Does improved water quality increase the value of houses? an Internet Discrete Choice Experiment

DRAFT VERSION: PLEASE DO NOT QUOTE!

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Abstract

This paper explores the valuation of the benefits of living near surface water with good water quality. In particular, the economic value associated to improved water quality is derived from the additional house prices associated to improved water quality with an Internet survey amongst dwelling owners and house hunters in three case study areas, the Vecht river basin, Flevoland province and surrounding freshwater lakes, and the lakes near the river Meuse. Respondents are willing to pay 7.7% and 3.0% higher house prices for a good ecological status of the surface water and the presence of natural banks respectively. The WTP for house prices declines with the distance to surface water up and vanishes at approximately 1000 meters.

1. Introduction

One of the objectives of the Water Framework Directive (WFD) is to attain a good ecological and chemical status of surface waters. There are many studies conducted on the costs of the measures of achieving the goals of the WFD. On the other hand, there is a growing interest in measuring the benefits of the WFD in terms of valuing the benefits of improved water quality. In the literature, there are a few number of examples that have attempted to value the benefits of improved water quality. In the international literature, Discrete Choice Experiments (DCE) are nowadays widely applied to the valuation of environmental externalities, although there are hardly any Dutch applications, see Brouwer (2006).

Adamowicz et al. (1994) found a significant impact of river quality improvements on utility based on the increased water-based recreation. In their study on the public preference for catchment management plans in the Moore Catchment, Australia for the reduction of the problems of salinity, eutrophication and flooding, Burton et al. (2000) found that the importance of the cost attribute depends on the level of environmental responsibility. According to Heberling et al. (2000), households have a positive were willing to pay for improved water quality in terms of reducing pollution from acid mine drainage, where water quality was classified as ‘drinkable’, ‘fishable’ and ‘swimmable’ water. Georgiou et al. (2000) used the Contingent Ranking approach for the ranking of three combinations of four attributes. The four attributes included the number of fish species and the number of fish, plants and wildlife, recreational activity such as boating and swimming, and the costs in terms of additional council taxes. Finally, Hanley et al. (2006) estimated the economic value of river ecology improvements with a DCE. They included three components of the ecological status, the presence of particular fish species, the presence of litter and sewage, and the condition of natural river banks. The costs are the higher payments of households to the sewage operator. Respondents put positive values to all three ecological indicators, although these values do not significantly differ. In addition, Hanley et al. (2006) also concluded that the economic value of river ecology improvements are location specific. The hypothesis of benefits transfers was rejected.

In all studies, respondents make a trade-off between improved water quality and a regular payment to the authority that is responsible for improved water quality. However, households may also benefit from the improved water quality because they derive more utility from their dwelling due to improved water quality of surface water in their neighborhood. This increased utility can be reflected in increased housing prices for instance. These additional house prices are approximates of changes in income.

With a hedonic regression analysis Luttik (2000) showed that the presence of surface water has a positive impact of the housing price. Luttik's results were not correct for water quality status, and based on a small sample. Witteveen+Bos (2006) used Luttik's results to estimate the total benefits of increased house prices due to the presence of good quality surface water. The economic value ranges from 704 million to 2.3 billion euro which depends on the stringency of the water quality objective. With a contingent valuation (CV) study, Ruijgrok and Vlaanderen (2001) estimated that the annual WTP for natural river banks amounts € 11,60.

Neither of the studies addressed the benefits derived from the utility of living close to good quality surface water. This paper explores the valuation of the benefits of living near surface water with good water quality. In particular, the economic value associated to improved water quality is derived from the additional house prices associated to improved water quality. The survey is conducted via Internet amongst dwelling owners and house hunters. We use a Discrete Choice Experiment because the water quality improvements will be realized in the (near) future. Next to the additional house price, we take into account other water-related attributes such as distance to surface water, water transparency, the type of water and an ecological quality indicator as we will discuss later on. The distance to surface water is used to test whether there is a distance decay effect in the economic valuation of living close to good quality surface water.

The structure of the paper is as follows. Section 2 discusses the study design and Section 3 the methodology. In Section 4, we summarize the data and in Section 5 we present the results. Finally, Section 6 concludes.

2. Study design

The purpose of the DCE is to get insight on the impact of relevant attributes on water quality improvements in relation to the additional house prices. The selection of attributes and the levels of the attributes are crucial in a DCE. The attributes have to reflect the main aspects of the choice, so that the results of the DCE are useful for policy makers (Bateman et al., 2002). On the other hand, the DCE cannot be to complex in term of the number of attributes and attribute levels, otherwise respondents will not understand the experiment which might lead to non-response or ambiguous answering (see Brouwer et al., 2007). These issues were tested in three pre-tests.

