An Accidental Oil Spill Along the Belgian Coast: Results from a CV Study

Karl van Biervliet, Dirk Le Roy
and Paulo A.L.D. Nunes

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Karl van Biervliet and Dirk Le Roy, *ECOLAS*
Paulo A.L.D. Nunes, *Department of Economics, University of Venice and Fondazione Eni Enrico Mattei*

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Summary

This paper offers an economic assessment of the loss of non-use values resulting from different oil spill scenarios along the Belgian Coast. Estimation results show that if no oil spill prevention policy action is undertaken, a significant welfare loss may result. As a matter of fact, contingent valuation estimation results show such a welfare loss ranges from 120 million Euro to 606 million Euro, depending on the size and the frequency of the oil spill under consideration. Therefore, any investment program targeted at the prevention of oil spills, and its damage on the marine environment, can be clearly defended from a cost-benefit perspective as long as its cost is no higher than 120 million Euro.

Keywords: Oil Spill, Prevention Scenario, Contingent Valuation, Cost Benefit Analysis

JEL Classification: Q51, Q53, Q54, Q58

Address for correspondence:

Karl van Biervliet
ECOLAS
Lange Nieuwstraat 43
B-2000 Antwerp
Belgium
E-mail: karl.vanbiervliet@ecolas.be

1. INTRODUCTION

The North Sea is situated between Great Britain, Norway, Sweden, Denmark, Germany, The Netherlands, Belgium and France. The Belgian North Sea coast has a total length of 65km.This coastline plays a significant role for both regional and national economies since on that same area are located important industrial and service activities including fisheries, sand extraction, and tourism. On the other hand, the Belgian sea and coast is also a unique ecological system. Such an ecological system does not only provide different environmental benefits, such as the protection of valuable terrestrial and marine habitats, including sand-banks, beach, flat and salt marsh, estuary, dune biotopes, which host a wide range of mammal and plant life diversity. For example, vulnerable sea and coastal birds have their breeding ground and wintering place at the Belgian coast. In addition, such an ecological system is characterized by a dynamic and resilient functioning that, in turn, provides an important ecological services such a the chemical balance of the water.
Since most of this range of environmental benefits do have a price and all the industrial and service activities are market price, human interventions have been invested in promoting these same economic activities leaving the marine and coastal ecosystem under heavier pressure.

Accidental oil spills are one example of the human pressure and constitute one of the biggest threats to that ecologic system. Annually ten thousand ships sail through the canal heading to or coming from the ports around the North Sea, some of which with an international character such as Rotterdam in the Netherlands and Antwerp in Belgium. Through the small depth of the Southern North Sea the large ships (among which oil tankers) are channelled in a central, deep shipping route. These shipping circumstances, climatic conditions, such as dense fog and possible human errors cause a real risk on accidents.
In the period 1991-1998 eight shipping accidents happened in the Belgian part of the North with oil spillage as a result. The largest accident, until now, in 1992, (`Amer Fuji'/'Meritas' collision) resulted in an estimated 225m³ oil spill. Accidents with large oil pollution happen regularly in European waters. End 1999, in France, the accident with the Erika happened in coastal waters near Britannia. End 2002, in Spain, there was the accident with the Prestige. Both accidents caused an enormous damage to the marine environment. For this reason the economic valuation of the damage caused reveals to be an important instrument for environmental damage assessment (e.g. assessing who is affected by the spill and how important is the damage in monetary terms) and policy guidance (e.g. assessing which type of government intervention to implement – shall one invest in prevention or restoration activities?).

Following the general framework of environmental economics, we can make a distinction between damages to use and non-use functions. In case of an oil spill, the

most important use functions are commercial fishing and recreation activities. The data for valuation of these functions can be respectively based on market data and alternative valuation methods such as the travel cost method (Loomis and Walsh 1997).

In addition to use values, a marine and coastal ecosystem has an important non-use, existence or passive use value, which may be affected by an accidental oil spill. Existence values are defined as the benefit received from simply knowing the resource exists even if no use is made of it. If the marine environment is affected by the disaster, e.g. the extinction of locally protected seabirds, our welfare is negatively affected. This welfare change can be estimated in monetary terms by use of the Contingent Valuation (CV) method. In a CV study, a contingent valuation questionnaire is designed (see Nunes 2002). If a respondent was directly asked 'How much would you be prepared to pay for the non-operating function of the Belgian part of the North Sea?', it would be very difficult for that respondent to know what we would be paying for. That is why the non-use function of the Belgian part of the North Sea is 'translated' into something more tangible; something the respondent is more familiar with. For this reason, economists work together with natural scientists so as to create a oil protection scenario that is described in the instrument survey and well understood by the respondents. This method has among other things been applied for the estimation of non-use values in case of the Exxon Valdez oil spill (Carson et al. 1992). In the study present for discussion, the CV method has been applied in case of an oil spill before the Belgian Coast.

