



LIFE12 ENV/GR/000427 LIFE reclaim "Landfill mining pilot application for recovery of invaluable metals, materials, land and energy"

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

SUBJECT:

**TECHNICAL REPORT
FOR THE LOCAL SURVEY**



Municipality
of Polygyros



NTUA
School of
Mining &
Metallurgical
Engineering

With the contribution of the LIFE financial instrument of the European Union

ATHENS, SEPTEMBER 2015

Contents

| | |
|--|----|
| 1. Executive Summary | 2 |
| 2. Introduction | 4 |
| 3. Valuing the benefits of proper waste management | 5 |
| 3.1. Valuation of non-market goods and services | 5 |
| 3.2. Valuation approaches | 7 |
| 4. Literature review | 13 |
| 4.1. Valuing externalities of landfilling | 13 |
| 4.2. Valuing the benefits of improved waste management practices | 16 |
| 4.3. Valuing the benefits of landfill mining | 25 |
| 5. Application of the CVM in Polygyros LFM project | 25 |
| 5.1. Theoretical model | 26 |
| 5.2. Design of the study | 27 |
| 5.3. Summary of survey data | 29 |
| 5.4. Willingness-To-Pay for LFM | 31 |
| 5.4.1. Non parametric estimation of WTP | 32 |
| 5.4.2. Parametric estimation of WTP without covariates | 33 |
| 5.4.3. Parametric estimation with WTP determinants | 35 |
| 6. Conclusions | 37 |
| References | 38 |

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 survey conducted in Polygyros area by means of a stated-preference valuation method, namely the Contingent Valuation, in order to estimate society's willingness to pay (WTP) for LFM projects. The survey was carried out between April and June 2015 involving residents of the Polygyros municipality. In total 286 completed questionnaires were collected and the response rate was around 70%. According to the main findings of the study, more than 95% of the respondents feel that there should be a LFM program. However, 77.3% said that they don't feel that it is their responsibility to pay for it. The respondents' attitude towards their financial responsibility is associated primarily with the current economic situation in Greece. To wit, 95% of the respondents declare annual household income lower than 30,000€ and three-fourths of the respondents lower than 20,000€. Moreover, issues related to the economic situation (i.e. unemployment and poor economy) are mentioned as the most important problem by more than 85% of the respondents.

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

- about two-thirds of the respondents characterize the benefits of resource and energy conservation as 'very important' and 26% as 'moderate important'
- about 21% of the respondents characterize the benefits of prevention and reduction of environmental pollution and nuisance as 'very important' and 69.2% as 'moderate important'
- about 22.4% of the respondents characterize the benefits of conservation of landfill space as 'very important' and 44.8% as 'moderate important'

Concerning the financial support for LFM programs, the elicited value was zero for 76% of the respondents. According to the answers given to the follow-up question, 51% of those who refused to pay said that they couldn't afford it due to low income. This finding indicates that society's WTP for LFM programs could be much higher under different economic conditions.

The mean annual WTP (considering the parametric and non-parametric estimation methods) is estimated at around 12 € 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 20-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 in Polygyros area by means of a stated-preference valuation method, namely the Contingent Valuation, in order to estimate society's willingness to pay for LFM projects. The rest of the report is structured, 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 Polygyros 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

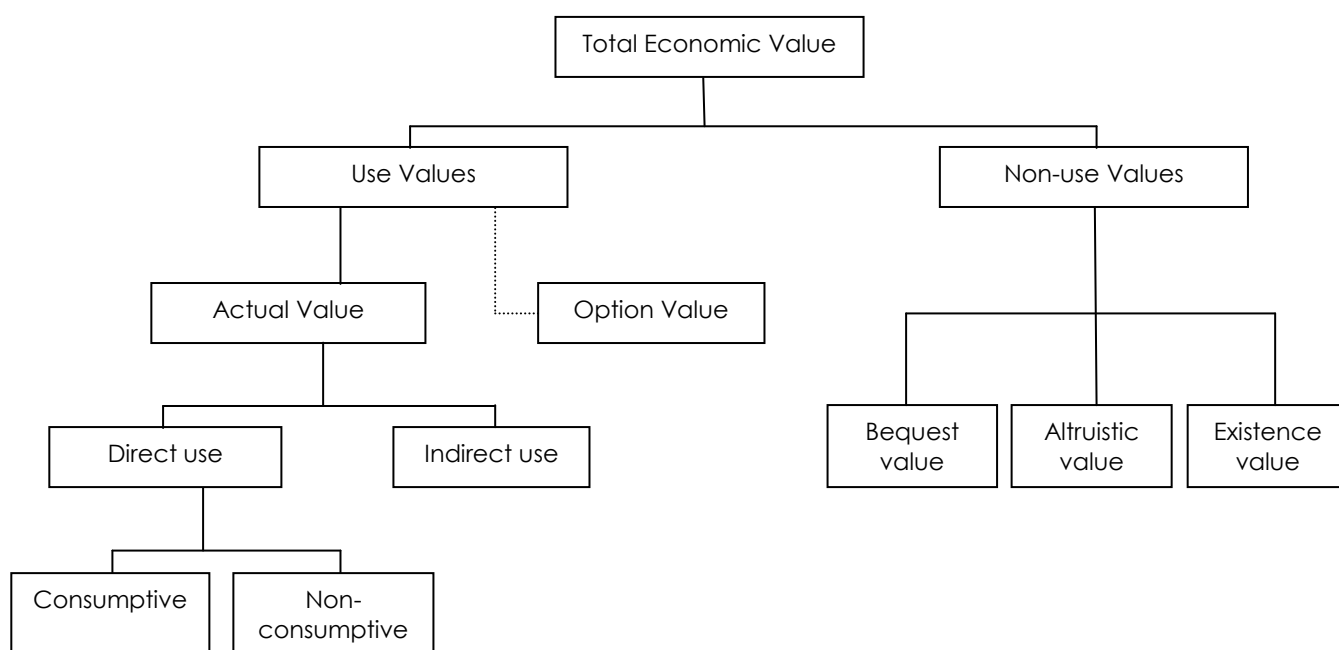


Figure 1: Values within the TEV approach

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 (n=7 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.

