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Use of the Contingent Valuation Method in the assessment of a landfill mining project

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ABSTRACT

A comprehensive approach for the evaluation of the economic feasibility of landfill mining (LFM) should take into account not only the direct costs and revenues for the private investor, but also the social benefits or costs (generally called externalities), in such a way that projects generating major social benefits (and no significant private revenues) are not overlooked.

With a view to contributing to the development of a common framework for the evaluation of LFM projects, this paper presents the results of a case study where the issue of the assessment of social benefits from a LFM project is addressed. In particular, the Contingent Valuation Method is applied 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.

Based on the results of a survey carried out on a random sample of people living near the old landfill, the economic values of the individual willingness to pay (WTP) for LFM and the subsequent creation of a public park were calculated and the correlations with the relevant variables (distance from the landfill site, age, income, sex, education level) assessed. The results were then suitably extended and the monetary value of the welfare increase of the whole population resident in the area and potentially affected both by LFM and the creation of the park was calculated.

1. Introduction

Landfill mining (LFM) consists in the excavation and treatment of waste from landfills, providing for recovery of material and energy as well as land reclamation.

According to Krook et al. (2012), the characterization of the deposited material is the most studied topic in LFM research involving the assessment of waste composition (with focus on the effectiveness of separation in homogeneous streams in view of material and energy recovery) and of biochemical and physical characteristics (e.g. biological stability, humidity, calorific value, etc.) relevant to LFM process (Prechthai et al., 2008; Masi et al., 2014).

The characterization of the landfill body is an issue too. Technical difficulties can arise during the excavation in case of high leachate levels and/or significant residual emission potential due to biodegradables in the waste mass; such conditions would cause waste mechanical instability and the presence and possible accumulation of methane (possible formation of explosive mixtures) and other trace compounds in the excavation area, hampering the operations and producing safety concerns. For these reasons, the design of LFM should be preceded by geotechnical and hydraulic surveys (Cossu et al., 2009) and, according to the results of specific tests (Raga and Cossu, 2013), in situ aeration should be considered as landfill pretreatment for the enhancement of waste biological stability, providing for reduced emissions during excavation and easier management of the excavated material (Bilitewski et al., 1995; Cossu et al., 2003a; Goeschl and Rudland, 2007; Raga and Cossu, 2014).

Although the procedures for waste and landfill characterization and pretreatment before LFM are not standardized and the need for harmonization is clear in the scientific community, the experience gained in the past years and the results of numerous pilot scale applications proved the technical feasibility of waste excavation and further separation and under safe and controlled conditions, fostering the application of LFM worldwide (Cossu et al., 1995; Hogland et al., 2004; Rettenberger, 1995; Jain et al., 2013).

However, despite the potential offered by LFM and the increasing interest roused in the last two decades, the number of full-scale projects has been unexpectedly low so far, mainly due to the difficulties in proving the economic feasibility of the many candidate

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cases. LFM projects can be implemented by enterprises provided that direct benefits to the company (revenues) outweigh the costs. This is likely to occur when the LFM activities generate valuable land for town expansion or new volumes for the extension of landfill service life (Goeschl and Rudland, 2007; van der Zee et al., 2004; Raga and Cossu 2014).

In all other cases LFM profitability for private companies can be discussed and depends on very site-specific conditions. Except for cases of mono-landfills for industrial waste (Zanetti and Godio, 2006), LFM activities have not been carried out with focus on resource recovery so far and the very limited research effort for the enhancement of the recycling potential for the excavated waste has led to discouraging results; for these reasons, it is not realistic to consider LFM if the main motivation is material recovery and further research for innovative separation and transformation technologies is needed (Krook et al., 2012; Jones et al., 2013).

The trigger for LFM can be the removal of the landfill as a (potential) source of groundwater and surface water contamination. This would grant a dramatic reduction of the aftercare costs for the landfill and the avoidance of the unpredictable cost for the possible long-term groundwater remediation. However, it is likely that public funding cannot be avoided in this case (van der Zee et al., 2004; Hull et al., 2005) unless a profitable enough use of the recovered land is foreseen.