2. SURVEY DESIGN AND FINAL STRUCTURE OF THE QUESTIONNAIRE

The CV method is the subject of lots of criticism. The question is whether the CV method can generate valid economic values. The CV method was critically analysed in 1993 by a committee, appointed by the National Oceanic and Atmospheric Administration (NOAA) and chaired by two Nobel Prize winners. The committee concluded that the CV method can generate valid economic values, but it is necessary that the structure of the survey fulfil certain stipulations (Arrow et al. 1993). During the development of this CV study, the NOAA criteria were taken into consideration.

The development of the CV survey instrument took over 10 months. A first survey was formulated by means of a literary study. Because of the need of a reliable scenario structure, a team of experts was brought together several times. The result was a number of background documents serving as a scientific basis for the different scenarios of the survey. As a result of these background documents, a second survey was formulated, in which the structure of the scenario was adapted. Afterwards, a working visit was paid to an expert in the CV method, Professor J. Loomis from Colorado State University. The second survey was presented to him. With the suggestions he made, the second survey was adapted. Finally, two focus groups were brought together to further adapt the survey. In the next step, eight in-depth interviews were executed. Knowing the results of these interviews, a final survey was formulated. Little adjustments were made to the final survey after the pre-tests.
Below the final structure of the questionnaire is described with special attention to the design of the scenario and design of the valuation questions.

2.1. Initial questions

The interview starts with a question which checks on the social attitude of the respondent with regard to a number of social problems. At the start of the interview the respondent doesn't know that the specific subject of the interview concerns oil pollution. The second question builds further on the first question. Here the respondent must choose between a number of specific environment topics among which oil pollution on sea. These first two questions also serve as introducing questions. They help the respondent to empathize and to put him at his ease.
After answering both questions, the respondent is conducted slowly to the core of the interview, namely the scenario and the program with the willingness-to-pay (WTP) questions. Mainly the respondents get an explanation about the use of the opinion of the citizen for the government. At the end he is informed about the real contents of the interview: a programme for prevention of environment damage caused by accidental oil pollution in front of the Belgian Coast.

2.2. Presentation of the reference situation and the scenario

2.2.1. Presentation of the Belgian part of the North Sea

First of all the area in the North Sea Belgium is responsible for is indicated. Then the different functions of the North Sea, the economic, the recreation and the ecologic function of the North Sea are explained with a number of examples. Next the most important parts of the North Sea are discussed with their unique function for nature, among other things the sand-banks, the beaches and the nature reserves the Zwin and the IJzermonding. Everything is shown on drawings or photographs, in that way the respondent can process the information more easily.
Also a number of threats to this natural wealth is listed: over fishing, pollution with environmental dangerous substances, disruption of nature areas and oil pollution by accidents with ships and tankers. The respondent is informed that in front of the Belgian coast a number of accidents with oil pollution has already happened, but with limited damage compared to damage by accidents in surrounding countries.
Then, as a consequence, there is stated that within a number of years there will almost certainly happen an accident with damage to the marine environment of the Belgian part of the North. This caused by the narrow channels, frequently occurring fog, bad weather conditions and possible human errors.
Hereafter there is told that the international legislation will oblige a number of measures preventing oil damage as from the year 2010. Because of this the chance on oil pollution with heavy impact on the surrounding environment will be very small as from 2010. To avoid an accident in the meantime, the Belgian government can put into action prevention - and intervention programme. In that way the nature value of the Belgian part of the North Sea is protected as much as possible.

2.2.2. Financing the programme

To be able to finance the Belgian programme, a financial contribution is expected from both the producer and of the consumer of oil products. There is also shown that almost every Belgian citizen is an oil user: products such as fuel for heating and transport, medicines, plastics and shampoo. The oil companies would pay the functioning costs of the intervention programme and the Belgian citizens would pay the investment cost of the intervention - and prevention programme.
There is explained that each family would have to pay one-time financial contribution and this approximately four months after the execution of the interview. This means that when the interview is executed in April, the respondent should pay the financial contribution in September.
Then there is told that it is not certain that the programme will be installed, but that it depends on a referendum. Afterwards it is clearly explained that the aim of this interview is to examine if the Belgian population would vote in favour or against the intervention and prevention programme in such a referendum.

2.2.3. Presentation of the intervention and prevention programme

In this part of the questionnaire the scenario is presented with clear photographs and illustrations. The scenario in this questionnaire consists of a risk at an accidental oil spill before the Belgian Coast, with a certain environmental impact, which can be avoided with an intervention and a prevention programme.
The impact is presented by means of five parameters:

- Number of birds that will die;
- Number of fish, crabs, shrimps and lobsters that will die;
- Pollution of the beach;
- Pollution of the nature reserve the Zwin;
- Pollution of the nature reserve the IJzermonding.

A range of measures is necessary to prevent damage to the marine environment. These measures are split up in two parts. First a prevention programme which must prevent accidents, consisting of:

- A separate shipping route;
- Communication system.