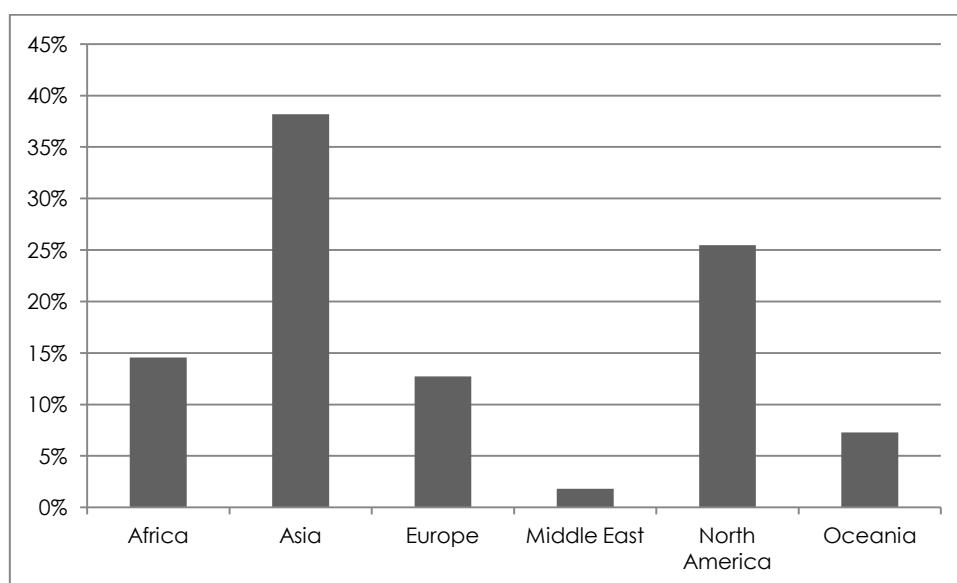


Figure 2: Distribution of valuation studies per geographical region

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 ($\chi^2=28.810$, $df=1$, $p=0.000$), 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 ($\chi^2=3.325$, $df=5$, $p=0.65$). 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 than 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) |
| <i>Model statistics</i> | | |
| N | 50 | |
| Adj. R ² | 0.489 | |

Note: dependent variable: annual HH WTP in USD₂₀₁₄; **: $p < 0.10$; ***: $p < 0.05$ 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 USD₂₀₁₄ using purchasing power parity rates, and the adjusted WTP values per HH per year in USD₂₀₁₄, 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 USD₂₀₁₄, 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 siting 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 sample of residents of Polygyros Municipality. 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

In addition, the results of the survey will provide input for specific socioeconomic indicators (Action C.2: Monitoring the socioeconomic impact of project Actions) and the Social Cost Benefit Analysis (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 \mathbf{q}^0 with an income y and the improved quality of the environment due to LFM program \mathbf{q}^1 but income at y -WTP, according to the following indirect utility function:

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

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

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

where \mathbf{p} is a vector of prices for marketed goods, \mathbf{q}^1 and \mathbf{q}^0 represent the final (i.e. improved) and the initial (i.e. status quo) level of the environment, U^0 is the reference utility level given by the indirect utility function $V(\mathbf{p}, \mathbf{q}^0, y)$ and y is the income. In other words, the individuals must spend more, remaining at utility level 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; Strazzer 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 June 2015 involving residents of the Polygyros municipality. In total 286 completed questionnaires were collected and the response rate was around 70%, since attention was paid to reduce non-response bias designing the survey properly (e.g. preparation of a questionnaire with clear and concise wording, use of well-trained interviewers, etc.). Respondents were selected on a random basis at different locations across Polygyros municipality and at different parts of the day to ensure a cross section of residents. 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 for the area and sample demographics are mentioned, which are related to denials especially among older respondents and women respondents (Table 6).

Table 6: Sample demographics

| Variable | Cases | Relative Frequency |
|-------------------|---------------------|--------------------|
| Gender | Women | 42% |
| | Men | 58% |
| Age | Between 18 and 29 | 29% |
| | Between 30 and 39 | 32% |
| | Between 40 and 49 | 17% |
| | Between 50 and 59 | 11% |
| | Between 60 and 69 | 9% |
| | More than 70 | 2% |
| Marital status | Married | 55% |
| | Not married | 35% |
| | Living with another | 2% |
| | Divorced/Widowers | 8% |
| Household members | 1 | 12% |
| | 2 | 22% |
| | 3 | 40% |
| | 4 | 24% |
| | Over 4 | 2% |

| Variable | Cases | Relative Frequency |
|-------------------|--|--------------------|
| Education | No education | 0.4% |
| | Primary school | 2.5% |
| | Secondary School | 2.8% |
| | High school | 38.7% |
| | Technical High school | 18.3% |
| | College degree (2 years) | 8.1% |
| | Bachelor's degree (3 years or more) | 21.1% |
| | Master's degree | 7.7% |
| | Doctorate degree | 0.4% |
| Employment status | Employed for wages (full- & part-time) | 18.7% |
| | Self-employed | 33.5% |
| | Unemployed | 24% |
| | Pensioners | 9.5% |
| | Students | 6.7% |
| | Housekeepers | 7.7% |
| Income | Less than 10,000€ | 40.3% |
| | 10,000 to 19,999€ | 41.7% |
| | 20,000 to 29,999€ | 13.8% |
| | 30,000 to 39,999€ | 3.5% |
| | 40,000 to 49,999€ | 0.4% |
| | More than 50,000€ | 0.4% |

Approximately 70% of the respondents state that the most important problem that they face is unemployment, followed by the poor economy (22.4%) and the environmental pollution (4.2%). As regards the environment in their area, around 74% declare that they are somewhat or very dissatisfied and the rest declare that they are somewhat or very satisfied. Consistent with the abovementioned findings, around 67.5% of the respondents consider job creation more important than the preservation of the environment, 22.7% believe that the protection of the environment should not be sacrificed in order to save jobs and around 10% neither agree nor disagree with any of these claims.

About 70% 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 6% many times. Nevertheless, about 22% of them have never heard anything about those issues. In comparison with other environmental issues in their area, SWM are of equal importance for the vast majority of the respondents (i.e. 88.8%). Only 4.4% of the respondents believe that SWM issues are more important and 6.6% support the opposite view.

Respondents seem to be well-informed about the risks of uncontrolled landfilling provided that almost all (i.e. more than 96.5%) state that the specific waste disposal practice is associated with significant problems. Furthermore, almost four-fifth of them (i.e. 83.2%) 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 70% of the respondents recognize water pollution as the most important issue, followed by soil pollution (9%), air pollution (6%), and global warming (4%) and deforestation (4%).

