Spatial effects in stated preference studies for environmental valuation

Marije Schaafsma

Promotoren: Prof.dr. J.C.J.M. van den Bergh
Prof.dr. R. Brouwer

Leescommissie: Prof.dr. I. Bateman
Prof.dr. E.C. van Ierland
Prof.dr. J.B. Opschoor
Prof.dr. H.J.P. Timmermans
Prof.dr. E.T. Verhoef

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Promotoren: Prof.dr. J.C.J.M. van den Bergh
Prof.dr. R. Brouwer

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List of abbreviations

CE	Choice experiment
CNL	Cross-Nested Logit
CS	Consumer Surplus
CV	Contingent valuation
ECM	Error Component Model
GES	Good Ecological Status
GIS	Geographical Information Systems
GEV	Generalized Extreme Value
IIA	Independence of Irrelevant Alternatives
MNL	Multinomial Logit
MRS	Marginal Rate of Substitution
NL	Nested Logit
RP	Revealed Preference
RPL	Random Parameter Logit
RUM	Random utility models
RUT	Random utility theory
SP	Stated Preference
UL	Universal Logit
WFD	Water Framework Directive
WTA	Willingness to Accept
WTP	Willingness to Pay

1. Introduction

1.1 Water as an economic good

Since water is a physiological need, its availability is required for the existence of life on earth. Water resources deliver numerous goods and services that are beneficial to humans (De Groot et al. 2002). As water becomes increasingly scarce, the legitimacy of treating it as a free resource is ever more questioned (e.g., Young 2005). Water scarcity in terms of quality and quantity leads to conflicts in time (overuse, depletion) and in space (across political boundaries). It is generally recognised that at many locations, current water use exceeds optimal levels in terms of social-welfare maximization. In other words, it would be possible to make people better off by reducing the level of water use. Of course, the optimal level of water use (both in terms of extraction and pollution) is unlikely to be zero. The main question is therefore how to allocate scarce water resources efficiently across different uses.

The main reason for suboptimal water use is the absence of markets for many goods and services provided by water or the failure of existing markets (Turner et al. 2004). There are two reasons why existing markets fail to allocate water resources efficiently. First, water is often a common property resource, which means that it is rivalrous and non-excludable. Consumption by one consumer prevents the consumption by another. Yet as a result of its open access nature, especially in case of surface water, it is often impossible to prevent people who have not paid for the good from enjoying its benefits. Private solutions to resource allocation repeatedly do not succeed if there is no enforcement of the agreed use levels and the costs of excluding individuals from using the common-pool resource are high (Wade 1987). As a result, water resources may suffer from the "tragedy of the commons" (Hardin 1968). This entails that there is a lack of incentive for any one user to invest in the maintenance of the water resource, because the improvement will immediately lead to (intensified) use by others. Excessive resource use may follow if the parties involved do not reach a mutually beneficial agreement in which one party compensates the other to the point that an optimal use of the resource is achieved.

The second cause of inefficient resource allocation is the presence of external costs or externalities: the direct or physical unintended effects of action of one agent on the utility or production of another agent without any payment or compensation to offset these effects. Externalities are by definition not accounted for in the market. For example, a farmer might contaminate a water resource that is used by others as a source of drinking water. A negative externality arises if the farmer, when deciding how much fertiliser to use, does not take into account that the associated contamination imposes a cost upon others through public health effects or the need for water purification. The farmer could be motivated to pollute less if he would also bear the external cost of his activity.

The sustainable management of water resources is complicated for at least three reasons (Dolšak and Ostrom 2003). First, the complexity of water-based ecosystems makes it difficult to agree on the extent of allowable resource use and the allocation among various uses. Second, water resources are not delineated by political boundaries; its externalities can extend over vast distances, for instance, when pollution upstream is transported to downstream areas. Third, the heterogeneity in the spatial distribution of water quality and related ecosystem services requires that users divide access rights to highly valuable spots if they want to manage the resources sustainably. The services provided by water bodies depend on the location and characteristics of the water bodies, the functioning of upstream-downstream relationships and on the spatial distribution of the human population that uses water services. For instance, the proximity and distribution of rivers, lakes and streams determines the way people enjoy and recreate at water sites.

It is increasingly recognised that the spatial characteristics of water services and many other ecosystem services need to be taken into account when designing policies for ecosystem management, for instance, in the identification of the location of beneficiaries (Fisher et al. 2009). In addition to the spatial nature of water externalities and other common property resources, the temporal dimension matters. Water pollution may persist for very long periods of time and thereby affect future users.

Inefficient allocation of water over uses in time and space can be solved by adequate water pricing schemes that internalize the externalities in decision-making. Pricing in this context refers to the introduction of financial charges in situations where water use was previously free of charge or under-priced. Pricing requires consideration of the economic value of water in decision-making through the use of appraisal and accounting procedures, such as monetary valuation techniques and cost-benefit analysis (Brouwer and Pearce 2005). If water resources are not correctly priced and prices are not internalised in decisions, market distortions are created. This results in misallocation of resources and sub-optimal levels of social welfare. Correct pricing can lead to more efficient allocation across different uses by affecting the allocation decisions of those with competing wants (Elnaboulsi 2009). For instance, payments for environmental services (PES) schemes have been proposed to provide users with an incentive to use water in a more sustainable manner (Ferraro 2009).

1.2 Economic valuation of water benefits

For the design of efficient environmental policies, i.e. policies that achieve an optimal allocation of resources, knowledge of the marginal costs and benefits of alternative resource uses is required. This involves an estimation of the economic value of competing uses. The valuation of the economic benefits of water resource use, which usually remains unquantified in water policy appraisals, is at the core of the current study. Protecting water from excessive use or contamination has many benefits, which can be categorized in use and non-use values. Use values comprise direct and indirect use and option values (Pearce and Warford 1993). Direct uses include extraction for drinking water purposes, irrigation and water use in industrial production, and non-extractive activities, such as recreation. Water resources are used indirectly for the disposal of chemical waste, including excess fertiliser and pesticides from agriculture. People that currently do not use a water resource may place a value on having the option to use it in the future. Water may also have non-use values if people who are currently not using the resource place a value on its continued existence or on its availability for future generations.

The economic valuation of the benefits of water resources comprises an assessment of the utility society derives from these benefits. Valuation is used in conventional economic terms to refer to the estimation of welfare changes associated with changes in the quality or quantity of a resource. There are four possible measures of welfare change, which are based on Hicks-compensated demand functions (Freeman III 2003). Estimates of Willingness-To-Accept (WTA) compensation reflect the money-equivalent of the utility that people derive from accepting resource loss or foregoing a resource gain. Similarly, Willingness-To-Pay (WTP) estimates reflect utility changes related to obtaining gains or avoiding losses. The economic value of a good or service to society as a whole is determined by aggregating all individual WTP or WTA amounts. The aggregate value can be used as input to water pricing, environmental damage assessment, environmental accounting and cost-benefit analysis.

The question that immediately follows is how to value changes in water resources and obtain the theoretically correct welfare measure of WTP or WTA. Some values associated with water use are directly observable in existing water markets, for instance when water users pay a fee for the quantity of water they extract. Often, however, markets do not exist and appropriate non-market valuation methods have to be used (Young 2005). Non-market valuation methods include stated preference (SP) techniques, such as contingent valuation (CV) (Mitchell and Carson 1989; Bateman et al. 2002a) and choice experiments (CEs) (Hanley et al. 1998; Hensher et al. 2005a). These methods build upon neoclassical microeconomic welfare theory. SP research for environmental valuation has a long tradition in the Netherlands, beginning in 1974 (Opschoor 1974), followed by numerous studies, including Oosterhuis and Van der Linden (1987), Hoevenagel (1994), Spaninks and Hoevenagel (1995), Ruijgrok (2000), Nunes and Van den Bergh (2004), Bulte et al. (2005), Van der Heide et al. (2008), and various studies by Brouwer (e.g., Brouwer and Slangen 1998; Brouwer et al. 2003; Brouwer 2004; 2006).

In spite of the increased recognition of the spatial nature of environmental goods, there is surprisingly little consideration of the spatial aspects in the vast number of existing SP studies in the environmental economics literature. Spatial variables have been included in revealed preference methods, such as hedonic pricing and travel cost methods using GIS (Bateman et al. 2002b). The majority of SP studies in the environmental valuation literature have taken, however, a non-spatial approach by disregarding the effect of distance and substitutes on preferences. Although Bateman et al. (2002a) propose distance decay as a validity check and its examination as a minimum requirement for SP studies, only about 25 SP studies account for the effect of distance on WTP (see Chapter 3). Distance decay implies that the further the respondent lives away from the site under valuation, the less (s)he is willing to pay for conserving or improving this site. One of the main reasons to account for distance decay is to determine the size of the market of the environmental good. This market stands for the affected population over which WTP values can be aggregated to calculate the total welfare change to society.

There are a number of limitations in the way SP studies have analysed distance-decay effects. First, it is not standard practice in site-valuation studies to apply geographically-balanced sampling strategies, ensuring the possibility to estimate distance effects. Second, with little empirical evidence, there are no rules of thumb for the appropriate order of magnitude of the distance-decay effect, which can serve as a validity check or help to define spatial sampling strategies. Third, a sound theoretical underpinning of the functional form is missing. Studies have commonly focused on statistical fit rather than behavioural soundness of the estimated decay functions. Fourth, studies typically include the straight-line distance or road distance rather than the cognitive distance. The cognitive distance is the distance as perceived by individuals. According to spatial cognition theories, the cognitive distance is used when choosing among different destinations, rather than objective, geometrical distance.

Emotional factors, such as place attachment reflecting the functional and emotional attachment of people to locations, may also influence individual distance decay. Last but not least, existing SP studies accounting for distance-decay take an isotropic or one-dimensional approach. Isotropy means that the spatial relationship only depends on distance and is uniform in all directions (Haining 1993). Isotropic distance-decay effects suggest that WTP decreases as distance increases, independent of the direction. Differences in distance decay across respondents from areas with few and many alternative sites are not accounted for. The spatial distribution of substitutes creates differences in the scarcity of the good under valuation and is expected to result in variation in distance-decay depending on the direction from the site (Hanley et al. 2003; Bateman et al. 2006). Anisotropic or two-dimensional approaches are necessary to examine additional spatial variation in WTP.

Distance-decay and substitution effects are hence related. On the topic of substitution effects, there is an even larger gap in the SP literature on environmental valuation. Substitutes are here defined as goods that can satisfy the same need (Henderson and Quandt 1958) or can fulfil the same consumption goal (Betancourt and Gautschi 1990). In this study, substitutes include sites that provide similar environmental goods and services generating use and non-use values, including recreational and nature values. Only a few CV studies have included the effect of availability of substitutes on individual WTP estimates (Brown and Duffield 1995; Pate and Loomis 1997). Guidelines for environmental valuation have paid limited attention to substitution effects or other indicators of the relative scarcity of the good under valuation in survey design and statistical analysis. Most SP studies focus on individual sites and pay little attention to the availability and characteristics of substitutes.

The question if and how people take substitute sites into account is highly relevant for SP studies. Under the assumption of perfect information underlying consumer choice theory, decision-makers are expected to evaluate all substitutes simultaneously when making choices. Empirical results that violate this assumption have been explained by survey-instrument biases, including insensitivity-to-scope, part-whole and embedding bias (Mitchell and Carson 1989; Carson and Mitchell 1995). In other cases, the lack of substitute effects on WTP has been related to anomalies in decision-making, arising when rationality assumptions are not met (Braga and Starmer 2005). The evaluation of all substitution possibilities may lead to a high task complexity for respondents and invoke different, non-compensatory decision strategies, such as the elimination-by-aspects theory (Tversky 1972). Swait and Adamowicz (2001) show that complex choice scenarios result in choices that are less consistent with rationality assumptions than simple scenarios. A dilemma arises for spatial choice analysis: on the one hand, the assessment of the WTP of the affected population for environmental goods provided at a certain location may require studying a large area to ensure that all relevant substitutes are taken into account. On the other hand, increasing the geographical scale of the study is likely to complicate choices and induce anomalies, because the number of alternatives will increase. For reliable spatial choice analysis, it is required to understand in which cases choices may be too complex and violations of rational choice behaviour occur. This would help to design surveys that are comprehensible to respondents where possible without reducing the relevance of the design.

The potential presence of anomalies raises the question if standard choice models are capable of capturing the underlying spatial decision-making process and if these anomalies affect WTP estimates. In order to analyse the presence of anomalies, the behavioural decision-making process in spatial choices needs to be understood. Preferences for spatial alternatives depend on the spatial knowledge and decision-making strategies of individuals. In contrast with the rationality assumption of neoclassical economic theory, the spatial cognition literature reviewed in this study puts forward that hierarchies in spatial information processing can lead to a hierarchical spatial choice process in which people do not evaluate all alternatives simultaneously.

To estimate more valid and reliable WTP values, one would ideally want to develop a WTP function that includes the full set of variables that can capture the spatial variation in WTP. The set includes socio-demographic characteristics (e.g., income), spatially dependent respondent characteristics (e.g., sense of place: Brody et al. 2004), location-characteristics (e.g., surrounding land-use and landscape: Willis and Garrod 1993; Johnston et al. 2002), distance between sites and respondents (e.g., Sutherland and Walsh 1985), and distance between substitute sites (e.g., Termansen et al. 2008). The use of models that capture the spatial variation in WTP may lead to increased accuracy of WTP results in SP studies.

1.3 Main objective

This dissertation aims to contribute new insights to the literature on stated preference techniques for environmental valuation by offering a systematic approach to the analysis of spatial effects among observations in valuation surveys. This approach is applicable to the assessment of use and non-use values attached to environmental changes. The main objective of this study is to develop and test an improved analytical framework for SP research of spatial choices between environmental goods and services provided at different locations, in casu water quality changes. The framework aims to capture different elements of spatial perception, cognition, preferences and the decision-making structure that influence the spatial decision-making process. To this end, the standard framework from microeconomic theory is compared with concepts of spatial choice behaviour from other disciplines, including environmental psychology and human geography. In addition, different physical spatial factors are included that are expected to affect the valuation of environmental changes in SP research. These factors relate to the location, spatial distribution and characteristics of the sites as well as the respondents. They are expected to cause non-random variation in the spatial distribution of WTP values and lead to spatial dependencies between WTP values of alternative sites.

To operationalise the analytical framework with supporting modelling techniques, the applicability of existing statistical models to spatial choice problems in environmental valuation is evaluated. Alternative study design and modelling approaches from other disciplines are proposed. This includes, for instance, the introduction of spatial analysis techniques to address distance-decay and spatial heterogeneity.

The proposed analytical framework for stated preference research involving spatial choices in environmental valuation is presented in Chapter 2 and elaborated in Chapters 3 and 4. Priority is given to distance decay and spatial substitution effects. The different elements of the framework are tested in two case studies focusing on water quality improvements in two regions in the Netherlands following the introduction of the European Water Framework Directive. The two case studies provide a new set of values for water quality changes in the river basins of the Scheldt and Rhine in the Netherlands.

1.4 Research questions

The objective of this thesis is translated into the following main research question:

Can the design and analysis of stated preference studies be improved in order to increase the validity and reliability of WTP results by accounting for the effects on preferences and choices of the spatial context of the provision of environmental goods and services?

Several sub-questions will be addressed in order to answer the main research question:

a. Which implicit assumptions do standard economic models make regarding choices for environmental goods and services and to what extent might the validity and reliability be compromised in the case of spatial choices?
b. How do the perception of spatial characteristics of environmental goods and services and their spatial context influence preferences and choices in stated preference research?
c. How have existing stated preference studies accounted for the effect of distance on WTP in study design and analysis and how do existing practices affect the validity and reliability of the resulting WTP estimates?

d. How have existing studies accounted for the effects of the availability and characteristics of substitutes on the WTP of environmental goods and services provided by a study site and how do existing practices affect the validity and reliability of the resulting WTP estimates?
e. How can the characteristics of spatial choices be more adequately addressed in study designs and which statistical models are suitable for spatial choice studies so that the validity and reliability of stated preference studies for the valuation of spatially defined environmental goods and services can be improved?

The framework developed in this study starts from a-spatial, generic WTP models. These are extended to capture elements of spatial choice behaviour, such as cognitive distance and spatial characteristics of the good under valuation, including site-specific values, distance decay, directional variation and substitute availability. The study assesses the relevance of perception-based (self-reported) specifications of distance and substitutes in SP models. The central hypothesis is that accounting for spatial choice behaviour and spatial heterogeneity of respondents and environmental goods and services provision increases the validity and reliability of WTP estimates. This hypothesis is tested by comparing existing a-spatial models with spatially explicit approaches in two case studies on the valuation of water quality improvements.

1.5 Outline

The structure of the remainder of this thesis is as follows. Chapter 2 summarises microeconomic consumer theory underlying economic valuation and associated stated preference techniques. Validity and reliability criteria relevant to spatial choice settings are described. Addressing sub-question a, neoclassical economic theory of consumer choice is compared with relevant literatures on environmental psychology and economic geography literature which study the characteristics of spatial choices. Thereby, situations in which anomalies may arise in spatial choices can be identified (sub-question b). Furthermore, concepts and approaches from spatial and geographical analysis are described to analyse spatial dependencies between observations at different locations. Finally, Chapter 2 brings these different approaches together in an improved analytical framework of spatial choices for environmental valuation.

Chapter 3 addresses sub-question c and first gives an overview of SP approaches dealing with distance-decay effects. The chapter offers an assessment of the empirical literature, as well as an overview of the theory underlying distance decay. A conceptual distance-decay model is presented, including the potential explanatory variables of individual distance-decay effects in WTP for environmental goods and services. This conceptual model includes variables reflecting respondent's spatial perception. Furthermore, the conceptual distance-decay function accounts for the effect of substitute availability, which may cause spatial heterogeneity in distance-decay. Finally, the applicability of different functional specifications of the distance-decay effect is discussed.

Chapter 4 addresses the question how substitution effects have been accounted for in the SP literature and aims to identify the main limitations (sub-question d). It outlines the different discrete choice models and resulting substitution patterns. Furthermore, the issue of choice set specification, i.e. the selection of alternatives that are considered to be relevant, is discussed. Different models for spatial choices from different disciplines are suggested as alternatives to standard a-spatial models. Finally, different ways to include substitution effects in the study design are described.

The two case studies are presented in Chapters 5 and 6 and focus on the perceived benefits of water quality changes under the implementation of the European Water Framework Directive (WFD). The case study of the Scheldt river basin in Chapter 5 addresses site-specific values, substitution effects, place attachment and spatial heterogeneity in distance decay. The second case study of the lakes in the Rhine-West river basin, presented in Chapter 6, explores directional heterogeneity and cognitive distance effects in distance decay. The effects of the spatial distribution of the alternatives on choice behaviour, substitution rates and subsequent WTP estimates for water quality changes are tested. In addition, the effect of increasing the geographical scale of the study and the subsequent increase in choice complexity on decision-making is analysed. Chapter 7 concludes this dissertation with a summary of the main findings. The analytical framework is evaluated based on the results of the two case studies. The limitations of the research are discussed and options for further research are identified.

2. Preferences, choice behaviour and valuation

2.1 Introduction

The possibility of placing a monetary value on environmental goods and services is one of the most important contributions of economics to environmental problems. When markets do not exist and non-use values form a considerable part of the value that individuals attach to an environmental good, stated preference (SP) techniques can be used. Since the 1980s, there has been a strong increase in the number of valuation studies using SP techniques, following the publication of the contingent valuation manual of Mitchell and Carson (1989).

The validity and reliability of SP valuation studies has been questioned in those cases where the empirical findings do not conform to the general assumptions underlying neoclassical welfare and random-utility theory. Some of the problems are due to biases related to the survey instrument and implementation (Carson et al. 2001), whilst recently more attention is given to so-called 'anomalies' in choice behaviour to emphasise the bounded rationality underlying choices (Braga and Starmer 2005).

This chapter aims to identify the limitations of SP valuation techniques for eliciting spatial preferences and the gaps in the current valuation literature regarding spatial choices. In Section 2.2, the standard neoclassical economic theory and its assumptions of individual choice behaviour are summarised on which the SP valuation techniques are based. Different anomalies that have been identified in the valuation literature relevant to spatial choices are outlined. Section 2.3 presents the two main SP techniques in the valuation literature: the contingent valuation (CV) method and choice experiments (CEs). Section 2.4 describes validity and reliability criteria and the advantages and disadvantages of both techniques. In Sections 2.5 and 2.6, insights from other disciplines, such as environmental psychology, economic geography and spatial analysis, are described to provide refinements and alternatives for the non-spatial approach often taken in the SP valuation literature. These insights are brought together in an improved analytical framework for the analysis of spatial choices, presented in Section 2.7. Section 2.8 summarises the key issues that will be further elaborated in Chapters 3 and 4.

2.2 Preferences, behaviour and choice

Economic valuation of environmental benefits involves the assessment of the utility that people derive from ecosystem goods and services. This utility is revealed through willingness-to-pay (WTP) or willingness-to-accept (WTA) compensation, reflecting the trade-off between a monetary payment for undergoing or preventing an environmental change and (not) having this change.

The standard toolkit of valuation techniques is based on neoclassical economic theory. Here, consumers are assumed to behave rationally and in their self-interest. Their choices are driven by preferences and subject to constraints, notably personal time and income constraints, which force people to make trade-offs. People are assumed to be willing and able to make choices reacting to changes in their situation: changes in the good of interest, prices, costs, institutional constraints and incentives, income and wealth. Experience with and information about these changes influence perceptions, attitudes and beliefs, which in turn drive decision processes.

Choice behaviour and the final choice outcome are assumed to be consistent and coherent with the principles of utility maximization. Perfect consistency is the strongest principle, and requires choices to be consistent over time, context and occasions (Rieskamp et al. 2006). For choices to be consistent, preferences need to satisfy the regularity conditions: complete, transitive and strongly monotonic (Mas-Colell et al. 1995). The assumption that preferences are complete means that the individual has a well-defined preference when it comes to choosing between any two possible alternatives. Transitivity implies that in a sequence of pair-wise choices, preferences will not appear to cycle: if *y* is preferred over *x* and *z* over *y*, *z* will be preferred over *x*. Finally, strong monotonicity means that larger amounts of commodities are preferred to smaller ones. The regularity conditions prohibit changes in preference order and preferences reversals. The regularity assumption states that the addition of a new alternative should not increase the probability of choosing existing options from the original set (Block and Marschak 1960). For example, the probability of choosing option *j* in a comparison of *j* and *k* cannot be lower than the probability of choosing option *j* in a comparison of *j*, *k* and *l*. The stronger version of the regularity assumption is the Independence of Irrelevant Alternatives (IIA) assumption, which will be discussed in further detail in Chapter 3. This assumption requires the ratio of choice probabilities of two alternatives to remain the same independent of adding or removing other alternatives from the choice set.

Although the simplicity of the neoclassical assumptions is very attractive for undertaking choice analysis, empirical research often finds choice behaviour that contradicts these assumptions (for overviews, see McFadden 1999; Rieskamp et al. 2006; Starmer 2000). There are different approaches to analyse choice behaviour and account for anomalies: an economic, a behavioural and a statistical approach (Adamowicz et al. 2008). In the neoclassical economic approach, people are assumed to make fully rational choices that are well-informed based and consistent with random utility maximization. Here, the cognitive process of utility maximization is regarded as a black box. Research on the anomalies that violate standard economic theory can be divided into two types: the first considers anomalies as characteristics of human decision-making for which random utility theory (RUT) fails to account, whilst the second attributes inconsistencies with RUT to flaws in study design. The statistical approach does not have any ideological standpoint, but develops models that fit the data best.

The behavioural approach is a more psychological strand and focuses on the decision elements of the cognitive process that results in choices (McFadden 1999). In this literature, choice behaviour is not only constrained by income or determined by preferences, but also by differences in cognitive abilities and experiences. Theories of bounded rationality argue that people often do not have well-defined preferences, but rather make choices using heuristics or rules-of-thumb and have context-dependent or constructed preferences, especially in complex settings. Psychology characterises choice behaviour by a cognitive decision process, informed by perceptions (cognition of sensation), including beliefs (mental models of the world, probability judgments) and preferences (comparative judgments between entities). This decision process is based on the available information and knowledge about the surrounding environment. The way people process this information and structure the cognitive task of making a choice is influenced by affect (the emotional state of the decision-maker), attitudes (stable psychological tendencies to evaluate particular entities with favour or disfavour), and motives (drives directed toward perceived goals) (McFadden 1999). These cognitive processes can be many and are both conscious and unconscious (Slovic et al. 2007). Behavioural economics also considers decisions taken in social situations, which relaxes the assumption of pure self-interest to include choices taken out of social motives and other-regarding behaviour (Fehr and Fischbacher 2002).

In spatial choices, the number of available alternative destinations is often large. This may increase the complexity of the choice task to such an extent that it leads to anomalies in decision-making. The regularity assumptions, mainly the completeness assumption, may hence be violated. Instead, spatial choices may be context-dependent and based on heuristics.

The assumption of complete and transitive preferences has been examined in a number of studies. The discovered preference hypothesis of Plott (1996) asserts that people have stable and context-free preferences, standard to RUT, after they have gone through a learning process about the institutional setting of a (hypothetical) market and their own preferences. Repeated choices and feedback on the consequences of their choices are required for this learning process. In studies on environmental goods, Braga and Starmer (2005) and Bateman et al. (2008) show that initial differences in WTP between distinct elicitation question formats or different types of reference information disappear after sufficient repetition. Similarly, List (2003) and Ladenburg and Olsen (2008) find that anomalies decrease with experience, in support of the discovered preference hypothesis. However, in other iterative choice studies, repetition of choices does not eliminate preference reversals. Even if experience with past choices could be used as information in new choices and feedback on the consequence of the outcome was given, preference reversals can persist (Braga et al. 2009). Other anomalies, related to the endowment effect, status quo bias and loss aversion, have been found to be robust and persist over repetitions and different survey formats (Knetsch et al. 2001). These results violate the assumption of consistent, complete and transitive preferences. Iteration of choices may also lead to “coherent arbitrariness” (Ariely et al. 2003). Preferences may be coherent in the sense that the relative valuations of different amounts of a good comply with the assumption of monotonic preferences. However, they may be arbitrary in the sense that they are dependent on the context, framing of the question or the presence of prior cues or anchors. Respondents seem to construct their preferences during the process of making a decision (see Slovic 1995; Hoeffler and Ariely 1999). As respondents go through a series of valuation questions, they want to be coherent with the first value statement made (Ariely et al. 2003). This may, for instance, lead to the incorrect conclusion that WTP values are sensitive to scope, whereas in fact they may be coherent but biased by an initial, not necessarily well-defined, preference statement.

The assumption of complete preferences includes that people are assumed to consider all available alternatives before making a final choice. Random utility models assume that decisions are compensatory, or substitutable in utility: the decrease in a characteristic of an alternative can be offset by the increase in another characteristic. Empirical studies have shown, however, that in complex choice situations involving many alternatives, people use simplifying heuristics or other (non-compensatory) decision-making strategies. Strict lexicographic decision-rules do not allow for any substitution, the elimination-by-aspects theory (Tversky 1972) includes limited substitability. An example of a simplifying heuristic is to use only part of the information that is available. Effort-minimizing strategies are useful in every-day-life or habitual choices of which the accuracy is not very important (Payne et al. 1993). Simplifying heuristics may lead to violations of the regularity assumption, when the addition of a clearly inferior or superior alternative to the choice set affects the choice probabilities of the existing options, depending on the degree of similarity with the new option (Tversky 1972). One would normally expect the new product to draw proportionally more choices away from similar alternatives than from relatively dissimilar ones. Tversky (1972) called this the similarity hypothesis. Huber et al. (1982) show that sometimes, the reverse of the similarity hypothesis holds. Introducing a new, dominant alternative may 'help' the more similar item in the choice set. An 'asymmetric dominance effect' appears when the addition of an inferior option increases the market share of the superior option. Simonson and Tversky (1992) speculate that these choice context effects may play a larger role when respondents have less well-defined preferences, leading them to use the context to infer information about the alternatives. Although some authors have argued that simplifying heuristics can be broadly consistent with random utility assumptions as long as they are based on underlying preferences (e.g., Hensher and Rose 2005), most of these heuristics are considered to reflect bounded rationality. In spite of the limitations of neoclassical economic theory, it is still the basis for the SP methods described in the next section.

2.3 Stated preference methods

Stated preference (SP) methods are direct approaches to non-market valuation in the sense that they directly ask respondents in a survey to state their WTP or WTA for an environmental change as explained in a hypothetical scenario. In this scenario, a hypothetical market is created for a proposed change in the provision of an environmental good and an institutional setting which provides this change. The stated WTP reflects a trade-off between money and the environmental change. SP techniques are the only techniques that are available for estimating non-use values, including existence and bequest values. The two main SP techniques are contingent valuation and choice experiments.

2.3.1 Contingent Valuation

The contingent valuation (CV) method provides an effective means to assess non-market goods and has therefore often been applied in environmental economics. The technique is called *contingent*, because the valuation is contingent on the information presented in the hypothetical scenario. Many guidelines exist which define a minimal set of rules to generate reliable and valid WTP statements in CV surveys, of which the NOAA panel guidelines are an important starting point (see Arrow et al. 1993; SEPA 2006).

The goal of CV is to assess the value people attach to a positive or negative change in the good under valuation. The WTP is defined as the amount of income reduction an individual is willing to accept in exchange for the change in provision of the environmental good, while keeping his/her utility constant. This can be represented as follows:

$$U_i = V_i + \varepsilon_i \qquad (2.1)$$

where $$V_i\ (y - WTP, p, q_1, Z) = V_i(y, p, q_0, Z). \qquad (2.2)$$

The indirect utility function U_i represents the utility that an individual derives from an alternative *i* and decomposes into two parts: a deterministic element (*V*) and a stochastic element (ε). The deterministic component of the indirect utility function *V* is represented in functional form by equation (2.2). Here, *y* is income, *p* is a vector of prices faced by the decision maker including those of substitutes, and q_1 and q_0 are the different levels of provision of the environmental good before (q_0) and after (q_1) a change. *Z* is a vector of individual characteristics that influence the trade-off that the economic agent makes between income and the change in the provision of the good.

CV surveys typically present one or two scenarios to respondents, in which a WTP statement is asked for a change from q_0 to q_1. CV allows estimating the total value of an environmental change rather than components of the total value comprising this change, for instance, different ecosystem services provided by a site. Choice experiments, which can be used to value components, are described in the next section.

2.3.2 Choice Experiments

Choice experiments (CEs) offer another way to assess the value of non-market goods or services. In a CE, respondents are presented a series of choice tasks and are asked to choose their most preferred alternative. The alternatives differ in terms of their characteristics, referred to as attribute levels. In order to express utility in money-terms, one of these attributes is usually price. Similar to CV, the alternatives are offered on a hypothetical market as described in the survey.

Choice models are rooted in RUT and Lancaster's attribute based utility theory (Lancaster 1991). To be able to interpret the results in standard welfare economic terms, one of the alternatives in the choice set must always be in the current set of feasible choices of the respondent (Hanley et al. 2001). Therefore, each choice set contains a baseline alternative, usually defined as "do nothing" or "status quo".

In a standard utility function U_i of choice experiments, *V* is usually specified as a linear index, where X_i is a vector of *k* attributes and price *p* associated with alternative *i*, in addition to the individual respondent characteristics, β_i is a coefficient vector, and ε_i represents unobservable influences on individual choice. The indirect utility function can then be represented by:

$$U_i = V_i + \varepsilon_i = \beta_i X_i + \varepsilon_i \quad (2.3)$$

Based on microeconomic theory, the WTP for a particular attribute *k* is calculated by the marginal rate of substitution (in terms of utility) between the coefficients for the attribute *k* and the price *p* as follows:

$$WTP(k) = \frac{\beta_k}{\beta_p} \quad (2.4)$$

CEs are expected to have a number of advantages compared to the CV method. The utility functions of a CE can include more attributes of the alternative than just two provision levels q_1 and q_0 as in CV studies (see equation (2.2)). With CEs, it is possible to estimate the value of the individual attributes in *X*. Thereby, the marginal values of changes in various characteristics of environmental programs can be measured (Hanley et al. 2001) and positive and negative effects of environmental changes can be traded-off. On the other hand, CEs will usually impose a higher cognitive burden on respondents than CV, due to the larger number of alternatives and attributes per choice task, and repetition of choice tasks in the survey. One of the most important advantages is that CEs allow for the simultaneous presentation of substitute goods (Rolfe and Bennett 2006). These advantages will be further discussed in Section 2.4 with respect to the validity and reliability of SP methods. The next subsection will first present different discrete choice models that can be used to analyse CE data.

2.3.3 Discrete choice models

Most discrete choice models use Random Utility Models (RUM) assuming rational agents. The conditional choice probability that a respondent prefers alternative *i* can be expressed as (McFadden 1974):

$$P_C(i) = \frac{e^{\mu V_i}}{\sum_{k \in C} e^{\mu V_k}} \quad (2.5)$$

Here, μ is a scale parameter and *C* is the choice set. The probability of selecting alternative *i* increases as the utility associated with that alternative increases. The scale parameter reflects the error variance. In most analyses, the scale is assumed to be 1, implying constant error variance, which is necessary for the identification of the model.

The standard multinomial logit model (MNL) is the basic model used to analyse discrete choice data. The MNL model assumes that the random components of the utility of the alternatives are independently and identically distributed (*i.i.d.*) with a type I extreme value (EV) distribution. The Independence of Irrelevant Alternatives (IIA) property, which follows directly from the *i.i.d.* EV error terms, states that the ratio of probabilities of two options being selected is unaffected by the introduction or removal of other alternatives. The IIA assumption hence implies proportional or symmetric substitution among all alternatives. Models assuming IIA cannot account for similarities between alternatives. Similarities can be represented by correlations or covariances in the variance-covariance matrix. In the MNL, error terms are uncorrelated and the covariance terms are all equal to zero. In addition, the responsiveness to attributes of different alternatives is assumed to be homogeneous across individuals. In other words, preferences are assumed to be homogeneous.

More advanced models avoid the IIA assumption and account for similarities between alternatives. The family of generalized extreme value (GEV) models (McFadden 1978) includes the nested logit (NL) and cross-nested logit models. These models are estimated through conventional maximum likelihood procedures. In the NL model, relatively similar alternatives are grouped together in a nest. The nests are defined *a posteriori* by the analyst, based on a discrete variable that is often not included in the model itself. This model has a hierarchical structure: the probability of choosing an alternative depends not only on its observed characteristics, but also on the probability that the nest to which the alternative belongs is chosen. The latter depends on the utility of the common characteristics in the nest. The NL model assumes that the IIA assumption holds within nests, that is, groups of alternatives, but not between nests.

Whilst in the NL model alternatives can only belong to one nest, the cross-nested logit (CNL) model allows for alternatives to belong to more than one nest. Theoretically, a CNL could capture a wide range of correlations between the error-terms of alternatives (Bierlaire 2006). Again, the nesting structure must be defined by the analyst.

Another generalisation of the MNL model is the universal logit (UL) model. The UL model defines the utility function of an alternative in terms of both its own as well as its substitutes' characteristics (McFadden 1975), and can hence be used to avoid the IIA restrictions. Cross-effects are estimated by including the attributes of other alternatives in the specification of the utility function of each alternative (Oppewal and Timmermans 1991), resulting in the following utility function:

$$U_i = \alpha_i + \beta_{ik} X_{ik} + \beta_{jk} X_{jk} + \varepsilon_i \tag{2.6}$$

As before, U_i represents the utility of alternative i, X_{ik} is a vector of k attributes associated with alternative i, β_{ik} is the associated coefficient vector, and ε_i represents unobservable influences on individual choice. X_{jk} is a vector of k attributes associated with alternatives $j \neq i$, and β_{jk} is the associated coefficient vector, representing the cross-effects. These cross-effects are interpreted as corrections of direct marginal effects. In other words, cross-effects imply that the effect of a marginal change of the attribute of alternative A on the choice probability of alternative B is not the same as the effect on the probability of choosing alternative C. As a result, the UL model is not restricted by the IIA assumption and permits asymmetric substitutability, which may arise if some alternatives are perceived as being closer substitutes than others.

In spite of its flexibility and strength to capture asymmetric substitutability among alternatives, there are not many applications of the UL model in the literature compared to MNL or NL models. This may be because of the complexity of the model specification in studies with many alternatives and attributes[1], or because the large experimental design needed to estimate an UL model and associated practical problems of sample size or survey length. The UL has been criticized for generating results that may be inconsistent with RUT and for generating counterintuitive (sign-switching) cross-elasticities (Ben-Akiva 1974). UL results may violate the regularity assumption, which states that the probability of an alternative being chosen cannot increase with the addition of a new alternative to the choice set. It should be stressed that there is no proof in the literature that the UL model is inconsistent with RUT, but checking for consistency can be complicated (McFadden 2001). The UL has been applied to consumer shopping behaviour (Timmermans et al. 1991), choices among telecommunication services (Agarwal 2002), in transport economics (Bos and Molin 2006), and tourism (Crouch et al. 2007). In these papers, inconsistencies with RUT are not discussed. UL models have not been applied in environmental valuation research, where consistency with utility maximization is important for the purpose of welfare calculation.

One important limitation of these MNL, NL, CNL and UL models is that it is impossible to control for the panel structure of the data. SP data sets typically include a number of observations from the same respondent. It is important to control for the correlation between these observations and avoid biased parameter estimates. Models based on simulation can accommodate correlation between choices in panel data sets to account for the fact that the socio-economic variables and preferences of an individual will be correlated between choice occasions. Panel data models hold the error term for an

[1] In a study with a choice set consisting of J alternatives and K attributes, the utility function of alternative in an UL model can include up to $J*K$ variables.

alternative constant over all choices made by one individual. Mixed logit models include error-components models (EC) and random parameter logit (RPL) models. These models do not assume the IIA property.

In short, mixed logit models allow for correlation in the unobserved utility ε_i between alternatives by including coefficients that vary in the population. Random parameter logit (RPL) models assume that the coefficients follow an underlying distribution instead of being fixed, accommodating preference heterogeneity in the population. The choice probability function is the integral of the conditional individual probabilities over all possible variables of *β*, defined as (Train 2003, 139):

$$P_{ni} = \int \left(\frac{e^{\beta x_{ni}}}{\sum_j e^{\beta x_{nj}}} \right) f(\beta|\theta) d\beta \qquad (2.7)$$

Here, $f(\beta|\theta)$ is the density function of *β* with distribution θ. In RPL models, correlation between alternatives can be accommodated by specifying more than one random parameter common to the alternatives and allowing for correlation between these random parameters (Hensher and Greene 2003). To this end, the off-diagonal elements in the covariance matrix of the random parameters are allowed to be nonzero. RPL models have been regularly used in environmental valuation studies, among others, to estimate the WTP for erosion control (Colombo et al. 2006), water quality (Hanley et al. 2006) and animal welfare (Carlsson et al. 2007).

Error-component (EC) models allow for correlation between the error-components (variance) of different alternatives. Thereby, they avoid the *i.i.d.* assumption and allow for heteroscedasticity (differences in error terms across the *X* variables). EC models can address correlation between alternatives by including a common random parameter with zero mean in the utility function specification of those alternatives that are likely to be correlated (Brownstone and Train 1998). These models can also be applied when comparing less familiar or hypothetical alternatives with better known ones (Scarpa et al. 2005).

RPL and EC models have been proven to conform to RUT under mild regularity assumptions (McFadden and Train 2000) and argued to allow for more flexible substitution patterns than MNL models (Brownstone and Train 1998). Steenburgh and Ainsley (2010) however argue that the flexibility of the model is not sufficient. Using Monte Carlo simulations, they show that the mixed logit model does not ensure that the substitution patterns indicated by the models are as expected under rational behaviour if the choice set contains perfect or close substitutes.

In equation (2.8), the choice probability function of a random parameters model with error-components is specified, which accounts for the panel structure of the data and the difference in error terms between the hypothetical alternatives and the status quo:

$$P_{int} = \frac{exp[\alpha_n + \beta_n X_{int} + \delta Z_{int} + \sum_{m=1}^{M} d_{im}\theta_m E_{nm}]}{\sum_q^N exp[\alpha_n + \beta_n X_{qnt} + \delta Z_{qnt} + \sum_{m=1}^{M} d_{qm}\theta_m E_{nm}]} \quad (2.8)$$

α_n is the alternative specific constant, β_n is the mean of the randomly distributed parameters X_{int} is the set of the attributes and individual characteristics in the utility function of individual *n* in choice occasion *t* for alternative *i*, δ is a vector of non-random parameters of the attributes and individual characteristics Z_{int}, E_{nm} is the individual specific random error-component *m*, assumed to have a standard normal distribution N[0,1] with scale factor θ_m, entering the utility function of alternative *i* if dummy variable d_{im} takes the value 1.

The specification of the random components knows at least two complications. First, the distribution of the random effects should be consistent with economic theory. For instance, the price coefficient is expected to be negative across the entire population and therefore the coefficient should be negative along the entire distribution (Greene and Hensher 2003). This is possible by constraining the distribution of random parameters to the positive or negative domain or using a lognormal distribution. Second, the confidence intervals of WTP estimates based on a randomly distributed price-coefficient may be very wide. For that reason, price is sometimes included as a fixed coefficient, even though the assumption of homogeneous marginal utility of money is debatable, and will result in correlated WTP estimates through correlation in the price-coefficient (Train and Weeks 2005). Models in preference space are estimated by normalizing by the scale parameter. Therefore, the utility and scale parameters are multiplicative and confounded (Louviere et al. 2000). The scale parameter reflects the standard deviation of utility over different choice situations (Train and Weeks 2005). Hence, the scale parameter is inversely related to the variance of the model: the higher is the scale, the smaller is the variance, and the better is the model fit. And also: the larger is the scale, the bigger are the parameters. Louviere argues in a number of papers (e.g., Louviere et al. 1999; 2008) that taste heterogeneity does not only manifests itself in the mean of parameters, modelled by random coefficients, but also in the variance of the variance, which requires modelling the scale heterogeneity.

It is possible to re-parameterise the utility model in WTP space (Cameron and James 1987; Sonnier et al. 2007). The estimation of models in WTP-space can indicate to what extent there is scale heterogeneity after accounting for heterogeneity in the means of random parameters. In Annex I to this thesis, it is described how the model in WTP-space can be obtained. Besides allowing for scale heterogeneity, an important advantage of the WTP-space model is that the coefficients of the random parameters can immediately be interpreted as the marginal WTP effects and are uncorrelated. Secondly, the confidence intervals of the WTP estimates do not need to be derived using for instance the Krinsky and Robb procedure (Krinsky and Robb 1986). Models in WTP-space produce WTP estimates with smaller confidence intervals than mixed logit models in preference space, which is appealing from a behavioural point of view (Scarpa et al. 2008a). WTP-space models are relatively new to the environmental valuation literature. Examples of applications include SP studies on pesticide reduction (Balcombe et al. 2009) and the demand for sustainably produced carrots (Scarpa et al. 2008a), and at least one revealed preference study on alpine site choice (Scarpa et al. 2008b).

2.4 Validity and reliability in environmental valuation of spatial alternatives

Validity and reliability are two important criteria for testing the accuracy of WTP responses (Mitchell and Carson 1989). The main question in this thesis is if the validity and reliability of SP studies can be improved if more attention is paid to the spatial context, notably the effect of distance and substitutes.

The reliability of a study is the degree of stability and replicability of a measurement. Reliability refers to the extent to which the variance of the WTP amounts given by the respondents is due to random sources, or 'noise' (Mitchell and Carson 1989, 122). Variance results from 'true' underlying variation in WTP, the survey instrument or sampling biases. A common test of reliability involves the test-retest procedure in order to assess the replicability of WTP estimates over time. The goodness of fit of a WTP-model is the most straightforward indicator of reliability.

The validity of a measure is the degree to which it measures the theoretical construct under investigation. Here, expectations regarding decision-making are mainly based on neoclassical economic theory and its principles of complete, transitive and monotonic preferences. Since the "true" WTP cannot be observed, the validity and reliability can only be tested indirectly (Pearce et al. 2006). Three types of validity can be distinguished: content, criterion and construct validity. Content validity refers to the extent to which the survey design, including the questionnaire, sampling and analysis, conforms to the state of the art (Freeman III 2003). Criterion validity assesses whether the results of the SP method are comparable to some alternative measure that can be take as the criterion for assessment, such as non-hypothetical behaviour. Construct validity assesses whether the measure relates to other measures as predicted by theory and includes (1) convergent validity - whether the measure is correlated with other measures of the same theoretical construct, for instance, WTP-results of contingent valuation compared to those of travel cost studies (Carlsson and Martinsson 2001), and (2) theoretical validity - whether the measure is related to measures of other constructs in a manner predicted by theory.

The most important list of validity and reliability criteria for WTP estimates was developed by the NOAA panel (Arrow et al. 1993). Although this list was primarily developed for CV studies, many of the recommendations are also applicable to CE studies. Arrow et al. did not address spatial aspects specifically. The most relevant recommendations of Arrow et al. for spatial choice studies are (1) the reminder of alternative expenditure possibilities, and (2) sensitivity to scope, which will be explained below.

More recent guidelines contend that testing for distance decay should be a first and minimal requirement of construct validity, preferably differentiating between users and non-users of an environmental good (Bateman et al. 2002a; SEPA 2006). Most SP valuation studies neglect the spatial aspect of the problem (Carruthers and Mundy 2006), in contrast to hedonic pricing studies (e.g., Leggett and Bockstael 2000) and travel cost studies (e.g., Lutz et al. 2000; Termansen et al. 2008). There are about 25 SP studies that address the effect of proximity on WTP. Equally important, only part of the spatial heterogeneity in WTP value will be addressed by including a distance parameter as another socio-demographic variable (e.g., Hanley et al. 2003) or as an attribute in a choice experiment (Luisetti et al. 2008). First, these studies all use a one-dimensional, or isotropic, concept of space, thereby ignoring spatial heterogeneity (see Chapter 3). Second, the few SP studies that include an indicator of substitutes to analyse their effect on WTP do so by including the size or number of substitutes, but do not account for their location or accessibility (see Chapter 4).

Regarding substitution effects, Arrow et al. argue that each SP survey should remind respondents of alternative expenditure possibilities. Many SP studies, especially CV studies, focus only on a single site. The main criticism is that such studies draw all respondent's attention to the site under valuation, as a result of which respondents do not properly consider substitution possibilities and income constraints in answering the WTP questions (Carson et al. 1998). This point was stressed by Brown and Duffield (1995), pointing at the need for guidelines for deciding what information about substitutes should be presented to respondents and how that information should be presented in CV research. Chapter 4 will go deeper into the effectiveness of substitute reminders and alternative modelling and survey design strategies to control for substitution effects.

The recommendation to remind respondents of alternatives was suggested as one of the solutions to the scope-sensitivity problem. The sensitivity-to-scope-test requires that WTP should vary appropriately as the size of the good under consideration changes. In other words, the marginal utility that people derive from a change in provision of the good should not decrease as the amount offered increases. The scope-sensitivity of WTP values is often used as a first indicator of theoretical consistency of WTP estimates with neoclassical economics as it is argued to provide a clear test of the monotonicity assumption. However, Banerjee and Murphy (2005) show that sensitivity-to-scope is not sufficient to test for consistent preferences and will not hold in case of satiation, i.e. when the demand is satisfied. Furthermore, Carson and Groves (2007) argue that survey formats to test sensitivity-to-scope may provide strategic incentives. In such cases, WTP values that are insensitive to scope do not violate the assumptions of neoclassical economics.

As with other anomalies, the discussion on sensitivity-to-scope goes into two directions. On the one hand, it is argued that insensitivity is due to fundamental flaws in SP survey design (e.g., Hanemann 1994). On the other hand, it is argued that people might not hold as well-defined preferences for the goods under valuation as neoclassical economic theory assumes and may be unable to answer CV questions reliably (Kahneman and Knetsch 1992; Schkade and Payne 1993; Diamond and Hausman 1994). One of the causes of scope insensitivity is part-whole bias, classified by Mitchell and Carson (1989) as a type of amenity misspecification bias, where the perceived good being valued differs from the intended good. Part-whole bias is caused by embedding: the notion that respondents often value a larger good than the researcher intended to offer on the hypothetical market (Hoevenagel 1996). CV results show in that case that people state the same WTP for a single part of an embedded good as for the good as a whole. As a result of this bias, WTP estimates do not differ between the part and the whole good, even if the marginal utility of the increase in provision of the good is in fact positive (Hanemann 1994). This induces a risk of overestimation in studies that focus on a single good.

Sensitivity-to-scope biases are relevant to spatial choice studies as they may occur in the form of geographic embedding. Geographic embedding or nesting is a type of part-whole bias, which results if there is a difference in framing of the good between the researcher and the respondent. As a consequence, respondents give the same value to a larger area, including the study site, as to the study site alone (Carson and Mitchell 1995). Hence, geographical part-whole bias reduces the reliability of aggregating WTP values of different studies in different geographic areas (Mitchell and Carson 1989, 283; Hoehn and Loomis 1993; Smith and Osborne 1996). The sequence in which goods are presented to the respondent may also cause embedding (Mitchell and Carson 1989). For instance, respondents in an area where several lakes are polluted may value cleaning up the first lake more than cleaning up the second lake, because (1) the first lake can be a substitute for the second lake, and (2) the respondent has a budget limitation which reduces the money available for cleaning up the second lake. Valuing the lakes separately and then adding up the values may overestimate their total value, as every respondent will treat the lake under study as if it were the first and only lake available (see also Schulze et al. 1998). This clarifies the risk of overestimation in studies that focus on a single good.

One of the solutions to reduce embedding biases is to inform the respondent about the full set of alternatives prior to the first WTP question and ask to value the large good prior to the small good (Bateman et al. 2004a). If a small product is valued prior to the large product without informing the respondent about this larger good, the WTP for the small product may be overestimated as the respondent has devoted all available budget to the small good.

In comparison to CV, CEs might be a better way of dealing with some of the validity and reliability issues. For instance, CEs can address the embedding problem directly as it provides an internal scope test (Hanley et al. 1998; 2001). In a CE, it is possible to include the different parts of an inclusive good, for instance, different sub-regions belonging to one region or different ecosystem services of the same ecosystem, and ask respondents to value them simultaneously. Hence, if all attributes generating utility are included in the CE design and they are additive in utility, CEs can be used to assess the WTP for the parts as well as the inclusive good. However, the assumption of the linear additive utility model, commonly used in CEs, expressing that the value of the inclusive good is equal to the sum of the parts, may be violated. Adding-up the values of individual CE-attributes may lead to overestimation of total WTP. Foster and Mourato (2003) compare CV and CE elicitation formats and find that their CE results are significantly larger than results from a comparable CV survey in which the inclusive good is valued. They conclude that CEs are not immune to the adding-up effect occurring when summing the values of single-site CV studies. Furthermore, the sensitivity-to-scope effect in the CE results is much stronger than in the CV results.

Another important advantage of CEs is that they can provide a more appropriate question frame than CV studies. By including, besides the site of interest, several other sites as different alternatives, CE can offer a broader decision context (Bennett and Blamey 2001). On the one hand, such a design would go beyond a simple substitute reminder needed to avoid the focus on a single good. On the other hand, designing a large choice set may cause inconsistencies in choice behaviour or decrease the reliability of the results, because the number of alternatives, attributes and attribute-levels in the choice set complicates the choice task. The issue of choice set composition and choice task complexity will be further discussed in Section 4.4. The next section describes the insights from other disciplines and their analyses of spatial preferences and decision-making processes.

2.5 Geographical knowledge, preferences, and choice behaviour

In order to shed further light on the behavioural aspects underlying choice behaviour in geographical settings, this section addresses alternative disciplines and discusses their views on geographical preferences and decision-making. Environmental psychology theories address the cognitive process of preference maximization and work on alternative models that do not assume rationality. Social and economic geography disciplines study spatial behaviour and decision-making, spatial information storing and spatial knowledge processing. The process of constructing, understanding and remembering geographic information and knowledge is described by spatial or geographic cognition theory, a field that is also supported by psychologists, linguists and anthropologists. Spatial cognition theory concerns the study of knowledge and beliefs about spatial properties of objects and events in the world (Montello 2001).

In spatial cognition theory, spatial knowledge evolves in time with experience and increased interaction with our environment. Spatial learning involves three sequential steps (Mallot et al. 1998). The first step is knowledge formation of *landmarks*, places that function as reference points in space and are easy to recognise. The second step is *route knowledge* about trajectories that connect landmarks. The last step in spatial learning is *survey knowledge*: using maps to learn about interrelations of locations, distances and directions. This three-step learning process results in spatial knowledge of the surrounding environment.

Spatial knowledge is stored in a so-called cognitive or mental map. The cognitive map is a mental model of the environment representing the perception of the geographical environment and containing spatial, non-spatial and subjective information (Gärling and Golledge 2000). In the cognitive map, information from many different data sources in included and combined with non-spatial attributes, such as perceived qualities of and emotional associations with locations and routes (Montello 2001). As a mental map combines factual and emotional information, mental maps may differ substantially from reality. Empirical studies show that cognitive maps are not two-dimensional or mathematically linear-in-distance (Montello 2001). In Figure 2.1, a cartographic and a mental map of an area in Amsterdam are compared. The mental map includes sentimental annotations with certain locations. Moreover, it is immediately obvious that the mental map gives a distorted picture of the cartographic reality.

In environmental psychology, the notion of "place attachment" (and related notions of "sense of place" and "rootedness") explains that people have a functional and non-functional attachment to landscape and show affect and attachment through emotional and behavioural actions (Bricker and

Kerstetter 2000). Place attachment consists of two dimensions: place dependence and place identity. Place dependence is determined by how well a place functionally facilitates the user. The perception of use-oriented people depends on activities that a site can provide and these people might substitute a site for any other site where they can perform a similar activity (Brown et al. 2002). The notion of place identity describes deeper values, associated with emotional and symbolic meanings. Place identity is a combination of values, attitudes, thoughts, beliefs, and behavioural tendencies. The sense of place reflects a general feeling of belonging, attachment and identification with a particular subregion (Jorgensen and Stedman 2001). This sense of place is not only related to the importance attached to the natural amenities of this area, but is a combination of affect, cognition and behavioural intentions with the location (Kyle et al. 2004). Sense of place may include other locations, for instance the area where someone has grown up, besides the residential location.

Another important characteristic of this map is that the spatial information is loosely connected or stored in hierarchies of different, sometimes embedded, spatial scales and categories (Tversky 1992). The human mind makes categories of cities, regions and states and includes these as perceptual regions in the mental map. Perceptual regions are constructs of spatial units and reflect perceptions and attitudes towards areas. Such regions are personal, following from one's perception of the surrounding world. They may be reference dependent, because location attributes of residencies or other spatial reference points influence people's perceptions (Reginster and Edwards 2001). For instance, when shown a map, people isolate the figures of interest and organise them by relating their locations and orientations to a frame of reference and to other figures, such as landmarks from other or hierarchically higher categories.

People use their cognitive map to make spatial decisions among locations or routes. Economic geography studies have shown that people organise and retrieve spatial knowledge in a hierarchical manner to make spatial decisions (Fotheringham 1988). The use of cognitive maps in spatial choices may lead to "distortions" or bounded rationality, for example regarding distances. Tversky (1992; 2003) describes that the use of cognitive maps rather than cartographic maps produces systematic errors in respondents' judgement of space and spatial choice behaviour. These errors result in differences between cartographic and perceived information, for instance, in differences between cognitive and objective distance. Research is required to test if these errors affect people's preferences for the good under valuation and should be controlled for in order to improve the reliability and validity of SP results.

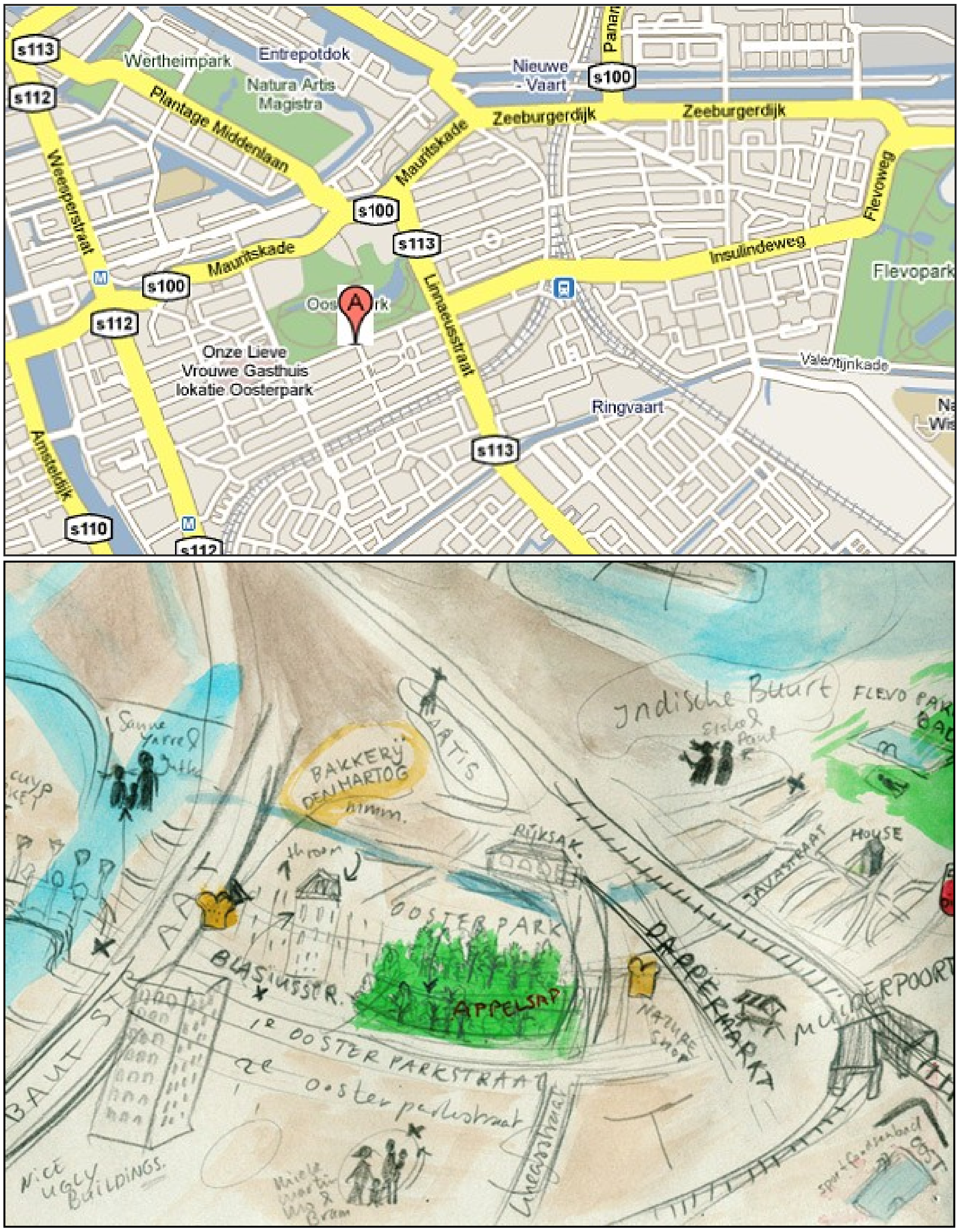


Figure 2.1 Cartographic (above) and cognitive (below) map of an area in Amsterdam
Sources: Google maps (above) and Amsterdam Mental Mapping Project (below)

The hierarchical knowledge storage in the mental map and consequent errors in direction and distance judgements may also influence decisions and spatial choices among locations or destinations. As the cognitive task to consider the information about all locations simultaneously can be very demanding, people may use heuristics to simplify their choices. In the hierarchical theory, choices among locations or destinations follow a hierarchical process. In this process, alternatives are not all simultaneously compared, but in sequential steps. In the mental map, alternative locations are clustered in groups or perceptual regions, according to the spatial distribution of alternatives over the relevant area. People first consider and select a larger-scale perceptual region, before choosing a certain location within that region. The first step of comparison hence takes place at the higher level categories to which the alternatives belong, so as to limit the cognitive burden. In this decision-process, information about a specific location might be inferred from information at a higher spatial level within the hierarchy. Sometimes non-spatial information about a location is used to facilitate spatial judgment about nearby locations within the same region (Franklin 1992). Using a mental map with different sources of information, such as text, maps and experience from other places, people are able to construct preferences of locations they have never visited before.

Although the hierarchical theory seems well embedded in spatial cognition theory, some theoretical issues and practical limitations remain to be answered before hierarchical choice theory can be applied to environmental valuation and translated into different study designs or models. First, the literature does not discuss to what extend this hierarchical choice process is fully conscious. The use of hierarchical decision-rules may remain unobservable to the analyst if people are not able to describe or realise their decision-making process. The analyst may not be able to identify the perceptual regions of each individual and base the model structure on those regions. Second, it is not clear at which number of alternatives hierarchical evaluation is likely to replace simultaneous evaluation processes. This is likely to be a context-specific and individual-specific, empirical question. Bettman (1979) and Fotheringham and O'Kelly (1989) suggest that this hierarchical choice process operates in choices when choice sets consist of six or more alternatives, at which point the limits of the cognitive capacity of individuals to process and gather information may be reached. Third, hierarchical choice processes have been associated with destination choices, involving use values, but there has been no research so far on the influence of the spatial distribution of alternatives on non-use related preferences. Non-use values are not necessarily influenced by distances to the site under valuation or between alternative locations.

