



Validity of CVM related to the type of environmental good; an empirical test

Erik Wierstra, Peter Geurts and Anne van der Veen *

University of Twente, Enschede, The Netherlands

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This research explores the boundaries of a valid application of contingent valuation as a method to value environmental changes. Recent criticism from social psychologists refers to unrealistic cognitive demands upon respondents. Criticism from economists point to the problem of measuring preferences in relation to non-use values. In this research the hypothesis is tested that the CV method in valuing goods with non-use value and with a complex content of information produces less valid results than with use values and non-complex content of information. Validity is tested across goods (sample survey: $N = 832$). Results show that scope validity is ambiguous for goods with high content of complexity. Construct validity is not guaranteed for environmental changes with non-use values: Economic factors are not significant, only attitudes are relevant. Given the importance of WTP figures in cost-benefit analysis these results are of paramount importance for the trust in contingent valuation.

Keywords: contingent valuation, cost-benefit analysis, validity

1. Introduction

The contingent valuation method is an accepted and established monetary valuation method for environmental changes (Hanley [19]). The hypothetical nature of contingent valuation (CV) methods, however, is an important source of criticism. This hypothetical nature creates the possibility to give an arbitrary response without bearing the consequences of (wrong) decisions. Conversely the hypothetical nature creates the advantage of valuing goods which cannot be valued by methods based on revealed preferences. The CV method is then being able to value environmental changes, which have never occurred yet, and to value changes with which respondents are not familiar. This implies that CV can be a useful instrument in *ex ante* decision making, like cost-benefit analysis (CBA). However, if CBA is to be accepted as a valid method to allocate scarce resources, the inclusion of willingness-to-pay (WTP) or willingness to accept (WTA) for environmental goods should also be based on a valid method.

In the discussion about the outcomes of CV studies, the survey design plays a major role. The independent NOAA CV Panel formulated various stringent guidelines, after which they conclude “that under those conditions [...] CV studies convey useful information” (Arrow et al. [5, p. 4610]). We will argue that this impression is optimistic. The conditions imposed on the survey design should in our view be interpreted as *necessary* conditions to obtain valid CV results, that is valid estimates of WTP or WTA. For the application of CV outcomes in economic decision making only a good result on a thorough test on validity of the application of the CV method is a *sufficient* condition. “It is not

possible to evaluate the contingent valuation method without considering the reliability and validity of its observed responses—the WTP amount” (Mitchell and Carson [8]).

In this article we will follow an experimental road to test the range of the valid application of the CV method. In our experiment the stimuli are environmental goods and the WTPs are the results. In contrast to the standard approach in literature on the CV method where one varies on the measurement instrument (e.g., comparison of the effect on the validity of single and double bound elicitation of WTP), we vary on the characteristics of the environmental good to be valued. We are not aware of any study that extensively tries to evaluate validity of WTP results across goods within one design.

Related to the characteristics of the environmental goods the discussion on validity of the CV method can be focused on two issues:

- (1) The question of a valid measurement of the WTP of environmental goods with non-use elements.
- (2) The question of the validity of the outcomes of the CV method in relation to the extent to which respondents are capable of handling complex information (as a characteristic of an environmental good).

1.1. Use/non-use elements in environmental goods

Criticism on the contingent valuation method in the assessment of non-use values as opposed to the application to use values is given in inter alia Diamond et al. [10]. The conclusion of this Exxon group, mainly based on empirical studies, is that the CV method is *not* suitable for measuring preferences. The main argument for this view is that

* Corresponding author; e-mail: a.vanderveen@bsk.utwente.nl.

WTP response is not plausible and also inconsistent with the assumption of rational choice in neoclassical economics. This implies that, if indeed the measurement of non-use values is inconsistent with the basic assumptions of neoclassical economics, economic theory will not very well predict WTP responses.

Despite the fact that many researchers are of the opinion that they enfeeble the thesis of the Exxon group by pointing at the bad survey design in these studies, it still remains questionable whether the CV method generates valid WTP results in measuring non-use values. Therefore, the first stimulus in our experiment will vary on the degree of use- and non-use elements of environmental goods.

1.2. Complexity of information related to environmental goods

In a CV scenario information is given to the respondents about the good and changes in the availability of the good which should be valued. The information about the good has to be simple enough for respondents to understand what they are asked to value. However, information about certain types of goods may be hard to understand. Moreover, it may be the case that even specific information about the good is not sufficient for respondents to give a valid WTP. Gregory et al. [16] are even of the opinion that the “unrealistic cognitive demands upon respondents” (p. 178) is the main problem in current CV methods.

The way a scenario within the CV method is described presupposes knowledge from the researchers about information processing of respondents. The degree of complexity of the scenario and the task difficulty, relates to the ability of respondents to keep the change in the to be valued good in perspective and to understand the consequences for their own situation (Harris et al. [20]; Krosnick [22]). CV studies which value the changes in goods that intrinsically need a complex scenario or a high task difficulty will therefore produce less valid WTP results. It is therefore recommended that more attention has to be paid to the limited capacity of individuals to handle a problem (Harris et al. [20]). Respondents frequently do not absorb essential information and take short cuts to solve their decision problem (Fischhoff et al. [13]). This presumes that respondents take a reference point to arrive at a certain choice of WTP amount. This may be related to the task complexity (i.e., to express a valid monetary indicator of preferences for a good) which is seen in cognitive psychology as an important cause of the lack of the procedural and descriptive invariance in decision-making (Payne et al. [27]). Respondents need help to process relevant information and to incorporate the information in their value statement.

The way psychologists approach the hypothetical nature of the scenarios economists make in researching the WTP for the preservation of certain environmental values, and the difficulties psychologists foresee, lead us to make a distinction between environmental goods with a high complexity of information and a low complexity. This complexity depends

on the degree to understand the information, accept the information and to overlook and realise the consequences. Therefore as a second stimulus we use variation in the complexity of information in our experiment.

1.3. Hypotheses

Given the discussion on use/non-use values and complexity of information we *hypothesise that the CV method in valuing goods with non-use value and with a complex content of information produces less valid results than with use values and non-complex information.*

In the next section we will elaborate on several aspects of the design of our study. In section 3 we will present a short description of the goods to be valued. In section 4 we present the plan of analysis with the inclusion of some specifics on the estimation of the WTP. Subsequently we consider the validity (i.e., internal consistency) of the psychological constructs and the results of the survey for construct validity of the separate environmental goods, whereas in section 5 we end with a discussion for the trust in CV analysis as a method for valuing environmental changes.

2. Design of the study

Introduction

Our experimental design is based on systematic variation in the use value and information complexity by using a diversity of environmental goods as stimuli. The hypotheses implicate variation in the validity of the resulting WTP results. What is generally understood by validity of results will therefore be the first subject of this paragraph. Then we reconsider shortly the theoretical stimuli and the empirical translation into three separate stimuli, i.e., environmental goods. Also, a short description is given on the organisation of the survey. This section ends with a short description of the assignment of respondents to the stimuli.

2.1. Validity of the WTP

The key variable in our research is the WTP. The hypothesis is that the validity of a WTP value depends on the above-mentioned characteristics of the specific good.

