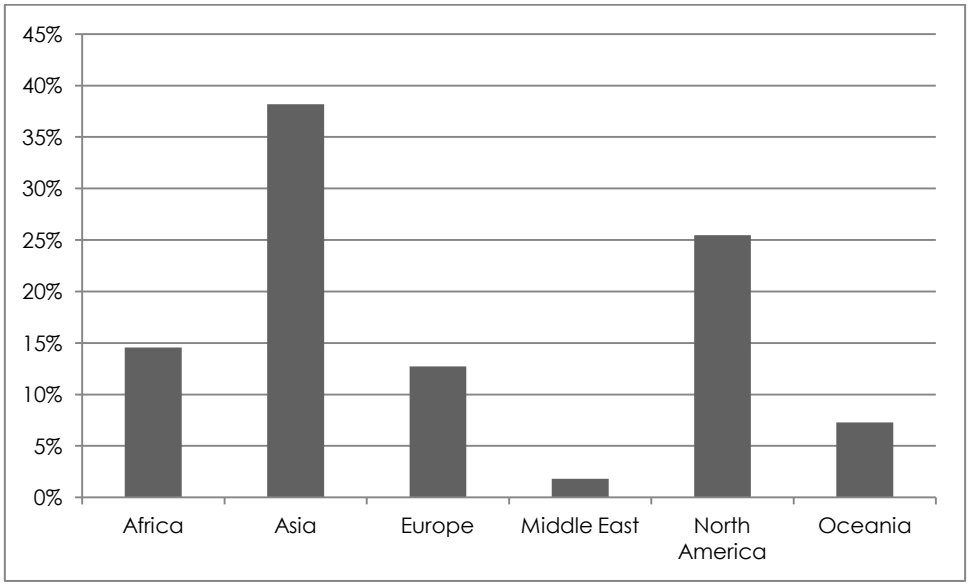

Figure 2: Distribution of valuation studies per geographical region

Table 3: Valuation studies examining society's WTP for improved MSW management, recycling schemes

Authors	Country	Region	Study	WTP format	Campaign	Study year	Sample size	Value	WTP/HH/ annum	Comments
Aadland and Caplan (2000)	USA	North America	CVM	OI	Telephone	1997	401	USD	24.60	
Aadland and Caplan (2006)	USA	North America	CVM	DBDC	Telephone	2002	4000	USD	35.64	Calibrated WTP for hypothetical bias
Aadland and Caplan (2006)	USA	North America	CVM	DBDC	Telephone	2002	4000	USD	67.32	Uncalibrated
Afroz and Masud (2011)	Malaysia	Asia	CVM	DBDC	Face-to-face	2009	467	MYR	264.00	
Afroz et al. (2009)	Bangladesh	Asia	CVM	DBDC	Face-to-face	2006	480	Taka	156.00	
Alhassan and Mohammed (2013)	Ghana	Africa	CVM	DC	Face-to-face	2013	200	GHC	44.00	
Altaf and Deshazo (1996)	Pakistan	Asia	CVM	OE	Face-to-face	1990	968	Rs	134.40	
Arekere (2004)	USA	North America	CVM	DC-FU	Mail	1999	618	USD	29.16	
Arekere (2004)	USA	North America	CVM	DC-FU	Mail and personal	1999	757	USD	35.16	
Arekere (2004)	USA	North America	CVM	DC-FU	Mail	1999	618	USD	10.80	
Arekere (2004)	USA	North America	CVM	DC-FU	Mail and personal	1999	757	USD	17.76	
Ayalon et al. (1999)	Israel	Middle East	CVM	OE	Telephone	1998	600	NIS	170.00	
Banga et al. (2011)	Uganda	Africa	CVM	DBDC	Face-to-face	2007	381	Ushs	29,268.00	
Basili et al. (2008)	Italy	Europe	CVM	DBDC	Face-to-face	2004	713	Euro	15.89	
Begum et al. (2007)	Malaysia	Asia	CVM	OE	Face-to-face	2004	130	RM	69.88	Value/ton
Berglund (2006)	Sweden	Europe	CVM	OE	Mail	2002	603	USD	56.25	
Blaine et al. (2005)	USA	North America	CVM	DC	Mail	2002	721	USD	28.20	
Blaine et al. (2005)	USA	North America	CVM	PC	Mail	2002	737	USD	18.48	
Bluffstone & DeShazo (2003)	Lithuania	Europe	CVM	DBDC	Face-to-face	1999	460	Litas	32.74	Median value
Bohara et al. (2007)	USA	North America	CVM	DC	Face-to-face	2002	458	USD	67.68	

Authors	Country	Region	Study	WTP format	Campaign	Study year	Sample size	Value	WTP/HH/ annum	Comments
Caplan et al. (2002)	USA	North America	CR		Telephone	2000	350	USD	69.00	
Caplan et al. (2002)	USA	North America	CR		Telephone	2000	350	USD	96.60	
Ezebilo (2013)	Nigeria	Africa	CVM	DC	Face-to-face	2009	236	Naira	3,660.00	
Ezebilo and Animasaun (2011)	Nigeria	Africa	CVM	PC	Face-to-face	2009	224	Naira	4,676.00	
Ferreira and Marques (2015)	Portugal	Europe	CVM	DC	Email	2013	1186	Euro	33.60	
Fonta et al. (2007)	Nigeria	Africa	CVM	DC-FU	Face-to-face	2003	200	Naira	2,764.00	
Geganzo and Guillermo (2013)	Philippines	Asia	CVM	DC	Face-to-face	2012	240	PhP	700.00	
Gillespie and Bennett (2011a)	Australia	Oceania	CE		Face-to-face	2010	200	AUD	131.49	
Gillespie and Bennett (2011a)	Australia	Oceania	CE		Face-to-face	2010	200	AUD	149.79	
Gillespie and Bennett (2011b)	Australia	Oceania	CVM	DC	Web	2010	712	AUD	35.23	
Gillespie and Bennett (2011b)	Australia	Oceania	CVM	DC	Web	2010	710	AUD	32.29	
Hagos et al. (2012)	Ethiopia	Africa	CVM	DC	Face-to-face	2008	226	ETB	142.68	
Hagos et al. (2012)	Ethiopia	Africa	CVM	OE	Face-to-face	2008	226	ETB	94.60	
Jin et. al. (2006)	Macao	Asia	CVM	DBDC	Face-to-face	2004	252	MOP	799.29	
Jin et. al. (2006)	Macao	Asia	CE		Face-to-face	2004	241	MOP	938.80	
Joel et al. (2012)	Kenya	Africa	CVM	OE	Face-to-face	2012	199	Ksh	4,356.00	
Jones et al. (2010)	Greece	Europe	CVM	OE	Telephone	2008	140	Euro	0.50	Value/waste bag
Karousakis and Birol (2008)	UK	Europe	CE		Face-to-face	2006	188	GBP	32.20	
Khattak et. al. (2009)	Pakistan	Asia	CVM	OE	Face-to-face	2008	216	Rs	1,800.00	
Koford et al. (2012)	USA	North America	CVM	DC	Mail	2007	600	USD	27.48	
Lake et al. (1996)	UK	Europe	CVM	DC	Mail	1993	285	GBP	35.69	
Murad (2007)	Malaysia	Asia	CVM	PC	Face-to-face	2003	300	MYR	156.00	
Naz and Naz (2006)	Philippines	Asia	CE		Face-to-face	2005	604	PhP	506.00	
Othman (2001)	Malaysia	Asia	CVM	OE	Face-to-face	2001	600	MYR	264.00	
Othman (2001)	Malaysia	Asia	CE		Face-to-face	2001	600	MYR	324.00	
Othman (2007)	Malaysia	Asia	CE		Face-to-face	2001	859	MYR	144.00	