Second an intervention programme is presented which must minimise damage resulting from a possible accident. This programme consists of a set of four measures:

- Number of tugboats;
- Number of oil-combating platforms;
- Measure to close the nature reserve the IJzermonding;
- Measure to close the nature reserve the Zwin.

The survey scenario is always a change in environmental quality opposed to the reference situation. This means that a CV study values a certain change in quality of the good. To check how the WTP changes in function of the environmental quality, different scenario's need to be developed.
The three scenarios that were elaborated are described in Table 1.

Table 1. Description of the different scenarios.

Features	*Severe scenario*	*Moderate scenario*	*Light scenario*
Damage			
Size of the oil spill	10 000 m³	5 000 m³	200 m³
# of birds that will die	43 000 – approximately 65%	20 000 - approximately 30%	3 500 - 5%
# of fish, crabs, shrimps and lobsters that will die	20%	10%	0%
Pollution of the beach	60 km - 90%	25 km - 40%	0 km - 0%
Pollution of the nature reserve the Zwin	Yes	No	No
Pollution of the nature reserve the IJzermonding	Yes	Yes	No
Program			
Separate shipping route	20 km	10 km	5 km
Communication system	Yes	Yes	Yes
# of tugboats	3	2	1
# of oil-combating platforms	3	2	1
Measure to close the nature reserve the IJzermonding	Yes	No	No
Measure to close the nature reserve the Zwin	Yes	Yes	No

In order to have a sufficient large sample per scenario, more than one scenario was incorporated in most of the questionnaires. Each respondent got two different scenarios in the survey (in some cases only one: version 4). A variation in the frequency of appearance of an accidental oil spill was also included in the questionnaire to check whether this would have an effect on the willingness to pay.
The frequency of possible accidents differs from questionnaire to questionnaire; an accident will occur every three, five or ten years. The four different versions of the questionnaire are shown in Table 2.

Table 2. Overview of the different questionnaire versions.

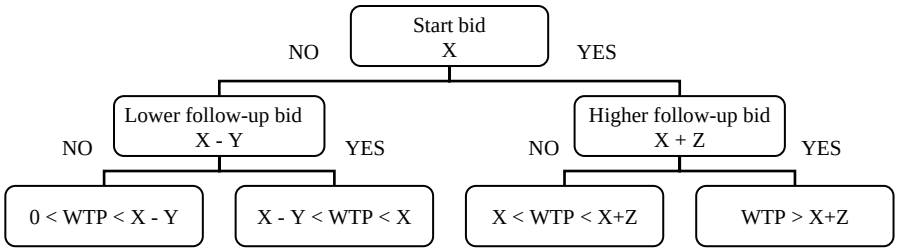
Questionnaire version	*Scenario 1*	*Scenario 2*	*Frequency*
Version 1	Light (A)	Moderate (B)	1 in 3 years
Version 2	Light (C)	Severe (D)	1 in 5 years
Version 3	Moderate (E)	Severe (F)	1 in 10 years
Version 4	Severe (G)	-	1 in 10 years

2.3. Valuation questions

2.3.1. Willingness-to-pay questions

The design of the WTP questions was almost similar to the design of two earlier CV oil spill studies in the US (Carson et al. 1992 and Carson et al. 1996).
The WTP questions are asked in the form of a referendum. The contribution only needs to be paid when more than 50% of the Belgian households agree with the programme. A one-time-contribution is required. The payment vehicle is a payment to a fund. The money in this fund can only be used for the execution of the programme.
The ‘Dichotomous choice with one follow-up’ was chosen as the most appropriate elicitation method and this for two major reasons. Firstly, respondents have difficulties to put a value on the program without any assistance (Mitchell and Carson 1989: 97). Secondly, the statistical power of the estimation of the willingness to pay raises with a follow-up question (Carson et al. 1992: 17). Each respondent is asked whether they’re prepared to pay a certain amount (starting bid) for a suggested programme to avoid damage. When the respondent answers yes, the same question is asked with a higher amount (higher follow-up bid). When the respondent answers no, the same question is asked with a lower amount (lower follow-up bid).
In that way we get four possible intervals for every bid card which reflects the willingness to pay of the respondent (See Figure 1). When a respondent answers 'yes-yes', the WTP is between zero and the lower follow-up bid, when he answers 'no-yes', the WTP is between the lower follow-up bid and the start bid, when he answers 'yes-no', the WTP is between the start bid and the higher follow-up bid, when he answers 'yes-yes', the WTP is higher than the higher follow-up bid.

Figure 1. Dichotomous choice with one follow-up



A WTP question is asked after the first and after the second scenario in every questionnaire. Seven different bid cards were used for the first scenario to receive an equal spreading of amounts; the amounts on the bid cards for the second scenario were each time 20% higher compared to the amounts on the bid card of the first scenario (see Table 3).

Table 3. Different bid cards for scenario 1 and 2.

