Evaluating Environmental Impact Caused By Industrial Activities – Implementation Of The WTP-WTA Approach

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Abstract. In this work, a methodological framework under the form of an algorithmic procedure, including 28 activity stages and 6 decision nodes, has been developed for evaluating environmental impact caused by industrial activities. The main part of this procedure is a modification of the Contingent Valuation Method (CVM), which is heavily relied on survey-based estimation of WTP-WTA (willingness to pay/accept, respectively). The survey may take place either under a strictly controlled environment or *in situ* and as-is ('laboratory conditions' or 'field conditions', respectively, in the terminology of experimental economics). Implementation of this methodology is presented, referring to three cases of industrial pollution (in three different sites) caused by (i) a cement producing units, (ii) an oil refinery complex, and (iii) an industrialized small city with an intensively polluted port, where several industrial units co-exist, all of them located in the vicinity of Athens, Greece. The results are interpreted/discussed and conclusions are drawn.

Keywords: environmental impact, Willingness To Pay (WTP), Willingness To Accept (WTA), industry relocation.

INTRODUCTION

During the last three decades there has been growing interest in developing methods for assessing the preferences (of experts, stake holders, community/organization members, independent individuals) for environmental quality. Among them, the contingent valuation method (CVM) is frequently applied to (i) economic valuation of environmental projects or works/activities (planned or in operation) with a significant environmental impact and (ii) damage assessment after environmental accidents, i.e., after incidents that deteriorate environmental quality. This method is heavily relied on survey-based estimation of (i) willingness to pay (WTP), which is the maximum amount of money a person would be willing to pay, sacrifice or exchange for a good, and (ii) willingness to accept (WTA), which is the minimum amount of money a person would be willing to accept in order to abandon a good. WTP is bounded by income while WTA is potentially unlimited. Whether WTP or WTA is appropriate, depends on the prior distribution of property rights and the direction of change under consideration. The current endowment of an environmental commodity is often taken as implying legal right to an increase in the quantity of an environmental amenity and should be valued using WTP whereas reductions should be valued using WTA. If WTP and WTA were evaluated at the same level of utility, they should be identical, but empirical evidence consistently demonstrates that WTA may exceed WTP by an order of magnitude [1-3].

The aim of this work is to present a dynamic methodological framework for evaluating environmental impact caused by industrial activities by means of the CVM, referring to alternative routes of investigation and including successive levels of information granularity in continuous interaction with a dedicated local Knowledge Base (KB) created *ad hoc*. Results from three case studies are also presented.

METHODOLOGY

For the purposes mentioned above, we have designed/developed the following methodological framework under the form of an algorithmic procedure, including 28 activity stages and 6 decision nodes (for their interconnection, see Fig. 1).