The final DCE includes five attributes as mentioned above and summarized in Table 1. From the pre-tests, the inclusion of two different types of ecological indicators turned out to be too complicated for respondents, although ecological quality has several dimensions. To overcome this issue, we used two versions of the DCE: (1) ecological status of the water in terms number of fish and fish species, and (2) the presence of natural banks.

Respondents answered five choice questions which each consisted of a three-way choice as shown in Figure 1: the options House A and House B give an improvement of at least one attribute and a positive additional house price. Option C is the 'status quo', no improvement and no additional house price.

INSERT FIGURE 1 ABOUT HERE

Furthermore, we have conducted two versions of the DCE. In version 1, we included ecological status as an additional attribute and in the second version, we included the presence of natural banks at rivers, ditches, lakes or canals. Table 1 shows the levels of all the attributes. These levels were obtained after pre-testing. Irrelevant combinations of attributes are excluded, such as city canal and natural banks.

INSERT TABLE 1 ABOUT HERE

All five choice questions have different combinations of attribute levels for options A and B. After each choice question, respondents have the opportunity to motivate their choice. If respondents choose the status quo five consecutive times, they were asked to motivate their consistent choices.

Since we use an web-based questionnaire, we can enlarge the design of the DCE.[1] We used a design of 300 different sets with 5 choice questions and two versions. For the generation of the design, we used SSI Web from the Sawtooth Software Company. We used the balanced overlap method to generate the design, as it approximates the orthogonality condition for the design and it allows for predefined relationships between attributes. In our DCE, the view on surface water is relevant for lakes, but not for ditches or small canals in rural areas, for instance.

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[1] Most DCE's mentioned in the literature use personal interviews, while we use a web-based survey. The advantage of a web-based DCE is that it is relatively cheap compared to personal interviews. Moreover, an additional advantage is that the size of the design can be enlarged considerably. If DCE are either conducted with personal interviews, the size of the design is often limited due to practical reasons.

In addition to the DCE, there were four other sets of questions in the questionnaire Firstly, respondents were asked about the characteristics of their current dwelling (number of bedrooms, presence of garden etc) and its neighborhood (distance to water, quality of surface water). Secondly, respondents are asked how they value a dwelling nearby surface water in general, and how credible the alternatives of the choice experiments were. Finally, a series of questions on demographic and socio-economic determinants were included (for more details see Brouwer et al., 2007a).

3. Methodology

The theoretical model of the DCE is the 'multi-attribute utility' theory (zie bijvoorbeeld Ben-Akiva en Lerman, 1985; Train, 2003). This theory is based on Lanchaster (1966) theory that a product or service is valued based on its characteristics. The value of a car is determined by its shape, maximum speed, accessories, brand etc. The theory has more frequently been applied to environmental goods and services in the last two decades, such as in choice of destination or travel modes choices in transportation studies.

DCE's are usually analyzed with a Multinomial Logit (MNL) model, see for instance Hensher et al. (2005). With a MNL, the attributes of the individual's choice behavior can be analyzed. In particular, this paper analyzes the additional house price of individuals are willing to pay for an improved water quality status. The MNL model describes the indirect utility of individuals. The indirect utility function is divided in a ''fixed' and 'random' part. The 'fixed' part depends on the observed attributes, while the stochastic random part reflects the unobservable influences of choice behavior. We assume that this unobserved part of indirect utility is random across individuals.

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \sum_{k} \beta_K X_{ikj} + \varepsilon_{ij} \qquad (1)$$

where U_{ij} reflects the total utility of individual *i* derived from alternative *j*, V_{ij} is de observed part of utility which depends on the attributes amongst others, and ε_{ij} is the random utility part of utility for individual *i* derived from alternative *j*. The indirect utility depends on attribute *k* of the alternative *j* for individual *i*, and the utility coefficient β_k associated with attribute *k*. The error terms are independent and identical distributed with a Gumbel distribution with a type I extreme value distribution. The probability (*P*) for choosing alternative *j* is a logistic distribution (McFadden, 1973), and the MNL model can be estimated with the Maximum Likelihood method:

$$P_i[j \mid C] = \exp\{\beta_j X_{ij}\} \Big/ \sum_{k} \exp\{\beta_k X_{ik}\}, \qquad (1)$$

The model has the Independence of Irrelevant Alternatives (IIA) property. The probability that an individual chooses alternative *j* increases if the utility for alternative *j* increases. The preferences of individuals are assumed to be homogeneous.