	Bid card scenario 1			*Bid card scenario 2*		
	Start bid	*Higher bid*	*Lower bid*	*Start bid*	*Higher bid*	*Lower bid*
Bid card 1	24.79	61.97	9.92	29.75	74.37	12.39
Bid card 2	37.18	74.37	18.59	44.62	89.24	22.31
Bid card 3	49.58	99.16	24.79	59.49	118.99	29.75
Bid card 4	61.97	123.95	30.99	74.37	148.74	37.18
Bid card 5	74.37	148.74	37.18	89.24	178.48	44.62
Bid card 6	99.16	198.31	49.58	118.99	237.98	59.49
Bid card 7	123.95	247.89	61.97	148.74	297.47	74.37

2.3.2. Second round of the WTP questions

After the WTP questions the respondent gets the chance to revise his answer. This can be necessary when the respondent should have misunderstood something. For this reason it is examined if it was clear to the respondent that he would only have to pay a one-time contribution and if it was clear that he would only have to pay for one of the programmes.
Also if the respondent understood everything well, he got the possibility to revise his WTP answer for the first scenario, this because the respondent could change his judgement for the first scenario after being informed about the second scenario

(extra information). If the respondent wishes to change his WTP for the first scenario, he also got the chance to change his WTP for the second scenario.

2.4. Questions about the respondents' attitude and (possible) use of the good

In this part of the questionnaire a number of questions is asked about the attitude of the different family members concerning the North Sea.
Firstly the respondent is asked if anyone of his family visits (how many times) the Belgian Coast and what the reason is for these visits. There is also asked if the family sometimes visits foreign coasts.
The next question examines if a possible oil spill before the Belgian Coast would influence the profession and/or income of the respondent.
The last part concerns the attitude of the respondent towards nature in general. Questions are asked about the family members watching nature documentaries on television or reading books about nature. There is also asked if one or more family members are member of an environmental association and if they donate money to environmental projects.

2.5 Evaluation questions

Two evaluation questions are asked. The first question examines if the respondent thinks that the proposed programmes to prevent damage are very effective, effective, or not effective. The second evaluation questions examines if the respondent felt influenced during the interview and if he felt free to give his opinion.

2.6 Questions about the respondents' socio-demographic situation

In this part questions are asked concerning the sex, the age, the professional situation, the gained diploma, the income category and the domestic situation (partner and number of children living at home) of the respondent and its family.

2.7. Evaluation questions for the interviewer

All the questions in this section need to be filled in by the interviewer after the interview.
The first question concerns the proceeding of the interview. If the interview didn't proceed well, the interviewer can give some reasons for that, such as 'the respondent wasn't interested', 'the interview was frequently disturbed' …
The second question examines if the respondent understood everything well. When this was not the case, the interviewer needs to indicate which part and why he thinks that.
For the last question the interviewer needs to give his opinion about the WTP answers of the respondent. The interviewer needs to indicate if he thought that the respondent answered honestly and took into account its budget constraint.

3. SURVEY EXECUTION

3.1. Sample drawing

The relevant population for this CV study consists of all Belgian households, this because the one-time contribution needs to be paid per household. The interviews are as much as possible directed to the person who is responsible for the expenditures in the household.
The sample was built up to be as much as possible representative at federal, regional and province level. The city selection in every province took into account the type of city following the hierarchy 1997 of E. Van Hecke (Van Hecke 1998). In every province one type of city is randomly selected. In every selected city the 'random route sample drawing with repetition' is applied. A number of start addresses for every selected city is chosen randomly. Beginning with the start address, 6 doorbells are rung. When nobody is at home, the interviewer goes back one time at another day of the week and another hour of the day. The number of start addresses per city is determined by multiplying the size of the sample with the relative number of inhabitants per type of city and province.

3.2. Training and supervision of the interviewers

Most of the interviewers were students that were involved in the project through their thesis. A manual was prepared for the interviewers. The manual contained a part dealing with the CV method, an organisational part and a part with a questionnaire with an extra explanation per question. Next to this manual all interviewers got an education ranging from a half to one day. During this education some test interviews were done. Before starting with the real interviews, every interviewer had to do an internal test interview. All interviewers needed to report regularly to the coordinator of the interviews.

3.3. Survey execution

The interviews were executed in the period March-August 2001 in the Flemish District, in the period July-September 2001 in the Walloon District and in August 2001 in the Brussels District. The objective was to have 500 to 600 executed interviews. In total 2 626 doorbells were rung and 571 interviews were executed (see Table 4).

In total 1.790 households were reached and were 571 interviews executed, this means an overall response rate of 32%.

The response rate in the Flemish District (33%) is 2% higher than the response rate in the Walloon District. The low response rate in the Brussels district can be compared with the response rate in other big cities such as Antwerpen and Liège.

Table 4. Response rate per district.