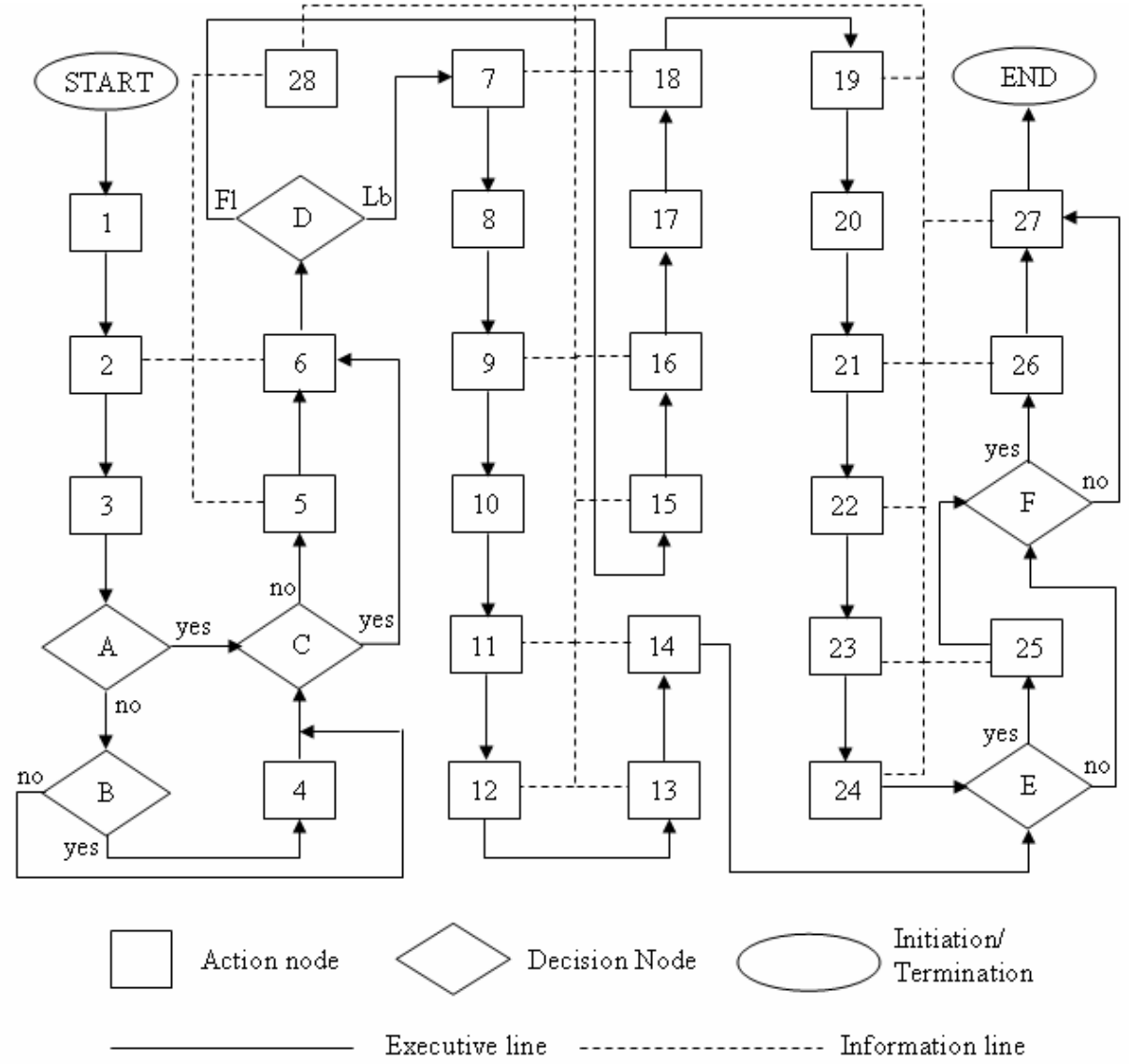

Figure 1. The methodological framework, under the form of an algorithmic procedure, developed for evaluating environmental impact caused by industrial activities.

1. Description of the domain under consideration by means of a Geographical Information System (GIS), including separate layers for the spatial distribution of the relevant parameter values, like industrial activity, roads network, commercial activity, permanent and transient (due to tourism) population, waterbodies and pollution.
2. Description of the environmental project to be evaluated.
3. Selection of permanent population characteristics, putting emphasis on the economic parameters necessary to estimate the various kinds of elasticity.
4. Stratification of population, according to the characteristics selected in (3).
5. Collection of feasible scenarios about improving environmental quality.
6. Multicriteria choice of the most realistic/promising scenario.
7. Design of the CVM questionnaire.
8. Sample selection, according to the stratification performed in (4).
9. Training of the interviewees participating in the evaluation.
10. Communication/cooperation with the interviewees to obtain reliable answers to the Lb-questionnaire.

11. Processing of the data obtained in the responses to the Lb-questionnaire.
12. Conclusions covering the various entities of the Lb-questionnaire.
13. Circulation of a post-CVM questionnaire to obtain information about the functionality of the method itself.
14. Multifaceted/holistic conclusions.
15. Design of Fl-questionnaire.
16. Preparation of supporting material for interviewees' training.
17. Intermediate circulation of the basic questionnaire among the respondents (small/medium sample size) to obtain information at a lower granularity level.
18. Processing of the data obtained in the responses to the basic Fl-questionnaire.
19. Basic conclusions and final formulation of the questionnaire.
20. Final circulation of the refined/detailed questionnaire among the respondents (medium/large sample size) to obtain information at a higher granularity level.
21. Processing of the data obtained in the responses to the refined/detailed Fl-questionnaire.
22. Conclusions covering the various entities of the Fl-questionnaire.
23. Circulation of a post-CVM questionnaire to obtain information about the functionality of the method itself.
24. Multifaceted/holistic conclusions.
25. Synthesis of results obtained herein with information extracted from similar cases.
26. Meta-analysis, including comparison of methods.
27. Proposals for environmental policymaking.
28. Creation/operation/enrichment/updating of a Knowledge Base (KB), to cover the needs of the current work; searching within external Bases by means of an Intelligent Agent (IA), as that described in [4].

A. Do the interviewees form a homogenous set?
B. Is stratification and corresponding sampling feasible?
C. Are these estimates of income elasticity (as regards expenses for improving/sustaining environmental quality) available?
D. Will the survey take place within a strictly controlled environment or *in situ* and 'as-is' ('laboratory conditions' and 'field conditions', respectively, in the terminology of experimental economics, quoted as Lb and Fl in Figure 1)?
E. Is there additional endogenous (already processed/stored in the KB) information extracted from similar cases?
F. Is there additional exogenous information extracted from similar cases found in external KBs by means of the Intelligent Agent of stage 28?