In contrast with the hierarchical theory for spatial choices, non-hierarchical theory claims that spatial objects are stored in a non-hierarchical, holistic structure (Kitchin and Blades 2002). In this theory, cognitive maps have a network structure. Distortions in spatial cognition are attributed to the stage of information retrieval from memory, rather than to storage as in the hierarchical theory. According to the non-hierarchical theory, cognition of distance may be distorted due to intervening environmental objects or features, such as the number of turns in a travel route or topographical barriers between the reference and destination location (Ankomah et al. 1995). The question that rises is to what extent spatial information processing strategies may influence subsequent choice behaviour and WTP in SP studies for environmental valuation.

The general decision-process of choice behaviour described in Section 2.2 has been elaborated for different types of spatial choice behaviour, but not for SP research for environmental valuation. For instance, Timmermans and Golledge (1990) describe activity-based behaviour, in which people move through space from one location to another, such as home-work movements, public transport choices, recreation and migration. There are three important reasons why the existing limited spatial choice approaches should be further tested and refined for application to environmental valuation studies using SP methods. First, the spatial effects resulting from the physical and psychological context are commonly studied separately, but have not been addressed in an integrated approach for environmental valuation. Second, in addition to use values environmental improvements are associated with non-use values, which do not require the individual to physically move through space and bear costs of travelling. This is a clear distinction between spatial choices in environmental valuation involving non-use values and other topics, like recreation, shopping or commuting decisions. Third, the use of SP methods usually involves individuals without experience with the hypothetical market, so that they cannot learn from the outcomes of previous choices.

2.6 Spatial analysis: addressing spatial dependencies

Whilst economic geography and environmental psychology help to understand how people perceive their geographical environment, spatial analysis techniques may be useful to improve the statistical analysis of variation in spatial relationships in regression models. Spatial regression models use information about the spatial relationships among variables to capture spatial dependency. Spatial analysis builds upon Tobler's (1970) first law of geography, which states: "Everything is related to everything else, but near things are more related than distant things". Spatial analysis covers a group of techniques that accounts for geographic, topological and geometric properties of subjects, including spatial econometrics. In spatial analysis, the notion of space is related to the *two-dimensional* geographical specification of observations representing locations on the surface of the earth.

Relationships are expected to be stronger between nearby than distant locations. Proximity can be defined in terms of distance, connectivity or direction (Miller 2000).

Ignoring spatial relationships may lead to biased parameter estimates. There has been more attention paid to spatial relationships in travel demand analyses than in SP studies (e.g., Bhat and Zhao 2002). However, the spatial considerations that affect travel behaviour are also likely to affect WTP for environmental changes obtained in SP surveys. Similar to travel demand analysis, the use-values associated with environmental quality changes often involve the evaluation of the site, including its spatial characteristics and its recreational amenities, as well as the distance. The spatial relationships are reflected in three statistical issues in spatial analysis: spatial dependency (or autocorrelation), spatial heterogeneity and spatial heteroskedasticity (Anselin 2003). *Spatial dependency* implies that observations from two locations influence each other or possess the same characteristics. *Spatial heterogeneity* refers to variation in relationships between dependent and independent variables over space. Multi-directionality is one of the typical features of spatial dependency and heterogeneity (Florax and Nijkamp 2003). This means that the parameters of the model vary following a spatial structure. Therefore, general parameter estimates may be biased and not accurately describe processes at any given location (Anselin 2003). The last possible source of bias is *spatial heteroskedasticity*, which reflects the fact that the variance of the unobserved influences may be different across spatial units.

In the presence of spatial heterogeneity and dependency, a sampling process is required that determines a sample of locations sufficiently reflecting this heterogeneity and dependence. Spatial sampling designs focus on minimizing the sample size and maximizing the variance in the dependent and explanatory variables. At least one of these variables has a spatial property. Spatial sampling ensures that the sample represents the population over space (Haining 2003).

Spatial analysis makes use of many types of modelling techniques to overcome problems of spatial heterogeneity and dependence, such as spatial autocorrelation, interpolation and interaction methods. Spatial autocorrelation techniques account for similarity between nearby locations and use spatial weight matrices reflecting the intensity of the relationship between observations, which is usually determined by their proximity, connectivity or contiguity. Hedonic pricing studies make use of these techniques to identify and control for spatial correlation between housing prices. Spatial interpolation techniques estimate the values for unsurveyed locations based on the values of observed nearby locations. Campbell et al. (2009) present the only application of spatial interpolation in environmental valuation to accommodate benefit transfer.

Spatial heterogeneity is usually addressed by including distance and location variables in the analysis. Spatial interaction models are used to estimate interaction between alternative locations, given the characteristics of the origin, destination and distance between these two. These models have mostly been applied to aggregate levels of visitation patterns, i.e. at the population level, whereas discrete choice analysis is concerned with choices at the individual level.

One of the possibilities to model spatial heterogeneity, developed in the geographic literature, is the spatial expansion method (Casetti 1972; Fotheringham et al. 2002). This model allows for two-dimensional spatial variation in the parameters β of the model by including spatial trends. The parameters of the model are specified as functions of the spatial coordinates (*x*, *y*) of the location of the observation:

$$\beta = f(x, y) = \beta_o + \beta_1 x + \beta_2 y \quad (2.9)$$

While many of the spatial analysis techniques in the geography literature are applied to reveal spatial variation in the model coefficients, economic analyses put more emphasis on the theoretical justification of possible spatial variation. The most important characteristic of spatial analysis models is that they often take a two-dimensional approach to control for different types of spatial relationships between locations or observations. In addition, they acknowledge the importance of distance in interactions between locations and allow for similarity between nearby observations.

Not all the spatial modelling techniques are applicable to, or most suitable for, SP studies, in which the dependent variable is the individual's WTP. Respondents in the survey are not expected to influence each other's WTP statements and spatial dependency in WTP observations is therefore not likely to be an issue. In many cases, it may be possible to capture similarity between preferences of nearby respondents by controlling for the factors that cause this similarity, via variables like income, neighbourhood characteristics, travel distance, and the distance to substitute sites. However, there are possible remaining unobserved factors that may cause spatial heterogeneity due to differences in cultural characteristics as respondents may be coming from different regions.

2.7 An improved framework for the analysis of spatial choices in environmental valuation

Stated Preference studies for the valuation of spatially defined environmental goods and services have used models built on neoclassical assumptions of rational decision-making. Spatial cognition theory suggests that the neoclassical assumptions may be violated in case of spatial choices based on spatial perceptions, knowledge and decision heuristics. Furthermore, SP studies hardly account for spatial variance in WTP values other than unidirectional analyses of distance decay. A two-dimensional conceptualisation of space is needed to capture additional spatial heterogeneity. Hence, there is a need within the field of environmental valuation using SP techniques for an analytical framework which includes spatial choice behaviour and spatial heterogeneity underlying the observations in valuation surveys that aim to assess use and non-use values attached to site-specific environmental changes.

The framework proposed here includes the spatial characteristics of the physical as well as the psychological context of spatial choices. It builds upon and adapts the framework presented in McFadden (2001) discussed in Section 2.2. The framework is visualised in Figure 2.2. The arrows in the figure are not intended to give a comprehensive reflection of all the connections between the elements of the framework, but reflect the main relationships. This study will address different elements of this analytical framework.

The main aspect of the framework is the combination of the physical spatial context and psychological aspects of spatial choice behaviour. The upper rectangle reflects the spatial context in which the environmental goods or services under valuation are provided. The physical context of the environmental goods or services is characterised by the spatial distribution of the sites that provide these goods and services and the population that benefits from them, and the interaction between sites and population. In the lower rectangle of Figure 2.2, the elements of the decision-making process that lead to a spatial choice are depicted. The spatial context in which the environmental change takes place is expected to affect the WTP for this change through spatial perceptions and preferences. Hence, accounting for the spatial context and the perception and preferences of this context in study design and analysis is expected to improve the validity and reliability of the resulting WTP estimates.

There are five sets of characteristics of the *physical* context that spatial choice analysis has to account for (Pellegrini and Fotheringham 2002):

a) Characteristics (spatial and non-spatial) of all alternative sites, such as size and environmental quality;
b) Social, demographic and psychological characteristics of respondents;
c) Separation variables: the distance from the respondent to the alternatives;
d) Situation variables: the spatial distribution of the alternatives;
e) The spatial distribution of respondents.

The distribution of respondents across the study area can be important if other unobserved factors are expected to cause spatial heterogeneity in respondents' preferences, besides distances, socio-demographic characteristics and the availability of substitutes.

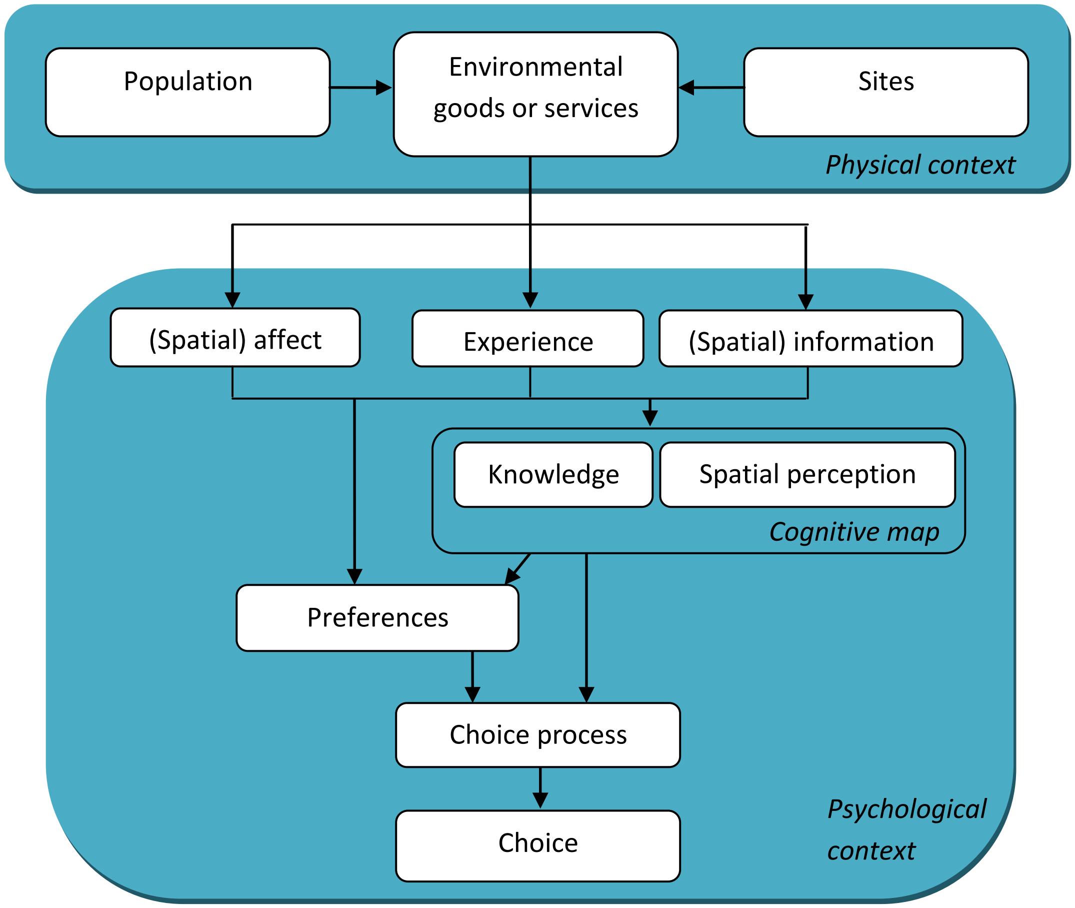


Figure 2.2 Conceptual framework

The benefits of an environmental change are dependent on the characteristics of the site where the environmental change takes place, including its ecosystem, adjacent land use and other factors related to its embedding in the landscape. The geographical characteristics may require different descriptions of the effects of environmental changes in the valuation scenario. For instance, in case of sites in different spatial contexts, different attribute descriptions or levels of attributes reflecting ecological goods and services to which respondents attach use and non-use values may have to be used.

The *psychological* part of the framework expands the decision-making process as described in Section 2.2 with the concepts from spatial cognition theory highlighted in Section 2.5. In the framework it is assumed that the spatial choice process is affected by spatial knowledge and (spatial) perception as reflected in the cognitive map. Spatial information about the physical context, affect for the spatial context in which the environmental good is embedded and experience with locations and their environmental goods and services influence spatial perception and knowledge. Spatial affect reflects the emotional association of the respondent with the environmental goods and services provided at different locations: the so-called sense of place or place attachment. Experience, spatial affect and information are processed, form preferences and are stored in the cognitive map. In spatial choices, people use their mental maps. It is expected that respondents also use their mental map in their choice process when they are asked to state the value attached to environmental goods and services in a SP survey. The preferences for different environmental goods and services are also directly affected by experience, affect, information and perception. Hence, choices revealing the WTP for the environmental good or service are based on the perception and resulting preferences for this good, including its spatial context, such as the location providing the goods and services, distance and substitution variables.

The general decision-rule is the rational utility maximization rule, in which preferences are assumed to be complete and transitive across choice contexts (Swait and Adamowicz 2001). However, the framework considers that when the environmental change under valuation takes place in a spatial context characterised by many substitute sites located at different distances from the individual, people might use a heuristic, i.e. a decision-strategy that reduces the complexity of evaluating all the alternatives simultaneously. In addition, learning about the spatial context during a SP survey may cause inconsistencies in choice behaviour. In case of spatial choices, the expected heuristic is to employ a hierarchical decision-making strategy, driven by the hierarchical structure in which information in the cognitive map is organised. In this strategy, people first consider perceptual regions containing these alternatives before making a final choice for a specific alternative. For instance, if respondents are asked to choose their most preferred water body out of a larger number of sites, they first determine their preferred larger region and, in the second step of their decision-making process, select a specific water body. The complexity of spatial choices depends on the geographical scale of the study: increasing the geographical scale will usually imply that more alternatives located in this wider area have to be evaluated. This may result in choices that violate the completeness and consistency assumptions of rational utility maximization. The empirical SP research focussing on the effect of the choice set size on preferences and choices is not conclusive regarding the maximum number of alternatives that can be included before the complexity of the choice tasks becomes too high to make rational choices. Violations of rational utility maximization therefore have to be tested when choice sets include a large number of alternatives. Accounting for the characteristics of spatial choice behaviour in the analysis is expected to result in more valid and reliable estimation of WTP for environmental changes. Chapter 4 will evaluate different choice models and address the problems involved in the choice set specification and the definition of substitute sites.

The next step is to operationalise the framework and develop the methodological approach. The general WTP model for spatial choices includes these characteristics and is specified as follows:

$$WTP_{ni} = f(\Delta Q_i, X_i, Z_n, DD_{in}, S) \quad (2.10)$$

WTP_{ni} is the willingness-to-pay of individual *n* for an environmental change ΔQ_i at site *i*, X_i is a vector of characteristics of site *i*, Z_n is a vector of socio-economic, demographic and psychological characteristics of individual *n*, DD_{in} is the distance-decay function of respondent *n* for site *i* and *S* are the available substitutes. Individual preferences for these factors determine the substitutability of a site and its price. The WTP for ΔQ consists of use values (e.g., value attached to recreation possibilities), option values (e.g., value attached to future recreation possibilities) and non-use values (e.g., value attached to biodiversity or conservation of the ecosystem goods and services for future generations).

The effect of distance is included in the framework as a parameterised distance-decay function, which encompasses different sets of explanatory factors. The aim of this function is to address spatial heterogeneity in the distance-decay rate of individual *n* for a particular site *i* in order to improve upon the estimation of a generic, unidirectional distance-decay parameter. The parameterised distance-decay function will be elaborated in Chapter 3.

Different models to account for the physical and psychological factors of spatial choice will be described and evaluated in Chapters 3 and 4. The framework adopts concepts and modelling techniques developed in the field of transport and geography to address spatial heterogeneity across observations at different locations.

Next, to test if this framework, including the alternative modelling approaches, leads to more reliable WTP estimates than non-spatial analyses, the framework is applied to the valuation of water quality changes in two case studies. The case studies address various aspects of the framework. First, the conceptual distance-decay function is tested by applying and comparing different approaches to model directional heterogeneity in distance decay. Second, the use of subjective definitions of distance and substitutes as explanatory factors of WTP is tested against the use of their objective counterparts, by examining their effect on the statistical efficiency of the estimated choice models. In addition, the effect of place attachment is examined. Third, differences in distance decay between users and non-users and between sites providing different types of ecosystem services are assessed. Fourth, different discrete choice models are compared to select those that capture spatial choices and the correlation structure of different locations best. Particular attention is paid to the mixed logit, universal logit and competing destinations models and the possibilities these models offer to capture different degrees of substitutability of the ecosystem services provided by different sites, which are expected to depend on their site-characteristics and their spatial distribution. A final objective is to assess the influence of the geographical scale of the study and consequent choice task complexity on spatial choices.

In the first case study on the Scheldt river basin in Chapter 5, respondents are asked to choose among three sites, with different ecosystem characteristics. The main objective of the study is to assess the substitution pattern of the goods and services that the sites provide, which are expected to have site-specific values and differ in their degree of substitutability. Different models are compared to address the substitution patterns between the study sites as well as the influence of substitutes other than those included in the choice set of the CE. Furthermore, different elements of the theoretical distance-decay function are tested. In the second survey, respondents are asked to choose among eleven lakes, situated in the Rhine river basin. These lakes provide similar goods and services. This study focuses on the effect of the spatial distribution of the alternatives on the substitution pattern. The objective is to see if this spatial distribution affects the WTP as it determines the scarcity throughout the area and may therefore cause additional spatial heterogeneity in WTP. By changing the composition and scale of the choice set, the study also aims to assess the effect of choice task complexity on resulting choices. The two case studies are presented in the Chapters 5 and 6.

2.8 Summary and conclusions

In this chapter, an overview is given of the core concepts of neoclassical economic theory underlying SP methods. The validity and reliability of these methods is discussed with respect to spatial choices. Several limitations are identified why the reliability of validity of the results of SP studies could be reduced when dealing with the effect of distance and substitutes, as well as spatial choice behaviour. To overcome the limitations identified in the SP literature, an improved analytical framework for the analysis of spatial choices in environmental valuation studies using SP methods is proposed. The framework combines the psychological characteristics of spatial choice behaviour and the physical context of spatially defined environmental goods and services provision. The main aspect of the psychological context is the notion that spatial choice behaviour is driven by the spatial cognition as represented in the cognitive map of the respondents. Spatial variation in WTP values for environmental changes is determined by preferences for the environmental change itself, as well as by variation in the characteristics and the spatial distribution of the respondents and the choice alternatives.

The framework aims to address four main shortcomings in the existing SP literature for environmental valuation involving spatial choices. First, spatial relationships between observations and spatial variation in these relationships often depend on proximity. Analysis of the resulting spatial dependencies requires a two-dimensional conceptualisation of spatial context in the analysis. The isotropic, one-dimensional approach to distance that distance-decay analysis in SP studies take may lead to biased estimates of distance decay and WTP in the presence of directional heterogeneity. The next chapter will give an overview of how SP studies have so far accounted for the effect of distance from the respondent to the site on WTP and suggest alternative approaches to the assessment of distance-decay effects.

Second, human knowledge about the spatial organisation of the surrounding environment is not necessarily a cartographic representation that is linear in distance, but may be affected by knowledge and experience, and the way spatial information is organised. There can be systematic judgment errors in the perception of the spatial environment and the way people use cartographic information, including the estimation of travel distance. Hence, the effect of spatial cognition on distance-perception and individual distance-decay rates requires further attention in SP studies when aiming to capture the distance decay in WTP values reliably. Chapter 3 will address this issue.

Third, the complexity of spatial choice settings as a result of the large number of alternatives that may be considered and the use of the cognitive map in spatial decision-making may cause violations of the assumptions of economic theory regarding rational decision-making. Instead, people may employ a hierarchical decision-making strategy, by choosing first between categories at a higher spatial level to which the alternatives belong, before selection the preferred alternative from those within the lower level category. This simplifying heuristic might affect the valuation results if it is not taken into account. The spatial hierarchical decision-making strategies may require different study designs for spatial choice studies in order to avoid anomalies in preferences and choices.

Fourth, SP studies have paid little attention to the effect of changes in the availability or characteristics of substitutes on the WTP for an environmental good of service. Apart from assessing if WTP changes as the amount of the good under valuation is changed in scope-sensitivity studies, empirical studies give little to no information on substitution effects and are often limited to the inclusion of substitute reminders. However, this simple reminder of substitution possibilities is unlikely to ensure that substitution effects are reflected sufficiently in SP studies for environmental goods. Substitution effects will be addressed in Chapter 4.

3. Distance decay in environmental valuation

3.1 Introduction

One of the basic and most straightforward, yet often omitted methods to address spatial variation in WTP estimates is to account for distance decay. Distance decay implies that individuals' WTP decreases as the distance from the site to respondents' homes increases. In this chapter, it is argued that the way distance decay has been addressed in the existing SP literature may have produced unreliable results as cognitive distance effects, substitution effects and associated spatial heterogeneity in distance decay are not controlled for.

The objective of identifying a distance-decay effect is to determine at what distance of the study site people are no longer willing to pay for some environmental change. This boundary determines the market over which WTP values can be aggregated to calculate a total WTP, i.e. for the entire population of beneficiaries of the environmental change. It should be noted that if the sample on which the mean individual WTP is based is representative, not only in terms of socio-demographics but also in space, for the population across the area over which the values are aggregated, then using the sample mean for aggregation will lead to unbiased aggregate estimates. However, biased aggregate values may result if the sample only covers part of the area over which the mean WTP is aggregated. Valuation studies have often focused on the political borders of a water body, provincial or national, or borders that demarcate the regions under a certain governmental jurisdiction or water management institution. However, economic market boundaries may be different from political borders. Besides time and budget constraints, economic demand can be constraint by factors, such as mobility, accessibility, or physical boundaries.

In view of the importance of distance-decay effects for determining the economic market size, the provision of guidelines on distance-effects may help researchers to determine the effective sampling area size. To this end, this chapter will first discuss spatial discounting theory, which offers a theoretical underpinning of distance effects. Next, a literature review of the empirical SP studies that account for distance decay, 25 in total, is given. These studies vary in their explanation of the underlying causes of the distance-decay effects. This review will identify the possible explanatory factors of distance decay that need to be controlled for. Methodological issues regarding heterogeneity, the specification of the distance-decay function and the measurement of distance are also discussed. The aim is to develop a theory-based specification of a parameterised distance-decay function.

3.2 Spatial discounting and distance decay

Discounting is a procedure to make costs and benefits that occur at different points in time or space commensurate (Frederick et al. 2002). Spatial discounting can be interpreted as a description of consumer preferences with respect to space, most commonly considered to be discounting over geographical distance. Smith (1975) lists the general assumptions for spatial discounting in travel behaviour, in which the level of trip consumption depends on the site characteristics and the travel distance to that site: positive substitutability – larger distances to a site can be offset by better characteristics; monotonicity – sites with shorter travel distance and better characteristics are always preferred; and proportionality – the substitution rate for characteristics and distance is constant. The spatial discounting model by Smith assumes that the accessibility of goods is purely dependent on distance without further costs or impedances.

There is also empirical evidence of distance-decay functions suggesting that people discount over space. The literature on spatial discounting provides two areas of empirical evidence: studies on the Environmental Kuznets Curve that relates environmental quality to income, and studies on preferences for spatially dispersed environmental impacts, including environmental valuation studies (Perrings and Hannon 2001). The Environmental Kuznets Curve has an inverted U-shaped curved, relating increases in income to environmental health. The curve is found for short-term and nearby environmental pollution, but not for long-term and distant effects. This implies that as income rises, people are more concerned about the short-term environmental impacts or pollution of their own neighbourhood than about pollution with long-term effects or at distant locations, such as nuclear waste or carbon emissions. For example, investments in safe drinking water supply offer direct local benefits and therefore tend to get a higher priority than pollution with more global effects, such as CO_2 emissions.

The second line of empirical evidence is found in studies relating preferences for environmental impacts to distance. The distance-decay function reflects the degree of concern of (environmental) impacts over space. In transport economics distance decay is interpreted as someone's propensity to travel, often dependent on the travel mode and purpose of travelling (Krygsman et al. 2004). According to Hannon (1994), the geographical discount function can be interpreted as fear or desire for a good: people desire to be close to aesthetic views and away from non-aesthetic or dangerous objects. For example, the NIMBY (Not In My Back-Yard) effect reflects the objection to the proposed location of an undesirable object close to one's home, such as hazardous waste facilities (Mitchell and Carson 1986). It is an expression of territoriality and location preference. Someone's "sense of place" (see Chapter 2) determines the strength of his or her individual discount rate. The closer people live to their preferred location, the stronger their concern for their nearby environment and the higher their spatial discount rate.

To what extent distance-decay estimates vary across respondents with different socio-demographic or taste characteristics has hardly been studied empirically in the field of environmental valuation, except for differences between users and non-users. According to the literature in the field of environmental psychology and economic geography, the individual discount rate is dependent on context, the reference points of respondents, culture, experience and knowledge, awareness and locational preference. For instance, people living closer to a certain environmental good are often more concerned or knowledgeable with respect to this good due to their proximity and will therefore have higher preferences and attach a higher WTP than those living further away (Brody et al. 2004).

Distance-decay rates may also vary across goods, depending on the type of associated value and the risk level and scale of their provision. Empirical research on spatial discounting has found that ecosystems providing (non-use related) values associated with intrinsic, life-sustaining and future goods and services, have much lower discount rates than use-related values, such as recreational, subsistence, therapeutic and aesthetic values (Brown et al. 2002). In economic theory, non-use values are not expected to depend on distance, as travel costs are not assumed to affect the WTP negatively.

Hannon (1994) notes that spatial discounts rates may differ between goods, depending on their type and the risk of their provision. Ecological processes operate over a range of spatial scales. Whilst some services are beneficial on a national scale, other services only create utility on local scale. These scale effects determine the geographical scale of the market for environmental quality changes. Consumers might prefer local over global effects, because of the uncertainty involved in distant effects or the possibility to benefit from effects further away. The geographical discount rate is then a reflection of psychological and aesthetic concerns over distance with additional elements of risk.

These empirical results suggest that distance-decay rates will vary across people and environmental goods and services. The next section will give an overview of the current SP literature on distance decay.

3.3 Distance decay in stated preference studies

The use of distance-decay functions in SP research primarily mirrors the revealed preference valuation work based on travel cost studies, originally introduced by Hotelling (1947). The main theoretical expectation regarding the effect of distance on WTP is that as distance increases, travel cost to the site increase, and in turn demand for the site decreases. This effect is expected to be most prominent in the WTP for environmental goods with mainly recreational or other use values.

A number of alternative explanations for distance decay have been suggested besides the direct travel cost effect. Distance is often inversely correlated with visitation rates, length of residency, information and knowledge about the good under valuation. These variables are common explanatory variables in many SP studies (e.g., Pate and Loomis 1997; Bateman et al. 2005; Concu 2005). As people live closer to the study site, they are more likely to know more about the site, either via media, own visits or those by friends and family (Sutherland and Walsh 1985).

Distance-decay effects are also explained by the presence of substitutes. For non-unique sites, the availability of substitutes will often increase with distance from the site. The greater the supply is, the lower will be the demand and the WTP for one particular site. Brouwer and Slangen (1998) find significant distance-decay effects and attribute these to substitution effects between the site under valuation and other similar sites. A few studies therefore account for the presence of substitutes in the area of the respondent in the regression analysis, e.g., by including the number of alternative rivers (Brown and Duffield 1995) or by the total surface of substitute sites (Pate and Loomis 1997), and still find a significant distance-decay effect. These studies do not account for the distance from respondents' residences to these substitute sites. The WTP will in such cases not capture the substitutability between sites, reflecting how travel costs of different sites are traded-off against each other.

Whilst distance decay of use values has a clear theoretical explanation, there is no theoretical expectation for declining non-use values as distance increases. Empirical results in the SP literature are mixed and partly obscured, because distinguishing pure non-use from use values is practically difficult and mixed with discussions on differences between users and non-users. No distance-decay effect among non-users was found for National Parks (Barrick and Beazley 1990) or species people do not often see, such as seals in Holland (Bulte et al. 2005). Goods with a large share of non-use value do not show distance decay in the study of Payne et al. (2000). However, in contrast to theoretical expectations, Sutherland and Walsh (1985) find distance decay in non-use values held by users. Other studies find distance decay in WTP-estimates of non-users (Bateman et al. 2000; Hanley et al. 2003). Option values expressed by current non-users may depend on distance (Hanley et al. 2003). Bateman et al. (2006) suggest that the distance-decay effect for an improvement might be higher than for the prevention of a deterioration related to the same site. When the good under valuation is an improvement over the current situation of a site and respondents are asked to state their WTP, current non-users may think they will use the site in the future and hence include use values in their WTP. This conversion is more likely among non-users living closer to the site than among those further away, as nearby non-users have lower travel costs and therefore more use-prospects. Conversion of non-users into users will thus lead to distance decay in WTP values held by non-users and increase the distance-decay effect of an improvement scenario among the total sample when a compensating surplus measure is assessed. When the environmental quality does not improve and respondents are asked to state their WTP for preventing environmental deterioration, i.e. an equivalent loss measure is assessed, conversion of non-users to users is less likely to occur and the resulting distance-decay effect will on average be lower.

Other cases in which a distance-decay effect is weaker or less likely to occur is for environmental goods that are considered to be important because of their unique characteristics, for example, symbolic species or national parks. This uniqueness may call for a protection status, leading to widely spread knowledge about the good, and implies that there are likely to be few substitutes. For salmon, a symbolic species, Loomis (1996; 2000) finds a low distance-decay effect and Pate and Loomis (1997) do not find any DD-effect. Whenever goods have a local importance due to some cultural association with the good, WTP is likely to fall abruptly beyond a political or social border. Such discontinuous distance-decay effects for “local” goods are suggested to be due to a “sense of ownership” (Bateman et al. 2004b) or “spatial identity” (Hanley et al. 2003). Another case in which distance decay is less likely to be observed is when environmental improvements are expected to cause losses of local jobs.

Table 3.1 Stated preference studies addressing distance-decay effects

Authors	Year	Value type	Valuating population	Type of good	Number in plot
Contingent valuation studies with significant distance-decay effects					
Sutherland and Walsh	1985	Option	Non-users	Water quality	1
		Existence	Non-users		2
		Bequest	Non-users		3
Brown and Duffield	1995	Use and non-use	Users, non-users	Instream flow (water quantity)	4
Loomis	1996	Use and non-use	Users, non-users	Dam removal for salmon population restoration	5
Bateman et al.	2000	Use and non-use	Holiday-makers	Preservation of the Norfolk Broads	6
			Non-users		7
			Day-trippers		8
Pate and Loomis	1997	Mainly non-use	Users, non-users	Wetland improvement	9
		Mainly non-use	Users, non-users	Contamination control	10
Georgiou et al.	2000	Use and non-use	Users, non-users	River water quality	11
Hanley et al.	2003	Use and non-use	Users	Low flow (water quantity)	12
			Non-users		13
Contingent valuation studies excluded from Figure 3.1					
Carson et al.	1994	Use and non-use	Users, non-users	Protection of National Park	
Breffle et al.	1998	Use and non-use	Users, non-users	Preservation of undeveloped urban land	
Brouwer and Slangen	1998	Use and non-use	Users, non-users	Wildlife preservation	
Loomis	2000	Use and non-use	Users, non-users	6 Natural public goods	
Daun and Clark	2000	Use	Users	Flood risk reduction	
Stumborg et al.	2001	Use and non-use	Users, non-users	Water quality improvement	
Bateman et al.	2004b	Use and non-use	Users, non-users	Water quality improvement	
Contingent Valuation studies without significant distance-decay effects					
Barrick and Beazley	1990	Option value	Non-users	Forest conservation	
Pate and Loomis	1997	Use and non-use	Users, non-users	Salmon improvement	
Bennett et al.	1998	Use and non-use	Users, non-users	Wetland protection	
Payne et al.	2000	Use and non-use	Users, non-users	5 different environmental programs	
Powe and Bateman	2004	Use and non-use	Users	Wetland protection	
Stanley	2005	Use and non-use	Users, non-users	Preservation of endangered species	
Bulte et al.	2005	Mainly non-use	Non-users	Conservation of seals	
Choice Experiment studies with significant distance-decay effects					
Adamowicz et al.	1994	Use	Users, non-users	Quality of water-recreation sites	
Boxall et al.	1996	Use	Users	Forest management for moose hunting	
Hanley et al.	2001	Use	Users	Rock climbing	
Concu	2005	Use and non-use	Users, non-users	Protection of bushland (National Park)	

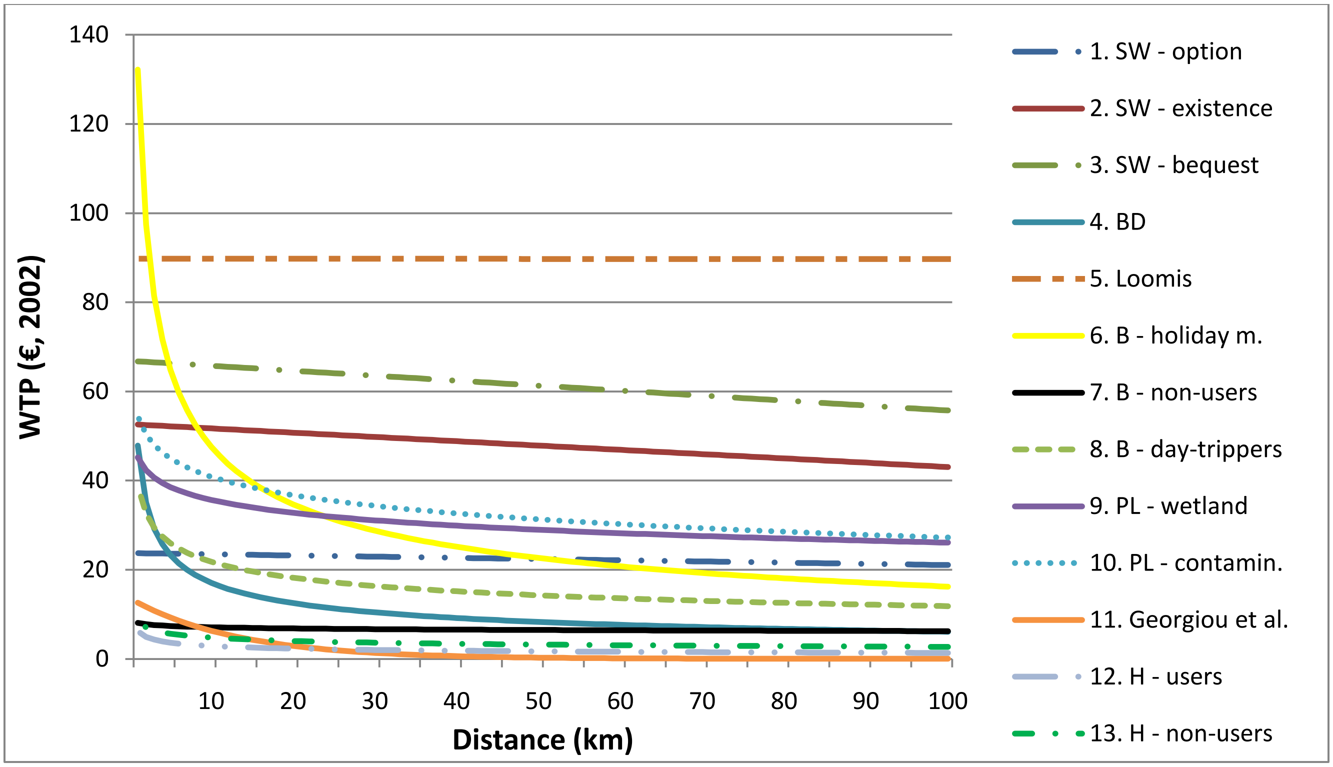


Figure 3.1 Distance decay in stated preference studies using CV
WTP values are converted to PPP-corrected 2002 Euros. For Pate and Loomis (1997), values have been divided by 10 to better fit the plot.

Table 3.2 Distance-decay functions of series in Figure 3.1

	Authors	Characteristic	Distance-decay function	Original Unit
1	Sutherland and Walsh (SW)	Option	WTP=13.50-0.0153*D	US$(1981)/Km
2		Existence	WTP=29.95-0.0547*D	US$(1981)/Km
3		Bequest	WTP=38.02-0.0634*D	US$(1981)/Km
4	Brown and Duffield (BD)		$WTP=44.907*D^{-0.4477}$	US$(1989)/Mile
5	Loomis		WTP=78-0.0001608*D	US$(1989)/Mile
6	Bateman et al. (B)	Holiday-makers	$WTP=62.284*D^{-0.432}$	GBP(1991)/Km
7		Non-users	$WTP=4.740*D^{-0.043}$	GBP(1991)/Km
8		Day-trippers	$WTP=18.96*D^{-0.233}$	GBP(1991)/Km
9	Pate and Loomis (PL)	Wetland improvement	WTP=371.67-32.71*ln(D)	US$(1990)/Mile
10		Contamination control	WTP=451.21-46.64*ln(D)	US$(1990)/Mile
11	Georgiou et al.		$WTP=e^{2.137-0.0000771*D}$	GBP(1999)/Metre
12	Hanley et al. (H)	Users	$WTP=4.1*D^{-0.332}$	GBP(2001)/Km
13		Non-users	$WTP=5.5*D^{-0.244}$	GBP(2001)/Km

Sampling biases may also obscure or bias distance-decay estimates (Bateman et al. 2006). Aggregating the mean WTP of a spatially representative sample over the entire are over which is sampled should not lead to biased aggregate WTP estimates. However, many studies do not use spatially representative samples. Studies using samples that are not based on the economic market area but on a smaller area near the environmental good may produce distance-decay effects that cannot be extrapolated beyond the sampling area. Loomis (1996) points out that the identification of the relevant population over which WTP can be aggregated is similar to the choice of the relevant sampling area. Furthermore, self-selection bias may occur if relatively more users with interest in the good respond than non-users. In order to ensure that a distance-decay effect can be estimated to reliably demarcate the geographical boundaries of the market, a geographically balanced sampling strategy, which provides sufficient variation in distance and substitute availability variables, should be applied.

In spite of the importance of distance decay for WTP-aggregation procedures, there are at most 25 published stated preference studies that report distance-decay effects, 19 of which find significant effects for a wide variety of environmental goods, countries and populations. With so little empirical evidence, it is impossible to estimate a reliable average distance-decay effect or general distance-decay function for the WTP for environmental goods based on a meta-analysis. Hence, no rules of thumb can be defined to identify a minimum or maximum range over which sampling should take place.

Table 3.1 lists these 25 SP studies on distance decay, together with the type of good, value and population segment stating their WTP. CV studies include distance as a separate explanatory variable in the regression analysis. In logit models of choice experiments (CEs) distance can enter the model in interaction with other explanatory variables or the alternative specific constant (Concu 2005). Alternatively, distance can be included as an attribute of a CE as a proxy for travel costs (Adamowicz et al. 1994). Only two studies estimate different distance-decay functions for different types of use and non-use values: Sutherland and Walsh (1985) and Concu (2005). Bateman et al. (2000) and Hanley et al. (2003) provide different estimates for users and non-users. All other studies include a single distance-variable in the utility function, without attempting to assess differences between value types or heterogeneity between respondents in distance decay.

Figure 3.1 plots the distance-decay functions estimated in the SP studies. The figure only reflects studies that find a significant, continuous distance-decay function, listed in the first part of Table 3.1. Seven studies have not been included in the figure, either because they use distance-dummies (Carson et al. 1994; Stumborg et al. 2001; Bateman et al. 2004), or because the studies do not provide enough information to derive the distance-decay effect from the results (Brouwer and Slangen 1997; Loomis

2000; Daun and Clark 2000). The study of Breffle et al. (1998) has been excluded, because the sampling area was limited to a one mile zone around the good under valuation, which severely limits the comparability with the other studies. The last part of the table lists studies that report insignificant distance-decay effects. Table 3.2 provides information regarding the distance-decay functions of the studies included in Figure 3.1.

Figure 3.1 shows that the WTP functions do not cross the x-axis. This means that all respondents within a 200 kilometre range are willing-to-pay a positive amount of money for the good that they are offered. Hanley et al. (2003) and Georgiou et al. (2000) find WTP estimates that approach zero. Observation of Figure 3.1, which reflects mostly exponential and loglinear functions, would also lead to think that distance-decay effects are strongest within roughly the first 10-20 kilometres from the site being valued. This raises the question if the demand for an environmental good is indeed as price-elastic in the short run as these distance-decay curves suggest. Three possible explanations for this pattern are as follows. A first option may be that the WTP estimates of these studies partly reflect non-use values that are independent of distance and only the use values show distance decay. This would explain why the WTP functions do not cross the x-axis. Secondly, the studies may not have sampled over a sufficiently large area to cover those respondents with zero WTP. Also, they may not have sampled sufficiently within a short distance from the sites. A last explanation is statistical, namely that this finding may be due to the logarithmic and negative exponential specifications that are used in the studies. It is doubtful if the distance-decay results of these studies can be used to estimate distance decay for other study sites, especially if there are differences in the spatial context. For instance, distance decay is expected to be higher so that WTP eventually equals zero when the environmental resource under valuation is abundant. Section 3.6 offers guidance on the selection of the functional form of the distance-decay function. Furthermore, two issues have been ignored in these 25 studies: (1) cognitive distance errors and (2) directional heterogeneity. These are discussed in the following two sections.

3.4 Cognitive distance errors

The SP studies reviewed in the previous section calculate distance-decay rates based on real or objectively measured travel distance. The objective distance is based on cartographic maps. It can be specified as a straight line (Euclidean distance) or based on the road network, using sophisticated GIS applications. Travel cost studies also commonly use GIS based distance calculations, or sometimes travel time. In addition, many studies assume that people minimize their travel costs by choosing the shortest route to the chosen site (Bateman et al. 2006). Typically, SP studies do not use respondents' assessments of route distance.

However, as described in Chapter 2, spatial decisions are often based on the mental model of the environment rather than the physical reality (Gärling and Golledge 2000). The question rises to what extent accounting for cognitive distance errors will lead to more reliable estimates of distance-effects in WTP estimation. The main motivation to include the effect of cognitive rather than objective distance is that the former may be a better explanatory factor in spatial decision-making than the latter. Cadwallader (1975; 1981) argues that consumers rationalise their behaviour in terms of cognitive distance by showing that consumer shopping behaviour is better modelled with cognitive distance than objective distance. Therefore, Cadwallader suggests that the use of cognitive rather than objective distance can improve spatial models. Perceived distances might less accurately reflect travel costs or time than objectively measured distances, but might better reflect the effect of perceptions on choice.

Distortions in distance estimation can result from the use of mental maps. The cognitive distance is defined as people's beliefs about the distance between two locations that are not visible from each other (Montello 1991). A number of empirical studies show that the cognitive distance as stored in the cognitive map is significantly different from objectively measured distance (Walmsley and Jenkins 1992). The discrepancy between objective and subjective distance is influenced by the characteristics of the respondent, the location and its surrounding environment, and the interaction between the respondent and the location, i.e. a respondent visiting a location (Briggs 1976).

Tversky (1992; 2003) describes three systematic errors that the use of cognitive maps rather than cartographic maps produces in spatial choice behaviour. These errors are due to (1) the hierarchical storage of spatial information, (2) the cognitive perspective, and (3) the cognitive reference point. The effect of hierarchical storage or memory of spatial information implies that distance and directions are estimated based on the region they lie in. For example, people compute directions between two cities in different regions by the relative position of those regions. People also have more difficulty in determining the distance and direction between cities in the same region than between cities in different regions. The distance between two landmarks in the same perceptual category is often underestimated compared to distances between landmarks in different categories. The second cause of error is the cognitive perspective. For instance, people tend to underestimate distances between two places far away from their perspective compared to distances between two places close by. They also estimate the distance from A to B differently than in the opposite direction from B to A (Worboys 1996). Cognitive reference points are a third source of error. Places of reference, such as landmarks, are perceived to be closer to each other and to the baseline position than relatively unknown or ordinary places. They distort a mathematical perception of the space around them. Cognitive distance differs more from the real distance if respondents are less familiar with a location (Coshal 1985). People perceive the distance to well-known goods to be shorter than to unknown goods.

People sometimes use surrogates to estimate distance, such as number of turns and the amount of information remembered. Distance to a site is often overestimated in when the route to the site has many landmarks, barriers or intersections (Tversky 2003). Furthermore, the difference between cognitive and objective distance is dependent on the length of the route. In general, short distances tend to be overestimated and greater distances underestimated. Empirical studies find that short distances are overestimated more frequently than long distances, both at intracity and intercity scale (Walmsley and Jenkins 1992). In other cases, people underestimate distances, for instance when locations lie in the same region or are perceived to be very attractive (Ankomah and Crompton 1992). These findings have led to the scaling hypothesis (Sadalla and Magel 1980), which presumes that the cognitive distance D_c is a power function of the real distance D_r with a positive exponent b around 1 and $a>0$: $D_c=aD_r^b$. The exponent b is often found to be slightly below 1, implying that the ratio of cognitive distance to the real distance declines as the trip length increases. The mixed empirical results indicate that a large variance in the difference between the cognitive and objective distance may be present.

Including cognitive distance in analyses may be complicated, because people find it difficult to state the estimated travel distance or time. Rietveld et al. (1999) describe two sources of errors in subjective travel time and distance estimates: rounding and conjecture errors. Rounding errors arise because people tend to state distances in rounded multiples of five minutes. Conjecture errors result when people do not exactly know the distance and are asked to supply some estimate after their trip (based on the cognitive map) (Witlox 2007). Given the difficulty of obtaining reliable estimates of an individual's cognitive distance (Montello 1991), the inaccuracy of cognitive distance may be used alternatively to account for cognitive distance. This inaccuracy or cognitive distance error reflects the difference between objective and cognitive distance (Lin and Morais 2008).

To account for cognitive distance errors in SP, a variable reflecting under- or overestimation of the real distance could be used. This could improve the reliability of SP studies on spatial choices as it corrects for cognitive distance inaccuracy. A simple approach would be to create a dummy variable taking the value 1 whenever the cognitive distance differs from the objective distance, reflecting the cognitive distance error. This dummy can then be included in probabilistic models of site choice in combination with the effect of objective distance. Information on the cognitive distance can be obtained by asking respondents how far they think the travel route (via the road network) to a certain location will be from their outset location (Ankomah et al. 1995). This question would be most convenient for respondents if presented with pre-defined distance categories. The information on the cognitive distance can be compared to the objective distance based on the road network, for which only information about the address of the respondent is required.

3.5 Spatial heterogeneity of distance-decay functions

All SP studies in environmental valuation estimate a unidirectional or isotropic distance-decay effect. Isotropy means that the spatial relationship only depends on distance and is uniform in all directions (Haining 1993, 66). By including isotropic distance-decay effects, distance-decay effects do not reflect differences between respondents from areas with few and many alternative sites, i.e. for the effect of the spatial distribution of alternatives. Substitute sites are usually not randomly distributed over space in terms of quantity and quality. Substitutability and distance effects are interdependent. The availability of substitutes is one of the possible causes of distance decay. Vice versa, distances between alternatives and between alternatives and respondents influence the substitutability of sites in the same geographical market. The distribution of alternative locations over space and their possible substitutability or complementarity (e.g. in case of multiple-site trips) is expected to cause variation in substitutability and distance decay across regions (Moran 1999). The spatial context or environment, for instance the surrounding land-use, may also affect distance decay, through the perception of the route and associated costs or benefits. As a result, distance decay may vary across respondents and regions, and exhibit spatial heterogeneity. Spatial heterogeneity refers to non-constant model coefficients or error variance (heteroskedasticity), where the spatial location of the observations drives the heterogeneity (Anselin 1999). For instance, distance-decay effects may vary across respondents following a spatial pattern. Cameron (2006) shows that including only a distance variable and ignore directional effects can lead to insignificant distance-decay effects, or produce biased distance estimators due to omitted variables.

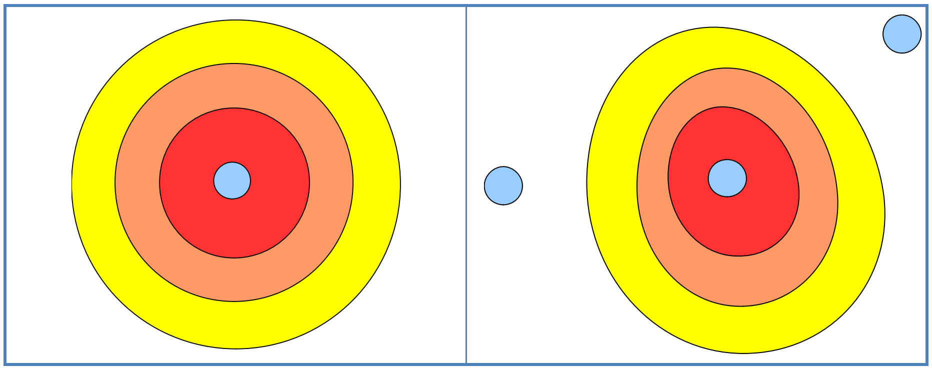


Figure 3.2 Distance decay without (left) and with (right) substitution effects

Note: The blue circles depict alternative sites. The colours in the figure reflect different WTP categories: higher values are reflected by dark red and lower values by yellow.

The variation in distance-decay effects for individual sites is depicted in Figure 3.2, in which the colours reflect WTP-categories from the highest values in red to the lowest values in yellow. On the left side of the figure, the distance-decay function is equal in all directions, whereas on the right side, substitute sites cause a higher distance-decay effect, and therefore lower WTP values and smaller markets, in the direction of other sites. The figure hence shows that distance-decay functions will not be uniform, but depend on the location of the substitutes. Accounting for such variation requires a two-dimensional analysis.

Three different options to model spatial heterogeneity in distance decay are as follows. The first solution would be to include the distance to substitutes in the WTP-model. However, the identification and selection of relevant substitutes can be difficult as will be discussed in Chapter 4. Two other possibilities are using the spatial expansion method or directional dummy variables.

The spatial expansion method (see also Section 2.7) allows for two-dimensional spatial variation in the parameters of the model by including spatial trend variables (Casetti 1972; Fotheringham et al. 2002). In other words, it allows the model coefficients to drift based on their spatial context, acknowledging that functional relationships are not constant over space. To this end, the parameters of the initial distance-decay model have to be rewritten in terms of polar coordinates of the observations, using geometry. All longitudinal and latitudinal distances from a respondent's home to the sites have to be calculated. The effect of the distance *D* is split into a direct effect and two linear spatial trends *x* and *y* for the distance in north-south and east-west directions (Fotheringham et al. 2002, 16). These trend variables, reflecting a continuous relationship between individual choices over the longitude (*x*) and latitude (*y*), are added to the model. These trends can be expressed in terms of the sine (latitude $y = D * \sin \vartheta$) and cosine (longitude $x = D * \cos \vartheta$) of the angle ϑ measured in radians between a site *i* and a respondent n. Following Cameron (2006), directional intercept shifters $cos\vartheta_i$ and $sin\vartheta_i$ can be added allowing the intercept to differ by direction. These shifters force all directional quadrants (north, east, south or west) of a site to share the same α, which is necessary if we expect to find much stronger distance decay in one of the quadrants. Note that each combination of the sine and cosine will have a unique value in each quadrant. The resulting distance-decay function is as follows:

$$\beta_D = f(x,y) = \delta_1 cos\theta_{in} + \delta_2 sin\theta_{in} + \beta_i * D_{in} + \varphi_1 long_{in} + \varphi_2 lat_{in} \quad (3.1)$$

Here, δ_1 and δ_2 are the parameters for the intercept shifters $cos\vartheta_{in}$ and $sin\vartheta_{in}$, measured in radians, β_i is the parameter for the road distance D_{in}, while φ_1 and φ_2 are the parameters for the longitudinal and latitudinal distances in kilometres between the respondent and the site.

Equation (3.1) shows that in the presence of significant spatial trends, the inclusion of a single distance-decay parameter without the specification of trend variables may hence result in biased estimators of the distance effect. The WTP models of most existing studies only include one parameter for distance.

An alternative method to account for spatial heterogeneity is to subdivide the sample of respondents into subsamples lying in different compass directions. Then, dummy variables can be created for the location of the site relative to the respondent specified in a two-dimensional (spatial) plane. For example, when using four quadrants, these dummy variables take the value 1 if the respondent n is located to the north-east (*NE*), south-east (*SE*), south-west (*SW*) or north-west (*NW*) quadrant from the site *i,* leaving one-category out as reference value for which the dummy has the value zero. The directional dummies can be included as parameters in the distance-decay function as a correction of the general effect of the distance D_{in}, resulting in the following function in which *NW* serves as the baseline category:

$$DD_{in} = f\,(D_{in} * (1 + NE_{in} + SE_{in} + SW_{in}) \quad (3.2)$$

Significant coefficients of the interaction terms between the dummies and the distance variable reflect spatial heterogeneity and imply a different distance-decay effect for those respondents located in the respective compass region of the site. Various specifications are possible, from a simple discrete north-south or east-west division to more refined directional regions. The appropriate specification depends on the spatial effect of the good under investigation and therefore draws on the researcher's expectations of the spatial pattern (Cameron 2006).

There are few empirical studies that examine directional heterogeneity in distance decay of the WTP for environmental goods and services. Only three hedonic pricing studies correct for directional heterogeneity in distance-decay effects. In these studies, wind directions determine the distribution of airborne pollution and thereby affect housing prices in a particular direction from the pollution source, Cameron (2006) applies the spatial expansion method and Herriges et al. (2005) and Agee and Crocker (2008) use directional dummy variables. No SP study used this approach yet.

Accounting for directional effects to reflect spatial heterogeneity is expected to improve model fit and the reliability of resulting WTP estimates, especially if substitutes are not randomly distributed over space. The main advantage of accounting for heterogeneity in distance decay, using either directional dummies or the spatial expansion method, is that it allows for a two-dimensional analysis revealing how relationships vary over space. The main advantage of the spatial expansion method compared to directional dummies is that and that it creates a smooth surface of distance-decay effects. Another advantage compared to including control for the distance to substitutes in the WTP-model is that these methods are easier to apply as information about addresses of respondents is easy to obtain in surveys, whereas spatial information about different substitute goods and services is not always available to the researcher. The main drawbacks are that the results are not easily interpretable and the analyst has to define the functional specification. A disadvantage of both methods is that the parameters for these spatial trend variables or directional dummies are not transferable to other regions. Neither the spatial expansion method nor directional dummies give information about the underlying causes of directional heterogeneity. In principle, the preferred approach would be to include the variables that drive preferences and WTP. However, if the source of spatial heterogeneity is unknown or if the main objective is to identify spatial heterogeneity, the methods are useful analytical tools. It is likely that the methods will capture the relative scarcity of the environmental good under valuation due to differences in substitute availability across the sampling area. In some cases these methods may also reveal spatial heterogeneity in WTP caused by other variables and reveal omitted variable biases.

3.6 The functional form for distance-decay effects

The studies reviewed in Section 3.3 differ in their specification of the distance-decay function, but hardly ever discuss the interpretation or justification of that specification. Studies commonly present the specification that gives the best statistical fit. Unfortunately, there are no guidelines on the validity of functional forms for describing choice behaviour in SP studies. The transport literature does not offer strong theoretical arguments for any particular specification either (Glenn et al. 2004). The fact that different functional specifications will have different interpretations is often ignored. Ideally, the specified distance-decay function depends on the assumed effect on utility. The aim of this section is to discuss the applicability of the various statistical functions in terms of their behavioural implications.

In Figure 3.3 the most often used distance-decay functions are plotted. The linear specification of a distance-decay function applies whenever utility is linearly affected by changes in distance, for instance when WTP is strongly use-value related and only variable costs of travel distance matter. Fotheringham and O'Kelly (1989) suggest that a linear relation between utility and distance can best describe short distance trips, such as those within an urban area. Given the character of the cognitive process of decision-making and the non-mathematical perception of travel distances due to the presence of landmarks, linear specifications of distance are unlikely to reliably capture spatial preferences. This is not only a limitation of stated preference studies, but will also reduce the validity of travel cost studies that use a constant price per kilometre as a proxy for the willingness-to-pay for using a site. In addition, Cameron (2006) shows that a linear specification does not apply whenever substitutes are absent or completely randomly distributed over space.

Utility can also be linearly related to the natural logarithm of distance. This specification is often used to capture long-distance behaviour, such as migration flows. It is less suitable to model short-distance behaviour as it tends to overestimate distance-decay effects in short ranges and implies strong price-elasticity. The log-linear function is asymptotic to the y-axis and will therefore not give a good fit for WTP-behaviour of respondents living very close to a site, i.e. where the distance-variable approximates zero. With a loglinear distance-decay function, WTP decreases drastically at short distances from the site and then more gradually as distance from the site increases, eventually going to zero. Another option is that substitutes are available in close proximity of the site, which implies rapidly decreasing WTP values over a short distance. The cognitive distance inaccuracy is expected to decrease as distance increases following the scaling hypothesis (Sadalla and Magel 1980). A logarithmic distance transformation would also apply if people do not estimate distances in a linear way, but rather overestimate the distance, for instance, when they are not familiar with the travel route. The negative exponential function is similar to the loglinear specification, but is asymptotic to the x-axis. It would apply to situations where WTP is partly independent of distance, for instance when WTP contains 'pure' non-use values and therefore not expected to equal zero.

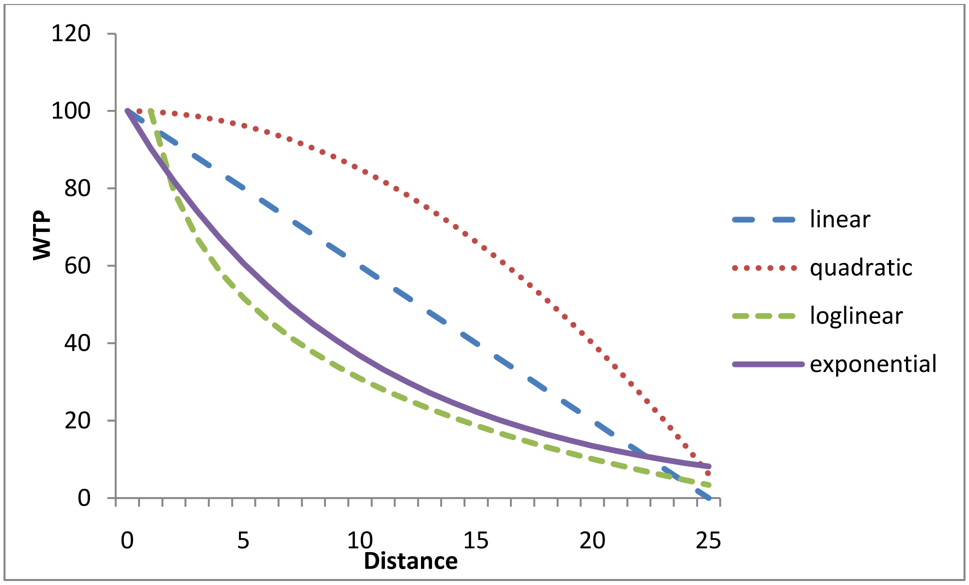


Figure 3.3 Different specifications of the distance-decay function

Quadratic and other power functions apply when WTP initially decreases a little, but then decreases more rapidly as distance increases. Such a distance decay pattern may be found in situations in which people underestimate the travel distance and therefore show lower distance-decay, with increasing underestimation at greater distances. Empirical research on cognitive distance errors suggests that such a pattern is often found for greater distances, as described in Section 3.4. This behaviour may hold for landmarks or other sites that are well-known, or for popular sites, characterised by price-inelastic demand. A power function is also likely to be most suitable to model distance decay for locations with relatively equal local values and much lower values at larger distances. This distance-decay pattern may, for instance, be found if some threshold or border effect is present or when substitutes are present at large distances from the study site.

Whilst these distance-decay functions are continuous and smooth, many environmental effects and subsequent WTP values may not decay smoothly, continuously and monotonically over space (Perrings and Hannon 2001), but are affected by boundaries, borders and barriers of the natural or political environment. Especially for goods with local importance, some studies define a dummy indicator for zones (in kilometre ranges around the asset or for administrative zones) to indicate whether the respondent is a resident of the country, province or state in which the good is located. In such cases, a dummy variable for certain distance ranges, or piecewise, zone-specific distance-decay function may better approximate the underlying choice behaviour.

Finally, there are at least three ways to reveal which relationship between distance and WTP is present in the data. A first option is to compare the different specifications discussed in this section and compare them on the basis of the resulting model fit. A second parametric approach is to define dummy-variables for different distance categories to try and disclose the distance-decay pattern. Third, non-parametric approaches could be used, where the relationship is fully driven by the underlying pattern in the data. The results of non-parametric results can be used to guide parametric specifications, but also as final findings (Ferrini and Fezzi 2010). No matter how the distance-decay relationship is determined, it is important to assess the validity of the chosen distance-decay specifications and its behavioural implications.