To tackle the problems of use/non-use and complexity of information of environmental goods in relation to the CV method we have to be more precise on what is meant with validity. We apply the basic ideas of classical measurement theory and sampling theory where a distinction is made between the true value and the observed value. In this case the WTP is the observed value. “The true value is defined as the average score that would be obtained if *the object* (added by WGV) was re-measured an infinite number of times on that variable” (Carmines and Zeller [7], but see also Mitchell and Carson [24]). Following Mitchell and Carson, and Carmines and Zeller in a formal definition of validity,

the true WTP of a good with characteristic j for individual i is defined as:

$$\text{WTPT}_{ij} = F(A, \alpha), \quad (1)$$

where A is a matrix of relevant characteristics of individual i (like economic and psychological attributes) and characteristics of good j (like use value, complexity of information, and risk level), and α is a vector of unknown parameters. However, it is impossible to observe the true WTP of person i of good j , we only can observe the revealed WTPR_{ij} .

$$\text{WTPR}_{ij} = Fr[F(A, \alpha), G1(B, \beta), G2(C, \gamma)]. \quad (2)$$

A , B , and C represent matrices of variables; α , β , and γ are vectors of unobserved parameters. $F(A, \alpha)$ is the true WTP_{ij} ; $G1(B, \beta)$ represents the result of the random error process (reliability); $G2(C, \gamma)$ describes the systematic error process; Fr is an aggregator function with unknown properties.

Also the variance (V_{ij}) of the WTP is a result of two factors, a random error component, and a deterministic factor. Now the validity of the WTP is formally defined as follows,

$$E(\text{WTPR}_{ij} - \text{WTPT}_{ij}) = 0, \quad V_{ij}. \quad (3)$$

The greater the difference between the revealed WTPR and the true WTPT , the greater the invalidity of the measurement of the WTP. Or in other words the validity is the degree to which one measures what one intends to measure.

$G2$ affects validity in (2). However, the factors in $G2$ are difficult to assess. Because of the hypothetical nature of the WTPR revealed we cannot make use of the comparison of the WTPR revealed with the result of another way of measurement like, e.g., travel cost method. A second approach is to produce more circumstantial evidence for the validity of the CV method. *In standard CVM literature on exploring the validity of the CV method one varies the measurement instrument as we already remarked, as we explicitly do not. We apply exactly the same method to each good.* The discussion on the relevance of the CV method is on the handling of non-use elements and on the capability of individuals to process complex information and therefore we systematically vary the elements of matrix C (in equation (2)). In our experiment we thus will vary not on the form of the measurement instrument, but on the characteristics of the environmental good to be valued which will supposedly affect the validity of the WTP.

It is also standard in CVM research to test the validity by assessing the theoretically predicted influences of individual *economic* as well as *psychological* characteristics on the WTP. This approach of a test of validity is also applied in the social and behavioural sciences literature where different behaviour is explained by personal characteristics (e.g., Adorno et al. [1], Fishbein and Ajzen [11]).

Here we assume that standard economic theory applies with behavioural differences explained by differences in income and household characteristics (Deaton and Muellbauer [9]). The better the individual economic characteris-

tics explain the variation of the WTP, the higher is the *economic construct* validity.

Elaborating on these issues, we observe that neo-classical economics as being the base for CV analysis, is said to lack a theory of motivation for non-use values (Green et al. [15], Bateman et al. [6] and Plott [28]). Individual motives underlying non-use values however, can be explored by including a number of statements to reveal attitudes towards (among others) the environment in general, the specific to-be-valued environmental change and the payment vehicle. In testing validity, theoretical models from social psychology are increasingly important as for example the model of reasoned behaviour (Fishbein and Ajzen [11]) or the model of planned behaviour (Ajzen [2,3]). In accepting these models, a powerful instrument is added to validate the CV results by relating the WTP to attitudes. The better the individual psychological characteristics explain the variation of the WTP, the higher is the *psychological construct* validity.

A complicating issue in our study is the so-called embedding problem. Hanley [19, p. 116] warns that, although tests on construct validity may be passed, embedding effects may invalidate this result as a consequence of (in)validity of scope. The validity of scope is the degree to which the WTP varies adequately with changes in the scale or scope of the environmental good being valued (Hanemann [18]).

2.2. General form of the design

In order to test the hypothesis we conducted a three-group post test design with three environmental goods as stimuli (called treatments in experimental design literature). The stimuli vary on the dimensions “complexity of information” and “use/non-use elements” (total sample size is 832).

The three environmental goods are thoroughly chosen and the questionnaire is tested repeatedly.

- A first pre-test of the general format of the questionnaire was fulfilled in 1994 on the good “Rottumeroog” (see below for details) (Geurts et al. [14], Overkamp [26]).
- The choice for the goods varying on the stimulus-dimensions use value and complexity of information was made as follows. We consulted experts on environmental issues in the Environmental Department of our university for an inventory of such goods. Then we presented to these experts the definitions of complexity of information and of use value of goods. Subsequently we asked them to come up with examples of such goods and to place the goods mentioned in a given use/complexity space. Remarkable was the fact that not any of the experts came up with a complex non-use good.
- After having made a choice we controlled our pick (in relation to the dimensions) again by consulting our colleagues.
- The next step was to apply the questionnaire to a limited number of persons in order to test our questionnaire format and to test our choice of the goods.

Table 1
Assignment of respondents by different use value and complexity of information.

Degree of use value	Complexity of information	
	Simple	Complex
High use value	N1 = 205 Changing to biological agricultural production	N3 = 402 Prevention of risk increase of inundation
Low (no) use value	N2 = 225 Prevention of disappearance of the isle of "Rottumeroog"	–

- The rather complicated questionnaire was then converted into an electronic form (CAPI: computer assisted personal interviewing) and again tested in a laboratory situation (videotapes were made of interviews).

The sample survey consisted of 832 randomly picked inhabitants of 18 years of age and older of the Netherlands and was applied in April–May 1995. In fact we applied a two stage stratified sampling technique in order to spread the respondents over the whole country.

The survey was conducted by a professional fieldwork organisation under our supervision.

The survey *design* has been set up according to the recommendations of the NOAA CV Panel (Arrow et al. [5]). For example, the elicitation method is the double bounded dichotomous choice (although not a referendum), computer-assisted personal interviews, trained and experienced fieldworkers, pretesting and extensive discussions with the fieldwork organisation.

Also, the *structure* of the survey was set up according to the structure of the survey used in the Alaska oil study of Carson et al. [8] and consists of four parts. The survey started with questions on societal problems and what would be the priority to solve these problems by the government (this part took about 15 min). The empirical results on these questions showed no surprises (in comparison with figures from Carson et al. [8]). This result indicates that our panel survey produces a valid picture of the Dutch population. These general attitude questions were followed by good specific attitudinal questions. After this, information was given on the "to be valued good" and then the WTP was asked. This second part lasted about 20 min. The questionnaire ended with background questions and a possibility to revise the earlier given WTP, which took about 15 min. The interviewer evaluated each interview afterwards in the fourth part of the questionnaire.

2.3. Assignment of the respondent to the stimuli

We assigned a respondent to a good by random generators in the laptops of the interviewers (see table 1):

- A simple information good with mainly use value: *paying for changing to biological agricultural production* (probability 1 : 4).
- A simple information good without any use value: *paying for the prevention of the disappearance of Rottumeroog*,

an uninhabited island in the Dutch wetlands (probability 1 : 4).

- A complex information good with mainly use value: *paying for prevention of risk increase of inundation (in order to enable to test for scope validity probability 1 : 2; see section 4)*.

3. Description of the goods (stimuli)

In this section we reproduce a short description of information on the three goods that we use as stimuli as presented to the interviewees.

3.1. Changing to biological agricultural production (use value and simple information)

This stimulus concerns the willingness to pay more for all agricultural products if these were to be produced by biological farming methods instead of regular farming.

In the Netherlands biological grown agricultural products are on sale in supermarkets specialised shops, and on the market. There is an ongoing political discussion on reducing pollution by changing agriculture into a more nature friendly agriculture. So it is a well-known use good already. This good is a valid indicator of a good with simple cognitive demands on the respondent and with mainly use value, because there is no reference to non-use elements of environmental degradation, and because the respondents are used to pay for agricultural products.

We present here the main information and the willingness-to-pay questions. In appendix A we show additional details of the questions asked (Wierstra [31]).