Currently, a new vision is opening encouraging scenarios for the full exploitation of LFM potential market opportunities. According to Jones et al. (2013), LFM should be "*embedded in a broad resource management perspective*" where a significant role is played by resource recovery (including energy from biogas before excavation) from the landfilled waste. This is one of the key issues of the Enhanced Landfill Mining (ELFM) concept, where (old and new) landfills are considered as "*temporary storage place, awaiting future valorisation*" (Geysen et al., 2009): after waste excavation and treatment, the non-recyclable fractions are deposited in purpose built landfill sectors, to be stored until proper technologies for treatment and recycling are available and further LFM becomes profitable. Temporary storage of waste before future valorisation is currently an issue in numerous European countries and the related challenges have been recently addressed (Wagner and Bilitewski, 2009; Ibrahim and Hogland, 2013).

1.1. Social value of LFM

According to EPA (1997) most economic benefits associated with LFM are indirect and fall on a broad community; particularly, on those living close to the landfill in question. In order to take them into account, social issues should be properly assessed (by assigning them a monetary value) and integrated in a methodological framework to support private and public actors in the evaluation process of LFM feasibility (van Passel et al., 2013), in order to avoid the risk of overlooking those cases in which LFM would guarantee large social benefits without any significant private revenues. In such cases however, a fundamental role should be played by appropriate government policies, support schemes and incentives (Jones et al., 2013).

Examples of full-scale applications of LFM where public funding was available and LFM was part of a wider project of public interest are reported. van der Zee et al. (2004) present case studies where the local government was involved in promoting and funding landfill mining activities for the development of industrial areas (two cases) and for the avoidance of possible contamination of the surroundings of a landfill. Cossu et al. (2003a) report a case study where landfill mining was completely funded by the Italian government, in the framework of a huge project for the construction of the high speed railway line connecting Milan and Bologna. Van Passel et al. (2010) describe the application a purposely-developed simulation tool for the evaluation of the influence of the major economic drivers on the feasibility of ELFM projects in the Flanders region in Belgium (approx. 20 km^2 of potential candidate area for ELFM). The output showed that the major part of calculated benefits would come from the waste to energy conversion; the overall cost-benefit analysis (CBA) proved that ELFM in the region has a positive economic potential mainly thanks to government incentives, granted as a compensation for the social value of ELFM for "*the attainment of, among others, the renewable energy targets imposed by EU legislation*".

It is a common position among the scientific community that a comprehensive assessment of landfill mining projects should take into account not only private costs and revenues, but also social and environmental issues. This should be achieved through the application of a CBA which includes the monetary evaluation of those costs and benefits (generally called externalities) affecting somebody (i.e. citizens living in the area, the society) other than the people engaged in the LFM project and which are not reflected in prices. Some externalities commonly associated to LFM are:

– reduction of environmental footprint (air, soil, surface water and groundwater pollution);
– lower import dependency for energy and materials;
– nature restoration and creation of recreational areas;
– benefits for the citizens from the urban development in the recovered area;
– noise, smells, dust and increased traffic during excavation.

All of them should be properly encompassed in the assessment procedures of a LFM project. To this regard, the implementation of a methodological framework is in progress and the first results of the assessment of private profitability as well as costs and benefits to society of an ELFM project are available (van Passel et al., 2013). Concerning the benefits to society, the authors compared the carbon footprint for the current scenario with a hypothetical one where ELFM is applied. The simulation proved that the ELFM scenario is more beneficial in terms of greenhouse gas mitigation; the CO_2 emissions of the energy recovery from selected fractions of the excavated waste are compensated by the carbon emission savings offered by the material recovery. The same authors conclude that the methodological framework must be refined and extended, particularly regarding the assessment of social costs and benefits.

With a view to contributing to the development of a common framework for the evaluation of LFM projects, this paper presents the results of a case study where the issue of the assessment of social benefits from a LFM project is addressed. In particular, the Contingent Valuation Method is applied for the monetary assessment of the perceived benefit that a community may gain from the remediation of an old uncontrolled waste deposit by means of LFM and the conversion of the area into a park.

2. Methods for the assessment of social benefits

The evaluation of social benefits is generally omitted in the economic assessment made by private operators for three main reasons: (a) they refer to economic agents (i.e. individuals or firms) who are different from those involved in the LFM operations (b) although they affect other agents′ welfare, the direct effects of these benefits are not transmitted through market prices and therefore remain outside market mechanisms and (c) their monetary value needs to be analysed using complex and ad hoc evaluating procedures (D'Alpaos, 2012).

Since the preferences of individuals are to be taken as the source of perceived benefits, it is necessary to know to what extent