Authors	Country	Region	Study	WTP format	Campaign	Study year	Sample size	Value	WTP/HH/ annum	Comments
Rahim et al. (2012)	Malaysia	Asia	CVM	DC	Face-to-face	2011	300	MYR	166.92	Value/capita
Roy and Deb (2013)	India	Asia	CVM	OE	Face-to-face	2013	378	Rs	127.47	
Sakata (2007)	Japan	Asia	CE		Face-to-face	2002	500	Yen	49.00	
Sarkhel and Banerjee (2010)	India	Asia	CVM	DBDC	Face-to-face	2007	570	Rs	228.00	
Tiller et al. (1997)	USA	North America	CVM	DC-FU	Face-to-face	1992	481	USD	48.00	
Wang et al. (2014)	China	Asia	CVM	MBDC	Face-to-face	2007	223	Yuan	205.20	
Yuan and Yabe (2014)	China	Asia	CVM	DC	Face-to-face	2013	391	Yuan	107.14	
Zen et al. (2014)	Malaysia	Asia	CVM	OE	Face-to-face	2013	460	MYR	88.80	
Zhang et al. (2015)	China	Asia	CVM	MBDC	Face-to-face	2013	4638	Yuan	23.41	

Notes: CVM: Contingent Valuation Method; CE: Choice Experiment; CR: Contingent Ranking; OE: Open-ended; DC: simple Dichotomous Choice; DCFU: Dichotomous Choice with follow-up question; DBDC: Double Bounded Dichotomous Choice; MBDC: Multiple Bounded Dichotomous Choice; PC: Payment Card; OI: Ordered Intervals

As regards the valuation method, only stated preference approaches were recorded. Specifically, the vast majority of the studies used the CV method (around 82%), followed by CE (14%) and CR (4%). Further, more than 65% of the studies collected information via face-to-face interviews, 13% via telephone interviews, 13% via mail surveys, and the rest via hybrid and other methods (i.e. combination of mail survey and personal interviews, emails, etc.). Focusing on CV studies, 28.9% followed a standard Dichotomous Choice (DC) protocol, 24.4% a Double or Multiple Bounded DC (DBDC) approach, and 13.3% a DC protocol with a follow-up question. Further, 24.4% of the studies used an open-ended valuation question and 6.7% a payment card. The most commonly used payment vehicle is a fee or tax charged for having the service (around 85%). Almost half of the studies (48.5%) examine policy scenarios referring to SWM improvement, in general, whereas the rest of them are related specifically to recycling issues (e.g. kerbside recycling services, creation of drop-off recycling centres, etc.). Interestingly, almost 82% of the "SWM improvement" studies have been conducted in developing countries. On the contrary, 90% of the "recycling improvement" studies were carried out in developed countries. This finding, which is statistically significant (χ^2=28.810, df=1, p=0.000), reveals the different research needs and activities, as well as the SWM priorities among developed and developing countries.

The transferred unit values are summarised in Table 4. Among the observations recorded, only those contained enough information for further analysis are listed.

Table 4: Transferred values in €$_{2014}$

Study	Country	Region	Study	WTP/HH/ annum	Comments
Aadland and Caplan (2000)	USA	North America	CVM	23.3	
Aadland and Caplan (2006)	USA	North America	CVM	30.1	Calibrated WTP for hypothetical bias
Aadland and Caplan (2006)	USA	North America	CVM	56.9	Uncalibrated WTP
Afroz and Masud (2011)	Malaysia	Asia	CVM	136.5	
Afroz et al. (2009)	Bangladesh	Asia	CVM	6.6	
Alhassan and Mohammed (2013)	Ghana	Africa	CVM	31.7	
Altaf and Deshazo (1996)	Pakistan	Asia	CVM	38.9	
Arekere (2004)	USA	North America	CVM	26.6	
Arekere (2004)	USA	North America	CVM	32.1	
Arekere (2004)	USA	North America	CVM	9.9	
Arekere (2004)	USA	North America	CVM	16.2	
Ayalon et al. (1999)	Israel	Middle East	CVM	47.4	
Banga et al. (2011)	Uganda	Africa	CVM	40.1	
Basili et al. (2008)	Italy	Europe	CVM	17.2	
Berglund (2006)	Sweden	Europe	CVM	47.6	
Blaine et al. (2005)	USA	North America	CVM	23.9	
Blaine et al. (2005)	USA	North America	CVM	15.6	
Bluffstone and DeShazo (2003)	Lithuania	Europe	CVM	19.2	Median value
Bohara et al. (2007)	USA	North America	CVM	57.2	
Caplan et al. (2002)	USA	North America	CR	61.0	
Caplan et al. (2002)	USA	North America	CR	85.4	
Ezebilo (2013)	Nigeria	Africa	CVM	75.4	
Ezebilo and Animasaun (2011)	Nigeria	Africa	CVM	96.3	

Study	Country	Region	Study	WTP/HH/ annum	Comments
Ferreira and Marques (2015)	Portugal	Europe	CVM	37.3	
Fonta et al. (2007)	Nigeria	Africa	CVM	91.5	
Geganzo and Guillermo (2013)	Philippines	Asia	CVM	26.0	
Gillespie and Bennett (2011a)	Australia	Oceania	CE	61.0	
Gillespie and Bennett (2011a)	Australia	Oceania	CE	69.5	
Gillespie and Bennett (2011b)	Australia	Oceania	CVM	16.3	
Gillespie and Bennett (2011b)	Australia	Oceania	CVM	15.0	
Hagos et al. (2012)	Ethiopia	Africa	CVM	29.8	
Hagos et al. (2012)	Ethiopia	Africa	CVM	19.7	
Jin et. al. (2006)	Macao	Asia	CVM	187.1	
Jin et. al. (2006)	Macao	Asia	CE	219.7	
Joel et al. (2012)	Kenya	Africa	CVM	78.4	
Karousakis and Birol (2008)	UK	Europe	CE	38.8	
Khattak et. al. (2009)	Pakistan	Asia	CVM	80.3	
Koford et al. (2012)	USA	North America	CVM	20.2	
Lake et al. (1996)	UK	Europe	CVM	59.8	
Murad (2007)	Malaysia	Asia	CVM	106.6	
Naz and Naz (2006)	Philippines	Asia	CE	25.5	
Othman (2001)	Malaysia	Asia	CVM	192.7	
Othman (2001)	Malaysia	Asia	CE	236.5	
Othman (2007)	Malaysia	Asia	CE	105.1	
Roy and Deb (2013)	India	Asia	CVM	5.0	
Sarkhel and Banerjee (2010)	India	Asia	CVM	13.9	
Tiller et al. (1997)	USA	North America	CVM	52.0	
Wang et al. (2014)	China	Asia	CVM	49.8	
Yuan and Yabe (2014)	China	Asia	CVM	19.9	

Study	Country	Region	Study	WTP/HH/ annum	Comments
Zen et al. (2014)	Malaysia	Asia	CVM	40.8	
Zhang et al. (2015)	China	Asia	CVM	4.3	

Notes: CVM: Contingent Valuation Method; CE: Choice Experiment; CR: Contingent Ranking; OE: Open-ended; DC: simple Dichotomous Choice; DCFU: Dichotomous Choice with follow-up question; DBDC: Double Bounded Dichotomous Choice; MBDC: Multiple Bounded Dichotomous Choice; PC: Payment Card; OI: Ordered Intervals

The mean annual WTP per household is 56.8 €$_{2014}$ (median: 38.9 €$_{2014}$, s.d.: 54.1 €$_{2014}$), ranging from 4.4 €$_{2014}$ up to 236.5 €$_{2014}$ (95% C.I. lower bound: 41.7 €$_{2014}$ and upper bound: 72.0 €$_{2014}$). A more conservative estimate (i.e. 5%-trimmed mean) is 50.6 €$_{2014}$.