3.7 Towards a new conceptual understanding of distance decay

Based on a review of theoretical and empirical studies on spatial discounting, spatial perception and distance decay, a conceptual distance-decay function as in equation (3.3) can be formulated that encompasses different sets of explanatory factors. Rather than estimating a unidirectional distance-decay parameter, this parameterised function as specified in equation (3.3) can be used to address spatial heterogeneity and cognitive effects in distance decay:

$$DD_{in} = f(D, X_i, Y_n, S) \quad (3.3)$$

$$= f((D_{in}, Dir_{in}), (U, O, NU), (DErr, SPl, K, M), (X_{j\neq i}, D_{jn}, D_{ij}))$$

The distance-decay of individual *n* rate for a particular site *i*, represented by DD_{in}, is dependent on the spatial separation *D* between the individual and the site, the characteristics *X* of site *i*, the characteristics *Y* of the individual *n*, and the substitutes *S*. The separation effect can be split into the effect of the objective distance from the site to the individual D_{in} and the direction Dir_{in} of the respondent relative to the site. Directional effects can be included using either the expansion method or directional dummy variables. The set of relevant site-characteristics *X* includes the type of good or service provided by the site, and more specifically the type of value (use *U*, option *O*, non-use *NU*) attached to the service. The characteristics of the individual that influence DD_{in} may include the error in cognitive distance *DErr*, the sense of place *SPl,* the knowledge *K* and experience with the site and route, and the mode *M* of transport. The set of substitute characteristics *S* includes the characteristics *X* of substitute sites *j≠i*, and the distance from the substitute site *j* to the individual *n*, D_{jn}, and from site *i* to substitute sites *j*, D_{ij}. The identification of substitute sites raises a problem that will be addressed in Chapter 4.

The distance-decay function may furthermore depend on the risk of provision of the good or services and whether the change in provision involves a loss or a gain. However, these latter characteristics will not be tested in this thesis, as the scenarios of water quality changes in the case studies only involve quality improvements and exclude risk effects.

To operationalise this conceptual distance-decay function, information on its different components is required. SP techniques are well equipped to collect this information, especially about the perception-based variables and the characteristics of the respondent.

3.8 Summary and conclusions

Although distance-decay effects have been proposed as a validity check in SP studies by some, accounting for the effect of distance on WTP is still far from common practice. This chapter has reviewed the existing SP literature on distance-decay effects, showing that there is little empirical evidence regarding the effect of distance on WTP relative to the extensive number of SP studies. Moreover, the empirical results are mixed with regards to differences between users and non-users, use and non-use values and different ecosystem goods and services. It remains rather unclear why some studies show significant distance decay and others not. Hence, there is insufficient empirical evidence to guide decisions on the optimal spatial range over which sampling should take place to include all people affected by the environmental change under valuation. The empirical evidence is also insufficient to develop generic distance-decay estimates, let alone parameterised distance-decay functions to be used in, for instance, benefit transfer studies or value aggregation exercises.

Furthermore, there are a number of limitations in the way SP studies have addressed distance decay. First, the distance-decay estimates of the reviewed studies may be biased by inappropriate sampling strategies, both at short and long distances from the good under valuation. This is reflected in strong price elasticity at short distance and WTP values that remain positive at far distances from the study site. Second, existing SP studies have ignored the effect of cognitive distance on individual distance-decay parameters. Third, the applied statistical approaches are one-dimensional and cannot account for spatial heterogeneity. As a result, SP studies may have found insignificant distance-decay effects, which may be one of the reasons why relatively few studies report on distance-decay effects.

In this chapter, a conceptual distance-decay function has been developed to model the individual distance-decay rate as a function of the characteristics of the sites, substitutes and respondents, including the effect of spatial perception. The characteristics may explain heterogeneity across sites and respondents in their sensitivity to distance. It has been suggested to control for the inaccuracy of distance perception on the individual distance-decay parameter. The conceptual function also takes into account that different distance-decay relationships may be found for different resource types. Furthermore, given the impact of substitutes and spatial heterogeneity in preferences, the importance of allowing for a two-dimensional analysis has been stressed. Three alternative modelling approaches have been proposed to capture spatial heterogeneity in WTP values: including (1) spatial trend variables, (2) directional dummy variables or (3) distance to substitute sites in the WTP models. The suitability of different functional forms for application in valuation studies has been evaluated in the light of cognitive distance, which can facilitate the interpretation and validation of distance decay results in future studies.

Further empirical research is needed on the factors included in the conceptual distance-decay function. This will help to refine distance-decay effects as a function of different site- and respondent characteristics. The next chapter addresses the topic of substitutes in the literature on SP techniques.

4. Substitution in the stated preference literature

4.1 Introduction

Different nature and recreation sites can serve as economic substitutes for each other in terms of the functions and associated goods and services they provide. Standard economic theory expects respondents to know and consider substitutes in every choice they make. It will be argued in this chapter that the SP literature on environmental valuation has not paid sufficient attention to substitutability of environmental goods.

Substitution rates depend on the level of (perceived) similarity of sites in their provision of goods and services, and on spatial site-characteristics, such as size and distance. The availability of substitutes or complements influences scarcity conditions and thereby the WTP for a good (Carson et al. 1998). Differences between regions in the number of available substitutes are likely to play a role in the substitution pattern. Therefore, researchers need to consider two issues when assessing substitution patterns. First, studies need to decide on the choice set specification in the design phase of the study. Second, WTP models of spatial choice studies furthermore need to allow for substitution patterns, which are (1) flexible enough to allow for respondent heterogeneity and (dis)similarity between sites, and (2) spatially explicit to control for the spatial distribution of alternatives.

This chapter will recapture the economic theory underlying substitution in Section 4.2 and examine how SP studies have addressed substitution so far. In Section 4.3, existing econometric models for discrete choice analysis will be evaluated regarding their applicability to spatial choice studies and compared to models from other disciplines, such as economic geography. These disciplines use models that account for spatial choice behaviour in different ways, which may provide solutions for environmental economic studies in which substitution effects are likely to have a significant impact on

WTP estimates. Subsequently, the problem of choice set specification and the selection of substitutes that can be included in a survey will be discussed in Section 4.4. Section 4.5 discusses and concludes.

4.2 Substitution effects in stated preference studies

Substitutability plays a central role in microeconomic utility theory: the decision-maker chooses among goods that are substitutable in terms of their utility provision, at least in the margin. Substitution effects refer to the effect of changes in the presence of available substitutes and changes in the characteristics (price and quality) of these substitutes on the WTP for a change in the characteristics of the alternative of interest. There are two different types of substitution effects that need to be accounted for when estimating the WTP for a change in the characteristics of alternative A (Koelemeijer and Oppewal 1999):

a) *Availability cross marginal-effects*: the effect of a change in the availability of another alternative B in the choice set on the probability that alternative A will be chosen and thereby on the WTP for A;
b) *Attribute cross marginal-effects*: the effect of a change in an attribute (characteristic) of alternative B on the probability that alternative A will be chosen and thereby on the WTP for A.

The marginal rate of substitution (MRS) reflects the degree of substitutability between goods and indicates how much a person is willing to give up of good A in exchange for good B to maintain the same utility level. The more similar the goods are in terms of utility, the closer to unity is their MRS. Marginal cross-effects are positive if the goods are substitutes, and negative if the goods are complementary. This means that the price or WTP for good A may change, depending on the substitutability with respect to other goods:

a) A and B are independent (MRS=0) if WTP for A remains the same under a change in the attributes of B;
b) A and B are (imperfect) substitutes (MRS>0) if WTP for A decreases under an improvement in the attributes of B;
c) A and B are complements (MRS<0) if WTP for A increases under an improvement in the attributes of B.

It is important to note that the economic concept of dependency between sites in terms of complementarity and substitution effects may be different from “ecological substitution” (Mitsch and Gosselink 2000). For instance, water quality changes can affect the level of provision of goods and services at other water sites as often occurs in an upstream-downstream direction. The ecological connectivity between up- and downstream water bodies depends on distance and direction. Ecologically speaking, a downstream water quality improvement cannot substitute a similar improvement in an upstream water body. In economic terms, however, a downstream quality improvement might compensate the utility change resulting from an upstream water quality decrease. Economic substitution effects between water bodies depend on relative scarcity of the ecosystem services that the water bodies provide, but less on ecological connectivity.

SP studies have paid relatively little attention to the estimation of the substitution effects across alternatives and ecosystem services. The majority of SP studies focus on the valuation of a single site, which may draw the respondent's attention away from relevant alternatives. This can lead to an overestimation of WTP, usually referred to as framing or embedding bias (e.g., Hoehn and Loomis 1993; Carson et al. 1998; Freeman III 2003). Critics of such CV studies point at the large contribution people are willing to pay in the light of the large number of available substitutes (see Arrow et al. 1993). These CV studies suffer from the same limitations as single-site travel cost studies: they do not account for changes in the availability or characteristics of relevant alternatives. In travel cost studies, this is primarily the result of not including the travel cost of substitute sites in the demand equation. As a consequence, WTP estimates may be biased.

The NOAA Report (Arrow et al. 1993) advised to include a reminder of alternative spending options to ensure that the respondent takes the relevant substitutes into account and overcome insensitivity-to-scope. The effectiveness of such a reminder has been questioned (Loomis et al. 1994; Whitehead and Blomquist 1999; Kotchen and Reiling 1999). Cummings et al. (1994) and Neill (1995) argue that to elicit WTP estimates that reflect substitution effects, respondents should be asked to value substitutes and study sites simultaneously, and otherwise, surveys should provide at least a good description of available substitutes, using pictures, maps or text.

Substitution effects that arise if the characteristics of multiple sites change simultaneously are an issue that has hardly been covered in the valuation literature (Carson et al. 2001). This is surprising, given that most national environmental policies valued in SP studies are large scale projects, which will not only affect the demand for the study site, but also for the surrounding substitute sites. In CV studies, sequencing and scope-sensitivity effects are sometimes attributed to substitution (Carson et al. 2001). However, the resulting magnitude of the scope effect of these studies does not give a valid indicator of substitution effects (Banerjee and and Murphy 2005). This is because *a priori* information about the substitutability of the goods in question is missing and the magnitude of these scope-effects has been argued to be too large to be validly interpreted as substitution effects (Bateman et al. 2004a).

A small number of CV studies include multi-programme scenarios in which different goods are valued simultaneously to test for substitution and complementarity effects. Respondents are presented programmes at different locations and asked to value the study site as well as its alternatives. The substitution effects between the affected sites can be used to determine the optimal number of sites to include in the policy. These studies are limited to estimating the effect of inclusion of different locations in the alternative policy scenarios (availability cross marginal-effect). They do not estimate cross-effects indicating to what extent the utility of one alternative responds to changes in the characteristics of another alternative (attribute cross-effects). The empirical results are mixed in terms of the resulting substitution and complementarity effects. Hoehn and Loomis (1993) ask respondents to value five different environmental programmes in the same region separately and combinations of two and three packages taken together. They find lower WTP values for combinations than for an individual programme, implying substitution effects (Hoehn and Randall 1989). Cummings et al. (1994) ask respondents to value three different types of policy programmes. Their results indicate that environmental and non-environmental programmes are viewed as substitutes, and that WTP values are higher when the programmes are valued in isolation. In Hailu et al. (2000), respondents can choose as many single environmental policy packages, each with a particular price, as they are willing to pay for, so that they can make their own preferred combinations. The WTP for a combination of packages is higher than the WTP for the packages separately, reflected through a positive interaction term between the programs. This suggests that goods in the same region are considered complementary goods: there is extra value associated with getting two packages together.

The number of single-site CV studies making an effort to account for substitution is limited. Brown and Duffield (1995) include the number of alternatives and Pate and Loomis (1997) account for the size (acreage) of possible substitutes. Both studies find a negative effect of substitutes on WTP. Variables reflecting the quantity of a good can be used as a proxy to account for the scarcity of a good, but do not give information about substitution behaviour in terms of the effect of changes in the price or quality of the available substitutes on WTP. The problem with the CV method with respect to estimating substitution effects is that the number of valuation questions that can be included in surveys and the possibilities to create variation in the scenario, for instance via the number and site-characteristics of alternatives, are limited. The effect of on-site characteristics, such as size or recreational facilities, on site-selection behaviour and WTP can only be assessed by changing these characteristics in the valuation scenario, or evaluating site selection behaviour across a large number of sites that differ in these characteristics (see e.g., Scarpa et al. 2000).

Choice experiments (CEs) are in this sense better equipped to model substitution effects, because the CE design can include different alternatives varying their characteristics over the choice tasks (Boxall et al. 1996; Rolfe et al. 2002). The marginal rate of substitution of two attributes can directly be calculated by taking the ratio of two attribute-coefficients using the formula (Hensher et al. 2005a) $MRS_{k1,k2} = \beta_{k1}/\beta_{k2}$, where β_{kj} reflects the coefficients of the specific attributes in the choice experiment indicated by the subscripts. The MRS indicates how much attribute *k1* of an alternative will have to change for a unit change in another attribute *k2* in order to keep the probability of choosing that alternative constant.

A distinction can be made between direct marginal effects and cross-marginal effects. Direct marginal effects are the changes in the probability of choosing a particular alternative in the choice set given a unit change in an attribute of the *same* alternative, whereas cross-marginal effects reflect the probability changes given a unit change in a *competing* alternative. The latter thus capture the degree of substitutability between alternatives. The direct or cross MRS can be calculated using the formulas (4.1) respectively (4.2) (Hensher et al. 2005a):

$$M_{X_{ikn}}^{P_{in}} = \frac{\partial P_{in}}{\partial X_{ikn}} = [1 - P_{in}]\beta_{ik} \quad (4.1)$$

$$M_{X_{jkn}}^{P_{in}} = \left[-\beta_{jk} \cdot P_{jn}\right] \quad (4.2)$$

Here, *M* denotes the marginal effect of the probability *P* of alternative *i* for individual *n* with respect to a marginal change in attribute *k* of alternative *i* (X_{ikn}) for the direct effects. The cross marginal effects in equation (4.2) reflect the impact on P_{in} of a change in attribute *k* of alternative *j*.

Hence, if the relevant choice set contains multiple sites, a CE is a suitable technique to assess substitution effects of changes in the price, quality or availability of substitutes that arise, by designing the experiment as a site choice study. Typical site choice studies focus on choices among sites as a function of site access and other site-characteristics, including, for example, water quality changes (e.g., Kaoru 1995; Needelman and Kealy 1995; Parsons and Massey 2003). To assess the substitution patterns among sites, they commonly use random utility models (RUM). RUM are flexible in including characteristics of other alternatives and other spatial variables in the utility function of a site (Parsons 2003), facilitated by the use of Geographical Information Systems (GIS) (Bateman et al. 2002b). Almost all multiple site studies in the literature are based on RP data. Few CE studies in the SP environmental valuation literature have focused on substitution effects between sites. The only known example is the study by Rolfe et al. (2002), in which respondents are asked to choose between rainforests in different continents across the world.

The inclusion of existing locations as choice alternatives in a CE requires a design, in which location names can serve as labels of the alternatives. There are few labelled choice experiments in the environmental valuation literature. Most CE studies focus on the marginal values attached to certain characteristics, for instance water quality or recreation possibilities, using generic ('unlabeled') alternatives. In the CE studies evaluating environmental changes at different sites, each generic alternative commonly represents a scenario covering a large area with varying changes over space following the implementation of a particular policy programme, such as a regional-wide water quality policy implemented in a catchment as a result of which all lakes or rivers change (e.g., Holmes et al. 2004; Hanley et al. 2006; Brouwer et al. 2010). Alternatively, respondents are asked to choose between hypothetical improvements at unlabelled locations with distance as an attribute changing in the scenarios (e.g., Adamowicz et al. 1994; Luisetti et al. 2008).

There are advantages and disadvantages associated with the use of labels in CEs. A label may contain information about the characteristics of the alternative, which may help to reveal the preferences associated with the context of the alternative that is not captured by the attributes. Labels may thereby reduce the cognitive weight of the choice task (Blamey et al. 2000). The risk of labelling a design is that respondents pay more attention to the label than to the attributes of interest. Blamey et al. (2000) compare the two approaches and find different choice behaviour but no significant differences in welfare estimates between the two designs. Huybers (2005) comes to the same conclusion in a comparison of unlabelled and labelled destination CEs.

Using labelled alternatives further allows using maps in the survey depicting the location. Maps may help the respondent to estimate the travel distance to the site. The main purpose of including maps is to provide the respondent with enough information to determine his or her preferences. To this end, maps can also specify alternative locations that may serve as substitutes. It is now common to include maps in the survey materials of SP studies to depict the study site (e.g., Bateman and Langford 1997; Rollins and Lyke 1998; Brouwer et al. 2010). Unfortunately, there is little attention in the valuation literature to the way people interpret and use maps in decision-making and which information maps should provide to support respondent in making well-informed choices. There are differences in the way people use maps, pictures or other visuals in their decision process. For instance, the presentation of the same distance on differently designed maps can lead to different distance estimates (McFadden 2001).

Spatial choice studies may not only require a specific design, but also an analytical approach that addresses three important issues: the effect of the spatial distribution of alternatives on substitution patterns, the choice set specification and spatial choice behaviour. The next section will evaluate standard discrete choice models in terms of their suitability for spatial substitution patterns.

4.3 Discrete choice models and spatial substitution effects

A typical characteristic of spatial choices is that the provision of goods and services at alternative locations is dependent on their spatial distribution, i.e. substitutability is influenced by the distance between alternatives (Borgers and Timmermans 1987; Fotheringham 1988). The effect of heterogeneity in the spatial distribution of alternatives on decision-outcomes has been addressed in other research fields, such as studies on migration (e.g., Fotheringham and Pitts 1995; Pellegrini and Fotheringham 2002) and home-based trips (Bhat et al. 1998; Bernardin et al. 2009), using revealed preference data.

Standard, non-spatial discrete choice models may not always be suitable to capture such substitution patterns. It has been argued that spatial choice models have to account for the possibility that certain sites are better substitutes, for instance, due to differences in spatial proximity and varying degrees of similarity in location characteristics (Haynes and Fotheringham 1990; Hunt et al. 2004). Moreover, the proximity of locations may lead to correlation in the unobserved utilities, for instance, if respondents only consider alternatives in a certain region (Hunt et al. 2004) or base their opinion on an unknown site on its surrounding locations. Due to these substitution patterns, the IIA assumption of proportional substitution underlying the standard multinomial logit model is likely to be violated (see Chapter 2). Violations of the IIA assumption imply either that preferences are heterogeneous across individuals, or that the alternatives have characteristics that are omitted from the model. Finally, spatial choice models may have to accommodate the hierarchical structure of the spatial choice process, a consequence of the use of heuristics and mental maps with "perceptual regions" (see Section 2.5).

In Figure 4.1, the left-hand picture illustrates the effect of "perceptual regions". The square depicts the residential location of the respondent, the blue ellipses represent lakes and the circles depict distance radii. If we assume that substitutability only depends on distance to the respondent, the black encircled lake is most likely to be substituted by the lake below based on the shortest distance.

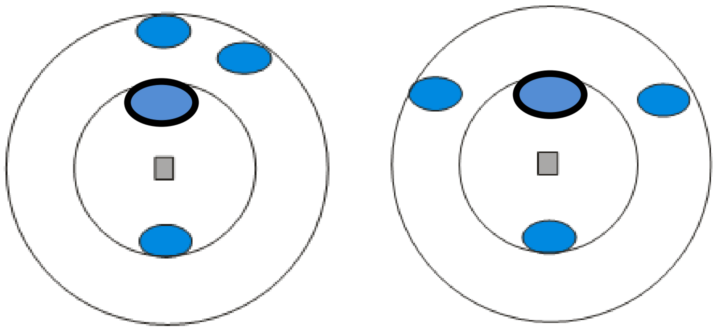


Figure 4.1 Spatial substitution in a two-dimensional frame
Explanatory notes: the blue ellipses reflect lakes, the square depicts the residential location of the respondent and the circles are distance-ranges from the respondent. The black circle identifies the lake for which the closest substitute is selected.

If we assume, however, that people use perceptual regions in their choice process, the upper three lakes in the left picture are closest together are therefore likely to be perceived as a group in the same region. In a hierarchical choice process, people first choose a region before choosing an alternative within that region. In that case, the black encircled lake is more likely to be substituted by one of the other upper lakes as these lie in the same perceptual region and are hence more substitutable, although these are further away from the respondent.

The question is whether other discrete choice models, such as the closed-ended nested, cross-nested and universal logit models, are better capable of capturing these effects than the MNL. The hierarchical structure of the NL model suggests that the model is capable of accommodating the hierarchical psychological process underlying site choices. Some authors, for instance Hensher et al. (2005a, 482), argue that the hierarchical structure of NL models should not be interpreted to reflect hierarchical decision-making behaviour, but is just a statistical solution to allow for correlation in the variance of alternatives and accommodate violations of the IIA assumption. However, Batley and Daly (2006) show that the statistical model proposed to capture choices based on an elimination-by-aspects strategy is mathematically equivalent to a nested logit model. This suggests that different decision-making strategies can be captured by similar statistical models. Another argument against the use of NL models for spatial choices is that the analyst has to decide on the discrete categorisation of the different nests in the model. Some authors argue, however, that there is no discrete variable for distinguishing the nests in spatial choices (Fotheringham 1988; Hunt et al. 2007), because the distance between alternative sites is continuous. Fotheringham further argues against the use of NL models, noting that the assumption of equal substitution rates within nests will not hold if the distance between the alternatives varies. Moreover, the categorisation is fixed for all respondents. Under the assumption that people use “perceptual regions” to choose among large numbers of alternative locations, the categorization of alternatives into regions causes heterogeneity among respondents, because the individual definition of the perceptual region is based on, for instance, personal experience or knowledge. The definition of nests by an analyst in a NL model is therefore likely to be arbitrary.

The picture at the right of Figure 4.1 illustrates the problem of the nested logit (NL) model assumption of equal substitution rates within nests. Imagine that in the picture the three upper lakes are included in the same nest and in the same “perceptual region”. In case of a hierarchical choice process, a quality decrease in the upper-left lake will then increase the choice probability of the black encircled lake, as it is located nearer to the upper-left lake than the lake at the upper-right. NL models will however assume in this case that these two upper lakes lake are equally substitutable.

Since cross-nested logit (CNL) can capture a wide range of correlation between the error-terms of alternatives (Bierlaire 2006), they circumvent part of the problem of the NL models. According to Hunt et al. (2007), these models are applicable to choice studies that involve spatially related alternatives. For CNL models, no discrete grouping variable is needed and the nesting structure is allowed to vary across respondents. However, controlling for the panel structure in CNL models is very difficult if not impossible (Hess et al. 2004).

The universal logit (UL), which circumvents the IIA restrictions by including the attributes of other alternatives in the specification of the utility function of each alternative, has also been used to capture spatial substitution (e.g., Timmermans et al. 1991), but not in SP studies for environmental valuation. A limitation of this model is that the substitution pattern is not dependent on the spatial distribution of the alternatives. The UL can be used, however, to identify possible stronger correlations between alternatives or as a guide in the specification of the substitution pattern in more complex models.

In spatial choice studies using SP data from repeated choices, it is important to account for the panel structure of the data. Therefore, simulation based mixed logit models, including error-components (EC) and random parameter logit (RPL) models, are preferred (see Chapter 2). EC models can allow for correlation in the unobserved variation across geographically nearby locations by adding error-components to the utility functions of locations near one another (Herriges and Phaneuf 2002). Termansen et al. (2008) apply this approach in a recreation choice study using revealed preference data and find a significant improvement in model fit. In such a way, EC models can also be used to mimic the nesting structure of (cross-)nested logit models, while they are at the same time able to account for the panel data structure. As with the NL, a possible limitation for the specification of spatial substitution patterns is that the nesting structure will still be based on a rather arbitrary discrete variable rather than on the continuous distance between alternatives.

Besides using error-components to model the correlation between alternatives, RPL models can be used to accommodate (spatial) heterogeneity across respondents. Correlation between alternative locations can be added by specifying a random parameter common to both locations or allowing the random parameters of both locations to be correlated. However, such a specification is not based on the proximity of the sites.

Mixed logit models can also be integrated with spatial econometric techniques to estimate spatial dependency and heterogeneity across observations at different locations. Hunt et al. (2004) give examples of applications of mixed logit models in migration (e.g., Bhat and Guo 2004) and transport studies, in which the error-component of the model includes a spatial weight term (see Section 2.6) to account for correlation among observations. These studies use revealed preference datasets with observations from a large number of destinations. SP studies typically include a smaller number of alternatives. Instead of using models with complicated spatial weight matrices, simpler models that include the most important explanatory factors of WTP, including spatial variables, may suffice.

4.4 Substitution and choice set specification

Another challenge in estimating substitution effects is defining the relevant choice set of alternatives, i.e. the number of substitutes that can and should be included in the design and analysis. The choice set specification is important as it will affect parameter estimates (Pellegrini et al. 1997; DeShazo and Fermo 2002) and resulting economic welfare estimates (Parsons and Hauber 1998). The problem is that it is difficult to *a priori* identify the perceived choice set. In most spatial choice studies, there are many possible alternatives (Cummings et al. 1994) and the boundaries of the study or market area are hard to define.

There are two steps in the choice set definition: the types of alternative first have to be determined and then identified in the study area. Different decision rules have been used in spatial choice studies to determine the relevant alternatives, such as all sites of a similar type (e.g., all water bodies), all outdoor recreation sites in an area, all recreation and leisure options (including culture), or alternatively all sites known by the respondent (Parsons and Hauber 1998). Next, these substitutes have to be identified in the study area, which may lead to a large number of potentially relevant alternatives. A subsequent decision involves the number of alternatives that can be included in the choice task. In RP studies, there are two general approaches to specify the choice set, both in which the analysts determines the set: (1) include all locations considered as possible substitutes by the analyst, whether relevant to the respondent or not – the universal choice set (Pelligrini et al. 1997), or (2) arbitrarily predefine a subset of alternatives that are most likely to be relevant. In early studies in environmental valuation, using RP data and RUM, choice sets defined by the researcher were most common. For instance, only sites located within a reasonable range from the respondent's location are included. For use values, maximum travel time ranges might set the boundaries of the area that includes the sites of the relevant choice set (Parsons and Hauber 1998). However, the relevant set of substitutes may vary across goods and sampled populations (Boyle and Bergstrom 2001). The spatial and temporal constraints depend largely on socio-demographic factors, such as age, gender, employment status, time budget, transport mode and income (Bhat and Zhao 2002), while different social contexts, experience and information also influence individuals' propensity to travel. For non-use values, boundaries based on time or distance constraints might not apply, although some degree of knowledge and awareness regarding is necessary for distant sites to be included in the relevant choice set.

Alternatively, the identification of relevant alternatives can be modelled as an endogenous part of the choice process (e.g., Swait and Ben-Akiva 1987; Ben-Akiva and Boccara 1995). In these studies, the availability of a site in the choice set is commonly a function of latent personal constraints, for instance, on a maximal distance range within which available alternatives should fall. Instead, Peters et al. (1995) and Haab and Hicks (1997) simply ask respondents about the relative alternatives. These approaches are based on Manski's (1977) two-stage choice process, in which the probability of choosing an alternative is conditional on the probability that the alternative is considered and included in the individual's relevant choice set.

These approaches do not account for the distance between alternative sites and are not directly applicable to spatial choice problems. The competing destinations model of Fotheringham (1983; 1986; 1988) captures the degree of competition among destinations based on the distance between the alternatives. Fotheringham (1986) argues that the probability that an alternative is chosen depends on the proximity of a destination to other destination. He claims that his model captures the hierarchical choice processes described in Chapter 2, giving the model a behavioural foundation.

In the competing destinations model in equation (4.3), a so-called accessibility indicator, based on Hansen (1959), is added to the discrete choice model to reflect the effect of spatial structure on choices. The model thereby internalises the information process of choice set composition, using the clustering of alternatives as a weight on the probability that an alternative is included in the individual's choice set. This accessibility indicator can be considered as a weight on the likelihood that an individual perceives option i being in perceptual region M, which consists of the relevant choice set from which (s)he chooses an option. In other words, instead of simultaneously evaluating all alternatives in choice set *J*, the respondent chooses hierarchically and does not evaluate those alternatives excluded from *M* (Pellegrini and Fotheringham 2002). The accessibility indicator is used in the logit model as a probability weight of the systematic utility *V* and can be individual specific:

$$P'_{in} = \frac{e^{V_{in'}} \cdot l_n(i' \in M)}{\sum_i e^{V_{in}} \cdot l_n(i \in M)} \tag{4.3}$$

Fotheringham's (1983) specification of the probability weight l_n $(i' \epsilon M)$ that reflects whether alternative *i* is included in *M* is a measure composed of the inverse distance between *i* and all alternatives in *J* (d_{ij}), weighted by the attractiveness of alternative *j* (W_j):

$$l_n(i'\epsilon M) = (a_n)^\theta = \left[\frac{1}{J-1}\sum_{\substack{j \\ j\neq i}} \frac{W_j}{d_{ij}}\right]^\theta \tag{4.4}$$

W, the attractiveness of an alternative, can include site-characteristics that may affect the probability that an alternative is evaluated, such as the size of the alternative. Characteristics of the option already included in the systematic part of utility *V* are usually not included in *W*. This indicator partially reflects the degree of similarity and accounts for spatial structure and substitution. ϑ is a parameter that has to be estimated. The accessibility indicator is included as an additional variable in the utility function (Cascetta et al. 2007; Bernardin et al. 2009). If ϑ is equal to zero, the probability that an alternative is evaluated is equal to 1, i.e. the consumer evaluates all alternatives. In that case, a standard conditional logit model remains and no hierarchical decision-making process is present. ϑ larger than zero implies that proximity to similar sites may increase the probability that a site will be chosen, indicating agglomeration effects (complementarity) between sites (Fotheringham 1988). Vice versa, $\vartheta < 0$ implies that proximity to alternative sites reduces the chance of being included in the relevant choice set M of the respondent, indicating competition (substitution) between sites. For instance, if people prefer a cluster of lakes to an isolated lake, the WTP for a lake will be positively influenced by the proximity of the other lakes.

The competing destinations model has been applied in migration studies (Fotheringham and O'Kelly 1989; Pellegrini and Fotheringham 1999), telecommunication (Guldmann 1999), commuting (Gitlesen and Thorsen 2000; Uboe 2004; Elhorst and Oosterhaven 2006), recreation and tourism (Hanink and Stutts 2002; Bernardin et al. 2009). One of the main advantages of the model is that it does not require an *a priori* categorization of alternatives into nests, but tests whether the distance between alternatives has any effect in the model specification. Thereby, it also circumvents the IIA assumption of MNL models. In the competing destinations model, the addition of a new alternative may affect the probability ratio of existing alternatives through the accessibility indicator. As it accommodates agglomeration forces, it allows the probability of an existing alternative to increase if a new alternative is considered to be relevant and included in the set *M*. A drawback of the model is that the behavioural link between the statistical model and the theory of hierarchical choices based on unknown, personal perceptual regions has been argued to be weak (Thill 1992), because the accessibility indicator does not include more subjective indicators, such as knowledge and familiarity with the alternatives. However, it could be modified to account for such indicators in addition to physical distances and size by including perceptual factors in W_j. It could also be argued that any correlation between nearby alternatives should be not controlled for in the deterministic part *V* of the utility function, as there is no theoretically valid reason in the economic literature why the proximity to other alternatives should increase the utility of an alternative in case of choices across hypothetical scenarios.

The problem of information processing strategies and subsequent choice-rules is very relevant to spatial choice studies, especially SP studies. The amount of information provided in a stated CE can affect choices and thus parameter estimates. Complex choice settings with a large number of alternatives in the choice task may impose a high cognitive burden on respondents. The number of choice tasks, or choice cards, alternatives within a task, attributes within an alternative, levels within an attribute, and the range of the attribute levels together determine the choice task complexity (Caussade et al. 2005). Furthermore, complexity may be dependent on the type of good under valuation, and respondent familiarity with these goods. If the amount of information related to the choice task that has to be processed to make a choice imposes such a cognitive burden that the choice task exceeds the cognitive ability of the respondent to process this information, choice task complexity may prohibit the respondent choosing the most preferred alternative (Caussade et al. 2005). Therefore, task complexity may lead to violations of rationality assumptions and invoke different decision-strategies (Payne et al. 1993). For instance, Swait and Adamowicz (1996) find that as the choice tasks become more difficult, people are more likely to choose the opt-out and focus more on a product’s brand than on its attributes. This may reflect that respondents start to apply lexicographic decision-rules, by choosing an alternative based on their ranking of one of its attributes that they consider most important (Alpizar et al. 2001).

In discrete choice studies, the effect of task complexity can be analysed by looking at changes in the error variance of the model under different levels of complexity of the choice set designs (Mazzotta and Opaluch 1995). As the scale parameter is inversely related to the variance of the error term, scale increases indicate that the variance in the model decreases (Louviere et al. 2000, 368). In turn, this reflects that choices become more deterministic. Easier choices are hence associated with higher scale parameters and lower overall model variance.

Changes in the variance across different treatments can be tested by employing a heteroskedastic mixed logit model (e.g., DeShazo and Fermo 2002; Rose and Black 2006). Error-components are also used to control for scale-differences between datasets in studies combining different datasets, such as SP and RP data (e.g., Brownstone et al. 2000; Hensher et al. 2005b). Another option to test for differences in the attribute and scale parameters is the Swait and Louviere test (Swait and Louviere 1993). This test was originally developed to compare MNL models. The applicability of the test to RPL models has not been well described in the literature, even though it is often applied to models with panel data and random parameters. The test cannot control for the panel structure of the data, when a respondent makes a sequence of choices. A short description of the Swait and Louviere test is included in Annex II of this thesis.

A few studies have analysed the effect of the complexity of the choice set design on the variance. Swait and Adamowicz (2001) develop a parameterised function of entropy, reflecting the information contained in a choice task, and assessed its affect on model variance. DeShazo and Fermo (2002) find a quadratic relationship between the number of alternatives and the variance, with a maximum scale reflecting the precision of preferences when the choice set includes three alternatives. Caussade et al. (2005) confirm these findings and suggest that the effect of the number of alternatives on the remaining error variance follows an inverted U-shaped pattern, with an optimum in terms of minimum variance at four alternatives. Similarly, Arentze et al. (2003) argue that too large choice sets negatively affect respondent’s choice consistency. These studies, however, pay little attention to the different information processing strategies that respondents employ when evaluating a large number of alternatives, attributes or attribute levels in a CE survey. Recently this issue has started to receive more attention (e.g., Puckett and Hensher 2008). If the task complexity gets too high, respondents may apply different, simplifying decision-strategies, which, for instance, violate the assumption that all alternatives are evaluated simultaneously and their characteristics traded-off. Some studies have found that when respondents are asked to answer a series of questions, they learn about and discover their preferences (Swait and Adamowicz 2001; Holmes and Boyle 2005). This is reflected in a decrease in the variance of the initial questions. The variance may however increase again after a certain number of questions if respondents become fatigued (Savage and Waldman 2008).

The effect of task complexity is important for spatial choice studies, as the number of alternative locations in the study area that might be relevant to respondents can be high. As the geographical scale of the study area is increased, the analyst has to decide which alternatives of the 'relevant choice set' of the respondent to include in the 'experimental choice set' of the CE. A larger experimental choice set may increase choice complexity, but not necessarily. On the one hand, too many alternatives in the experimental choice set might negatively affect the reliability of the results due to the high choice task complexity. Moreover, if these alternatives lie further away from the respondent and are therefore less familiar to the respondent, too large choice sets may lead to less determined preferences. On the other hand, including many alternatives may serve to assure that respondents consider all available options. The increase in distance may in fact facilitate choices, as the alternatives differ more in "parameter space" and are hence easier to be distinguished (Hensher et al. 2005b). Rose and Hensher (2004) argue that respondents are able to handle more complex tasks if all included alternatives and attributes are relevant. The question is how to determine the spatial scale and the number of alternatives in the experimental choice set at which the choice task complexity does not exceed the cognitive capabilities of the respondents. There are also practical limitations to the number of alternatives and attributes that can be included in the survey design of a CE given the statistical efficiency of the experimental design based on a specific sample size. In practice, most SP studies, both CV and CEs, reduce the number of alternative sites *a priori* in order to keep the study design simple.

In contrast to RP studies, most SP studies do not consider the alternatives outside the set in the experiment (DeShazo et al. 2009). For those alternatives that are not included in the survey as one of the goods under valuation, i.e. not in the experimental choice set, but expected to affect the perceived relative scarcity and hence included in the relevant choice set, there are a number of possible indicators that can be included in the WTP model to control for additional substitution effects:

1. Respondent perception of the characteristics of the substitute sites ;
2. External data on the presence, number or size of substitutes;
3. A dummy variable equal to one if the respondent also visits substitutes;
4. (A ratio of) the number of substitutes that are visited in the study area (and the total number of available substitutes);
5. The cost of visiting other sites or the distance to these sites.

Indicators 1-4 give information about the relative scarcity of the good under valuation (1 and 2) or the substitution consideration of the respondent (3 and 4). The accuracy of WTP estimates in SP studies could potentially increase by including such relative scarcity indicators in the WTP model. Of the above mentioned indicators, only the fifth indicator gives information about substitution in terms of prices – based on the assumption that distance is a valid proxy for the WTP of the substitute sites outside the CE. Information about the trade-offs between sites can only be obtained directly by asking people to choose between sites and including the distance to those sites in the analysis. There are hardly any published SP studies that have included either the costs of or distance to substitutes in the analysis, while this is common practice in travel cost and recreation demand studies.

4.5 Summary and conclusions

This chapter has reviewed the SP literature on substitution effects. It was shown that the extent to which existing studies have accounted for substitution effects between sites that provide environmental amenities is limited. Scope-sensitivity and embedding studies have examined if WTP changes as the amount of the good under valuation is changed. They can only signal the presence of substitute effects, but do not give valid information on the size of the substitution effect. A limited number of multi-program studies have assessed the effect of changes in the presence of substitutes on WTP. Remaining studies do not go beyond including a simple substitute reminder. One of the main gaps in the SP literature is that existing studies give no insight in the effect of environmental changes at one site on the WTP for environmental changes at another site, in spite of the increasing number of applications of the CE method, which would enable such an analysis.

It has been argued in this chapter that CEs provide more flexibility to capture substitution effects among different locations than the CV technique. CEs offer the possibility to include more aspects of the spatial context, for instance by including substitutes as alternatives in the choice set. The standard discrete choice models were evaluated regarding their suitability for spatial choice analysis. Of all models, error-component models seem to have most potential to model correlation between geographically nearby alternatives. However, the main disadvantage of the standard discrete choice models is the limited possibility and model flexibility to account for the effect of the spatial distribution of alternatives, reflected in the distance between alternatives, on substitution patterns. As an alternative modelling approach, the competing destinations model, which accounts for the spatial proximity of alternatives, was described.

In this chapter, different options to account for substitution effects in study design and statistical analysis have been described. One of the main characteristics of spatial choice studies is that the number of alternatives is often very large. To account for the effect of substitutes on WTP, the researcher has to define the choice set that comprises the relevant substitutes. The number of alternatives that can be included in a SP survey without imposing an excessive cognitive burden on respondents is limited. Moreover, the complexity of having to choose among a large number of alternatives may exceed the cognitive abilities of respondents and hence prohibit the evaluation of all alternatives simultaneously to choose the most preferred alternative, as assumed in rational choice theory. An important question that remains to be answered is to what extent choice task complexity plays a role in SP studies for environmental valuation if the spatial scale of choice set is increased and a large number of alternatives is included in the choice set. There is a need for more empirical research to examine whether respondents employ a hierarchical decision-making strategy when they consider the complexity of evaluating spatially distributed alternatives simultaneously.

In order to test if alternative spatially explicit design and modelling approaches lead to more reliable WTP estimates than non-spatial analyses, two case studies will be carried out. In the first case study on the Scheldt river basin in Chapter 5, respondents are asked to choose among different scenarios of water quality improvements at three sites with different ecosystem characteristics in a labelled choice experiment. The objective of the study is to assess the substitution pattern of the goods and services that the sites within the choice set provide, as well as the substitution effect of substitutes not included in the choice set, either defined by the researcher or the respondent. In the second case study in the Rhine river basin, presented in Chapter 6, respondents are asked to choose between similar lakes under changes in the spatial scale of the choice set. This case study focuses on the effect of the spatial distribution of the alternatives and choice task complexity on the substitution pattern and directional variation in distance decay.

5. Analysing differences in distance decay and substitutability: a case study of the Scheldt river basin

5.1 Introduction

This chapter presents a case study of the Scheldt river basin in the Netherlands. The study addresses substitution and distance effects on the WTP for non-market benefits of ecological quality changes in three different water bodies located along the Scheldt estuary. To estimate the substitution between these non-market benefits, a labelled choice experiment (CE) is developed in which respondents are asked to select their preferred option from quality improvement scenarios at the three sites.

The study has four interconnected objectives, aimed at answering the question: to what extent does accounting for spatial characteristics increase the validity and reliability of stated preference (SP) valuation studies (subquestion d of this thesis)? First, the study explores differences in WTP between the three sites for similar ecological policy objectives. The study design allows for site-specific valuation of a common set of attributes. The second objective is to assess the substitution pattern between the sites, looking at differences in the cross-effects of attributes. In the analysis, a novel modelling approach is developed to quantify complex substitution patterns in spatial choices for environmental valuation, which cannot be captured by employing error-component or random parameters alone. Thirdly, the study looks at differences in the effect of distance on willingness-to-pay (WTP) across respondents and sites. The final aim is to assess the effect of substitutes that are not included as alternatives in the choice set on the spatial distribution of WTP values. The directional heterogeneity of distance-decay parameter is addressed to test the isotropy of distance effects.

The outline of the chapter is as follows. The main objective and hypotheses are presented in Section 5.2. Section 5.3 describes the modelling approach. The case study area and the survey design and implementation are introduced in Sections 5.4 and 5.5. The results are presented in Section 5.6, followed by the main conclusions in the final Section 5.7.

5.2 Main objectives and hypotheses

The four objectives of this case study address the main issues of the framework presented in Chapter 2. The first objective is to explore potential differences between sites with different site-characteristics in the WTP for changes in environmental goods and services, which are expected to result from achieving the ecological quality objective as defined under the European Water Framework Directive (WFD). The *a priori* expectation is that achieving the WFD objective will generate different values across sites, because this objective implies different physical outcomes for the three case study sites depending on their ecosystem types. This would imply that achieving a general policy objective at a location is not a perfect substitute for achieving the same ecological standards at a different location, if other factors are controlled for *(ceteris paribus)*. This leads to the first hypothesis:

H_0^1: Similar attributes reflecting the provision of environmental goods and services have the same value independent of the location that provides them.

Rejection of this hypothesis has implications for benefit transfer studies. It implies that unadjusted value transfer using the WTP for achieving similar policy objectives can lead to significant transfer errors. Johnston (2007) and Colombo and Hanley (2008) show that the degree of similarity of the context of the population may influence the reliability of transferring the WTP. These studies compare the WTP for landscape changes at a fixed location, presented as unlabelled options in a CE, from one subsample to another subsample living in a different area. In this case study, however, the values for different sites held by the same individuals are compared when these sites are presented together as labelled alternatives in one choice set.

The second objective of this case study is to the capture substitution patterns between the study sites. Here, the *a priori* expectation is that the substitution pattern will not be proportional and violate the Independence of Irrelevant Alternatives (IIA) restrictions underlying standard multinomial logit models (Train 2003). Moreover, as some alternatives and attributes may be perceived as closer substitutes than others, the substitution pattern may be too complex to be captured by conventional mixed logit models. The second null hypothesis is therefore:

H_0^2: The substitution pattern underlying site choices can be captured using conventional mixed logit models.

The identification of disproportional substitution patterns due to differences in relative similarity of attributes across sites may require more flexible models, reflecting the effect of changes in attributes of one alternative in the choice set on the probability that another alternative will be chosen. In a broader perspective, such correlations between alternatives imply that the value of environmental goods and services provided at different sites are correlated and should not be valued independently. It would also implicate that adding-up separately assessed values for different sites may lead to biases in total WTP estimates. Rejection would hence cast doubt on the validity and reliability of single-site studies.

The third objective is to analyse the effect of distance from the site to the respondent on choice behaviour. The expectation is that the three study sites will show different distance-decay effects, because they vary in the goods and services they provide and in their familiarity among the sampled population. The distance-decay functions are expected to differ in terms of their functional specification and order of magnitude, as reflected in hypotheses 3a, 3b and 3c below. A number of questions in the survey specifically address distance effects and potential drivers of heterogeneity in distance-decay effects among respondents: knowledge about the three sites, current and future visitation, sense of place and the cognitive travel distance. These variables are added to the model in combination with the direct effect of distance.

H_0^{3a}: The distance-decay effect is not statistically different across sites.

H_0^{3b}: The distance-decay effect has the same functional specification across sites.

H_0^{3c}: The distance-decay effect is not statistically different across respondents.

The rejection of these hypotheses implies that it is not possible to estimate and apply a generic distance-decay coefficient to any type of environmental good or site without correcting for the characteristics of the good under valuation and the relevant population. Instead, the market size for the aggregation of WTP estimates is determined by site-specific distance-decay functions, controlling for respondent heterogeneity.

Besides respondent heterogeneity and site-specific characteristics, differences in the context of the sites, notably the availability of substitute sites not included in the choice set, is expected to affect distance decay. The fourth and last objective is hence to test the effect on WTP of substitutes not included in the choice set other than the three sites in the CE, for which two different modelling approaches will be used. First, it is tested if distance decay is isotropic (uniform) against the alternative hypothesis of directional heterogeneity in distance decay:

H_0^4: Distance decay is uniform in all directions.

A significant directional effect suggests that the estimation of uniform distance-decay parameters will result in biased coefficients. It should be noted that the distance-decay effects in this study are estimated based on the existing road network, because the use of straight-line, Euclidean distances is compromised by various natural barriers that prohibit approximately straight travel routes. Directional heterogeneity is hence not expected to be caused by differences in road network density across regions.

The next question is if the availability of substitutes affects WTP. This effect is addressed in the model by including the distance to these substitutes, reflecting the relative scarcity of the good under valuation. The fifth null-hypothesis that will be tested is:

H_0^5: Distance to substitutes not included in the choice set of the choice experiment does not affect WTP.

If this hypothesis is rejected, disregarding the effect of the distance to substitutes may lead to biased WTP estimates. As discussed in Chapter 4, the selection and identification of these substitutes are not straightforward. In this case study, different selection strategies will be applied and evaluated.

Finally, these two approaches to capture the remaining spatial heterogeneity after controlling for distance decay are compared. The question is if it is possible to capture all spatial heterogeneity in WTP by controlling for the distance to other substitutes in the model. There may be other causes of directional effects besides substitute accessibility. The last hypothesis reflects the expectation that the indicators for directional heterogeneity will not only capture the effect of substitute availability, but may also reveal remaining additional spatial heterogeneity:

H_0^6: Spatial trend variables are not significant if distance to substitutes in included in the model.

The next section will describe the modelling approach to test the six hypotheses.

5.3 Modelling approach

The six hypotheses are tested by comparing different model specifications. In total, eight different models are estimated, all variations based on one general utility model. In this choice experiment, a choice for a quality improvement at one of the locations is explained by variation in the site-specific attributes *X* of the choice experiment, distance *D,* socio-demographic variables *Y*, including place attachment and use variables, and substitute accessibility *S*. The general utility function is hence specified as follows:

$$U = f(X, Y, D, S) \quad (5.1)$$

In order to test the first hypothesis, the objective is to identify site-specific values for similar environmental services provided at different locations. Model I, specified in equation (5.2), is an error-components model, which accounts for the panel structure of the data. It also controls for the heterogeneity in the variance that may arise if the hypothetical scenarios are perceived differently from the current situation represented by the opt-out, following Scarpa et al. (2005). In the utility specification U of alternative i, α is the alternative specific constant (ASC) for each alternative i, X denotes the attributes k of alternative i, Y_n the respondent characteristics, D_{in} is the distance between alternative i and the respondent n, and ε reflects the individual specific error term. The attributes X_{ki} represent the changes in environmental goods and services provided by the different sites. The set of respondent characteristics Y_n includes variables that are expected to have a significant effect on WTP according to economic theory, such as household income and whether or not the respondent has visited the alternative i. A dummy variable d_{in} taking the value 1 for each hypothetical alternative is included in the utility function of alternative i. λ_{in} is the parameter of the individual specific random error-component, assumed to have a standard normal distribution N[0,1].

The parameters β, γ and δ in Model I are generic, assuming that changes in the environmental services will be valued equally at the sites and respondent characteristics and distance will have the same impact on the choice probabilities of all sites. This model is compared to Model II in equation (5.3), which includes site-specific parameters for the explanatory variables β_{ki}, γ_i and δ_i. Model II can therefore account for possible differences in the values of similar ecosystem services across sites, i.e. distinct direct effects of similar attributes. The significance of the models and site-specific variables is tested using Wald- and Likelihood-Ratio tests.

Models I and II are specified as follows:

Model I: $$U_i = \alpha_i + \beta_k X_{ki} + \gamma Y_n + \delta D_{in} + \lambda_{in} d_{in} + \varepsilon_{in} \quad (5.2)$$

Model II: $$U_i = \alpha_i + \beta_{ki} X_{ki} + \gamma_i Y_n + \delta_i D_{in} + \lambda_{in} d_{in} + \varepsilon_{in} \quad (5.3)$$

In order to test the second hypothesis, a modelling approach is developed to estimate disproportional substitution patterns among the alternatives by including cross-effects in the site-specific utility functions, using the advantages of mixed and universal logit models. The UL modelling approach relaxes the IIA assumption by including the attributes of other alternatives $j \neq i$ in the specification of the utility function of each alternative (McFadden 1975; Oppewal and Timmermans

1991). This approach is combined with an error-components model to account for the difference in variance between the hypothetical options and the opt-out, resulting in Model III as specified in equation (5.4). Model III identifies significant cross-effects, while site-specific values and the panel structure of the data are also accounted for. The utility specification not only includes the alternative's own attributes X_{ki}, but also the attributes of alternative sites $j \neq i$ in X_{kj}. The possible disproportional substitution effects due to different relative similarity of attributes are captured by β_{kj} representing the cross-effects of X_{kj}.

Model III is compared to the extended mixed logit model (Model IV in equation (5.5)) to test if mixed logit models with additional random parameters and error-components are sufficient to capture the substitution pattern indicated by the cross-effects. In Model IV, μ_{ni} is a vector of random coefficients of the observed variables X for individual n representing that person's taste. Some of these random parameters are common across alternatives and therefore permit inter-alternative correlation. Furthermore, for those alternatives for which the cross-effects in Model III suggest stronger substitutability, m error-components are added in Model IV, mimicking a nested logit model. Next, the cross-effects of Model III are added in Model IV in order to test if they are robust, i.e. remain significant after including control for correlated choices, alternatives and attributes through the random parameters and error-component structure, and result in a better model fit.

Model III: $$U_i = \alpha_{\mathrm{i}} + \beta_{ki}X_{ki} + \beta_{kj}X_{kj} + \gamma_i Y_n + \delta_i D_{in} + \lambda_{in} d_{in} + \varepsilon_{in} \tag{5.4}$$

Model IV: $$U_i = \alpha_i + \beta_{ki}X_{ki} + \beta_{kj}X_{kj} + \mu_{ni}X_{ik} + \gamma_i Y_n + \delta_i D_{in} + \lambda_{in} d_{in} + \lambda_{in}^{1\ldots m} d_{in}^{1\ldots m} + \varepsilon_{in} \tag{5.5}$$

Hence, equation (5.5) tests the need to extend the mixed logit specification with cross-effects to capture the additional disproportional substitution patterns suggested by Model III. If the cross-effects remain significant in Model IV, this suggests that context-effects leading to disproportional substitution patterns cannot be captured by the specification of additional random parameters and error-components alone.

The third hypothesis involves a test of the theoretical functional specification of the distance-decay effect as developed in Chapter 3. Model II is used as a basis. First, different transformations of the distance variable, including exponential and logarithmic transformations, are compared to find the statistically best-fit functional form of the direct effect δ_i of distance D_{in} for each site i. Then, a number of variables are added to the model, including dummy variables for knowledge and familiarity K, sense of place *SP*, mode of transport to the site *M*, and visitation of substitute sites *S*. Specific attention is paid to the difference in distance decay between respondents who have visited the sites in the past and current non-users. To this end, an interaction term between the distance variable and the dummy variable *R* taking the value 1 for visitors is included. This results in Model V in equation (5.6):

Model V: $$U_i = \alpha_i + \beta_{ki}X_{ki} + \gamma_i Y_n + \delta_i D_{in} + \lambda_{in} d_{in} + \varepsilon_{in}, \tag{5.6}$$

where $$\delta_i = f(D_{in}, K_{in}, SP_{in}, R_{in}, M_{in}, S_{in})$$
$$= \delta_i^D D_{in} + \beta_i^K K_{in} + \beta_i^{SP} SP_{in} + \delta_i^{RD}(R_{in} * D_{in}) + \beta_i^M M_{in} + \beta_i^S S_{in}.$$

The presence of direction heterogeneity in the distance-decay effects is tested using the spatial expansion method, providing a test of the fourth hypothesis. As described in Section 3.5, this model allows for two-dimensional spatial variation in the parameters of the model by including spatial trend variables. In Model VI in equation (5.7), the distance parameters of the model are specified as functions of the spatial coordinates (*x*, *y*) of site *i*. Hence, Model II is expanded with a pair of linear spatial trend variables, reflecting the variation in distance-decay relationships over the longitude (*x*) and latitude (*y*). Directional intercept shifters $cos\vartheta_{in}$ and $sin\vartheta_{in}$, with ϑ_{in} reflecting the angle of the direction measured in radians between the site *i* and the respondent *n*, are included to allow for stronger distance decay in one of the quadrant than the others. Each combination of the sine and cosine will lead to a unique value for every respondent in one of the four quadrants. Different distance-decay functions are estimated for users and non-users by interacting the five components of the directional distance effect with the user-dummy R_{in}. The resulting WTP function of Model VI is presented in the following equation:

Model VI: $$U_i = \alpha_i + \beta_{ki}X_{ki} + \delta_i D_{in} + \gamma_i Y_n + \lambda_{in} d_{in} + \varepsilon_{in}, \tag{5.7}$$

where $$\delta_i = \left(\delta_i^D D_{in} + \delta_{1i} cos\theta_{in} + \delta_{2i} sin\theta_{in} + \varphi_{1i} long_{in} + \varphi_{2i} lat_{in}\right)$$
$$+ \left(\delta_i^{RD}(D_{in} * R_{in}) + \delta_{3i}(cos\theta_i * R_{in}) + \delta_{4i}(sin\theta_i * R_{in})\right.$$
$$\left. + \varphi_{3i}(long_i * R_{in}) + \varphi_{4i}(lat_i * R_{in})\right)$$

Here, δ_1 and δ_2 are the parameters for the intercept shifters $cos\vartheta_{in}$ and $sin\vartheta_{in}$ for non-users, and δ_3 and δ_4 for users, φ_1 and φ_2 are the parameters for the longitudinal and latitudinal distances for the non-users, and φ_3 and φ_4 for users. The main differences between this application of the spatial expansion method and the hedonic pricing study by Cameron (2006) are that this study (a) provides an application in the context of a stated choice model for environmental valuation, (b) tests for differences between users and non-users, (c) uses the spatial expansion method to test the spatial heterogeneity that remains after controlling for the distance to substitutes.

The fifth hypothesis is tested by expanding Model II with variables for distance from the respondents to substitute sites DS_{in}. Different substitute sets are developed and tested for their significance to explore if respondent or researcher-based sets best capture the effect on WTP of substitutes not included in the choice set. The effect of distance to substitutes is estimated separately again for users and non-users, leading to Model VII in equation (5.8):

Model VII: $$U_i = \alpha_i + \beta_{ki}X_{ki} + \gamma_i Y_n + \delta_i D_{in} + \lambda_{in} d_{in} + \varepsilon_{in} \quad (5.8)$$

Where $$\delta_i = f(D_{in}, DS_{in}, R_{in}) = \delta_i^D D_{in} + \delta_i^{RD}(R_{in} * D_{in}) + \beta_i^{DS} DS_{in} + \beta_i^{RDS}(DS_{in} * R_{in})$$

Finally, the sixth hypothesis is tested by expanding Model VI with the substitute set variables of Model VII, resulting in Model VIII. The hypothesis is that after including the variables for distance to substitute sites, spatial trend variables will become insignificant in Model VIII, as the spatial heterogeneity in distance decay detected in Model VI is caused by distance to substitute sites. In the estimation of the models, data of the CE in the Scheldt river basin are used. The next section shortly describes the case study area.

5.4 Case study area

The Scheldt river basin district extends from North-West France, via the western half of Belgium to the Netherlands, where it debouches into the North Sea. The Dutch part of the basin covers 3229 km^2, including the province of Zeeland, and has a population of 450 thousand inhabitants. About one-third of the Scheldt catchment is water. In the 58 kilometres long Westerscheldt estuary, the habitat area is characterised by *schorren* - mud and sand flats and salt marshes, water channels and shallow waters. The North Sea at the mouth of the Westerscheldt has sandy beaches on both shores. The Westerscheldt falls under the Ramsar convention, as well as EU Directives dealing with birds, habitat, fish and shellfish water, and encompasses ten Bathing Water Directive sites. The Dutch Scheldt subbasin provides a wide range of ecological functions, including many recreational amenities attracting local, national and international visitors.

The European Water Framework Directive (WFD), currently being implemented in the Netherlands, imposes new ecological standards for all European water bodies specified as “good ecological status”. The WFD objectives are defined in terms of water quality (largely chemical and clarity criteria), hydromorphological modification, and biological or ecological status. The Westerscheldt is designated as a “heavily modified” water body, which means that humans have changed it greatly, mostly as a result of defences against flooding and dredging for navigation purposes. Currently, the water quality in the Westerscheldt according to WFD standards is "bad", with high levels of nutrients, heavy metals and PAHs[2], such that it severely impacts benthic invertebrates and fish; biodiversity is limited. As such, the Westerscheldt does not meet standards for chemical or biological quality. The coastal part of the North Sea near the mouth of the Westerscheldt has a "moderate" biological quality. All water bodies in the Scheldt are deemed at risk of not meeting 2015 objectives.

Three sites were selected as case-study sites: the beaches of Breskens, Braakman and Saeftinghe (see Figure 5.1). These sites are located in the south-western province Zeeland in the Netherlands within the Scheldt catchment. The sites represent the most important water body types in the catchment, provide typical water-recreation functions, and are well-known among local residents. Breskens is a popular beach site, attracting many recreationists. Braakman is the mouth of a small river, very suitable for family recreation. The so-called "Verdronken Land van Saeftinghe" is an ecologically valuable tidal mudflat, which provides a habitat for various protected species. This site attracts mostly nature enthusiasts as access is restricted to preserve these natural assets. In addition, Saeftinghe does not provide bathing possibilities. The three sites hence differ in the recreational functions they perform. The Westerscheldt area is rich in other water bodies providing similar natural and recreational amenities.

5.5 Survey design and implementation

In order to estimate site-specific values and analyse the substitution patterns underlying the WTP for changes in environmental service provision at different sites, a labelled site-selection CE was developed. Respondents were asked to choose the site they prefer to be improved from ecological quality improvement scenarios for the three case-study sites. The choice set was limited to three different sites plus an opt-out after pre-testing to limit the cognitive burden of including too many sites in the choice task.

Quality levels at the three sites currently do not meet the WFD's ecological standards. Achieving the WFD objectives is expected to increase ecosystem service provision and generate substantial use and non-use values at the study sites, justifying the application of a SP method (Brouwer 2008). The use of a CE enables the trade-off of the amenities subject to changes under the WFD.

[2] Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds of which some bio-accumulate and can be carcinogenic.

Figure 5.1 Map of the Scheldt case study area and the three case study sites

The implications of the WFD for the site-amenities were translated into three easily understandable attributes, explained in meaningful lay terms: walking, bathing and nature quality. Figure 5.2 gives an overview of the attributes and their levels as used in the survey. Providing reliable yet understandable information about the relationship between goods and services on the one hand, and ecological quality parameters on the other in the valuation scenario of a SP survey, is important for meaningful valuation, because the effects of environmental quality changes can be difficult to see, be manifested later in time or may be very subtle. The size of the benefits of goods and services of water bodies are dependent on a set of water quality parameters, such as chemical substances, microbiological indicators, biodiversity and visibility. Each parameter can affect one or more goods and services. Previous studies have shown that attributes based on technical descriptions of water quality levels and bio-physical WFD indicators may be hard to understand for the general public, and result in insignificant parameter estimates (Hanley et al. 2006).

The development of the CE design involved background literature research on the WFD and regional tourism, and discussions with ecologists and regional water managers. Since reaching the WFD objectives implies different bio-physical outcomes for the three selected locations, the foreseen quality improvements were explained by site-specific descriptions and different photographs for walking and nature improvements. Additionally, restrictions were included in the CE to increase the realism and credibility of the scenarios. For example, in contrast to the current 'bad' quality levels of most attributes at all three sites, the current bathing quality at Breskens is moderate, which was therefore reflected in the status quo description of this site. The bathing quality attribute was excluded at Saeftinghe. Site characteristics that are not affected by the WFD, and hence not included explicitly in the choice task, but that are expected to affect choices, are captured by including the site names as labels. The fourth attribute in the CE was a monetary attribute, expressed as an increase in annual water board taxes paid by all local households. The six levels of this attribute ranged from five to eighty Euros per year.

The final design consisted of 24 different fixed versions (blocks) of choice sets including five choice tasks each. The choice sets were based on a D-efficient experimental design generated using Sawtooth Software (2008). The correlations of the design were minimal with most ≤ 5 percent and others ≤ 10 percent. The design was based on zero-priors and approximated a full-factorial design. Minimising the correlation among all attributes and alternatives and using a large design enabled the estimation of cross-effects and ensured that any substitution pattern in the data would not be caused by correlations in the design. The use of fixed blocks of choice sets prevents confounding differences in individual preferences and error variability with differences in design, which would result if individualised designs were used.