The indirect utility function in Eq. (1) for version 2 then is (see Table 1):

$$U = \beta_{distance}X_{distance} + \beta_{view}X_{view} + \beta_{transparency}X_{transparency} + \beta_{water\ type}X_{water\ type} + \beta_{natural\ banks}X_{natural\ banks} + \beta_{house\ price}X_{house\ price} + \gamma_{other}Y_{other} + \varepsilon \qquad (2)$$

For convenience, we neglect the subscripts for individuals *i* and alternatives *j*. The coefficient γ_{other} is the vector of coefficients associated to demographic and socio-economic characteristics (Y_{other}) of the household, such as income, education. Note that these demographic and socio-economic characteristics are constant for an individual.

Since we include a price attribute in the set of attributes, we are able to derive the Hicksian measure of welfare like the equivalence variation (EV):

$$EV_{attribute} = \frac{\beta_{attribute}}{\beta_{price}} \tag{1}$$

For the DCE in this paper, we define the choice questions based on water-related characteristics of the dwelling, see previous section. Other relevant characteristics of the neighborhood of the dwelling, such as the presence of natural parks and the distance to public facilities such as schools and stores, are assumed to be fixed for the respondent. This also holds for the characteristics of the dwelling, such as the year of construction, facilities in the house, the size of the dwelling and the number of bed rooms.

4. Data

In September 2007, we conducted a survey in three study areas, namely the province Flevoland and surrounding fresh water lakes, the Vecht river basin in the provinces Utrecht and North-Holland, and the lakes area near the Meuse river in the provinces Limburg and North-Brabant. The invitations for the survey were equally divided over the three areas and the versions of the DCE. The survey is conducted amongst house owners and house hunters subscribed to house hunter website[2] The main reason to focus on these group of individuals is that they have recent experience on the housing market (private property).[3] There were sent out 6,000 invitations for this survey equally divided over the three study areas and the two versions of the survey. The gross response rate was 10 percent.

[2] We only invited house hunters that did not have any objections to be approached for other purposes via the website. www.dimo.nl.

[3] In the Netherlands, slightly more than half of the dwellings is private property. The rest of the houses are rented houses.

INSERT TABLE 2 ABOUT HERE

Eventually, 609 respondents filled out the questionnaire. Table 2 shows that there is a slight majority of male respondents (57 percent) in the survey. The average age of the respondents is 43 years in the range of 18 to 83 years, although more than 30 percent of the respondent is between 31 and 40 years of age. The average size of the family is 2.8 persons, which is slightly above the national average of 2.3 (Statistics Netherlands, 2007). More than 50 percents of the respondents has children in the family. About 15 percent of the respondent are a single person household, which is well below the national average of 35 percent (Statistics Netherlands, 2007). The level of education is high: 63 percent of the respondent has a bachelor or master degree. The monthly income in the survey is €3,160 which is well above the average of €2,550 (Statistics Netherlands, 2007).

INSERT TABLE 3 ABOUT HERE

Furthermore, Table 3 shows that 85 percent of the respondent owns a house. The average age of the dwellings is 38 years old, although half of the number of dwellings is built after 1980. On average, dwellings have 3.3 rooms, and 80 percent of the dwellings have a garden. Almost 50 percent of the respondents live in a semi- or non-detached terraced house (49 percent), while 21 percent lives in some sort of apartment. In addition, 16 percent of the dwellings are mansions, villas or farmhouses, and 10 percent is detached terraced houses. The average house price is 315 thousand euro for a terraced dwelling. This is the price at the housing market in September 2007 observed by the respondents. Obviously, the house prices vary with the type of dwelling. A city canal house costs 540 thousand euro and is the most expensive dwelling type, while an apartment is the cheapest with 260 thousand euro. In addition, there are also significant differences between the three study areas for housing prices, although these house prices are not corrected for the characteristics of the dwellings or local housing market conditions.[4]

On average the distance from the respondent's dwelling to surface water is 730 meter and it ranges from 0 meters to 16 kilometers. This distance significantly differs per study area. Respondents from the Vecht river basin live 400 meters from surface water, while in Flevoland the distance amounts more than 700 meters. In the Meuse lakes area the distance is almost 1,200 meters. One out of five respondents in the whole survey states that they have a house close (less than 10 meters) to surface water.