- (1) In the Netherlands, there are roughly one hundred thousand agricultural companies with about five million cattle, fifteen million pigs and one hundred million chickens. Due to, amongst others, the use of fertilizers and pesticides, Dutch agriculture has the world's largest production per hectare of agricultural soil. The pesticides, the animal fertilizers and the artificial fertilizers have as only side-effect that they cause soil pollution.
- (2) Next to this REGULAR agriculture, there is an increasing use of BIOLOGICAL agriculture in the Netherlands. NO use is made of artificial fertilizers and chemical pesticides on these agricultural companies. The result of

using biological cultivation methods is thus primarily much less pollution of agricultural soil.

- (3) The government is considering converting regular agriculture to biological agriculture, whereby no more use is made of artificial fertilizer and chemical pesticides. If we in the Netherlands completely convert to biological agriculture, then the pollution of agricultural soil will be much less than is the case now. After converting to biological agriculture, there will also be less production per hectare. This has as a consequence that the prices of vegetables, fruit and potatoes will rise.
- (4) The willingness-to-pay question then was: “If the government decides to change over all agriculture to biological agriculture, it is estimated that your household will pay. . . per month more for vegetables, fruit and potatoes. Are you prepared to pay. . . per month EXTRA for vegetables, fruit and potatoes if the government ensures that Dutch agriculture will completely switch to biological agriculture?”

(1) Yes, (2) no, (3) no plus protest, (4) maybe/unsure.

If “yes” (if “no” is not reproduced here): You have just said that you would be prepared to pay. . . extra for vegetables, fruit and potatoes, if these are biologically cultivated. It is possible that the prices of biologically cultivated products turn out higher. Imagine the ULTIMATE estimate is that it will cost your household. . . per month extra to switch to products that are biologically cultivated. Are you then willing to pay. . . per month extra for vegetables, fruit and potatoes that have been biologically cultivated. (1) Yes, (2) no, (3) maybe/unsure.

What is the highest amount per month that you are willing to pay if it can be used to ensure that all agricultural products are biologically cultivated?

3.2. Prevention of disappearance of the uninhabited island Rottummeroog in the Dutch wetland ecosystem (a non-use and simple information good)

The second stimulus concerns the willingness to pay for the preservation of part of a wetland in the Dutch Waddensea. This part, Rottummeroog is uninhabited and it is prohibited to visit the island. The island has an important function in preservation of nature and wildlife. Because of erosion on the West side of the island and growth on the east side during the last centuries, Rottummeroog has drifted to the east. Due to increased erosion and the rise in sea level, the island is getting smaller and it is predicted that Rottummeroog will disappear completely in the next twenty five years, unless it is protected by very specific and costly measures to be taken by Dutch “Rijkswaterstaat”.

Note that every citizen in the Netherlands knows the Waddensea and Rottummeroog. The Dutch people are used to pay for the preservation of pieces of Dutch nature.

Again, we present the main information we gave the respondents and the WTP question. Details are very much in line with the good “biological agriculture” and are omitted

here. (An extensive report on the precise question wording is in Wierstra [31]: appendix A.)

- (1) One of the dilemma’s with regard to environmental and nature areas that confronts the government has to do with the island Rottummeroog, which lies along the coast of the province of Groningen. (Present photo 1.) On this map you can see the five inhabited islands and the uninhabited island Rottummeroog. With the current developments, Rottummeroog is in danger of completely disappearing into the sea in about thirty years.
- (2) Every year part of Rottummeroog is lost on the west side of the island, due to erosion caused by storms and the ocean current around Rottummeroog. If there is no maintenance, the island will have completely disappeared in the sea in 20–30 years. At the moment, a large number of plant and bird species appear on Rottummeroog. A number of these plant and bird species are rare in the Netherlands and appear almost exclusively on Rottummeroog. Birds have a large interest in the existence of Rottummeroog, because they can rest and breed there without being disturbed.
- (3) The past decades, Rottummeroog has become smaller and smaller. In order to preserve the current state and size of Rottummeroog, it is essential that maintenance tasks are carried out more often. Furthermore, once every three years, the dunes will have to be raised with large amounts of sand.
- (4) The willingness-to-pay question was: “We are holding this inquiry to find out how much money your household is prepared to contribute to protect Rottummeroog. If the government decides to implement protection measures for Rottummeroog, it is estimated that this will cost your household. . . per month. This amount will be paid through a special additional tax-charge. It is guaranteed that this amount will ONLY be spent on the protection of Rottummeroog. Are you prepared to pay. . . per month if it is used to pay for measures with which Rottummeroog can be protected?”

(1) Yes, (2) no, (3) no plus protest, (4) maybe/unsure.

If “yes” (if “no” is not included here): You have just said that you are prepared to pay. . . per month if the government ensures the protection of Rottummeroog. It is possible that the cost of the protection measures turn out to be higher. Imagine the UTLIMATE estimate is that it will cost your household. . . per month. Are you willing to pay. . . per month in this case? (1) Yes, (2) no, (3) maybe/unsure.

What is the highest amount per month that you are willing to pay if this ensures that Rottummeroog will be preserved in its current state?

3.3. Prevention of risk increase of inundation (a use and complex information good)

The third stimulus concerns the scenario that, because of a rise in sea level, the risk of inundation is increasing. The

Netherlands is a low-lying area and about half of the area is below mean sea level. Dikes along the coast protect the land, which have a risk of failure of about 1 in 3 000 year. An increase in risk can be avoided by the extension of sea defence infrastructure. Note that 50% of the Netherlands is below sea level and note also that in the year of the survey we had some huge inundation of rivers and that people are used to pay a large amount of monthly taxes for inundation protection. However assessment of risks is known to be a complex task (Fischhoff and Furby [12] and Fischhoff et al. [13]).

The following information was given to the respondent (Details are in Wierstra [31]):

- (1) After the flood in Zeeland in 1953, the Deltaworks were implemented in the Netherlands to prevent such a disaster from ever happening again. The probability of such a flood ever occurring again is 1 in three thousand. This means that the dikes and other protection measures have been made so strong that ON AVERAGE, a flood will occur 1 time every 3 000 years. Ruling out a flood is of course, not possible.
- (2) Since a few years, it is known that the average height of the sea-level is rising. Experts expect that in 100 years, the sea-level will be about 60 cm higher than is the case now. The cause of the rising of the sea-level is not only the expected increase of the greenhouse-effect, but also has other more natural causes. One of the consequences of a rising sea-level is that we will have a greater chance of a flood than now. The probability of a flood in the Netherlands will increase from 1 in 3 000 to 10 in 3 000, thus to an AVERAGE of 1 time every three hundred years.
- (3) If the sea-level has changed, then the probability of a flood by the coast is equal to 10 in 3 000, thus 1 in three hundred years. The best measure that the government can take to prevent the chance of a flood by the coast from increasing, is to further reinforce the dikes along the coast. So, if the dikes by the coast are reinforced, then the chance of a flood will be the same as now, even after a rise of the sea-level.
- (4) If it is decided to reinforce the sea-dikes, then the government will have to set aside an extra sum of money for this. Because the revenues of the government come from the tax-payers, every household will have to contribute through an additional tax-charge. In this investigation, we want to ask people how much money they are prepared to sacrifice if it can be used to pay for measures that will ensure that the chance of a flood by the coast remains the same as is the case now. It appears that some people are prepared to pay a certain amount, while other people are NOT prepared to pay that amount or cannot pay it. All have good reasons for their choice.
- (5) The willingness-to-pay question was:
 "If the dike-reinforcement by the coast is implemented, then it is estimated that it will cost your household. . .

per month. This amount will be paid through an additional tax-charge. The costs of the dike-reinforcement will have to be paid for a period of 10 years. It is guaranteed that this amount will ONLY be spent on the reinforcement of the dikes by the coast. Are you prepared to pay. . . per month if it is used to pay for measures with which the probability of a flood will not increase to 10 in 3 000, but will remain equal to the current situation, namely 1 in 3 000?"