The survey was pre-tested in four rounds over a three-month period at different locations in the study area. Based on the pre-test results, local residents appeared to be sufficiently knowledgeable and familiar with the selected study sites to be able to make well-informed choices. The final version of the questionnaire consisted of 45 questions, of which more than half were closed-ended. The questionnaire was divided into five main parts: questions covering (1) general water recreation activities and intensity, (2) water recreation at the three study sites and possible substitute sites, (3) the choice experiment, (4) socio-demographic characteristics, and (5) control questions. The questionnaire is included as Annex III.

In the second part of the survey, respondents' "sense of place" was assessed to correct for heterogeneity in distance-decay functions. A novel and simple approach was developed and implemented, asking respondents to encircle the region they feel most attached to, the so-called "personal region", on a map of the study area. The *a priori* expectation was that whenever a study site is included in someone's region, this site would be preferred to sites outside the personal region. Furthermore, questions were included about visit frequency, most important activities, perception of water quality and other site characteristics. In order to assess the cognitive distance to each of the sites, respondents were asked to estimate travel distances to the CE sites, using distance-categories.

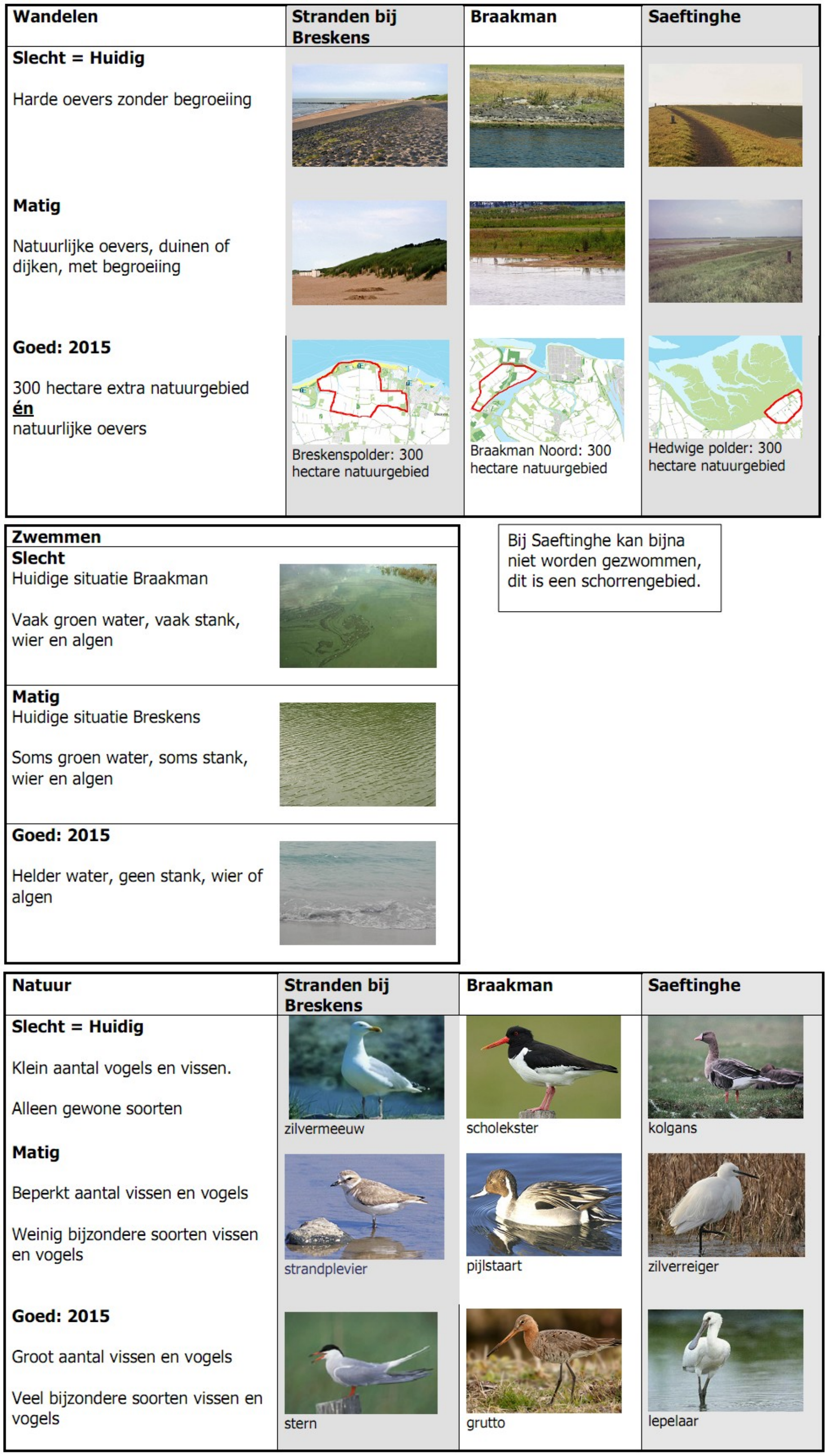


Figure 5.2 Overview of attributes and levels used in the choice experiment of the Scheldt case study

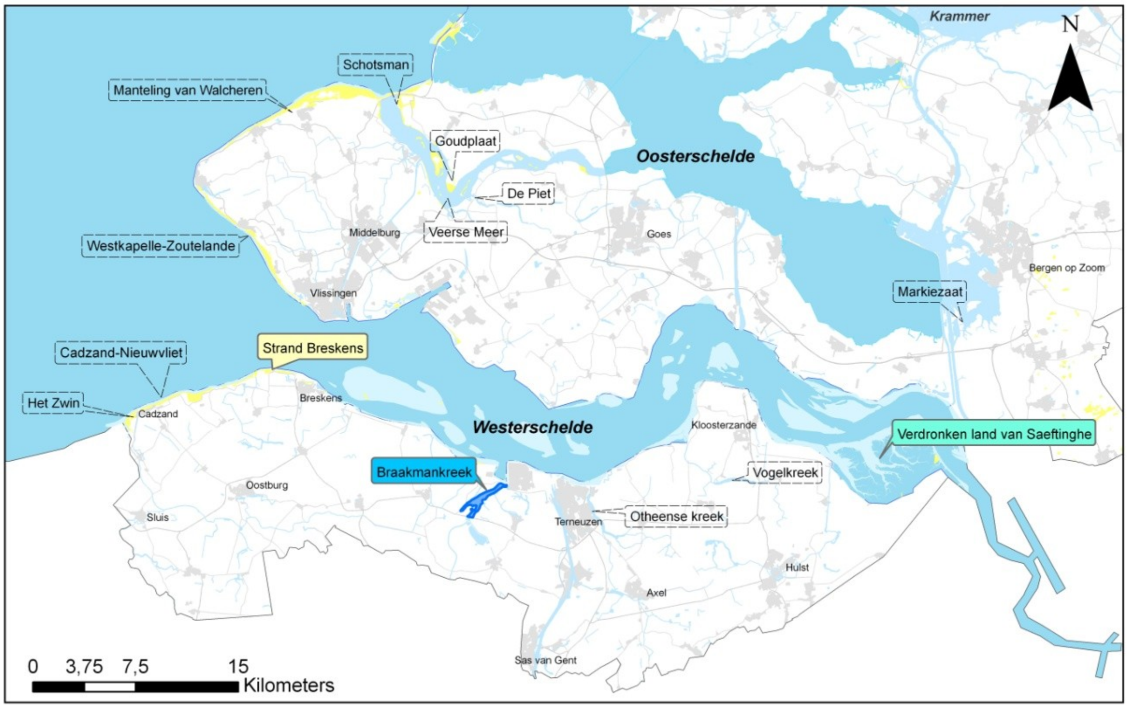


Figure 5.3 Map of study area of choice experiment in the Scheldt case study depicting the substitute sites

By registering respondents' postal codes, their objective travel distances could be calculated. These objective distance measures were based on the shortest route via the existing road network to the three sites, using Microsoft Milecharter software (2007). Shortest route distances to substitute sites were computed similarly[3].

In addition, the survey included questions prior to the CE about other sites in the area most often visited by respondents, the visitation frequency and recreational activities undertaken at these sites. These questions were supported by a map of the Dutch Scheldt basin and a list of alternative water sites to aid recollection of site names. Respondents were also asked what they would do if their most preferred site in the CE would face a decline in quality, so that it could no longer offer the same recreational opportunities. By including detailed questions about the other sites people visited before the start of the CE, the study went far beyond merely reminding respondents of substitutes. Thereby, it is expected that the associated risk of overestimating WTP for a particular site is reduced. Instead, respondents were encouraged to think actively about the relevant alternatives in their choice set.

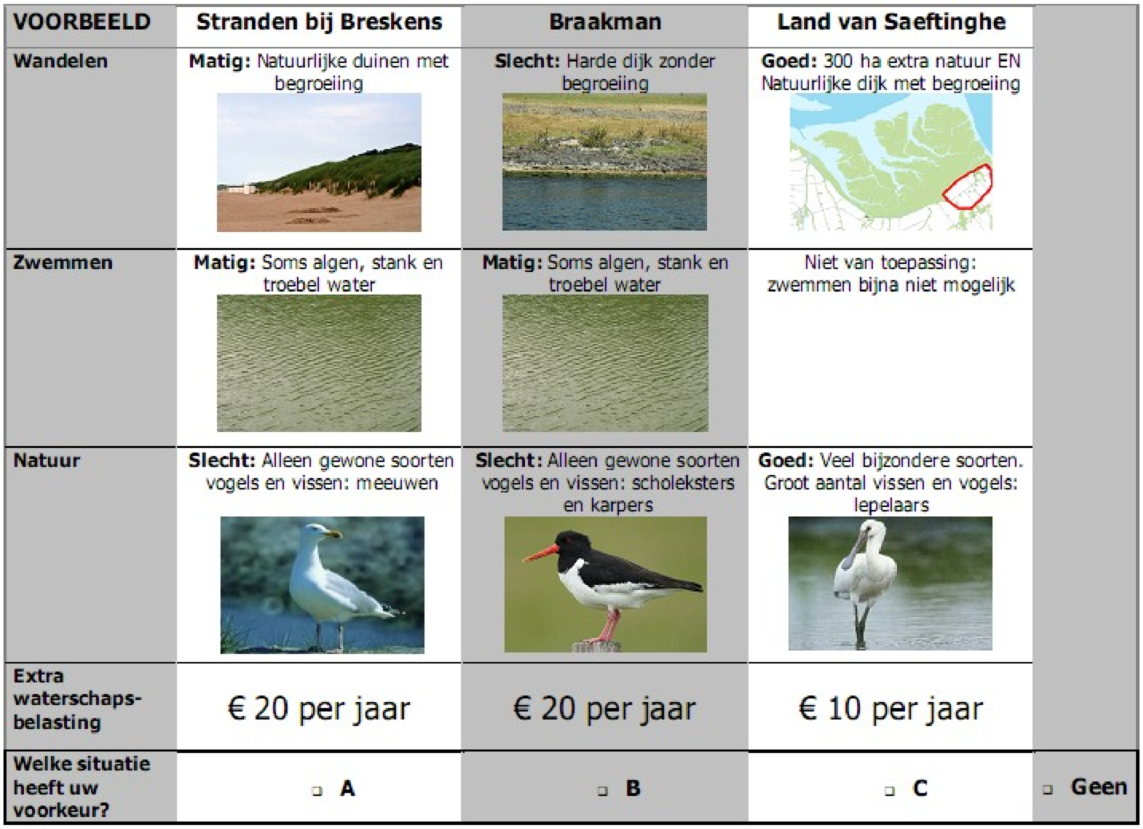
[3] Distances were measured by taking entry points of nature parks, visitor information centres or parking places or points at the nearest road. For large water bodies, such as the Oosterschelde or Lake Grevelingen, the average distance of all official bathing water directive locations along these water bodies was taken when respondents did not mention a specific entry point along them.

This study also aimed to address possible biases in the distance-decay effect due to the accessibility of substitutes besides the three sites included in the CE, in terms of distance to those substitutes. The relevance of sets containing researcher-defined alternatives is compared with sets including respondent-selected substitutes. The main advantage of using researcher-defined selection criteria is that it is replicable in other areas. The respondent-selection of substitutes may, however, better reflect respondents' perceptions of relevant substitutes. The sets are restricted to locations within the sampling area. Two selection strategies were employed to compose the researcher-defined substitute sets, resulting in different substitute sets for each study site:

1. A strict selection of substitutes, using the nature types in the provincial nature policy plans and the water typology under the WFD as selection criteria. These sets include sites that could provide the same environmental goods and services as the sites included in the CE if all attributes were at 'good' WFD objectives' levels. This approach resulted in three substitute sites for Breskens, three for Braakman, and five for Saeftinghe[4]. Figure 5.3 depicts the substitute sites resulting from this approach;
2. A broad selection of substitutes, where eligible sites either fall under the 2006 Bathing Water Directive locations or Natura 2000 legislation. The sets of this selection strategy included all official coastal bathing water locations for Breskens, all inland bathing locations for Braakman, and all Natura 2000 sites for Saeftinghe.

Whereas the substitutes for Braakman and Saeftinghe are distributed over the entire geographical sampling area, the substitute beaches for Breskens are only available along the coastline. Given this spatial pattern, a directional effect in distance decay is expected in Model VI reflecting different distance-decay rates for Breskens among respondents living along the coastline from those living further inland in the eastern part of the study area. For the two other sites, the expectation regarding the pattern of possible directional heterogeneity is not as clear-cut.

[4] For Saeftinghe, the strict researcher-defined selection is based on listing in the Nature Policy Plan of the Province (Geoloket Provincie Zeeland 2008), listing as Natura 2000 site and in Birds or Habitat Directives, and on similarity of the nature type *mudflats*. For Breskens, the same criteria are used, with as nature type *dunes*. Additionally, substitutes have to fall under the Swimming Water Directive and water bodies have to be classified under the WFD as water body type M1: buffered ditches (Kornman et al. 2004). Similarly for Braakman, substitutes have to be a bathing water location and have the same water typology under the WFD, namely M30 or M31: brackish water. Here, the enature type is *inland waterways*. The resulting selection includes three substitute sites for Breskens (Manteling van Walcheren, Cadzand/Nieuwvliet, Westkapelle/Zoutelande), three for Braakman (Vogelkreek, Otheense Kreek, Veerse Meer), and five for Saeftinghe ('t Zwin, Schotsman, De Piet, Kamperland, Markiezaat).



VOORBEELD	Stranden bij Breskens	Braakman	Land van Saeftinghe	
Wandelen	**Matig:** Natuurlijke duinen met begroeiing	**Slecht:** Harde dijk zonder begroeiing	**Goed:** 300 ha extra natuur EN Natuurlijke dijk met begroeiing	
Zwemmen	**Matig:** Soms algen, stank en troebel water	**Matig:** Soms algen, stank en troebel water	Niet van toepassing: zwemmen bijna niet mogelijk	
Natuur	**Slecht:** Alleen gewone soorten vogels en vissen: meeuwen	**Slecht:** Alleen gewone soorten vogels en vissen: scholeksters en karpers	**Goed:** Veel bijzondere soorten. Groot aantal vissen en vogels: lepelaars	
Extra waterschaps-belasting	€ 20 per jaar	€ 20 per jaar	€ 10 per jaar	
Welke situatie heeft uw voorkeur?	❑ A	❑ B	❑ C	❑ Geen

Figure 5.4 Example of a choice card used in the Scheldt case study

The CE in the third part of the questionnaire began with an explanation of the choice task, including an overview of all attributes and levels, the current situation at each of the sites, and an example of the choice card (see Figure 5.4). Next, five different choice cards were offered to every respondent. Each card presented four alternatives: the three sites, which all improved in at least one attribute against a certain payment, and the opt-out. The opt-out was defined in terms of the current quality levels for all attributes at all sites at zero price. Respondents were asked to choose the site they preferred to be improved. It was emphasised that only one site could be chosen at the given price levels and that the money paid for the preferred improvement would not be spent on the improvement of the other sites. Whenever respondents chose the opt-out, they were asked to motivate their answer in a follow-up question to identify possible protest responses. An additional question after each choice task was included to see if current non-users were potential future users under increased quality levels of their preferred site. This information permits to examine if option values form part of the total stated WTP and drive the decision-making process.

The survey was implemented door-to-door from July until September 2007. Trained interviewers conducted face-to-face interviews in 46 towns and villages in the sampling area, following a geographical sampling strategy. This strategy ensured sufficient variation in distance between the respondents and the locations in the experiment and at the same time adequately reflected the geographical distribution of the population throughout the area. This enabled the inclusion of distance from respondents to the CE sites as an additional attribute in the WTP analysis. Distances from respondents to the three sites ranged from 2 to 160 kilometres.

5.6 Results

5.6.1 General survey results

In total, 2,322 households were approached, of which 1,524 refused to participate. This corresponds to a response rate of 34 percent. After data cleaning, the useable response was slightly reduced from 798 to 780 respondents. Table 5.1 presents an overview of the descriptive statistics of the sample.

The sample contains slightly more female respondents (61%). The average age of the respondents is 51 years. The average household size is 2.7, which is slightly higher than the Dutch average of 2.3. Disposable household income in the sample is, on average, €2,117 per month, which is close to the average net household income in the region. The majority of the respondents have a higher secondary education degree. Based on these statistics, the sample is considered to be representative for the population of Zeeland and non-response bias is not expected to play a role in the study.

As expected, given the abundance of water in the study area, a majority of respondents (94%) visits open water for recreation. 146 Respondents (19%) have never visited any of the three sites in the CE, while 156 respondents (20%) have visited all three sites at least once. Less than four percent had never heard of any of the locations prior to the survey. Breskens is the most popular site: 62 percent of the respondents have visited this location at least once, compared to 45 percent for Braakman and 42 percent for Saeftinghe. Walking is one of the most popular activities at all sites. Breskens is also popular for bathing, and Saeftinghe attracts, as expected, many visitors who enjoy nature. Visitors value especially nature, wildlife, peace and quiet, with these latter characteristics being most prominent for Saeftinghe.

Half of the respondents believe that current water quality is generally good throughout the catchment, but nevertheless considers further improvement of water quality in the coming years important. Forty percent is of the opinion that water quality is not good enough and should be improved further. Among the three sites, water quality at Breskens is perceived best (as ‘good’) by most respondents. Water quality at Saeftinghe and Braakman is, on average, perceived as ‘moderate’, but the number of people who feel informed enough to evaluate water quality at these sites is substantially smaller than at Breskens.

The survey results point out that 75 percent of all respondents also visit other sites besides the three included in the CE and they travel on average 23 kilometres to get to their preferred site. This result underlines the importance of accounting for possible substitution effects. The respondent-selection of substitutes does not entirely overlap with the researcher-selection. One of the main reasons for differences between the selected sets of substitutes might be that respondents often visit smaller sites that are not listed in the official directives or policy documents on which the researcher-defined sets were based. The average distance to any alternative water body is 12 kilometres and shows little spatial variation across the sample.

Respondents reported substitution behaviour in terms of sites and activities. If water quality at their most frequented site declined to such a low level that their most preferred activity would no longer be possible at that site, two-fifth of the respondents would go to another, preferably nearby location. Thirty percent would continue going to their preferred site, but half of them would switch to another activity at that site. One-fifth of the respondents would no longer engage in water recreation.

A comparison of current users and non-users suggests that a large part of stated WTP is related to option values (see Table 5.2). As expected, almost all respondents who have visited a site in the past expect to visit the site again in the future under improved conditions as described in the CE. The number of users that will not visit the site in the future, and are therefore assumed to express mainly non-use values[5], is small (3%). Also a large number of current non-users expect to visit the chosen site in the future, especially for Saeftinghe. The high conversion rate suggests a large share of option or use-related values in total WTP. Distance-decay effects can therefore be expected for all sites and respondents. Given the stated future behaviour, distance-decay effects are expected to be highest for Breskens, which has the smallest number of respondents (15%) without stated option values under the proposed scenarios and more users that will continue visiting the site. Braakman and Saeftinghe are expected to show slightly lower distance decay, because more respondents (around 20 percent of the choices) do not plan to visit these sites in the future.

[5] Even under the proposed scenarios non-users might still have option value if they simply did not consider the improvements to be good enough to visit the site. WTP results of future non-visitors should therefore not be interpreted as pure non-use values.

Table 5.1 Descriptive statistics of the sample of the Scheldt case study

Socio-demographic characteristics	**Statistic**
Mean age (years)	51
Gender: percentage of females	61
Mean household size	2.72
Mean household income (€ net/month)	2117
Median education level	higher vocational education
Recreation and perception	
Visitors open water (% respondents)	94
Percentage of users (% respondents)	
- Breskens	62
- Braakman	45
- Saeftinghe	42
Mean distance from respondent to CE locations (km)	
- Breskens	43
- Braakman	34
- Saeftinghe	46
Mean max. distance willing to travel for a daytrip to open water (km)	56
Percentage of visitors of other water bodies	75
Distance to most frequently visited substitute site	23
Percentage of respondents who include location in personal region[1]:	
- Breskens	35
- Braakman	38
- Saeftinghe	25

Note: [1] Personal region: encircled area on the map of Zeeland to which the respondent feels most attached

Table 5.2 Stated intentions to visit the sites of the Scheldt case study in the future

	Users (future visitor)	**Users** (no future visitor)	**Non-users** (no future visitor)	**Non-Users** (future visitor)
Breskens[1]	71%	3%	12%	14%
Braakman[1]	55%	4%	17%	24%
Saeftinghe[1]	51%	2%	18%	29%
Total	***61%***	***3%***	***15%***	***21%***

Note: [1] Percentages are of the total number of choices for the location

Table 5.3 Comparison of cognitive and objective distances

	Objective (mean)[1]	Cognitive (mean)[1]	Underestimation (% of observations)	Overestimation (% of observations)
Breskens	3.80	3.33	34%	18%
Braakman	2.99	2.72	34%	16%
Saeftinghe	3.89	3.48	38%	25%

Note: [1] Categories: 1: 0-10 km; 2: 10-20 km; 3: 20-40 km; 4: 40-60 km.

The average distance based on the road network to Braakman is 34 kilometres, compared to 43 kilometres to Breskens and 46 kilometres to Saeftinghe. These objective distances are compared to cognitive travel distances (see Table 5.3). Most respondents found it too difficult to specify exact distances and preferred to select among distance categories of 10-20 kilometre ranges. Non-parametric tests show that the cognitive travel distances are significantly different from objective distances[6]. The figures differ between Braakman versus Saeftinghe and Breskens. For the central location Braakman, differences between objective and cognitive distances are small. Respondents make larger over- or underestimations of the distance to Breskens and Saeftinghe. 25 percent of the respondents overestimate the distance to Saeftinghe.

Next, differences between users and non-users are tested to see if the cognitive travel distances of users, having experience with the travel routes, are closer to the road network distance than those of non-users. Users of Braakman and Saeftinghe are found to estimate the travel distances to these sites significantly more accurate than non-users. Hence, the distance-decay functions of users and non-users for these sites in the choice models are expected to differ. No differences are found between users and non-users for Breskens in this respect.

The length of the travel route also affects the cognitive distance. Figure 5.5 displays three scatter plots depicting the difference between real and cognitive distances (in categories on the y-axis) relative to the absolute real distance (on the x-axis) to the three sites. Underestimation occurs when the cognitive distance is smaller than the real distance, resulting in positive values on the y-axis. For all sites, greater distances (> 40 km) are more frequently underestimated, whereas shorter distances are overestimated. This confirms findings in empirical studies as discussed in Chapter 3. Underestimation of distances also occurs for shorter distances to Breskens, whereas overestimation also occurs for greater

[6] For this comparison, objective distances were categorised according to the categories used for the cognitive, stated distances. Kendall's W test was used, a non-parametric statistic used to assess agreement among respondents. Differences were significant for Breskens, Braakman and Saeftinghe at the 5% level.

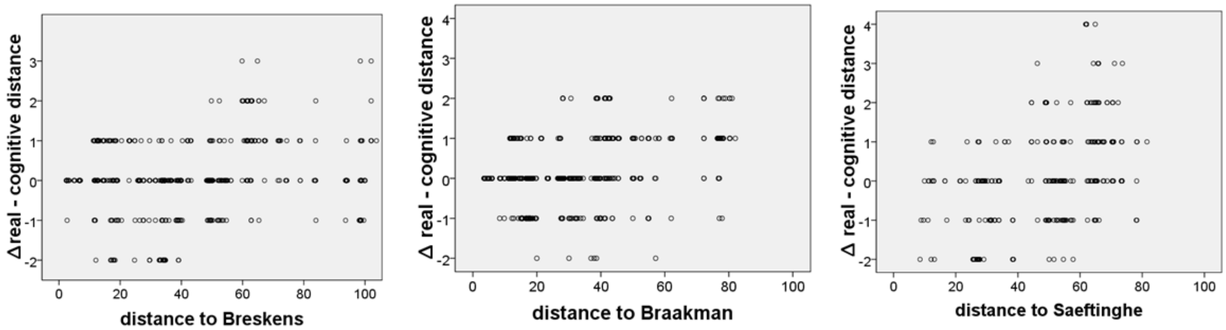


Figure 5.5 Scatterplots of difference between cognitive and perceived distance

distances to Saeftinghe. The frequent underestimation of travel distances to Breskens may be the result of the high familiarity of Breskens, whereas the opposite occurs for the less well-known site Saeftinghe. These results are expected to amount in different and non-linear distance-decay functions for these two sites.

Besides cognitive distance, "sense of place" is also expected to influence the individual distance-decay effect. When respondents are asked to draw the region they feel personally most connected with on a map, a quarter of the respondents indicate a region that includes Saeftinghe. This proportion is higher for Breskens and highest for the centrally located site Braakman. For the latter site, distance-decay effects are therefore expected to be smallest. In the analysis, a site-specific dummy variables equal to one is included in the model if a study sites is included in the personal region.

In summary, the evaluation of use and option values, the cognitive distance errors and the indicated "sense of place" suggest that different specification across sites and respondents can be expected, which allows refining the third hypothesis. Breskens is expected to show a high distance-decay effect due to the large attraction of visitors. Also, relatively many people underestimated the distance in the short range and no difference was found in cognitive distance errors between users and non-users. Distance-decay rates are therefore expected to be non-linear, with similar effect for users and non-users. For Braakman, a weak distance-decay effect is expected. For Saeftinghe, it is expexted that users and non-users hold dissimilar preferences for distance and that non-users show distance decay reflecting their option values. The functional form for this site is expected to be non-linear, due to a tendency to misjudge and overestimate distances to the site, which is less familiar and further away.

5.6.2 Site-specific values and substitution effects

In this section, the general results of the CE and the results of Models I-IV discussed in Section 5.3 are presented. Out of the 3,900 choice occasions, the opt-out was chosen 1,026 times. 127 Respondents

(16%) consistently chose the opt-out, of which 66 were classified as protest votes (8%). Protest voters were removed from the database as they are principally against paying extra for the proposed quality improvements. Reasons for not willing to pay complying with economic-theoretical expectations and therefore included in the subsequent analysis were that respondents thought that the proposed alternatives did not give good value for money, or they never visited the site(s) before and had no intention to do so in the future. Quality improvements at Breskens were chosen most often in the CE (36% of all choice occasions), followed by Braakman (24%) and Saeftinghe (22%), which roughly coincides with the relative visitation frequencies to the sites.

Table 5.4 presents the results of Models I-IV, which lead to two important findings. First, the results of Models I and II show that WTP for water quality changes at the three sites is site-specific for the proposed bathing and nature improvements. Second, the results indicate that there is a complex substitution pattern underlying the choices for quality improvements at the three sites, which is captured by the cross-effects in Model III. As the results of Model IV show, standard mixed logit models are not sufficiently flexible to capture this substitution pattern. These findings will be further described below.

Given their categorical nature, all attributes were dummy coded with current quality levels as the baseline level. For the price parameter linear coding was used. Table 5.4 only shows variables that have a significant impact on choice behaviour at least at the five percent level. The model fit can be compared based on the Loglikelihood of the models since they are nested. In all models, all attribute parameters are significant at the one percent level, except for moderate bathing quality in Model I, which is significant at the ten percent level. As expected, all quality improvements have a positive effect, and price a negative effect. The significant error-component 1 for the three sites implies that the variance for the three alternatives is different from the opt-out.

The first objective is to assess differences in the marginal rates of substitution of the attributes between the three sites. The first hypothesis is tested by comparing the results of the Model I including generic coefficients with those of Model II including site-specific coefficients. The models include interactions of the ASC with variables for the main respondent characteristics explaining (part of the) preference heterogeneity among respondents, for instance, household income, distance and a dummy variable taking the value 1 if the respondent has visited the study sites. The Likelihood-Ratio test shows that Model II results in a significantly better model fit than Model I (LR-test statistic=64 > χ^2_6 (0.05)= 12.6).

Table 5.4 Results of Models I-IV of the choice experiment of the Scheldt case study

Explanatory factor	MODEL I ECM + generic coefficients	MODEL II ECM + site-specific coefficients	MODEL III MII + cross-effects	MODEL IV MIII + random parameters + additional error-components
ASC Breskens	-8.560*** (3.637)	-8.580*** (3.662)	-8.610*** (3.659)	-8.565*** (3.372)
ASC Braakman	-9.015*** (3.829)	-9.369*** (3.997)	-9.427*** (4.003)	-9.561*** (3.764)
ASC Saeftinghe	-8.588*** (3.65)	-6.936*** (2.958)	-7.190** (3.049)	-6.589** (2.465)
Attributes				
Walking – moderate quality	0.344*** (4.919)	0.368*** (5.194)	0.374*** (5.254)	0.439*** (5.592)
Walking - good quality[a]	0.921*** (15.13)	0.959*** (15.549)	0.962*** (15.373)	1.202*** (15.030)
Spread of random parameter				1.202*** (15.030)
Bathing – moderate quality	0.201* (1.727)	0.498*** (3.879)	0.491*** (3.833)	0.601*** (4.294)
Bathing – good quality	0.830*** (12.14)			
Bathing - good quality[a] (Breskens)		0.557*** (6.479)	0.561*** (6.499)	0.701*** (7.226)
Spread of random parameter				0.701*** (7.226)
Bathing - good quality (Braakman)		1.338*** (11.365)	1.440*** (11.734)	1.790*** (13.317)
Nature – moderate quality	0.385*** (5.499)	0.380*** (5.321)	0.404*** (5.580)	0.494*** (6.146)
Nature – good quality	0.908*** (14.6)			
Nature – good quality[a] (Breskens & Braakman)		0.818*** (11.084)	0.821*** (11.070)	1.043*** (12.134)
Spread of random parameter				1.043*** (12.134)
Nature – good quality (Saeftinghe)		1.110*** (10.264)	1.148*** (10.550)	1.515*** (12.188)
Price	-0.017*** (19.806)	-0.017*** (19.583)	-0.017*** (19.190)	-0.022*** (20.502)

Table 5.4 continued.	MODEL I	MODEL II	MODEL III	MODEL IV
Cross-effects				
Saeftinghe * (moderate nature quality at Braakman)			0.249** (2.251)	0.312** (2.470)
Saeftinghe * (good bathing quality at Braakman)			0.299*** (2.635)	0.390*** (2.944)
Respondent characteristics				
Income (ln)	1.343*** (4.28)	1.329*** (4.257)	1.332*** (4.248)	1.310*** (3.864)
Distance (km)	-0.011*** (9.453)			
Distance (Breskens) (km^2*10^{-3})		-0.115*** (7.289)	-0. 115*** (7.287)	-0.163*** (4.337)
Distance (Braakman) (km)		-0.0075*** (2.844)	-0.0076*** (2.847)	-0.011** (2.165)
Distance (Saeftinghe) (ln, km)		-0.557*** (9.808)	-0.548*** (9.657)	-0.782*** (5.465)
User (dummy: 1= user)	0.733*** (15.176)			
User (Breskens)		0.864*** (13.884)	0.865*** (13.871)	1.132*** (9.092)
User (Braakman)		0.864*** (13.884)	0.865*** (13.871)	1.132*** (9.092)
User (Saeftinghe)		0.508*** (7.281)	0.509*** (7.279)	0.663*** (4.069)
Error-components				
Sigma error-component 1 (Breskens, Braakman, Saeftinghe)	2.816*** (14.697)	2.783*** (14.514)	2.796*** (14.523)	2.859*** (15.030)
Sigma error-component 2 (Breskens, Braakman)				1.438*** (12.134)
Sigma error-component 3 (Braakman, Saeftinghe)				1.150*** (7.226)
Model statistics				
Loglikelihood	-3454	-3422	-3415	-3269
No.obs.	3180	3180	3180	3180

Notes: Models are estimated using NLOGIT 4.0. T-values are presented between brackets. Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

[a] For these variables, random parameters are specified in Model IV with a uniform distribution and the spread restricted to the mean.

Given the significance level of the coefficient estimates and the outcome of the Wald- and Likelihood Ratio tests, site-specific values are found for quality improvements of nature and bathing, but not for walking. The parameter estimate of nature improvements to good levels at Saeftinghe is significantly higher than the parameter estimate for a similar change at Breskens and Braakman, for which nature improvements have no significantly different value. Similarly, improving bathing quality at Braakman to a good level has a significantly higher coefficient than a similar improvement at Breskens. Hence, the first hypothesis stating that similar ecological objectives will be valued equally across sites is rejected for the bathing and nature improvements.

Looking at the respondent characteristics, income (in natural logarithmic form) has a positive effect on the probability of choosing among the three sites: the higher household income, the higher WTP for one of the alternatives. Respondents who have visited one of the sites in the choice set of the CE have a higher probability of choosing that particular site, as reflected by the positive coefficient for the user-dummy. The results of Model II show that the user-effect is significantly lower for Saeftinghe than for Breskens and Braakman. The effect of distance is also site-specific, which will be further discussed in relation to the results for the fourth hypothesis in the next section.

The second hypothesis is tested by specifying cross-effects as in Model III to see if changes at other sites affect the utility of the chosen site and result in disproportional probability changes. Two cross-effects are found to be significant[7]. Model III outperforms the more restrictive Models I and II and seems better capable of capturing substitution effects than Models I and II (Models II vs. and III: LR-test statistic =14 > χ^2_2 (0.05)=6.0).

The first cross-effect reveals a disproportional substitution effect if nature improves to the moderate level at Braakman. This cross-effect, present in the utility function of Saeftinghe, shows that improving nature to a moderate level at Braakman has a less negative effect on the probability of choosing Saeftinghe than on the probability of choosing Breskens. The parameter value (0.249) reflects the additional effect of a nature improvement at Braakman on the probability of selecting Saeftinghe, over and above the proportional effect captured by the generic parameter (0.404). Probability share simulations (Hensher et al. 2005a, 401) based on Model III show that improving nature at Braakman to a moderate level would only draw choices away from Breskens, and would hardly reduce Saeftinghe's probability share. A model without this cross-effect would predict a proportional probability loss for

[7] In the estimation process, all attributes were tested for possible cross-effects. After many repetitions, including different combinations of cross-effects, only two cross-effects were found to be significant, which is a number common to other studies using universal logit models.

Saeftinghe for such a nature improvement scenario. In other words, the probabilities are context-dependent: when nature at Braakman improves from bad to moderate level, the resulting substitution pattern shows stronger substitutability between Breskens and Braakman compared to Saeftinghe with its relatively unique nature and wildlife conditions. Respondents perceive Braakman and Breskens as more similar and hence substitutable compared to Saeftinghe.

A second cross-effect is found for good bathing quality at Braakman, also included in the utility function of Saeftinghe. The positive coefficient implies that an improvement in bathing quality at Braakman to a good level draws proportionally fewer choices away from Saeftinghe than from Breskens. Probability share simulations show that such an improvement at Braakman would result in only three percent fewer choices for Saeftinghe compared to thirteen percent fewer choices for Breskens. This cross-effect possibly reflects a shift in choices of those respondents most interested in bathing water quality, due to the absence of bathing possibilities at Saeftinghe. It implies again that a different substitution pattern between the three sites can be observed when bathing possibilities at Braakman improve to a good level and suggests that Braakman and Breskens are in this respect perceived to be closer substitutes.

In Model IV, the robustness of the cross-effects of Model III is tested by including random parameters and additional error-components. In the estimation process of Model IV, all attributes were included as random parameters with a constrained uniform distribution. A uniform distribution was used for the random parameters because of the categorical nature of the quality levels (Hensher et al., 2005a, 612). The spread of the distributions was fixed to the mean to ensure that the parameters are positive over the entire distribution, as theoretically expected to be the case for the quality effects. Other distributions, such as normal and triangular, were also tested, but they did not improve the model fit. Since the distributions were constrained, it was not possible to control for correlation between these random parameters. Price was included as a fixed effect to avoid extreme WTP values.

The results of Model IV show that the specification of random parameters and additional error-components leads to a better model fit than Model III (LR-test statistic=292 > χ^2_2 (0.05)=6.0). The three significant random parameters in Model IV for the highest quality levels of walking, nature at Braakman and Breskens and bathing at Breskens demonstrate that these attributes are subject to preference heterogeneity. No significant random effects were found for the other attributes. The cross-effects are hence not the result of heterogeneity in preferences for these attributes. No significant differences in socio-demographic characteristics and user-profiles were identified explaining the observed heterogeneity in the means of the random coefficients. Hence, the data do not give further information about the segmentation of the respondent population into different preference profiles causing disproportional substitution patterns. Similar to Models II and III, bathing quality is valued higher at Braakman than at Breskens and respondents have a higher preference for good nature quality at Saeftinghe that at the two other sites.

The cross-effects of Model III and IV indicate stronger substitution between Braakman and Breskens. The common random coefficient for improving nature quality at these sites facilitates correlation in the preferences for nature improvements at Braakman and Breskens. In Model IV, additional error-components for all possible combinations of the three sites (Breskens and Braakman, Braakman and Saeftinghe, Breskens and Saeftinghe) are included, allowing for bilateral correlation in the error variance. The error-components are significant at the one percent level for the combinations Breskens-Braakman and Braakman-Saeftinghe, but not for Breskens-Saeftinghe. The resulting structure is comparable to a cross-nested logit model with overlapping nests where Braakman is present in both nests. In addition, this error-component structure mimics a spatial contiguity matrix, as those error-components for nearby locations are significant. As Figure 5.3 shows, Breskens and Saeftinghe are located furthest away from each other. In other words, the error-components in Model IV reflect that nearby locations are more correlated than distant ones.

Despite the additional error-components and controlling for preference heterogeneity in the good levels of the quality attributes through the random parameters in Model IV, the results show that the cross-effects remain significant and the LR-test shows that they contribute significantly to the model fit (LR-test statistic=14 > χ_2^2 (0.05)=6.0). This implies that the cross-effects are robust and a disproportional substitution pattern exists that cannot be captured by standard error-components or random parameters alone. This is confirmed when testing more common model specifications, such as nested logit models, to see if these could also, and possibly better, capture the correlation between the utility functions of the sites Breskens and Braakman. For the sake of brevity, the results of these models and others with unconstrained uniform and normal distributions are not presented here, but they lead to the same findings regarding the significance of the cross-effects.

Table 5.5 Implicit prices of attributes resulting from Models I-IV in Euros per household per year

Attributes	**MODEL I** ECM + generic coefficients	**MODEL II** ECM + site-specific coefficients	**MODEL III** MII + cross-effects	**MODEL IV** MIII + random parameters and error-components
Walking – good [1]	55 (46;64)	57 (48;67)	57 (48;67)	55 (2;107)
Bathing – good	49 (40;59)			
Bathing – good (Breskens) [1]		33 (23;44)	33 (23;44)	32 (0;64)
Bathing – good (Braakman)		79 (64;96)	85 (69;104)	81 (67;96)
Nature- good	54 (45;64)			
Nature- good (Breskens & Braakman) [1]		49 (39;59)	49 (39;59)	47 (2;94)
Nature- good (Saeftinghe)		66 (52;81)	68 (54;83)	68 (56;81)
Cross-effects				
Saeftinghe * (Braakman nature moderate)			15 (2;27)	14 (3;24)
Saeftinghe * (Braakman bathing good)			18 (5;32)	17 (6;30)

[1] Note that the confidence intervals of these parameters are wider in Model IV as they are specified as random parameters.

Louviere (2001) suggests that cross-effects and possible subsequent violations of the regularity assumption may in fact reflect heterogeneity in the scale parameter. To test the presence of scale heterogeneity, Model III is re-estimated in WTP-space, which allows for scale-heterogeneity. The results, presented in Annex IV to this thesis, show that the cross-effects remain significant, while no significant scale heterogeneity is found. This implies that the cross-effects are robust and do not reflect scale heterogeneity[8]. The simulated market shares suggest that the cross-effects do not lead to an increase of

[8] Besides estimating the model in WTP-space, the Swait and Louviere (1993) test is performed to examine potential changes in the attribute and scale parameters along the sequence of choice tasks in the CE. The test results are included in Table II.I in Annex II to this thesis. The results reveal that in only one case, namely when comparing choice cards 2 and 3, there is significant heterogeneity in the variable or scale parameter at the 5% level. Since this heterogeneity is not significant at the 2.5% level and given that no significant heterogeneity is found for the comparisons of other combinations of choice cards and the results of the WTP-space model, it is argued here that the results of the cross-effects are not due to scale heterogeneity in the CE.

choice probabilities of other alternatives (if the relevant attributes changes), which indicates that the regularity conditions are not violated. The second hypothesis is thereby rejected.

An important question is whether the site-specific attribute parameters and the cross-effects result in significantly different welfare estimates compared to more parsimonious models. In Table 5.5, the WTP estimates (implicit prices) resulting from Models I-IV for marginal improvements in individual attributes are presented. Table 5.6 shows the compensating surplus (CS) estimates for quality improvement scenarios for the three sites from bad to moderate and good levels. The implicit prices and CS are expressed in Euros per household per year, reflecting the MRS of attributes with respect to the monetary attribute. The WTP and CS estimates reflect the value of a change from the status quo. The confidence intervals are calculated using Krinsky and Robb (1986) simulation techniques. Tests as described in Poe et al. (2005) are used to test for differences between implicit prices and CS across sites and models.

First, the differences in WTP between sites for similar quality improvements are tested. The implicit prices for the attributes in Table 5.5 resulting from the site-specific Models II-IV are significantly different from the generic Model I. Comparison of the implicit prices of bathing quality derived from Models I and II shows that Model I underestimates the value of good bathing quality at Braakman (€49 vs. €79, p=0.01) and overestimates the value of good bathing quality at Breskens (€49 vs. €33, p=0.01). Model II reveals that the WTP for improving nature to good conditions at Saeftinghe is significantly higher than for a similar change at Breskens and Braakman (p=0.02). The generic prices in Model I give an underestimation of the site-specific price for Saeftinghe (€54 vs. €66, p=0.07). Model I slightly overestimates mean prices for achieving good nature quality at Braakman and Breskens compared to Model II, but the difference is not significant at the ten percent significance level (p=0.23). Overall, these results show that the same policy objective for quality improvements can generate significantly different values at different sites due to site-specific characteristics.

The site-specific attribute values also lead to significant differences in CS estimates across sites. The site-specific Models II-IV suggests that quality improvements at Braakman are most beneficial to society, in contrast to the results of Model I, which suggest that the value of improving quality levels from bad to moderate does not lead to differences in CS across sites (scenarios 1, 2 and 3a, p=0.15). In Model I, improving quality levels to good levels would mean a higher CS for Breskens and Braakman than for Saeftinghe, due to the additional benefits generated by good bathing quality at the first two sites (scenarios 4, 5 and 6a, p=0.01). However, Model II shows that the CS estimates for Braakman under moderate and good conditions are significantly higher than for Saeftinghe and Breskens due to the site-specific value for bathing water quality at Braakman (p=0.01 and p=0.01). Differences in the CS for improvements to good quality levels in Model II, between Breskens and Saeftinghe are not significantly different (p=0.13), in spite of the absence of bathing amenities at the latter site. This is mostly due to the higher WTP for nature improvements at Saeftinghe. Model III leads to the same conclusions. After controlling for taste heterogeneity in Model IV, the CS results for the moderate level scenarios are similar to Model II and III. However, in contrast to Models I-III, the WTP estimates for the good quality scenarios do not differ significantly across the sites because of the wide confidence intervals of the uniformly distributed random parameters.

Next, the test results indicate that the cross-effects in Models III and IV also result in different CS estimates under different choice contexts of ecological quality conditions. The two cross-effects can be interpreted as a correction of the WTP due to a contextual change. The CS estimates for improvement scenarios accounting for cross-effects are shown separately in Table 5.6. Respondents value an ecological quality improvement at Saeftinghe on average €14-15 per year higher if at the same time the scenario at Braakman includes a change of nature to moderate quality (see Table 5.5). Similarly, if in the scenario at Braakman bathing quality changes to a good level, an ecological improvement at Saeftinghe is valued €17-18 per year higher. The cross-effects suggest that synergy effects in water management investments can be achieved if both Braakman as well as Saeftinghe are improved. In Model IV, mean WTP for moderate ecological quality at Saeftinghe (€56) is perceived to be significantly higher at the ten percent level (p=0.08) if presented with a nature improvement at Braakman to a moderate level (scenario 3b) compared to a situation with no improvement at Braakman (€42 in scenario 3a). Achieving moderate ecological quality at Saeftinghe is also significantly different at a ten percent level in both Models III (p=0.08) and IV (p=0.01) when presented in a context with good bathing quality at Braakman (scenario 3c). So, ignoring these cross-effects would underestimate welfare improvements for Saeftinghe in the latter case by as much as 40 percent. The differences between scenarios 6a and 6b or 6c are not significant at the ten percent level. This is mainly due to the magnitude of the cross-effects in comparison with the confidence intervals of the CS for the good quality scenarios, and the large confidence intervals of the random parameters in Model IV.

Table 5.6 Consumer surplus estimates for different policy scenarios in Euros per household per year

Policy scenario	**MODEL I** ECM + generic coefficients	**MODEL II** ECM + site-specific coefficients	**MODEL III** MII + cross-effects	**MODEL IV** MIII + random parameters and error-components
1) Breskens: all attributes moderate	43 (31;56)	44 (31;58)	46 (33;59)	42 (31;53)
2) Braakman: all attributes moderate	55 (37;74)	74 (55;94)	75 (55;96)	69 (53;87)
3a) Saeftinghe: all attributes moderate	43 (31;56)	44 (31;58)	46 (33;59)	42 (31;53)
Including cross-effects				
3b) with contextual change: Braakman nature moderate	-	-	61 (42;80)	56 (40;73)
3c) with contextual change: Braakman bathing good	-	-	64 (44;85)	59 (42;78)
4) Breskens: all attributes good	158 (139;179)	139 (120;159)	139 (120;161)	134 (43;223)
5) Braakman: all attributes good	158 (139;179)	185 (160;212)	191 (165;220)	183 (101;265)
6a) Saeftinghe: all attributes good	108 (94;124)	123 (104;144)	125 (106;147)	123 (67;179)
Including cross-effects				
6b) with contextual change: Braakman nature moderate	-	-	140 (116;165)	137 (80;195)
6c) with contextual change: Braakman bathing good	-	-	143 (117;171)	140 (82;199)

5.6.3 Heterogeneity in distance-decay effects

The next objective of this case study is the analysis of the effect of distance on site-choices. Hypotheses 3a, 3b and 3c pose that distance has a generic effect on all sites and the same functional specification can be applied to all sites and all respondents. The heterogeneity across sites and respondents is tested by comparing the results of Models I and II, and further explored in Model V. In Models VI-VIII, spatial heterogeneity in distance-decay is tested. The results show that accounting for spatial heterogeneity and distance to substitutes results in a better model fit and significantly different WTP estimates.

The generic linear distance decay effect in Model I in Table 5.4 has a small negative parameter, implying that preferences for the sites decay at a constant rate per kilometre. The small coefficient for distance suggests a weak distance-decay effect, possibly reflecting a more general provincial attachment of the sampled local residential population to the sites. As the results of Model II show, however, the the distance-decay effects differ significantly across sites. The different site-specific transformations of the distance effect in Model II contribute to a better model-fit. For Breskens, the quadratic function gives the best statistical fit and implies that WTP decreases at an increasing rate the further away the respondent lives. The distance-decay function of Braakman is linear. In the case of Saeftinghe, the natural logarithmic form yields the best statistical fit, indicating that WTP values decline quickly within a short distance of the site and slowly stabilise at larger distances. The hypotheses 3a and 3b are therefore clearly rejected as significant differences in distance-decay effects between sites are found, both in magnitude as well as functional specification.

Models V further explores heterogeneity in distance decay between users and non-users. Results are presented in Table 5.7. Past use of the site is expected to be the main source of heterogeniety, as past visits are related to knowledge and familiarity with the environmental goods and services provided by the sites and with the travel route. Therefore, an interaction effect between the distance and user-dummy is included in Model V. The results show that for Breskens, there is no difference in the distance-effect between current users and non-users conform hypothesis 3c. The functional form of the function may be due to respondents' underestimation of the distance to the site. When respondents perceive the site to be nearer than it is in reality, they show lower distance decay than with a linear distance-decay function. This cognitive distance error is expected to be higher for respondents near the site and to decline as distance increases (see Chapter 3).

As expected for Braakman and Saeftinghe, the empirical results indeed show a difference between the user and non-user groups. Previous visits to Braakman increase the probability of choosing quality improvements at this site. As the interaction term for distance and the dummy representing previous visits to the site is significant, but the coefficient for distance is not, distance decay in the WTP for Braakman is only found for users. The value of Braakman held by non-users does not vary over distance, in spite of their stated option values. The distance-decay function of Saeftinghe has a logarithmic form. Significant distance decay is found for all respondents. In addition, a significant positive effect is found for the interaction between the user-dummy and distance, implying that users give a lower weight to distance in their choices than non-users. This effect may result from a lower tendency among users to overestimate travel distances to this site. There is no direct effect of using the site on the probability of choosing quality improvement scenarios at Saeftinghe, probably because people tend to visit nature-oriented sites less frequently in general. Hence, hypothesis 3c is rejected for Braakman and Saeftinghe.

Table 5.7 Results of Models MV-MVIII of the choice experiment of the Scheldt case study

Explanatory factors	**Model V** Model II + theoretical distance decay	**Model VI** Model II + spatial trend variables	**Model VII** Model II + distance to substitutes	**Model VIII** Model VII + distance to substitutes
ASC Breskens	-9.003*** (-3.795)	-8.460*** (-3.528)	-8.680*** (-3.655)	-8.604*** (-3.590)
ASC Braakman	-10.047*** (-4.231)	-9.482*** (-3.956)	-9.410*** (-3.951)	-9.479*** (-3.965)
ASC Saeftinghe	-7.352*** (-3.094)	-5.913** (-2.446)	-5.489** (-2.282)	-6.127** (-2.545)
Attributes				
Walking – moderate quality	0.379*** (5.243)	0.361*** (4.999)	0.366*** (5.101)	0.362*** (5.005)
Walking - good quality	0.965*** (15.570)	0.955*** (15.192)	0.954*** (15.232)	0.954*** (15.131)
Bathing - moderate quality	0.522*** (4.030)	0.520*** (4.004)	0.529*** (4.073)	0.520*** (4.001)
Bathing - good quality (Breskens)	0.552*** (6.390)	0.563*** (6.496)	0.556*** (6.462)	0.563*** (6.498)
Bathing - good quality (Braakman)	1.372*** (11.511)	1.369*** (11.489)	1.369*** (11.562)	1.365*** (11.479)
Nature - moderate quality	0.387*** (5.344)	0.382*** (6.496)	0.380*** (5.261)	0.385*** (5.326)
Nature - good quality (Breskens & Braakman)	0.819*** (11.013)	0.831*** (11.141)	0.828*** (11.131)	0.831*** (11.172)
Nature - good quality (Saeftinghe)	1.107*** (10.137)	1.088*** (9.965)	1.088*** (9.976)	1.081*** (9.921)
Price	-0.0168*** (-19.355)	-0.0168*** (-19.294)	-0.0167*** (-19.343)	-0.0167*** (-19.280)
Distance and user-effects				
Distance (km^2*10^{-3}) (Breskens)	-0.086*** (-5.263)	-0.111*** (-5.164)	-0.226*** (-8.757)	-0.140*** (-6.468)
User (Breskens)	0.802*** (10.860)	0.936*** (7.209)	1.191*** (8.490)	0.888 *** (6.824)
User (Braakman)	1.135*** (7.864)	1.872*** (12.038)	1.703*** (11.508)	1.938*** (12.650)
User*distance (Braakman)	0.012*** (-2.762)	-0.028*** (-5.637)	-0.026*** (-5.542)	1.938*** (12.650)
Distance (ln(km+1)) (Saeftinghe)	-0.539*** (-8.992)	-0.745*** (-9.373)	-0.856*** (-11.180)	-0.681*** (-9.256)
User*distance (ln(km+1)) (Saeftinghe)	0.128*** (6.599)	0.105*** (3.028)	0.154*** (8.063)	-

Table 5.7 continued.	Model V	Model VI	Model VII	Model VIII
Respondent characteristics				
Perceptual region (dummy)	0.384*** (5.924)			
Income (ln +1)	1.359*** (4.298)	1.284*** (4.024)	1.282*** (4.045)	1.289*** (4.048)
Directional effects				
Breskens: cosineθ		0.365*** (2.724)		0.576*** (3.347)
Breskens: sineθ		-0.476*** (-5.725)		-0.331*** (-3.391)
Breskens: user*longitude (km)		-0.0085* (-1.764)		-0.048** (-3.010)
Braakman: cosineθ		0.178* (1.869)		-
Braakman: user*longitude (km)		-0.021*** (-2.962)		-0.012** (-2.214)
Saeftinghe: user*cosineθ		-0.266* (-1.772)		-0.600*** (-7.196)
Distance to substitutes				
Distance to substitutes (Breskens)			0.028*** (5.999)	-
Distance to substitutes* user (Breskens)			-0.014*** (-3.266)	0.032** (-3.391)
Error-component				
Sigma error-component (Braakman, Breskens, Saeftinghe)	2.784*** (14.572)	2.814*** (14.456)	2.779*** (14.297)	2.816*** (14.511)
Model statistics				
Loglikelihood	-3361	-3361	-3371	-3363
No.observations	3140	3150	3150	3150

Notes: Models are estimated using NLOGIT 4.0. T-values are presented in brackets.
Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

The dummy for a respondent's "personal region" has a generic positive effect, which shows that a respondent is more likely to choose an improvement at a site if this site falls inside the area he or she feels most attached to. This variable has no site-specific effect and is not significant when included as an interaction with distance to the site. The inclusion of this dummy variable leads to lower coefficients for distance, compared to the other models. In other words, it suggests that models in which the effect of personal attachment to a site is ignored might overestimate the effect of distance decay.

A number of other variables that were expected to affect distance-decay were tested, but not found to be significant. The effect of different modes of transport is not significant, probably because the frequency of public transport in the province Zeeland is limited and the majority of respondents therefore rely on their own cars when visiting the sites. In this case, knowledge of the site was highly correlated with site visits and left out of the model to avoid multicollinearity. As an indicator of the effects of substitutes not included in the choice set, a dummy variable taking the value 1 if a respondent visits other sites was created. This dummy is not significant in any of the models.

The effect of substitutes not included in the choice set is further addressed by testing hypotheses 4, 5 and 6. The fourth hypothesis addresses possible directional heterogeneity in distance-decay effects. Model VI is based on the spatial expansion method and includes longitudinal and latitudinal variables, whilst accounting for differences between users and non-users. As presented in the second part of Table 5.7, six directional variables are found to be significant and the fifth hypothesis is hence rejected. The results indicate that there is significant spatial heterogeneity in WTP values for water-related environmental quality improvements. This pattern is partly related to the accessibility of other sites outside the CE choice set that provide similar environmental goods and services.

The directionality parameters in Model VI should be interpretated as additional effect to the direct effect of travel distance to the CE-sites on WTP. The positive cosine intercept shifter in the function of Breskens means that respondents living east from the site are more likely to choose Breskens. The intercept shifter depends on the angle of the direction in radians and is strongest straight east from the site where cos(0°)=1. Similarly, the sine intercept shifter in the function of Breskens implies lower probabilities north from the site, where sin(90°)=1. The longitudinal distance effect among users implies that the further away users live in the eastern direction from Breskens, the less likely they are to choose the site, whilst the probability increases as users live further west from Breskens. The overall effect is that people living in the north-west have a lower probability of choosing Breskens, slightly offset among users by the longitudinal effect. This result can be explained by the presence of the many beaches along the coastline in the north-western part of the sampling area. Respondents from the north also face a great travel distance to Breskens, because they have to cross the Westerscheldt.

There is also some directional heterogeneity in the distance decay for the two other sites in the CE. For Braakman, the interaction term of the user-dummy and the longitudinal distance implies that the further east a user lives, the lower the probability of choosing Braakman. Similar to the cosine-effect for Breskens, the positive cosine intercept shifter in the function of Braakman means that the probability of choosing Braakman depends on the angle between the respondent and the site. The effect is highest east from Braakman, where cos(0°)=1. For Saeftinghe, there is little directional heterogeneity. Only the intercept shifter $cos\vartheta$ for users is significant. The intercept shifter shows that users living west from the site, where the cosine equals -1, have the highest probability of choosing Saeftinghe (c.p) compared to other directions.

The next question is if this spatial heterogeneity can be explained and modelled by a variable reflecting the distance to substitutes, besides direct distance decay and user effects, as formulated in the fifth hypothesis. The effect of substitutes not included in the CE set on the choice probabilities of the study sites is tested in Model VII. Model VII accounts for additional spatial heterogeneity due to differences in substitute accessibility, measured as the distance from the respondent to either researcher or respondent identified substitutes. The results show that the fifth hypothesis can be rejected only for Breskens. Only the researcher-defined broad set of substitutes has a significant effect on choosing this site, namely the distance to the nearest beach of all beach sites falling under the Bathing Water Directive in the study area. The positive coefficient of this variable indicates that as distance to other beach sites increases, so does the probability of choosing Breskens. This result implies substitution effects or competition between Breskens and other beaches that fall under the Bathing Water Directive. The effect of distance to substitutes is lower for respondents who have visited Breskens in the past, as indicated by the negative coefficient for the interaction of the user-dummy variable and distance to the nearest alternative beach site. These respondents have a higher preference for Breskens.

The other researcher-defined and respondent-defined substitution indicators do not have a significant effect. The distance to the most frequently visited alternative site does not significantly affect the choice for any of the sites in the CE either. The insignificance of the respondent-based substitute sets is expected to be due to the low variation in the observed distance to the substitute sites reported by respondents. As there are many water bodies in the study area, most respondents have a substitute available close to their homes.

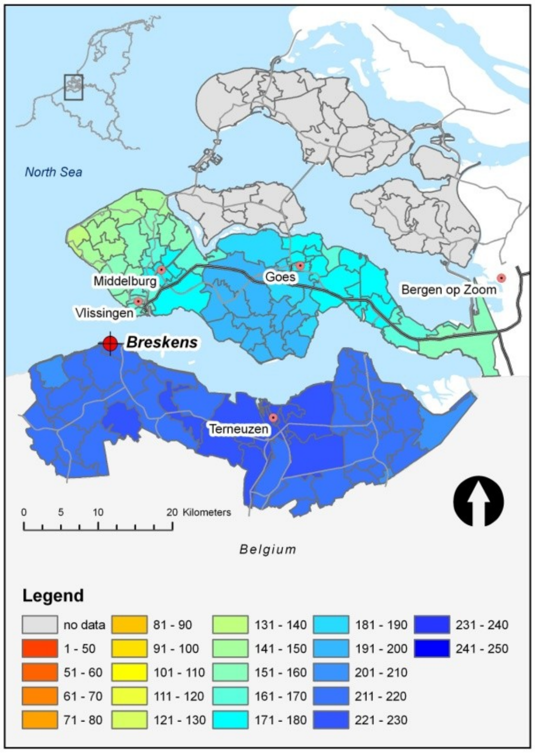
Model VIII combines Models VI and VII and includes directional shifters for the distance-decay effects and the distance to substitutes. The results show significant directional heterogeneity in the choice probabilities of the three sites. The effect of the distances to substitutes remains significant, but only among the users of Breskens. Hence, the sixth hypothesis is partly rejected. The positive coefficient implies that as users of Breskens live closer to another beach site, they are less likely to choose Breskens. The cosine intercept shifter for Braakman, which was significant in Model VII, is no longer significant in Model VIII. The results of Model VIII suggest that the spatial trend variables capture part of the directional heterogeneity due to substitute availability in Model VII, and furthermore reveal that there are other variables causing spatial heterogeneity in distance decay, besides distance to substitutes.

The results of the LR-tests show that Model VIII fits the data significantly better than Model VII, but the fit of Model VI is slightly better than of Model VIII (LR-test statistic=16 > χ_3^2 (0.05)=7.8). The better fit of Model VI suggests that the spatial expansion method may describe the spatial heterogeneity in choice probabilities better than Models VII and VIII. Comparing Models VI - VIII to Model II, there is no reason to believe that the variables for the directional variability in choice probabilities are picking up any other non-random spatial distribution of the explanatory variables included in the models. The coefficients of the attributes and income are similar across the three models.