INSERT TABLE 4 ABOUT HERE

In addition, the distance to surface water relates to the type of water which is closest to dwellings. Table 4 shows that the distance to city canals in urban areas, ponds and ditches are short, while the distance to rivers and lakes is usually much longer. Obviously, the type of water types differ across study areas. Rural area canals and ditches are most frequently mentioned in Flevoland, and ditches in the Vecht river basin. In the Meuse lakes study area, rivers are most frequently mentioned. More than one-third of the respondents in the study areas of the Vecht river basin and the Meuse lakes judge the quality of the surface water as poor, while in Flevoland 20 percent of the respondents mark the quality of surface water as poor. In Flevoland, 45 percent of the respondents state that the surface water quality is good or very good. In the Vecht river basin and the Meuse lakes this is 23 and 31 percent respectively.

Finally, 9 percent of the respondents mention the presence of surface water as one of the key elements of their decision in the search for a dwelling. However, 36

[4] We asked respondents for the average housing prices in their neighborhood instead of the value of their dwelling for to reasons. Firstly, in this way we try to avoid any possible resistance of respondents when we would have asked for the value of their own dwelling. Secondly, respondents which currently rent a house can give an estimate as well.

percent of the respondents is positive about a house near water. The presence of surface water seems to be an important element, although it has not the highest priority in the decision of the purchasing a dwelling. In the next section, we estimate the relevance of the different attributes.

5. Results

This section discusses the results of the two versions of the WTP for improved water quality based on the multinomial model presented in Section 3. For both version, the results of two estimations are presented: the model with only attributes and the best-fit model. In addition, the EV is derived from the only attributes models.

Attribute only model

The first column of Table 5 shows the results of the MLN estimation including ecological status. For the distance attribute, we add a quadratic term in order to check for a possible distance decay effect. The results for the linear and quadratic distance attribute indicate that there is a distance decay effect with respect to the WTP for water quality improvement. If the dwelling is further away from surface water, respondents have a significant lower WTP value for improved water quality. Except the presence of canals in rural areas, all coefficients of the attributes are significant and have the expected sign. The water types as lakes, rivers, and city canals have a positive coefficient, which means that these water types are more valued than rural canals.

INSERT TABLE 5 ABOUT HERE

For water transparency, we included a quadratic terms. Water transparency has a significant positive effect, although water transparency has a saturation point at a transparency is about 2 meters. The additional house price has a significant negative coefficient as expected. The view on surface water and the improvement of the ecological status from poor to moderate and from poor to good all have significant positive effects. In addition, the coefficients of the moderate and good ecological status differ significantly, which means that respondents are willing to pay for good ecological status with respect to the moderate ecological status. In the other model with natural banks, the presence of the natural banks have a significant effect on the choice of an alternative. In addition, if we compare the coefficients of the attributes only model for both versions, the attribute coefficients do not differ significantly.

INSERT TABLE 6 ABOUT HERE

Based on the estimates of both versions of the attributes only model, we derive marginal economic welfare measures, as defined in Section 2. Table 6 shows the marginal values for the significant results of both versions of the models. For the attributes distance to surface water and water transparency, the marginal values depend on the level of the attribute due to the presences of the quadratic terms of the attributes. Therefore, we present marginal economic values for three different attribute levels.

For distance to surface water, the marginal value is negative for a distance at 500 meters or shorter. This means that the economic value of improved water quality declines with the distance to water. However, the absolute value of the marginal value is larger if the dwelling is closer to the surface water. If a dwelling borders to surface water, the marginal value declines with €26 per meter if the dwelling is located further away from the water. If the distance to surface water is already 500 meters, the marginal value declines with €15 per meter if a the dwelling is moved further away from the water. At 1,000 meter distance, the marginal value becomes insignificant for both versions of the model. For water transparency, the marginal value is €190-203 per centimeter if the water transparency is 25 centimeters. At 75 cm water transparency, the marginal value declines to €131-147 per centimeter. At 150 cm, the marginal value is €43-64 per meter and still significant. Note that the marginal values for water transparency are slightly higher in the sample of the respondents with the natural banks version, although this difference is not significant.

In addition, the presence of a lake, a river or a city canal have significant marginal values of over the presence of a wide rural canal. The presence of a lake has the highest marginal value of €25,000, while the presence of a river is valued at €15,000. If we relate it to the average housing price in the sample of €330.000, this amounts to 7,5 percent of the housing price for the presence of a lake, and 4,5 percent for rivers. For city canals, the marginal value is estimated at the range of 8-9,5 thousand euro (about 2,5 percent). Usually, the housing prices of dwellings near city canals are much higher than the average housing price, due to the presence of other facilities of a city centre.