More than 95% of the participants said that they participate at recycling programs. As far as the motivations are concerned, resource conservation is the most favourable option (38.5%) among the respondents, followed by protection of the environment (36.6%) and energy conservation (23.1%). Among those respondents who participate in recycling programs, almost 95% declare that they recycle packaging waste, 71% recycle paper, 71% recycle batteries and 10% 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 indicate 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 two-thirds of the respondents characterize the benefits of resource and energy conservation as 'very important' and 26% as 'moderate important'
- about 21% of the respondents characterize the benefits of prevention and reduction of environmental pollution and nuisance as 'very important' and 69.2% as 'moderate important'
- about 22.4% of the respondents characterize the benefits of conservation of landfill space as 'very important' and 44.8% as 'moderate important'

Concerning the support for the LFM concept, more than 95% of the respondents feel that there should be a LFM program. Nevertheless, 18.2% said that they feel some responsibility for paying for it, while 77.3% said that they don't feel that it is their responsibility to pay for it. The respondents' attitude towards their financial responsibility is associated with the current economic situation in Greece, considering the responses given in the social part of the questionnaire.

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. The elicited value was zero for 76% of the respondents. According to the answers given to the follow-up question, which explored the cause of denial, the reason of 51% of those who refused to pay is that they couldn't afford it due to low income. Around 48% of the 'zero answers' were protest bids. The prevailing reasons were that 'other economic activities should pay for the plan' (19.5%), 'I already pay enough

municipal/income taxes' (18%) and, 'the government/local authorities should be responsible for the plan' (7%).

The rest of the respondents (24%) offered more than 5 € up to 120 € per year in increased municipal taxes for supporting a LFM program. All the amounts declared correspond to less than 0.5% of respondent's income. On average, respondents offer 37% of their WTP amount for ensuring a better environment for their household (use value); 19% for ensuring a better environment for other households (non-use altruistic value); 25.5% for ensuring a better environment for future generations (non-use bequest value); and, finally, 18.5% for protecting the ecosystems affected by landfilling (non-use existence value). In total, the estimated non-use value is equal to 63% 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:

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

Where:

\bar{C} = the mean WTP value

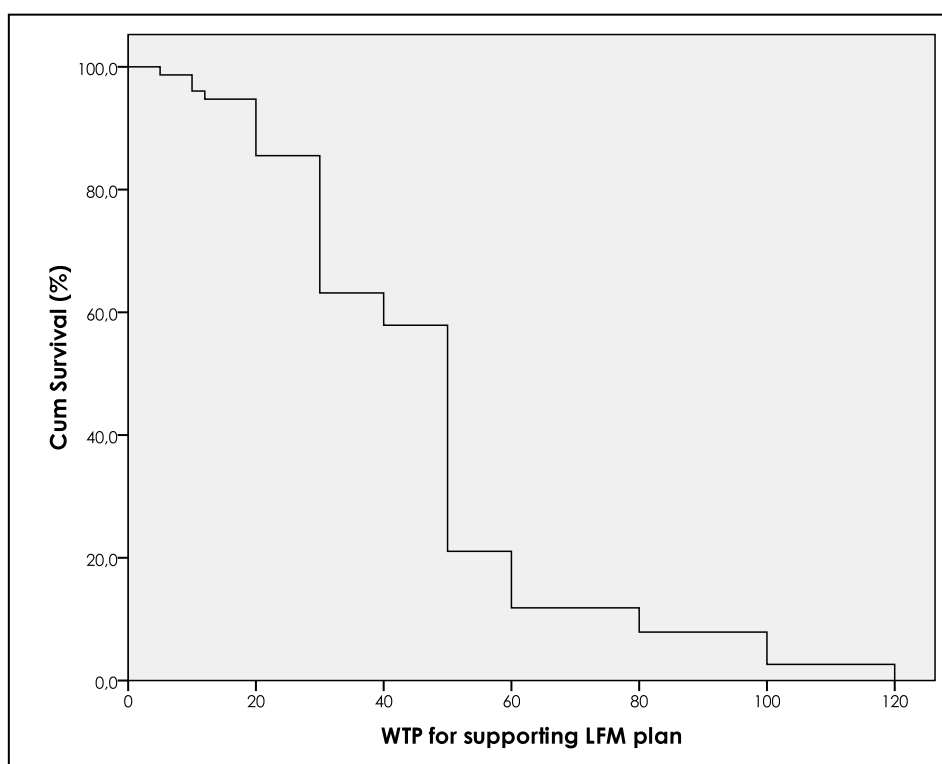
C_j = the ordered WTP values from lowest to highest. C_0 is equal to zero and C_J is the largest WTP value in the sample

$\hat{S}(C_j)$ = 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 12.5 € (95% C.I. 9.7 – 15.3) per household per year and the median value is 0.

Table 7: Kaplan-Meier mean and median WTP estimates

| Mean | | | | Median | | | |
|----------|------------|-------------------------|-------------|----------|------------|-------------------------|-------------|
| Estimate | Std. Error | 95% Confidence Interval | | Estimate | Std. Error | 95% Confidence Interval | |
| | | Lower Bound | Upper Bound | | | Lower Bound | Upper Bound |
| 46.7 | 2.731 | 41.4 | 52.0 | 50.0 | 1.269 | 47.5 | 52.5 |


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:

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

For an observed random sample of n individuals, $\delta_i = 1$, 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 $\prod_{w_i > 0}$ 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:

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

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

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

By MLE, μ and σ were calculated to 3.7051, and 0.5634 respectively, and by substituting the estimated p (which was found equal to 76%), μ and σ to Eq. 7 and Eq. 8, the mean and median WTP values are found equal to 11.4 and 0, 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 |
|------------|-----------|---|
| LMF_PAY | 4.529*** | Support LFM and responsible to pay |
| ENV_STATUS | .623*** | Satisfaction about the environmental status |
| GENDER | .971** | Gender |
| EDUC | .510* | Education level |
| INCOME | .354** | Total household income |
| Constant | -6.732*** | |

$n = 283$, $-2LL = 198.554$, 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 status of the environment in their area (as the satisfaction level increases the willingness to financially support LFM program increases in order to preserve the environment), 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), the education level of the respondents (people with higher education are more likely to place a positive bid) 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 | 2.169*** | |
| INF_FREQ | .394*** | How often hear about SWM issues |
| HHMEMBERS_U18 | .135** | Number of household members under 18 |
| INCOME | .311*** | Total household income |

n=74, Adj. R²=33.2%

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

The coefficients have the expected 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 78% (=p) of the responses, equals to 9.8 € and the median WTP to 0 €, respectively.