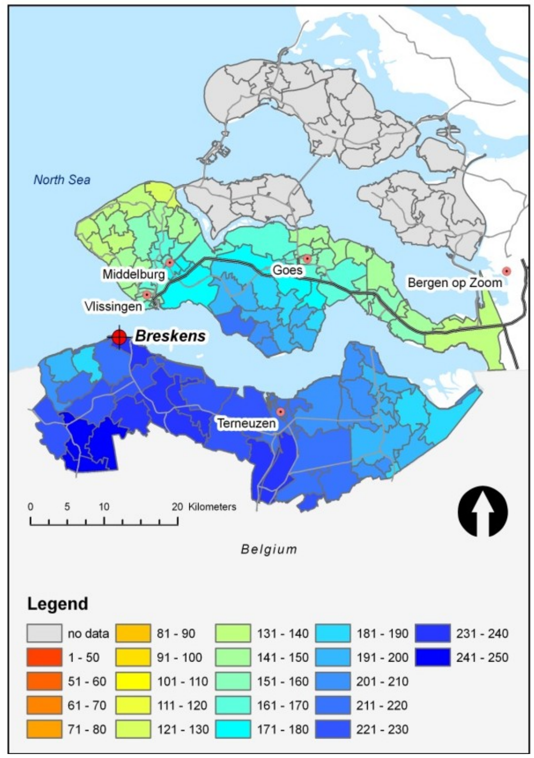
In order to assess if accounting for directionality results in higher spatial variation in individual WTP estimates of users and a different pattern for non-users, the WTP for achieving good ecological quality at Breskens across the 4-digit postal code areas in the sampling area based on Models VII (including the distance to substitutes) and VIII (including distance to substitutes and the spatial trend variables) is visualised in Figure 5.6 for users (above) and non-users (below). The midpoints of the postal code areas are used to calculate the distance to Breskens and to the substitutes. Note that the values are not aggregated over areas outside the sampling area for which the results may not be representative.

For users, the maps show that Model VII overestimates the WTP in the north-east and north-west compared to Model VIII. In the southern area (Zeeuws-Vlaanderen), Model VII also results in little spatial variation in the WTP of users compared to Model VIII. The differences between Models VII and VIII for non-users are most prominent in the zones near the coast and in the southern part of the sampling area. For non-users in the south-east, the results of Model VII suggest that the negative effect of distance to the site is overrided by the positive effect of distance to substitutes. For this area, where beach locations are scarce and the nearest alternative for Breskens is located at a similar distance as Breskens, the overall result is that WTP increases as distance to Breskens increase. In the results of Model VIII, this pattern is not as strong as in Model VII, as can be seen in the lower-right figure, as a result of the spatial trend variables. Further research is required to be able to compare these results to for validation.

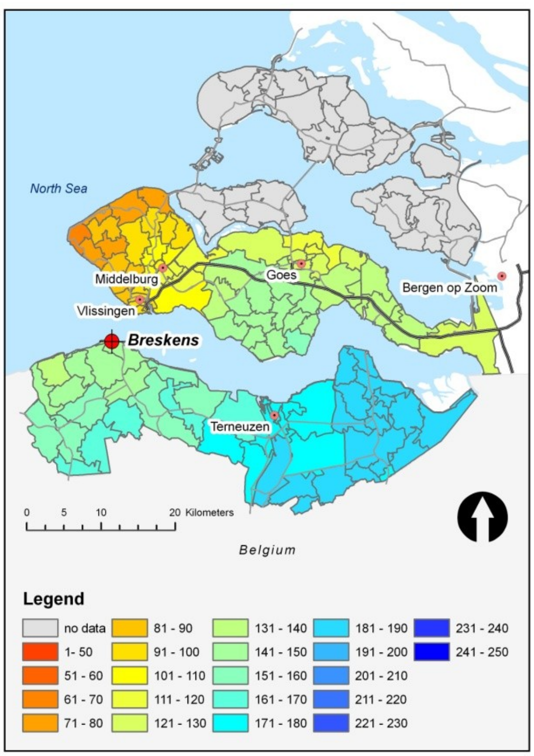
Model VII: individual WTP of users



Model VIII: individual WTP of users



Model VII: individual WTP of non-users



Model VIII: individual WTP of non-users

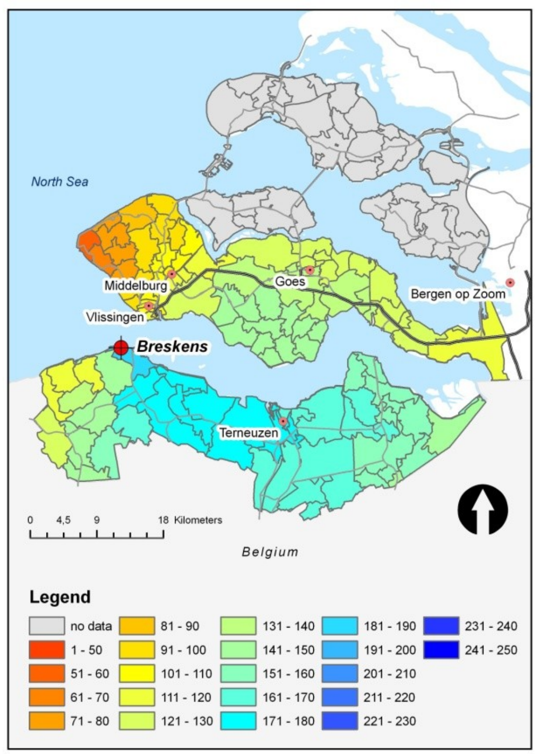


Figure 5.6 Maps of individual WTP for good ecological quality at Breskens
Note: the WTP values reflect individual WTP in Euros per household per year. The arrow denotes the north.

Comparison of the WTP results of Models VII and VIII with those of Model II, which only includes distance to the sites, shows that Model II overestimates WTP values of non-users up to 42 percent and underestimations range up to 26 percent in some of the postal code areas compared to Model VIII. The differences in WTP per postal code area between Models VII and VIII vary from -20 to 27 percent for non-users and from -15 up to 14 percent for users. Non-parametric Kolmogorov-Smirnov tests show that Models VII and VIII lead to significantly different distributed WTP values for both users and non-users at the five percent level (p=0.01 and p=0.04). Poe-tests (Poe et al. 2005) show that these differences are significant for some, but not all, postal code areas. This implies that accounting for directional heterogeneity in addition to the distance to substitutes not only results in a better model fit, but also in significantly different mean WTP estimates.

5.7 Summary and conclusions

Existing SP valuation studies in environmental economics have paid little attention to spatial variation in WTP values due to, among others, substitution and distance effects. The CE in the Scheldt river basin presented in this chapter provides an empirical test of different elements of the framework introduced in Chapter 2. Respondents in the survey were asked to select their preferred option from a set of three alternative sites, which provide a mix of environmental services and are located in a confined geographical area. The case study addressed three interrelated issues on spatial choices in environmental valuation in the design and analysis: (1) site-specific effects, (2) substitution effects, and (3) distance decay. For the estimation of site-specific values and flexible substitution patterns, the study used a labelled experiment and a large experimental design.

The first objective was to assess the effect of site-characteristics on the WTP for similar ecosystem services. The results show that the non-market benefits of ecological quality improvements at a water body are site-specific and depend on changes at other water bodies in the same catchment. This complicates the practice of benefits transfer based on generic attribute values for similar quality objectives between sites. In case of site-specific values, benefits transfer between sites is less accurate without adjusting for differences in physical site-characteristics. In this study, bathing and nature quality conditions are valued significantly different between sites, indicating that achieving a policy objective at one site is not a perfect substitute for the achievement of the same objective elsewhere. Furthermore, the results of the study provide insight in site-specific values and thereby help policymakers prioritising the allocation of their limited budgets based on welfare maximization principles.

The second objective was to analyse the substitution patterns among different locations providing similar services. A novel modelling approach developed in this chapter aimed to estimate disproportional substitution patterns between the alternatives, combining the advantages of mixed and universal logit models. Cross-effects of the attributes of alternatives were included in the site-specific utility functions in a mixed logit model. These cross-effects reflect disproportional effects of attribute changes of an alternative on its substitutes, which may arise if some alternatives are perceived to be more substitutable, or closer substitutes, than others. The inclusion of cross-effects allows for extra flexibility in the resulting substitution patterns in addition to the flexibility provided by random parameters and error-components.

Two cross-effects were found to be significant in the empirical analysis. The additional cross-effects showed that the two sites Braakman and Breskens with bathing opportunities are closer substitutes than Saeftinghe without bathing possibilities, but with a unique natural environment. The analysis showed that the cross-effects were not caused by scale or taste heterogeneity. Accounting for cross-effects resulted overall in a better model fit and produced significantly different welfare estimates for ecological improvement scenarios. Disregarding these cross-effects resulted in significant overestimation of WTP for improvement scenarios to moderate ecological quality levels up to 40 percent. This result questions the validity and reliability of existing welfare estimates from single-site studies in which such substitution effects are ignored. However, the impact of cross-effects on WTP estimates was not significant for all ecological quality improvement scenarios, for instance if the cross-effects estimates were small and scenarios included random parameters with wide confidence intervals. The conclusion is that standard mixed logit models are not flexible enough to control for remaining substitution effects caused by differences in the similarity of the alternatives. The results from this study point out the necessity to pay adequate attention in spatial choice studies to a complex pattern of substitution effects to reduce bias in WTP estimates. More empirical applications are needed to gain further insight in the impact that cross-effects can have on WTP estimates.

The methodology is presented with some shortcomings. The number of alternatives and attributes in this study was limited. If the size of the choice set is increased to include more alternatives, the identification of significant cross-effects may become more complicated, because the number of potential cross-effects becomes very large. Including an extensive number of alternatives and attributes also requires a large experimental design to estimate cross-effects. A large design (with many choice tasks for each respondent to fulfil) may cause practical implementation problems related to sample size or survey length, besides demanding too much from the cognitive capabilities of the respondents.

The third objective of the study concerned the conceptual distance-decay function presented in Chapter 3. Rather than simply estimating a generic distance-decay parameter for all locations and respondents, differences in distance decay across respondents and sites were assessed. The results showed that distance-decay effects differ between sites in magnitude and functional specification, and between users and non-users. These differences were explained by site-characteristics, such as the type of environmental goods and services they provide, besides respondent-characteristics, such as use and familiarity with the sites and the stated option values held by non-users. The cognitive distance error, reflecting the difference between objective and cognitive distance, was also expected to explain the different functional forms of the distance-decay estimates. Overestimation of the travel distance was linked to a different distance decay pattern than distance underestimation. However, the effect of cognitive distance errors was not tested statistically. The second case study presented in the next chapter will include this effect in the statistical analysis.

Furthermore, the results showed that if a study site was located in the region to which respondents felt most attached, the probability of choosing that site was significantly higher. Studies that disregard this feeling of place attachment may overestimate distance decay. No empirical evidence was found supporting the effect of the mode of transport on distance-decay effects, probably because cars are the main means of transport in the study area.

Finally, the study examined if the WTP values were subject to additional spatial heterogeneity caused by a non-random distribution of substitutes not included in the choice set across the study area. Two methods were used to analyse these effects: including the distance to substitutes excluded from the CE choice set in the WTP model, and applying the spatial expansion method. The results of the first approach showed that substitute effects were present between the study site Breskens and a set of other beaches in the study area. Respondents living close to another beach were willing to pay less for ecological quality improvements at Breskens. No substitution effects were found in the WTP for the other study sites or for the substitute sets containing sites listed by the respondents. The results hence suggest that substitute sets selected by researchers based on the similarity of the type of ecological type and recreational amenities of sites can be used to capture the effect of substitute accessibility.

Secondly, the spatial expansion method was applied to analyse directional effects in the choice probabilities and reduce biases in distance-decay effects. The results showed that simply including distance to substitutes was not sufficient to capture all spatial heterogeneity in distance decay in this study. Additional spatial variation was found in distance decay and hence in the WTP of all sites. The spatial expansion method led to better model fit and a significantly different spatial distribution of WTP estimates. The results revealed an overestimation of individual WTP values of more than 25 percent in some cases if directional effects were ignored.

Hence, both methodological approaches to assess spatial heterogeneity show that distance-decay parameters and WTP results may be biased if the accessibility of substitutes and remaining spatial heterogeneity are not controlled for. The recommendation for future valuation studies of spatially defined environmental goods is to test and where necessary control for this spatial variation in the specification of distance-decay functions, to produce more reliable WTP results and market delineation procedures for WTP aggregation. The methods both have advantages and disadvantages. Compared to including the distance to substitutes, the spatial expansion method is relatively easy to apply and only requires information about respondents' addresses and study site locations. It is therefore a useful method to identify spatial heterogeneity in WTP for analysts with limited access to GIS. A drawback of the method is that the interpretation of the results is not straightforward. Furthermore, the resulting WTP-function cannot easily be applied to other areas in benefit transfer studies. If transferability is required, including the distance to substitutes in the WTP-model may be the preferred approach, because this variable is clearly related to preference formation.

The results of this case study draw attention to the importance of site-specific values of environmental changes and of associated distance-decay effects, the substitution pattern between these sites and the effect of substitute accessibility on spatial heterogeneity in distance decay. The next chapter will present the case study in the Rhine river basin, in which various other aspects of distance decay and substitution will be addressed.

6. Testing for spatial choice set effects and spatial heterogeneity in WTP: a case study of the Rhine river basin

6.1 Introduction

This chapter presents a second case study, which examines the value of ecological improvements of eleven lakes in the Rhine-West basin. These eleven major lakes lie amidst the largest cities of the Netherlands in the western part of the country. They are popular for water-based recreation and at the same time provide habitat for a range of protected bird and animal species. A labelled choice experiment (CE) is designed in which respondents are asked to choose for an ecological improvement scenario at one of the lakes, against a certain payment. The study addresses several spatial effects on the valuation of ecological quality changes in these lakes.

The central question of this case study is how the spatial context of alternatives affects the probability of an alternative to be chosen. The case study has four objectives linked to the physical as psychological context of the analytical framework presented in Chapter 2. The first objective is to analyse the effects of cognitive distance on distance-decay effects by parameterising the effect of cognitive distance errors in the model. Second, directional heterogeneity in distance decay is assessed using one of the modelling approaches presented in Chapter 3. Third, the effects of enlarging the choice set by increasing the geographical scale on spatial choices are studied. The availability of a large number of alternatives is a typical characteristic of spatial choices. The expansion of the size of the choice set is expected to increase the choice task complexity. In this case study it is assessed if WTP estimates change and respondents become more uncertain as the choice set is expanded with additional, more distant alternatives. Finally, it is examined if the spatial distribution of alternatives influences choices in complex choice situations. The applicability of the competing destinations model, suggesting that the underlying decision-making process follows a hierarchical structure, is evaluated and compared to the outcomes of error-component models which allow for correlation between geographically nearby locations (Herriges and Phaneuf 2002).

The chapter is organised as follows. The next section lists the hypotheses that will be tested in this case study. In Section 6.3, the modelling approach is outlined. In Sections 6.4 and 6.5, the case study area and the study design are described. The general survey and model results are presented in Section 6.6. The chapter ends with a summary and conclusion in Section 6.7.

6.2 Main objectives and hypotheses

6.2.1 Heterogeneity in distance decay

The first two objectives of the case study are aimed at evaluating the distance-decay function of the analytical framework presented in Chapter 2. The null-hypothesis is that distance decay is best modelled using a generic parameter is tested against alternative specifications that allow for heterogeneity in distance decay across sites, respondents and directions from the sites.

The first issue of interest is the distance-decay function and its heterogeneity, providing further tests of the theoretical distance-decay function developed in Chapter 3. As in the Scheldt case study, differences in distance decay between sites and between users and non-users will be tested. Furthermore, the effects of cognitive distance will be addressed and a different modelling approach to test directional heterogeneity will be used. The first hypothesis to be tested is if distance-decay effects are site-specific:

H_0^1: The distance-decay effect is not significantly different across sites.

A higher WTP and therefore a lower distance-decay effect is expected for respondents that have visited the site compared to those who have not. The second hypothesis addresses potential differences in distance decay between users and non-users:

H_0^2: The distance-decay effect is not significantly different for users and non-users.

Rejection of this hypothesis would confirm the findings of the previous case study that visitation and corresponding knowledge and experience with a site affect distance decay. However, past visitation levels do not provide a basis for a strict division between use and non-use values. Further taste heterogeneity in distance decay that can be attributed to use and non-use values for water quality changes is examined by asking respondents what their main motivation is to contribute financially to the proposed scenarios of water quality improvements. This leads to the third hypothesis:

H_0^3: The distance-decay effect is not significantly different for use and for non-use related values.

In this case study non-use related values are defined as WTP driven by the motivation to improve the quality of the water bodies for the benefit of animals and plants. It is expected that WTP motivated by non-use values shows lower distance decay, because such values are not dependent on travel costs.

The next objective is to assess the effect of cognitive distance on choices and WTP estimates. Cognitive distance refers to people's beliefs about the distance between places that cannot be seen from each other (Montello 1991). As described in Section 3.4, there can be a difference between objective distance (e.g., in terms of kilometres based on the existing road network) and the cognitive distance (Walmsley and Jenkins 1992): a so-called cognitive distance error. The expectation is that respondents will use cognitive rather than objective distance when making choices. Controlling for cognitive distance errors in model estimation is hence expected to produce more reliable estimates of distance decay and significantly different WTP estimates. The fourth and fifth hypotheses of the case study are therefore:

H_0^4: The cognitive distance error does not affect preference and choices between locations;

H_0^5: The effect of cognitive distance errors does not result in significantly different WTP estimates.

Rejection of the fourth hypothesis would imply that the reliability of objective distance as an indicator of the distance-decay effect is questionable. This would be concerning for existing SP and travel cost studies, which have commonly used objective distance estimates and potentially produced biased WTP results. The fifth hypothesis is tested to see whether differences between objective and cognitive distance decay result in significantly different WTP estimates[9].

The study furthermore tests for spatial heterogeneity in distance decay. Spatial heterogeneity in the distance-decay parameter is expected arise due to differences in the availability of substitutes. It may also result from spatial differences in, for instance, perception of ecological quality or general attitude towards nature conservation or outdoor recreation. In such cases, the distance-decay effect will not be uniform across directions from the site. The sixth and seventh hypotheses that will be tested are:

H_0^6: Directional heterogeneity does not affect distance-decay parameters;

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[9] It is possible that controlling for cognitive distance errors increases the model fit, but does not result in significantly different WTP estimates. If the effect of cognitive distance error and its marginal value are small compared to the effect of objective distance (or the confidence intervals of the WTP estimates of the objective distance are wide), difference in the WTP between respondents who make distance judgment errors and those who estimate the distance correctly is not necessarily significant.

H_0^7: Directional heterogeneity does not lead to significantly different WTP estimates.

Acceptance of these hypotheses would suggest that the estimation of uniform distance-decay parameters reliably captures distance-decay effects in this case study.

6.2.2 Effects of the spatial scale of the choice set and spatial distribution of alternatives

One of the main characteristics of spatial choices is the complexity resulting from the availability of many different alternatives. The study aims to assess whether complexity of spatial choice tasks and learning effects influence choices in stated CEs.

Previous studies assessing the impact of choice complexity as a result of the number of alternatives in the choice set have performed tests *between* respondents provided with different numbers of alternatives (Swait and Adamowicz 2001; DeShazo and Fermo 2002; Arentze et al. 2003; Caussade et al. 2005). These studies find that the model variance initially decreases suggesting that preferences and choices become better-defined as more alternatives are added to the choice set. However, the variance increases when choice sets include more than three to four alternatives. The increased variance indicates that choices become less well-defined and the selection of the preferred alternative becomes less precise due to a higher complexity involved in choices with a larger number of alternatives (see Section 4.4). Larger variances may also indicate fatigue effects. Empirical results of fatigue effects in the literature are mixed. Some studies find significant fatigue effects (e.g., Kontoleon and Yabe 2003), whereas others do not (Ohler et al. 2000; Savage and Waldman 2008). It has also been argued that the exclusion of relevant substitutes in the choice set might bias parameter estimates and inflate WTP values (DeShazo et al. 2009). Including more alternatives is likely to increase the probability that relevant substitutes are included in the choice set.

The case study presented here provides the possibility for a *within*-respondent test of the effects of the choice set size. To this end, the CE is decomposed into three parts with choice sets of different sizes. The total choice set contains the eleven largest lakes in the study area. In the first part, consisting of three choices, respondents are asked to choose among ecological improvement scenarios at the four lakes closest to their residential location. In the second part of the CE, consisting of four choices, the other lakes are added to the choice set. In each choice task in the second part, different combinations of seven of the eleven lakes with associated quality and price increases are presented as eligible alternatives, following the experimental design. In the third part the respondents are asked to make an additional two choices among ecological improvement scenarios at the four nearest lakes to their home. The first and third part of the CE will be referred to as the “small set” and the second part as the “large set”.

A comparison can be made between the choices among alternatives in the small versus the large choice set and resulting WTP values for ecological improvements for the same lake. This comparison provides a test of the effect of the geographical scale of the choice set on WTP, with embedded tests of learning and complexity effects. Learning effects, reflected in decreasing model variance, may appear along a sequence of choices, as respondents learn about the CE setting and familiarise themselves with the choice tasks. In this case study, changing the size of the choice set provides another possibility for learning. Embedding the small set in the large set which contains more substitutes requires respondents to actively evaluate these additional substitutes and the spatial setting, rather than only taking the information about the quality and location of these substitutes provided in the explanatory text into account. Thinking about additional substitutes may help respondents to learn and refine their preferences for the alternatives in the second part of the small set. However, it may also make respondents increasingly aware of their budget allocation possibilities, which might increase the perceived difficulty of their choices.

Different hypotheses are formulated to test the effect of the geographical scale of the choice set on WTP. First, it is examined if adding alternatives increases the complexity of the choice task and consequently leads to inconsistent choices and preferences, measured as changes in coefficients of the attributes. Under assumptions of complete and transitive preferences, it is expected that the marginal value of a quality change at one of the lakes does not change after the inclusion of other improvement scenarios at other lakes in the choice set. However, the preferences for the attributes might change if the complexity of the choice task in the larger choice set, where respondents have to evaluate additional substitutes, becomes too large. The increased complexity could also result in larger model variance, hence a smaller scale parameter. This leads to the following hypotheses:

H_0^8: WTP for water quality changes at lake *i* is independent of the geographical scale of the choice set in which it is embedded: WTP_i (small set)=WTP_i (large set);

H_0^{8a}: The variable coefficients of the small and large set are not different;

H_0^{8b}: The scale coefficients of the small and large set are not different.

Rejection of this hypothesis H_0^8 would imply that choice sets including more alternatives from a larger geographical scale lead to different WTP results. Different model results for choices based on the large choice set than the small set due to unstable preferences would lead to question the validity and reliability of parameter estimates of the large set and would call for a reduction in the number of alternatives included in the choice set. By examining differences in preferences as a result of changes in choice task complexity of spatial choices, this study may provide more information on the trade-off in choice set size between increasing the complexity involved in large choice sets and the importance of controlling for relevant substitutes.

A limitation of the study design is that asking respondents to choose first among a subset of the alternatives in order to familiarize them with the choice task and part of the alternatives may have reduced the complexity involved in choosing among the large set with an increased number of alternatives. All respondents were presented the small choice set prior to the large one. If part of the sample had started with the large choice set, the hypothesis that choice task complexity can be mitigated by presenting a subset of alternatives first could have been tested more rigorously, as it would have provided the opportunity to control for ordering effects. As a consequence of the study design learning and complexity effects are confounded when comparing the choices in the first part of the small set and the choice of the large set.

Potential learning effects can be tested in two additional ways. First, the choices of first and second part of the small set are compared. Thereby, it is tested if respondents change their WTP after active consideration of additional locations included in the large choice set. The hypotheses to be tested are:

H_0^9: WTP for water quality changes does not change after evaluating the larger choice set:

WTP (1^{st} part of the small set) =WTP (2^{nd} part of the small set);

H_0^{9a}: the variable coefficients of the 1^{st} and 2^{nd} part of the small set are not different;

H_0^{9b}: the scale parameter of the 1^{st} and 2^{nd} part of the small set are not different.

If WTP values between the first and last part of the choice experiment differ, this may indicate that the preferences of respondents regarding ecological quality improvements in the lakes in the small choice set have changed after consideration of the substitutes in the surrounding area. If attribute parameters are not statistically different between the first and second part of the small set H_0^{9a}, the conclusion would be that respondents have complete and transitive preferences. If the variance is not significantly different either (H_0^{9b}), failure to reject this hypothesis would suggest that no learning effects are present. It would also imply that respondents do not find the choice tasks in the small set more demanding after consideration of the large choice set and do not suffer from fatigue after considering the choice tasks. As respondents may have learned but may also find the choice task more difficult after actively considering the substitutes in the large choice set or suffer from fatigue, the variance can either decrease or increase.

A second learning effect may be present in the choice sequence of the large set. Similar to the previous hypothesis, respondents' preferences may not be fully complete and transitive. This would lead to the rejection of H_0^{10a} specified below. In addition, preferences may become more deterministic in which case H_0^{10b} would be rejected. This leads to the following set of hypotheses:

H_0^{10}: WTP for water quality changes does not change during the choices in the large choice set;

H_0^{10a}: the variable coefficients of the 1st and 4th choice in the large set are not different;[10]

H_0^{10b}: the scale parameter of the 1st and 4th choice in the large set are not different.

Figure 6.1 gives a schematic overview of the composition of the choice experiment with nine choice tasks divided over the small and large choice sets. The columns refer to the tested hypotheses and the colours indicate which choices or subsets of choices will be compared in each test (dark blue against light blue choices). The tests based on the pooled model for which the data of the small and large choice sets are put together, and the Swait and Louviere tests will be explained in the following section.

The final objective of this case study is to assess the effect of the spatial distribution of the alternatives and related complexity of choice set composition. Differences in variance as addressed in the 8th hypothesis indicate that the complexity of the choice tasks including a larger number of alternatives might be different. They may also give information about possible changes in decision-strategies. For spatial choice behaviour, the expectation is that increased complexity may lead to hierarchical decision-making strategies. As described in Chapter 2, economic geography and spatial cognition theories argue that people use so-called "cognitive maps" whenever they make choices between a large number of alternatives over space. The information contained in these cognitive maps is stored in a hierarchal manner, categorising locations into so-called perceptual regions at several spatial scales. In this theory, the hierarchical format influences the choices when people have to retrieve spatial information. It is assumed that as a result of hierarchical information storage people choose a region before choosing a specific alternative within that region, thereby reducing the complexity of having to evaluate all alternatives simultaneously.

[10] It was considered to be sufficient for identifying learning effects to test if the parameters at the first and final choice task in the large set were consistent.

Choice sets	Choice tasks	Pooled model		Swait & Louviere test					
Small set – 1st part : 4 nearest lakes (C4_1)	1st Choice	H_0^8	H_0^9		H_0^8				
	2nd Choice			H_0^8					
	3rd Choice					H_0^8	H_0^9	H_0^9	
Large set: choice between 7 lakes (C7)	1st Choice	H_0^8			H_0^8	H_0^8			H_0^{10}
	2nd Choice								
	3rd Choice			H_0^8					
	4th Choice								H_0^{10}
Small set – 2nd part 4 nearest lakes (C4_2)	4th Choice	H_0^8	H_0^9	H_0^8			H_0^9		
	5th Choice							H_0^9	

Figure 6.1 Schematic overview of choice sets, hypotheses and tests

In this case study the applicability of the competing destinations model (see Chapter 4) will be tested and compared to an error-component model which controls for differences in the variance related the proximity of the eleven water bodies. Water bodies, like many other environmental media and the services they provide, are often unevenly or non-randomly distributed over space. The first question is if the proximity of alternative locations affects WTP for changes in ecosystem services provided by different water bodies. Related to that is the question is whether there is evidence for hierarchical decision-making in choices for valuation of these environmental goods and services.

Hence, the final hypothesis to be tested concerns the effect of the spatial distribution of alternatives:

H_0^{11}: Differences in proximity to other alternatives do not affect the probability of an alternative to be chosen.

Rejection of this hypothesis would imply that discrete choice models have to control for the spatial distribution of alternatives to reliably reflect the substitution pattern between environmental goods and services provided at different locations. Moreover, it would imply that the substitution pattern cannot be captured only by including the distance from the respondents to the sites. The modelling approach which will enable testing of these hypotheses is presented in the next section.

6.3 Modelling approach

The CE aims at the valuation of changes in the provision of ecosystem goods and services at eleven lakes resulting from ecological quality changes. The utility U is modelled as a function of the characteristics X

of the good, respondent characteristics *Y*, distance *D* and price *P*, as well as a random component reflecting unobserved utility *e*, specified as follows:

$$U = f\ (X, Y, D, P) + e \qquad (6.1)$$

In order to test the hypotheses presented in the previous section, six different models will be estimated. Model I in equation (6.2) can be estimated as a mixed logit model and includes the attributes and the distance to the sites. In the utility specification *U*, α reflects the alternative specific constant (ASC) for each alternative *i*, *X* denotes the attributes of the CE with their corresponding parameters β, and ε reflects the error term. The attributes represent the changes in environmental goods and services provided by the different sites. The distance-effects *D* in Model I are expected to be individual and site-specific. The distance variable D_{in}, reflecting the objective distance from site *i* to respondent *n*, is included in the model in interaction with the quality attributes X $(X_i * D_{in})$. The distance-coefficients are expected to be subject to preference heterogeneity across respondents, for instance caused by individual differences in experience or familiarity with the site or the perceived cost of travelling. They are therefore included as random parameters in the models. An error-component is included that accounts for the difference in error terms between the hypothetical alternatives and the status quo. λ_{in} is the parameter of the individual specific random error-component, assumed to have a standard normal distribution N[0,1]. The model controls for the panel structure of the data.

In order to test the first hypothesis, differences in the distance-decay effect among sites are explored by specifying site-specific distance-decay effects. Their significance is tested using Likelihood-ratio (LR) tests. The second hypothesis addresses differences in distance-decay effects between users and non-users. This hypothesis is tested by including an interaction between a dummy-variable *R* taking the value 1 if an individual *n* has visited site *i* and the interaction of distance and the quality attributes $(X_i*D_{in}*R_{in})$. Another interaction is included for respondent characteristics Y_n including non-use related preferences. A significant coefficient for the Y_n variable reflecting use and non-use values implies the rejection of the third hypothesis.

To test the fourth and fifth hypotheses, Model II as specified in equation (6.3) is estimated, which extends Model I with a variable E_n for the cognitive distance error. This variable takes the value 1 or -1 if the respondent *n* overestimates respectively underestimates the objective travel distance to the site. It provides a correction factor for cognitive distance errors on the effect of the objective distance. Therefore, the variable E_n is interacted with the quality attributes and individual distance interaction-term ($X*D_{in}$). A significant coefficient for the variable for cognitive distance errors *($X_i*D_{in}*E_{in}$)* will lead to rejection of the fourth hypothesis. Models I and II are specified as follows:

Model I: $$U_{in} = \alpha_i + \beta_i^x X_i + \beta^p P + \beta_{in}^d (X_i * D_{in}) + \beta_i^r (X_i * D_{in} * R_{in}) + \beta_i^y (X_i * D_{in} * Y_n) + \lambda_{in}^h d_{in} + \varepsilon_{in} \quad (6.2)$$

Model II: $$U_{in} = \alpha_i + \beta_i^x X_i + \beta^p P + \beta_{in}^d (X_i * D_{in}) + \beta_i^r (X_i * D_{in} * R_{in}) + \beta_i^y (X_i * D_{in} * Y_n) + \beta_i^e (X_i * D_{in} * E_{in}) + \lambda_{in}^h d_{in} + \varepsilon_{in} \quad (6.3)$$

Next, the WTP values are estimated for both models for a change in X to see if the cognitive distance error leads to different WTP estimates for the quality changes between Model I and Model II (H_0^5). This part of the analysis is only based on the data of the small set, as respondents were only asked to state their cognitive distance estimate for the four nearest lakes, contained in the small choice set.

The sixth and seventh hypotheses address the directionality of distance-decay effects, for which a two-dimensional analysis is necessary. To account for directional differences in distance decay, dummy variables for the location of the site relative to the respondent are specified. These dummies indicate whether the respondent is living north (*N*), north-east (*NE*), east (*E*), south-east (*SE*), south (*S*), south-west (*SW*) or west (W) from the site. The north-west direction is taken as the baseline. Since the study concerns the WTP for quality changes and its variation over space, the directional dummies are interacted with the interaction of the attributes and distance (*X*D*). The directional effects are expected to be site-specific. The directional interaction terms are included in the utility function in Model III in equation (6.4), which is specified as follows:

Model III $$U_{in} = \alpha_i + \beta_i^x X_i + \beta^p P + \beta_{in}^d (X_i * D_{in}) + \beta_i^r (X_i * D_{in} * R_{in}) + \beta_i^y (X_i * D_{in} * Y_n) + \beta_i^{reg}((X_i * D_{in}) * (N + NE + E + SE + S + SW + W)) + \lambda_{in}^h d_{in} + \varepsilon_{in} \quad (6.4)$$

β_i^{reg} in Model III represents the parameters reflecting site-specific directional effects in distance decay. Significant coefficients of the parameters β_i^{reg} reflect spatial heterogeneity and imply a different distance-decay effect for those respondents located in the relevant compass region from the site. This part of the analysis uses the data of the second part of the experiment (the large set), which contains observations for the lakes in different directions at a wide distance range from the sites. Models I-III are estimated in WTP-space (see Section 2.3 and Annex I). These models give the WTP estimate of the random parameters and, in addition, provide information about scale heterogeneity.

Three different tests of hypotheses H_0^8, H_0^9 and H_0^{10} are performed. As a first test of hypothesis H_0^8, Model I with a generic distance parameter is separately estimated for the small and the large set.

The resulting WTP estimates and their confidence intervals are compared. As usual, overlapping confidence intervals imply that the WTP estimates are not significantly different. A second test is performed by using the Swait and Louviere (SL) test for differences in the attribute and scale parameters (Swait and Louviere 1993) (see Section 4.4 and Annex II). This test is used for hypotheses H_0^8, H_0^9 and H_0^{10}.

Because of the limited possibility of the SL-test to control for the panel data structure, a mixed logit model is estimated based on the pooled dataset of the large and small sets, providing a third test of hypotheses H_0^8 and H_0^9. In this case study, error-components are used to capture scale-differences between the small and large choice sets. Model IV in equation (6.5) includes two additional error-components. One error-component is estimated for the large set (*C7*) in which people choose among quality scenarios at seven lakes out of the eleven lakes in the total choice set ($\lambda_{in}^7 C7_{in}$). A second error-component is included in the model for the last part of the small set (*C4_2*) containing the same four nearest lakes as in the first part ($\lambda_{in}^4 C4\_2_{in}$). As before, the λ_{in} parameters are assumed to have a standard normal distribution N[0,1]. Significant parameter estimates for these error-components indicate that the variance of the observations in these subsets is different from the initial three observations of the small set. Furthermore, to understand if preferences change, which is reflected in different parameter estimates for the quality attributes, dummy variables are created for the large set (*C7*) and second part of the small set (*C4_2*) and interacted with the quality attribute. This leads to the following model specification:

Model IV
$$U_{in} = \alpha_i + \beta_i^x X_i + \beta^p P + \beta_{in}^d (X_i * D_{in}) + \beta_i^r (X_i * D_{in} * R_{in}) + \beta_i^y (X_i * D_{in} * Y_n) + \beta_i^7 (X_i * C7) + \beta_i^{4\_2} (X_i * C4\_2) + \lambda_{in}^h d_{in} + \lambda_{in}^7 C7_{in} + \lambda_{in}^4 C4\_2_{in} + \varepsilon_{in} \quad (6.5)$$

The main limitation of this test is that for identification of the model, it is not possible to include the error-components for all the alternatives including the opt-out. Therefore, the error-components are left out of the utility function of the opt-out in the model specification: *C_7* and *C4_2* take the value zero for the opt-out. The share of opt-out choices is assumed to be similar across the two datasets.

The final hypothesis to be tested is if the spatial distribution of alternatives affects the substitution pattern in choices among different locations in complex choice settings. This part of the analysis uses the large data set, as the *a priori* expectation is that complexity effects due to the larger number of alternatives are more likely to influence choices than in the small set. Two different modelling approaches are compared. In the first approach, the competing destinations model is used, as introduced in Section 4.4. This model has been put forward to address hierarchical decision-making strategies. The assumption of the model is that the proximity of alternative sites affects the choice probability of a site as a result of the perceptual regions in which alternatives are embedded. Model V in equation (6.6) is a competing destinations model, which includes an accessibility indicator A_n in the utility specification:

Model V $$U_{in} = \alpha_i + \beta_i^x X_i + \beta^p P + \beta_{in}^d (X_i * D_{in}) + \beta_i^r (X_i * D_{in} * R_{in}) + \beta_i^y (X_i * D_{in} * Y_n) + \beta_i^A * A_i + \lambda_{in}^h d_{in} + \varepsilon_{in} \quad (6.6)$$

where $$A_i = ln\left[\frac{1}{J-1}\sum_{\substack{j \\ j\neq i}} \frac{W_j}{d_{ij}}\right]$$

The accessibility indicator reflects whether alternative *i* is included in individual's choice set and is a measure composed of the inverse distance between *i* and all other alternatives *j* in the full choice set *J* (d_{ij}), weighted by the attractiveness W_j of alternative *j*. Different specifications of the attractiveness of an alternative W_j are compared, using objective characteristics as well as perception based characterisation of the different lakes in the choice experiment. This model is compared to a model with additional error-components, presented as Model VI:

Model VI $$U_{in} = \alpha_i + \beta_i^x X_i + \beta^p P + \beta_{in}^d (X_i * D_{in}) + \beta_i^r (X_i * D_{in} * R_{in}) + \beta_i^y (X_i * D_{in} * Y_n) + \lambda_{in}^h d_{in} + \lambda_{in}^{1\ldots m} d_{in}^{1\ldots m} + \varepsilon_{in} \quad (6.7)$$

Since locations located near one another are expected to be closer substitutes than locations that lie further apart, *m* additional error-components are included ($\lambda_{in}^{1\ldots m} d_{in}^{1\ldots m}$). These allow for correlation in the unobserved variation between geographically nearby locations, as suggested by Herriges and Phaneuf (2002). Correlations in the error term of alternatives are expected to result when respondents cluster these alternatives based on similarities in their characteristics. Besides proximity, other criteria that may explain heteroskedasticity across different groups of alternatives are also tested, to see if it is indeed the geographical proximity that drives substitution between the sites, or if other criteria better explain correlation between the sites. Models IV-VI are estimated in preference space.

The results of the models are presented in Section 6.6. The next section shortly describes the case study area.

6.4 Case study area

The Rhine-West basin is the most westerly located sub-catchment of the Rhine delta. The total surface area of Rhine-West is around 1.2 million hectares, comprising the province of North Holland and parts of the provinces of South Holland, Utrecht and Gelderland. Rhine-West is for 60 percent under agriculture.

The Randstad, comprising the cities Amsterdam, Utrecht, Rotterdam and The Hague, is located in the Rhine-West area. The Randstad is the most densely populated urban area in the Netherlands. The center of the Randstad is relatively thinly populated and has a rural character, known as the Green Heart. Eleven lakes (see Figure 6.2) lying between these main cities were selected as alternatives and constitute the total choice set in the experiment: the Kagerplassen, Braassemermeer, Westeinder Plassen, Langeraarse Plassen, Nieuwkoopse Plassen, Reeuwijkse Plassen, Vinkeveense Plassen, Naardermeer, Ankeveense Plassen, Loosdrechtse Plassen and the Maarsseveense Plassen. These lakes are of reasonable size (most are larger than 200 ha) and provide a range of water recreation possibilities, including boating, fishing, bathing and nature watching. The area also offers a habitat for a number of "red list" bird species. Although they provide similar recreational possibilities, the lakes are not perfects substitutes as they lie up to 60 kilometres apart, which is a distance that recreationists in a small country as the Netherlands are likely to consider too far for a daytrip.

The lakes fall in similar water body classes under the WFD: most are shallow lakes of moderate size, except for the smaller natural lake Naardermeer and the deeper Vinkeveense Plassen. Eight of the eleven selected lakes were formed after peat extraction in the 18^{th} and 19^{th} centuries. All lakes are subject to ecological improvements under the Water Framework Directive (WFD), as they are currently considered to be "at risk" of not achieving the 2015 WFD objectives of Good Ecological Status (GES). The water system in the Rhine-West has been subject to substantial morphological change to guarantee and improve living and working conditions, including safety against flooding and navigability. More recently, changes have been oriented towards floodplain restoration and nature development. Eutrophication, a consequence of excessive nitrogen and phosphorus loads, is the main management issue for regional waters, including the case study sites. Drainage of agricultural land leads to nutrient levels, which far exceed existing standards. As a result, most lakes are currently of moderate quality, with the exception of the Naardermeer, which has a good ecological quality.

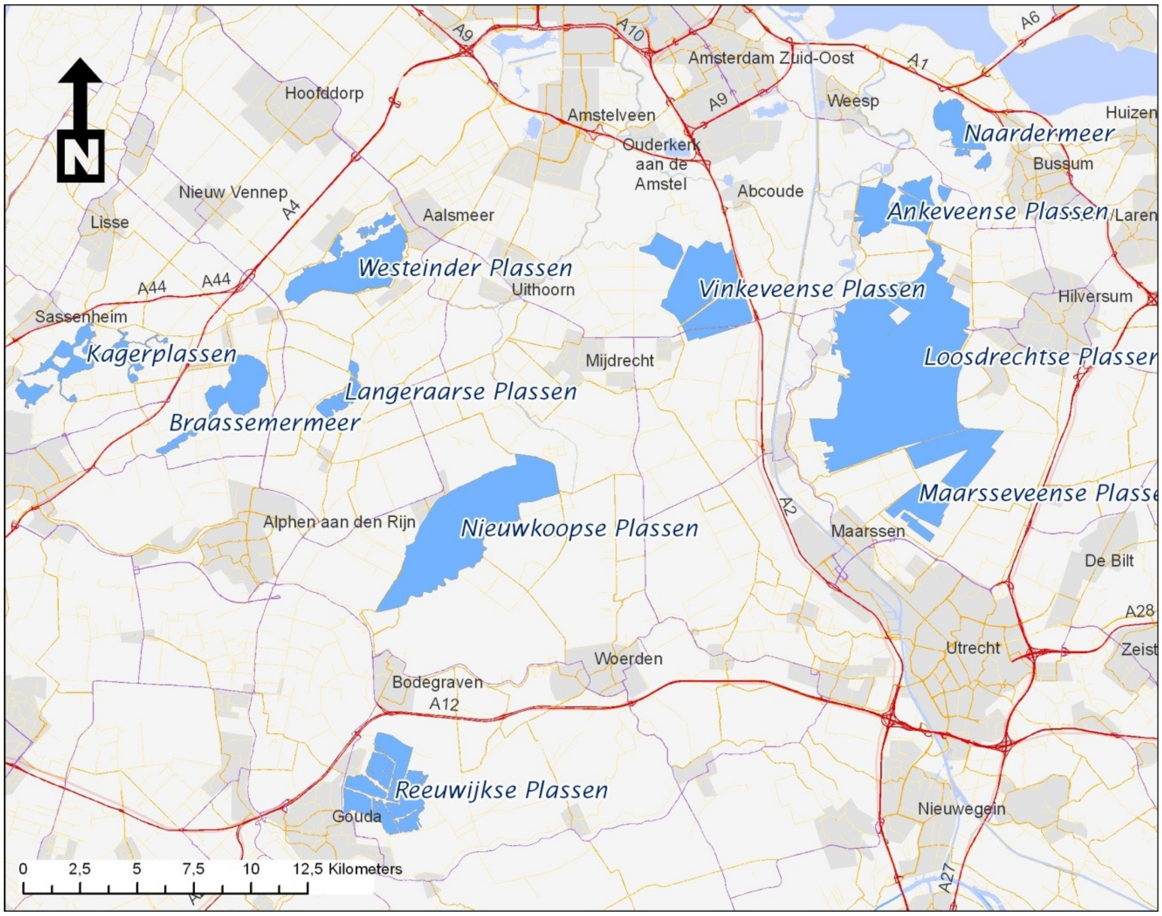


Figure 6.2 Map of the study area of the Rhine case study

The Vecht area, which includes the Naardermeer, Ankeveense Plassen, Loosdrechtse Plassen and Maarsseveense Plassen, has been subject to three other valuation studies. Bos and van den Bergh (1998) present a cost-benefit analysis, in which they include the benefits of recreation and amenity based on tourism expenditures and agricultural revenues. The same benefits types are included in Van den Bergh et al. (2001), who present a spatial ecological-economic model for the area. Van der Kruk (2001) presents a hedonic pricing study. These studies exclude non-use values. Brouwer and Slangen (1998) present a CV study on the economic value of wildlife conservation measures in peatland areas in the Netherlands, and in particular the southern area of the Green Heart, just south of the study area of this thesis.

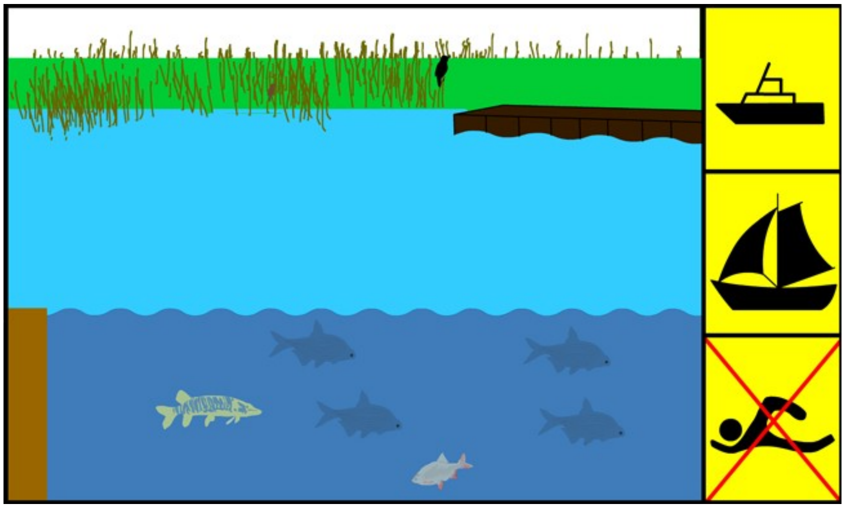
6.5 Survey design and implementation

In this stated CE, the non-market benefits that households attach to improved ecological quality in the eleven lakes in the Green Heart in the west of the Netherlands is assessed. The study was designed to test the hypotheses on distance decay and spatial correlation between the alternatives. A labelled choice experiment was used. Including the different locations as separate alternatives allows for the estimation of the spatial correlation in WTP and differences in variances across alternatives, expected to arise due to differences in site-characteristics and familiarity with the sites.

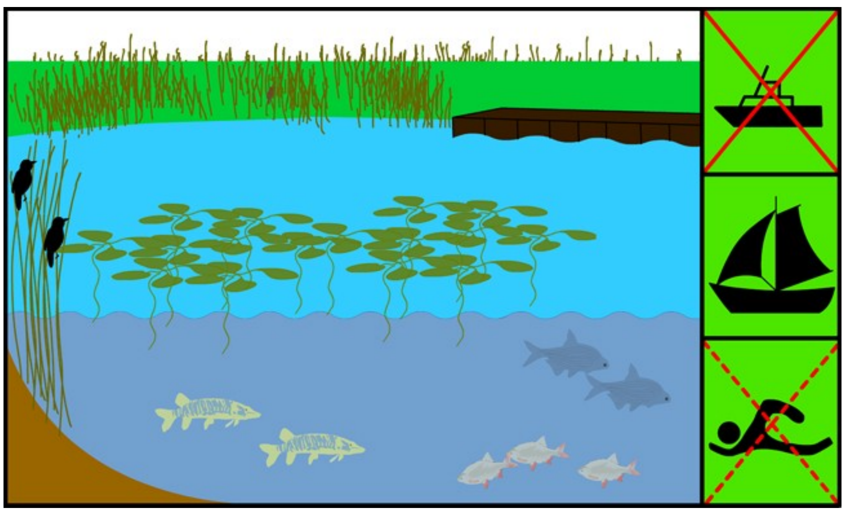
The good under valuation consists of the use and non-use values of ecosystem quality improvements of the eleven lakes following the implementation of the WFD aiming to achieve GES in 2015. The policy objectives for the eleven lakes were translated by an ecologist into three different ecological equilibrium states, reflecting the current status, an intermediate state and the optimal level of GES. These states were specified in terms of the number and diversity of fish and birds, water clarity, in-water and on-shore vegetation and the presence of bank structures. The description of the three ecological states were visualised in easily interpretable illustrations with pictograms reflecting the possibilities for motorized boating, sailing and bathing, accompanied by a textual explanation (see Figure 6.3).

Expanding reed areas and limiting the recreation possibilities for motorized boating were considered necessary to achieve the highest ecological quality level; i.e. the provision of habitat for birds, purification of water, and prevention of eutrophication and disturbance of nutrients deposited in the soil. This implies that achieving the intermediate and optimal state will increase the provision of ecosystem services such as nature watching and bathing amenities but reduce boating possibilities at the same time compared to the current state. Because of this trade-off, the ecologically optimal status may not be necessarily associated with the highest WTP. The ordering of the two improvement levels is therefore expected to be subject to taste heterogeneity. Preferences are likely to differ across respondents, depending on the type of recreation or amenity they value most and differences in the perceived suitability of the lakes to provide recreational and nature values.

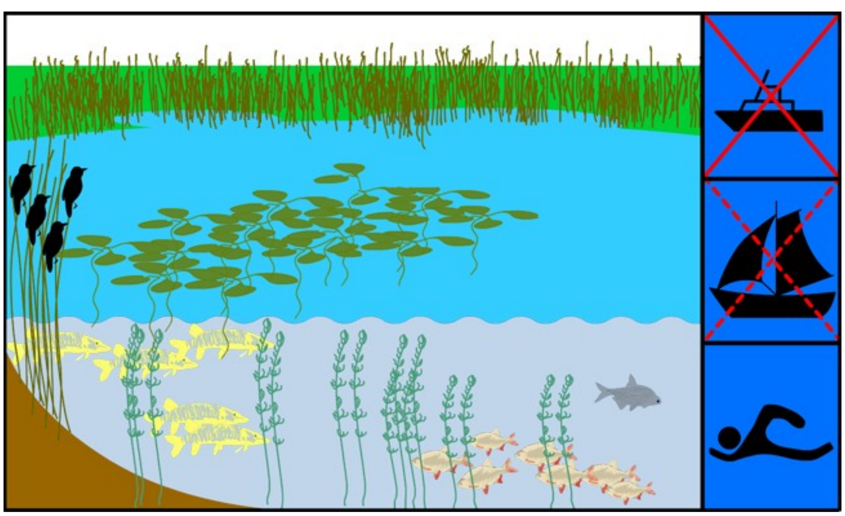
The three levels were colour-coded: yellow for the current state, green for the intermediate state and blue for the optimal state. These colours were thoroughly pretested and used in the design of the choice cards to depict the future quality levels at the different locations along with their respective prices. Figure 6.4 shows examples of choice cards of the small and large sets. In the survey, the illustrations of the ecological quality were depicted beside each choice card.



At the **YELLOW** level, the water is turbid, and you can see less than a meter deep. There are few birds, especially few endangered bird species. There are many breams, but few other fish species, such as pike. Reed grows along some of the banks. Bathing is often prohibited due to toxic algae blooms. Sailing and motorized boating is allowed and there are many piers.



At the **GREEN** level, the water is rather clear and visibility is about one meter. There are some breams and pikes. A small number of endangered bird species are present. There are some water plants and reed is found along the banks. Due to toxic algae, bathing is prohibited a couple of times each summer. Motorized boating is prohibited, but sailing is possible and piers are available.



At the **BLUE** level the water is very clear. There are many fish species, primarily pike. There are also various protected bird species present, such as the reed warbler. There are many water plants and thick reed areas along most of the banks. Swimming is possible during the entire summer. There are more shallow areas, in which sailing is not possible. Motorized boating is prohibited.

Figure 6.3 Ecological quality descriptions used in the choice experiment

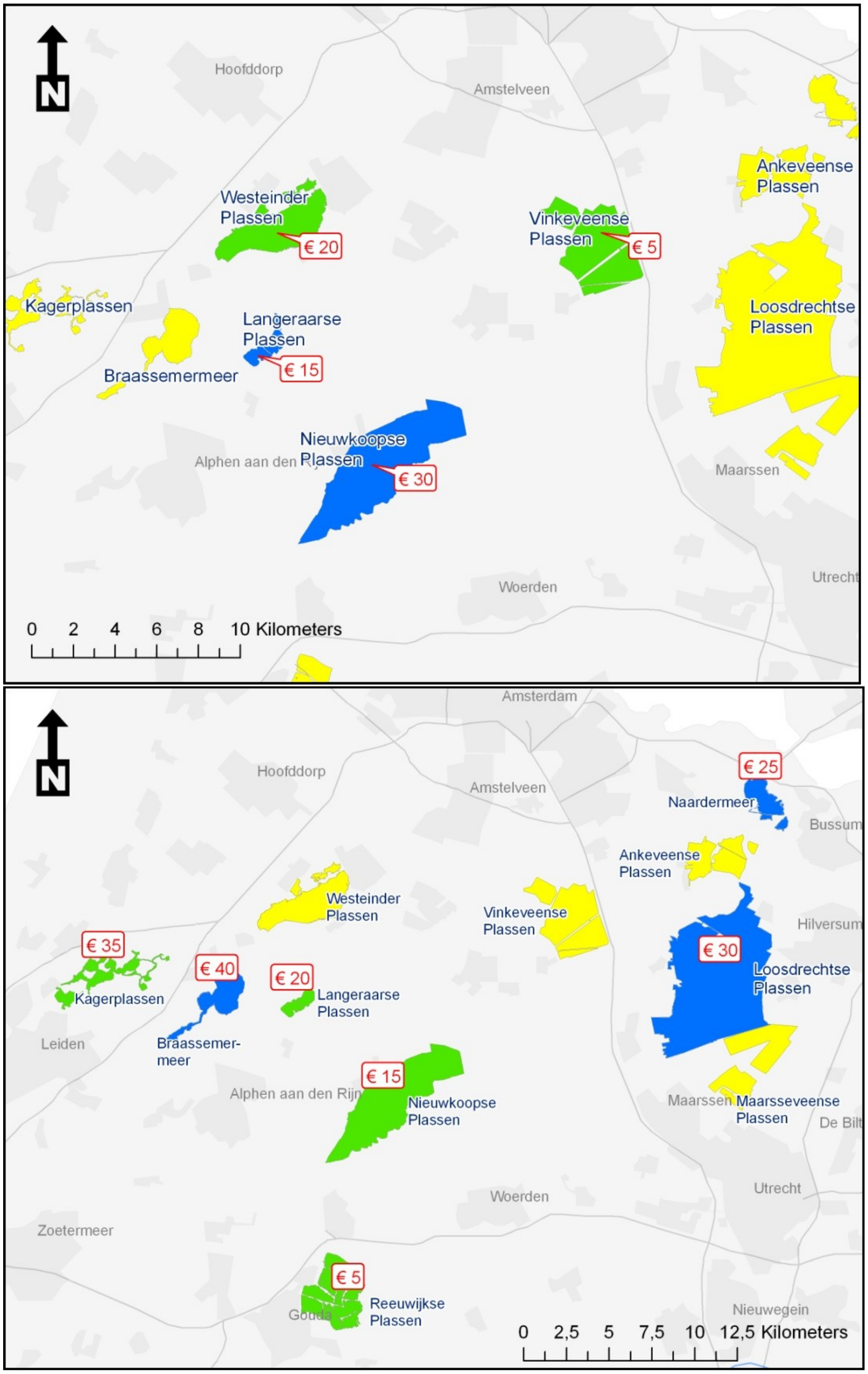


Figure 6.4 Example choice card of the small (above) and large (below) choice sets

Table 6.1 Composition of choice sets in subsamples

Lake	Subset 1	Subset 2	Subset 3	Subset 4	Subset 5	Subset 6
Kagerplassen		X				
Braassemermeer		X	X			
Westeinder Plassen		X				X
Langeraarse Plassen		X	X			X
Nieuwkoopse Plassen			X			X
Reeuwijkse Plassen			X			
Vinkeveense Plassen	X				X	X
Naardermeer				X	X	
Ankeveense Plassen	X			X	X	
Loosdrechtse Plassen	X			X	X	
Maarsseveense Plassen	X			X		

The price-attribute ranged from five to forty Euros per household per year, based on the maximum WTP stated in pre-tests. The payment vehicle was an increase in the annual waterboard tax that every household living in the area has to pay for local and regional water management. This payment vehicle has been used in other SP studies on the valuation of water quality valuation, for example, in Brouwer (2006). Respondents were asked to choose among various quality improvement scenarios of the lakes against an additional tax payment. Each choice task included an opt-out option, in which quality remained at current level and taxes would not increase. The survey text explained that the non-chosen lakes would remain at their current quality level and the tax increase would only be spent on the ecological quality improvement at the chosen (preferred) alternative.

As introduced in Section 6.2, in the first and third part of the experiment, each respondent was presented the small set containing the four lakes close to his or her home location. The sample was divided into six sub-samples based on the national 4-digit postal code areas to offer all respondents the possibility to choose among the four nearest lakes[11]. Hence, the choice set composition differs between the six sub-samples and the subsets overlap (see Table 6.1). The same D-efficient design with 5 blocks was used across the subsets, only the labels changed to reflect the lakes in each subset. The D-efficient design was generated using Sawtooth Software (2008).

[11] For most postal code areas, the small set includes the four nearest lakes. In a small number of postal code areas the fourth lake in the choice set was further away than one of the other alternatives. This was the result of a trade-off between sample size and alternative-relevance. Specifying more versions and sub-samples was considered too complicated for the experimental design and practical implementation of the survey.

In the second part of the choice experiment, the geographical scale of the experiment was expanded. The choice tasks were based on a D-efficiency design with 30 blocks. Here, respondents could choose their preferred alternative from seven out of the eleven lakes in the wider area changing in quality against a tax increase. Hence, in each choice task, different combinations of seven out of eleven lakes with an associated quality and price increases were presented as eligible alternatives.

The questionnaire was finalized after a focus group discussion and six thorough pre-testing rounds, both in face-to-face interviews and online. The questionnaire consisted of three main parts with questions covering: (a) the perception of lake quality and recreation, (b) the choice experiment, and (c) socio-demographic characteristics. The questionnaire is included in Annex V.

The data was collected in March 2009 using an online panel of respondents. Respondents were selected and assigned to one of the subsets based on their postal codes. Eligible respondents lived in postal code areas within a 40-kilometre range of the four lakes closest to their home. One invitation and two reminders were sent to obtain sufficient responses and ensure representativeness of the sample for the population living in the area. Figure 6.5 shows the distribution of the sample with green dots reflecting the residential locations of the respondents.

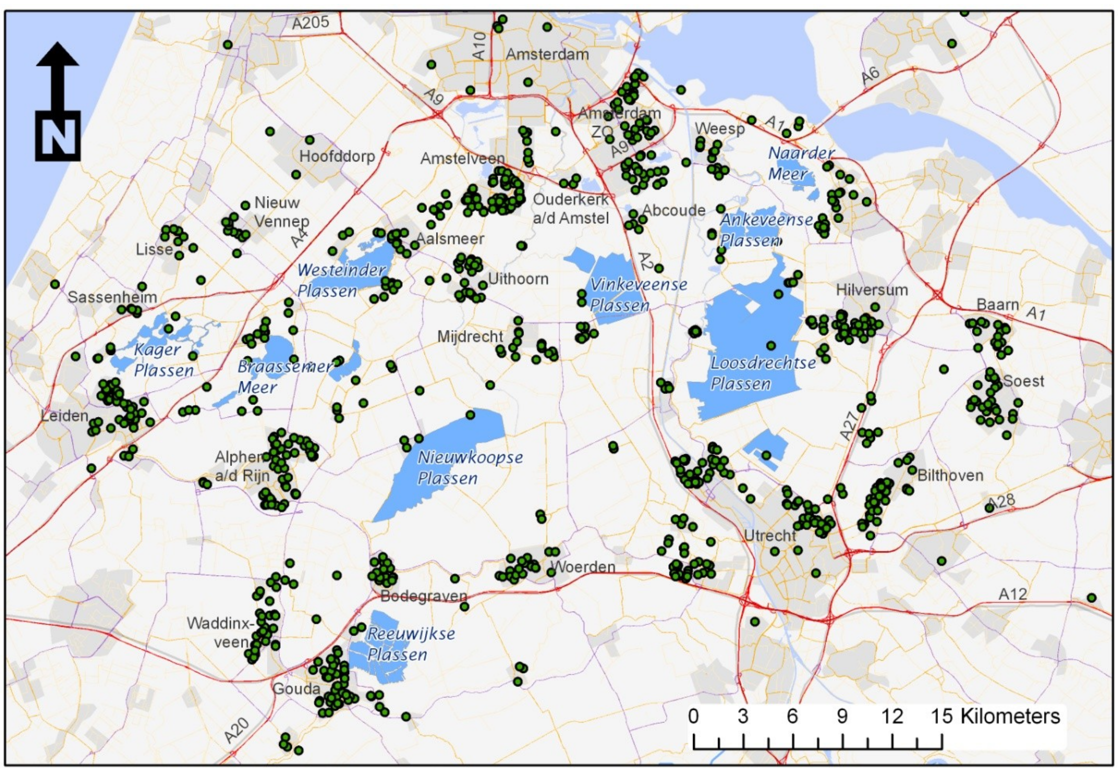


Figure 6.5 Sample distribution

6.6 Results

6.6.1 General survey results

A panel of in total 889 respondents was acquired from an online survey company. The descriptive statistics are presented in Table 6.2. It took respondents on average 15 minutes to complete the survey. The modal education level is higher vocational training (HBO), 15 percent of the respondents have completed a middle vocational training and 17 percent hold a university degree. This education level is higher than the average for the whole Dutch population (CBS 2008), but conform regional socio-economic statistics (Ruimtemonitor 2008). Most households earn a modal up to double modal income, which is €31500 respectively €63000 gross per year, conform the regional statistics of the three relevant provinces (CPB 2010)[12]. These statistics suggest that the sample is representative.