Also, respondents are willing to pay a higher house price for a view on surface water and for improved ecological status. The marginal value for moderate ecological quality is almost 18 thousand euro (5,4 percent), while for good ecological quality is more than 25 thousand euro (7,7 percent). Note that the marginal value for good quality compared to a moderate quality is approximately €7,500, i.e. the difference between the marginal values of the two ecological status in the first column of Table 6. For natural banks, respondents are willing to pay almost €10,000. Note that respondents from the natural banks version value the water quality improvement lower than the respondents from the ecological status version. However, the respondents from the natural banks version value all other attribute slightly higher, although this higher valuation is not significant.

"Best fit' model

To check whether the estimates of the attributes only model are robust, we also test the presence of a-priori preferences with the inclusion of demographic characteristics, and the presence of heterogeneous preferences with the inclusion of interaction terms of attributes with demographic variables. Table 5 shows the results in the 'best fit model' columns for both versions. Due to missing data in the demographic characteristics, we had to exclude a number of respondents from both subsamples.

For most attributes in both model versions, the estimated coefficients of the attributes do not change significantly. There are two exceptions. The positive coefficient for the presence of city canals vanishes. However, the city canals effect is picked up by interaction terms. For version 1, the impact of city canals is related to the Vecht study area. Respondents in the Vecht study area value the presence of city canals much higher than in the other study areas. For version 2, the value associated to city canals are based on the view on surface water.

Although the presence of natural banks has a significant effect in the attribute only model, it becomes insignificant when other variables and interaction terms are included in the model. It turns out however that the presence of natural banks is valued by respondents that actually use the surface water for water related recreational activities.

Furthermore, income has a positive impact on the choice for improved water quality. For both subsamples, the age of respondents has a diminishing impact on the value of improved water quality. Older respondents are less willing to pay for the improvement of water quality. The negative impact of age is significant higher in version 2. Part of the interaction terms is the association of effects to regions. Respondents of the Meuse lakes study area value the view on surface water significantly lower than respondents in the Vecht river basin and Flevoland. Twenty percent of the respondents in the Meuse lakes report negative associations with the view on surface water due to the presence of children in the family. In the other study areas, only ten percent of the respondents mention negative associations with the view on surface water. Surprisingly, respondents around the Meuse lakes are do not mention higher probability of flooding is not mentioned as an explanation, while the Meuse lakes area has a higher risk with respect to flooding.

The interaction term of a low house price and relative additional house price has a significantly negative coefficient. This means that if all respondents are presented an alternative scenario with the same relative changes in house prices, respondents in low house price areas are less likely to choose this alternative. For version 1, we find the positive coefficients for the interaction terms of water transparency and ecological status with water related recreation. In other words, respondents who use the water for recreation are more likely to choose the alternative with ecological status improvements. Finally, the credibility of the choice questions has a negative effect. If respondents think that one or both of the alternative choices is unrealistic, they will be more likely to choose the ‘neither of them’ option. In the whole sample, 15 percent of the respondents mentioned that the alternative choices were not credible.

6. Discussion and conclusions

This study presents of a stated preference research on the estimation of the value that individuals associate to living close to surface water. In the process of conducting a social cost-benefit analysis for the implementation of the WFD in the Netherlands, policy makers argue that one of the largest benefits is the valuation of the pleasure of living close to surface water with a good quality status. However, there is no reliable estimate for this benefit yet. With a web-based survey we tried to estimate the economic value that individuals associate to living close to good quality surface water. The survey was divided into two versions with respect to the measurement of improved water quality: improved ecological status in terms of number of fish and fish species, and the presence of natural banks. Due to the cognitive burden of respondents, we did not include both water quality attributes into one experiment.

As mentioned in Section 3, 84 respondents (14 percent of 693 respondents) did not complete the survey. These respondents did not have resistance to the amounts of additional house prices presented in the experiments. Only 84 of the respondents (14 percent) chose the ‘neither of them’ option in all five experiments. From these 84 respondents, only 4 respondents were protest bidders as they refused to participate in the DCE. The main reason for the other 80 respondents not to fully participate was the high additional value of the housing price. Most of these respondents actually have a lower disposable income compared to the respondents that fully participated. The earlier CVM study of Ruijgrok en Vlaanderen (2001) on natural banks suffered from much higher shares of protest bidders and zero-bidding respondents (40 percent of the sample).