The highest mean value is observed for Asian studies (83.1 €$_{2014}$), followed by Africa (57.8 €$_{2014}$) and Middle East (47.4 €$_{2014}$), for which there is only one observation. The values are significantly lower for developed regions, i.e. Europe (36.6 €$_{2014}$), North America (36.4 €$_{2014}$) and Oceania (40.4 €$_{2014}$). Nevertheless, differences are statistically insignificant, as proved by the Kruskal-Wallis test (χ^2=3.325, df=5, p=0.65). Furthermore, urban populations are more likely to pay higher amounts (mean: 66.1 €$_{2014}$) for improved SWM systems than those in rural or semi-rural areas (mean: 26.7 €$_{2014}$) (Mann-Whitney U=118.00, p=0.01). The mean WTP amount for an improvement in SWM is 78.3 €$_{2014}$, while it is almost the half for recycling, i.e. 36.1 €$_{2014}$ (Mann-Whitney U=208.00, p=0.027).

CV studies proved to be more conservative that CE and CR techniques. Specifically, CV studies resulted in a mean value of 47.5 €$_{2014}$, which was significantly lower (Mann-Whitney U=82.00, p=0.007) than that of the other techniques (mean=100.2 €$_{2014}$). Differences are also observed in the estimated values as regards the data collection techniques, with the highest mean value (i.e. 68.9 €$_{2014}$) being recorded for personal interviews. Nevertheless, the differences are statistically insignificant.

In addition to value transfers, several meta-regression models were examined using geographical, methodological and socioeconomic factors, after transforming nominal variables into dummy variables. The indicators that were finally included are not data demanding in order to keep the model as simple and practical as possible. Furthermore, following Shrestha and Loomis (2003), the meta-regression model retained only the variables significant at $p \leq 0.20$. The results are reported in Table 5.

Table 5: Estimated BT model using meta-regression analysis

Variable	b	Description
Constant	-1.106	
GNIpercapita	.003****	Gross National Income per capita PPP in USD$_{2014}$
ECONOMY	-99.478***	Study carried out in developed country (yes:1; no:0)
URBAN	35.521**	Study surveyed urban population (yes:1; no:0)
SCOPE	46.717**	Survey scenario (SWM improvement:1; Recycling:0)
Model statistics		
N	50	
Adj. R^2	0.489	

Note: dependent variable: annual HH WTP in USD$_{2014}$; **:p<0.10; ***:p<0.05 and ****:p<0.001

The sign and significance of the coefficients are consistent with expectations. To wit, *GNIpercapita*, *URBAN* and *SCOPE* variables reveal a positive sign consistent with the analysis of the transferred values. *ECONOMY* variable, finally, has a negative sign, indicating that studies being carried out at

developed countries result in more conservative estimates. This finding is sustained by the WTP-to-income ratios. More specifically, using the average household size per country, the Gross National Income (GNI) per capita converted to international USD_{2014} using purchasing power parity rates, and the adjusted WTP values per HH per year in USD_{2014}, it was estimated that households in Africa and Asia are willing to contribute 0.56% and 0.16% of their annual income, respectively for improved MSW management. In developed regions, i.e. Europe, North America and Oceania (actually Australia), WTP-to-income ratios range between 0.04% and 0.07. Provided that the Gross National Income (GNI) per capita is expressed in USD_{2014}, those interested in applying the model should convert final estimates at national currency, following Pattanayak et al. (2002) or Bateman et al. (2002).

4.3. Valuing the benefits of landfill mining

As mentioned, the review of environmental economics literature showed that only one study exists dedicated to monetizing the benefits of LFM. More specifically, Marella and Raga (2014) applied the CVM for the monetary assessment of the community-perceived benefits from the remediation of an old uncontrolled waste deposit by means of LFM and the conversion of the area into a park. The survey was carried out in Northern Italy close to a small town, on a random sample of people living near the old landfill and their WTP was examined. In total, 150 questionnaires were filled in via personal interviews, out of 174 submitted to the residents.

Two possible distinct future scenarios were presented to the respondents. According to the first scenario, LFM is carried out for the complete removal of the deposited waste and the underlying soil affected by leachates. In the second, the respondents are asked to assume that LFM is completed and the area is converted into a public park. As a result, the monetary value related to the increase in the collective well-being following the LFM was estimated. Subsequently, two different estimates of residents' WTP for the abovementioned interventions were elicited using the iterative bidding game technique.

Almost all of the respondents (91.3%) declared to be willing to pay for the LFM and the mean WTP was equal to approximately 196 €, similar to the findings of Sasao (2004), who reports a one-time WTP of approx. 200 USD (external costs associated with the sitting of a landfill for industrial waste). Regarding the creation of the park, the percentage of those who had declared their WTP fell slightly (87%) but the amount of WTP was, on average, approximately 200 €.

5. Application of the CVM in Polygyros LFM project

This section presents the results of the primary survey conducted by means of the CVM on a random national sample of Greek citizens. The aim of the survey is threefold:

- To determine what people believe about the existing MSW management practices and their behaviour and attitude towards recycling

- To understand people's beliefs about LFM and its perceived benefits
- To estimate people's support and their WTP for LFM projects

Moreover, the results of the survey will provide valuable input for the Social Cost Benefit Analysis that will be conducted in the context of the Project (Action B.9: Financial and socioeconomic analysis).

In the following sections, first the theoretical framework for the CVM analysis is provided, including a model for deriving WTP estimates, then the design of the survey is discussed and, finally the survey results used in this study are presented.

5.1. Theoretical model

The CVM relies on a direct questionnaire approach, asking a sample of individuals to state their hypothetical maximum willingness-to-pay (WTP) or their minimum willingness-to-accept (WTA). These values derive from the Hicksian welfare measures of the compensating variation (CoV) and the equivalent variation (EV). More specifically, WTP is the maximum amount an individual would pay to gain an environmental improvement (CoV) or to avoid an environmental deterioration (EV), while WTA is the minimum amount an individual would take as a compensation to accept an environmental deterioration (CoV) or to forgo an environmental improvement (EV). The two measures differ by the implied assignment of property rights (Champ et al., 2003). For instance, if the initial utility level (status quo) is the basis for comparison (i.e. the property rights is the status quo) and an environmental improvement is considered, the compensating welfare measure should be used. However, if the environmental improvement aims at restoring an environmental damage (i.e. the property rights corresponds to the final utility after the change) then the equivalent welfare measure should be used.