Only eight percent of the sample never visit open water (excluding the sea) and another 11 percent have not visited any fresh water bodies over the last 12 months. The most popular recreational activities at open waters are walking, cycling and running along the banks, followed by bird and other wildlife watching and bathing. The popularity of nature- and wildlife-based recreation suggests that the WTP values reflect a combination of use and non-use values. A third of the respondents visit lakes for sailing, surfing, canoeing or rowing and only a quarter engages in motorized boating and waterskiing. The latter category of recreationists will face limitations of their recreational activities if the 'blue' quality level is achieved.

Although two-thirds of the respondents consider the current water and nature quality of the lakes to be good in general, a large majority (88%) find further improvements important. For a third of the respondents, the current 'yellow' quality at the sites (and 'green' for Naardermeer) reflects their perceptions well. More than half of the respondents state that the current quality according to the map is worse than they expected.

In almost a third of the choice tasks of the CE (32%), the opt-out is chosen. Nine percent of all respondents choose the opt-out because of protest-reasons, mostly because they believe the water institutions or government should finance the plans with the current budgets. The remaining opt-out choosers give a reason for not being willing to pay that can be labelled as a legitimate-zero bid, i.e. because they do not visit the lakes, consider the tax increase too high in comparison with the quality improvement or would rather spend their money otherwise.

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[12] The eleven lakes lie in the provinces of North-Holland, South-Holland and Utrecht. The Rhine-west basin stretches out to the province Gelderland. This province is too far away from the study sites and therefore did not form part of the sampling area.

Almost 60 percent of the respondents want to contribute to better water quality because they visit the lakes (24 percent) or want to improve the flora and fauna (33%). Both are considered valid reasons for WTP as they are related to the good under valuation. A fifth of the respondents are willing to pay because they believe that everybody should have the opportunity to enjoy lakes of better quality. In addition, more than a fifth just enjoy giving to charity, want to contribute to better water and nature quality regardless of the costs or because they feel it is their moral duty. These reasons do not reflect that the welfare changes attached to the scenarios is motivated by pure self-interest, but may reflect "warm-glow" or altruistic feelings (e.g., Nunes and Schokkaert 2003).

Most respondents focus primarily at the location when making choices in the CE (44%). The distance to the lakes is one of the main determinants for 23 percent of respondents. Another 22 percent of respondents base their choices on the combination of the price, quality and location. Quality and price are both mentioned by around 15 percent of the respondents.

After the CE, respondents were asked if they had a preference for one of the three researcher-defined combinations of lakes. The north-eastern lakes in the so-called Gooi and Vecht area, including the Naardermeer, Loosdrechtse, Ankeveense, Maarsseveense and Vinkeveense Plassen, are the most popular lakes: 40 percent of the respondents prefer this area. 16 percent have a clear preference for the southern lakes (Nieuwkoopse and Reeuwijkse Plassen) and 17 percent for the western lakes (Kager-, Westeinder- and Langeraarse Plassen). Almost half of the respondents visit other lakes besides the four nearest to their home location. 32 percent of the respondents list alternatives that are smaller than the study sites or located outside the geographical area covered by the experimental choice set.

In the final part of the questionnaire, respondents were also asked for their opinion about the choice tasks they were given. Respondents find the choices in the CE on average neither easy nor difficult, whilst more than a quarter of the respondents find the tasks (very) easy and almost a third finds the choices difficult to make.

The Loosdrechtse Plassen are the most frequently visited lakes, followed by the Vinkeveense Plassen (see Table 6.3). Together with the Reeuwijkse Plassen, these lakes are best known among the respondents. These lakes offer the widest range of possibilities for visitors, with marinas, cycling and walking paths and many cafes and restaurants. The smaller Langeraarse Plassen are only visited by 12 percent of the respondents whilst 29 percent of the respondents have never even heard of them. The next sections will discuss the results of choice models and hypotheses tests.

Table 6.2 Descriptive statistics of the sample

Socio-demographic characteristics	Statistic
Mean age (years)	49
Gender: percentage of females	51
Mean household size	2.54
Median gross personal income (€/year)	31500 – 63000
Median education level	higher vocational education
Recreation and perception	
Visitor open water (% respondents)	92
Recreational activity (% respondents):	
- on-shore recreation: walking, cycling, running, picnicking, etc.	92
- swimming	50
- sailing, surfing, canoeing, rowing	35
- boating (motorized), waterskiing	26
- angling	12
- nature and wildlife watching	66
Choice experiment and WTP questions	
Zero-bids (% total responses)	23
Protest-bids (% total responses)	9
Choices in CE based on (% total responses)	
- Location	44
- Distance to the lakes	23
- Price, quality and location	22
- Quality	16
- Price	15
- Size of the lakes	9
- Recreation possibilities	6
Preference for area (% total responses)	
- north-east (Gooi & Vecht area: Naardermeer, Loosdrechtse, Ankeveense, Maarsseveense en Vinkeveense Plassen)	40
- west (Kager-, Westeinder- en Langeraarse Plassen, Braassemermeer)	17
- south (Reeuwijkse and Nieuwkoopse Plassen)	16

Table 6.3 Descriptive statistics related to the study sites

	Visit (% visitors of total sample)	**Objective distance** (in km, mean total sample)†	**Objective distance** (in km, mean subsets)†	**Cognitive distance error**	
				% Over-estimation††	% Under-estimation††
Kagerplassen	16	36.17	8.24	42	10
Braassemermeer	16	32.25	16.93	39	21
Westeinder Plassen	19	24.59	10.69	36	17
Langeraarse Plassen	12	28.30	16.39	35	24
Nieuwkoopse Plassen	22	23.80	15.21	31	27
Reeuwijkse Plassen	20	36.87	9.31	19	21
Vinkeveense Plassen	29	23.57	15.96	26	36
Naardermeer	16	35.79	16.49	20	41
Ankeveense Plassen	15	30.62	18.16	25	34
Loosdrechtse Plassen	39	24.51	14.09	29	31
Maarsseveense Plassen	19	32.47	14.58	18	43

Notes: † For the subsets, the mean distance is based on the distance from the respondents to the lakes in the small sets, which only contain the four nearest lakes to the respondents. Therefore, the objective distance is systematically higher for the total sample, which covers all six subsets and includes respondent from the entire sampling area, than within subsets.
†† Percentages refer to the number of respondents who over- and underestimate the objective distance.

6.6.2 Cognitive distance errors

This section presents the results of the Models I and II, developed to test the hypotheses 1-4 regarding heterogeneity in distance decay across sites and resulting from visitation, non-use preferences and cognitive distance errors. Model I includes site-specific distance-decay parameters. In Model II, the effect of cognitive distance errors is added. Table 6.4 presents the results of the models estimated in WTP-space, the models in preference-space are included in Table VI.II in Annex VI. In the analysis, effects coding was used. Because of their categorical nature, the quality attributes are included as two variables. The parameter values of the quality levels are interpreted against the baseline of the current level. The results show that the attributes are significant and have the theoretically expected signs: price has a negative effect and respondents attach a positive value to ecological quality improvements.

In the models, the Langeraarse Plassen are taken as the baseline for comparison of the labels of the lakes. The Langeraarse Plassen are smallest and least visited and therefore expected to be valued lower than the other lakes. Following the significance of these labels, the results suggest that respondent attach a lower value to the quality improvement scenarios at the Kagerplassen compared to the Langeraarse Plassen, and a significantly higher value to the improvement scenarios Braassemermeer, Westeinder, Nieuwkoopse, Loosdrechtse and Vinkeveense Plassen and the Naardermeer. In Model II, the alternative specific constants of the Reeuwijkse, Ankeveense and Maarsseveense Plassen also have significant, positive coefficients.

The coefficient for quality level 1 is close to the coefficient for the highest level 2. However, a model with two separate coefficients results in a better model fit than if a generic quality coefficient is estimated (LR-test statistic=11.35 > χ_1^2 (0.01)=6.64). The mean WTP for the quality levels 1 and 2 is €123 and €127 at zero distance from the sites. No respondent characteristics were found to be significantly affecting one but not the other quality level. For instance, respondents who engage in motorized boating were not found to have a significantly lower WTP for quality level 2, in which their preferred activity is prohibited, compared to other recreationists. Furthermore, no significant site-specific values for the quality levels are found, once site-specific characteristics are accounted for through the labels, reflecting that the ecosystem services provided by the lakes are perceived to be similar[13].

Since the main interest lies in the effect of distance decay on the WTP for quality changes, distance is added to the model and included as a normally distributed random parameter in interaction with the quality levels *(X*D)*. In the WTP-space models, the results of the random parameters for the distance-effects models can be interpreted directly as the change in WTP for a change in distance to the site. Models with distance included after natural log transformation and three different distance-decay parameters, reflecting different groups of lakes, give the best statistical fit, based on LR-tests. Hence, the first hypothesis is rejected in this case. The three groups were determined based on the magnitude of site-specific distance parameter estimates after testing of their equality.

As expected, the effect of distance is negative for all lakes. Distance decay is highest for quality changes at the Braassemermeer (BR), for which the WTP decreases at €83 per ln(km+1). For quality changes at the Westeinder (WE), Langeraarse (LA), Nieuwkoopse (NK) en Vinkeveense (VV) Plassen, distance decay is lower at €63 per ln(km+1). These lakes lie relatively central in the study area. The scenarios for the lakes in the outward range of the study area, the Kager- (KA), Reeuwijkse (RW),

[13] Unfortunately, income is not significant in the models. This is expected to be due to very little variation and a considerable number of missing observations in the income data across the sample. Respondents in the pre-tests stated a maximum WTP of less than €40 per lake, and gave no reason to expect that the maximum of the range of the price attribute of €40 per household per year per lake would not put a sufficient constraint on the propensity to pay. Some heterogeneity in the sample is found explained by four respondent perception variables. These are left out of the presented models for the sake of brevity and clarity, but will shortly be described here. These more extended models show that respondents who consider the peace and quiet around a lake to be good are willing to pay more for an improvement at that site. Respondents who find further improvements of the ecological quality in the area important are also willing to pay more than respondents who assign lower importance to the policy issue. Furthermore, respondents who thought that the current ecological quality was equal or lower than explained in the survey text are willing to pay less than others. Finally, respondent who are willing to pay more irrespective of the sum are almost price-insensitive with a total price-coefficient around zero, as indicated by the parameter estimate of an interaction-term of a dummy variable for these respondents with the price-coefficient. Leaving these four parameters out of the models presented in this section and following sections does not change the main results and conclusions.

Ankeveense (AV), Loosdrechtse (LD) and Maarsseveense (MV) Plassen and the Naardermeer (NM), show the lowest distance-decay rate at €51 in WTP-space per ln(km+1). A possible explanation is that these lakes face less competition from the other lakes in the area.

The distance-decay effects are also subject to heterogeneity explained by differences in respondent characteristics as can be seen from the significant standard deviations of the estimated random parameters. Significant distance decay is found in the WTP values held by all respondents, but the positive coefficient for the interaction term between distance and the user-dummy implies that the distance-decay effect is adjusted upwards for users. This implies that the distance decay of users is lower than for non-users, rejecting the second hypothesis. The significant distance-decay effect among non-users may reflect option values held by this group, expecting to make future use of the site if quality increases. No site-specific user-effects were found.

Furthermore, respondents who are willing to pay a tax increase out of the non-use related motivation to improve the quality of the water bodies for the benefit of animals and plants (33 percent of all respondents) have a lower distance-decay rate than respondents who give other reasons to pay, for instance, related to recreation and other private benefits. Hence, the theoretical expectation that non-use values are less distance-dependent is confirmed and the third hypothesis is rejected.

To analyse the effect of cognitive distance errors on choice behaviour, Model II is estimated and compared to Model I. Prior to the choice experiment, respondents were asked to estimate the distance from their residential location to the four lakes in the small set. Descriptive statistics of the objective distance are included in Table 6.3, followed by the percentage of respondents with a cognitive distance error. The statistics of under- and overestimation are compared to other characteristics of the lakes, such as the objective distance, familiarity or visitation frequency of the lakes. These characteristics could not explain the pattern of the under- and overestimation of distances. In this case study, users do not have a significantly different cognitive distance error than non-users at the 5 percent level[14], except for the Westeinder and Langeraarse Plassen. For these latter lakes, non-users tend to underestimate the distance to the lakes more frequently than users.

[14] Non-parametric Kolmogorov-Smirnov and Mann-Whitney U-tests were performed to compare users and non-users for each lake. Results are presented in Annex VI in Table VI.I.

Table 6.4 Results of Models I and II

Lakes	Model I	Model II
Kagerplassen (KA)	-1.026***	-0.582*
	(-3.110)	(-1.735)
Braassemermeer (BR)	1.044**	1.042**
	(2.124)	(2.235)
Westeinder Plassen (WE)	0.443***	0.468***
	(3.967)	(4.086)
Nieuwkoopse Plassen (NK)	1.400***	1.383***
	(12.915)	(12.217)
Reeuwijkse Plassen (RW)	0.475	0.834**
	(1.335)	(2.342)
Vinkeveense Plassen (VV)	0.804***	0.719***
	(6.690)	(5.694)
Naardermeer (NM)	0.680**	0.952***
	(2.084)	(2.851)
Ankeveense Plassen (AV)	0.334	0.699**
	(1.014)	(2.077)
Loosdrechtse Plassen (LD)	1.053***	1.428***
	(3.255)	(4.332)
Maarsseveense Plassen (MV)	0.340	0.576*
	(1.164)	(1.775)
Random parameters (normal distribution):		
Quality * Distance to KA, RW, NM, AV, LD, MV	-51.282***	-52.457***
	(13.578)	(15.479)
standard deviation	26.585***	22.319***
	(11.972)	(12.305)
Quality * Distance to WE, LA, NK, VV	-63.022***	-60.345***
	(15.013)	(15.295)
standard deviation	29.106***	25.846***
	(14.865)	(14.533)
Quality * Distance to BR	-82.964***	-77.229***
	(9.163)	(10.166)
standard deviation	31.963***	30.171***
	(7.307)	(10.378)
Non-random parameters		
Price	-0.055***	-0.056***
	(-14.530)	(-14.475)
Quality level 1	6.798***	7.142***
	(20.994)	(21.841)
Quality level 2	6.999***	7.344***
	(21.580)	(22.416)
Quality * Distance * User (dummy)	0.504***	0.468***
	(20.759)	(18.490)
Quality * Distance * non-use reason for WTP (dummy)	0.761***	0.710***
	(5.462)	(5.201)
Quality * Distance * Cognitive distance error	-	0.509***
		(11.525)

Table 6.4 continued	**Model I**	**Model II**
Cholesky matrix: Diagonal values		
Quality * Distance to KA, RW, NM, AV, LD, MV	25.063*** (11.238)	21.958*** (11.970)
Quality * Distance to WE, LA, NK, VV	13.508*** (8.865)	6.285*** (4.206)
Quality * Distance to BR	3.878 (0.676)	18.195*** (5.422)
Cholesky matrix: Below diagonal values		
Quality * Distance to KA, RW, NM, AV, LD, MV : price	-8.864*** (6.558)	3.996*** (11.970)
Quality * Distance to WE, LA, NK, VV : price	-7.858*** (4.678)	-8.692*** (6.111)
Quality * Distance to WE, LA, NK, VV: Quality * Distance to KA, RW, NM, AV, LD, MV	-24.555*** (11.696)	23.516*** (13.106)
Quality * Distance to BR : price	12.814*** (3.748)	-6.368 (1.163)
Quality * Distance to BR: Quality * Distance to KA, RW, NM, AV, LD, MV	7.018*** (1.542)	23.202*** (6.256)
Quality * Distance to BR: Quality * Distance to WE, LA, NK, VV	6.718 (1.577)	0.537 (0.099)
Covariance of random parameters and scale		
Scale: Quality * Distance to KA, RW, NM, AV, LD, MV	0.852*** (13.026)	0.945*** (15.692)
Scale: Quality * Distance to WE, LA, NK, VV	-0.358*** (4.830)	-0.268*** (3.062)
Scale: Quality * Distance to BR	-0.239*** (3.364)	-0.061 (0.816)
Scale		
Variance parameter in scale (tau)	0.408*** (6.028)	0.390*** (5.883)
Sigma : mean	1.471	1.500
Sigma : standard deviation	1.771	1.734
Model statistics		
No. Observations	3880	3880
Loglikelihood	3862	3821
No. Parameters	31	32

Notes: Models are estimated using NLOGIT 4. T-values are presented between brackets. Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

A variable for the cognitive distance error is created, taking the value 1 or -1 if the objective distance is higher respectively lower than the cognitive distance (1=underestimation and -1 = over-estimation)[15]. This variable is included in Model II in interaction with the objective distance*quality interaction *(X*D)*[16]. The results of Model II show that the cognitive distance error has a significant effect on the choice probabilities. Model II has a significantly better model fit than Model I (p<0.01), as indicated by LR-test results (LR-test statistic=82 > χ_1^2 (0.01)=6.64). Hence, the fourth hypothesis is rejected as the cognitive distance error has a significant impact on the distance effects.

As expected, the positive parameter estimate indicates that the distance-decay effect is corrected upwards for respondents underestimating the distance. In other words, respondents perceiving the lake where the quality improvement takes place to be closer show lower distance decay. Vice versa, overestimation of the distance is associated with a negative adjustment of the direct effect of distance, reflecting a higher distance-decay effect. However, the parameter estimate for the cognitive distance error (0.509)[17] and the corresponding mean WTP adjustment for the cognitive distance error (€9/ln(km+1)) are small compared to the direct effects of distance.

Given the significant but small parameter estimates of the cognitive distance error, the question rises if controlling for cognitive distance errors results in different WTP estimates. Figure 6.6 visualises the effect of distance (on the x-axis) on WTP held by users for a quality change to level 1 for the first group of lakes (KA, RW, NM, AV, LD and MV) (on the y-axis) in Models I and II. The WTP for ecological quality changes is the sum of the WTP for the quality attribute and its interaction with distance, the reason for paying, the user-dummy and cognitive distance error. For the variable reflecting the reason to pay, the sample average (33%) is taken. For Model II, three lines are included, reflecting the WTP for respondents without cognitive distance error, those who underestimate the distance and those who overestimate the distance.

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[15] To identify if respondents over- or underestimated the objective distance, the objective distance was first reclassified into the distance categories of 5 and 10 kilometres, which were used in the survey for the cognitive distance questions (see question 7 in the survey). Next, the objective and cognitive distance estimates were compared based on these categories.
[16] A single variable taking the value -1 and 1 for the cognitive distance error resulted in better model fit than two separate dummy-variables for over- and underestimation of the cognitive distance. Hence, accounting for the ‘direction’ of the cognitive distance error does not improve the model fit. No site-specific effects were found for the cognitive distance error and also the interaction with the user-dummy did not have a significant impact.
[17] Note that the coefficient of non-random parameters cannot be interpreted directly as WTP-estimates.

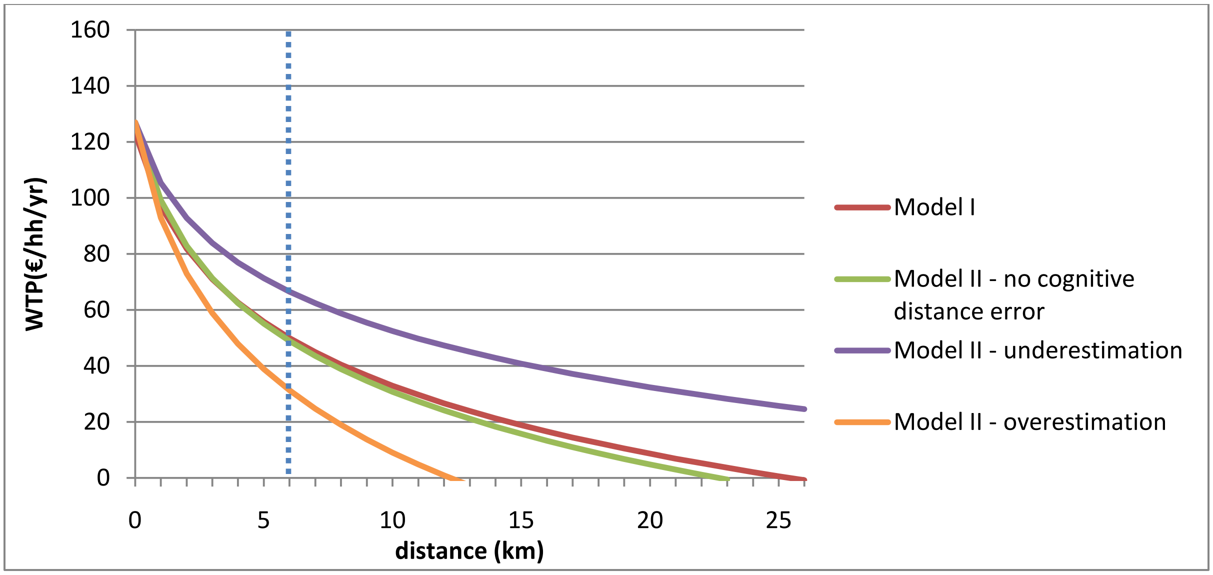

Figure 6.6 Distance-decay graphs of Models I and II

Figure 6.6 shows that the differences in WTP resulting from Model II due to the cognitive distance errors are small. The confidence intervals of the WTP estimates held by respondents with and without cognitive distance errors in Model II overlap. This suggests that their WTP estimates are not significantly different over the distance-range at which WTP is positive. In this respect, the fifth hypothesis cannot be rejected. However, the difference in WTP between respondents under- and overestimating the distance to the site is significant. For users, the difference in WTP for quality changes between under- and overestimators starts to become significant at 6 kilometres from the site. This boundary is indicated in Figure 6.6 by the dashed vertical line.

There may be two reasons for the small effect of cognitive distance errors in this study. First, the locations in this CE are relatively well-known and nearby. Second, a categorical variable for the cognitive distance error was used, thereby ignoring differences between small and large cognitive distance errors. Models in which the magnitude of the errors was included did not result in a better model fit in this case. Further research is necessary to see if cognitive distance errors have a more significant impact if distances are longer, as the errors are expected to be higher for greater distances and less familiar sites.

Figure 6.6 shows that the market for quality changes at the first group of lakes (KA, RW, NM, AV, LD and MV) ends at 23 kilometres from the sites. Markets for the improvements at the other lakes are smaller. The mean WTP held by users for quality improvements at the Westeinder, Langeraarse, Nieuwkoopse and Vinkeveense Plassen is zero at 13 kilometres from the sites and at 9 kilometres for non-users. The market of quality changes the Braassemermeer ends at 6 kilometres for users and at 5 kilometres for non-users.

The remaining discussion concerns the results of the Cholesky matrix and scale parameter, reported in the lower part of Table 6.4. Since the random parameters in the model are allowed to be correlated, their standard deviations are not independent (Hensher et al. 2005a, 673). The Cholesky decomposition matrix captures the variance-covariance structure among the random parameters. It is used to decompose the standard deviation parameters into their attribute-specific and attribute-interaction standard deviation (Bierliere 2009)[18]. The elements of the Cholesky matrix are used in the calculation of the mean WTP for the attributes,.

The significance of the τ-parameters in the models implies that there is significant scale heterogeneity across respondents, even after accounting for taste heterogeneity using random parameters and correlation between these random parameters. In addition, the models control for the correlation between the random parameters and the scale parameter. This correlation is significant for the all random distance parameters, as can be seen from the covariance results.

In summary, the results of Model I show that there is significant heterogeneity in distance decay across sites and between users and non-users. Distance decay also differs between respondents who state reasons for their WTP related to non-use values and those with other reasons to contribute to increased ecological quality at the sites. The results of Model II imply that accounting for cognitive distance errors results in better model fit, but the resulting WTP estimates are not significantly different between respondents with and without cognitive distance errors. Significant differences in WTP values are only found between respondents overestimating and those underestimating the travel distances to the sites.

6.6.3 Directional heterogeneity

The second main topic addressed in this case study is the assessment of directional heterogeneity in distance-decay effects. This part of the analysis is based on the choice data of the large choice set. The models are estimated in WTP-space, the models estimated in preference space may be found in Annex

[18] Cholesky decomposition separates the contribution to the standard deviation related to the correlation with other random variables, and the actual contribution related to heterogeneity around the mean of the random parameter itself. The diagonal values of the Cholesky matrix represent the variance for each random parameter independent from other random parameters, and significant below-diagonal elements indicate significant cross-correlations among the random parameter estimates. The results of the Cholesky matrices of Models I and II show that the random parameters are significantly correlated among each other, but their independent levels of variance remain significant as can be seen from the diagonal values. In Model I, the significance of the random parameter for the distance to the Braassemermeer (BR) seems to be due to correlation with the price and the first random distance parameter for KA, RW, NM, AV, LD, MV (given the below diagonal values). However, but the random parameter for distance to BR is significant in Model II in spite of the correlation. The other two random parameters are also significantly correlated with the price parameter.

VI. The model results are summarized in Table 6.5. Model I is similar to Model I in the previous section. Model III includes directional dummy variables interacted with the quality-distance interaction-terms.

As in the model results based on the data of the small choice set, the attributes are significant and have the expected sign: quality levels have a positive and price a negative effect. There is no significant difference between the coefficients of the two quality levels. In both models, a generic parameter estimate is included for distance in interaction with the two quality attributes[19]. The distance parameter is specified as a random parameter with a normal distribution after natural log transformation, because this resulted in the best model fit. The results show that the distance-decay effect is slightly weaker than in the models based on the small set in the previous section, but this cancels out against the lower parameter estimates of the quality levels. Users have a lower distance-decay rate than non-users. In addition, respondents who are willing to pay based on non-use considerations have a lower distance-decay rate than respondents with other reasons for expressing a positive WTP. Slightly different from the results of the small set, all lakes (except for the Westeinder Plassen in Model III) have a significant and positive coefficient in the models based on the large set compared to the Langeraarse Plassen, which serve again as the baseline.

Model III includes directional dummies and results in a better fit than Model I (LR-test statistic= 54 > χ^2_7 (0.01)=24.32). In the final model, seven directional effects remain significant at the five percent level. Based on these results, the sixth hypothesis is rejected. The seven directional effects are found in the site-specific utility functions of six of the lakes in the study, with two directional effects found for quality improvements at the Nieuwkoopse Plassen.

Positive directional effects are found for the quality improvements at the Westeinder, Ankeveense and Maarsseveense Plassen. In case of the Westeinder Plassen, the dummy variable takes the value 1 for those respondents living north-east from this lake. The positive parameter implies that these respondents have a lower distance-decay effect and hence a higher WTP compared to other respondents living in other directions from the site. A possible explanation is that these respondents have fewer substitutes compared to respondents living west or south and the Westeinder Plassen are easier to get to than the Vinkeveense Plassen (see the map of the study area in Figure 6.2). The distance-decay effect among respondents living east from the Ankeveense Plassen is significantly lower than in other directions, most likely caused by the small number of alternatives in the eastern direction.

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[19] The specification of two distance-decay parameters resulted in slightly better model fit (LR test statistic = 20 > χ^2_5 (p=0.01)=15.09). For the sake of clarity, models with a single distance-decay parameter are presented here. The inclusion of a single distance parameter does not change the results of the model regarding the directional effects.

Table 6.5 Results of Models I and III

Lakes	**Model I**	**Model III**
Kagerplassen (KA)	0.510***	0.520***
	(3.448)	(3.496)
Braassemermeer (BR)	0.443***	0.444***
	(3.091)	(3.096)
Westeinder Plassen (WE)	0.374***	0.120
	(2.653)	(0.772)
Nieuwkoopse Plassen (NK)	1.280***	1.446***
	(10.051)	(10.794)
Reeuwijkse Plassen (RW)	1.088***	1.220***
	(7.514)	(8.281)
Vinkeveense Plassen (VV)	1.105***	1.101***
	(8.578)	(8.498)
Naardermeer (NM)	1.252***	1.256***
	(8.741)	(8.685)
Ankeveense Plassen (AV)	0.640***	0.549***
	(4.373)	(3.647)
Loosdrechtse Plassen (LD)	1.472***	1.505***
	(11.723)	(11.838)
Maarsseveense Plassen (MV)	0.746***	0.648***
	(5.321)	(4.424)
Random parameters (normal distribution)		
Quality * Distance (log (distance in km+1)	-47.251***	-44.607***
	(14.935)	(15.685)
standard deviation	24.467***	22.387***
	(11.973)	(11.98)
Non-random parameters		
Price	-0.050***	-0.049***
	(-11.951)	(-14.050)
Quality level 1	5.035***	4.966***
	(21.922)	(21.653)
Quality level 2	5.078***	5.008***
	(21.926)	(21.593)
Quality * Distance * user (dummy)	0.470***	0.461***
	(23.193)	(22.437)
Quality * Distance * non-use reason for WTP (dummy)	0.573*** (5.576)	0.531*** (5.089)
Directional dummies		
Quality * Distance *		0.831***
Westeinder Plassen *north-east		(4.219)
Quality * Distance *		-0.773***
Nieuwkoopse Plassen *north		(-3.881)
Quality * Distance *		-0.541**
Nieuwkoopse Plassen *north-east		(-2.131)
Quality * Distance *		-1.021***
Reeuwijkse Plassen *east		(-2.825)
Quality * Distance *		1.213***
Ankeveense Plassen *east		(3.34)

Table 6.5 continued	Model I	Model III
Quality * Distance * Loosdrechtse Plassen *north		-0.868** (-2.189)
Quality * Distance * Maarsseveense Plassen*south-east		0.639*** (3.267)
Cholesky matrix		
Diagonal values: Quality * Distance	22.848*** (11.451)	19.024*** (13.479)
Below diagonal values: Quality * Distance * price	-8.751*** (-4.66)	-11.803*** (-7.155)
Scale		
Variance in the scale parameter (tau)	0.314** (2.550)	0.134 (0.78)
Sigma: mean	1.547	1.548
Sigma: standard deviation	1.704	1.597
Covariance of random and scale parameters		
Scale: Quality * Distance	1.011*** (15.718)	1.000*** (20.978)
Model statistics		
No. Observations	3184	3184
Loglikelihood	-4153	-4126
No. Parameters	20	27

Notes: T-values are presented between brackets. Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

The significant directional effect in the utility function of the Maarsseveense Plassen implies that respondents living south-east from these lakes are willing to pay more compared to respondents living in other directions. For these respondents the Maarsseveense Plassen are the nearest option in the choice set.

Significant negative directional effects are found for the improvement scenarios at the Nieuwkoopse, Reeuwijkse and Loosdrechtse Plassen. The two significant directional effects found in the utility function of the Nieuwkoopse Plassen show that respondents living north and north-east from these lakes have a stronger distance decay and hence a lower WTP. This can be explained by the large number of substitutes located north and north-east from the Nieuwkoopse Plassen, such as the Vinkeveense, Ankeveense and Loosdrechtse Plassen. For the quality changes at the Reeuwijkse Plassen, a stronger distance-decay effect is found for respondents living east from this lake. Respondents living east from this site live relatively far away, near the city of Utrecht and hence closer to substitute lakes, whereas the population density close to this site in the eastern direction is low. Finally, respondents living to the north of the Loosdrechtse Plassen have a higher distance-decay rate and lower WTP for improvements at this site. This may be because of the recreational opportunities that especially the Ankeveense Plassen and the Naardermeer provide, which lie north from the Loosdrechtse Plassen and at shorter distance for most respondents. In summary, most of the directional effects can be explained by the availability of substitutes in different directions.

The distance coefficients of Models I and III are of similar magnitude, hence for all directions for which no significant directional effect is found, Models I and III do not lead to significantly different markets and WTP estimates. The interesting question is to what extent the directional effects result in different WTP estimates and market sizes. Table 6.6 shows the mean WTP values resulting from Models I and III held by users for an improvement of the ecological quality to level 1 for those lakes for which directional heterogeneity was found. WTP values are expressed as tax increases in Euros per household per year. The sample average is used for the reason for WTP (33%). The confidence intervals are estimated using parametric bootstrapping techniques (Krinsky and Robb 1986), controlling for the correlation between the variables. The heterogeneity in the mean of the random parameters was not accounted for in this procedure (Hensher et al. 2005a, 686).

The third column of Table 6.6 reflects the distance between the site and the respondent at which WTP is zero, given the general distance-decay rate of Model I. For instance, the WTP held by users for achieving quality level 1 in the Westeinder Plassen decreases from €109 at zero distance to €0 at 24 kilometres from the site. The right part of the table presents the results for the directional effects of Model III. The fifth column shows that the WTP decrease due to distance decay is adjusted by €17 per ln(km+1) for respondents living in the north-eastern direction from the Westeinder Plassen. In this direction, the extent of the market of people willing to pay for this improvement lies at 69 kilometres from the site, as can be seen in column 6. As a result of the lower distance-decay effect, the market is larger in the north-east direction (69 vs 24 km). The same exercise is repeated for the six other significant directional effects of Model III.

All directional effects result in significantly different WTP estimates as distance from the site increases, except for the two directional effects of the Nieuwkoopse Plassen. Hypothesis H_0^7 is hence rejected. The differences in WTP across the directions are significant from a few kilometres onwards from the sites, varying between 3 and 12 kilometres depending on the lake. These results show that markets for ecological quality improvements at the Westeinder, Reeuwijkse, Ankeveense, Loosdrechtse and Maarsseveense Plassen show significant differences in WTP estimates across different directions.

The results for the directional effect on the WTP for quality improvements at the Ankeveense and Reeuwijkse Plassen in visualised in Figure 6.7a and b. The pictures reflect the spatial distribution of the WTP based on Model I with an isotropic distance decay effect (upper) and Model III with additional directional effects (lower) held by users living in the study area. The distance is measured from the centroids of the 4-digit postal code areas. The two pictures in Figure 6.7a depict the WTP for quality improvements at the Ankeveense Plassen. The picture of Model III shows that the directional effect results in higher WTP for respondents living east from this site. Similarly, the two pictures in Figure 6.7b show that the population living east from the Reeuwijkse Plassen is WTP less than respondents living in other directions from the site.

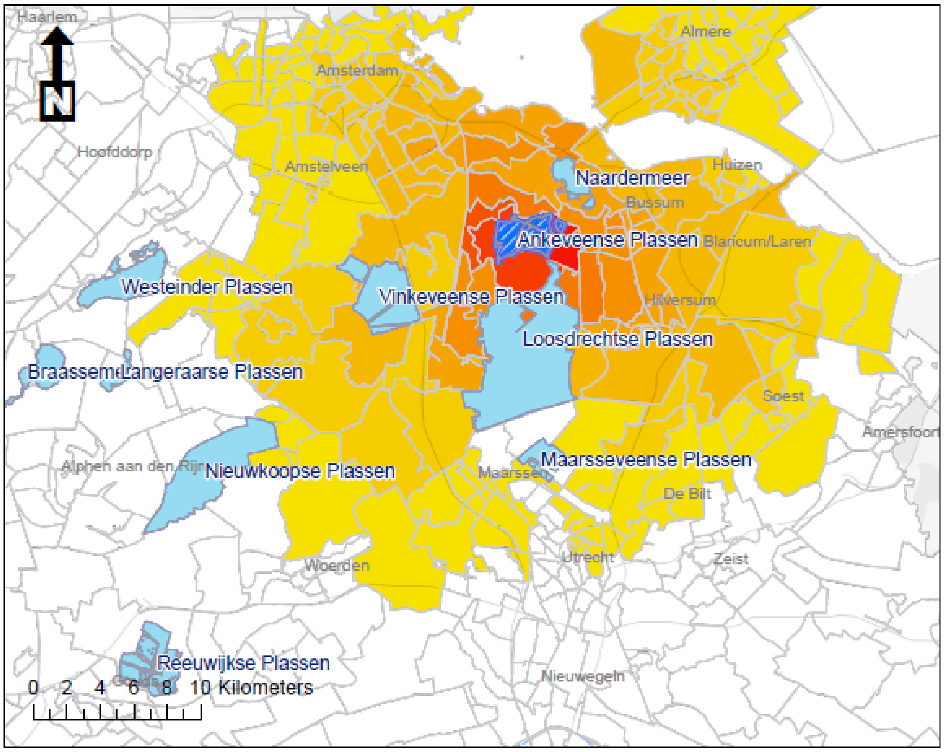
Turning to the remaining results in the second part of Table 6.5, the below diagonal values of the Cholesky matrix show that there is significant correlation between the random parameters for distance and price. The diagonal values of the Cholesky matrix indicate that the heterogeneity in the mean of the distance-parameter remains significant if this correlation is controlled for. Significant scale heterogeneity is found for Model I, but after controlling for directional heterogeneity in Model III the individual scale parameter becomes insignificant. The correlation between the random scale and distance parameters is significant in both models.

In summary, the comparison of Models I and III shows that accounting for directional-effect in distance decay leads to significant differences in individual WTP for water quality improvements. Moreover, the markets reflecting the population over which individual WTP estimates can be aggregated to estimate total WTP for the environmental improvement have different extensions, depending on the direction from the sites. The directional effects are expected to be caused by differences in substitute availability across the different directions.

Table 6.6 WTP and distance-decay effects of Models I and III for users

	Model I		Model III – directional effects		
	WTP	Distance WTP=0	Direction	WTP Dir. Effect	Distance WTP=0
Westeinder Plassen	€109 (€93, €128)	24 km	North-east	€17 (€9, €25)	69 km
Nieuwkoopse Plassen	€127 (€109, €150)	42 km	North	-€16 (-€24,- €8)	8 km
			North-east	-€11 (-€22,- €1)	9 km
Reeuwijkse Plassen	€124 (€106, €145)	37 km	East	-€21 (-€36,- €6)	5 km
Ankeveense Plassen	€127 (€108, €150)	29 km	East	€25 (€10, €39)	>75 km
Loosdrechtse Plassen	€160 (€144, €177)	47 km	North	-€18 (-€34,- €2)	5 km
Maarsseveense Plassen	€131 (€113, €154)	30 km	South-east	€13 (€5, €21)	58 km

WTP: Ankeveense Plassen with uniform distance decay (Model I)



WTP: Ankeveense Plassen with the directional effect (east) (Model III)

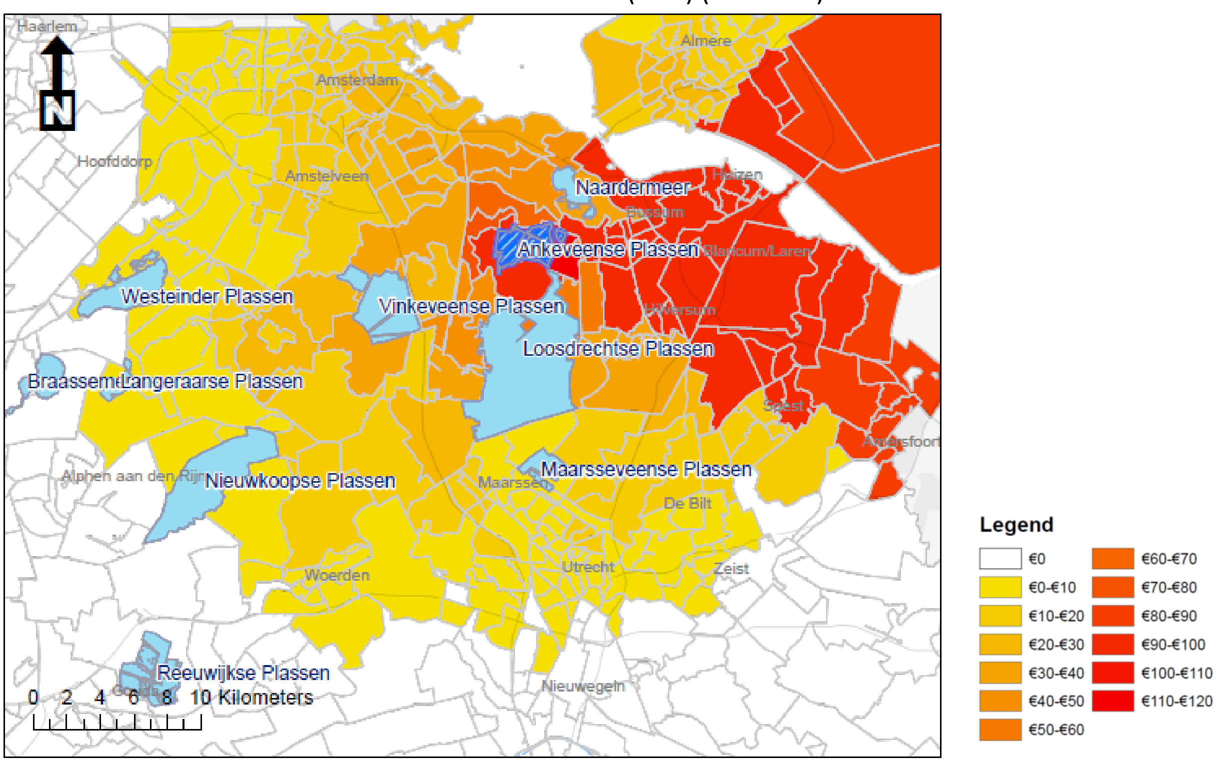
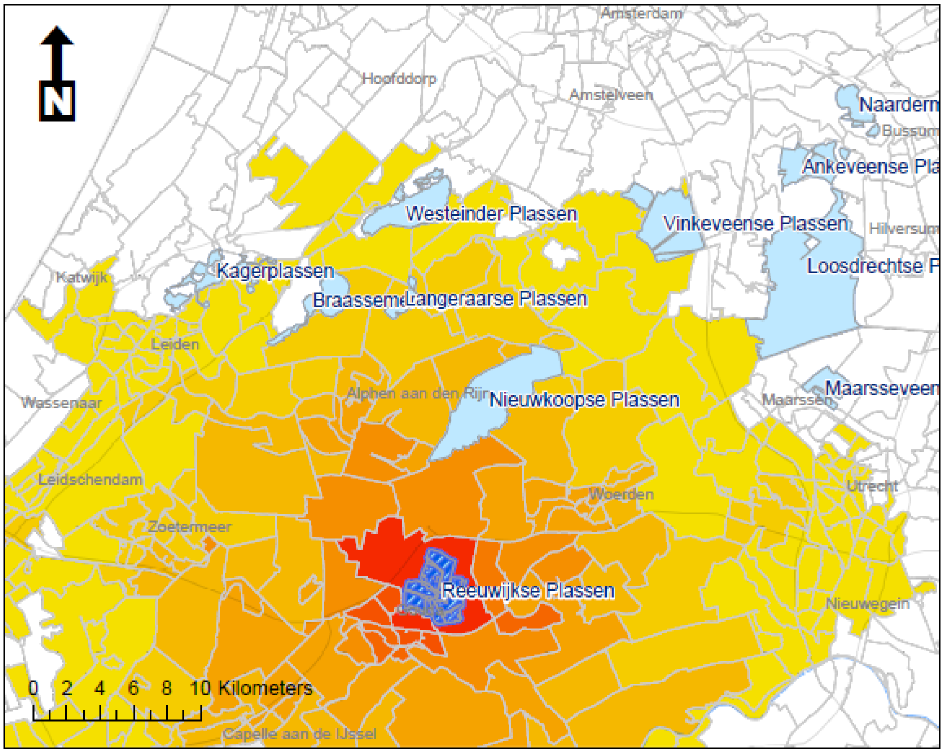


Figure 6.7a Spatial distribution of WTP for water quality improvements in the Ankeveense Plassen

WTP: Reeuwijkse Plassen with uniform distance decay (Model I)



WTP: Reeuwijkse Plassen with the directional effect (east) (Model III)

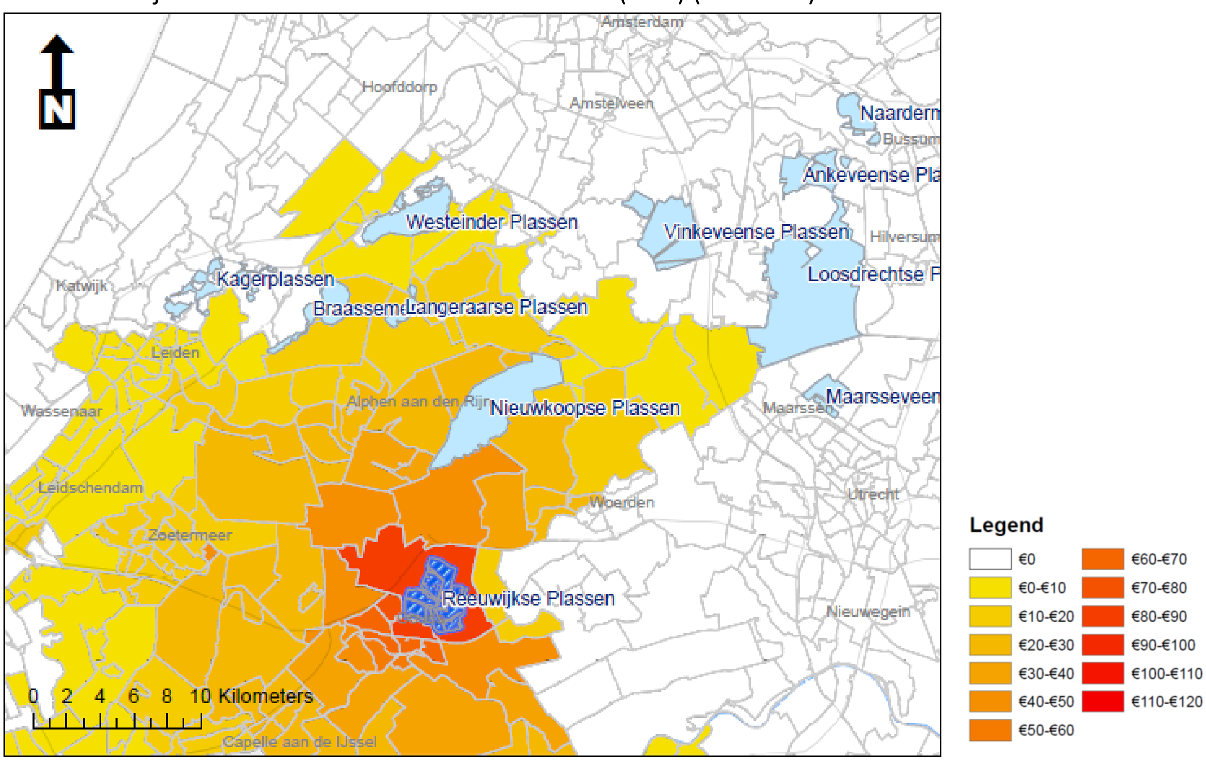


Figure 6.7b Spatial distribution of WTP for water quality improvements in the Reeuwijkse Plassen

6.6.4 Expanding the geographical scale of the choice set

The objective of the results presented in this section is to analyse the effect of changes in the choice set specification resulting in varying degrees of choice task complexity on choice behaviour and WTP estimates. To test these effects, the choice experiment was split into three sections: the first section consisted of three choices among the small set of alternatives, the second section presented the large set and contained four choices and in the third section the small set was presented again and respondents were asked to complete two choice tasks (see Figure 6.1). Three different choice set effects are evaluated:

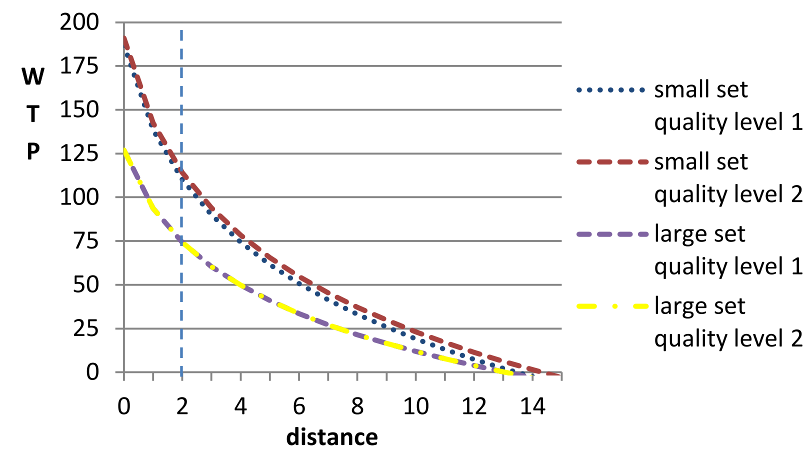
1. The difference between choices among alternatives in the small and large choice sets: H_0^8
2. The difference between choices among alternatives in the first and second part of the small choice set: H_0^9
3. The differences between choices among alternatives within the large choice set: H_0^{10}.

These hypotheses are tested in three different ways. As a first test of hypothesis H_0^8, the WTP results of Model I separately estimated for the small and large sets are compared. The models are estimated in preference space and distance included as a generic instead of site-specific effect in the model for the small set. The overlap of the confidence intervals of the WTP estimates is examined. By taking the ratio of parameter estimates of the quality and distance attributes and the price, difference in the scale between the subsets cancel out. The main results are presented in Table 6.7.

The comparison of the WTP results of the models of the large and small set suggests that the WTP for quality changes is lower in the large set. The graph at the right hand side of Table 6.7 shows that the WTP values of the small and large set have significantly different values at zero distance. However, the WTP for quality changes is also dependent on the distance effect which is included as an interaction term with the quality levels. As can be seen from the graph, the WTP values of the small and large sets converge as distance increases. As a result of the weaker distance-decay effect found for the large set, the confidence intervals of the WTP values of the two choice set specifications overlap after 2 kilometres from the site. The dotted line in the graph indicates the 2 kilometre distance from where onwards the WTP values of the small and large sets are not significantly different. Hence, the different choice set sizes do not result in significantly different WTP estimates for water quality changes in the study area and the hypothesis H_0^8 cannot be rejected.

Table 6.7 WTP results for the small and large choice sets

WTP	**Model I: small set**	**Model I: large set**
Quality level 1	187 (167,209)	127 (105,152)
Quality level 2	191 (172,214)	127 (106,153)
Quality * Distance	-70 (-79,-62)	-48 (-55,-41)
No. obs.	3880	3184
Loglikelihood	-3919	-4206



The second test of the choice set effects that is performed is the scale test developed by Swait and Louviere (1993) (see Annex II). The Swait and Louviere (SL) test is used for hypotheses H_0^{8a}, H_0^{9a} and H_0^{10a} adressing consistent preferences for the attributes, by comparing single choice tasks. For H_0^{8a} the full large and small sets are also compared. Hypotheses H_0^{8b}, H_0^{9b} and H_0^{10b} address possible scale differences reflecting effects of learning or fatigue[20]. The results of these tests are presented in Table 6.8. The results from the SL test suggest that respondents have to get used to the CE setting in the first part of the choice experiment. After the initial choice preferences remain consistent and no persistent learning or fatigue are found. The results are explained in more detail below.

$H_0^{8a}$and H_0^{8b} are first tested by comparing all choices in the small and large set. The SL test results show that H_0^{8a} is rejected when the small and large datasets as a whole are compared. No further testing is possible. This result indicates that there is a significant difference in the scale or beta parameters between the large and the small set. This could be caused by increasing the number of alternatives in the choice set of the experiment, but also from learning of respondents about the choice task. Similar results are found when testing H_0^{8a} and H_0^{8b} by comparing the first choice task of the small set to the first task of the large set. However, no significant beta and scale parameter differences are found for the third choice in the small set and the following first choice in the large set, and $H_0^{8a}$and H_0^{8b} cannot be rejected. Together these results suggest that respondents initially have to get used to the setting of a CE and the questions when making their first choice in the small set. However, from the

[20] In the estimation of the models to compare two choice tasks, the panel data structure is not accounted for. For H_0^8, the panel data structure is only accounted for within the large and small sets of the datasets. All models estimated here include a generic distance-decay parameter.

third choice in the small set onwards the results suggest preference stability and no learning or fatigue effects.

This result is further supported by in the results of the tests to reveal learning effects in the choices of the small set due to the evaluation of the large set with more substitutes. H_0^{9a} and H_0^{9b} are tested by comparing the third choice task of the first part of the small set to the fourth and fifth choice in the second part. The results show that no significant changes in parameter estimates are found so that H_0^{9a} cannot be rejected. This suggests that preferences for the attributes in the model are stable in accordance with the findings of Model IV. The scale parameter is significantly higher for the choice in the second part of the small set directly following the large set and H_0^{9b} is rejected. The higher scale implies lower variance, which, in contrast to Model IV, suggests that respondents have learned after making four choices among the alternatives in the large set. However, the scale difference is only just significant. When comparing the third and fifth choice in the small choice set H_0^{9a} and H_0^{9b} cannot be rejected suggesting that no learning effect is found in line with the results of Model IV. Hence, only very weak evidence is found for learning effects and no evidence for preference instability after consideration of the alternatives on a wider geographical scale.

Finally, H_0^{10a} and H_0^{10b} are tested by comparing the first and fourth choice tasks within the large set to reveal learning effects within the large choice set. As can be seen from the results in the final row of Table 6.8, there is no significant difference between these choices in the scale or beta parameters: H_0^{10a} and H_0^{10b} cannot be rejected. Hence, within the large choice set preferences seem to be stable and no learning or fatigue effects are found.

Given the possible limitations of the SL-test in case of panel data, a third test is performed by estimating a pooled model is estimated based on the data of the small and large choice sets. Model IV as presented in equation (6.5) includes error-components for the large set and the second part of the small set to identify heterogeneity in the variance of these treatments. This model provides further results for H_0^8 and H_0^9. Interaction-terms of the quality attributes and dummy-variables for the large choice set and second part of the small set are added to reveal differences in parameter estimates between the different treatments. To facilitate the comparison between the small and large set, a generic distance-decay parameter is estimated.

Table 6.8 Swait and Louviere test-results

Test	(1)-(2)	LL (1)	LL(2)	LL(1&2) ($\mu_1 \neq \mu_2$)	LR-test (df=17)[1]	H_0^a: β_i=β_j rejected?	Rel. Scale μ_1/μ_2	LL (1&2) ($\mu_1 = \mu_2$)	LR-test (df=1)[2]	H_0^b: $\mu_1 = \mu_2$ rejected?
$H_0^{8a,b}$	Small-large	3828	3987	8095	560	yes	-	-	-	-
$H_0^{8a,b}$	Small 1st- large 1st	887	11753	2079	32	yes	-	-	-	-
$H_0^{8a,b}$	Small 3rd-large 1st	929	1175	2112	16	no	0.87	2113	2.05	no
$H_0^{9a,b}$	Small 3rd- 4th	929	926	1858	6	no	1.16	1861	4.26	yes
$H_0^{9a,b}$	Small 3rd- 5th	929	948	1882	10	no	1.00	1882	0.34	no
$H_0^{10a,b}$	Large 1st - 4th	12323	1198	2436	12	no	1.09	2438	2.19	no

[1] χ^2_{17} (p=0.05)= 27.6
[2] χ^2_1 (p=0.05)= 3.84
[3] The difference in LL for the 1st choice task in the large set is caused by different sample sizes used for the comparisons as a result of the exclusion of protest bids.

The results of the full Model IV are presented in Table 6.9. The results of the full model show that only the error-component for the large choice set is significant[21]. This result implies that the variance for the large choice set is different than for the small choice set and H_0^{8b} is rejected. The increase of the number of alternatives in the choice set raises the variance, which can be attributed to higher complexity experienced by the respondents. However, hypotheses H_0^{8a} and H_0^{9} cannot be rejected based on the results of Model IV, as will be explained below.

The insignificant interaction terms of the dummy for the large set and the quality attributes indicate that the attributes do not have a different value in the large set compared to the small set. Hence, the number of alternatives does not affect the parameter estimates for the quality attributes and H_0^{8a} cannot be rejected. The model results suggest that when the difference in variance is controlled for, no differences in preferences for the attributes are observed.

Furthermore, the error-component for the second part of the choice set is not significant. There is no significantly different variance for the choices in the second part of the small choice set and hence no indication that respondents have learned or become fatigued. The interaction terms of the dummy for the second part of the small set are also insignificant, indicating that preferences in the second part

[21] The error-components for the large set and second part of the small set are mentioned in the upper part of Table 6.9 under the random parameters, because they are included in the model as random parameters with zero mean and a normal distribution. This allows for controlling for correlation between the error-components and the random distance parameter.

have not changed compared to the first part after the exposure to the large choice set. H_0^{9a} and H_0^{9b} cannot be rejected based on the results of this model.

Model IV is re-estimated with only the error-component for the large choice set, which significantly increases the model fit (LL=7566, compared to LL=7610 for Model I without this error-component). The results are presented in Table VI.IV in Annex VI. Accounting for the difference in variance results in higher WTP estimates for quality changes and larger market sizes over which individual WTP values can be aggregated to estimate the total WTP of the relevant population compared to Model I. However, the confidence intervals of the WTP estimates of Model I and IV overlap which implies that the differences in WTP are not statistically significant. Hence, based on the results of Model IV, H_0^{8} and H_0^{9b} cannot be rejected in spite of the difference in variance between the large and small sets.

In summary, the expansion of the choice set over a wider geographical area does not lead to significantly different WTP estimates for the quality levels at the lakes in the choice sets. The results of Model IV and the SL test are not completely consistent with respect to H_0^{8}. When the SL test fails to reject H_0^{8a} it is impossible to make a distinction between differences in the scale and beta-coefficients. However, Brownstone et al. (2000) and Hensher et al. (2005b) suggest that this distinction can be made using error-components, such as included in Model IV. The results of Model IV indicate that the parameter estimates are similar and only the variance differs between the small and large set: the expansion of the choice set is associated with higher variance. The separate models for the small and large set show that there are no significant differences in WTP between resulting from increasing the geographical scale of the choice set. The combined results of the three tests suggest that H_0^{8} cannot be rejected and the WTP of the small and large set is not significantly different in spite of the scale differences.

The increased variance underlying the choices of the large set is expected to be caused by the higher complexity involved in choosing among a larger number of alternatives. The alternatives added to the choice set are quality changes taking place at lakes that lie further away, which are therefore also likely to be less familiar to respondents. In spite of the complexity, preferences are found to be stable within the larger choice set. The results of this analysis hence suggest that respondents are able to evaluate seven alternatives (and an opt-out possibility) simultaneously. Increasing the geographical scale and choice set size does not result in significant differences in preference parameters between choice tasks, at least, once they have evaluated a subset of these alternatives.

In the comparison of the choices among quality changes at the four lakes presented before and after the expansion of the choice set, only very weak results are found regarding learning effects. The SL test indicates significant scale differences reflecting learning effects within the small set between the first and second part of the small choice set. However, the learning effects are not persistent in the following choice tasks. Also no significant differences in the variance of the first and second part of the small set are found in the pooled model.

One of the reasons that increasing the number of alternatives does not have a strong impact on the WTP may be that the questions and information preceding the CE in the survey helped respondents sufficiently to reflect on their preferences for water quality changes at the eleven lakes in the choice set. Only a small learning effect seems to be present as a result of the inclusion of the large choice set. In the survey, all lakes in the total choice set for which quality improvements were proposed were introduced before the CE started and respondents were asked several questions addressing their preferences and attitudes regarding all eleven lakes. These questions go far beyond merely presenting a glossary of attributes and their levels and the choice task instructions. Inclusing such a glossary is common practice in most CE studies, but does not necessarily lead to different WTP estimates than studies that do not provide such a glossary (Bateman et al. 2008). The results of this study suggest that careful survey design may help to avoid inconsistencies in preference and choice. The influence of survey elements preceding a CE, such as warm-up questions, deserves more attention in CE studies assessing the complexity of choice set designs and related learning and preference stability hypotheses. Further research is necessary to see if different conclusions will result from a different order of the choice set, starting with the large choice set, as discussed in Section 6.2.

A second possible explanation is that in the design of the choice experiment the inclusion of a larger number of alternatives was traded off against a smaller number of attributes: a label, a single attribute reflecting the water quality changes and a price parameter. Hence, the complexity of the choice experiment might not have been high enough to lead to inconsistencies in preferences. Hensher et al. (2005b) argue that a very small number of alternatives do not necessary simplify the choice task and might make differentiation between alternatives more difficult (see Section 4.4). Evaluating relatively unfamiliar goods such as water quality may have added another level of complication to the choices. The next section further explores the question if respondents simplified the choice among seven options by employing a hierarchical decision-making strategy.