	Belgium		*Flemish District*		*Walloon District*		*Brussels District*	
# of doorbells rung	2 626	100%	1 469	100%	954	100%	203	100%
# of households reached	1 790	68%	1 083	74%	629	66%	78	38%
# of interviews executed	571	32%	358	33%	196	31%	17	22%

The main reasons why people don't want to cooperate are 'no interest' and 'no time'. The different interviews are divided over the different questionnaires as follows:

- 30% for the questionnaire version Light-Moderate
- 30% for the questionnaire version Moderate-Heavy
- 30% for the questionnaire version Light-Heavy
- 10% for the questionnaire version Heavy

The different bid cards are divided proportionally among the survey respondents.
The average duration of an interview is 26 minutes. In the Flemish district the average is seven minutes lower than in the Walloon district and the Brussels district. The longest interview lasted 1 hour and 20 minutes; the shortest interview lasted 10 minutes. 80% of the interviews lasted between 20 and 40 minutes.

4. RESULTS

4.1. Descriptive analysis of the valuation questions

4.1.1. Type of response per questionnaire version

Table 6 and Table 7 present the percentage Yes-Yes (YY), Yes-No (YN), No-Yes (NY) and No-No (NN) answers per scenario en per bid card on the WTP questions. The percentage yes-yes answers on the lowest bid card are always higher than the percentage yes-yes answers on the highest bid card. This confirms the theory saying that the number of votes drop when taxes rise. The percentages of the bid cards in between don't follow always this theory consequently. The reason for that is that the different bid cards are relative close to each other with a relative low number of observations per bid card.

Table 6. Answers to the WTP questions of the first scenario.

Bid card	*Light 1/3 (A)*				*Light 1/5 (C)*				*Moderate 1/10 (E)*				*Severe 1/10 (G)*				*All 1st scenario's*			
Start bid (EUR)	*YY*	*YN*	*NY*	*NN*	*YY*	*YN*	*NY*	*NN*	*YY*	*YN*	*NY*	*NN*	*YY*	*YN*	*NY*	*NN*	*YY*	*YN*	*NY*	*NN*
24.79	60%	12%	4%	24%	46%	21%	13%	21%	55%	23%	0%	23%	30%	70%	0%	0%	51%	25%	5%	20%
37.18	35%	35%	8%	23%	28%	48%	12%	12%	42%	38%	0%	21%	45%	18%	18%	18%	36%	37%	8%	19%
49.58	28%	44%	8%	20%	41%	37%	4%	19%	36%	40%	4%	20%	50%	38%	0%	13%	36%	40%	5%	19%
61.97	37%	44%	0%	19%	13%	57%	9%	22%	25%	46%	13%	17%	36%	36%	9%	18%	27%	47%	7%	19%
74.37	20%	40%	20%	20%	29%	25%	8%	38%	27%	32%	23%	18%	33%	33%	11%	22%	26%	33%	16%	25%
99.16	23%	42%	15%	19%	29%	33%	10%	29%	22%	48%	13%	17%	11%	33%	22%	33%	23%	41%	14%	23%
123.95	13%	17%	13%	57%	23%	36%	14%	27%	23%	32%	9%	36%	13%	63%	25%	0%	19%	32%	13%	36%

Table 7. Answers to the WTP questions of the second scenario.

Bid card	*Moderate 1/3 (B)*				*Severe 1/5 (D)*				*Severe 1/10 (F)*				*All 2nd scenario's*			
Start bid (EUR)	*YY*	*YN*	*NY*	*NN*	*YY*	*YN*	*NY*	*NN*	*YY*	*YN*	*NY*	*NN*	*YY*	*YN*	*NY*	*NN*
29.75	56%	20%	4%	20%	38%	29%	8%	25%	41%	41%	0%	18%	45%	30%	4%	21%
44.62	38%	27%	4%	31%	28%	48%	12%	12%	33%	33%	8%	25%	33%	36%	8%	23%
59.49	32%	40%	8%	20%	44%	33%	4%	19%	36%	40%	4%	20%	38%	38%	5%	19%
74.37	26%	52%	4%	19%	9%	52%	9%	30%	24%	40%	8%	28%	20%	48%	7%	25%
89.24	12%	52%	12%	24%	25%	33%	4%	38%	19%	43%	19%	19%	19%	43%	11%	27%
118.99	27%	35%	15%	23%	33%	24%	14%	29%	30%	39%	13%	17%	30%	33%	14%	23%
148.74	13%	13%	13%	61%	27%	36%	14%	23%	18%	36%	0%	45%	19%	28%	9%	43%

4.1.2. Protest answers

A number of respondents neither want to pay the start amount nor the lower follow-up bid (No-No answer). For the first scenario in the questionnaire there are in total 129 No-No answers (= 23%), for the second scenario there are in total 130 No-No answers (= 26%). Respondents who give such an answer are asked for their reason. The two important reasons to give a No-No answer are 'the oil companies have to pay everything' and 'I don't want to pay extra, the government needs to pay everything. A large number of reasons can be considered as a protest answer. This means that out of the reason to answer No-No to the WTP questions, we can conclude that the respondent possible has a positive valuation for the good. The two reasons that were not considered as a protest answer are 'The proposed project has not such a big value for me' and 'My income doesn't allow me to pay that amount'. For the first scenario in the questionnaire there are in total 114 protest answers (= 20%), for the second scenario there are in total 113 No-No answers (= 22%) (see Table 8). The higher number protest answers in the second scenario can be explained by the fact that some respondents declared 'the first programme is enough'. From Table 8 we can conclude the number of protest answers is higher in the Walloon and the Brussels District. An important reason for this difference is that respondents in the Walloon and the Brussels District state that the Flemish District (where the Coast is situated) should pay everything. No conclusions can be made for the very high rate of protest answers in the Brussels District since the number of observations is very low.