(1) Yes, (2) no, (3) no plus protest, (4) maybe/unsure.

If "yes" (if "no" is not included here): You have just said that you are prepared to pay. . . per month if the government ensures that the chance of a flood remains the same as is the case now. It is possible that the costs of dike-reinforcement turn out to be higher. Imagine the ULTIMATE estimate is that it will cost your household. . . per month. Are you willing to pay. . . per month in this case?

(1) Yes, (2) no, (3) maybe/unsure.

What is the highest amount per month that you are willing to pay to ensure that the chance of a flood remains equal to the current situation?

Note that we had to add a time limit to the extra taxation because of heavy overspending in the before mentioned Deltaworks; the scenario would be unrealistic without such a time limit.

4. Analysis

The results of the application of the CVM to each of the goods will be handled sequentially.

Because we used the by the NOAA panel recommended double bounded dichotomous choice method of measurement of WTP, separate attention to the method of estimation has to be paid first. Then we introduce the economic characteristics of the individuals as explanatory factors of the WTP. Also we mention shortly the psychological factors which are to be used together with the economic variables in the assessment of the construct validity. In the next three sections each stimulus is treated separately. In these three sections we firstly estimate an economic model of the WTP, then we introduce and assess the psychological factors and lastly, we present a final model containing significant economic and psychological predictors. In the section where we discuss the results of the "complex information" good we pay also attention to the design and results of a test on scope validity.

4.1. Estimation of WTP

As recommended by Arrow et al. [5] we applied double-bounded dichotomous choice valuation questions (otherwise stated a take-it-or-leave-it approach with *one* follow-up). This *elicitation procedure* for the household WTP is the same for each good. The procedure puts a moderate cognitive burden on the respondent in formulating an answer (that is "yes" or "no" to a specified bid). It is clear that double-bounded interval data yield *more information* than

Table 2
Versions of bid structures in Dutch guilders for all treatments.

Version	Initial bid	If “yes” to initial bid	If “no” to initial bid
I	5	10	2.5
II	10	20	5
III	20	30	10
IV	30	50	20

its single-bounded counterpart, because for any sample size, the estimate for WTP is more accurate resulting in a *tighter* confidence interval. Respondents were given randomly one out of four versions of bid structures as presented in table 2.

We emphasise that our hypothesis concerns validity differences across goods; and that we are not interested and therefore do not present an estimation of the level and variation of the WTP of each good in detail, but only as far as needed for the test of our hypothesis.

The double bounded elicitation procedure produces interval-censored data (Nelson [25]; Carson et al. [8]). The adequate method to analyse these data is survival analysis. Survival analysis should be carried out where the stochastic variable is assumed to have a certain cumulative distribution function. In this method the researcher assumes a cumulative distribution function with two unknown parameters a and b , represented by $F(x; a, b)$. The WTP of each individual is not known precisely, but is known only to be located in a certain interval $x_i \in [L_i, U_i)$, with L_i the lower bound and U_i the upper bound of the interval. To estimate parameters a and b of the distribution function, the likelihood function, or equivalently the log-likelihood function, can be maximised. The log-likelihood function takes the following form:

$$\log L = \sum_{i=1}^n \ln[F(U_i; a, b) - F(L_i; a, b)]. \quad (4)$$

The researcher can assume various specific distributions for $F(x; a, b)$. Given the assumption of a specific distribution, the maximisation process of the log-likelihood yields (ML-) estimators of the parameters a and b . The result is an efficient estimation of the population WTP. For more details on the statistical framework of interval-censored data see: Nelson [25], Hanemann et al. [17], and Anderson et al. [4].

The WTP data resulting from the dichotomous choice questions may be analysed by either a *parametric* or a *non-parametric* statistical analysis. A danger with parametric approaches is that the results of a parametric approach are not necessarily robust against a misspecification of the WTP distribution. In other words, if the assumption of a specific distribution is not correct, the estimates will be inconsistent. Therefore non-parametric approaches may be an alternative approach to reduce the risk of wrong conclusions based on an inappropriate assumption of some particular distribution. As the parametric approaches, the non-parametric approaches aim at estimating the survival function or cumulative distribution function. Based on the outcomes fitting the distribution we made a choice out of the Weibull, the lo-

gistic, the log-logistic, the exponential, the normal and the log-normal distribution.

We carried out parametric as well as non-parametric statistical analyses. However, we will discuss only non-parametric results if this is needed in the course of our analysis.

4.2. Theoretical predictors

Regarding the *explanatory variables* in testing the construct validity we base our research on the assumptions of neoclassical economics and social-psychological theory (Fishbein–Ajzen [11]). These theories predict the WTP by way of *economic* factors and *psychological* factors or *attitudes*, respectively.

The *economic* factors (see for an underpinning Arrow et al. [5], and Deaton and Muellbauer [9]) are of course the same for each good:

- (1) “Income” as measured by the midpoint of the relevant income category; (net) income has a positive influence on WTP.
- (2) “Fixed housing expenses” as measured by the midpoint of the category, which applied, to the household. Housing expenses decrease disposable income and have a negative impact on WTP.
- (3) “Household size” as the number of persons in the household (with a maximum of six persons (including adults and children); household size has a positive influence on WTP.

The *psychological* variables are attitudes towards the change in the specific environmental good and are different for each good (see below). The attitudes are made operational by means of attitudinal scales. For the good “*changing to biological agricultural production*” we developed four attitudinal scales. For the good “*Rottummeroog*” five attitudinal scales, and finally, for the good “*Prevention of risk increase of inundation*” two attitudinal scales.

4.3. Testing construct validity for the good “*Changing to biological agricultural production*”

The general approach of the analysis is as follows: firstly, we include only the economic predictors as covariates in a statistical analysis. Then we introduce the attitudinal scales and assess their internal consistency. After that we add the attitudes and present a “final model”.¹

Based on outcomes fitting the WTP distribution by survival analysis, the statistical analysis for the good “*changing to biological agricultural production*” is performed on the assumption of a Weibull distribution. The non-parametric analysis did not show significant differences with the Weibull analysis.

¹ The final model is the result of an optimisation process in the survival-module of SYSTAT in which the “best” model is derived from a given set of covariates. In SURVIVAL this procedure is called a “step approach”.

Table 3

Economic predictors of WTP based on the assumption of Weibull distribution for the good “changing to biological agricultural production” ($N = 205$).

Explanatory variable	Predicted	Parameter estimate	Asymptotic t -value
Household size	+	0.010	0.131
Income	+	0.213	2.107
Fixed housing expenses	–	–0.374	1.547

We start with the economic predictors as covariates. It appears that income and fixed housing expenses are significantly related to the WTP, but the household size is not. This means that the economic construct validity is sufficient (table 3).

We included four attitudinal factors in the analysis. Before we present the final results we shortly introduce these psychological variables and discuss their internal consistency.

We developed four attitudinal scales for this good: Attitude towards pollution by agricultural production, attitude towards extra costs of biological agricultural production, attitude towards government intervention in agricultural production, and opinion on economic feasibility of a transformation (see table 4). For each of these specific scales several questions were presented to the respondents. The basic idea in this approach is that each question relating to a scale essentially asks for the same (latent) variable. Therefore, ideally each question (item) produces the same answer. If that is indeed the case the internal consistency of the scale is perfect. Standard procedure in every study of attitude is a judgement of internal consistency. Comparable levels of internal consistency are a necessary condition for the acceptability of the scales to be validly used in explanatory models. A well-known measure of the internal consistency is the so-called Cronbachs’ α (Carmines and Zeller [7]).

$$\alpha = \frac{N\rho_{\text{mean}}}{1 + \rho_{\text{mean}}(N - 1)} \quad (5)$$

in which N equals the number of items constituting the scale, the mean ρ equals the mean inter-item correlation. α varies between zero (total inconsistency) and 1.00 (total consistency).