6. Conclusions

This report summarizes the results of a survey conducted in Polygyros area by means of the CV method, in order to estimate society's willingness to pay for LFM projects. According to the main findings of the study, more than 95% of the respondents feel that there should be a LFM program. However, 77.3% said that they don't feel that it is their responsibility to pay for it. The respondents' attitude towards their financial responsibility is associated primarily with the current economic situation in Greece. To wit, 95% of the respondents declare annual household income lower than 30,000€ and three-fourths of the respondents lower than 20,000€. Moreover, issues related to the economic situation (i.e. unemployment and poor economy) are mentioned as the most important problem by more than 85% of the respondents.

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

- about two-thirds of the respondents characterize the benefits of resource and energy conservation as 'very important' and 26% as 'moderate important'
- about 21% of the respondents characterize the benefits of prevention and reduction of environmental pollution and nuisance as 'very important' and 69.2% as 'moderate important'
- about 22.4% of the respondents characterize the benefits of conservation of landfill space as 'very important' and 44.8% as 'moderate important'

Concerning the financial support for LFM programs, the elicited value was zero for 76% of the respondents. According to the answers given to the follow-up question, 51% of those who refused to pay said that they couldn't afford it due to low income. This finding indicates that society's WTP for LFM programs could be much higher under different economic conditions.

The mean annual WTP (considering the parametric and non-parametric estimation methods) is estimated at around 12 € 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 20-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.

References

- Aadland, D.M. & Caplan, A.J. (2000) Household Valuation of Curbside Recycling. *Journal of Environmental Planning and Management*, 42(6), 781-800
- Aadland, D.M. & Caplan, A.J. (2006) Curbside recycling: Waste resource or waste of resources?. *Journal of Policy Analysis and Management*, 25, 855-874
- Adamowicz, W., Louviere, J., Williams, M. (1994). Combining revealed and stated preference methods for valuing environmental amenities. *Journal of Environmental Economics and Management*, 26, pp. 271–292.
- Afroz, R., Hanaki, K. & Hasegawa-Kurusu, K. (2009) Willingness to pay for waste management improvement in Dhaka city, Bangladesh. *Journal of Environmental Management*, 90(1), 492–503
- Ajzen, I., Brown, T.C. & Carvajal, F. (2004). Explaining the discrepancy between intentions and actions: the case of hypothetical bias in contingent valuation. *Personality and social psychology bulletin*, 30(9), pp.1108-1121.
- Alhassan, M. & Mohammed, J. (2013) Households' demand for better solid waste disposal services: case study of four communities in the new Juaben Municipality, Ghana. *Journal of Sustainable Development*, 6(11), 16-25
- Altat, M.A. & Deshazo, J.R. (1996) Household demand for improved solid waste management: A case study of Gujranwala, Pakistan. *World Development*, 24(5), 857-868
- Andreopoulos, D. Damigos, D. Comiti, F., Fischer, C. (2015). Estimating the non-market benefits of climate change adaptation of river ecosystem services: a choice experiment application in the Aaos basin, Greece, *Environmental Science and Policy*, 45, pp. 92–103.
- Arekere, D.M. (2004) Examining solid waste management issues in the City of Bryan. Doctoral dissertation, Texas A&M University. University. From Texas A&M (2004): [http : / /hdl .handle.net /1969.1 /3190](http://hdl.handle.net/1969.1/3190). (April 28, 2015)
- Ayalon, O., Avnimelech, Y. & Shechter, M. (1999). Issues in designing an effective solid waste policy: the Israeli experience. In: T. Sterner (Ed.), *The Market and the Environment: The Effectiveness of Market based Instruments for Environmental Reform*, Edward Elgar, UK.
- Banga, M., Lokina, B.R. & Mkenda, A.F. (2011) Households willingness to pay for improved solid waste collection services in Kampala City, Uganda. *The Journal of Environment & Development*, 20, pp. 428-448.
- Bartelings, H., van Beukering, P., Kuik, O, Linderhof, V. and Oosterhuis, F. (2005). *Effectiveness of Landfill Taxation*. Institute for Environmental Studies, Amsterdam.
- Barton, D.N. (2002). The transferability of benefit transfer: contingent valuation of water quality improvements in Costa Rica. *Ecological Economics*, 42 (1–2), pp. 147–164.

-
- Basili, M., Di Matteo, M., & Ferrini, S. (2006). Analysing demand for environmental quality: A willingness to pay/accept study in the province of Siena (Italy). *Waste Management*, 26(3), pp. 209-219.
- Bateman, I.J., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R., and Swanson, J. (2002). *Economic Valuation with Stated Preference Techniques: A Manual*, Edward Elgar, Cheltenham, UK.
- Begum, R.A., Siwar, C., Pereira, J.J. & Jaafar, A.H. (2007) Factors and values of willingness to pay for improved construction waste management – A perspective of Malaysian contractors. *Waste Management* 27, pp. 1902–1909.
- Berglund, C. (2006) The assessment of households' recycling costs: the role of personal motives. *Ecological Economics*, 56(4), pp. 560–569.
- Blaine, T. W., Lichtkoppler, F. R., Jones, K. R. & Zondag, R. H. (2005) An assessment of household willingness to pay for curbside recycling: A comparison of payment card and referendum approaches. *Journal of Environmental Management* 76 (1), pp. 15-22.
- Bleich, D., Findley III, M. and Phillips, G. (1991). An evaluation of the impact of a well designed landfill on surrounding property values. *Appraisal Journal*, 59(2), pp. 247-252.
- Bluffstone, R., & DeShazo, J.R. (2003) Upgrading municipal environmental services to European Union levels: a case study of household willingness to pay in Lithuania. *Environment and Development Economics*, 8, pp. 637–654.
- Bohara, A. K., Caplan, A. J. & Grijalva, T. (2007) The effect of experience and quantity-based pricing on the valuation of a curbside recycling program. *Ecological Economics*, 64(2), pp. 433-443.
- Bonnieux, F. and Rainelli, P. (1999). Contingent valuation methodology and the EU institutional framework, in Bateman, I.J., Willis, K.G. (eds.), *Valuing environmental preferences, Theory and practice of the contingent valuation method in the US, EU and Developing Countries*, New York, Oxford University Press, pp. 585-612.
- Bouvier, R., Halstead, J., Conway, K. and Monalo, A. (2000). The effect of landfills on rural residential property values: Some empirical analysis. *Journal of Regional Analysis and Policy*, 30(2), 23-37.
- Boyle, K.J., Kuminoff, N.V., Parmeter, C.F. & Pope, J.C. (2009) Necessary Conditions for Valid Benefit Transfers. *American Journal of Agricultural Economics*, 91(5), pp. 1328-1334.
- Brisson, I. and Pearce, D. (1995). Benefits Transfer for Disamenity from Waste Disposal. CSERGE working paper WM 95-06.
- Cambridge Econometrics, EFTEC and WRc (2003). A Study to Estimate the Disamenity Costs of Landfill in Great Britain. http://archive.defra.gov.uk/environment/waste/strategy/legislation/landfill/documents/landfill_disamenity.pdf. (June 23, 2009).
-