The results of the choice models seem valid and robust. Important attributes, such as price (additional house price) and income were significant, had the correct sign, and were consistent across different version of the model. In addition, the choice behavior of respondents from the three different study areas hardly differs. The water related attributes are important in the choice behavior of respondents. Respondents around the Meuse lakes area have more negative association with living close to water than in the other areas due to the danger for accidents with little children. The share of the respondents with children is relatively high in this area. In the Vecht river basin, the presence of city canals is significant. The other areas do not have city canals.

The estimated marginal economic value of natural banks amounts almost 3 percent of the average house price in the sample. For a good ecological status of the surface water, the marginal economic value is even 8 percent of the house price. These percentages are in the same range as the estimated 5 percent of in Witteveen+Bos (2006).

However, further validation of our results is required to check whether and to what extent the presence of surface water and the quality of surface water is relevant for the decision of purchasing a dwelling. Since the emphasis of our survey is on water-related characteristics, respondents might overestimate the value or relevance of water related attributes over other characteristics, such as the distance to shopping centers, schools and highways for instance. In our analysis, these other characteristics are assumed to be constant for choice questions.

In future research, we will compare our results with the revealed preference study of Brouwer et al. (2007b). They use a hedonic regression of house prices including characteristics on housing characteristics, neighborhood characteristics, and surface water related characteristics. One of the water related characteristics are water quality measurements (nutrients, heavy metals etc). The house prices are actual market prices. Moreover, Brouwer et al. used similar study areas for their analysis.

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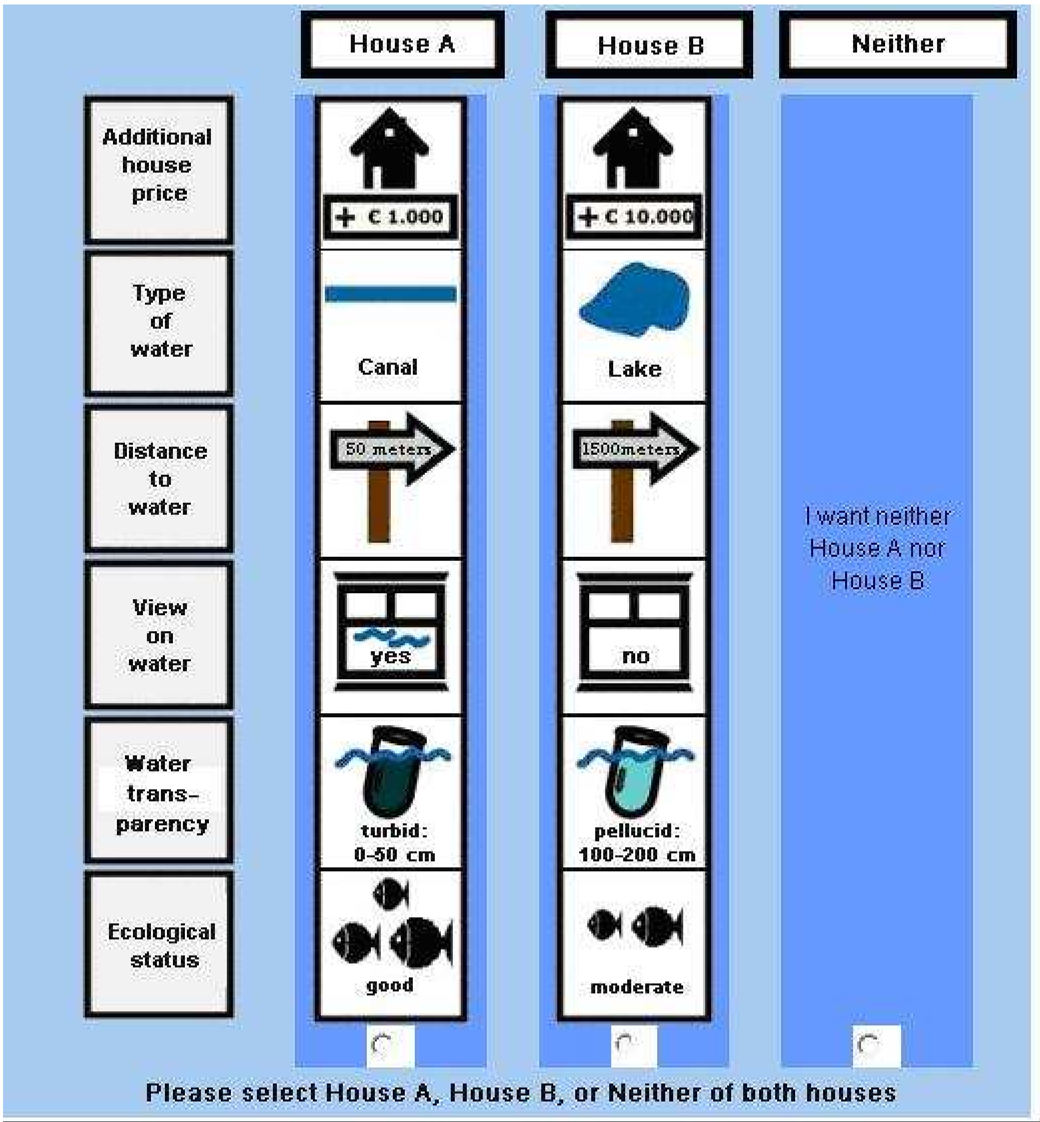