Applying this procedure to the four scales for the good under investigation, we conclude that the Cronbach’s alpha fulfilled the thresholds (van der Pligt and de Vries [30]) for a valid introduction of the scales in the explanatory model for this good (see table 4).

When the four attitudinal factors are included in the analysis, the “final model” as presented in table 5 results. Two out of four attitudinal variables are significantly related to the WTP and at the same time the economic predictors remain significant. The fact that economic and attitudinal variables have a significant impact on the WTP of this simple information environmental good with mainly use value means that the economic and psychological construct validity concerning this good is sufficient.

Table 4

The internal consistency of psychological scales on “changing to biological agricultural production”.

Attitudinal scale (label)	Cronbach’s α (N of items)
The degree to which a person feels that – biological agricultural production is less polluting than regular agricultural production (pollution);	0.76 (5)
– biological agricultural production would cost extra money (costs);	0.77 (4)
– the government should encourage or impose transformation to biological agriculture (government);	0.78 (6)
– transformation of agricultural activities is economically feasible (feasibility).	0.45 (3)

The precise *content* of the attitudes is reported in Wierstra [31].

Table 5

Final model of prediction of WTP, based on assumption of Weibull distribution for the good “changing to biological agricultural production”.

Explanatory variable	Predicted	Parameter estimate	Asymptotic t -value
Attitude “pollution”	+	0.588	3.768
Attitude “costs”	+	0.696	4.026
Income	+	0.161	2.157
Fixed housing expenses	–	–0.530	2.497

Table 6

Economic predictors with assumption of log-normal distribution for the good “Rottumeroog”.

Explanatory variable	Predicted	Parameter estimate	Asymptotic t -value
Household size	+	0.196	1.957
Income	+	–0.105	1.233
Fixed housing expenses	–	–0.197	0.556

4.4. Testing for construct validity for the good “Rottumeroog”

Rottumeroog is a simple information good with mainly non-use value. According to the survival analysis the WTP for Rottumeroog has the form of the log-normal distribution (this is not contradicted by the non-parametric results).

The only economic predictor, which is significantly related to the WTP, is household size (table 6). Therefore, economic construct validity is judged as low.

As psychological predictors we introduced five scales: cultural historical interest, government responsibility, land/coast protection, importance of nature, and intervention in nature (see table 7). Again, Cronbach’s Alpha showed sufficient results.

When the five attitudinal factors and the economic variables are included in the analysis, a final model comes up where only three attitudinal factors are significant (table 8); these attitudinal factors are apparently better predictors for the WTP for Rottumeroog than the economic predictors.

The conclusion for this environmental good with mainly non-use value is that economic variables have no significant impact. Only attitudes matter. This means that the economic

Table 7

The internal consistency of psychological variables on “Rottumeroog”.

Attitudinal scale (label)	Cronbach's α (N of items)
The degree to which a persons feels that	
– “Rottumeroog” is of cultural/historical interest (cultural/historical);	0.75 (3)
– the government has the responsibility to protect “Rottumeroog” (government);	0.57 (3)
– every piece of land of the country should be protected against the sea (land/coast);	0.85 (3)
– nature is an important aspect of “Rottumeroog” (nature);	0.79 (3)
– it is permitted to interfere in a more or less natural process (human intervention)	0.74 (2)

The precise *content* of the attitudes is reported in Wierstra [31].

Table 8

Final model: case “Rottumeroog”; assumption of log-normal distribution.

Explanatory variable	Predicted	Parameter estimate	Asymptotic t -value
Attitude “cultural-history”	+	0.321	1.810
Attitude “government”	+	0.866	4.170
Attitude “human intervention”	+	0.313	2.368

construct validity *is insufficient* and that the psychological construct validity *is sufficient*. This result is in accordance with our hypothesis.

4.5. Testing for construct validity for the good “prevention of risk increase of inundation”

The good “prevention of risk inundation” is a use value/complex information good. Only for this good we report on the validity of scope (see section 2.1) and construct validity.

First we elaborate on scope validity and why this is important here. Then we discuss the parametric analyses as we did for the other two stimuli. Moreover, we add in this case non-parametric analyses because levels of WTP play a central role in the assessment of validity of scope.

4.5.1. Validity of scope

In order to test whether possibly problems concerning the validity of scope are biasing the outcomes on construct validity we make use of the fact that the subjective risk perceived by respondents may differ from the objective risk as determined by experts. The level of subjective risk and changes in changes in the level of subjective risk influence the willingness to pay to prevent or stimulate the proposed change, not the objective risk. It is questionable whether the objective risk information given in a questionnaire is convincing enough to change (if necessary) the perception of respondents from subjective risk to objective risk. Because the good “prevention of risk increase of inundation” is suitable to vary across individuals and is not varying on our main stimuli (use-value and complexity of information), it is possible to test the *validity of scope*. In order to test for scope validity we introduced four different scenarios varying on

Table 9

The four sub-treatments for the good “risk increase” are:

Scenario: content	No.	Sample size
1 : 3 000 years \rightarrow 1 : 300 years	I	$N_{3I} = 138$
1 : 3 000 years \rightarrow 1 : 100 years	II	$N_{3II} = 72$
1 : 1 200 years \rightarrow 1 : 300 years	III	$N_{3III} = 100$
1 : 1 200 years \rightarrow 1 : 100 years	IV	$N_{3IV} = 92$

the levels of risk and changes in risk. The respondents were randomly assigned to the four scenarios (see table 9).

A specific measurement problem in CV risk change studies is how to convey present risk levels and changes in risk to respondents. A possible solution to this problem is given in Jones-Lee et al. [21] where two hints are given to improve the respondents’ understanding of the risk change. In our case these hints were put in practice by:

- To show the present risk and new risk information in verbal terms (see section 3 and table 9).
- To supplement the risk information by a graphical representation with 3 000 or 1 200 squares and to mark the appropriate number of squares (not presented here, Wierstra [31]).
- As an extra support we added another way of promoting the understanding of the risk change for respondents with help of a card of other “unpleasant” events such as risk on burglary (1 in 40), risk to be killed in a traffic accident (1 in 15 000) and risk on hospitalisation after a traffic accident (1 in 1 500).

In the course of the empirical analysis we will introduce the relevant predictions in order to assess the validity of scope.

The degree of consistency of the WTP related to variation in level and changes in risk will indicate the degree to which embedding effects play a role in the observed construct validity.

4.5.2. Results of parametric analyses

Our hypothesis is that the prevention of a greater risk will result in a higher WTP, i.e., that there are no embedding effects. See also Loomis and duVair [23] on an evaluation of CVM responses to different risk communication devices, with a similar hypothesis. This implies in operational terms for the WTP per scenario:

$$\begin{aligned} \text{WTP (II)} &> \text{WTP (I)} \\ \text{WTP (II)} &> \text{WTP (III)} \\ \text{WTP (II)} &> \text{WTP (IV)} \\ \text{WTP (III)} &< \text{WTP (IV)} \\ \text{WTP (I)} &> \text{WTP (III)}. \end{aligned}$$

In testing these predictions we introduce three dummies with scenario IV as reference category. Since the good “prevention of risk increase of inundation” has mainly use value, for construct validity it is predicted that at least the economic predictors “income”, “household size” and “fixed housing

Table 10

Economic predictors on assumption of Weibull distribution for the good “prevention of risk increase of inundation”.