Table 6.9 Results of Models I and IV for the pooled database

Lakes	**Model I**	**Model VI – full**
Kagerplassen (KA)	0.343***	0.338***
	(3.909)	(3.801)
Braassemermeer (BR)	0.332***	0.332***
	(4.407)	(4.360)
Westeinder Plassen (WE)	0.384***	0.377***
	(4.863)	(4.688)
Nieuwkoopse Plassen (NK)	1.300***	1.309***
	(18.463)	(18.400)
Reeuwijkse Plassen (RW)	1.278***	1.305***
	(14.135)	(14.076)
Vinkeveense Plassen (VV)	0.952***	0.949***
	(12.784)	(12.544)
Naardermeer (NM)	1.416***	1.424***
	(16.711)	(16.478)
Ankeveense Plassen (AV)	0.904***	0.909***
	(10.499)	(10.407)
Loosdrechtse Plassen (LD)	1.627***	1.639***
	(21.205)	(20.817)
Maarsseveense Plassen (MV)	0.844***	0.852***
	(9.807)	(9.684)
Random parameters (normal distribution)		
Quality * Distance (log (distance (km)+1)	-2.189***	-2.086***
	(-30.313)	(-29.946)
standard deviation	1.190***	1.142***
	(22.527)	(18.834)
Large set (zero mean): standard deviation		2.038***
		(11.913)
Small set second part (zero mean): standard deviation		1.040***
		(4.719)
Non-random parameters		
Price	-0.037***	-0.038***
	(-32.324)	(-32.375)
Quality level 1	5.303***	6.121***
	(22.205)	(19.938)
Quality level 2	5.402***	6.298***
	(22.702)	(20.753)
Quality * Distance * user (dummy)	0.431***	0.430***
	(34.385)	(33.192)
Quality * Distance * non-use reason for WTP (dummy)	0.689***	0.580***
	(6.210)	(5.207)
Quality level 1 * Large set (dummy)		-0.098
		(-0.567)
Quality level 1 * Large set (dummy)		-0.225
		(-1.287)
Quality level 1 * Second part small set (dummy)		-0.098
		(-0.604)
Quality level 2 * Second part small set (dummy)		-0.179
		(-1.091)

Table 6.9 continued.	Model I	Model VI – full
Diagonal values in Cholesky Matrix		
Quality * Distance		1.142***
		(18.834)
Large set		2.029***
		(11.939)
Second part small set		0.426
		(1.120)
Below diagonal values in Cholesky matrix		
Large set: Quality * Distance		-0.191***
		(0.903)
Second part small set: Quality * Distance		0.542***
		(2.633)
Second part small set: Large set		-0.778
		(4.437)
Error-components		
All lakes	4.679***	5.648***
	(22.527)	(20.407)
Model statistics		
No. Observations	6831	6831
Loglikelihood	-7610	7556
No. Parameters	18	27

Notes: T-values between brackets. Significance of the estimates is marked by asterisks: *** at 1%, ** at 5%, * at 10%.

6.6.5 Spatial distribution of alternatives

This section presents the analysis evaluating the effect of the spatial distribution of the alternatives in the choice set on choices, substitution effects and WTP estimates, testing the 11th and final hypothesis of this case study. The applicability of a competing destinations model including an accessibility indicator is tested and compared to the application of an error-component model. A further question is if geographical proximity is the main factor for perceived similarities across lakes or if other characteristics of the alternatives better reflect correlations between alternatives. Models are estimated again in preference space.

The data of the large set is used, as this set contains the choices among a larger number of alternatives, which was expected increase the choice task complexity compared to the small set. Moreover, the large set covers a larger geographical area in each choice task. Respondents are therefore more likely to cluster the alternatives in perceptual regions as assumed in hierarchical choice behaviour in the choices in the large set than in case of the small set. However, the results of the previous section, notably the significant error-component in Model IV, only weakly support the expectation that expanding the choice set increases choice task complexity and hence that respondents will apply a hierarchical decision-making strategy.

The competing destinations model, introduced as Model V in equation (6.6), includes an accessibility indicator, a weighting variable reflecting the attractiveness W_j of the competing alternative j. Different specifications of the nominator of the accessibility indicator are developed using objective and subjective criteria. The list of objective criteria includes the size, circumference and recreational possibilities of the location. The subjective and self-reported criteria include the frequency of visiting the lakes and the perception of respondents about water quality, accessibility, tranquillity and availability of recreational facilities at the lakes.

The denominator of the accessibility indicator is determined by the distance between alternatives. In the analysis, this indicator is not based on the distance between the eleven lakes in the total choice set, but depends on distance between the seven available alternatives in each choice set. This allows for creating variation in this variable and reflects that alternatives absent in the choice set of the specific choice task are non-eligible. The assumption is hence that alternatives only face competition from the other six alternatives that are available in the choice set of the CE and the four remaining alternatives of the total choice set are ignored. A significant accessibility indicator implies that the distance between the available alternatives in the choice set has a significant effect on preferences and choices, weighted by the factors used in the specification of the accessibility indicator.

The accessibility indicator is included as an additional parameter in the utility function in interaction with the two quality attributes, thereby directly reflecting its impact on WTP for water quality improvements[22]. The results are presented in Table 6.10. No significant impacts are found for any of the specifications of the accessibility indicator. Three additional model specifications are tested, in which the accessibility indicator is included as a random parameter, an error-component and an explanatory variable of heteroskedasticity. The two latter model specifications test if the spatial distribution affects the variance of the model, reflecting that the stochastic part of the utility depends on the distance between alternatives but not the deterministic part. Again, no significant effects are found. Different transformations of the distance also do not lead to significant parameter estimates for the accessibility indicator.

[22] The accessibility indicator can also be interacted with the alternative specific constants. This is not different from the model specification with an interaction with the two quality levels and does not result in significant parameter estimates for the accessibility indicator.

Hence, based on the competing destinations model, hypothesis H_0^{11} cannot be rejected. The models do not provide significant results indicating that the proximity of other alternatives affects choice probabilities once distance to the site has been controlled for. The competing destinations model does not give statistical evidence for a hierarchical decision-making process taking place in this CE.

Next, different error-component models are estimated to see if these models are better capable of detecting any effects of the geographical distribution of alternatives on choices among water quality change scenarios. These models do not include the distance between alternatives, but control for correlations in the error variance among similar alternatives. Different error-component structures are tested for the alternative quality improvement scenarios at sites that are geographically close to one another, reflecting similarities in the perception of these alternative and their characteristics. The model fit improves significantly by specifying four additional error-components, grouping together the geographically nearby lakes. Separating the lakes best-known by the respondents, namely the Reeuwijkse, Loosdrechtse, Vinkeveense and Kagerplassen, increases the model fit even further. These four error-components cluster (1) the western lakes: the Westeinder, Langeraarse and Kagerplassen and the Braassemermeer, (2) the northern lakes: the Vinkeveense and Ankeveense Plassen and the Naardermeer, (3) the Gooi and Vecht-lakes: the Naardermeer, Ankeveense, Loosdrechtse and Maarsseveense Plassen, and finally (4) the southern lakes: the Nieuwkoopse and Reeuwijkse Plassen. The results of this latter model, labelled Model VI, are presented in Table 6.10 in which Model I as presented in the previous section is included as a base for comparison.

The fit of Model VI (LL=4138) with four additional error-components is significantly better than Model I without additional error-components (LL=4206)[23]. Hypothesis H_0^{11} is rejected based on this model specification as the proximity-based error-components significantly increase the model fit[24]. Despite the better model fit, the difference in the model parameters for price, quality and distance between Models I and VI are too small to lead to significantly different WTP estimates. With a difference

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[23] Although the parameter estimates for the error-components for (VV, NM, AV) and (NM, AV, LD, MV) are similar and these sets of lakes overlap, two separate error-components as specified in Model V lead to a significantly better model fit than a single error-component for these lakes together.

[24] As the parameters of the error-components in Model VI are not based on the continuous distance, additional models were estimated. First, additional variables are included in the utility functions for all bilateral distances, but these do not lead to significant parameter estimates. Next, an error-component structure is created mimicking a contiguity matrix, by including a dummy variable taking the value 1 for all bilateral combinations of lakes that lie next to each other in the utility functions of the sites as a random parameter with N[0,σ]. Neither a significant parameter for this dummy is found, nor when the dummy is replaced by the distance between each pair of lakes. None of the specifications based on the continuous distance between alternatives result in significant parameter estimates.

of €12, the mean WTP estimates for the quality improvements are slightly lower in Model VI with additional error-components than in Model I, but this difference is not statistically significant. Model VI leads to smaller markets reflecting the population holding positive WTP values. For instance, the WTP held by users is zero at 39 kilometres according to Model VI compared to 57 kilometres in Model I. Although the differences in WTP are not statistically significant, controlling for differences in the variance could potentially lead to different aggregated values due to different market sizes.

As a further test of the relevance of the geographical proximity, the possibility that other factors than geographical proximity better reflect correlations between the alternatives is considered. The same researcher- and respondent-based criteria are used to create different combinations of lakes as for the accessibility indicator. The results of these models are included in Table VI.III in Annex VI. The best model fit (LL=4134) is found when lakes of similar size are clustered in three error-components: one for the three largest lakes, one for the medium-sized lakes and a third for the remaining smallest lakes. This result suggests that people make different choices among lakes depending on the lake size. Among the perception-based indicators, an error-components structure combining the lakes with similar visitation frequencies results in the best model fit (LL=4138). Again, three additional error-components are included in the model, grouping together the two most often frequented lakes, the four regularly visited lakes, and the four least visited lakes. Hence, heterogeneity is also found across respondents based on how often they visit the lakes. These specifications do not improve much upon Model VI, in which error-components are based on geographical proximity, but show that size and frequency of visitation also cause correlations between the choices for different sites.

In spite of the better model fit of these two alternative model specifications with additional error-components compared to Model I, the differences in the model parameters are again too small and hence the WTP estimates are not significantly different from those of Model I. The WTP values for improved water quality at the sites are slightly lower in the models with extra error-components, varying between €4 and €7 for the error-component based on visitation frequencies and between €8 and €11 for the error-component based on the sizes of the lakes. As a result, the extent of the market over which the mean WTP is positive according to the visitation-based ECM is smaller than indicated by Model I and even smaller for the size-based ECM. For the latter model, the range of the market is especially smaller among users ending at 43 kilometres compared to 57 kilometres for Model I. This raises the concern that distance-decay estimates may be biased if the heterogeneity in the model variance is not accounted for, which can affect aggregation results, especially in areas with high population density.

The objective of this section was to evaluate the applicability of the competing destinations and error-component models to spatial choice experiments and the importance to account for the spatial distribution of the alternatives in the choice set. None of the specifications of the competing destinations model produces significant results, but significant parameters for error-components which cluster nearby lakes are found in an ECM specification. Accounting for correlation between nearby lakes in this ECM results in significantly better model fit. A potential limitation of the ECM is that the error-components do not reflect the continuous distance between alternatives in contrast to the accessibility indicator of the competing destinations model. Further research may help to explore the potential of mixed logit models for SP research to reflect the spatial distribution of alternatives more precisely than with simple binary error-components.

The competing destinations and the error-component models and their results have been interpreted in two ways in the literature: in a behavioural and a statistical sense. In the first interpretation the models and their structure are given behavioural meaning and argued to reflect the choice process. The competing destinations model in particular has been proposed to capture hierarchical decision-making applied to complex spatial choices by controlling for the spatial distribution of choice alternatives (Fotheringham 1983; 1986; 1988). To a lesser extent error-component models have also been given behavioural meaning, similar to the nested logit models. Some researchers argue that the econometric models capture nothing more than correlations in the error variance and cannot be given any behavioural meaning regarding the choice process. However, different decision-making strategies can be captured by similar statistical models. In this case study, clustering of alternatives based on a similar characteristic, for instance proximity, was expected to result in correlations between the error terms of these alternatives. The significant results for the error-components based on geographical proximity may hence reflect that the correlation between choice probabilities of different locations is affected by clustering of nearby alternatives and a hierarchical choice strategy. However, the results of additional ECM specifications show that the size and visitation rates of the lakes result in a slightly better model fit, which suggests that the spatial distribution of alternatives is not a dominant factor causing correlations between alternatives.

Table 6.10 Results of the Models I and VI and corresponding WTP-values

Lakes	Model I	WTP-values	Model VI	WTP-values
Kagerplassen (KA)	0.473**	€12	0.469***	€ 10
	(2.492)	(€3, €21)	(3.031)	(€ 4, € 17)
Braassemermeer (BR)	0.405**	€10	0.400***	€ 9
	(2.206)	(€1, €19)	(2.743)	(€ 2, € 15)
Westeinder Plassen (WE)	0.378**	€9	0.289*	€ 6
	(2.089)	(€1, €18)	(1.930)	(€ 0, € 13)
Nieuwkoopse Plassen (NK)	1.245***	€31	1.518***	€ 34
	(7.105)	(€23, €41)	(8.230)	(€ 26, € 43)
Reeuwijkse Plassen (RW)	1.078***	€27	1.331***	€ 30
	(5.996)	(€18, €36)	(6.820)	(€ 21, € 39)
Vinkeveense Plassen (VV)	1.091***	€27	1.463***	€ 30
	(6.082)	(€18, €36)	(7.140)	(€ 21, € 38)
Naardermeer (NM)	1.288***	€32	1.493***	€ 34
	(6.716)	(€23, €41)	(7.140)	(€ 24, € 44)
Ankeveense Plassen (AV)	0.643***	€16	0.777***	€ 17
	(3.333)	(€7, €26)	(3.660)	(€ 8, € 27)
Loosdrechtse Plassen (LD)	1.439***	€36	1.721***	€ 39
	(8.041)	(€27, €46)	(9.525)	(€ 30, € 47)
Maarsseveense Plassen (MV)	0.726***	€18	0.980***	€ 22
	(3.861)	(€9, €28)	(5.059)	(€ 13, € 31)
Random parameter (normal distribution)				
Quality * Distance (ln, km)	-1.878***	-€47	-2.085***	- € 47
	(-18.665)	(-€55, -€41)	(-23.562)	(-€ 53, -€ 42)
standard deviation	0.993***		0.954***	
	(8.313)		(11.287)	
Non-random parameters				
Price	-0.040***		-0.044***	
	(-16.739)		(-21.881)	
Quality level 1	5.031***	€126	5.064***	€ 114
	(10.650)	(€105, €152)	(14.645)	(€ 99, € 129)
Quality level 2	5.067***	€127	5.099***	€ 115
	(10.706)	(€106, €153)	(14.729)	(€ 100, € 130)
Quality * Distance * user (dummy)	0.438***	€11	0.490***	€ 11
	(16.662)	(€9, €13)	(19.082)	(€ 10, € 13)
Quality * Distance * non-use reason for WTP (dummy)	0.597*** (4.903)	€15 (€9, €21)	0.672*** (5.718)	€ 15 (€ 10, € 21)
Error-components				
All lakes	3.895***		3.661***	
	(42.950)		(12.257)	
KA, BR, WE, LA			1.418***	
			(9.296)	
VV, NM, AV			1.012***	
			(7.181)	
NM, AV, LD, MV			1.071***	
			(8.453)	
NK, RW			0.645***	
			(2.905)	

Table 6.10 continued	Model I	WTP-values	Model VI	WTP-values
Model statistics				
No. Observations	3184		3184	
Loglikelihood	-4206		-4138	
No. Parameters	18		22	

Notes: Models are estimated using NLOGIT 4. T-values are presented between brackets.
Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

Even if one is willing to give a behavioural meaning to statistical models, the statistical properties of the models may not be able to capture subconscious choice behaviour, such as a hierarchical evaluation of alternatives. It might have been possible to attribute a behavioural interpretation to these mixed statistical results if the CE was combined with, for instance, qualitative methods to reveal underlying decision-making strategies. The use of an online panel for this study prohibited asking detailed questions discussing the choice behaviour and trying to reveal subconscious choice processes. The development of different spatial choice models provides an opportunity for further research, which may help to understand how people make choices among different locations for the valuation of ecosystem services by these locations in experimental settings.

A possible explanation for the insignificant results of the competing destinations model relates to the design of the experiment. The number of lakes in the large choice set (seven) may not have been sufficient to identify a spatial structure effect, in which there is a different substitution pattern at local scale (e.g., three or four nearby lakes) than at a higher, regional scale (the eleven lakes in the choice). It is important to note that the respondents in the focus-groups did not perceive the area as one homogeneous entity, mostly because of the limited number of direct travel routes and cycling paths to the lakes and because the lakes lie at considerable distances from each other. Grouping of alternatives in different subsets was therefore expected prior to the analysis. Given the experimental design, it was also assumed that only the distance to *available* alternatives in the choice task would affect choice probabilities. The possibility that other alternatives may have affected choice tasks in the CE was not controlled for (e.g., Holmes and Boyle 2005). Furthermore, using an online panel also had practical implications for the presentation of the choice set. Pre-tests of the survey showed that respondents preferred the survey material, such as the choice cards and quality pictures, to fit the screen so that they would not have to scroll down to see the entire choice card. This prohibited the use of larger maps to represent the choice tasks, which may have limited the effect of distance between alternatives on choice probabilities.

Another explanation for the insignificant results of the competing destinations model is that the level of complexity involved in evaluating seven lakes simultaneously may not be high enough to invoke hierarchical decision-making to simplify the choice task replacing utility optimisation strategies. The results presented in the previous section give little evidence for preference instability due to complexity of the choice tasks. The results of this case study do not confirm those of previous transportations studies that have found the choice task complexity to increase with the number of variables and alternatives (e.g., Caussade et al. 2005) and findings in the brand choice literature that a hierarchical choice process operates in choices of sets consisting of six or more alternatives (Fotheringham and O'Kelly 1989, 75). It may be that hierarchical decision-making strategies are only applied when many more alternatives have to be considered. In addition, the questions and information in the survey prior to the CE may have helped respondents sufficiently to supplement their knowledge and make more accurate and simultaneous choices.

Finally, the competing destinations model has been successfully applied to topics such as migration and commuting, but has not been applied before in SP research when WTP consists of use and non-use values. The insignificant results found in this study could hence suggest that this model is not applicable to utility associated with environmental changes. Perhaps, the spatial distribution of alternatives only affects behaviour involving use values related to migration or recreation, but does not affect choices involving non-use values associated with environmental improvements. Although including error-components based on geographical proximity improved the model fit, additional ECM specifications based on the size and visitation rates resulted in slightly better model fit, suggesting that the spatial distribution of alternatives is not the main factor causing correlations between alternatives.

6.7 Summary and conclusions

This chapter presented a second case study for estimating the WTP for water quality changes in eleven lakes in the Rhine-West basin in the Netherlands. These lakes are of similar ecological typology under the Water Framework Directive and provide comparable use and non-use values. Different elements of the framework presented in Chapter 2 were tested in the case study: the heterogeneity in distance decay across sites and across respondents due to past visitation. Differences in distance decay across directions from the sites were also tested. To this end, directional dummy-variables were used, as an alternative methodology to those used in the previous case study. The effect of cognitive distance errors was tested by including these errors as an additional variable in the model. For these tests, the models were estimated in WTP-space. Furthermore, the effects of increasing the geographical scale of the choice set and the spatial proximity of alternatives on substitution effects were addressed.

The CE developed in this case study included one attribute reflecting the ecological quality changes, specified with two levels, besides a monetary attribute. In contrast to the case study presented in Chapter 5, no site-specific values were found for these improvements. The results also showed that the general public is willing to pay for increased water quality, but does not attach a significantly higher WTP to the ecosystem services provision under Good Ecological Status (GES) than to the services provided at an intermediate ecological quality level. Achieving GES demands restrictions on some of the recreational activities that respondents can undertake. The improvements related to the GES may therefore not be sufficient to compensate for the loss of recreational value in comparison with the intermediate level of ecological quality.

Significant spatial heterogeneity across the sampling area was found in WTP for water quality changes at the eleven study sites. Distance decay was subject to heterogeneity between users and non-users, use and non-use related values, and cognitive distance errors. Non-users were willing to pay for quality improvements, but showed significantly lower WTP than users. The distance decay in the WTP for non-users probably reflected the presence of option values. Moreover, in accordance with the theoretical expectation, lower distance decay was found for non-use related WTP. Distance-decay effects did not differ between the ecosystem services provided at intermediate ecological state and GES and between alternative transport modes.

Furthermore, the results of the case-study showed that accounting for cognitive distance errors, which reflect the difference between cognitive and objective distance, had a significant impact on distance-decay parameters and resulted in a better model fit. WTP estimates of respondents with cognitive distance errors were not significantly different from WTP results of respondents without cognitive distance errors. The results seem to justify the current use of objective distance measures in SP research and travel cost studies. However, WTP estimates are different between respondents who over- and underestimated the distance. Further research is needed to explore if cognitive distance errors are larger and have a stronger effect on WTP for sites that are further away and are less well-known among the sampled population.

The analysis addressed directional heterogeneity in distance decay by including directional dummy-variables in the site-specific utility functions. This approach is relatively simple and the results are easier interpretable compared to the spatial expansion method employed in the previous case study in the Scheldt. The directional heterogeneity resulted in significantly different distance-decay effects and related mean WTP estimates across different directions from the site, which showed that accounting for distance-decay effects is not sufficient to capture spatial heterogeneity. The spatial pattern in WTP values revealed by the directional dummy-variables suggested that the spatial variation in WTP depended mainly on the availability of substitute sites across different directions from the site of interest. The results show that the extent of the market varies across directions from the site. Further research is required to assess if the total WTP, aggregated over the entire economic market, will be different when these directional effects are controlled for.

This case study also aimed to contribute to further understanding of the effect of the size of the choice set on choice task complexity and consequently WTP estimates for ecological quality changes. To this end, the size of the choice set was changed during the sequence of choices in the survey. The CE started with a subset of the four lakes nearest to the home location of the respondent, followed by a larger choice set covering a wider geographical scale, before returning to the small subset.

The comparison of results of the small and large set suggests that preference remained stable when increasing the number of alternatives in the choice set, as the different treatments did not result in significantly different preference parameters or WTP estimates. A higher error-variance was found among the choices in the large choice set compared to the small set, which was attributed to the higher complexity involved in the evaluation of more alternatives. These additional alternatives were also likely to be less familiar to respondents. Only weak evidence was found for learning effects. The results of the scale tests suggest that respondents found the choice among the four nearest alternatives easier after they had considered their WTP for water quality changes in the substitutes in the wider area. However, this effect was not persistent. Moreover, no learning seemed to take place during the choices in the large set. The stability of preference and absence of learning effects were expected to result from the detailed questions included in the survey prior to the CE about the perception of the eleven lakes and the way the CE was built up, starting with the small subset of nearby lakes.

No evidence was found in this case study for a hierarchical decision-making process employed by respondents or the effect of the spatial proximity of alternatives on the substitution pattern using a competing destinations model. This model includes an accessibility indicator, reflecting the proximity of an alternative to other options in the choice set, in the site-specific utility functions. No significant parameter estimate was found for the accessibility indicator. This result suggests that the spatial distribution of the alternatives did not have a significant effect on choices for water quality changes provided by the eleven lakes. Besides limitations in study design, a number of issues regarding the applicability of the competing destinations model may explain this result. Perhaps the number of alternatives was not sufficient to increase the choice task complexity to such a level that respondents employed a hierarchical decision-making strategy instead of evaluating all alternatives simultaneously in a utility optimising strategy. It may also be that the spatial distribution of alternatives has less effect on choices in environmental valuation surveys where alternatives are associated with non-use values as in this case study than in other fields of research where the utility of alternatives consists mainly of use values. Furthermore, the statistical properties of the competing destinations model may not be able to capture decision-making processes.

As an alternative modelling approach to capture the effect of the spatial distribution of alternatives on the substitution pattern, a model with additional error-components was estimated that grouped geographically nearby lakes. The error-components were found to be significant and to improve the model fit, indicating that choices between improvement scenarios at nearby lakes were correlated. The results suggest that the error-component model is better capable of capturing correlation between geographically nearby alternatives than the competing destinations model in the study presented here. However, the hypothesis that the distance between alternatives matters for spatial choices on the spatial scale chosen in this study was weakly supported. Other error-component specifications also showed that quality improvements at frequently visited lakes and larger sized lakes are perceived differently from similar changes in less frequented lakes or smaller lakes. These specifications even resulted in a slightly better model fit than when grouping nearby lakes. Hence, other characteristics of the alternatives related to their accessibility have a significant, and possibly stronger, effect on the substitution between the alternatives than geographical proximity.

Based on the results of the error component and competing destinations models of this case study, there is no clear evidence that a hierarchical decision-making affected the choices and WTP in this CE. The results could imply either that respondents did not apply a hierarchical decision-making process driven by the proximity of the available alternatives or that the statistical properties of the models were not appropriate to capture this process. In combination with the results presented in Sections 6.6.5, no evidence was found for preference instability or other violations of rationality assumptions in this case study. The study design may have given respondents sufficient opportunities to learn about the choice alternatives before entering the full choice set of the CE, which reduces the possibility that increasing the geographical scale of the choice set leads to violations of rationality assumptions. The next chapter provides a summary and conclusions of the findings of the two case studies and discusses the validity and reliability of the proposed framework.

7. Summary and conclusions

7.1 Introduction

Water is the cornerstone of life on earth. Water resources provide a wide range of environmental services with associated human benefits. In spite of the importance, the quality and quantity of water resources are increasingly under pressure from pollution and overexploitation. One of the key reasons that water resources are overexploited is related to the common-pool property of water, which often makes it impossible to prevent people who have not paid for using the water resource from enjoying its benefits. The negative externalities of water use result in an inefficient allocation of the water-related environmental services over different uses in time and space. One of the reasons is that prices do not reflect the socio-economic value of these services held by the human population.

Water pricing can provide incentives to use water resources more efficiently. Effective pricing policies have to reflect the costs of water use including those of environmental externalities. This requires the economic valuation of the market and non-market goods and services of water quantity and quality changes. The value of a resource is reflected by the Willingness-To-Pay (WTP) for a marginal change in the (potential) use of a resource. The individual WTP is aggregated over the relevant population to estimate the total WTP reflecting the social welfare change resulting from the change in the provision of services of water quality and quantity. The total WTP estimate can for instance be used in cost-benefit analyses to account for the market and non-market benefits of water resources.

Understanding the spatial nature of the environmental services and the spatial distribution of the associated benefits is paramount for reliable estimation of both individual and total WTP and the identification of the relevant population of beneficiaries. However, most existing stated preference (SP) studies have paid little attention to the spatial context of the goods under valuation. A limited number of empirical SP studies account for the spatial dimension underlying natural resource valuation through the effect of distance on WTP and find that WTP decays as people live further away from the study site. In the economic literature, this so-called distance-decay effect is attributed to the increased travel costs involved in visiting a site and enjoying the environmental goods and services it provides. But the existing SP studies pay little to no attention to additional spatial heterogeneity due to heterogeneous respondent profiles and different distance-decay rates across sites, across environmental goods and services or across regions with different substitute availability. Ignoring the heterogeneity in the distribution of the benefits of ecosystem services could potentially reduce the reliability of aggregate WTP estimates. Even more surprising is the lack of consideration of substitution effects in SP research. While choice experiments offer a good possibility in SP research to assess substitution between spatially distributed environmental goods and services, most studies have so far focused on single sites, ignoring possible substitution effects and hence likely reducing the reliability of the WTP results. The neglect of the SP literature on water resource valuation to address the effects of the spatial dimension was the main rationale for undertaking the research resulting in this thesis.

7.2 Main research question and objectives

The main objective of this thesis was to assess to what extent accounting for the spatial aspects of preferences for ecosystem goods and services provided at different locations would increase the validity and reliability of stated preference studies. The main research question was:

Can the design and analysis of stated preference studies be improved to increase the validity and reliability of WTP results by accounting for the effects on preferences and choices of the spatial context of the provision of environmental goods and services?

Several sub-questions were addressed in order to answer the main research question:

a. Which (implicit) assumptions do standard economic models make regarding choices for environmental goods and services and to what extent might the validity and reliability be compromised in case of spatial choices?
b. How does the perception of the spatial characteristics of environmental goods and services and their spatial context influence preferences and choices in stated preference research?
c. How have existing studies accounted for the effect of distance on WTP in study design and analysis and how do existing practices affect the validity and reliability of the resulting WTP estimates?

d. How have existing studies accounted for the effects of the availability and characteristics of substitutes on the WTP for environmental goods and services provided by a study site and how do existing practices affect the validity and reliability of the resulting WTP estimates?
e. How can the characteristics of spatial choices be more adequately addressed and which statistical models are suitable so that the validity and reliability of stated preference studies for the valuation of spatially defined environmental goods and services can be improved?

Chapter 2 provided an overview of the standard neoclassical economic literature on rational choice behaviour and existing SP methods. It highlighted that existing sensitivity-to-scope studies fail to adequately address the effect of substitutes on stated preferences and WTP. The limited attention paid in SP studies to substitution effects may cause anomalies and biases in WTP estimates. To identify potential violations of rationality assumptions in spatial choices (sub-question a), the concepts and methods from other disciplines analysing spatial behaviour and preferences, such as social and economic geography and environmental psychology, were reviewed. These disciplines address the effect of spatial perceptions on choice behaviour (sub-question b). They put forward that spatial perceptions are embedded in the so-called cognitive map. This map reflects spatial cognition and perception, including spatial information and emotional attachments to locations. A hierarchical formation and storage of spatial knowledge may affect distance decay as well as substitution effects and may lead to violations of rationality assumptions. The cognitive distance as reflected in the cognitive map may be different from the objective distance based on the road network and influence distance-decay effects in WTP. Hierarchical spatial cognition may also lead to different choice behaviour in complex spatial choice situations and affect substitution patterns between locations. Finally, the effect of spatial proximity on spatial relationships, and the statistical techniques used in spatial analysis to address these relationships, were shortly discussed. The relevance and importance of a two-dimensional conceptualisation of space in SP research was stressed, as this permits accounting for spatial heterogeneity in observations and distance-decay relationships in the analysis.

Insights about spatial choice behaviour from the other disciplines formed the basis for adapting the standard neoclassical economic framework for spatial preferences and choices elicitation procedures by accounting for the psychological and physical context of spatially defined environmental values. Based on theoretical considerations and insights from existing empirical research, it was hypothesised that addressing the effect of spatial cognition and perception in the analysis and adopting a two-dimensional conceptualisation of space would increase the validity and reliability of spatial choice studies. Different methodological approaches to operationalise the proposed framework and to capture spatial heterogeneity in distance decay and substitution patterns influencing preferences and choices were discussed in Chapters 3 and 4.

Two case studies were carried out to test if and to what extent spatial aspects in SP studies focusing on water services valuation influence WTP results. In both cases, choice experiments were used, as these were considered to be the most flexible SP technique for the assessment of substitution effects between sites, especially when respondents are asked to choose between these sites presented as labelled alternatives[25]. In the first case study in Chapter 5, a labelled choice experiment was developed in which respondents were asked to express their WTP for achieving improved ecological quality at three alternative study sites: the beaches near Breskens, the Braakman-creek and the tidal mudflats of Saeftinghe. These sites are located in a confined geographical area along the Dutch part of the Scheldt estuary and are well-known among the local population. In the second case study in Chapter 6, the effects of distance and substitutes were further explored. Special attention was paid to directional heterogeneity in distance decay and the effect of spatial scale on choice complexity and decision-making processes. In this labelled choice experiment, conducted in the Rhine basin in the Netherlands, respondents were asked to choose among different ecological improvement scenarios at eleven lakes at the expense of paying extra taxes. The study sites provide a wide range of environmental services and related nature amenity and recreational values. The biophysical characterisation of the study sites was informed through a consultation process of external experts and colleague ecologists at IVM (Gilbert et al. 2007; Gilbert and Schaafsma 2007).

[25] It was argued in this thesis that including multiple sites in a CE ensures that respondents account for substitutes when stating WTP for a single site. However, no empirical evidence was given for this statement by comparing the presented results to a CE in which one site was offered as the only possibility besides the opt-out. This was because according to the literature, such a CE is not expected to lead to reliable WTP estimates. Van Haefen et al. (2005) find that such a CE design can lead to non-participation. According to Breffle and Rowe (2002) and Rolfe and Bennett (2009), a CE with only one hypothetical option and the opt-out might be more difficult for respondents to answer, as the low variation in the options makes trade-offs difficult to make. These studies suggest that it is difficult to separate the effect of ignoring substitutes from the non-participation or complexity in a CE with only one alternative site. In fact, these studies provide another reason to include multiple alternatives in SP studies.

7.3 Main results and insights

The analytical framework and the empirical analysis of the two case studies focused on three interrelated subjects: (1) site-specific values, (2) distance decay, and (3) substitution effects.

7.3.1 Site-specific values

In the first case study, the selected study sites along the Scheldt offered different types of environmental services based on different ecosystem characteristics under ecological quality improvement scenarios. The results showed, as expected, that WTP values for achieving improved natural amenities and bathing conditions were site-specific and dependent on the physical context of the environmental goods and services under valuation. These site-specific values hamper the transfer of WTP values for specific ecosystem goods and services from one site to another.

In the second case study, the lakes in the Rhine-basin offered similar environmental services. Consequently, no site-specific WTP values were found for achieving better ecological quality at these lakes. Moreover, the results indicated that WTP for achieving good ecological status (the highest quality level) was not significantly different from WTP for the goods and services provided at an intermediate quality level. Achieving higher quality in terms of species richness and ecosystem health at the study sites would only be possible if existing recreational activities were restricted. It was expected that this trade-off between use and non-use values resulted in similar WTP estimates for the two quality levels.

7.3.2 Distance decay

The second subject was distance decay. In Chapter 3, a conceptual distance-decay function was formulated, including all variables that influence distance decay according to the theory, such as the type of values provided by the study site, familiarity, place attachment, mode of transport and the accessibility of substitutes. The chapter also discussed the statistical form of the distance-decay function and its behavioural interpretation (sub-question c), which may guide future empirical distance-decay analyses.

In both case studies of this thesis, the results showed that distance had a significant negative impact on public preferences for the sites. In the study of the Scheldt basin, the distance-decay effects proved to be site-specific. The differences in distance decay across the sites could be explained by the different ecosystem services and associated use and non-use values the sites provided. An important difference between the case studies was that distance-decay estimates found in the case study in the Rhine basin were much higher than those in the Scheldt. One reason may be that the distance-decay rates in the Rhine study reflected the effect of substitutes more accurately, as respondents were asked to trade-off more alternative sites than in the Scheldt survey. The distance-decay rates in the Rhine study were also higher than those found in existing SP studies, which focus on single sites. This comparison hence suggests that distance-decay estimates may be biased if respondents focus too little on available alternatives and are not asked to choose between a site and its substitutes. The main conclusion is that differences in distance decay across sites may compromise the validity and reliability of WTP estimates in SP research. Transferring distance-decay estimates from one site to another, especially when the type of ecosystems or the availability of substitutes between the sites is different, could lead to significant transfer errors.

Significant differences in distance decay were also found between users and non-users in both case studies. In addition, the results of the Rhine study showed that non-use dominated values are subject to significantly lower distance decay than WTP values based on other motivations. Users and non-users were identified based on past visitation behaviour and experience with the study sites. Knowledge and familiarity were highly correlated with past visitation and hence not included as additional variables in the WTP-models. No evidence was found in the case studies that the means of transport affected distance decay. Place attachment, a variable specifically related to spatial perception and cognition, had a significant impact on choices in the Scheldt study. This result implies that, in addition to travel costs, emotional attachment to locations may cause spatial heterogeneity in WTP and bias distance-decay estimates if ignored.

In Chapter 3, two gaps in the SP literature were distilled, namely the effects of cognitive distance errors and spatial heterogeneity on distance decay and WTP. Cognitive distance errors reflect the difference between the cognitive and the objective distance. They may arise, for instance, when locations are considered to be landmarks or for (un)familiar locations. Cognitive distance errors can bias distance-decay functions estimated based on the objective distance measures if ignored. Their effect was tested in the choice model in the Rhine study. Accounting for the effect of cognitive distance errors improved the model fit but did not result in significantly different WTP estimates compared to a model that ignored the errors. Differences WTP values were found, however, between respondents who overestimated and underestimated travel distances. The study sites included in this choice experiment were all located nearby and relatively familiar to respondents. Stronger effects are likely to result with less familiar or more distant locations.

Next, the presence of spatial heterogeneity in distance-decay effects and WTP values for ecological improvement scenarios was tested. This heterogeneity is expected to occur when spatial differences exist in the availability of substitutes or respondent characteristics. In Chapter 3, three methods were proposed to capture spatial heterogeneity in distance decay: (1) the spatial expansion method, (2) the use of directional dummy variables, and (3) the distance to alternative sites in WTP models. The methods were tested in the case studies.

Significant directional heterogeneity was found in choice probabilities and in the distribution of WTP values across the study areas in both case studies, in addition to distance decay. Accounting for directional heterogeneity led to significantly better model fit and significantly different WTP values across areas compared to models that ignored additional spatial heterogeneity. In the Scheldt study, the results of a model including the distance to substitute beaches showed that lower WTP values for the beach location were found among respondents living closer to coastal substitutes compared to those living further inland. No significant effect was found for other sites or for the distance to (other) respondent-selected sets of substitutes. The results of the spatial expansion method revealed a similar spatial pattern in WTP. The spatial expansion method allows for accounting for directional heterogeneity by specifying distance decay as a function of the geographical coordinates of the location of each respondent. The results also disclosed additional spatial heterogeneity in WTP, which could not be captured by accounting for the distance to substitutes. In the Rhine study, the inclusion of directional dummy variables in the choice model revealed that significant differences in distance-decay rates were present across different directions from the study sites, mainly explained by the non-random spatial distribution of substitutes. The analysis showed that directional heterogeneity can lead to significant differences in the market size reflecting the relevant population over which the individual WTP estimates can be aggregated to assess the total WTP.

7.3.3 Substitution effects

The third and final topic addressed in this thesis was substitution effects, where substitutes were defined as sites that provide similar environmental goods and services. Chapter 4 outlined the theory regarding substitution effects. The limited attention paid to substitution effects in SP studies was explained by acknowledging three common problems in study design. First, there are practical limitations when using surveys, which require, for instance, making a trade-off between survey length and providing a comprehensive description of the study sites as well as additional substitutes. Secondly, the researcher has to consider the limitations to the cognitive ability of respondents, who have to evaluate all alternatives simultaneously when stating their WTP for a proposed environmental change at study sites. Finally, researchers face problems in selecting the complete relevant set of substitutes that is considered by each individual, also referred to as the consideration set.

In both case studies, substitution patterns between the sites were subject to heterogeneity and correlation among adjacent sites. The results imply that the WTP for ecological quality improvements at the study sites depends on changes in ecological quality at other sites. Estimating the WTP using single sites and ignoring the effect of substitutes may reduce the validity of SP results. Similarly, adding up WTP estimates from single-site studies to estimate the WTP for a combination of changes in the provision of ecosystem services at different sites may lead to ill-informed policy decisions.

Chapter 4 argued that conventional discrete choice models, including mixed logit models, provide flexibility in capturing substitution patterns between alternatives, but suffer from two limitations. First, they may not be flexible enough when choice sets include sites of which some are closer substitutes than others. Second, the possibilities for the parameterisation of the effect of proximity of the alternatives on choice probabilities are limited. Alternative modelling approaches to overcome these limitations were tested in the case studies.

In the Scheldt study, a mixed logit model with random parameters and error-components to allow for correlation between alternatives was extended with cross-effects based on a universal logit approach. These cross-effects reflect the additional impact of the changes in attributes of an alternative on the probability that the site of interest is chosen. Accounting for these cross-effects resulted in significantly different WTP estimates for some of the policy scenarios, overestimating WTP up to 40 percent. The results point out the necessity to pay adequate attention in future spatial choice studies to possible disproportional substitution patterns due to differences in the characteristics across substitute sites. The extended mixed logit model also showed that existing mixed logit models may not be flexible enough when some of the alternatives in the choice set are closer substitutes than others. Existing models used in discrete choice analysis, such as nested and cross-nested logit models, which are unable to capture the panel data structure of SP surveys, were not considered to be applicable in the case studies. The results of the extended mixed logit model provide another reason to question the validity and reliability of existing welfare estimates from single-site studies in which site-specific and disproportional substitution effects have been ignored.

The effect of the spatial proximity of alternatives on substitution patterns was tested in the Rhine case study by evaluating the specification of additional error-components in a mixed logit model against the applicability of the competing destinations model. Including additional error-components that grouped together quality improvement scenarios at nearby lakes improved the model fit. The results suggested that the spatial distribution of the alternatives in the choice set affects choices for environmental quality improvement scenarios. Different substitution rates were hence found between nearby and more distant lakes. Error-component specifications based on other characteristics of the lakes related to their accessibility, such as the size and visitation rates of the lakes, resulted in similar or even slightly better model fit than geographical clustering. Hence, other characteristics of the alternatives may better capture the underlying substitution patterns between the alternatives than geographical proximity. However, none of the error-component specifications resulted in significantly different WTP estimates. This suggests that potential biases in WTP when ignoring spatial proximity might be limited.

The competing destinations model has the advantage of explicitly accounting for the distance between alternatives and has been used in migration and recreation studies. The model includes an accessibility indicator, which reflects the proximity of alternatives in the choice set and can include other site characteristics, such as size. The model has also been argued to be able to capture hierarchical decision-making strategies, in which respondents group a large number of alternatives in perceptual regions before selecting an alternative in their preferred region. This strategy is expected to be applied to simplify choices in complex choice situations when the task of evaluating all alternatives simultaneously is too demanding and exceeds the cognitive abilities of the respondents. In the Rhine case study, the competing destinations model did not produce significant results for the accessibility indicator.

Based on the results of the competing destinations model and error-component models, the case study did not provide convincing evidence for the hypothesis that a hierarchical decision-making process was employed for spatial choices between environmental improvements associated with use and non-use values at multiple lakes at a large spatial scale in a stated CE. Two possible explanations are as follows. It might be that for choices involving use and non-use values, the geographical proximity of alternatives and the embedding of alternatives in spatial perceptual regions is not as important as in migration choices where hierarchical processes have been detected. Non-use values may form a considerable part of individual WTP, but are not expected to be highly distance-dependent and hence the spatial proximity of alternative sites providing substitutable non-use values may be less influential.

Another explanation is that the choice tasks were not considered too complex and respondents were able to evaluate the alternatives simultaneously without much cognitive burden. The effect of choice task complexity was further tested in the CE in the Rhine by increasing the geographical scale of the choice set, thereby expanding the choice set size. Choices between larger numbers of alternatives were expected to be more complex and result in different choice behaviour if the complexity exceeded the cognitive ability of respondents to evaluate all alternatives simultaneously as assumed under rational behaviour. By comparing choice tasks consisting of four alternatives to choices between seven alternatives (out of a total set of eleven lakes), the transitivity and completeness of preferences were examined. The results indicated that the larger choice set was associated with higher error variance indicating higher perceived choice task complexity, but preferences for the attributes were nevertheless found to be complete and transitive. Furthermore, hardly any evidence for preference learning was identified in the choices among the four nearest lakes after the evaluation of all study sites in the larger choice set. The results suggested that respondents are capable of evaluating different combinations of seven alternatives out of a total set of eleven in a SP survey, at least if all alternatives are thoroughly introduced, respondents are asked to state their perception of these lakes before going through the CE and are first offered a subset of alternatives. Such a study design gives respondents the opportunity to learn about the choice alternatives before entering the full choice set of the CE, which reduces the possibility that increasing the geographical scale of the choice set leads to violations of rationality assumptions.

It may be that the small number of attributes in the CE in the case study in the Rhine basin has simplified the choice task. However, choice task complexity is also affected by the subject of the choice. Besides the quantitative dimensions of the choice task design in terms of the number of alternatives, attributes and attribute levels, the inclusion of environmental attributes such as water or ecological quality, are likely to increase the choice complexity compared to evaluating the characteristics of daily consumed products. The choice tasks in the Rhine case study may therefore not have been easy in spite of the small number of attributes due to the complexity of the subject.

In summary, the effects of the physical context of environmental changes, such as site-specific values, distance decay and related substitution effects, came out somewhat stronger than the psychological effects of cognitive distance and hierarchical choice behaviour in the empirical results. The results of the case studies show that the validity and reliability of SP studies can be improved by accounting for spatial preferences, distance decay and substitution effects. This requires careful design of the survey instrument with questions about relevant substitutes, the availability of different types of substitutes and asking respondents to make explicit trade-offs between payments and improvements in ecosystem service provision at alternative sites.

7.4 Policy relevance

The European Water Framework Directive (WFD) formed the policy context of the ecological quality changes that respondents were asked to value in the two case studies. The WFD was adopted in 2000 with the aim to guarantee a good ecological status (GES) of all surface and ground water bodies in the EU by 2015 and ensure safe access for different uses to this important resource. Water pricing is one of the policy instruments put forward in Article 9 of the WFD to stimulate efficient resource allocation and take environmental externalities into account. For the development of a water pricing strategy and the assessment of disproportionate costs as specified in Article 4, environmental valuation is to this end necessary as it can capture the perceived benefits of the WFD implementation. As the WFD implementation is expected to yield both use and non-use values, stated preference techniques are required. In the case studies, respondents were asked to pay extra for water quality improvements through an increase in their annual water board tax. Thereby, the institutional context of the WFD was captured in the payment vehicle of the studies. The results of the studies are relevant to policy development related to the WFD as they provide insight into public support and financial commitment to its implementation. In a broader perspective, the results are relevant to the development of pricing schemes aiming for a sustainable use of environmental goods and services.

The results of the case studies provide insight in the spatial distribution of WTP values for environmental quality changes under the WFD. First of all, values for environmental quality changes were found to be site-specific. Whereas generic values may be sufficient for policy development at national scale, regional policy-makers likely need more spatial detail. The analysis of site-specific values of water quality changes can help policy makers to allocate limited budgets and prioritise investments in quality improvements at those sites with the highest public benefits.

Furthermore, the Rhine study showed that public WTP for achieving GES does not necessarily exceed values for smaller ecological quality improvements, especially when achieving GES imposes limitations on certain recreational activities. The main policy implication of this result is that the marginal public benefits of achieving the highest ecological level may not exceed the marginal costs of investments needed to achieve this high level, over and above the intermediate level as specified in this study. If achieving GES comes at the expense of a loss of recreational amenities, projects to achieve GES may not pass a cost-benefit test.

A second impediment to the unconditional use of generic values is the site-specific distance-decay effects found in both case studies. The main objective of distance-decay analysis is to define the population over which individual WTP estimates can be aggregated to calculate the total WTP for policy scenarios of ecological quality improvements. Accounting for distance decay can be considered an important validity check of the results of valuation studies and were proven to increase the reliability of WTP estimates significantly. Distance-decay effects were shown to vary across sites in their functional specification and magnitude, across users and non-users and across directions from the study sites. Hence, the empirical results do not allow an average distance range to be taken from a site providing ecosystem services or an administrative unit to delineate the area in which the population benefiting from these services lives. Distance-decay estimates are dependent on the physical context including the availability of substitutes and the psychological perception of this context.

In the presence of areas with many different water bodies, policy-makers should be cautious when using the results of single-site studies, because substitution possibilities can have a significant impact on WTP estimates for environmental quality changes at a single site. As a result, WTP values of existing studies may be biased upwards. Substitution effects can be assessed by including the distance to substitutes in the model or preferably by asking respondents to choose among environmental changes at different sites.

Finally, the substitution and distance-decay effects found in this study show that benefits resulting from the implementation of the WFD may fall well beyond the political borders of the area for which a water board is responsible. Hence, water boards of adjacent affected areas are advised to collaborate in the development of efficient pricing schemes. Such coordinated implementation and cost-sharing between water boards representing benefitted areas is expected to results in more efficient implementation of the WFD.

7.5 Suggestions for further research

Although the case studies presented in this thesis have covered a broad range of spatial effects in WTP values for water-related environmental changes, a number of issues remain open for further research. The empirical results of this thesis are based on water-related studies. The findings and proposed methodologies are expected to be applicable to other types of environmental goods and services, especially when these are non-randomly distributed over space. Future studies on the WTP for non-water related ecosystems are necessary to confirm the general applicability of the findings of this thesis.

Although the CV method was not used in this thesis, the proposed methods to account for distance to sites or substitutes as well as spatial perception and cognition effects on distance decay can be incorporated in CV studies. Future CV studies may test the impact of these factors when assessing distance decay in WTP estimates.

Furthermore, the theoretical and empirical literature on environmental psychology suggests that distance decay is affected by the perceived risk of the provision of ecosystem goods and services in the future as a result of a policy change. Future research may shed more light on this relationship between risk and WTP. More research is also needed on the effect of the mode of transport on distance decay. No significant effect of transport mode was found in this thesis, but this contradicts the results of studies on other types of spatial choices, such as daily commuting to work.

Chapter 2 stressed the importance of spatial cognition and the violations of rational behaviour that might follow from using cognitive maps in spatial decision-making. The effects of place attachment and cognitive distance errors deserve further research. Despite a better model fit, the cognitive distance errors did not lead to significantly different WTP estimates, which may be due to the study sites included in this choice experiment being all nearby and relatively familiar to respondents. The effect of under- and overestimating travel distances to study sites may play a more prominent role in choices between alternatives that vary more in their familiarity and distance to respondents than the case study sites in this thesis.

The hierarchical theory in the geography literature suggests that spatial choice are subject to anomalies resulting from hierarchical decision-making and empirical studies have found evidence for differences in choice-behaviour as the number of alternatives increases. However, no evidence was found in the empirical studies presented in this thesis for hierarchical decision-making strategies when using the competing destinations model. Understanding spatial choice behaviour and the decision-rules employed by respondents is an important branch of future research. It may require the application of additional methods complementing SP surveys, such as asking detailed questions discussing how interviewees make choices in order to reveal subconscious choice processes through more qualitative approaches. To understand how people make choices among environmental quality changes at different locations in experimental settings, new statistical methods for spatial choice studies for environmental valuation may be needed which help to reveal different patterns or changes in decision-making strategies. More research on scale heterogeneity could help to better understand preference heterogeneity and changes in decision-making strategies. Future research could test the relevance of decision-making strategies other than utility optimisation, such as other non-compensatory strategies for environmental valuation, which have been put forward in different choice contexts. However, the possibilities to capture conscious and especially subconscious choice processes using statistical analysis of observed choices remain an important challenge.

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Annex I: Models in WTP-space

In the utility function of individual n in choice occasion t for alternative i, α_n is the alternative specific constant, β_n is the mean of the randomly distributed parameters X_{int} is the set of the attributes and individual characteristics in, δ is a vector of non-random parameters of the attributes and individual characteristics Z_{int}, and ε_{int} is the error term, which is i.i.d. across choices i and situations t with an EV distribution. This leads to the standard mixed logit model in equation (AI.1):

$$U_{int} = \alpha_i + \beta_n x_{int} + \delta z_{int} + \varepsilon_{int} \tag{AI.1}$$

$$\beta_n = \sigma_n(\beta + \Gamma v_n) \tag{AI.2}$$

$$\sigma_n = \exp[\sigma + \tau w_n] \tag{AI.3}$$

The β_n parameters in equation (AI.2) are scaled by σ_n, reflecting the individual error variance. Γ is the lower triangular Cholesky matrix and v_n has covariance matrix I, so that Var[β_n]=ΓΓ'. σ_n has a standard deviation τ, which reflects the coefficient of the unobserved scale heterogeneity w_n. w_n is usually assumed to be standard normally distributed. In the mixed logit model, τ=0 and the model is estimated by normalising by the scale parameter: $\sigma_n = \sigma = 1$.

The model in WTP-space is obtained by rewriting the standard mixed logit model in equation (AI.1) in utility space (Hensher and Greene 2009). First, the price and non-price attributes are separated:

$$U_{int} = \alpha_i + \beta_n x_{int} + \delta z_{int} + \varepsilon_{int} = \alpha_i + \beta_n^p p_{int} + \beta_n^x x_{int} + \delta z_{int} + \varepsilon_{int} \tag{AI.4}$$

Here, the error term ε_{int} is i.i.d. across choices i and situations t with an extreme value distribution, so that var$(\varepsilon_{int}) = \sigma_n \pi^2/6$ with σ_n representing the individual scale parameter. Then, the utility function is divided by the scale parameter σ_n, resulting in an error term ε_{int} with the same variance $\pi^2/6$ for all decision makers, and rewritten in terms of the ratio between non-price and price attribute coefficients:

$$\begin{aligned} U_{int} &= \alpha_i + \beta_n^p[p_{int} + (1/\beta_n^p)\beta_n^x x_{int}] + \delta z_{int} + \varepsilon_{int} \\ &= \alpha_i + \beta_n^p[p_{int} + \varphi_n^x x_{int}] + \delta z_{int} + \varepsilon_{int} \end{aligned} \tag{AI.5}$$

The model in equation (AI.5) is called a model in WTP-space. The coefficients φ_n^x are scale-free and are estimated for all x_{ijt}, directly reflecting their WTP. In the WTP-space model, β_n^p is used as the normalizing constant. The vector of random parameters β_n^x is rewritten as (Greene and Hensher 2009):

$$\beta_n^x = \left(\bar{\beta}^x + \Gamma v_n\right) \tag{AI.6}$$

where $$\sigma_n = \exp\left[\bar{\sigma} + \tau w_n\right] = \exp\left[-\frac{\tau^2}{2} + \tau w_n\right] \tag{AI.7}$$

The coefficients β_n^x for all random parameters x_{int} directly reflect their WTP. Equation (AI.6) shows that in the WTP-space model the unobserved heterogeneity Γv_i in the mean of the random parameter is set to vary proportionally to the scaling of the random attribute coefficients.

In equation (AI.7), τ is the coefficient of the unobserved scale heterogeneity w_i, usually assumed to be standard normally distributed. σ_i, the individual error variance, has to be positive for all individuals and therefore has a lognormal distribution with standard deviation τ. The mean of the variance $\bar{\sigma}$ is set to (– τ/2) to be able to estimate τ. τ now reflects the scale heterogeneity: higher values for τ imply higher scale heterogeneity.

Annex II: Swait & Louviere scale test

The Swait and Louviere (SL) test can be used to test for differences in the attribute and scale parameters (Swait and Louviere 1993). The test involves a number of sequential steps. First, a separate model is estimated for the single choice tasks and compared to a model based on these choice tasks together. For this latter model, a grid search for the scale-parameter is performed to optimise the Loglikelihood under different relative scale adjustments for the second choice. Then, a Likelihood Ratio-test is performed to see if restricting the beta-parameters to be equal for the two choice tasks results in significantly different model fit[26]. If the hypothesis H_0^a is rejected, there may be differences between the two choice tasks, but it will be impossible to attribute these to differences in either the beta and the scale parameters or the beta parameters alone, because the scale and beta parameters are confounded. If H_0^a is not rejected, then the Loglikelihood of the model with equal scale parameters for both choice tasks is compared to that of the model in which the scale is allowed to vary between the choice tasks to test if the scale parameter is significantly different between the tasks.

Table II.I Swait and Louviere test-results of the Scheldt case study

(1)-(2)	LL (1)	LL(2)	LL(1&2) ($\mu_1 \neq \mu_2$)	LR-test (df=21)[1]	H_0^a: $\beta_i = \beta_j$ rejected?	LL (1&2) ($\mu_1 = \mu_2$)	LR-test (df=1)[2]	H_0^b: $\mu_1 = \mu_2$ rejected?
Card 1-2	771.58	709.32	1495	28.2	No	1496	2	No
Card 1-3	771.58	712.00	1499	29.9	No	1499	1	No
Card 1-4	771.58	727.36	1511	23.8	No	1512	2	No
Card 1-5	771.58	729.60	1514	24.8	No	1513	1	No
Card 2-3	709.32	712.00	1439	35.2	Yes	-	-	-
Card 2-4	709.32	727.36	1450	26.8	No	1450	0	No
Card 2-5	709.32	729.60	1450	22.2	No	1451	2	No
Card 3-4	712.00	727.36	1455	30.6	No	1455	0	No
Card 3-5	712.00	729.60	1452	22.4	No	1454	3	No
Card 4-5	727.36	729.60	1462	9.3	No	1462	1	No

[1] χ^2_{21} (p=0.05)= 32.7
[2] χ^2_1 (p=0.05)= 3.84

[26] The LR-test is as follows: -2(LL(1&2)-(LL(1)+LL(2)) with d.f. (K-1), with K being the number of coefficients.

Annex III: Questionnaire of the Scheldt case study

Vragenlijst Water in de Westerschelde

Dit onderzoek wordt uitgevoerd door de Vrije Universiteit Amsterdam. Ik voer hiervoor interviews uit met inwoners uit deze omgeving over het water in de regio. Het gaat hierbij om uw beleving van de natuur en het water en dan vooral in de Westerschelde. Het doel van het onderzoek is om deze beleving van bewoners beter in kaart te brengen.

Het onderzoek is volledig onafhankelijk en de resultaten worden alleen door de Vrije Universiteit Amsterdam gebruikt. De antwoorden die u geeft op de vragen uit deze vragenlijst zullen strikt vertrouwelijk worden behandeld.

Het interview neemt ongeveer 20 minuten in beslag. Voor meer informatie naar aanleiding van dit interview kunt u contact opnemen met:

Marije Schaafsma

Vrije Universiteit Amsterdam

020-5989502

Naam enqueteur:

Datum:

Tijd begin:

Tijd einde:

Locatie (straat en huisnummer):

DEEL A ALGEMENE VRAGEN OVER WATERRECREATIE

LET OP: Indien in de vragenlijst wordt gesproken over water, dan wordt hiermee **<u>open water</u>** bedoeld zoals zeewater of water in rivieren, kanalen, sloten, kreken en meren.

1. Bezoekt u wel eens open water voor recreatie (zwemmen, varen, wandelen, fietsen, etc)?
   a. Ja
   b. Nee -> ga naar vraag 3.

2. Wat doet u voornamelijk als u aan waterrecreatie doet? U kunt slechts 1 antwoord geven.
   a. wandelen
   b. fietsen
   c. zwemmen
   d. vissen
   e. varen (motorboot, zeilen, kanoën, surfen)
   f. natuur bekijken
   g. anders, namelijk ……

[TOON KAART A]

3. Wat zijn voor u de 3 belangrijkste vormen van recreatie? Kunt u de **drie** belangrijkste in volgorde van belang aangeven: een 1 voor het soort recreatie dat voor u het belangrijkste is, etc?

	Volgorde
Zwemmen, vissen, varen	
Uit eten gaan, uitgaan, terrasje pakken	
Winkelen	
Bezoek aan musea of bezienswaardige gebouwen	
Bezoek aan natuur(gebied)	
Wandelen, fietsen	
Anders, namelijk	

[ga door naar deel B, als iemand nooit aan waterrecreatie doet – zie vraag 1]

[TOON KAART A]

4. Hoe belangrijk vindt u de volgende kenmerken van een gebied voor waterrecreatie? Kunt u de **drie** belangrijksten aangeven; 1 voor de belangrijkste, 2 voor de op 2-na belangrijkste, etc?

	Volgorde
a. Faciliteiten (horeca, toiletten, paden, parkeerplaatsen)	
b. Natuur, planten en dieren	
c. Afstand en/of reistijd	
d. Waterkwaliteit	
e. Rust (niet teveel mensen)	
f. Bereikbaarheid (openbaar vervoer, auto)	

5. Hoe ver of hoe lang bent u maximaal bereid te reizen voor de door u aangegeven activiteit, als u daarvoor een dagje uit gaat, met het vervoermiddel waarmee u meestal reist?

[zie vraag 2: gaat om waterrecreatie. Vul zowel (schatting) afstand als tijd in, en de manier waarop respondent meestal reist, tot de locatie]

Vervoermiddel	Afstand	Reistijd
	..... km OF ❑ 0-10 km ❑ 10-20 km ❑ 20-40 km ❑ 40-60 km ❑ 60-100 km ❑ > 100 km	.... uur OF ❑ 0-15 min ❑ 15-30min ❑ 30-45 min ❑ 45 min- 1 uur ❑ > 1 uur

6. **[TOON KAART B]** Hier ziet u kaartjes met open wateren. Deze wateren verschillen in grootte, aantal, afstand tot elkaar, verbindingen en vormen. We willen graag weten aan welk soort water u de voorkeur geeft als u gaat recreëren. Als u gaat **[activiteit vraag 2]**, aan welk water zou u dan de voorkeur geven?

	voorkeur
Grootte	❑ A ❑ B ❑ C ❑ Geen voorkeur
Aantal	❑ A ❑ B ❑ Geen voorkeur
Afstand	❑ A ❑ B ❑ Geen voorkeur
Verbinding	❑ A ❑ B ❑ Geen voorkeur
Vorm	❑ A ❑ B ❑ C ❑ Geen voorkeur
Natuurlijkheid	❑ A ❑ B ❑ C ❑ Geen voorkeur

DEEL B WATER IN DE SCHELDE

In het volgende deel van de enquête willen we u een aantal vragen stellen over water in de Westerschelde en uw mening over de Schelde in het algemeen.

[TOON KAART C] U ziet hier een kaart van het Schelde gebied in Nederland.

7. Kunt u op de kaart in de enquête het gebied dat u als <u>úw regio</u> beschouwt aangeven? Dat wil zeggen, het gebied waarmee u zich het meest verbonden voelt. Dit gebied kan kleiner zijn dan het gebied op de kaart, bijvoorbeeld alleen uw huis, straat of wijk, maar kan ook groter zijn dan het gebied op deze kaart, of niet op de kaart staan. U kunt <u>uw regio</u> gewoon op de kaart tekenen.

   [Eventueel: Toelichting:] mijn regio beslaat:
   1. Mijn wijk, dorp of stad
   2. Mijn gemeente
   3. De provincie
   4. Nederland
   5. Anders, namelijk …………………………..

[TOON KAART D]

We gaan nu een aantal vragen stellen over de Westerschelde. Hierbij kijken we eerst naar de drie volgende gebieden die op de kaart zijn aangegeven: het strand bij Breskens, De Braakmanskreek en het Verdronken Land van Saeftinghe.

Op de kleinere kaarten ziet u hoe groot de gebieden zijn, de wegen erheen en de omgeving van de gebieden. Zo liggen de stranden vlakbij de stad Breskens, de Braakman ligt in de buurt van Terneuzen en de Dow Chemical terreinen, en het Land van Saeftinghe ligt dichtbij Antwerpen in een landbouwgebied.