In the case studied, the maximum WTP is the change in income that makes an individual indifferent between the two situations, i.e. the original quality of the environment prior to implementing LFM program $\boldsymbol{q^0}$ with an income *y* and the improved quality of the environment due to LFM program $\boldsymbol{q^1}$ but income at *y-WTP*, according to the following indirect utility function:

$$V(\boldsymbol{p}, \boldsymbol{q}^0, y) = V(\boldsymbol{p}, \boldsymbol{q}^0, y\text{-}WTP)$$

The WTP of respondents in order to implement the LFM program is also defined with the following expenditure function:

$$WTP = e(\boldsymbol{p}, \boldsymbol{q}^0, U^0) - e(\boldsymbol{p}, \boldsymbol{q}^1, U^0)$$

where $\boldsymbol{p}$ is a vector of prices for marketed goods, $\boldsymbol{q^1}$and $\boldsymbol{q^0}$ represent the final (i.e. improved) and the initial (i.e. status quo) level of the environment, $\boldsymbol{U^0}$ is the reference utility level given by the indirect utility function $V(\boldsymbol{p}, \boldsymbol{q^0}, y)$ and *y* is the income. In other words, the individuals must spend more, remaining at utility level $\boldsymbol{U^0}$, in order to ensure that the environmental condition is improved.

5.2. Design of the study

In order to elicit the preferences of individuals for the implementation of a LFM program using the CVM, a questionnaire was designed. The initial questionnaire was tested via a pilot study to identify questions that could be misunderstood or any other potential problems that could lead to biased answers.

The final questionnaire (Appendix I) consisted of four main parts:

(a) A first set of three 'warm-up' questions investigating general beliefs of the respondent about environmental, social and economic issues.

(b) A set of four main questions and five follow-up questions aiming at identifying respondents' attitudes and beliefs relating to SWM (e.g. how often have they seen, heard, or read about SWM issues from internet, TV, radio, newspapers, etc.; how important is the issue of SWM in comparison with other environmental issues; how important are the environmental problems related to uncontrolled and controlled landfilling; do they recycle and why or why not, etc.).

(c) A set of questions concerning the main purpose of the survey, i.e. people's support and their WTP for LFM projects. This part begins with a simplified description of the landfilling problem and the concept of LFM. Then three questions follow that investigate respondents' opinion using a five-point Likert scale about the LFM benefits with respect to: resource and energy conservation; prevention and reduction of environmental pollution and nuisance; and conservation of landfill space and avoidance of new landfills. Following, in order to investigate public support for LFM projects, respondents were asked to state which the following sentences best reflects their thinking:

- "I feel that there should be a LFM program, and I feel some responsibility for paying for it"
- "I feel that there should be a LFM program, but I do not really feel that it is my responsibility to pay for it"
- "I don't think there should be a LFM program"

In the last questions of this part, survey participants were asked to express their WTP for a policy measure that would establish a LFM program. In order to develop a realistic WTP scenario, respondents were told that in the case that if the LFM plan was adopted, it would cost money. Assuming that economic activities that generate municipal waste, such as restaurants, would pay the cost that corresponds to them, citizens would be also asked to financially contribute to this plan. Respondents were informed that in this case ALL households would pay an additional amount of money through higher municipality taxes and they were asked to state what, in their opinion, would be a reasonable MAXIMUM

surcharge on their municipal tax. The elicitation question was asked in an open ended (OE) format.

It should be mentioned that collective payment was preferred to voluntary contribution in order to discourage "free riding" and strategic behavior, which is usual in voluntary payments (Damigos et al., 2009). Within the CV literature, the "free riding" concept has been used to explain why hypothetical contributions are often well above than actual ones (e.g. Hanemann, 1996; Carson, 1997). As far as the strategic bias is concerned, Carson (1997) and Carson & Groves (2007) argue that respondents may answer strategically and may overstate their WTP when presented with a voluntary payment scenario. However, relatively few surveys have been undertaken to systematically explore the sensitivity of WTP under collective and voluntary payment vehicles (e.g. Champ et al., 2002; Wiser, 2007).

Compulsory payment mechanism was also used as a means to reduce hypothetical bias (i.e. the difference between what a person indicates they would pay in the survey or interview and what a person would actually pay) (Loomis, 2014). Towards the same direction, a "cheap talk" script was used informing respondents that participants in past surveys have been shown to overstate their WTP. A "cheap talk" script describing and discussing hypothetical bias as an integral part of the CV questionnaire was introduced by Cummings and Taylor (1999), who found that this approach was successful in the lab. Similarly, other researchers (e.g. List, 2001; Landry and List, 2007; Champ et al., 2009) have found that "cheap talk" is primarily effective especially for respondents unfamiliar with the good under investigation. Nevertheless, other studies have had less success (Loomis, 2014). The script used in this study was, as follows:

> *"I want to talk to you about a problem that we have in studies like this one. In most studies of this kind, where they don't really have to pay money, respondents state different WTP amounts than they would in a real situation. This difference in the way people respond to hypothetical situations as compared to real situations is called "hypothetical bias".*
>
> *So, please before you make your decision, I would like you to consider that you must fulfill other needs in your life, for example housing expenses, entertainment, clothing, etc. and to ask yourself: "if this was a real situation, would I really want to pay this money?" and state the amount you would ACTUALLY pay"*

Finally, there were two follow-up questions, one for those respondents with a positive and one for those with a negative answer to the WTP question.

Those who agreed to pay were asked to identify the fraction of their bid: (a) for ensuring a better environment for themselves and their households (use value); (b) for ensuring a better environment for other households (non-use altruistic value); (c) for ensuring a better environment for future generations (non-use bequest value); and (d) for protecting the ecosystems affected by landfilling (non-use existence value).

Those who refused to support the LFM program were asked the reason of their denial, in an attempt to separate 'protest' and 'true zeros' (e.g. Halstead et al., 1992; Jorgensen et al., 1999; Strazzera et al., 2003; Meyerhoff & Liebe, 2008).

(d) A set of typical demographic notes, e.g., annual income, gender, age, family status, employment status, education, etc.

5.3. Summary of survey data

The survey was carried out between April and July 2015 using a national sample of 392 Greek households. Questionnaires were collected by telephone survey and the response rate was around 40%. Respondents were selected on a random basis from a phone number database including around 6.5 million records. The phone interviews were being conducted at different parts of the day to ensure a cross section of participants. In addition, during data collection response rates were closely monitored on the basis of age, gender and socioeconomic group quotas. Given the described probability sampling procedure, the sample is considered to be representative of the population. However, small deviations between census data and sample demographics may be mentioned. The demographic characteristics of the sample are given in Table 6.

Table 6: Sample demographics

Variable	Cases	Relative Frequency
Gender	Women	52%
	Men	48%
Age	Between 18 and 29	8.2%
	Between 30 and 39	14.3%
	Between 40 and 49	23.0%
	Between 50 and 59	23.8%
	Between 60 and 69	18.2%
	More than 70	12.5%
Marital status	Married	68.3%
	Not married	17.4%
	Living with another	3.3%
	Divorced/Widowers	11.0%
Household members	1	10.7%
	2	32.0%
	3	19.9%
	4	29.7%
	Over 4	7.7%

Variable	Cases	Relative Frequency
Education	No education	0.5%
	Primary school	7.2%
	Secondary School	6.4%
	High school	24.9%
	Technical High school	7.4%
	College degree (2 years)	5.4%
	Bachelor's degree (3 years or more)	37.7%
	Master's degree	8.2%
	Doctorate degree	2.3%
Employment status	Employed for wages (full- & part-time)	25.1%
	Self-employed	22.0%
	Unemployed	11.8%
	Pensioners	28.9%
	Students	2.8%
	Housekeepers	9.5%
Income	Less than 10,000€	20.3%
	10,000 to 19,999€	37.7%
	20,000 to 29,999€	23.6%
	30,000 to 39,999€	11.5%
	40,000 to 49,999€	2.8%
	More than 50,000€	4.1%

Approximately 45% of the respondents state that the most important problem that they face is unemployment (Polygyros Municipality: 70%), followed by the poor economy (16%; Polygyros Municipality: 22%), the poor health system (12.1%) and the environmental pollution (9.5%). As regards the environment in their area, around 49% declare that they are somewhat or very dissatisfied, 41% declare that they are somewhat satisfied and the rest declare that they are very satisfied. Contrary to the findings of Polygyros Municipality survey, 48.6% of the respondents believe that the protection of the environment should not be sacrificed in order to save jobs (Polygyros Municipality: 22.7%), 21.2% of the respondents consider job creation more important than the preservation of the environment (Polygyros Municipality: 67.5%) and around 30% neither agree nor disagree with any of these claims (Polygyros Municipality: 10%).