Explanatory variables	Predicted	Parameter estimates	Asymptotic <i>t</i> -value
Dummy 1: risk scenario I as compared to IV	^a	0.047	0.245
Dummy 2: risk scenario II as compared to IV	+	0.459	2.084
Dummy 3: risk scenario III as compared to IV	–	–0.069	0.335
Income	+	0.291	4.694
Fixed housing expenses	–	–0.533	2.598
Household size	+	–0.009	0.167

^a No prediction is possible, because scenario I and IV cannot be compared. See table 9.

Table 11

The internal consistency of psychological variables on “prevention of risk increase of inundation”.

Attitudinal scale (label)	Cronbach’s α (<i>N</i> of items)
The degree to which a person feels that – the national government is responsible in the prevention of flooding of the coastal zone (government); – risk of inundation is a serious threat (risk).	0.70 (8) 0.65 (5)

The precise *content* of the attitudes is reported in Wierstra [31].

expenses” have to be significantly related to the WTP. Also we hypothesise that for scope validity the specific risk scenario have to be a relevant variable. We start with the estimation of the parameters of six covariates: three dummy variables and three economic variables. The results showed in table 10 are based on the Weibull distribution.

Given the hypotheses concerning scope validity, the following can be said about the results in table 10.

- It was predicted that $WTP(II) > WTP(I)$. This is reflected in the parameters of the dummies. The parameter of dummy 2 is significantly exceeding the parameter of dummy 1.
- It was predicted that $WTP(II) > WTP(III)$. Dummy 2 exceeds dummy 3.
- It was predicted that $WTP(II) > WTP(IV)$. Dummy 2 is significant. Note that scenario IV is the reference.
- It was predicted that $WTP(III) < WTP(IV)$. Dummy 3 has the predicted negative sign, but not significantly.
- It was predicted that $WTP(I) > WTP(III)$. This is predicted by the dummies, but not significantly.

It appears that two of the economic variables are significant. The predictions concerning the dummies are partly not in line with the hypotheses. This provisional analysis thus shows that there are some doubts on the validity of scope.

We introduced two attitudinal scales as shown in table 11. Cronbach’s Alpha is sufficient and of a comparable level with the scales of the other stimuli.

When the attitudinal variables are added, the results show that only one of the psychological dimensions is signif-

Table 12

Final model assumption Weibull distribution for the good “prevention of risk increase of inundation”.

Explanatory variable	Predicted	Parameter estimate	Asymptotic <i>t</i> -value
Attitude “risk”	+	0.205	2.180
Dummy 2: risk scenario II as compared with IV	+	0.442	2.451
Income	+	0.288	4.668
Fixed housing expenses	–	–0.564	2.746

Table 13

Non-parametric results for the good “prevention of risk increase of inundation” based on Turnbull’s algorithm.

Scenario	Point estimate median	Point estimate mean
I–1 : 3000 → 1 : 300	9.76	19.99
II–1 : 3000 → 1 : 100	17.32	24.09
III–1 : 1200 → 1 : 300	12.88	21.74
IV–1 : 1200 → 1 : 100	11.48	21.18

icantly related towards the WTP (table 12), that two of the economic variables remain significant and that only dummy 2 is significant (and also in the predicted direction).

The results reveal serious doubts on scope validity as only dummy 2 is significant.

In order to check whether the results are robust, we added a non-parametric test.

4.5.3. Non-parametric test of scope validity

Our results for non-parametric analysis are based on Turnbull [29], who presents a general algorithm to analyse arbitrarily grouped, censored and truncated data. In table 13 we show the results for the four scenarios with the same predictions. Details can be found in Wierstra [31].

- It was predicted that $WTP(II) > WTP(I)$. This is indeed the case.
- It was predicted that $WTP(II) > WTP(III)$. This is also the case.
- It was predicted that $WTP(II) > WTP(IV)$. This is the case.
- It was predicted that $WTP(III) < WTP(IV)$. This is not the case.
- It was predicted that $WTP(I) > WTP(III)$. This is not the case.

Therefore, based on these non-parametric outcomes we again have serious doubts whether respondents have taken the relevant risk information into account when they stated a WTP.

4.5.4. Conclusions for the good “prevention of risk increase of inundation”

The findings imply that respondents do value risk changes, but seem to have difficulties in valuing differences in risk changes, which means that insensibility to scope is present. This points to a certain lack of scope validity, which is in

line with our hypothesis concerning goods with complex-information and with mainly use value. Note that this conclusion is contrary to the results by Loomis and duVair [23] who find that with their risk communication devices WTP moves in a systematic fashion with the absolute level of risk reduction. They, however, value several lifetime risks of death with a risk ladder and with a risk pie. In our study we value risk changes for one and the same good, prevention of an increase in inundation.

It appears that economic construct validity is sufficient. Psychological construct validity is also sufficient. The predicted problems with scope validity is serious and are thus affecting construct validity.

5. Conclusions on the empirical findings in terms of validity and reliability

In this section we present an overview on the validity and reliability criteria related to our hypothesis. Our hypothesis implies that the CV method in valuing goods with non-use value and with a complex content of information produces less valid results than with use values and simple information. We tested this hypothesis *across* goods varying on these properties. We applied a uniform design for each measurement of the various WTP. A preliminary, but necessary, test of the internal consistency of the attitudes produced positive results (tables 4, 7 and 11). Based on this result and the design used, we conclude that we may trust that the sources of variation in validity of WTP most likely will originate from the stated differences of properties of the goods and not from variation in design, sample, or quality of the attitudinal measurement.

In general the observed results are in line with our hypothesis. That is, a sufficiently high validity of the CV results concerning the good with mainly use value and a low complexity of information (“*changing to biological agricultural production*”). The validity of this good acts as a reference for our judgement of the validity of the other goods. We find a clearly lower validity of the CV results for both other goods. See table 14 for an overview.

We researched construct validity. It was also possible to research the scope validity with the good “*prevention of risk increase of inundation*”. Ambiguous results were produced with respect to scope validity.

The construct validity is divided into two indicators, namely what we call “economic” and “psychological” construct:

- “Economic” construct: This is the degree to which the responses are related to the *economic* predictors. This type of validity varies across the goods in the predicted direction. For the non-use/simple information good we find that the economic variables are not significant. Here the lack of importance of the variable “income” is alarming. For the use/complex information good we find a significant relationship for the economic variables. However, scope validity is a serious problem. Finally, for the use/simple information good we find a significant relationship for a subset of economic predictors.
- “Psychological” construct: This is the degree to which the responses are predicted by attitudinal factors. Firstly, we find for the non-use/simple information good that three out of four created attitudes are significant. This indicates, combined with the results at “economic” construct, that the valuation for a good with only non-use value is a process mainly driven by attitudes and less by economic considerations. Secondly, with regard to the use/complex information good we find that one of the attitudes is significantly related to the CV responses. Here attitudes may be a help to process complex information. Finally, for the use/simple information good adding attitudes has also a significant impact on the prediction of the WTP.

6. Discussion

We explored the boundaries of a *valid* application of contingent valuation as a method to value environmental changes.

The results give reason to conclude that “complexity of information” of environmental goods may have a negative impact on the validity of the CV outcomes (WTP). This result is in line with the critique of social psychologists on neoclassical economic theory.

Secondly, economic factors, like income, fixed housing expenses and household size, appear to have no influence on the WTP for non-use values. Therefore there are serious doubts whether WTP answers on environmental goods with non-use elements, produce valid and meaningful results.

Table 14
Overview of construct validity.

Kind of good	Label of the good ^a		
	Changing to biological production	Rottummeroog	Prevention of risk increase of inundation
	Non-complex mainly use	Non-complex non-use	Complex mainly use
Construct validity			
+ economic	+	–	±
+ psychological	+	+	+

^a (+) fits well; (±) ambiguous fit; (–) insufficient fit on criterion.