Table 8. Protest answers per scenario and per district.

Protest answers	*Belgium*		*Flemish District*		*Walloon District*		*Brussels District*	
	#	%	#	%	#	%	#	%
1st scenario	114	20%	64	18%	42	21%	8	47%
2nd scenario	113	22%	62	20%	42	24%	9	69%

4.1.3. Second round of the WTP answers

Most of the respondents (98%) understood well that they had to pay a one-time contribution for one of the two presented projects. 5% of the all the respondents revised their answer to the WTP in the first scenario, for the second scenario this was less than 1%. Only 15% of the respondents stating that they didn't understand that it was a one-time payment revised their answer. For respondents stating that they didn't understand that they only had pay for one scenario, the revision percentage was 25%. Two third of the respondents revising their WTP for the first scenario, changed their WTP answer to a No-No answer with as main reason that they preferred the second scenario above the first scenario.

4.2. Calculation and analysis of the revealed WTP

4.2.1. Methods for calculation of the revealed WTP

The revealed willingness to pay is estimated in a parametric way and a non-parametric way.
No assumption is made about the form of the underlying distribution when the revealed WTP is calculated in a non parametric way. The 'Turnbull likelihood estimation approach' (Turnbull 1976) is used for the estimation of the cumulated density function of the WTP in the intervals defined by the start bids and the higher and lower follow-up bids of the different bid cards[1].
A logit regression model is used for the parametric estimation of the revealed WTP. Such a model is able to work with a discrete dependent variable this in contrary to a linear regression model. We used the software developed by Joseph Cooper en Daniel Hellerstein (the US Department of Agriculture, Economic Research Service) for the analysis of 'double-bounded dichotomous choice CVM-studies'.[2] This program uses the 'maximum likelihood estimation with the analytic first and second derivatives' of Hanemann et al. (1991) for the estimation of 'double-bounded logit' coefficients.

4.2.2. Calculation of the average and total WTP

The average WTP per household is calculated in two ways:

- Non-parametric (Turnbull likelihood estimation approach). The 'Lower-bound mean' of the estimated cumulative density function is calculated (conservative average). When a cumulative density function looks as follows:

WTP-intervals (EUR)	*Cumulative density percentage*
60 - ∞	100%
40 - 60	90%
20 – 40	30%
0 - 20	10%

Than the 'Lower-bound mean' is calculated using following formula:
0 * 0.1 + 20 * (0.3 – 0.1) + 40 * (0.9 – 0.3) + 60 * (1 – 0.9) = 34 Euro.

1 *These calculations were executed with the Turnbull nonparametric density estimation for CVM - Gauss version 1.0, October 1996, Olvar Bergland - Commented and extended by Paulo Nunes (1997).*
2 *Referendum CVM Programs, June 1994, DBLOGIT.*

- Univariate–parametric (logit-model), the average WTP is calculated out of the coefficients of the generated logit-function:

$$\frac{\text{- Coefficient constant}}{\text{Coefficient bid amount}}$$

The average WTP is calculated for every scenario with the protest answers included and excluded.
From Table 9 we can conclude that the average WTP (protest answers included) calculated with the logit-model and the Turnbull likelihood estimation approach are close to each other (maximum difference = 6.96 Euro in the Heavy-1/5 scenario).
De average WTP (protest answers included) varies from 88 Euro per household in the Light-1/3 scenario until 112 Euro per household in the Heavy-1/5 scenario (difference of 23.7 Euro). The differences between the different scenarios are small (see also paragraph 4.2.3.).

Table 9. WTP per household in function of the scenario's, protest answers included (in EUR).

Scenarios	*Light*		*Moderate*		*Severe*	
	Parametric - Logit	*Non-parametric*	*Parametric - Logit*	*Non-parametric*	*Parametric - Logit*	*Non-parametric*
1 in 3 years	88.37	90.31	100.00	103.10		
1 in 5 years	89.22	93.33			105.11	112.07
1 in 10 years			97.67	97.1	106.97	110.21
					98.02	94.50

The same can be concluded for the sample without protest answers (see Table 10).

Table 10. WTP per household in function of the scenario's, protest answers excluded (in EUR).