-
- Caplan, A.J., Grijalva, T. & Jakus, P.M. (2002) Waste Not or Want Not? A Contingent Ranking Analysis of Curbside Waste Disposal Options. *Ecological Economics*, 43(2-3), pp. 185-197.
- Carson, R. (1997). Contingent valuation: theoretical advances and empirical tests since the NOAA panel. *American Journal of Agricultural Economics*, 79, 5, pp. 1501-1507.
- Carson, R., Groves, T. (2007). Incentive and informational properties of preference questions. *Environmental and Resource Economics*, 37(1), pp. 181-210.
- Carson, R.T. (2000). Contingent Valuation: A User's Guide, *Environmental Science and Technology*, 34, pp. 1413-1418.
- Carson, R.T. (2004). Contingent valuation – A comprehensive bibliography and history. Edward Elgar Publishing, Cheltenham, UK.
- Champ, P. A., Moore, R. and Bishop, R.C. (2009). A Comparison of Approaches to Mitigate Hypothetical Bias, *Agricultural and Resource Economics Review* 38, pp. 166–180.
- Champ, P., Flores, N., Brown, T., Chivers, J. (2002). Contingent valuation and incentives. *Land Economics*, 78(4), pp. 591-604.
- Champ, P.A., Boyle, K.J. & Brown, T.C. (2003). A Primer on Nonmarket Valuation. *The Economics of Non-Market Goods and Resources*, Vol. 3, p.592.
- Chee, Y.E. (2004) An ecological perspective on the valuation of ecosystem services. *Biological Conservation*, 120, pp. 459–565.
- Clawson, M. (1959). *Methods of Measuring the Demand for and Value of Outdoor Recreation*, Reprint Number 10, Resources for the Future, Washington D.C.
- Clawson, M. and Knetschm J. (1966). *Economics of Outdoor Recreation*, Johns Hopkins University Press, Baltimore, MD.
- Cummings, R.G. and Taylor, L.O. (1999). Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method, *American Economic Review* 89, pp. 649–665.
- Damigos, D. (2006). An overview of environmental valuation methods for the mining industry. *Journal of Cleaner Production*, 14(3-4), p.234-247.
- Damigos, D. and Anyfantis, F. (2011). The value of view through the eyes of real estate experts: A Fuzzy Delphi Approach. *Landscape and Urban Planning*, 101(2), pp. 171-178.
- Damigos, D. and Kaliampakos, D. (2012). Siting of waste disposal facilities and NIMBY challenges: A critical review", *International Conference on Sustainable Solid Waste Management 2012*, June 28 – 29, Athens, Greece.

Damigos, D., Tourkolias, C., and Diakoulaki, D. (2009). Households' willingness to pay for safeguarding security of natural gas supply in electricity generation. *Energy Policy*, 37(5), pp. 2008-2017.

Davies, B. and Doble, M. (2004). The Development and Implementation of a Landfill Tax in the UK. In: *Addressing the Economics of Waste*. Paris, France: OECD, pp. 63-80.

de Groot, R. S., Stuij, M. Finlayson, M., Davidson, N. (2006). Valuing Wetlands: guidance for valuing the benefits derived from wetland ecosystem services. Ramsar Technical Report No. 3, CBD Technical Series No. 27. Ramsar Convention Secretariat, Gland, 66 pp.

DEFRA (2004). Valuation of the External Costs and Benefits to Health and Environment of Waste Management Options. Final Report, Enviro Consulting Ltd. in association with EFTEC. www.defra.gov.uk/environment/waste/research/health/pdf/costbenefit-valuation.pdf. (July 3, 2009)

DEFRA (2007). An introductory guide to valuing ecosystem services. London, UK, 65 pp.

Diamond, P.A. & Hausman, J.A. (1994). Contingent Valuation: Is Some Number Better than No Number? *Journal of Economic Perspectives*, 8(4), pp.45-64.

Dijkgraaf, E., & Vollebergh, H. R. J. (2004). Burn or bury? A social cost comparison of final waste disposal methods. *Ecological Economics*, 50(3-4), pp. 233-247.

Du Preez, M. and Lottering, T. (2009). Determining the negative effect on house values of proximity to a landfill site by means of an application of the hedonic pricing method. *South African Journal of Economic and Management Sciences*, 12(2), pp. 256-262.

EMC (1996). Waste disposal management, analyzing direct and indirect costs. Final report, Israel (in Hebrew).

Enosh (1996). Solid waste management externalities. Final report, Israel (in Hebrew)

Eshet, T., Ayalon, O. & Shechter, M. (2006). Valuation of externalities of selected waste management alternatives: A comparative review and analysis. *Resources, Conservation and Recycling*, 46(4), pp. 335-364.

Eshet, T., Baron, M.G. & Shechter, M. (2007). Exploring Benefit Transfer: Disamenities of Waste Transfer Stations. *Environmental and Resource Economics*, 37(3), 521-547.

Eshet, T., Baron, M.G. & Shechter, M. (2007). Exploring Benefit Transfer: Disamenities of Waste Transfer Stations. *Environmental and Resource Economics*, 37(3), pp. 521-547.

Eunomia (2002). Economic analysis of option for managing biodegradable municipal waste. Final report and appendices http://ec.europa.eu/environment/waste/compost/pdf/econanalysis_finalreport.pdf. (May 30, 2012)

European Commission (2000). A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste. DG Environment, Final Appendix Report, Brussels. From: http://ec.europa.eu/environment/waste/studies/pdf/econ_eva_landfill_report.pdf (May 25 2012)

Ezebilo, E.E. & Animasaun, E.D. (2011) Economic Valuation of Private Sector Waste Management Services. *Journal of Sustainable Development* 4(4), pp. 38-46.

