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Implementing the Contingent Valuation Method for supporting decision making in the waste management sector

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ABSTRACT

This study presents an application of the Contingent Valuation Method (CVM) for valuing the environmental impacts associated with the operation of landfills for residues following waste treatment and depicts how the results of the analysis can be used for decision making in the field of waste management. The survey was conducted in Ikaria, Greece, a medium-sized island in the northern Aegean Sea, with a view to estimate the amount of compensatory benefits that are socially acceptable to be attributed to the hosting community of a new landfill for residues. The results showed that the mean willingness to pay per household to create a fund for financing social and environmental programs in the community that will host the landfill in question was estimated at €6.5–6.7 per 2-month and household taking into account all households of the sample. This estimate is at the same order of magnitude but at the lower band compared to the results of other relevant studies showing that the public in Ikaria is aware for the relatively limited environmental burdens associated with the operation of landfills for residues following an integrated waste management treatment.

1. Introduction

Municipal Solid Waste (MSW) management is one of the most challenging technical problems in Greece, given the high level of urbanization, the existence of a large number of islands, and the widespread denial of citizens to accept the installation of waste management facilities in their area (the NIMBY phenomenon). Despite the undeniable progress made in recent years, the problem remains open in most regions of the country, including the metropolitan area of Athens, raising serious questions about the possibility of achieving the legally binding targets set by the country for waste recycling and reuse in the context of the Waste Framework Directive (2008/98/EC). The increased number of technologies and the great variety in the possible paths from collection towards disposal significantly increase the complexity of finding the "optimal" solution. Very often, the significance of the environmental impacts associated with the waste management infrastructure, the selection of the appropriate technologies for waste management, the siting of the relevant infrastructures, the pricing of waste disposal services, the level of compensatory benefits that should be received by the communities hosting waste management infrastructure, etc., constitute conflict issues between the local communities, the regional authorities and the central government.

It is widely recognized that waste treatment and disposal are disturbing activities accompanied by a number of environmental impacts (see indicatively Hong et al., 2010; Dong et al., 2014; Assamoi and Lawryshyn, 2012; Zaman, 2010), which are usually not taken adequately into consideration in waste management decisions and pricing (Mavrotas et al., 2015; Eshet et al., 2006). Specifically, the operation of thermal treatment facilities is associated with the emission of greenhouse gases and other air pollutants that cause significant impact on public health and the natural environment, exacerbating the problem of climate change as well as with other environmental and social impacts such as noise emissions, aesthetic impacts on the landscape, and land use changes (EC, 2000; Eunomia, 2002; Eshet et al., 2006). On the other hand, managed or unmanaged landfills which receive mixed solid waste, create also various environmental pressures: degradation of soil and water from leachate releases; degradation of the atmospheric environment due to generated emissions of methane, carbon dioxide, and volatile organic compounds; and disamenity from wind-blown litter, noise, visual intrusion, traffic, flies, seagulls, odours, etc. (EC, 2000; Eunomia, 2002). Since waste residues disposed on land after waste treatment typically do not contain any biodegradable organic material, which, when decomposing, will

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generate leachate and methane emissions, environmental impacts in this case are almost entirely associated with disamenities. Therefore, the development of effective waste management policies should take into account not only the cost of the alternative management technologies but also the environmental implications of each technical solution.

This paper aims at exploiting techniques of environmental economics to value the environmental impacts associated with the development of MSW management facilities and to specify the level of compensatory benefits that are socially acceptable to be attributed to the hosting areas of the infrastructures in question, with a view to finance environmental and social actions and projects. The basic idea of these approaches is to assess in monetary terms the environmental impacts associated with waste management facilities, allowing a direct comparative evaluation of alternative projects and technologies and the selection of those options that minimize the potential negative effects on the society and maximize social welfare. This study presents an application of the Contingent Valuation Method (CVM) for valuing the environmental externalities attributed to a landfill for solid waste residues following waste treatment, which is scheduled to be developed in a Greek island, namely Ikaria. The implementation of the method was supported by a survey of the residents of the area in question, through the completion of an appropriately designed questionnaire with personal interviews. The findings of the analysis are comparatively evaluated with the results of similar studies conducted internationally, with a view to highlight the significance and the key parameters influencing the externality in question.

2. Implementing techniques of environmental economics on waste management: main findings

Research work assessing externalities of waste landfills into monetary terms is rather limited. In addition, none of these studies has dealt so far with disposal of solid waste residues following a waste treatment technology (as it is the case examined in the present paper); instead, to date research has focused on managed or unmanaged landfills which receive mixed solid waste.