Van deze gebieden willen we graag weten hoe goed u deze kent, of u deze bezoekt en wat u daar dan doet.

[ANTWOORDEN (CODES) INVULLEN IN TABEL: KAART E]

8. Kent u deze drie gebieden die zijn aangegeven op de kaart? Kunt u per gebied aangeven hoe goed u deze kent: goed, niet goed of nooit van gehoord?

9. Hoe ver moet u reizen om de aangegeven gebieden te bezoeken?
   [voor alle 3 locaties invullen: o.b.v. meest gebruikte vervoermiddel]
   [alleen categorieën gebruiken als respondent het niet zelf kan aangeven]

10. Hoe lang doet u erover om bij de aangegeven gebieden te komen?
   [voor alle 3 locaties invullen: o.b.v. meest gebruikte vervoermiddel]
   [alleen categorieën gebruiken als respondent het niet zelf kan aangeven]

11. Als u een of meer van deze gebieden bezoekt, kunt u dan per gebied aangeven hoe vaak u er jaarlijks gemiddeld heen gaat? **[voor alle 3 locaties invullen]**

12. Als u een of meer van deze gebieden bezoekt, kunt u dan per gebied aangeven wat u daar voornamelijk doet?
   [alleen 1 belangrijkste activiteit invullen]
   [alleen voor locaties invullen die mensen bezoeken]

13. Wat vindt u van de waterkwaliteit in de gebieden?
   [alleen voor locaties invullen die mensen kennen]

14. Kunt u van de gebieden die u bezoekt aangeven welke kenmerken u hiervan het belangrijkste vindt? Kies maximaal 2 kenmerken per gebied.
   [alleen voor locaties invullen die mensen bezoeken]

Gebied	8: Bekendheid	9: Afstand	10: Reistijd	11: Gem. aantal bezoeken	12: Belang-rijkste activiteit	13: Water-kwaliteit	14: 2 Belangrijkste Kenmerken
	(heel) goed niet goed, wel van gehoord nooit van gehoord	..... km 0-10 km 10-20 km 20-40 km 40-60 km 60-100 km > 100 km	.... uur 0-15 min 15-30 min 30-45 min 45 min-1u > 1 uur	1x/ week 1x/ maand 1x/ 3 mnd 1x/ jaar < 1x/ jaar nooit	wandelen fietsen zwemmen vissen varen natuur	Goed Matig Slecht Weet niet	Faciliteiten Natuur Afstand, reistijd Waterkwaliteit Rust Bereikbaarheid Anders, namelijk ......
Stranden rond Breskens							
De Braakman							
Verdronken Land van Saeftinghe							

Vervoermiddel:

Breskens:

Braakman:

Saeftinghe

15. Stel dat het water op **[vaakst bezochte locatie vraag 11]** niet van voldoende kwaliteit vindt om te **[belangrijkste activiteit op vaakst bezochte gebied],** wat zou u dan doen?
    [als mensen 2 locaties even vaak bezoeken, kies 1 en vul die hier in:………………….]
    [zie vraag 11 & 12 ; ALLEEN de drie locaties uit experiment]
    [niet relevant als mensen locaties niet bezoeken]
    [open vraag: vul locatie in!]
    [toon evt KAART C]

    a. Ik ga [activiteit 1] op een andere locatie zo dicht mogelijk in de buurt, namelijk ……..
    b. Ik ga [activiteit 1] op een andere locatie elders, namelijk ………….
    c. Ik ga wel naar [meest bezochte locatie], maar ga niet [activiteit 1]
    d. Ik ga iets heel anders doen dan waterrecreatie.
    e. Anders, namelijk………

16. Zijn er andere locaties in de het Schelde gebied die u bezoekt voor waterrecreatie?
    [TOON KAART C]
    a. Nee
    b. Ja

    Zo ja, kunt u in deze tabel aangeven:
    16 (a) welke zijn dit? **[geef maximaal 3 gebieden aan]**
    16 (b) hoe vaak gaat u daar gemiddeld jaarlijks heen?
    16 (c) wat doet u daar voornamelijk? **[geef 1 belangrijkste activiteit aan]**

A: Locatie	B: Aantal bezoek 1. eens per week 2. eens per maand 3. eens per 3 maanden 4. eens per jaar 5. < 1 keer per jaar	C: Activiteit 1. wandelen 2. fietsen 3. zwemmen 4. vissen 5. varen 6. natuur
1.		
2.		
3.		

DEEL C KADERRICHTLIJN WATER IN DE WESTERSCHELDE

[TOON KAART F]

In 2015 moet al het water in Europa, dus ook in Nederland, volgens een nieuwe richtlijn in goede toestand zijn. Dit betekent dat het **water van goede kwaliteit** is en **zonder gevaar voor de gezondheid** kan worden gebruikt voor recreatie en er een **natuurlijke, gevarieerde planten- en dierenwereld** kan bestaan. Deze nieuwe eisen gaan dus verder dan de bestaande zwemwatereisen.

In de hele Westerschelde is de toestand van het water nu onvoldoende en zal er zonder extra maatregelen geen goede toestand worden bereikt in 2015. Alle vervuilers, dus de industrie, scheepvaart, landbouw en ook u als huishouden, moeten gaan bijdragen om een goede waterkwaliteit te krijgen. **Ook België en Frankrijk** moeten voldoen aan de nieuwe richtlijn en hun waterkwaliteit verbeteren. De vervuiler betaalt dus!

[TOON KAART G]

17. Met welke stelling bent u het het meeste eens?
    a. Ik vind het niet belangrijk dat de waterkwaliteit verbetert.
    b. Ik vind het water nu al goed genoeg en het hoeft van mij niet te verbeteren.
    c. Ik vind het water nu goed, maar vind het belangrijk dat de waterkwaliteit nog beter wordt.
    d. Ik vind het belangrijk dat de waterkwaliteit verbetert, want ik vind het nu niet goed genoeg.

[TOON KAART H EN KAARTEN MET NIVEAUS]

Het volgende deel van de enquête gaat over wat u het waard vindt om de waterkwaliteit in bepaalde gebieden langs de Westerschelde te verbeteren, namelijk in het Verdronken Land van Saeftinghe, de Braakmanskreek en de stranden bij Breskens.

Op dit moment is de situatie in alle gebieden slecht: de kwaliteit van het water is onvoldoende. Rijkswaterstaat, de Provincie en de waterschappen hebben plannen voor extra maatregelen om de goede toestand te kunnen bereiken, in samenwerking met de landbouw, industrie en scheepvaart. Als de waterkwaliteit verbetert in deze gebieden, kunnen de natuur en de recreatiemogelijkheden verbeteren:

- **Het wordt mooier om te wandelen**, omdat natuurgebieden worden uitgebreid en harde dijken worden vervangen door natuurlijke oevers met begroeiing (geen verhoogd overstromingsrisico).
- **Er kan vaker en aangenamer worden gezwommen**, omdat er minder vaak algen en wier voorkomen, het water minder groen is en het minder stinkt
- **De natuur verbetert**: vissen en vogels krijgen een schoner leefgebied, waardoor het aantal dieren toeneemt en bijzondere soorten terug kunnen komen.

N.B. Wijs de respondent op de volgende punten:

- **Verbeteringen zien er anders uit op elk gebied: er zijn andere oevers, en er komen andere soorten vogels voor!!**
- **Wandelen in goede situatie: gebiedsuitbreiding EN natuurlijke oevers**
- **zwemmen: bij Saeftinghe kan niet worden gezwommen, dit is een schorrengebied.**

[TOON KAART I en voorbeeldkeuzekaart]

U krijgt nu 5 keer drie mogelijke toekomstige situaties op de drie locaties voorgelegd, waar de waterkwaliteit op een of meerdere van de bovengenoemde drie punten verbetert ten opzichte van de huidige, slechte situatie, doordat de voorgestelde plannen worden uitgevoerd. Eerst krijgt u een voorbeeld. Deze geven situaties in de drie gebieden langs de Westerschelde weer. Van elk gebied wordt beschreven in hoeverre u daar kunt zwemmen en wandelen, en wat de kwaliteit van de natuur is. Dit verschilt per situatie, want op elke locatie komen andere vissen en vogels voor en kun je andere dingen doen.

Bij elke situatie wordt een geldbedrag aangegeven, variërend van € 5 tot € 80 per jaar. **Dit is de stijging van de jaarlijkse waterschapsbelastingen dat uw huishouden zou moeten betalen tot het jaar 2015** zodat deze situatie kan worden behaald en de plannen kunnen worden uitgevoerd. Dit bedrag wordt alleen besteed aan het bereiken van de door u gekozen situatie in dat gebied. **We willen u vragen om te bepalen of u bereid bent dit extra bedrag te betalen om de waterkwaliteitsverbetering te behalen.**

Stelt u zich voor dat deze situaties zich zouden voordoen. De vraag aan u is om telkens aan te geven welke van de drie situaties uw grootste voorkeur heeft. **U moet dus een afweging maken tussen geld en waterkwaliteitsverbeteringen op de locaties**. U mag slechts een alternatief kiezen, dus maar 1 gebied, en **alleen daar verbetert de waterkwaliteit** dan. U kunt ook aangeven dat u geen van de situaties kiest, dat is goed mogelijk. U hoeft dan niet extra te betalen, maar de waterkwaliteit verbetert dan ook nergens (niet in de Westerschelde, niet in andere gebieden).

[Neem met de respondent de voorbeeldkaart door en leg alle onderdelen eventueel nogmaals uit.]

Keuzekaart [antwoord ook invullen]:

Aan welke situatie geeft u de voorkeur?
A
B
C
Geen van allen

VERSIE: .....

Dit gaan we nu 5 keer herhalen: u krijgt 5 kaarten te zien.

[toon kaart 1]

18. Aan welke situatie geeft u de voorkeur?
A
B
C
geen van allen, ga naar vraag 20

19. Zou u het gekozen gebied in de toekomst – bij deze nieuwe situatie zoals op de keuzekaart- ook bezoeken?
    a. Ja
    b. Nee -> Zo niet, waarom niet? **[open]** …………………………………

20. Indien u bij vraag 18 kiest voor geen van allen, waarom is dat? **[open vraag]**
    a. Ik vind de situaties van gelijke prijs-kwaliteit verhouding
    b. Ik vind de situaties niet van goede prijs-kwaliteit verhouding
    c. Ik bezoek de gebieden nooit en ga die onder deze omstandigheden ook niet bezoeken.
    d. Als ik niet kan zwemmen of wandelen, dan ben ik niet bereid extra te betalen
    e. Mijn inkomen is te laag
    f. Ik ben principieel niet bereid extra te betalen
    g. Anders, namelijk…………………….

[toon kaart 2]

21. Aan welke situatie geeft u de voorkeur?
    A
    B
    C
    geen van allen: ga naar vraag 23

22. Zou u het gekozen gebied in de toekomst – bij deze nieuwe situatie zoals op de keuzekaart- ook bezoeken?
    a. Ja
    b. Nee -> Zo niet, waarom niet? **[open]** …………………………………

23. Indien u bij vraag 20 kiest voor geen van allen, waarom is dat? **[open vraag]**
    a. Ik vind de situaties van gelijke prijs-kwaliteit verhouding
    b. Ik vind de situaties niet van goede prijs-kwaliteit verhouding
    c. Ik bezoek de gebieden nooit en ga die onder deze omstandigheden ook niet bezoeken.
    d. Als ik niet kan zwemmen of wandelen, dan ben ik niet bereid extra te betalen
    e. Mijn inkomen is te laag
    f. Ik ben principieel niet bereid extra te betalen
    g. Anders, namelijk…………………….

[toon kaart 3]

24. Aan welke situatie geeft u de voorkeur?
    A
    B
    C
    geen van allen, ga naar vraag 26

25. Zou u het gekozen gebied in de toekomst – bij deze nieuwe situatie zoals op de keuzekaart- ook bezoeken?
    a. Ja
    b. Nee -> Zo niet, waarom niet? **[open]** …………………………………

26. Indien u bij vraag 24 kiest voor geen van allen, waarom is dat? **[open vraag]**
    a. Ik vind de situaties van gelijke prijs-kwaliteit verhouding
    b. Ik vind de situaties niet van goede prijs-kwaliteit verhouding
    c. Ik bezoek de gebieden nooit en ga die onder deze omstandigheden ook niet bezoeken.
    d. Als ik niet kan zwemmen of wandelen, dan ben ik niet bereid extra te betalen
    e. Mijn inkomen is te laag
    f. Ik ben principieel niet bereid extra te betalen
    g. Anders, namelijk…………………….

[toon kaart 4]

27. Aan welke situatie geeft u de voorkeur?
    A
    B
    C
    geen van allen - ga naar vraag 29

28. Zou u het gekozen gebied in de toekomst – bij deze nieuwe situatie zoals op de keuzekaart- ook bezoeken?
    a. Ja
    b. Nee -> Zo niet, waarom niet? **[open]** …………………………………

29. Indien u bij vraag 27 kiest voor geen van allen, waarom is dat? **[open vraag]**
    a. Ik vind de situaties van gelijke prijs-kwaliteit verhouding
    b. Ik vind de situaties niet van goede prijs-kwaliteit verhouding
    c. Ik bezoek de gebieden nooit en ga die onder deze omstandigheden ook niet bezoeken.
    d. Als ik niet kan zwemmen of wandelen, dan ben ik niet bereid extra te betalen
    e. Mijn inkomen is te laag
    f. Ik ben principieel niet bereid extra te betalen
    g. Anders, namelijk…………………….

[toon kaart 5]

30. Aan welke situatie geeft u de voorkeur?
    A
    B
    C
    geen van allen - ga naar vraag 32

31. Zou u het gekozen gebied in de toekomst – bij deze nieuwe situatie zoals op de keuzekaart- ook bezoeken?
    a. Ja
    b. Nee -> Zo niet, waarom niet? **[open]** …………………………………

32. Indien u bij vraag 30 kiest voor geen van allen, waarom is dat? **[open vraag]**
    a. Ik vind de situaties van gelijke prijs-kwaliteit verhouding
    b. Ik vind de situaties niet van goede prijs-kwaliteit verhouding
    c. Ik bezoek de gebieden nooit en ga die onder deze omstandigheden ook niet bezoeken.
    d. Als ik niet kan zwemmen of wandelen, dan ben ik niet bereid extra te betalen
    e. Mijn inkomen is te laag

f. Ik ben principieel niet bereid extra te betalen
g. Anders, namelijk…………………….

****

33. Hoe weegt u telkens de alternatieven af en maakt u uw keuze?
    [of antwoord 1 of maximaal 2 kiezen uit antwoord 2 t/m 5]
    a. Ik weeg prijs, gebied, activiteit en natuurkenmerken tegelijkertijd tegen elkaar af
    b. Ik let voornamelijk op het gebied
    c. Ik let vooral op zwemmen
    d. Ik let vooral op wandelen
    e. Ik let vooral op natuur
    f. Ik let vooral op de prijs

34. Bij het maken van de keuzes in de voorgaande vragen: had u toen in gedachten dat andere delen van de Westerschelde ook moeten verbeteren als de situatie op de door u gekozen locatie zou verbeteren?
    a. Ja, ik dacht dat dan een groter deel van de Westerschelde zou verbeteren
    b. Nee, ik dacht dat alleen de gekozen locatie zou verbeteren

DEEL D: PERSOONLIJKE GEGEVENS

We willen u nu graag een aantal vragen stellen over uzelf. We garanderen u dat al uw antwoorden vertrouwelijk worden behandeld, niet ter beschikking worden gesteld aan derden en niet voor andere doeleinden dan voor dit onderzoek worden gebruikt.

35. Bent u een man of een vrouw?
    a. man
    b. vrouw

36. Wat is uw geboortejaar? ……

37. Wat is uw postcode en woonplaats?
    Postcode: ….. …
    Woonplaats: ……………….

38. Uit hoeveel personen bestaat uw huishouden?

1. …. Personen van 18 jaar en ouder
2. …. Kinderen onder de 18 jaar

39. Wat is uw hoogst voltooide opleiding?
    a. Basisonderwijs (lagere school)
    b. Middelbaar algemeen voortgezet onderwijs (VMBO, MAVO, (M)ULO)
    c. Lager beroepsonderwijs (LBO: LTW, LEAO, huishoudschool)
    d. Middelbaar beroepsonderwijs (MBO: MTS, MEAO, MHNO, INAS)
    e. Hoger beroepsonderwijs (HBO: HTS, PABO, SA, HLS, HEAO)
    f. Hoger algemeen en voorbereiden wetenschappelijk onderwijs (HAVO, HBS, MMS, VWO, Gymnasium)
    g. Wetenschappelijk onderwijs (WO/Universiteit)
    h. Anders, namelijk…………….

40. In welke categorie valt het maandelijks netto inkomen van uw gehele huishouden?
    [TOON KAART J- belangrijk dat vraag wordt ingevuld – benadruk anonimiteit]
    a. Minder dan 900 Euro per maand
    b. 900-1200 euro per maand
    c. 1200-1400 euro per maand
    d. 1400-1700 euro per maand
    e. 1700-2000 euro per maand
    f. 2000-2300 euro per maand
    g. 2300-2600 euro per maand
    h. 2600-3000 euro per maand
    i. 3000-3600 euro per maand
    j. meer dan 3600 euro per maand, namelijk ongeveer ….. euro per maand

41. Heeft u of iemand in uw huishouden een visvergunning?
    a. Nee
    b. Ja

42. Bent u in het bezit van een zeilboot, motorboot, surfplank, kano, of roeiboot?
    a. Nee
    b. Ja, ik heb een ….

43. Bent u of iemand in uw huishouden lid of donateur van een natuur- of milieubeschermings-organisatie?
    a. Nee
    b. Ja, namelijk van de volgende organisatie(s):

DEEL F: CONTROLE VRAGEN

44. Hoe moeilijk vond u het om te kiezen tussen de verschillende situaties?
    a. Heel moeilijk
    b. Moeilijk
    c. Niet moeilijk, niet makkelijk
    d. Makkelijk
    e. Heel makkelijk

45. Vond u de uitleg van de waterkwaliteit situatie geloofwaardig?
    a. Helemaal niet geloofwaardig
    b. Niet geloofwaardig
    c. Niet ongeloofwaardig, niet geloofwaardig
    d. Geloofwaardig
    e. Zeer geloofwaardig

BEDANKT VOOR UW MEDEWERKING!
OPMERKINGEN ENQUETEUR:

Annex IV: Additional results of Chapter 5

Table IV.I Results of Model III in WTP-space of the Scheldt case study

Explanatory factor	MODEL III
ASC Breskens	0.694 (0. 285)
ASC Braakman	-0.197 (0.081)
ASC Saeftinghe	2.097 (0.857)
Attributes – random effects	
Walking - good quality (normal distribution)	-5.583*** (10.591)
Nature – good quality (normal distribution) (Breskens & Braakman)	-5.409*** (7.632)
Bathing - good quality (normal distribution) (Breskens)	-3.099*** (4.423)
Attributes – fixed effects	
Walking – moderate quality	0.404*** (5.353)
Bathing - good quality (Braakman)	1.543*** (11.355)
Nature – moderate quality	0.448*** (5.739)
Nature – good quality (Saeftinghe)	1.263*** (10.283)
Price	-0.237*** (5.326)
Cross-effects	
Saeftinghe * (moderate nature quality at Braakman)	0.284** (2.173)
Saeftinghe * (good bathing quality at Braakman)	0.295** (2.367)
Respondent characteristics	
Income (logarithmic)	0.110 (0.345)
Distance (Breskens) ($km^2 * 10^{-3}$)	-0.145*** (7.774)
Distance (Braakman) (km)	-0.010*** (3.404)
Distance (Saeftinghe) (km, logarithmic)	-0.584*** (8.429)
User (Breskens)	0.887*** (12.528)
User (Braakman)	0.887*** (12.528)
User (Saeftinghe)	0.545*** (6.688)
Diagonal values in Cholesky matrix (of random parameters)	
Walking - good quality	2.386*** (3.319)
Nature – good quality (Breskens & Braakman)	0.305 (0.320)

Table IV.I continued	*Model III*
Bathing - good quality	1.682
(Breskens)	(1.150)
Error-component (Breskens, Braakman, Saeftinghe)	0.627
	(0.261)
Below diagonal values in Cholesky matrix (of random parameters)	
Walking - good quality: Price	-1.418
	(-1.545)
Nature – good quality: Price	-0.453
	(-0.281)
Nature – good quality: Walking - good quality	-4.225***
	(5.313)
Bathing - good quality (Breskens): Price	0 .754
	(0.457)
Bathing - good quality (Breskens): Walking - good quality	-2.897***
	(3.377)
Bathing - good quality (Breskens): Nature – good quality	1.866
	(1.454)
Error-component: Price	-0.508
	(0.553)
Error-component: Walking - good quality	-1.345
	(1.213)
Error-component: Nature – good quality	-6.667***
	(5.571)
Error-component: Bathing - good quality (Breskens)	-2.070
	(1.468)
Scale	
Variance parameter tau in GMX: scale parameter	0.489
	(1.505)
Sigma: mean	1.352
Sigma: standard deviation	1.487
Covariance terms between random parameters and sigma(i)	
Walking - good quality	-0.652***
	(4.120)
Nature – good quality	-0.267
	(1.573)
Bathing - good quality (Breskens)	-0.476
	(1.540)
Error-component (Breskens, Braakman, Saeftinghe)	-0.005
	(0.009)
Standard deviations of parameter distributions (normal distribution)	
Walking - good quality	2.775***
	(4.789)
Nature – good quality	4.259***
	(5.224)
Bathing - good quality (Breskens)	3.908***
	(4.208)
Error-component (Breskens, Braakman, Saeftinghe)	7.155***
	(6.583)
Model statistics	
Loglikelihood	3333
No.obs.	3180

Notes: T-values between brackets. Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%. The results show that the variance parameter tau, the scale parameter, is not significant. The cross-effects remain significant. Annex I includes a description of the model in WTP-space. The other elements of this table are explained and Chapter 6 where the models are estimated in WTP-space.

Annex V: Questionnaire of the Rhine case study

Vragenlijst leefomgeving Randstad

Dit onderzoek wordt uitgevoerd door de Vrije Universiteit Amsterdam. Het doel van het onderzoek is om de mening van bewoners uit de Randstad over hun leefomgeving beter in kaart te brengen. We willen graag een beeld krijgen van wat u als bewoner belangrijk vindt bij de ontwikkeling van uw omgeving. Er zijn geen goede of foute antwoorden. Het gaat nadrukkelijk om uw *persoonlijke* mening. We vragen in dit onderzoek mensen uit de hele regio naar hun mening.

Het onderzoek is volledig onafhankelijk en de resultaten worden alleen door de universiteit gebruikt voor onderzoeksdoeleinden. De antwoorden die u geeft worden vertrouwelijk behandeld en u blijft anoniem.

Let op: in het belang van het onderzoek kunt u in de vragenlijst niet terugbladeren. Gebruik niet de terug-knop van uw browser en zorg dat u het juiste antwoord invult.

Het invullen van de vragenlijst duurt ongeveer 15 minuten. Voor meer informatie kunt u contact opnemen met:

Marije Schaafsma

Vrije Universiteit Amsterdam

020-5984043

DEEL A ALGEMENE VRAGEN OVER WATER EN RECREATIE

LET OP
Als in de vragenlijst wordt gesproken over water, wordt hiermee **open water** bedoeld, zoals in rivieren, kanalen, sloten, plassen en meren.

1. Heeft u wel eens open water in Nederland bezocht voor recreatie (zwemmen, varen, wandelen, fietsen, enzovoorts)?
    a. Ja
    b. Nee -> ga naar VRAAG 4!

2. Hoe vaak heeft u gedurende de afgelopen 12 maanden open water bezocht – dus plassen, meren of rivieren (niet de zee)?

	Nooit
	Eens per 6- 12 maanden
	Eens per 3 maanden
	Eens per maand
	Eens in de 2 weken
	Wekelijks
	Dagelijks

3. Kunt u van de onderstaande activiteiten aangeven hoe vaak u deze doet bij bezoek aan open water? Vaak wil zeggen bijna elke keer, soms wil zeggen een enkele keer.

		Vaak	**Soms**	**Nooit**
A.	Langs de waterkant wandelen, de hond uitlaten fietsen, (hard)lopen, picknicken of zitten			
B.	Zwemmen			
C.	Zeilen, surfen, kanoën of roeien			
D.	Varen met motorboot of waterskien			
E.	Vissen			
F.	Vogels en andere dieren kijken			
G.	Anders, namelijk			

4. Wat is uw postcode?
   Postcode: …. .. (vb. 1234 AB)

DEEL B MEREN EN PLASSEN IN DE RANDSTAD

Deze enquête gaat over het open water in uw regio. U ziet hier een kaart van een deel van de Randstad met daarin de grotere plassen en meren. Eerst kijken we naar de vier plassen en meren die op de kaart binnen het kader zijn aangegeven.

[TOON GROTE KAART met kader]

5. Hoe goed kent u deze vier plassen en meren?
   a. (heel) goed
   b. niet goed, wel van gehoord
   c. nooit van gehoord

6. Hoe vaak per jaar bezoekt u deze plassen en meren gemiddeld?
   a. Nooit
   b. Eens per jaar
   c. Eens per kwartaal
   d. Eens per maand
   e. Eens per 2 weken
   f. Wekelijks
   g. Dagelijks

7. Welke afstand moet u afleggen om deze plassen en meren te bezoeken? Als u de afstand niet precies weet, geeft u dan een schatting.
   a. 0-5 km
   b. 5-10 km
   c. 10-15 km
   d. 15-20 km
   e. 20-30 km
   f. 30-40 km
   g. 40-50 km
   h. Meer dan 50 km

8. Hoe reist u *meestal* naar de plassen en meren?
    a. Auto, Motor
    b. Brommer of scooter
    c. Fiets
    d. Bus
    e. Trein
    f. Te voet
    g. Niet

9. Zijn er andere open wateren in de Randstad regio die u bezoekt?
    a. Ja
    b. Nee -> ga naar vraag 10.

[TOON GROTE KAART]

9b. Welke andere open wateren in de Randstad regio bezoekt u ook? Geef de 3 belangrijkste aan.
    a. Anders, namelijk…
    b. Anders, namelijk …
    c. Anders, namelijk…

10. Wat vindt u in het algemeen van de kwaliteit van het water en de natuur van de open wateren in uw omgeving?
    a. Goed
    b. Matig
    c. Slecht
    d. Weet niet

11. Hoe beoordeelt u de kwaliteit van het water en de natuur in en om de onderstaande plassen en meren?

	Goed	**Matig**	**Slecht**	**Weet niet**
Naardermeer				
Ankeveense Plassen				
Loosdrechtse Plassen				
Vinkeveense Plassen				
Nieuwkoopse Plassen				
Reeuwijkse Plassen				
Kagerplassen				
Braassemermeer				
Westeinder Plassen				
Langeraarse Plassen				

12. Hoe beoordeelt u de plassen en meren op hun bereikbaarheid?

	Goed	**Matig**	**Slecht**	**Weet niet**
Naardermeer				
Ankeveense Plassen				
Loosdrechtse Plassen				
Vinkeveense Plassen				
Nieuwkoopse Plassen				
Reeuwijkse Plassen				
Kagerplassen				
Braassemermeer				
Westeinder Plassen				
Langeraarse Plassen				

13. Hoe beoordeelt u de rust (weinig bezoekers en lawaai) bij de plassen en meren?

	Goed	**Matig**	**Slecht**	**Weet niet**
Naardermeer				
Ankeveense Plassen				
Loosdrechtse Plassen				
Vinkeveense Plassen				
Nieuwkoopse Plassen				
Reeuwijkse Plassen				
Kagerplassen				
Braassemermeer				
Westeinder Plassen				
Langeraarse Plassen				

14. Hoe beoordeelt u de aanwezigheid van recreatiefaciliteiten, zoals fiets- en wandelpaden, aanlegsteigers, informatieborden en sanitaire voorzieningen bij de plassen en meren?

	Goed	**Matig**	**Slecht**	**Weet niet**
Naardermeer				
Ankeveense Plassen				
Loosdrechtse Plassen				
Vinkeveense Plassen				
Nieuwkoopse Plassen				
Reeuwijkse Plassen				
Kagerplassen				
Braassemermeer				
Westeinder Plassen				
Langeraarse Plassen				

DEEL C WATER EN NATUUR IN HET GROENE HART

Er worden plannen ontwikkeld om de kwaliteit van het open water in uw regio te verbeteren. Deze plannen moeten ervoor zorgen dat het water en de natuur in de plassen en meren in uw regio in 2015 van betere kwaliteit zijn.

15. Hoe belangrijk vindt u het dat de kwaliteit van water en natuur in en om de plassen en meren wordt verbeterd?
    a. Niet belangrijk
    b. Niet belangrijk, niet onbelangrijk
    c. Belangrijk
    d. Weet niet

In de volgende vragen gebruiken we plaatjes om de kwaliteit van water en natuur in de plassen en meren aan te geven. Ieder kwaliteitsniveau heeft een andere kleur. Geel staat voor de laagste kwaliteit, dan komt groen, en tenslotte geeft blauw de hoogste kwaliteit aan.

De helderheid van het water en de aanwezigheid van waterplanten, riet, vogels en vissen verschillen per kwaliteitsniveau.

De kwaliteit van het water en de natuur kan van invloed zijn op hoeveel plezier mensen beleven aan waterrecreatie. Ook moet soms recreatie worden beperkt om betere kwaliteit te kunnen behalen. Fluisterboten zijn altijd toegestaan. De mogelijkheden voor zwemmen, zeilen en varen wordt aangegeven met de symbolen aan de rechterkant van de plaatjes. Als een symbool met een stippellijn is doorgekruist, is die activiteit beperkt mogelijk. Als een symbool met een dichte lijn is doorgekruist, is die activiteit helemaal niet mogelijk.

[toon ladder]

In de afgelopen jaren is de kwaliteit van de plassen en meren verbeterd. Zoals de kaart hieronder weergeeft, zijn alle plassen en meren nu gemiddeld van de GELE kwaliteit. Alleen in het Naardermeer is de situatie beter: dat heeft nu de GROENE kwaliteit.

[TOON KAART HUIDIGE KWALITEIT]

16. Komt de huidige kwaliteit zoals op de bovenstaande kaart staat overeen met wat u dacht?
    a. De huidige situatie is *veel beter* dan ik dacht.
    b. De huidige situatie is *iets beter* dan ik dacht.
    c. De huidige situatie is *ongeveer hetzelfde* als ik dacht.
    d. De huidige situatie is *iets slechter* dan ik dacht.
    e. De huidige situatie is *veel slechter* dan ik dacht.

Verbetering van de kwaliteit van het water en de natuur kost geld. Iedereen die bijdraagt aan de huidige gele kwaliteit, dus ook huishoudens in de omgeving en recreanten, wordt gevraagd mee te betalen om een betere kwaliteit te krijgen. De vervuiler betaalt.

De plassen en meren kunnen niet allemaal tegelijkertijd worden verbeterd, want er is beperkt budget. Ook moet soms een afweging worden gemaakt tussen natuur en recreatie.

We willen graag weten wat het u waard is om de kwaliteit van de meren en plassen te verbeteren. U krijgt achtereenvolgens een aantal kaarten te zien. Deze kaarten geven telkens toekomstige situaties weer voor de grotere plassen en meren bij u in de regio, waarin door maatregelen de kwaliteit is verbeterd ten opzichte van de huidige situatie.

Op de kaarten ziet u bij alle plassen en meren die verbeteren ook steeds een geldbedrag staan, variërend van €5 tot €40 per jaar. Dit is de *permanente stijging van de jaarlijkse waterschaps-belastingen,* die uw huishouden zou moeten betalen vanaf 2009 om de kwaliteit te verbeteren. Dit extra bedrag wordt alleen besteed aan het bereiken van de betere kwaliteit van het door u gekozen water.

In de meren die u *niet* kiest blijft de kwaliteit op het huidige GELE niveau – geen enkele plas of meer zal verslechteren.

[TOON VOORBEELDKAART]

Op de voorbeeldkaart hierboven ziet u dat u kunt kiezen voor een verbetering van **1 van de 4** meren tegen een bepaald bedrag:

- verbetering van de Westeinder Plassen van GELE naar GROENE kwaliteit voor €20 per jaar
- verbetering van de Langeraarse Plassen van GELE naar BLAUWE kwaliteit voor €15 per jaar
- verbetering van de Nieuwkoopse Plassen van GELE naar BLAUWE kwaliteit voor €30 per jaar
- verbetering van de Vinkeveense Plassen van GELE naar GROENE kwaliteit voor €5 per jaar

U wordt gevraagd te kiezen voor **1 van de 4** plassen en meren, waaraan u het meeste belang hecht en u het bereid bent het bijbehorende bedrag te betalen om de kwaliteit te verbeteren tot het aangegeven niveau.

U kunt ook geen van deze verbeteringen kiezen. U hoeft dan niets extra te betalen, maar de kwaliteit verbetert ook nergens.

Let op:

- Elke kaart is weer een *nieuwe* mogelijkheid. Het bedrag dat u betaalt voor de eerste situatie in de eerste vraag wordt dus niet opgeteld bij het bedrag van de tweede situatie in de volgende vraag, enzovoorts.
- Houdt u er ook rekening mee dat u het geld dat u extra betaalt natuurlijk niet meer kunt besteden aan andere zaken.

17. U ziet hier nogmaals de kaart. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/Geen van allen. € 0

We gaan u nu nog 2 van deze kaarten laten zien.

18. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/Geen van allen. € 0

19. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/Geen van allen. € 0

We gaan nu kijken naar alle grotere plassen en meren in de wijdere omgeving, want misschien gaat u voorkeur namelijk wel uit naar mogelijke verbeteringen van deze andere wateren. Ook hier is de huidige kwaliteit van water en natuur GEEL, behalve in het Naardermeer, waar de kwaliteit GROEN is.

U krijgt nu achtereenvolgens 4 kaarten te zien van de plassen en meren in de wijdere omgeving. Kunt u bij elke kaart wederom aangeven voor welke van de plassen en meren u het meest bereid bent het aangegeven bedrag extra bovenop uw jaarlijkse waterschapsbelasting te betalen om de kwaliteit te verbeteren?

20. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/E/F/G/Geen van allen. € 0

21. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/E/F/G/Geen van allen. € 0

22. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/E/F/G/Geen van allen. € 0

23. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/E/F/G/Geen van allen. € 0

Nu u de mogelijke verbeteringen in uw wijdere omgeving heeft overwogen, is uw mening over de vier eerdere plassen en meren wellicht veranderd. Daarom krijgt u nu nogmaals twee *nieuwe* kaarten voorgelegd over deze vier plassen en meren. Kunt u bij elke kaart aangeven voor welke van de plassen en meren u het meest bereid bent het aangegeven bedrag te betalen om de kwaliteit te verbeteren?

24. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/Geen van allen. € 0

25. Welke van de plassen en meren vindt u persoonlijk het belangrijkst om te verbeteren tegen betaling van het aangegeven bedrag?
    A/B/C/D/Geen van allen. € 0

Dit waren alle kaarten. We willen nu graag weten hoe u elke keer uw keus heeft gemaakt.

26. Hoe weegt u telkens de alternatieven tegen elkaar af? U kunt meerdere antwoorden kiezen.
    a. Ik weeg prijs, kwaliteit en meer of plas tegelijkertijd tegen elkaar af
    b. Ik let voornamelijk op een bepaalde plas of meer
    c. Ik let voornamelijk op de grootte van het meer
    d. Ik let voornamelijk op de afstand
    e. Ik let vooral op de verbetering in de kwaliteit van water en natuur
    f. Ik let vooral op de beperkingen die aan recreatie worden opgelegd
    g. Ik let vooral op de prijs
    h. Anders, namelijk……………..
    i. Ik heb bij geen enkele kaart een keus gemaakt voor een bepaalde plas of meer

27. Heeft u een voorkeur voor een bepaalde regio of een groep plassen en meren in deze regio? Zo ja, voor welke?
    a. Geen speciale voorkeur
    b. Voor de Gooi & Vecht streek (Naardermeer, Loosdrechtse Plassen, Ankeveense Plassen, Maarsseveense Plassen, Vinkeveense plassen)
    c. Voor het westelijk deel (Kagerplassen, Braassemermeer, Westeinder Plassen, Langeraarse Plassen)
    d. Voor het zuidelijk deel (Nieuwkoopse Plassen, Reeuwijkse Plassen)
    e. Anders, namelijk………………………….

28. Zijn er ook plassen of meren die u sowieso niet belangrijk genoeg vond om voor te betalen om de waterkwaliteit ervan te verbeteren?
    a. Nee
    b. Ja, namelijk ……

29. Wat was voor u de **belangrijkste** reden om bij te dragen aan de verbetering van de kwaliteit van plassen en meren?

Ik recreëer regelmatig bij deze plassen en meren.	❑
Ik wil de waterkwaliteit in plassen en meren verbeteren voor dieren en planten.	❑
Alle mensen moeten kunnen genieten van betere plassen en meren.	❑
Ik vind de verbetering van de kwaliteit van water en natuur belangrijk ongeacht de kosten.	❑
Ik vind het mijn morele plicht om bij te dragen.	❑
Ik geef graag aan goede doelen	❑
Anders, namelijk…………………………..	❑

30. Wat was voor u de **belangrijkste** reden als u bij een van de kaarten koos voor geen van de opties?

a.	Niet van toepassing: ik heb altijd voor een van de plassen of meren gekozen.	❑
b.	De stijging van de waterschapsbelasting is te hoog in vergelijking met de verandering van de kwaliteit.	❑
c.	Ik bezoek deze plassen en meren nooit.	❑
d.	Ik geloof niet dat de kwaliteit zal verbeteren zoals is beschreven.	❑
e.	Ik wil niet dat de mogelijkheden voor zeilen en varen worden beperkt.	❑
f.	Ik vind de huidige situatie goed genoeg.	❑
g.	Ik zou liever willen dat een ander open water verbetert.	❑
h.	De waterschappen of de overheid moeten dit betalen.	❑
i.	Ik kan de bedragen die op de kaarten waren aangegeven niet betalen.	❑
j.	Ik besteed mijn geld liever aan andere zaken.	❑
k.	Anders, namelijk………………………..	❑

DEEL D: CONTROLE VRAGEN

31. Hoe moeilijk vond u het om te kiezen voor een van de verschillende plassen en meren tegen betaling van hogere waterschapsrekening?
    a. Heel moeilijk
    b. Moeilijk
    c. Niet moeilijk, niet makkelijk
    d. Makkelijk
    e. Heel makkelijk

32. Vond u de haalbaarheid van de toekomstige kwaliteitssituaties geloofwaardig?
    a. Helemaal niet geloofwaardig
    b. Niet geloofwaardig
    c. Niet ongeloofwaardig, niet geloofwaardig
    d. Geloofwaardig
    e. Zeer geloofwaardig

33. Heeft u nog opmerkingen of vragen naar aanleiding van deze enquête?

BEDANKT VOOR UW MEDEWERKING!

Voor vragen of opmerkingen naar aanleiding van deze enquête kunt u contact opnemen met:

Marije Schaafsma

Vrije Universiteit Amsterdam

020-5984043

U kunt uw venster sluiten om de vragenlijst te beëindigen.

Annex VI: Additional results of Chapter 6

Table VI.I Non-parametric tests of difference between users and non-users in their cognitive distance errors

	Kolmogorov-Smirnov test	Mann-Whitney U-test
Kagerplassen	0.400	0.732
Braassemermeer	0.074*	0.043**
Westeinder Plassen	0.000***	0.008***
Langeraarse Plassen	0.008***	0.006***
Nieuwkoopse Plassen	0.676	0.942
Reeuwijkse Plassen	0.073*	0.101
Vinkeveense Plassen	0.976	1.000
Naardermeer	0.700	0.755
Ankeveense Plassen	0.813	0.683
Loosdrechtse Plassen	0.056*	0.123
Maarsseveense Plassen	0.282	0.123

Note: Significance is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

Table VI.II Models I, II and III in preference-space

Lakes	Model I	Model II	Expl. var	Model I	Model III
	Small set	Small set		Large set	Large set
Kagerplassen (KA)	-1.313***	-1.152**		0.473**	0.460***
	(2.783)	(2.390)		(2.492)	(3.038)
Braassemermeer (BR)	1.641**	1.497**		0.405**	0.394***
	(2.145)	(1.945)		(2.206)	(2.756)
Westeinder Plassen (WE)	0.261**	0.274**		0.378**	0.172
	(2.163)	(2.239)		(2.089)	(1.094)
Nieuwkoopse Plassen (NK)	1.470***	1.506***		1.245***	1.419***
	(12.973)	(12.811)		(7.105)	(10.913)
Reeuwijkse Plassen (RW)	0.249	0.319		1.078***	1.208***
	(0.502)	(0.627)		(5.996)	(8.054)
Vinkeveense Plassen (VV)	0.765***	0.732***		1.091***	1.081***
	(5.960)	(5.551)		(6.082)	(8.401)
Naardermeer (NM)	0.507	0.519		1.288***	1.270***
	(0.999)	(1.008)		(6.716)	(8.899)
Ankeveense Plassen (AV)	0.143	0.244		0.643***	0.545***
	(0.282)	(0.427)		(3.333)	(3.633)
Loosdrechtse Plassen (LD)	0.799	0.935*		1.439***	1.469***
	(1.600)	(1.840)		(8.041)	(11.63)
Maarsseveense Plassen (MV)	0.015	-0.028		0.726***	0.650***
	(0.030)	(-0.056)		(3.861)	(4.402)
Random parameters (normal distribution):					
Quality * Distance to KA, RW, NM, AV, LD, MV	-2.360***	-2.485***	Quality * Distance	-1.878***	-1.838***
	(-16.853)	(-17.030)		(-18.665)	(-23.462)
standard deviation	1.292***	1.366***	Standard deviation	0.993***	0.975***
	(11.350)	(11.048)		(8.313)	(12.832)
Quality * Distance to WE, LA, NK, VV	-2.941***	-3.023***			
	(-16.879)	(-16.594)			
standard deviation	1.405***	1.444***			
	(12.094)	(11.945)			
Quality * Distance to BR	-3.801***	-3.798***			
	(-10.967)	(-10.910)			
standard deviation	1.549***	1.624***			
	(7.843)	(8.089)			
Non-random parameters					
Price	-0.040***	-0.041***		-0.040***	-0.040***
	(-18.883)	(-19.168)		(-16.739)	(-21.315)
Quality level 1	7.341***	7.585***		5.031***	4.905***
	(14.644)	(14.927)		(10.650)	(15.976)
Quality level 2	7.517***	7.763***		5.067***	4.944***
	(15.089)	(14.927)		(10.706)	(16.072)
Quality * Distance * User (dummy)	0.492***	0.451***		0.438***	0.427***
	(19.361)	(17.255)		(16.662)	(20.75)
Quality * Distance * non-use reason for WTP (dummy)	0.877***	0.872***		0.597***	0.598***
	(5.058)	(4.827)		(4.903)	(5.136)

Table VI.II continued	Model I	Model II		Model I	Model III
Quality * Distance * Cognitive distance error	-	0.514*** (11.112)		-	-
Directional dummies					
Quality * Distance * Westeinder Plassen *north-east					0.648*** (3.193)
Quality * Distance * Nieuwkoopse Plassen *north					-0.763*** (-3.867)
Quality * Distance * Nieuwkoopse Plassen *north-east					-0.632** (-2.56)
Quality * Distance * Reeuwijkse Plassen *east					-1.046*** (-2.921)
Quality * Distance * Ankeveense Plassen *east					1.137*** (3.283)
Quality * Distance * Loosdrechtse Plassen *north					-1.014** (-2.47)
Quality * Distance * Maarsseveense Plassen *					0.498** (2.47)
Cholesky matrix: Diagonal values					
Quality * Distance to KA, RW, NM, AV, LD, MV	1.292*** (11.350)	1.366*** (11.048)			
Quality * Distance to WE, LA, NK, VV	0.534*** (8.687)	0.498*** (8.213)			
Quality * Distance to BR	0.677*** (6.106)	0.633*** (5.473)			
Cholesky matrix: Below diagonal values					
Quality * Distance to KA, RW, NM, AV, LD, MV : price	-	-			
Quality * Distance to WE, LA, NK, VV : price	-	-			
Quality * Distance to WE, LA, NK, VV: Quality * Distance to KA, RW, NM, AV, LD, MV	-1.299*** (-10.348)	-1.355*** (-10.354)			
Quality * Distance to BR : price	-	-			
Quality * Distance to BR : Quality * Distance to KA, RW, NM, AV, LD, MV	-1.324*** (-5.695)	-1.429*** (-6.740)			
Quality * Distance to BR : Quality * Distance to WE, LA, NK, VV	-0.433** (-2.123)	-0.443* (-2.218)			
Error-component					
All lakes: KA, BR, WE, LA, NK, RW, VV, NM, AV, LD, MV	4.891*** (13.111)	4.710*** (12.987)		3.895*** (42.950)	3.820*** (12.174)
Model statistics					
No. Observations	3880	3880		3184	3184
Loglikelihood	-3869	-3830		-4206	-4181
No. Parameters	25	26		18	25

Notes: T-values between brackets. Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

Table VI.III Error component models and competing destinations model

Lakes	**ECM-size**		**ECM-visitation**	**Comp. Dest.**
Kagerplassen (KA)	0.516***		0.214	0.489***
	(3.339)		(1.148)	(3.186)
Braassemermeer (BR)	0.452***		0.143	0.400***
	(3.084)		(0.803)	(2.795)
Westeinder Plassen (WE)	0.466***		0.346**	0.380***
	(2.615)		(2.301)	(2.676)
Nieuwkoopse Plassen (NK)	1.355***		1.263***	1.261***
	(8.079)		(9.600)	(9.869)
Reeuwijkse Plassen (RW)	1.244***		1.091***	1.125***
	(6.953)		(7.002)	(6.475)
Vinkeveense Plassen (VV)	1.154***		0.940***	1.103***
	(6.468)		(6.057)	(8.542)
Naardermeer (NM)	1.439***		1.128***	1.323***
	(9.573)		(6.662)	(8.662)
Ankeveense Plassen (AV)	0.714***		0.390**	0.661***
	(4.489)		(2.186)	(4.427)
Loosdrechtse Plassen (LD)	1.626***		1.351***	1.431***
	(9.922)		(8.913)	(11.322)
Maarsseveense Plassen (MV)	0.939***		0.729***	0.747***
	(5.570)		(4.729)	(5.089)
Random parameters (normal distr.)				
Quality*Distance (log (distance in km+1)	-2.058***		-2.012***	-1.883***
	(-23.100)		(-23.520)	(-23.985)
standard deviation	1.033***		1.000***	0.993***
	(13.291)		(12.729)	(13.265)
Non-random parameters				
Price	-0.045***		-0.044***	-0.040***
	(-21.885)		(16.361)	(-21.280)
Quality level 1	5.120***		5.242***	5.163***
	(15.475)		(16.361)	(12.673)
Quality level 2	5.231***		5.271***	5.199***
	(15.587)		(16.479)	(12.754)
Quality * Distance * user (dummy)	0.488***		0.488***	0.438***
	(19.381)		(20.290)	(21.498)
Quality * Distance * non-use reason for WTP (dummy)	0.641***		0.579***	0.595***
	(5.298)		(4.828)	(5.112)
Accessibility indicator ($1/D_{ij}$)				0.055
				(0.522)
Error-components		**Error-components**		
All lakes	3.724***	All lakes	3.702***	3.910***
	(12.548)		(12.226)	(12.445)
Large size: LD, NK, VV	1.237***	Often visited: LD, VV	1.218***	
	(10.443)		(8.857)	
Medium size: VV, WE, RW	0.831***	Regularly visited: NK, RW, WE, MV	0.513**	
	(6.132)		(2.496)	
Small size: AV, KA, BR, LA, NM	1.072***	Least visited: AV, KA, BR, NM	1.317***	
	(7.095)		(8.756)	
Loglikelihood	4134		4138	4206

Table VI.IV Results of Model VI (pooled) – significant variables

Lakes	**Model IV**
Kagerplassen (KA)	0.331***
	(3.737)
Braassemermeer (BR)	0.319***
	(4.219)
Westeinder Plassen (WE)	0.381***
	(4.771)
Nieuwkoopse Plassen (NK)	1.303***
	(18.265)
Reeuwijkse Plassen (RW)	1.280***
	(13.813)
Vinkeveense Plassen (VV)	0.947***
	(12.509)
Naardermeer (NM)	1.409***
	(16.370)
Ankeveense Plassen (AV)	0.898***
	(10.269)
Loosdrechtse Plassen (LD)	1.618***
	(20.734)
Maarsseveense Plassen (MV)	0.818***
	(9.331)
Random parameters (normal distribution)	
Quality * Distance (log (distance (km)+1)	-2.081***
	(-30.628)
standard deviation	1.182***
	(19.456)
Large set (zero mean): standard deviation	1.801***
	(10.539)
Non-random parameters	
Price	-0.037***
	(-32.156)
Quality level 1	6.048***
	(22.618)
Quality level 2	6.149***
	(23.062)
Quality * Distance * user (dummy)	0.428***
	(33.197)
Quality * Distance * non-use reason for WTP (dummy)	0.567***
	(5.087)
Diagonal values in Cholesky Matrix	
Quality * Distance	1.182***
	(19.456)
Large set	1.649***
	(9.189)
Below diagonal values in Cholesky matrix	
Large set: Quality * Distance	-0.725***
	(-3.459)

Table VI.IV continued	**Model IV**
Error-components	
All lakes	5.516*** (22.831)
Model statistics	
No. Observations	6831
Loglikelihood	-7566
No. Parameters	20

Notes: T-values between brackets. Significance of the parameters is marked by asterisks: *** at 1%, ** at 5%, or * at 10%.

Samenvatting in het Nederlands

Ruimtelijke effecten in stated preference studies voor milieuwaardering

De natuur brengt goederen en diensten voort die van belang zijn voor de welvaart van mensen. Door de totale economische waarde van deze milieugoederen te berekenen, kan hun bijdrage aan onze welvaart worden gekwantificeerd. Stated Preference (SP) methoden zijn geschikt om de waarde te bepalen die mensen aan het gebruik, het bestaan en het behoud van natuur hechten. Bij deze SP methoden wordt aan respondenten in een enquete gevraagd hoeveel zij bereid zijn te betalen voor het verbeteren van de kwaliteit van het milieugoed (of het behoud van de bestaande kwaliteit).

Voor een betrouwbare schatting van de totale economische waarde moet niet alleen worden onderzocht welk bedrag mensen bereid zijn te betalen, maar ook welke mensen willen betalen. Op basis van het effect van afstand op de betalingsbereidheid kan vervolgens worden bepaald op welke afstand van de locatie die het milieugoed voortbrengt de bevolking niet meer bereid is te betalen. De verwachting in de economisch theorie is dat naarmate mensen verder van de locatie vandaan wonen, hun betalingsbereidheid (Willingness-To-Pay, WTP) daalt. Dit komt bijvoorbeeld doordat de kosten van het bezoeken van de locatie hoger worden naarmate de afstand stijgt, maar ook doordat mensen minder bekend zijn met de locatie of zich er minder bij betrokken voelen. Naast afstand kan ook de beschikbaarheid van substituten, zoals andere gebieden die dezelfde milieugoederen voortbrengen, ruimtelijke verschillen in WTP veroorzaken. Wanneer een alternatief aanwezig is in de nabije omgeving, dan zal iemand waarschijnlijk minder bereid zijn te betalen voor het bestudeerde milieugoed.

Ondanks het belang van afstand en substituten voor een betrouwbare bepaling van de totale economische waarde, zijn er in de zeer uitgebreide SP literatuur slechts 25 studies die over het effect van afstand op WTP rapporteren. Er zijn nog minder studies die in de analyse controleren voor het effect van substituten op WTP. De verwachting is dat dit de betrouwbaarheid en validiteit van de bestaande SP studies negatief beinvloedt. Dit leidde tot de volgende onderzoeksvraag:

Kan het ontwerp en de analyse van Stated Preference studies worden verbeterd door te controloren voor het effect van de ruimtelijke context van milieugoederen en diensten op preferenties en keuzes om zodoende de validiteit en betrouwbaarheid van de resultaten te vergroten?

Voor het beantwoorden van deze onderzoeksvraag is een literatuurstudie verricht en zijn twee case studies uitgevoerd in twee verschillende rivierstroomgebieden in Nederland.

In het theoretische deel van dit proefschrift is gekeken in hoeverre gepubliceerde studies op betrouwbare wijze rekening houden met ruimtelijke effecten op de WTP. Er werden twee ruimtelijke groepen van factoren onderscheiden die de WTP kunnen beinvloeden: de fysieke en de psychologische factoren. Er werd gesteld dat de fysieke context van invloed is op de preferenties en keuzes die respondenten maken. Niet alleen zijn waarden vaak locatie-specifiek, afhankelijk van de kenmerken van de locatie, maar ook afstand en substituten zijn van invloed op WTP. Ook de *psychologische* context van ruimtelijke keuzes belicht. In andere onderzoeksvelden, zoals sociale en economische geografie, wordt vaak meer aandacht besteed aan de manier waarop ruimtelijke perceptie van invloed is op ruimtelijk keuzegedrag dan in de economische literatuur. De inzichten werden samengebracht in een analytisch raamwerk voor de analyse van ruimtelijke keuzes in SP studies ten behoeve van de waardering van milieu-goederen. Vervolgens werden verschillende methoden en analyse-technieken voorgesteld om de ruimtelijke variatie in WTP als gevolg van de de fysieke en psychologische factoren te toetsen.

Het raamwerk en de voorgestelde methoden en technieken werden getest in twee case studies. Het zogenaamde keuze-experiment werd verkozen als geschiktste techniek. Hierbij moeten respondenten het door hun hoogst gewaardeerde, ofwel meest geprefereerde, alternatief kiezen. In dit onderzoek vormden meren of wateren, waar tegen betaling van een bepaald bedrag een hogere waterkwaliteit wordt gerealiseerd, de mogelijk alternatieven. Zodoende werden substituten dus expliciet meegenomen in de vraagstelling van de enquetes.

De eerste case studie vond plaats in het Nederlandse deel van het Schelde stroomgebied in de provincie Zeeland. Drie verschillende locaties, te weten de stranden bij Breskens, de Braakman-kreek en het Verdronken Land van Saeftinghe, werden geselecteerd als alternatieven voor het keuze-experiment. Deze drie locaties verschillen sterk in het type milieugoederen en diensten dat zij voortbrengen. In de tweede case studie, die plaatsvond in het Rijnstroomgebied, werd respondenten gevraagd te kiezen tussen waterkwaliteitsveranderingen in elf meren temidden van de Randstad. De studies vielen binnen het beleidskader van de Europese Kaderrichtlijn Water, waaronder de lidstaten in 2015 een goede ecologische status in alle waterlichamen moeten behalen.

De resultaten zijn ingedeeld in drie onderwerpen: locatie-specifieke waarden, afstands- en substitutie-effecten. In de Schelde studie werden locatie-specifieke waarden gevonden voor sommige milieu-goederen. Natuurverbeteringen werden hoger gewaardeerd voor Saeftinghe dan voor de twee andere locaties. Ook de WTP-waarden van verbeteringen in de zwemmogelijkheden waren locatie-specifiek. Daarentegen werden de waterkwaliteitsverbeteringen in de Rijnstudie, waarbij de meren en bijbehorende milieugoederen veel meer op elkaar leken, niet verschillend gewaardeerd. De resultaten tonen aan dat WTP voor het behalen van de doelstellingen van de Kaderrichtlijn Water afhankelijk is van de karakteristieken van de locaties. Voor een locatie waarover geen onderzoek naar de economische waarde bestaat, kan het gebruik van WTP-waarden van andere locaties uit bestaande studies tot minder betrouwbare resultaten leiden wanneer de karakteristieken van de locaties verschillen.

In beide case studies werden significant effecten van afstand op de WTP voor waterkwaliteits-verbeteringen gevonden. Deze effecten verschilden tussen locaties en respondenten, zoals tussen mensen die de locaties wel of niet hadden bezocht. Ook verschilde het afstandseffect tussen mensen die de afstand tot de studielocaties onder- en overschatten. Door toepassing van verschillende methoden werd aangetoond dat er naast afstandseffecten nog aanvullende ruimtelijke verschillen in WTP waren. Deze verschillen werden voornamelijk veroorzaakt door de aanwezigheid van substituten. Zo werd in de Schelde studie gevonden dat mensen die dichtbij andere stranden wonen minder willen betalen voor de stranden van Breskens. Dit is nog niet eerder op deze manier aangetoond in dit type onderzoek.

Substitutie-effecten werden verder geanalyseerd in de modellering van de substitutiepatronen tussen de alternatieven in de keuze-experimenten. In de Schelde studie werd een statistische model voorgesteld en getest dat beter in staat zou zijn om verschillen in substitutiepatronen tussen alternatieven te ondervangen dan bestaande modellen. Uit de analyse kwam naar voren dat Breskens en Braakman als nauwere substituten werden beoordeeld in verhouding tot Saeftinghe. Een verbetering in Breskens veroorzaakte een relatief grotere daling in de keuzes voor Braakman dan voor Saeftinghe. Het controleren voor deze disproportionele substitutiepatronen door middel van het voorgestelde model leidde tot significant andere WTP-waarden en een betere model fit.

Tot slot werd in het keuze-experiment in de Rijnstudie geanalyseerd in hoeverre keuzes tussen een groot aantal locaties in SP onderzoek leidt tot ander keuzegedrag dan wordt verondersteld in de economisch theorie. In SP studies wordt het aantal alternatieven in keuze-experimenten vaak beperkt tot drie of vier om de keuzes niet te moeilijk te maken voor respondenten. Een van de kenmerken van ruimtelijke keuzes is juist dat het aantal mogelijke locaties vaak groot is. Dit kan de keuze tussen locaties bemoeilijken en leiden tot ander keuzegedrag. Bij hierarchisch keuzegedrag wordt verondersteld dat mensen de alternatieve locaties indelen in regio's en eerst een regio kiezen alvorens het voorkeurs-alternatief te selecteren. In het Rijn-onderzoek werd het aantal verkiesbare alternatieven vergroot gedurende het experiment. Uit de analyse bleek niet dat de respondenten het moeilijker vonden om uit het grotere aantal meren te kiezen: de keuzes waren consistent en de WTP-waarden bleven nagenoeg gelijk. Vervolgens werd getest of de ruimtelijke ligging van de verschillende meren ten opzichte van elkaar van invloed was op de keuzes. Uit de modelresultaten bleek dat er correlatie was tussen nabij gelegen alternatieven, maar ook werd correlatie gevonden tussen meren van dezelfde grootte. Ook op basis van de resultaten van het "competing destinations model" werd in de studie geen bewijs gevonden voor het effect van de ruimtelijke ligging en hierarchisch keuzegedrag. Deze studie toont hiermee aan dat het ook in SP onderzoek mogelijk is om het aantal alternatieven in het keuze-experiment te vergroten zonder dat hierbij de economische aannames over keuzegedrag worden geschonden.

Dit proefschrift beoogt een bijdrage te leveren aan de literatuur over economische waardering van milieugoederen met behulp van Stated Preference methoden door aan te tonen dat ruimtelijke effecten van belangrijke invloed zijn op de betalingsbereidheid voor deze goederen. Hoewel de case studies waterkwaliteitsverandering als onderwerp hebben, wordt verwacht dat de resultaten van dit onderzoek ook van toepassing zijn op andere milieugoederen, zeker wanneer deze op verschillende plaatsen voorhanden zijn en deze plaatsen ongelijk zijn verdeeld over de ruimte. Uit de studies komt naar voren dat de effecten van afstand en substituten leiden tot significant andere economische waarden. Voor de psychologische aspecten van ruimtelijke keuzes, zoals de perceptie van afstand en de complexiteit van het kiezen tussen een groot aantal locaties, werden minder sterke effecten gevonden. Toekomstig onderzoek zal verder moeten uitwijzen in hoeverre er in SP studies, waarbij mensen in een enquete moeten kiezen tussen verschillende locaties die allemaal milieugoederen voortbrengen, al dan niet sprake is van ander keuzegedrag dan wordt verondersteld in de economisch theorie.

The following papers are based on this PhD research:

Schaafsma, M., Brouwer, R., Gilbert, A., van de Bergh, J., and Wagtendonk, A. 'Substitution effects in a spatial choice experiment' (revised and resubmitted to *Environment and Resource Economics*)

Schaafsma, M., Brouwer, R., Gilbert, A., van de Bergh, J., and Wagtendonk, A. 'Advancing the estimation of distance-decay functions to account for spatial heterogeneity in stated preference research' (revised and resubmitted to *Land Economics*)

Schaafsma, M., Brouwer, R., and Gilbert, A. 'Hedwige polder: publieke waardering van natuur-ontwikkeling in Zeeland' H2O magazine (submitted)

The following presentations are based on this PhD research:

Schaafsma, M., Brouwer, R., Gilbert, A., van de Bergh, J., Wagtendonk, A. 'Substitution in spatial choice using a universal logit approach'. EARE Conference, 24-24 June 2009, Amsterdam

Schaafsma, M., Brouwer, R., Gilbert, A., van de Bergh, J., and Wagtendonk, A. ' Accounting for distance decay and substitution in SP research' Envecon Applied Environmental Economics Conference, 12 March 2010, Londen

Schaafsma, M. 'Spatial effects in stated preference studies for environmental valuation'. Interenational Research Workshop 'Towards improved measurement of landscape preferences: mixing methods and using GIS' 27-28 January 2010, Rijksuniversiteit Groningen