Ezebilo, E.E. (2013) Willingness to Pay for Improvement in Residential Waste Management in a Developing Country. *International Journal of Environmental Science and Technology* 10(3), pp. 413-422.

Ferreira, S., & Gallagher, L. (2010). Protest responses and community attitudes toward accepting compensation to host waste disposal infrastructure. *Land Use Policy*, 27(2), pp. 638-652.

Ferreira, S., & Marques, R. C. (2015). Contingent valuation method applied to waste management. *Resources, Conservation and Recycling*, 99, pp. 111-117.

Fonta, W.M., Ichoku, H.E., Ogujiuba, K.K. & Chukwu, J.O. (2007) Using a Contingent Valuation Approach for Improved Solid Waste Management Facility: Evidence from Enugu State, Nigeria. *Journal of African Economics*, 17(2), pp. 277-304.

Freeman, M., III. (2003). The measurement of environmental and resource values: Theory and methods, 2nd ed., Resources for the Future.

Fullerton, D. (2002). An Excise Tax on Municipal Solid Waste?'. Austin, TX: University of Texas at Austin, Department of Economics.

Garrod, G. and Willis, K. (1992). The amenity value of woodland in Great Britain: a compromise of economic estimates. *Environmental and Resource Economics*, 24, pp. 415-434.

Geganzo, L. & Guillermo, L. (2013) Who Should Shoulder the Cost on Solid Waste Management? An abstract submitted to The Philippine Economic Society's 51st Annual Meeting. The Philippine Economic Society, 51st Annual Meeting, Manila, 15 November.

Ghanbari, F., Sharee, F.A., Monavari, M. & Zaredar, N. (2012) A new method for environmental site assessment of urban solid waste landfills. *Environmental Monitoring and Assessment*, 184(3), 1221-1230.

Gillespie, R. & Bennett, J. (2011a). Willingness to pay for kerbside recycling the Brisbane Region, EERH Research Report No.97.

Gillespie, R. & Bennett, J. (2011b). Willingness to pay for recycling food waste in the Brisbane Region, EERH Research Report No.96.

Gorecki, P.K., Acheson, J. and Lyon S. (2010). An Economic Approach to Municipal Waste Management Policy in Ireland. The Economic and Social Research Institute Dublin. <http://www.dublinwastetoenergy.ie/uploads/ERSI%20Report.pdf>. (June 1, 2012)

-
- Hagos, D., Mekonnen, A., & Gebreegziabher, Z. (2012). Households' Willingness to Pay for Improved Urban Waste Management in Mekelle City, Ethiopia, EfD DP 12-06, Discussion Paper Series, Environment for Development.
- Halstead, J.M., Luloff, A.E., and Stevens, T.H. (1992). Protest Bidders in Contingent Valuation, *Northeastern Journal of Agricultural and Resource Economics*, 21, pp. 160–169.
- Hanemann, M. (1996). Theory versus data in the contingent valuation debate. In Bjornstad, D.J. and Kahn, J.R. (Eds.), *The Contingent Valuation of Environmental Resources: Methodological Issues and Research Needs*. Edward Elgar, Cheltenham, United Kingdom.
- Hanemann, M.W. (1991). Willingness to pay and willingness to accept: how much can they differ? *American Economic Review*, 81(3), 635–647.
- Hanley, N., Mourato, S., & Wright, R. E. (2001). Choice Modelling Approaches: A Superior Alternative for Environmental Valuation?, *Journal of Economic Surveys*, 15(3), pp. 435-462.
- Heyes, C.L. and Heyes, A. (1999). Recreational benefits from the Dartmoor National Park. *Journal of Environmental Management*, 55, pp. 69-80.
- Hogland, W., Marques, M. and Thörneby, L. (1997). Landfill Mining - Space Saving, Material Recovery and Energy Use. In: *Proceedings of Seminar on Waste Management and the Environment-Establishment of Cooperation Between Nordic Countries and Countries in the Baltic Sea Region*, 5-7 November 1997, Kalmar University, Kalmar, Sweden, pp. 339-355.
- Hoyos, D. (2010). The state of the art of environmental valuation with discrete choice experiments. *Ecological Economics*, 69, pp. 1595–1603.
- Jin, J., Wang, Z. & Ran, S. (2006) Comparison of contingent valuation and choice experiment in solid waste management programs in Macao. *Ecological Economics* 57, pp. 430– 441.
- Joel, S., Mark, K. & Grace J. (2012) Economic valuation of improved solid waste management in Eldoret Municipality. *Journal of Emerging Trends in Economics and Management Sciences*, 3, pp. 962–970.
- Johansson, P-V. (1993). *Cost-Benefit Analysis of Environmental Change*. Cambridge University Press, Cambridge.
- Jones, N., Evangelinos, K., Halvadakis, C.P., Iosifides, T. & Sophoulis, C.M. (2010) Social factors influencing perceptions and willingness to pay for a market-based policy aiming on solid waste management. *Resources. Conservation and Recycling*, 54(9), pp. 533–540.
- Jorgensen, B. S., Syme, G. J., Bishop, B. J., and Nancarrow, B. E. (1999). Protest responses in contingent valuation. *Environmental and Resource Economics*, 14(1), pp. 131-150.
- Kahneman, D. & Tversky, A. (1979) Prospect theory: an analysis of decisions under risk. *Econometrica*, 47(2), 263– 291.