Apart from the scarcity of relevant literature, available studies have used different methodologies for monetizing externalities; some utilized the willingness to pay (WTP)/willingness to accept (WTA) methodology through Contingent Valuation Method (Afroz et al., 2009; Sacratees and Govindaraj, 2014) or Choice Experiments (Karousakis and Birol, 2008), while others applied indirect approaches such as the Hedonic Pricing Method (HPM) focusing mostly on the impact of landfills to housing prices (Nahman, 2011; Hite et al., 2001; Ham et al., 2013). Furthermore, local characteristics at and around the landfill area (e.g. soil type, rest geomorphological features, distance from settlements, number of residents in nearby settlements, etc.) also affected the estimated figures of externalities. Particularly CVM has been used in the waste sector for evaluating alternative programs and technical waste management projects (see for example Jin et al., 2006; du Vair and Loomis, 1993; Parra et al., 2008; Vásquez et al., 2014), for recording households' preferences to improve existing waste management systems (Afroz et al., 2009; Afroz and Mehedi Masud, 2011; Begum et al., 2007), to identify the requirements of local communities in order to accept the installation of solid waste management facilities in their vicinity (Ferreira and Gallagher, 2010), etc.

A first review of studies that assessed in monetary terms the externalities associated with waste disposal on land was carried out by the European Commission (EC, 2000). In this work, apart from a thorough examination of all potential externalities, the authors formulated some typical examples (cases) which can be used in estimating externalities from landfills; for each of them they provided relevant cost figures (Table 1) that were estimated on the basis of values proposed by the studies reviewed. From Table 1 it is clear that the largest external costs of waste disposal on landfills are disamenity costs, followed by global warming emissions (especially methane generated by the biodegradation of the organic fraction of solid waste in the landfill). However, the authors pointed out that values for disamenity costs were based on US studies and might not be applicable in Europe, and therefore more studies on European level were needed.

Caplan et al. (2002) conducted a survey at the Ogden City, Utha-US, among a sample of 350 individuals and applied a discrete choice contingent ranking approach in order to estimate a household's WTP for reducing landfill disposal. By converting original values (expressed in the survey in $\$_{2000}$), the estimated WTP was $€_{2010}$ 45.6–103.4 per tonne of waste diverted for a curbside service that enables separation of green waste and recyclable material from other solid waste.

In another study, Sasao (2004) examined the externalities of three virtual landfill siting plans in the Morioka City, Japan, by estimating the marginal willingness to pay (MWTP). In the study it is assumed that the special tax corresponding to the MWTP will be levied only once on each of the households. For this purpose, questionnaires were sent to 600 households and 276 of them responded. Five attributes on siting a landfill were explored, namely range of accepting waste, area of deforestation, existence of drinking water source, and distance from respondent's house. In addition, regional factors (urban/rural areas, familiarity with landfill in place) were also analyzed. The results of the assessment are presented in Table 2; it reveals that externalities may vary significantly along socioeconomic and regional factors.

Eshet et al. (2006) reviewed several studies that were carried out between 1992 and 2003 and assessed the externalities of waste landfills in monetary terms. For the most recent of them (i.e. from 2000 and onwards), the range of reported values are presented in Table 3. Reported figures in two out of three cases refer only to externalities related to emissions (i.e. do not include disamenities),

Table 1
Examples of external costs for landfill disposal of waste (expressed in € 2010/ tonne of waste disposed at landfill). Source: EC (2000).

Impact	Example L1		Example L2	
	Best estimate	Full interval of potential values	Best estimate	Full interval of potential values
Global warming	7.5	1.5–20.9	12.0	3.6–34.4
Damage from air pollution	0.1	0.02 – 0.2	0	–
Damage from leachate	0	0–1.5	2.2	1.5–3.6
Disamenity	14.9	8.9–28.3	14.9	8.9–28.4
Total external costs	22.3	10.5–50.9	30.0	13.5–65.8
Pollution displacement	−6.0	−14.9 to −1.5	0	–
Net external costs	16.5	8.9–35.6	30.0	13.5–65.8

Note: L1: Modern landfill with leachate collection and treatment, as well as with collection of landfill gas to generate electricity and heat (CHP). L2: Old landfill without a liner nor collection of landfill gas. In both examples, coal is the energy source used. Original values of externalities were reported by EC in $€_{2000}$ and have been converted to $€_{2010}$ by the authors of the present paper.