Scenarios	*Light*		*Moderate*		*Severe*	
	Parametric - Logit	*Non-parametric*	*Parametric - Logit*	*Non-parametric*	*Parametric - Logit*	*Non-parametric*
1 in 3 years	116.16	115.79	134.83	133,84		
1 in 5 years	117.13	116.81			142.24	142.86
1 in 10 years			119.19	117.13	137.43	135.99
					112.59	108.87

When the averages are converted to the Belgian population (average per family multiplied with the number of families), the total one-time willingness to pay of the Belgian population varies, protest-answers excluded, between 492 million Euro and 606 million Euro and protest-answers included, between 375 million Euro and 476 million Euro. If you assume that the people who refuse to participate in the questionnaire have a zero WTP, then these values vary between 157 million Euro and 194 million Euro and protest-answers included, between 120 million Euro and 152 million Euro.

4.2.3. Comparative-analysis

To verify whether the differences in willingness to pay are statistically robust to alternative survey design specifications, we perform formal testing procedures regarding the sensitivity of the WTP regarding:

1. Order of the oil spill, and respective policy scenario, in the questionnaire (order effect);
2. Frequency of the oil spill, and respective policy scenario, in the questionnaire (frequency effect);
3. Size of damage of the oil spill, and respective policy scenario, in the questionnaire (scope effect).

Two tests are performed:

- The Turnbull Ratio Test (TR test) – regarding the non parametric WTP estimates – to check possible differences in the distribution of functions;
- The Wilcoxon-Mann-Whitney test (WMW test) – regarding the parametric WTP estimates – to check possible differences between average WTP across survey design specifications.

The different survey design specifications can be classified in function of the frequency and the size of the damage (Table 11).

Table 11. Classification of scenario's in function of the frequency and size of the damage.

	Light	*Moderate*	*Heavy*	
1 in 3 years	A	B		
1 in 5 years	C		D	
1 in 10 years		E	F	G

A-B: Questionnaire version 1; C-D: Questionnaire version 2; E-F: Questionnaire version 3; G: Questionnaire version 4.

Order effect

The order-effect can be measured by comparing two scenarios with the same frequency and the same size of damage, appearing in a different order in a questionnaire. Scenario F and scenario G can be used for this analysis. From the results of the two tests we can conclude that there is no order-effect.

Frequency effect
The frequency-effect can be examined for:

- Scenario 1/3 and scenario 1/5 (A and C)[3];
- Scenario 1/3 and scenario 1/10 (B and E)[4];
- Scenario 1/5 and scenario 1/10 (D and F)[4].

From the results of the TR test we can conclude that there is no frequency-effect. From the results of the WM test we can conclude that there is a frequency-effect between scenario 1/3 and scenario 1/10, this for the sample with protest answers. No conclusions can be made for the sample without protest answers.

Scope effect
The scope-effect can be examined for:

- Light scenario and Moderate scenario (A and B);
- Light scenario and Heavy scenario (C and D) [4];
- Moderate scenario and Heavy scenario (E and F) [4].

From the results of the TR test we can conclude that there is no frequency-effect. From the results of the WM test, sample with protest votes, we can conclude that there is no scope effect. From the results of the WM test, sample without protest votes, we can't make a conclusion about a possible scope-effect.

The results of the comparative-analysis are not clear. Possibly, more observations per scenario should have resulted in clearer results.

4.3. Valuation function

4.3.1. Construction of the multivariate WTP model

A valuation function checks which factors influence the willingness to pay. A logit-regression model is used to build up the valuation function (see paragraph 4.2.1.).
For the valuation function, the two scenarios per questionnaire are used as two separate observations with an extra variable in the function which states if the scenario appears first or second in the questionnaire. One type of questionnaire contained only one scenario (Heavy-1/5). This type of questionnaire is not used for the valuation function because for all other questionnaires the respondent has two observations. In this way every respondent gets the same weight in the valuation function. Also protest answers excluded for calculation of the valuation function.

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3 Scenarios B and D can't be used since there is also a difference in the size of damage.
4 These scenarios can be compared since there is no order-effect.

Finally 357 (of the 571) questionnaires are used as an input for the valuation function (= 714 observations). From the econometric point of view, the building of the empirical model is characterized by a the use of the 'forward step procedure'. In other words, the model starts with a constant, bid (start bid), bidlow (lower follow-up bid) and bidhigh (higher follow-up bid). A variable is each time added to the existing model. The 'Likelihood Ratio Test' examines if the new variable has an influence on the WTP. The test is done at a 5% significance level.

4.3.2. Final model estimates and interpretation

According to our estimation results, table 13 shows the model specification that best fits the data. The coefficients in Table 13 can be interpreted as follows: a positive coefficient (or exponent of this coefficient > 1) [5] means a positive influence of the variable on the WTP. Below a short explanation per variable is given.

As we can see the older the respondent the less she/he is willing to pay. In the same way, the higher is the reported income of the respondent the more she/he is willing to pay.

The respondent is willing to pay more for the second programme than for the first programme. This is logic because the second programme prevents more damage than the first programme (and as a result the bid amounts are also 20% higher in the second scenario). From the comparative-analysis in paragraph 4.2.3. we can conclude that there is no order-effect and for the scope-effect-test no conclusions could be made. From the results of the valuation function we can conclude that there is no scope-effect, since none of the variables related to damage and measures is selected in the model. But both effects together (order-effect and scope-effect) seem to have an influence on the WTP[6].