Based on our experiment we conclude that environmental goods with mainly non-use value and with complex information to process, WTP answers are clearly less valid. The consequence of this result is that it is not advisable to naively incorporate the WTP of non-use and complex information goods in a cost benefit analysis. However the standard practice in cost benefit analysis is adding an extra PM for environmental goods, which is also naive. Filling the gap between, on the one hand, the naive PM and, on the other hand, a WTP with limited validity requires a judgement on the to be expected validity of the WTP of the good to be incorporated in a CBA. For that reason we need research in order to construct a scale of the to be expected validity of environmental goods related to the mix of use and non-use value, respectively, the degree of complex information content.

Appendix A

A.1. Summary of part of the questionnaire for the good “Changing to biological agricultural production”²

In the Netherlands, there are roughly one hundred thousand agricultural companies. About five million cattle, fifteen million pigs and one hundred million chickens are kept on the cattle-breeding companies. Due to, amongst others, the use of fertilizers and pesticides, Dutch agriculture has the world’s largest production per hectare of agricultural soil. The pesticides, the animal fertilizers and the artificial fertilizers have as only side-effect that they cause soil pollution.

Next to this REGULAR agriculture, there is an increasing use of BIOLOGICAL agriculture in the Netherlands. NO use is made of artificial fertilizers and chemical pesticides on these agricultural companies. The result of using biological cultivation methods is thus primarily much less pollution of agricultural soil.

- (1) Do you or yourself or does anyone in your family grow their own vegetables or potatoes?
- (2) Do you ever buy biologically cultivated vegetables, fruit or potatoes?
- (3) What is the most important reason for your buying biologically cultivated vegetables, fruit or potatoes?
- (4) Is the PRICE of the biologically cultivated products higher, lower or about the same as the price of products from regular agriculture?
- (5) Do you find the TASTE of the biological products better, worse or about the same as the taste of the products from regular agriculture?
- (6) Do you find the QUALITY of the biological products better, worse or about the same as the quality of the products from regular agriculture?

² The complete English questionnaire can be obtained from the authors on request.

- (7) The government is considering converting regular agriculture to biological agriculture, whereby no more use is made of artificial fertilizer and chemical pesticides. If we in the Netherlands completely convert to biological agriculture, then the pollution of agricultural soil will be much less than is the case now. After converting to biological agriculture, there will also be less production per hectare. This has as a consequence that the prices of vegetables, fruit and potatoes will rise.
- (8) If the government decides to advance biological agriculture then the consumers will have to pay a higher price for their products because biological agriculture will yield less products per hectare. In this inquiry we want to ask people how much EXTRA money they are willing to pay for vegetables, fruit and agriculture if the government ensures that the entire Dutch agriculture will switch to biological agriculture. It appears that some people are prepared to pay a certain amount EXTRA, while other people are NOT prepared to pay that amount EXTRA or cannot afford to pay it. All have good reasons for their choices.

1. “If the government decides to change over all agriculture to biological agriculture, it is estimated that your household will pay. . . per month more for vegetables, fruit and potatoes.

Are you prepared to pay. . . per month EXTRA for vegetables, fruit and potatoes if the government ensures that Dutch agriculture will completely switch to biological agriculture?”

(1) Yes, (2) no, (3) no plus PROTEST, (4) maybe/unsure.

You have just said that you would be prepared to pay. . . extra for vegetables, fruit and potatoes, if these are biologically cultivated. It is possible that the prices of biologically cultivated products turn out higher. Imagine the ULTIMATE estimate is that it will cost your household. . . per month extra to switch to products that are biologically cultivated. Are you then willing to pay. . . per month extra for vegetables, fruit and potatoes that have been biologically cultivated.

(1) Yes, (2) no, (3) maybe/unsure.

What is the highest amount per month that you are willing to pay if it can be used to ensure that all agricultural products are biologically cultivated?

A.2. Summary of part of the questionnaire for the good “Prevention of disappearance of the uninhabited island Rottummeroog in the Dutch wetland ecosystem”

- (1) One of the dilemma’s with regard to environmental- and nature areas that confronts the government has to do with the island Rottummeroog, which lies along the coast of the province of Groningen. (Present photo 1.) On this map you can see the five inhabited islands and the uninhabited island Rottummeroog. With the current developments, Rottummeroog is in danger of completely disappearing into the sea in about thirty years.

- (2) The island Rottumeroog has for centuries been a part of the Dutch Wadden Sea area (photo 2). This photo shows Rottumeroog and was taken from the air at low tide. Rottumeroog was inhabited in the past. Since 1965, this island has been uninhabited and the Department of Transport and Public Works takes care of the maintenance. Rottumeroog is out of bounds for people like you and me. Because of the sea current and storms, parts of this island are disappearing at the west side. Up to a few years ago, the island was swelling at the east side, so you could say that the island was walking from west to east.
- (3) Have you ever visited the Wadden Sea or one of the Wadden Sea islands.
- (4) Have you ever seen a documentary about Rottumeroog on television.
- (5) Every year part of Rottumeroog is lost on the west side of the island, due to erosion caused by storms and the ocean current around Rottumeroog. If there is no maintenance, the island will have completely disappeared in the sea in 20–30 years. At the moment, a large number of plant and bird species appear on Rottumeroog. A number of these plant and bird species are rare in the Netherlands and appear almost exclusively on Rottumeroog. Birds have a large interest in the existence of Rottumeroog, because they can rest and breed there without being disturbed.
- (6) (Photo 3.) This photo shows a part of Rottumeroog. Most plants and birds you see appear here. The vanishing of the island means that these plants and birds, which now appear on the island will dissipate. No species, however, die out completely with the disappearance of the island.
- (7) There are also ways of preserving the island Rottumeroog. The government will then have to take extra measures and arrange more maintenance of the island. The government can, for example, construct special dikes on the sea-side of Rottumeroog to break the waves and thus prevent erosion (photo 4). Tidal screens that keep the sand together better can be installed in the dunes, an example of which can be seen on the photo. Quite often lime-grass is also planted in the dune areas. Because of the strong root-system of lime-grass, the sand in the dunes is also kept together.
- (8) The past decades, Rottumeroog has become smaller and smaller. In order to preserve the current state and size of Rottumeroog, it is essential that all these tasks are carried out more often. Furthermore, once every three years, the dunes will have to be raised with large amounts of sand.
- (9) We are holding this inquiry to find out from you how much money your household is prepared to contribute to protect Rottumeroog. If the government decides

to implement protection measures for Rottumeroog, it is estimated that this will cost your household *f*5,- per month. This amount will be paid through a special additional tax-charge. It is guaranteed that this amount will ONLY be spent on the protection of Rottumeroog.

Are you prepared to pay . . . per month if it is used to pay for measures with which Rottumeroog can be protected?

(1) Yes, (2) no, (3) no plus protest, (4) maybe/unsure.

You have just said that you are prepared to pay per month if the government ensures the protection of Rottumeroog. It is possible that the cost of the protection measures turn out to be higher. Imagine the UTLIMATE estimate is that it will cost your household. . . per month. Are you willing to pay. . . per month in this case?

(1) Yes, (2) no, (3) maybe/unsure.

What is the highest amount per month that you are willing to pay if this ensures that Rottumeroog will be preserved in its current state?