Figure 1: Choice card of the example choice question

Tabel 1 Summary of the levels of the attributes

Attribute	**Description**	**Levels**
$X_{distance}$	Distance to water	0; 50; 100;500;1500 meters
$X_{water\ type}$	Type of water	Urban canal, River, lake, wide rural canal, small rural canal, ditch
X_{view}	View on surface water	yes; no
$X_{transparency}$	Water transparency	turbid water (0-50cm); moderately turbid water (50-100 cm); pellucid water (100-200cm); very pellucid water (>200cm)
$X_{ecological\ status}$ (version 1)	Ecological status	poor; moderate; good
$X_{natural\ banks}$ (version 2)	Presence of natural bank	yes; no
$X_{house\ price}$	Additional house price	€1.000; €5.000; €10.000; €15.000; €25.000; €40.000

Tabel 2: Summary statistics of demographic en socio-economic characteristics of the respondents

Characteristics	**Total sample**	**Flevo-land**	**Vecht river basin**	**Meuse lakes**
Share of males (%)	56.5	62.3	48.6	63.8
Average age	43	45	40	43
Min-max age	18-83	22-77	18-71	24-70
Average household size	2.8	2.8	2.5	3.1
Share of single person hh (%)	15.2	13.5	20.6	7.7
Share of hh with children (%)	50.5	52.9	45.0	57.7
Share of highly educated persons* (%)	62.6	58.9	74.1	52.1
Average monthly income (€)	3,160	3,200	3,200	3,000
Number of observations				

* At least bachelor or master degree or equivalent

Table 3: Summary characteristics of the dwellings

Characteristics	**Total sample**	**Flevo-land**	**Vecht river basin**	**Meuse lakes**
Share of property owners (%)	85.1	87.9	79.5	90.8
Type of dwelling (%)				
Non-detached and semi-detached single-family dwellings	49.3	54.1	49.1	47.9
Detached terraced dwellings for single families	9.9	9.7	2.7	21.1
Flat or apartement (First-floor apartment, upstairs apartment	21.5	15	36.4	10.6
Mansion/villa/farmhouse	15.6	19.3	9.1	20.4
City canal house	1.1	0.5	2.3	0
Houseboat	0.5	1	0.5	0
Other types of dwellings	2.1	0.4	0	0
Average number of bed rooms	3.3	3.5	2.8	3.5
Share of houses with garden(%)	79.7	89.7	62.8	90.7
Average age of the house	38	25	53	32
Median year of construction	1981	1990	1970	1979
Min-max year of construction	1600-2007	1850-2007	1600-2007	1848-2007
Average house price (€)*	330.000	329.000	342.000	320.000

* only property owners

*Table 4: Average distance to closest surface water type per region**

Type of water	**Flevoland**		**Vecht river basin**		**Meuse lakes**		χ^2	***p<***
City canal	98	(27)	215	(55)	107	(7)	1.666	0.435
River	1500	(2)	247	(22)	1869	(33)	16.032	0.001
Lake	1341	(82)	1627	(29)	1447	(30)	0.811	0.667
Brook	507	(3)	11	(3)	633	(14)	5.507	0.064
Pond	164	(5)	127	(10)	355	(11)	7.696	0.021
Wide canal (rural areas)	295	(10)	355	(28)	1372	(32)	23.043	0.001
Canal (rural areas)	451	(34)	286	(12)	-		1.914	0.384
Ditch	270	(41)	257	(60)	444	(12)	21.186	0.001

* number of observations between brackets.