-
- Karousakis, K., & Birol, E. (2008). Investigating household preferences for kerbside recycling services in London: A choice experiment approach. *Journal of Environmental Management*, 88(4), pp. 1099-1108.
- Khattak, N.U.R., Khan, J. & Ahmad, I. (2009) An Analysis of willingness to pay for better solid waste management services in urban areas of District Peshawar. *Sarhad Journal of Agriculture*, 25(3), pp. 529-535.
- Koford, B. C., Blomquist, G. C., Hardesty, D. M., & Troske, K. R. (2012). Estimating Consumer Willingness to Supply and Willingness to Pay for Curbside Recycling. *Land Economics*, 88(4), pp. 745-763.
- Kristom, B. (1997). Spike models in contingent valuation. *American Journal of Agricultural Economics*, 79, pp. 1013-1023.
- Kula, E. (1994). *Economics of Natural Resources, the Environment and Policies*. Chapman and Hall, London, U.K.
- Lake, I.R., Bateman, I.J. & Parfitt, J.P. (1996) Assessing a kerbside recycling scheme: A quantitative and willingness to pay case study. *Journal of Environmental Management*, 46, pp. 239-254.
- Lancaster, K. J. (1966). A new approach to consumer theory, *Journal of Political Economy*, 74, pp. 132-157.
- Landry, C.E., and List, J.A. (2007). Using Ex Ante Approaches to Obtain Credible Signals for Value in Contingent Markets: Evidence from the Field." *American Journal of Agricultural Economics* 89, pp. 420–429.
- Lee, G. F. and Jones, R. A. (1990). Use of Landfill Mining in Solid Waste Management. In: *Proc. Water Quality Management of Landfills*, Water Pollution Control Federation, Chicago, IL, pp. 9.
- Lee, G. F., and Jones, R. A., (1989a). *Municipal Solid Waste Management: Long-Term Public Health and Environmental Protection*, Department of Civil and Environmental Engineering, New Jersey Institute of Technology, Newark, NJ, August.
- Lee, G. F., and Jones, R. A., (1989b). *Fermentation-Leaching Solid Waste Management System: A Solution for Landfill Siting and Management Problems*, G. Fred Lee & Associates, Maplewood, NJ, September.
- List, J.A. (2001). Do Explicit Warnings Eliminate the Hypothetical Bias in Elicitation Procedures? Evidence from Field Auctions for Sportscards, *American Economic Review* 91, pp. 1498–1507.
- Lockwood, M. and Tracy, K. (1995). Nonmarket economic valuation of an urban recreation park. *Journal of Leisure Research*, 27, pp. 155-167.
- Loomis, J.B. & Rosenberger, R.S. (2006). Reducing barriers in future benefit transfers: needed improvements in primary study design and reporting. *Ecological Economics*, 60(2), pp. 343–350.

-
- Loomis, J.B. (2014). Strategies for overcoming hypothetical bias in stated preference surveys, *Journal of Agricultural and Resource Economics*, 39, pp. 34-46.
- Louviere, J, Hensher, D., Swait, D., Adamowicz, W. (2000). *Stated choice methods: Analysis and applications*. Cambridge: Cambridge University Press.
- Luttik, J. (2000). The value of trees, water and open space as reflected by house prices in the Netherlands. *Landscape and Urban Planning*, 48, pp. 161-167.
- Marella, G., & Raga, R. (2014). Use of the Contingent Valuation Method in the assessment of a landfill mining project. *Waste Management*, 34(7), pp. 1199-1205.
- Meyerhoff, J. and Liebe, U. (2008). Do protest responses to a contingent valuation question and a choice experiment differ? *Environmental and Resource Economics*, 39(4), pp. 433-446.
- Murad, M.W., Raquib, M.A, & Siwar, C. (2007) Willingness of the Poor to Pay for Improved Access to Solid Waste Collection and Disposal Services. *The Journal of Environment & Development*, 16(1), pp. 84-101.
- Navrud, S. & Ready, R. (2007). Review of methods for value transfer, *Environmental Value Transfer: Issues and Methods*, pp. 1–10. Springer, Dordrecht.
- Navrud, S., & Pruckner, G. J. (1997). Environmental Valuation – To Use or Not to Use ? *Environmental and Resource Economics*, 10, pp. 1-26.
- Naz, A.C.C. & Naz, M.T.N. (2006). Modelling choices for ecological solid waste management in suburban municipalities: user fees in Tuba, Philippines, *Economy and Environment Program for Southeast Asia*, Research report, no. 2005-RR10, International Development Research Centre.
- Othman, J. (2001). *Benefits Valuation of Improved Residential Solid Waste Management Service in Malaysia*. Malaysia: School of Economics, Fac. of Economics and Business, Universiti Kebangsaan Malaysia, Bangi, Malaysia.
- Othman, J. (2007). Economic valuation of household preference for solid waste management in Malaysia: a choice modeling approach. *International Journal of Management Studies* 14 (1), pp. 189-212.
- Palmquist, R. (1991). Hedonic methods. In: J. Braden and C. Kolstad (Eds). *Measuring the Demand for Environmental Quality*, Elsevier, North-Holland, pp. 77-120.
- Pattanayak, S., Wing, J., Depro, M., Van Houtven, G., De Civita, P., Stieb, D. & Hubbell, B. (2002). *International health benefits transfer application tool: the use of PPP and inflation indices*. Final report, prepared for Economic Analysis and Evaluation Division, Office of Policy Coordination and Economic Analysis Policy and Planning Directorate, Healthy Environments and Consumer Safety Branch, Health Canada.
- Pearce, D. & Howarth, A. (2000). *Technical Report on Methodology: Cost Benefit Analysis and Policy Responses*, RIVM report 481505020, National Institute of Public Health and the Environment.

-
- Perman, R., Ma, Y., McGilvray, J., Common, M. (2003). *Natural Resource and Environmental Economics*, 3rd Edition, Pearson Education Limited.
- Porter, R.C. (2002). *The Economics of Waste*. Washington DC: Resources for the Future.
- Powell, J.C. and Brisson, I. (1994). The assessment of social costs and benefits of waste disposal. Working paper 0967-8875.
- Rabl, A., Spadaro, J. V., & Zoughaib, A. (2008). Environmental impacts and costs of solid waste: a comparison of landfill and incineration. *Waste management & research, ISWA*, 26(2), 147-162.
- Rahim, N.N.R.N.A., Shamsudin, M.N., Ghani, A.N.A., Radam, A., Manaf, L.A., Kaffashi, S. & Mohamed, N. (2012) Economic Valuation of Integrated Solid Waste Management in Kota Bharu, Kelantan. *Journal of Applied Sciences*, 12(17), pp. 1839-1845.
- Reiser, B. and Shechter, M. (1999). Incorporating zero values in the economic valuation of environmental program benefits, *Environmetrics*, 10, pp. 87–101.
- Resource Recovery and Recycling Authority (2007). Policy Brief: Getting Waste Management Prices Right. Resource Recovery and Recycling Authority of Southwest Oakland. From:
- Rosen, S. (1974). Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy*, 82, pp. 34-55.
- Rosenberger, R.S. & Loomis J.B. (2001). Benefit transfer of outdoor recreation use values: A technical document supporting the Forest Service Strategic Plan, (2000 revision). Gen. Tech. Rep. RMRS-GTR-72. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Roy, A.T. & Deb, U. (2013) Households Willingness to Pay for Improved Waste Management. In Silchar Municipal Area: A Case Study In Cachar District, Assam. *Journal of Humanities and Social Science*, 6(5), pp. 21-31.
- Rozan, A. (2004) Benefit Transfer: A Comparison of WTP for Air Quality between France and Germany. *Environmental & Resource Economics*, 29(3), pp. 295–306.
- Sakata, Y. (2007). A choice experiment of the residential preference of waste management services - The example of Kagoshima city, Japan. *Waste Management*, 27(5), pp. 639-644.
- Sarkhel, P. & Banerjee, S. (2010) Municipal Solid Waste Management, source-separated waste and stakeholder's attitude: A contingent valuation study. *Environment, Development and Sustainability*, 12, pp. 611-630.
- Sasao, T. (2004). An estimation of the social costs of landfill siting using a choice experiment. *Waste Management*, 24(8), pp. 753-762.