About 51% of the respondents state that they have seen, heard, or read about solid waste management (SWM) issues from internet, TV, radio, newspapers, magazines, information meetings or friendly conversations a few times and 35% many times, while 15% of them have never heard anything about those issues. The abovementioned findings show that the national sample seems to be more informed than the local sample of Polygyros Municipality.

In comparison with other environmental issues in their area, SWM are of equal importance for 43.2% of the respondents (Polygyros Municipality: 88.8%) and 48.8% believe that SWM issues are more

important (Polygyros Municipality: 4.4%). Finally, around 7% of the respondents believe that SWM issues are less important than other environmental problems.

Respondents seem to be well-informed about the risks of uncontrolled landfilling provided that almost all (i.e. more than 98%) state that the specific waste disposal practice is associated with major and/or significant problems. Furthermore, almost four-fifth of them (i.e. 85.7%) believe that controlled landfills create less significant problems than the uncontrolled ones, while the rest say that the problems are of equal importance. As regards the significance of the problems of waste disposal, more than 30% of the respondents recognize water pollution as the most important issue (Polygyros Municipality: 70%), followed by soil pollution (15%; Polygyros Municipality: 9%), air pollution (3.6%; Polygyros Municipality: 6%), odour (6.1%) and reduction in surrounding property values (2%). These findings also present remarkable differences when compared to the beliefs of Polygyros Municipality's residents.

More than 85% of the participants said that they participate at recycling programs (Polygyros Municipality: more than 95%). As far as the motivations are concerned, significant differences between the national and the local sample are observed. More specifically, protection of the environment is the most favourable option (66.8%) for the national sample, followed by far by resource conservation (10.2%). Furthermore, 4.5% of the respondents participate in order to save money, 4% because recycling creates social benefits and 2% because landfill space is conserved. Among those respondents who participate in recycling programs, almost 94% declare that they recycle packaging waste, 87% recycle paper, 22% recycle batteries and 17% recycle electrical and electronic waste.

As mentioned, respondents were, first, told about the LFM concept and, then, they were asked to evaluate the importance of LFM according to their opinion focusing on three fields: resource and energy conservation; prevention and reduction of environmental pollution and nuisance; and conservation of landfill space and avoidance of new landfills. The responses coincide with those of the local sample, indicating that the resource and energy conservation is the most important benefit to the participants followed by the prevention and reduction of environmental pollution and nuisance, and the conservation of landfill space and avoidance of new landfills. More specifically:

- about 61% of the respondents characterize the benefits of resource and energy conservation as 'very important' and 33% as 'moderate important'
- about 58% of the respondents characterize the benefits of prevention and reduction of environmental pollution and nuisance as 'very important' and 30% as 'moderate important'
- about 55% of the respondents characterize the benefits of conservation of landfill space as 'very important' and 36% as 'moderate important'

Concerning the support for the LFM concept, more than 96% of the respondents feel that there should be a LFM program. Furthermore, 47.3% said that they feel some responsibility for paying for it (Polygyros Municipality: 18.2%), and 49.1% said that they don't feel that it is their responsibility to pay for it (Polygyros Municipality: 77.3%). The differences in respondents' attitude towards their

responsibility to pay for LFM programs between the local and the national sample are consistent with the differences noticed in the responses given in the social part of the surveys. To wit, unemployment is declared as the most important problem from 45% of the national sample and from 70% of the local sample, respectively. Moreover, 21.2% of the respondents f the national sample consider job creation more important than the preservation of the environment, whereas in Polygyros Municipality 67.5% of the respondents hold this opinion.

5.4. Willingness-To-Pay for LFM

All the respondents were required to answer the question and state their maximum WTP amount provided that the payment mechanism was compulsory. About 32% of the respondents were unwilling to pay anything (Polygyros Municipality: 76% zero responses). According to the answers given to the follow-up question, which explored the cause of denial, the reason of 27.6% of those who refused to pay is that they couldn't afford it due to low income (Polygyros Municipality: 51%). Around 70% of the 'zero answers' were protest bids. The prevailing reasons were that 'I already pay enough municipal/income taxes' (38%), 'the government/local authorities should be responsible for the plan' (10%) and 'other economic activities should pay for the plan' (5%).

The rest of the respondents (68%) offered more than 1 € up to 500 € per year in increased municipal taxes for supporting a LFM program. Nevertheless, WTP values over 300€ were excluded from the analysis as outliers. According to Dalmau-Matarrodona & Puig-Junoy (2001), outliers are "*either low income respondents who gave WTP amounts representing an implausibly large percentage of their income, or upper-income respondents who gave a very low WTP, although their answers to other questions indicated strong demand for the good*". Following Tentes and Damigos (2012), outlier analysis was based on a two-step approach: first, analysis of bids versus income was conducted and a new variable was constructed assuming that bids should not exceed a certain fraction of income, i.e. WTP cannot exceed ability-to-pay (Bateman et al. 2002) and, then, simple statistical definition of outliers was based on this new variable, using box-plots and histograms. The analysis showed that 5 bids over 300 €, resulted in WTP-to-Income ratios from 2% to more than 5%, which were irrationally high compared to the rest of the sample. All the remaining amounts correspond to less than 2% of respondent's income (actually, 98% correspond to less than 1% of the respondent's income).

On average, respondents offer 21.4% of their WTP amount for ensuring a better environment for their household (use value); 11.5% for ensuring a better environment for other households (non-use altruistic value); 40.1% for ensuring a better environment for future generations (non-use bequest value); and, finally, 27.0% for protecting the ecosystems affected by landfilling (non-use existence value). In total, the estimated non-use value is almost 80% of TEV.

5.4.1. Non parametric estimation of WTP

Non-parametric estimation of the distribution of WTP was achieved through the Kaplan-Meier product limit estimator, which is an empirical approach to estimating the survivor function of WTP

responses (Bateman et al., 2002). The median value is calculated to the point at which the survivor function reaches a probability of 0.5. and the mean WTP value is calculated by the following equation:

$$\overline{C} = \sum_{j=0}^{J} \hat{S}(C_j) \cdot [C_{j+1} - C_j] \quad \text{(Eq. 1)}$$

Where:

$\bar{C}$= the mean WTP value

C_j = the ordered WTP values from lowest to highest. C_0 is equal to zero and C_J is the largest WTP value in the sample

$\hat{S}(C_j)$ = the empirical estimate of the survivor function at each of the C_j

The mean and median of the positive WTP values (i.e. excluding zero responses), together with the 95% confidence intervals and the standard error are given in Table 7, and the 'survival' function is illustrated in Fig. 3. The mean WTP for the whole sample (i.e. including zeros) is equal to 46.1 € (95% C.I. 40.7 – 51.5) per household per year and the median value is 30 €.