Table 5 Estimation results continued

	Ecological status (version 1)				Natural banks		(version 2)	
	Attributes only		Best-fit model		Attributes only		Best-fit model	
ASC	-1,839	**	-1,389	**	-1,270	**	-1,242	**
	0,197		0,353		0,182		0,245	
Value added to housing price	-0,040	**	-0,040	**	-0,036	**	-0,030	**
	0,004		0,005		0,004		0,005	
Distance dwelling-surface water (meters)	-0,001	**	-0,001	*	-0,001	**	-0,001	
	0,000		0,000		0,000		0,000	
Distance squared	0,0000006	*	0,0000006	*	0,0000005	*	0,0000004	
	0,0000002		0,0000003		0,0000002		0,0000002	
Transparency (in cm)	0,880	**	0,790	**	0,844	**	0,956	**
	0,231		0,246		0,217		0,233	
Transparency squared	-0,236	**	-0,221	*	-0,205	**	-0,233	**
	0,079		0,084		0,075		0,080	
River (yes=1; no=0)	0,533	**	0,544	**	0,606	**	0,566	**
	0,142		0,149		0,135		0,142	
Lake (yes=1; no=0)	0,922	**	0,901	**	0,987	**	0,935	**
	0,139		0,148		0,134		0,141	
Canal in urban areas (yes=1; no=0)	0,318	*	0,082		0,349	*	-0,219	
	0,143		0,182		0,138		0,230	
Canal rural areas (yes;=1 no=0)	0,082		0,056		0,186		0,124	
	0,148		0,156		0,140		0,148	
View on water (yes=1; no=0)	0,947	**	1,048	**	0,891	**	0,854	**
	0,101		0,112		0,096		0,116	
Moderate ecology status (yes=1; no=0)	0,717	**	0,541	**				
	0,111		0,144					
Good ecology status (yes=1; no=0)	1,014	**	1,045	**				
	0,110		0,117					
Natural banks (yes=1; no=0)					0,367	**	-0,026	
					0,077		0,122	
Demographic characteristics								
Household income			0,000099	**			0,000157	**
			0,000001				0,000048	
Age			-0,100	**			-0,422	**
			0,005				0,121	
Interaction terms								
Low housing price x relative value added to housing price			-0,033	*			-0,166	**
			0,013				0,008	
View x Meuse lakes study area			-0,331	*			-0,354	*
			0,150				0,141	
Perception of credibility of experiment			-0,489	**			-0,602	**
			0,127				0,129	
Distance x Water recreation in neighborhood			0,000				0,000	*
			0,000				0,000	

Table 5 Estimation results continued

	Ecological status (version 1)			Natural banks (version 2)		
	Attributes only	Best-fit model		Attributes only	Best-fit model	
Transparency of water x Activity recreative boating		0,330	**			
		0,100				
Moderate ecological status x Activity walking		0,384	*			
		0,166				
Canal urban area x Vecht river basin		0,481	*			
		0,223				
Natural bank x Water recreation in neighborhood					0,561	**
					0,138	
View x urban canal					0,718	**
					0,260	
Log Likelihood	-1383,107	-1204,651		-1453,473	-1282,881	
R-kwadraat	0,15985	0,188		0,12615	0,1507	
Number of observations	1505	1415		1520	1375	
Number of respondents	301	283		304	275	

Table 6: Marginal Economic Value (MEV) per attribute for both versions of the model

	Version 1 (Ecological status)			Version 2 (Presence of natural banks)		
	MEV	Standard error	Share in house price	MEV	Standard error	Share in house price
Distance to water						
at 0 meters	-26	9		-27	10	
at 500 meters	-15	4		-15	4	
at 1000 meters	13	10		15	10	
Water transparency						
at 25 cm	190	50		203	53	
at 75 cm	131	31		147	33	
at 150 cm	43	14		64	15	
A lake versus a wide rural canal	23,012	3,974	7.0	27,184	4,382	8.2
A river versus a wide rural canal	13,312	3,742	4.0	16,727	3,980	5.1
A city canal over a wide rural canal	7,935	3,652	2.4	9,544	3,908	2.9
A small over a wide rural canal	-			-		
View on surface water (no view is reference)	23,640	2,523	7.2	24,653	2,667	7.5
Moderate versus poor ecological quality	17,892	3,160	5.4			
Good versus poor ecological quality	25,317	3,501	7.7			
Natural banks (no natural banks is reference)				9,986	2,303	3.0