-
- Sayadi, S.M., Gonzalez-Roa, C., Calatrava-Requena, J. (2009). Public preferences for landscape features: the case of agricultural landscape in mountainous Mediterranean areas Source. *Land Use Policy*, 26(2), pp. 334–344.
- Schollum, P. (2010). Evaluation of the social optimum for the Landfill Levy in WA. CEED Project Number 09/002, UWA Business School, University of Western Australia.
- Schollum, P. (2010). Evaluation of the social optimum for the Landfill Levy in WA. CEED Project Number 09/002, UWA Business School, University of Western Australia.
- Spash, C. (2008). Deliberative Monetary Valuation and the Evidence for a New Value Theory. *Land Economics*, 83(3), pp. 469–488.
- Spash, C.L. & Vatn, A. (2006) Transferring environmental value estimates: Issues and alternatives. *Ecological Economics*, 60(2), pp. 379-388.
- Stone, R.F. and Ashford, N.A. (1991). Package Deal: The Economic Impacts of Recycling Standards for Packaging in Massachusetts. Massachusetts Institute of Technology.
- Strazzer, E., Scarpa, R., Calia, P., Garrod, G. D., & Willis, K. G. (2003). Modelling zero values and protest responses in contingent valuation surveys. *Applied Economics*, 35(2), pp.133-138.
- TEEB (2010). The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundation, Earthscan, London.
- Tellus Institute (1991). Disposal Cost Fee Study: Final Report. Boston MA: Tellus Institute
- Tentes, G., & Damigos, D. (2012). The Lost Value of Groundwater: The Case of Asopos River Basin in Central Greece. *Water Resources Management*, 26(1), 147-164.
- Tiller, K.H., Jakus P.M. & Park W.M. (1997) Household Willingness to Pay for Dropoff Recycling. *Journal of Agricultural and Resource Economics*, 22(2), pp. 310–320.
- Turner, R.K., Pearce, D. and Bateman I. (1994). Environmental economics: An elementary introduction. Harvester Wheatsheaf, Hertfordshire, U.K.
- Tyrväinen, L. (1996). The amenity value of urban forest: An application of the hedonic pricing method. *Landscape and Urban Planning*, 37, pp. 211-222.
- Tyrväinen, L., Miettinen, A. (2000). Property prices and urban forest amenities, *Journal of Environmental Economics and Management*, 39(2), pp. 205-233.
- United States District Court of Appeals for the District of Columbia Circuit (1989). State of Ohio vs U.S. Department of Interior, et al. Cases # 86-1529 and # 86-1575.
- USEPA (1997). Landfill Reclamation, United States Environmental Protection Agency, Solid Waste and Emergency Response (5306W), EPA530-F-97-001, July 1997.

Venkatachalam, L. (2004). The contingent valuation method: a review. *Environmental Impact Assessment Review*, 24(1), 89–124.

Wang, H., He, J., Kim, Y. & Kamata, T. (2014) Municipal solid waste management (SWM) is a major challenge for local governments in rural China, *Waste Management & Research*, 32(8), pp. 695-706.

Wiser, R. (2007). Using contingent valuation to explore willingness to pay for renewable energy: A comparison of collective and voluntary payment vehicles. *Ecological Economics*, 62(3-4), pp. 419-432.

World Bank (2015a). PPP conversion factor, GDP (LCU per international \$). From: <http://data.worldbank.org/indicator/PA.NUS.PPP?page=4> (May 25, 2015)

World Bank (2015b). Consumer price index (2010 = 100). From: <http://data.worldbank.org/indicator/FP.CPI.TOTL> (May 25, 2015)

Yuan, Y., & Yabe, M. (2014) Residents' Willingness to Pay for Household Kitchen Waste Separation Services in Haidian and Dongcheng Districts, Beijing City. *Environments* 2014, 1(2), pp. 190-207; doi:10.3390/environments1020190

Zen, I. S., Noor, Z. Z., & Yusuf, R. O. (2014) The profiles of household solid waste recyclers and non-recyclers in Kuala Lumpur, Malaysia. *Habitat International*, 42, pp. 83-89.

Zhang, X., Wang, R. , Wu, T. , Song, H. and Liu, C. (2015) Would Rural Residents Will to Pay for Environmental Project? An Evidence in China. *Modern Economy*, 6, pp. 511-519.



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



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 with the collaboration of Polygyros Municipality 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 | <input type="text"/> |
| Male | <input type="text"/> |

D2. Age

What is your age?

| | | | |
|-----------------|----------------------|-------------------|----------------------|
| 18-29 years old | <input type="text"/> | 50-59 years old | <input type="text"/> |
| 30-39 years old | <input type="text"/> | 60-69 years old | <input type="text"/> |
| 40-49 years old | <input type="text"/> | 70 years or older | <input type="text"/> |

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 | <input type="text"/> | €50,000 - 59,999 | <input type="text"/> |
| €10,000 - 19,999 | <input type="text"/> | €60,000 - 69,999 | <input type="text"/> |
| €20,000 - 29,999 | <input type="text"/> | €70,000 - 79,999 | <input type="text"/> |
| €30,000 - 39,999 | <input type="text"/> | €80,000 - 89,999 | <input type="text"/> |
| €40,000 - 49,999 | <input type="text"/> | More than €90,000 | <input type="text"/> |

For the Interviewer only:

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

| | |
|-----|----------------------|
| Yes | <input type="text"/> |
| No | <input type="text"/> |

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

| | |
|-----|----------------------|
| Yes | <input type="text"/> |
| No | <input type="text"/> |

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

| | |
|------|----------------------|
| Good | <input type="text"/> |
| Fair | <input type="text"/> |
| Poor | <input type="text"/> |