Table 7: Kaplan-Meier mean and median WTP estimates (excluding zeros)

Mean				**Median**			
		95% Confidence Interval				95% Confidence Interval	
Estimate	Std. Error	Lower Bound	Upper Bound	Estimate	Std. Error	Lower Bound	Upper Bound
68.2	3.28	61.8	74.6	50.0	1.184	47.7	52.3

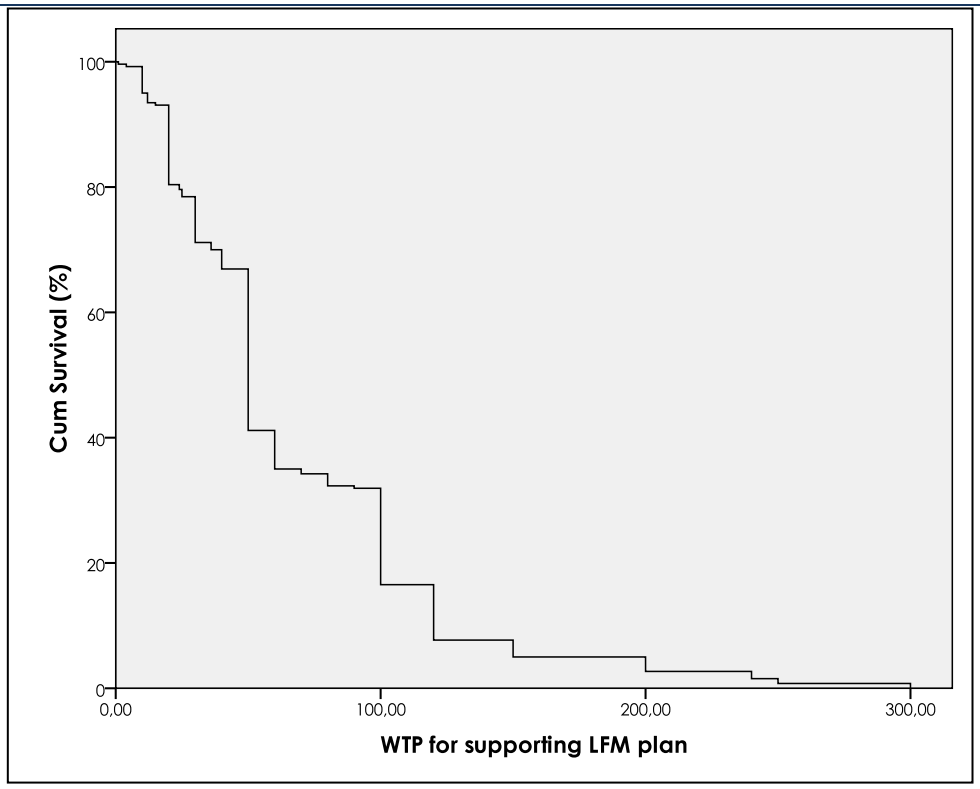

Figure 3: Kaplan-Meier survivor function for stated WTP bids

5.4.2. Parametric estimation of WTP without covariates

In order to identify the role of the zero-bids to the WTP distribution either a probability p to zero (a 'spike') should be assigned or, alternatively, zero-bids should be modeled (Bateman et al., 2002). In this analysis, the parametric estimation of WTP values followed the method proposed by Reiser & Shechter (1999), which is an extended spike model approach introduced by Kriström (1997). More specifically, a mixture model is used implying that the population of interest can be considered to be composed of two sub-populations: one sub-population is not willing to pay at all for the good in question, while the other sub-population is willing to pay and has a continuous WTP distribution.

Considering WTP answers without involving covariate information, let p indicate the probability that an individual chosen at random has WTP = 0 and let F(x), x>0 symbolize the continuous cumulative distribution function (cdf) for the sub-population willing to pay. The cdf for an open-ended response w is, as follows:

$$P(WTP < w) = \begin{Bmatrix} 0 & w < 0 \\ p & w = 0 \\ p + (1-p)F(w) & w > 0 \end{Bmatrix} \quad \text{(Eq. 2)}$$

For an observed random sample of n individuals, δ_i = 1, if the i-th individual's observed WTP is zero and 0 otherwise (i.e. w_i>0). The likelihood function can be written as proportional to:

$$\prod_{i=1}^{n} p^{\delta_i}[(1-p)f(w_i)]^{1-\delta_i} = \prod_{i=1}^{n} p^{\delta_i}(1-p)^{1-\delta_i}\prod_{w_i>0} f(w_i) \quad \text{(Eq. 3)}$$

where *f* is obtained as the derivative of F and $\Pi_{wi>0}$ represents the product taken over all individuals with observed WTP>0.

Reiser and Shechter's method suggests breaking up the likelihood function into two separate parts, which can be maximized separately to provide maximum likelihood estimates of the unknown parameters, i.e.

$$\prod_{i=1}^{n} p^{\delta_i}(1-p)^{1-\delta_i} \quad \text{(Eq. 4)}$$

and

$$\prod_{w_i>0} f(w_i) \quad \text{(Eq. 5)}$$

Maximizing Eq. 4 it comes out that $\hat{p} = \frac{\sum \delta_i}{n}$, which is the percentage of the observed zero answers provided by the participants.

In order to maximize Eq. 5, an appropriate distribution for F should be selected (e.g. lognormal, Weibull, etc.). In the case studied, it was found that positive WTP values follow the lognormal distribution, with:

$$F(z) = \Phi\left(\frac{logz-\mu}{\sigma}\right) \text{ and } \Phi(t) = \int_{-\infty}^{t} \frac{1}{\sqrt{2\pi}} e^{-u^2/2}\, du \quad \text{(Eq. 6)}$$

From Eq. 2 and Eq. 6, the mean and median WTP values can be estimated, as follows (Bateman et al. 2002):

$$mean = (1-p)e^{\mu+\sigma^2/2} \quad \text{(Eq. 7) and} \quad median = \begin{cases} (1-p)e^{\mu}, p < \frac{1}{2} \\ 0, \quad p \geq \frac{1}{2} \end{cases} \quad \text{(Eq. 8)}$$

By MLE, μ and σ were calculated to 3.9297, and 0.81716 respectively, and then by substituting the estimated p (which was found equal to 32%), μ and σ to Eq. 7 and Eq. 8, the mean and median WTP values are found equal to 48.3 and 35, respectively.

5.4.3. Parametric estimation with WTP determinants

In order to model WTP answers and WTP bids and connect them to census and opinion variable that are supposed to have an influence on them, the model of Reiser & Shechter (1999) described in Section 4.4.2 was implemented using information variables that could affect the parameters in the distribution F and p.

Introducing the subscript i on p, F (and f), the first part of the likelihood function (Eq. 4) can be estimated using a logistic regression (logit) model calibrated to interpret the response to the binary WTP question according to census and opinion variables, while the second part of the likelihood function (Eq. 5) consists of optimizing the cumulative distribution function F (and f) of the sub-population that is willing to pay anything. In this case, a general empirical linear regression model based on a lognormal bid function was used.

As regards the WTP binary question, the analysis aimed at exploring the influence of respondent's beliefs and demographic characteristics. The results of the logistic regression model are illustrated in the following Table 8.