IMPLEMENTATION

The methodological framework described above has been implemented in three cases at sites close to Athens (Lat. 37°58′42.22′′N, Long. 23°43′01.12′′E), referring to (i) the towns/ports Agioi Theodoroi (50.94 Km south of Athens, Lat. 37°55′44.55′′N, Long. 23°08′25.96′′E) and Khalkis (54.87 Km north of Athens, Lat. 38°27′47.06′′N, Long. 23°35′29.78′′E), where the source of pollution is an oil refinery and a cement production unit, respectively, and (ii) the small industrial city/port (actually a suburb 18.04 Km to the south of Athens) of Eleusina (Lat. 38°0.2′36.09′′N, Long. 23°32′31.63′′E), where there are several sources of pollution. Certain results are shown in Fig. 2, referring to WTP, WTA, WTR. In the town of Agioi Theodoroi, a quarter of the interviewees behave in an absolutely passive mode, while the rest exhibit a consistent attitude willing to pay or accept a rather small amount of money; nevertheless, 35% of them are in favor of relocation, possibly because they have interests with real estate or business associated with tourism. In the town of Khalkis, although 37% of the interviewees are not willing to pay, the corresponding percentage for WTA is negligible while the rest WTA-percentages are considerably high and in good agreement with the results for WTR. In the small city of Eleusina, the absolutely passive percentage is quite high for both, WTP and WTA (46% and 67%, respectively), but 47% of the interviewees are in favor of relocation; this can be attributed to the high price of land in this suburb of Athens; the interviewees think they can take advantage from changing the use of land from industrial to urban, while they believe that the industrial units, where most of the inhabitants work, will relocate to a nearby place, quite accessible without entailing excessive transportation cost.

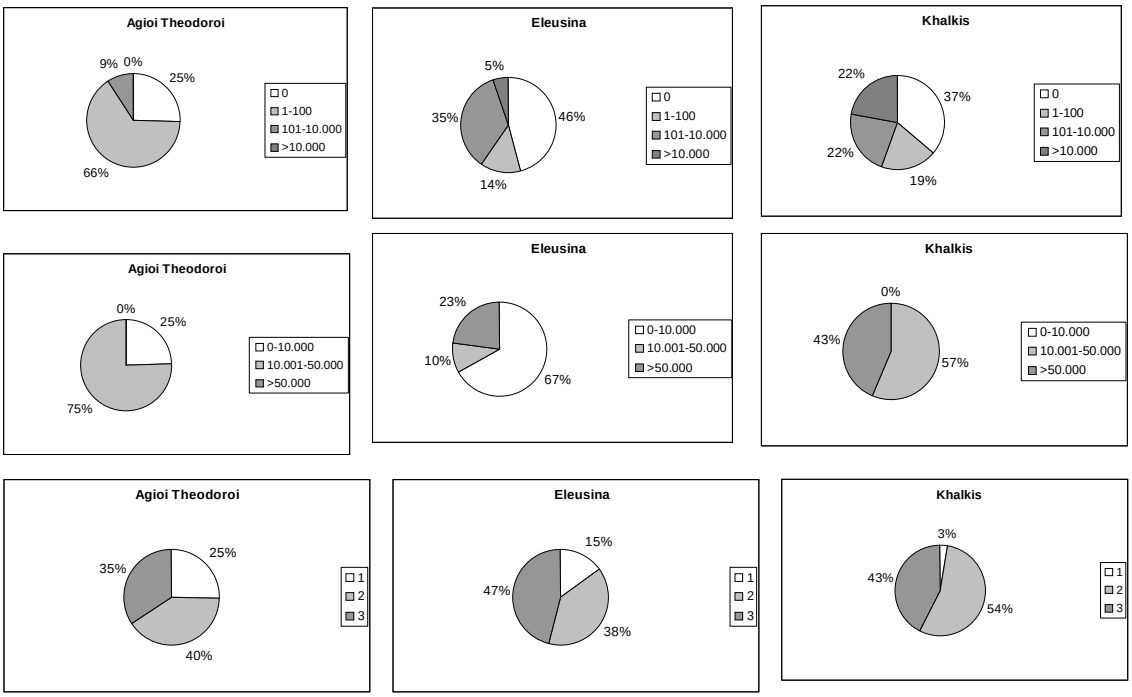

Figure 2. Pie charts presenting percentage of answers for Willingness To Pay (WTP), Willingness To Accept (WTA), Willingness To Relocate (WTR), in the first, second, third row, respectively.

CONCLUSIONS

The functionality of the methodological framework, developed under the form of an algorithmic procedure including 28 activity stages and 3 decision nodes, for evaluating environmental impact caused by industrial activities was proved by applying it to three cases at sites close to Athens, referring to (i) the towns/ports Agioi Theodoroi (50.94 Km south of Athens) and Khalkis (54.87 Km north of Athens), where the source of pollution is an oil refinery and a cement production unit, respectively, and (ii) the small industrial city/port (actually a suburb 18.04 Km to the south of Athens) of Eleusina, where there are several sources of pollution. Certain results presented herein give reasonable implications between WTP, WTA, WTR, although the absolute monetary magnitudes between WTP and WTA as well as their ratio differ significantly from what is quoted in technical literature; the relatively high percentage of interviewees answering in favour of the relocation of the polluting industrial units can be attributed to their belief that they can take advantage from changing the use of land from industrial to urban, while they think that the industrial units, where most of the inhabitants work, will relocate to a nearby place, quite accessible without entailing excessive transportation cost.

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