A.3. Summary of part of the questionnaire for the good "Prevention of risk increase of inundation"

- (1) I would now like to talk to you about floods. I will first talk about floods by rivers and then about floods by the coast. Most people can remember the floods by the rivers at the beginning of this year very well.
- (2) Did you or your family members have to leave your house at the beginning of this year?
- (3) Were you yourself or was any member of your family actually hit by the flooding of the rivers this year?
- (4) What were the consequences of this? <<INTV. WITH REFERENCE TO THE ANSWERS CLASSIFY IN THE FOLLOWING CATEGORIES, SEVERAL ANSWERS POSSIBLE>>
- (1) Serious damage to house; (2) slight damage to house; (3) serious damage to property; (4) slight damage to property; (5) psychological complaints; (6) physical complaints; (7) other; (8) <don't know>
- (5) Are you content with the compensation arrangement?
- (6) Do you have any relatives or acquaintances that were hit by the floods at the beginning of this year?
- (7) What were the consequences of this? <<INTV. WITH REFERENCE TO THE ANSWERS CLASSIFY IN THE FOLLOWING CATEGORIES, SEVERAL ANSWERS POSSIBLE>>
- (1) Serious damage to house; (2) slight damage to house; (3) serious damage to property; (4) slight damage to property; (5) psychological complaints; (6) physical complaints; (7) other; (8) <don't know>
- (8) Have you yourself or has anyone in your family at SOME OTHER TIME ever been hit by a flood?
- (1) Yes, (2) no.

- (9) What were the consequences of this? <<INTV. WITH REFERENCE TO THE ANSWERS CLASSIFY IN THE FOLLOWING CATEGORIES, SEVERAL ANSWERS POSSIBLE>>

(1) Serious damage to house; (2) slight damage to house; (3) serious damage to property; (4) slight damage to property; (5) psychical complaints; (6) physical complaints; (7) 1 or more dead; (8) other; (9) <don't know>

- (10) Was this damage partly or completely compensated?

(1) Yes, completely, (2) yes, partly, (3) no, (4) <don't know/no answer>

- (11) According to you, what was the most important cause of there being too much water in the rivers at the beginning of this year? <<INTV. WITH REFERENCE TO THE ANSWERS CLASSIFY IN THE FOLLOWING CATEGORIES, SEVERAL ANSWERS POSSIBLE>>

(1) much melt-water,
 (2) increase in precipitation,
 (3) increase of greenhouse-effect,
 (4) canalization of rivers,
 (5) other,
 (6) <<don't know/no opinion>>.

- (12) Do you think that when the river-dikes are reinforced, floods by the rivers are still possible?

(1) Yes, (2) no, (3) doubts.

- (13) The government has in the meantime decided to reinforce the river-dikes within a few years. The weakest parts of the river-dikes will even be reinforced this year or at the latest next year. The river-dikes will then be so strong that on average, a flood will take place once every 1 250 years. These measures cost a lot of money. The government will raise a part of the necessary money itself. The citizens will however, also have to immediately pay a part. The polder-taxes, which every household has to pay, will be raised for this. Every household will then pay several tens of guilders extra per year. The government will ensure that this money is only spent on the improvement of the river-dikes.

- (14) Until now, we have spoken about the water problems by rivers. From now on, I would only like to talk to you about the coast. The rest of the questionnaire will thus have nothing to do with the water problems by the rivers and the improvement of the river-dikes, but with the sea-coast.

After the flood in Zeeland in 1953, the Deltaworks were implemented in the Netherlands to prevent such a disaster from ever happening again. The probability

of such a flood ever occurring again is 1 in three thousand. This means that the dikes and other protection measures have been made so strong that ON AVERAGE, a flood will occur 1 time every three thousand years. Ruling out a flood is of course, not possible.

Since a few years, it is known that the average height of the sea-level is rising. Experts expect that in 100 years, the sea-level will be about 60 cm higher than is the case now. The cause of the rising of the sea-level is not only the expected increase of the greenhouse-effect, but also has other more natural causes. One of the consequences of a rising sea-level is that we will have a greater chance of a flood than now. The probability of a flood in the Netherlands will increase from 1 in 3 000 to 10 in 3 000, thus to an AVERAGE of 1 time every three hundred years.

- (15) We would now like to illustrate the notion of these probabilities in a different way. The information about the probabilities of a flood are presented in short in these figures. <<INTV. HAND OVER LARGE YELLOW CARD D1-1>>. Right now, the probability of a flood is equal to 1 in three thousand; a probability of 1 in three thousand is equal to the chance that if a random square is chosen in this figure (D1-1), this will be the black square. <<INTV. HAND OVER LARGE YELLOW CARD D1-2>>. If the sea-level has risen, then the probability of a flood by the coast is equal to 10 in 3 000, thus 1 in 300. A probability of 1 in 300 is equal to the chance that if a random square is chosen in this figure <<D1-2>>, this will be one of the black squares. <<INTV. HAND OVER CARD D3 (YELLOW)>>. The probability of a flood by the coast can also be compared to the chance of other unfortunate events. If you take CARD D3 before you, this will have the current probability of a flood by the coast on it, namely 1 in 3 000; beneath that is the new probability of a flood by the coast, namely 1 in 300. Other examples are that the probability that a random citizen of the Netherlands will die in traffic in the coming year is 1 in 15 000; the probability that somebody is involved in a traffic accident whereby this person will have to be treated in a hospital, is 1 in 1 500. Finally, the probability that a random citizen of the Netherlands will be the victim of a burglary is 1 in 40.

- (16) The probability of a flood in the Netherlands will increase from 1 in 3 000 to 30 in 3 000, thus to an AVERAGE of 1 time every 100 years. <<INTV. HAND OVER LARGE YELLOW CARD D1-3>>. If the sea-level has risen, then the probability of a flood by the coast is equal to 30 in 3 000, thus 1 in 100. A probability of 1 in 100 is equal to the chance that if a random square is chosen in this figure <<D1-3>>, this will be one of the black squares. <<INTV. HAND OVER CARD D4 (YELLOW)>> (469) CARD D4;

beneath that is the new probability of a flood by the coast, namely 1 in 100. Other (469). . .

- (17) The best measure that the government can take to prevent the chance of a flood by the coast from increasing, is to further reinforce the dikes along the coast. So, if the dikes by the coast are reinforced, then the chance of a flood will be the same as now, even after a rise of the sea-level.
- (18) I have now given you information about the safety along the coast and told you what will change. Do you have any questions about this?
- (19) If it is decided to reinforce the sea-dikes, then the government will have to set aside an extra sum of money for this. Because the revenues of the government come from the tax-payers, every household will have to contribute through an additional tax-charge. In this investigation, we want to ask people how much money they are prepared to sacrifice if it can be used to pay for measures that will ensure that the chance of a flood by the coast remains the same as is the case now. It appears that some people are prepared to pay a certain amount, while other people are NOT prepared to pay that amount or cannot pay it. All have good reasons for their choice.
- (20) We are holding this inquiry to find out from you how much money it is worth to your household to keep the chance of a flood same as is the case now. If the dike-reinforcement by the coast is implemented, then it is estimated that it will cost your household f5,- per month. This amount will be paid through an additional tax-charge. The costs of the dike-reinforcement will have to be paid for a period of 10 years. It is guaranteed that this amount will ONLY be spent on the reinforcement of the dikes by the coast. Are you prepared to pay f5,- per month if it is used to pay for measures with which the probability of a flood will not increase to 10 in 3 000, but will remain equal to the current situation, namely 1 in 3 000?

<<INTV: If asked if everybody has to pay, then answer that IF it is decided that the dikes will be reinforced, then EVERYBODY will have to pay>>

(1) Yes, (2) no, (3) no plus PROTEST, (4) maybe/unsure.

You have just said that you are prepared to pay. . . per month if the government ensures that the chance of a flood remains the same as is the case now. It is possible that the costs of dike-reinforcement turn out to be higher. Imagine the ULTIMATE estimate is that it will cost your household. . . per month. Are you willing to pay. . . per month in this case?

(1) Yes, (2) no, (3) maybe/unsure.

What is the highest amount per month that you are willing to pay to ensure that the chance of a flood remains equal to the current situation?

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