Table 8: Binary logistic model results

Variable	b	Description of variables
SWM_ENV	.354**	*Importance of SWM issues to other environmental problems*
LFM_BEN_RES	.388**	*LFM benefits to resource and energy conservation*
LFM_BEN_ENV	.257*	*LFM benefits to environment and nuisance*
LMF_PAY	1.877***	*Support LFM and responsible to pay*
GENDER	.507**	*Gender*
INCOME	.155*	*Total household income*
Constant	-4.462***	
n = 283, -2LL=198.554, Cox & Snell R^2=37.4%, Nagelkerke R^2=54.3%		

*: Significant at 90% level, **: Significant at 95% level, ***: Significant at 99% level

The logit model results are consistent with the anticipated signs of coefficients. More explicitly, bid probability depends on respondents beliefs about the importance of SWM issues in their area in comparison with other environmental problems (as the importance of SWM issues increases the willingness to financially support LFM program increases, as well), the benefits anticipated by the LFM program on resource and energy conservation and on the prevention and reduction of environmental pollution and nuisance (respondents who believe that LFM programs create significant benefits are more likely to place a positive bid), the responsibility that respondents feel about the support of LFM programs (respondents who feel responsible to pay for LFM programs are more likely to place a positive bid), the gender of the respondent (women are more likely to support LFM programs than men), and the income of the household (people with higher income are more likely to place a positive bid).

The bid function used (Bateman et al. 2002) was based on lognormal empirical regression model considering only positive WTP values, as follows:

$$ln(WTP) = f(x_i, \beta, \sigma, \varepsilon_i)$$

where:

x_i is a vector of the selected explanatory variables of respondent *i*, β is the estimated coefficient of corresponding explanatory variables, σ is a variance parameter, and ε_i is a random error component with mean zero.

The statistically significant explanatory variables and the respective coefficients are presented in Table 9.

Table 9: Bid function model results

Variable	b	Description of variables
Constant	3.411***	
LFM_BEN_ENV	.126**	*LFM benefits to environment and nuisance*
RECYCLE_RES	.347**	*Recycle for resource conservation*
LMF_PAY	.162*	*Support LFM and responsible to pay*
HHMEMBERS	-.105**	*Number of household members*
INCOME	1.237E-5***	*Total household income (in €)*
n=74, Adj. R^2=33.2%		

*: Significant at 90% level, **: Significant at 95% level, ***: Significant at 99% level

The coefficients have the excepted sign, indicating model credibility. More specifically, the positive sign in INF_FREQ, HHMEMBERS_U18 and INCOME implies that the respondents, who are more informed (i.e. read or hear more often about SWM issues), have children and higher household income, are willing to pay more for supporting LFM programs.

The average WTP per household per month given that zero bids predicted by the binary model account for 26.7% (=p) of the responses, equals to 51.3 € and the median WTP to 37.5 €, respectively.

6. Conclusions

This report summarizes the results of a national survey conducted by means of the CV method, in order to estimate Greek society's willingness to pay for LFM projects.

According to the main findings of the study, more than 96% of the respondents feel that there should be a LFM program, and 47.3% said that they also feel that it is their responsibility to pay for it.

Focusing on the benefits of LFM, the responses indicate that:

- about 61% of the respondents characterize the benefits of resource and energy conservation as 'very important' and 33% as 'moderate important'
- about 58% of the respondents characterize the benefits of prevention and reduction of environmental pollution and nuisance as 'very important' and 30% as 'moderate important'
- about 55% of the respondents characterize the benefits of conservation of landfill space as 'very important' and 36% as 'moderate important'

Concerning the financial support for LFM programs, the elicited value was zero for 32% of the respondents. According to the answers given to the follow-up question, 27.6% of those who refused to pay anything said that they couldn't afford it due to low income (Polygyros Municipality: 51%). Around 70% of the 'zero answers' were protest bids.

Significant disparities in respondents' attitude towards WTP for LFM programs were found between the local and the national samples. Nevertheless, these differences are consistent with the differences noticed in the responses given in the social part of the surveys as regards the prioritization of the problems, the unemployment rates, etc.

The mean annual WTP (considering the parametric and non-parametric estimation methods) is of the order of 50 € per household. This amount is comparable with the lump-sum payment of 196 € of Marella and Raga (2014) assuming a social discount rate of 3% and a 5-year period of payments.

The findings of this research will provide a useful input for estimating the external benefits of LFM towards conducting a Social Cost Benefit Analysis. Yet, further research is necessary into these issues provided that only one similar study has been conducted.

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APPENDIX I:

CVM QUESTIONNAIRE

Landfill mining pilot application for recovery of invaluable metals, materials, land and

NTUA School of Mining & Metallurgical Engineering

Municipality of Polygyros

ENVECO S.A. ENVIRONMENTAL PROTECTION MANAGEMENT & ECONOMICS

HELECTOR

INTRODUCTION

Dear Sir/Madam, please allow me to introduce myself.

My name is ……..

I am a member of a research team of the National Technical University of Athens (NTUA). We conduct a survey on municipal solid waste management issues and we're interested in finding out what people know and believe about these issues.

Please take the time to answer the questionnaire as thoroughly as possible because your input is very important to us. There are no right or wrong answers. We want you to tell us your honest feelings and ideas about the issues we discuss, so please choose the responses that best describe your opinion. We will use your answers to determine where to focus future efforts towards better SWM practices.

You were selected for this survey randomly. Please be aware that data or comments obtained in this survey are confidential and will be used for statistical purposes only. They will not be attributed to particular individuals.

The interview will take about 15 minutes to complete. May I proceed with the questions?

If **no**, end interview by saying "Sorry to have bothered you."

If **yes**, proceed with questionnaire by saying "Thank you in advance for your participation".

A. Environmental, social and economic Issues

1. In your opinion, which three of the problems below are the most important for state and local governments to solve in your area? (The question is open-ended – Please write a "1" next to the most important, a "2" next to the second most important and a "3" to the third most important).

   a. Unemployment_____
   b. Poor economy_____
   c. Crime_____
   d. Environmental pollution_____
   e. The quality of the public schools_____
   f. The quality of public health system_____
   g. Traffic congestion_____
   h. Other (please specify)_____

2. How satisfied are you with the status of the environmental setting in your area?

   a. Very satisfied_____
   b. Somewhat satisfied_____
   c. Somewhat dissatisfied_____
   d. Very dissatisfied_____
   e. Not sure/No opinion_____

3. Which of the following statements most closely reflects your opinion?

   a. Creating and protecting jobs is more important than preserving the environment_____
   b. Protection of the environment should not be sacrificed to save jobs_____
   c. I am not sure_____

B. Solid waste management issues

4. About how often have you seen, heard, or read about solid waste management issues from TV, radio, newspapers, internet or friendly conversations?

   a. Never_____
   b. A few times_____
   c. Many times_____

Please specify what have you seen, heard, or read

_____

_____

_____

5. In your opinion, how important are solid waste management issues compared with other environmental issues in your area?

   a. Not important_____
   b. Less important_____
   c. Equally important_____
   d. Very Important_____
   e. Do not know _____

6. In your opinion, how important are the problems related to uncontrolled waste dumping?

   a. Not important/Slightly important _____
   b. Moderately important_____
   c. Important_____
   d. Do not know_____

6A. In your opinion, are the problems generated by controlled landfills, in comparison with the problems generated by uncontrolled landfills:

   a. Less Important_____
   b. Equally important_____
   c. More important_____

6B. In your opinion, which are the three most important problems related to landfilling, in a significance ranking? (The question is open-ended - Please write a "1" next to the first problem mentioned, a "2" next to the second and a "3" to the third problem).