The province one is living in influences the willingness to pay. The values need to be interpreted in function of the reference province, this is the coast province West - Vlaanderen (coefficient 0). A positive coefficient (Vlaams-Brabant, Antwerpen en Luxemburg) means that in this Province the WTP is higher than in West-Vlaanderen.

Table 13. Selected variables in the final valuation function.

5 With exception of the variable 'Bid amount'. Hanemann et al. (1991) states that the negative value of the coefficient need to be taken.
6 For the formulation of the valuation function 714 observations are used, compared to approximately 260 observations in the difference analysis without protest answers.

Variable	*Coefficient*	*Stand. Dev.*	*T-Stat.*	*Exp (Coeff.)*
Constant	2.2453	0.7841	2.8640	9.4432
Bid Amount	-0.0007	0.00003	-20.3300	1.0007
Order of appearance of the scenario	0.4086	0.1580	2.5860	1.5048
Living in province (reference is West-Vlaanderen = Coastal province)				
Oost-Vlaanderen	-0.7459	0.3035	-2.4580	0.4743
Vlaams-Brabant	0.0733	0.3594	0.2040	1.0761
Antwerpen	0.0163	0.3109	0.05253	1.0165
Limburg	-0.0841	0.3771	-0.2231	0.9193
Waals Brabant	-0.8948	0.5161	-1.7340	0.4087
Henegouwen	-0.8517	0.3528	-2.4140	0.4267
Luik	-0.2152	0.3487	-0.6171	0.8064
Namen	-0.2808	0.4329	-0.6485	0.7552
Luxemburg	0.4715	0.8858	0.5322	1.6024
Brussels Gewest	-0.9468	0.8322	-1.1380	0.3880
Knowledge of the nature reserve ‘de IJzermonding’	0.4929	0.1959	2.5160	1.6370
Visiting the coast for the fresh and healthy air	-0.4305	0.2242	-1.9200	0.6502
Watching movies or reading books about nature (reference is very often)				
Often	-0.2572	0.2206	-1.1660	0.7732
Sometimes	-0.5292	0.2339	-2.2620	0.5891
Rarely	-0.2941	0.3390	-0.8675	0.7452
Never	-1.6275	0.5155	-3.1570	0.1964
Donating to an environmental organization or a specific environmental project	1.2133	0.2649	4.5810	3.3646
Age	-0.0181	0.5916	-3.0520	0.9821
Income (reference is class 0 – 496 Euro/month)				
496 - 992	1.3513	0.6185	2.1850	3.8623
992 - 1488	1.9996	0.6216	3.2170	7.3863
1488 - 1984	2.5384	0.6218	4.0820	12.6598
1984 - 2480	2.2105	0.6277	3.5210	9.1206
2480 - 2976	3.3619	0.6574	5.1140	28.8443
2976 - 3472	2.4854	0.6941	3.5810	12.0063
3472 - 3968	1.8171	0.7078	2.5670	6.1541
> 3968	4.2946	0.7663	5.6050	73.3037

Respondents who know the nature reserve ‘de IJzermonding’ (C1) are willing to pay more for the programmes. With this question we tried to select the respondents with

specific nature knowledge. In addition, respondents who frequently visit the coast for the fresh and healthy air (E32) are prepared to pay less for the programme than the other respondents.

The estimation results regarding the watching movies or reading books about nature *(E7)* need to be interpreted in function of the reference coefficient (watching and reading a lot). So, the more one watches nature films or reads books about nature the higher the willingness to pay. Equally interesting is to observe that respondents who already donated to an environmental organization or a specific environmental project are willing to pay more than other respondents. This may signal the presence of warm glow, i.e. the sense of moral satisfaction provided by the act of giving.

5. SYNTHESIS

This paper has offered an economic assessment of the loss of non-use values resulting from different types of oil spill along the Belgian Coast. For this economic assessment the contingent valuation method is used. The results show that if no policy action is undertaken as to prevent oil spill damage before the Belgian coastline a significant welfare loss may result. Only taking into account the non-use values from the CV study, the welfare loss amounts up to 606 million Euro, which corresponds to 0.24% of the Belgian GDP measured at market prices for the year 2001. When we use the most conservative value (scenario with lowest damage, including protest votes and assuming that respondents that refused to cooperate have a zero WTP) than the welfare loss amounts to 120 million Euro, which corresponds to 0.05% of the Belgian GDP. The estimated welfare loss ranges less in function of the size and the frequency of the damage. The Belgian Government has bought some years ago oil spill combating equipment for approximately 1.25 million Euro (VLIZ 2001). So we can conclude that such an investment, preventing even oil spills with a relative small impact on the marine environment, can be clearly defended from a cost-benefit perspective since it costs far less than 120 million Euro.

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