   a. Air pollution_____
   b. Surface- and groundwater pollution_____
   c. Soil pollution_____
   d. Sea pollution_____
   e. Deforestation_____
   f. Loss of biodiversity _____
   g. Global warming_____
   h. Overexploitation of natural resources_____
   i. Odors_____
   j. Reduction in land and property values in the adjacent area_____
   k. Other (please specify) _____

7. Do you or/and other members of your household recycle wastes and other products?
   a. Yes_____ (Proceed to Ques. 7A and 7B)
   b. No_____ (Proceed to Ques. 7C)

7A. What kind of products do you recycle? (Only for those answered "yes" in question 7 - The question is open-ended. Please check all that apply)

a. Packaging waste (aluminium, plastic and other) _____
b. Paper _____
c. Batteries_____
d. Electrical/electronic appliances _____
e. Other (please specify)_____

7B. What factor(s) best describes why you recycle? (Only for those answered "yes" in question 7 - The question is open-ended. Please check all that apply)

a. Environmental protection (not specified)_____
b. Natural resources conservation_____
c. Energy saving _____
d. Money saving_____
e. Increase of the available landfill space_____
f. Social benefits (not specified)_____
g. Benefits for future generations (not specified)_____
h. Other (please specify)_____

7C. What factor(s) best describes why you do not recycle? (Only for those answered "no" in question 7 – The question is open-ended. Please check all that apply)

a. No recycling scheme in my area_____
b. Takes too much time & effort_____
c. No financial benefit_____
d. No benefit at all____
e. No recycle bin near my house____
f. Nobody I know recycles_____
g. Other (please specify)_____

C. Potential implementation of a landfill mining project

Greece follows the European Commission's policy with regard to the municipal solid waste management. This policy suggests increasing the recycling/reuse target for municipal waste and packaging waste, as well as phasing out landfilling by 2025 for recoverable municipal waste, such as plastic, paper, metals, glass and organic materials. Regardless of these targets, however, there are hundreds of uncontrolled and controlled

landfills today in Greece and in many other countries around the World, either operating or closed. The wastes disposed of on these sites contain useful materials such as paper, plastic, metals, soils, etc. In addition some of these sites may be a source of contamination for the environment, may cause nuisance to the residents of the adjacent areas and may occupy valuable land that could be utilized for other development purposes.

Landfill mining is the process of excavating the wastes from solid waste landfills and sorting the useful materials, which can be then recycled or be used for energy generation. In addition, old uncontrolled landfills can be rehabilitated, while in operating landfills valuable space can be recovered, which means that the environment is being protected, since the need for new landfills and, thus, the occupation of new land, is restricted. Taking into consideration all the above:

8. How important to you are the benefits that will be achieved from:

A. Resource and energy conservation?

a. Not important_____
b. Slightly important_____
c. Moderately important_____
d. Very important_____
e. Do not know_____

B. Decreased pollution and nuisance associated with less landfilling?

a. Not important_____
b. Slightly important_____
c. Moderately important_____
d. Very important_____
e. Do not know_____

C. Extending the life of operating landfills and restricting the need to create new landfills?

a. Not important_____
b. Slightly important_____
c. Moderately important_____
d. Very important_____
e. Do not know_____

9. Which of the following best reflects your thinking?

   a. I believe that there should be a LFM plan and I feel some responsibility for paying for it_____
   b. I believe that there should be a LFM plan but I do not really feel that it is my responsibility to pay for it_____
   c. I don't believe that a LFM plan is necessary_____

10. If a plan for LFM was to be implemented in landfills and uncontrolled waste dumps, it would cost money. In this case all the economic activities that produce wastes, such as shops, restaurants, industries, etc., would pay for the waste they generate. Households would also be asked to financially contribute to this plan, since they produce a significant amount of waste.
    In your opinion, which should be the MAXIMUM amount that EACH household should be obliged to pay per year for this purpose through municipal taxes?
    Before you answer the question, I want to talk to you about a problem that we have in studies like this one. In most studies of this kind, where they don't really have to pay money, respondents state different WTP amounts than they would in a real situation. This difference in the way people respond to hypothetical situations as compared to real situations is called "hypothetical bias".
    So, please before you make your decision, I would like you to consider that you must fulfill other needs in your life, for example housing expenses, entertainment, clothing, etc. and to ask yourself: if "this was a real situation, would I really want to pay this money" and state the amount you would ACTUALLY pay.

    Amount: €_____ per household per year

[For those who declined to contribute]

11. Why did you vote against the plan? (Do not prompt)

    a. I cannot afford it_____
    b. I don't care much about landfill mining_____
    c. The proposed plan is not feasible, convincing, etc._____
    d. I do not believe that the benefits from such a plan are important_____
    e. I am satisfied with the existing situation_____
    f. It is the government's/ local authorities' responsibility_____
    g. It is industries' and other economic activities' responsibility_____
    h. I already pay enough municipal/income taxes_____
    i. Other (please specify) _____

[For those who accepted to contribute]

12. Could you please tell me what part of …… [WTP amount], is just for:
[Read all options before allowing response]

    a. Ensuring a better environment for you and your household members_____(amount)
    b. Ensuring a better environment for other households _____(amount)
    c. Ensuring a better environment for future generations _____(amount)
    d. Protecting the ecosystems affected by landfilling _____(amount)

[If respondent's total is less than 100%, or the total amount differs from the WTP amount then ask:]

Your response totals to _____. Would you like to change your response, or is there some other reason you were considering?

Other reason (specify)_____

[Be sure these sum to 100%]

D. Demographic notes

D1. Gender

Female	☐
Male	☐

D2. Age

What is your age?

18-29 years old	☐	50-59 years old	☐
30-39 years old	☐	60-69 years old	☐
40-49 years old	☐	70 years or older	☐

D3. Permanent residence

In what area do you live?

_____

D4. Marital status

What is your marital status?

Single	☐	Widowed	☐
Married	☐	Divorced	☐
Living with another	☐	Separated	☐

D5. Size of household

How many people live in your household?

Under 18 years old	☐
Over 18 years old	☐

D6. Education

What is the highest degree or level of school you have completed?

No schooling completed	☐
Elementary	☐
Middle school graduate	☐
High school graduate, diploma or the equivalent	☐
Trade/technical/vocational training	☐
College degree (2 years)	☐
Bachelor's degree (3 years or more)	☐
Master's degree	☐
Doctorate degree	☐

D7. Employment status

What is your employment status?

Employed for wages, full-time	☐
Employed for wages, part-time	☐
Self-employed	☐
Unemployed and seeking work	☐
Unemployed but not seeking work at the present time	☐
Student	☐
Full-time homemaker	☐
Retired	☐

What is your occupation (job)?_____?

D8. Household income

What was your total household income received by the adult members of your household last year from all sources (before taxes)?

Less than €10,000	☐	€50,000 - 59,999	☐
€10,000 - 19,999	☐	€60,000 - 69,999	☐
€20,000 - 29,999	☐	€70,000 - 79,999	☐
€30,000 - 39,999	☐	€80,000 - 89,999	☐
€40,000 - 49,999	☐	More than €90,000	☐

For the Interviewer only:

A. Was the person who answered the questions focused during the interview?

Yes	☐
No	☐

B. Do you think the respondent made an effort to tell the truth about the willingness-to-pay questions?

Yes	☐
No	☐

C. How would you rate the overall quality of the interview?

Good	☐
Fair	☐
Poor	☐