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Testing the Influence of Substitute Sites in Nature Valuation by Using Spatial Discounting Factors

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Abstract This paper investigates the effect of nearby nature substitute sites on preferences for nature restoration. Contrary to prior studies, we use a respondent-centric approach to control for substitute sites. We assess each respondent-specific spatial context by computing densities of nature substitute sites within various ranges from each respondent's home. This approach considers the use and non-use values of nature together. Data from three similar discrete choice experiments carried out in Flanders (Belgium) are compared. Different spatial discounting factors are tested to explore how the substitution effect behaves with regard to distance. Latent class analyses are performed to account for preference heterogeneity among respondents. We observe divergent behaviours across groups of respondents. The "distance-to-substitutes" affects how respondents gauge substitute sites. We find a significant influence of the squared average buffer distance but this effect varies in sign across case studies and classes of respondents. Our results demonstrate that individual-specific GIS data can significantly improve the representation of the spatial context and the transferability of value functions. However, the roles played by preference heterogeneity and nature perception on respondents' capacity to value nature still deserves further attention in future research.

Keywords Benefit transfer · Discrete choice experiment · Ecosystem services · GIS · Latent class · Nature · Non-market valuation · Spatial · Substitute

JEL Classification Q20 · Q26 · Q51 · Q57

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1 Introduction

In the past few years, nature valuation has become increasingly popular to estimate the non-market economic value of ecosystem services (Adamowicz et al. 1994). In stated preference (SP) studies (Pearce and Özdemiroglu 2002), public preferences have been investigated by looking into collective willingness-to-pay (WTP) for certain ecosystem services, most often at one specific natural site. Because of the costly process of carrying out valuation studies, value functions calculated at a primary location (study site) started to be applied elsewhere (policy site), assuming perfect transferability across sites (Brouwer 2000). Past research has shown, however, that value functions are in fact rarely transferable because neither the differences in the spatial context (spatial heterogeneity), nor the characteristics of the individuals valuing the site (individual heterogeneity) are sufficiently controlled for (Colombo et al. 2007), leading to transfer errors (Bateman et al. 2011).

One essential phenomenon at work in the definition of the spatial context is the substitution effect, i.e. the availability of similar substitute sites[1] near the site under valuation. Early references to the substitution effect are found in recreation research (Burt and Brewer 1971; Cesario and Knetsch 1973). Later on, the influence of substitutes has been approached from various angles, such as spatial choice models (Borgers and Timmermans 1987; Hunt et al. 2004) and revealed preference studies based on the travel cost method (Brainard et al. 2001; Lovett et al. 1997). Substitute sites have been generally considered as "competing destinations" in these revealed preference studies (Adamowicz et al. 2011; Fotheringham 1983; Pellegrini and Fotheringham 2002). Competing destination models study the decision-making process of an individual who must choose between the study site and a specific selection of alternative destinations. By contrast, only a few SP studies made the substitution question the central part of their analysis (Hoehn and Loomis 1993; Pate and Loomis 1997; Schaafsma et al. 2013; Schaafsma and Brouwer 2013).

Due to the limited SP literature treating the substitution question, at least three questions remain poorly understood. First, how does the substitution effect behave with regard to distance? Past research about spatial cognition (Cadwallader 1981; Fotheringham 1983, 1986) and mental mapping (Soini 2001) has demonstrated that humans attach higher importance to nearer places (such as sites surrounding their home) than to farther ones. In SP research, WTP was shown to decline with the distance separating an individual from the site under valuation. Scientists call this phenomenon "distance-decay" (Loomis 2000). Studies focusing on distance-decay showed that nearer natural recreational sites were given higher values than more distant ones (Hanley et al. 2003; Loomis 2000; Schaafsma et al. 2013). Therefore, the distance separating an individual from potential substitute sites (hereafter the "distance-to-substitutes") and the density of substitutes in that individual's neighbourhood are also likely to affect their valuation capacity and deserve special attention.

Second, how to correct for preference heterogeneity originating in respondent-specific perception of space and knowledge about their surrounding environment? The social-psychological literature shows that culture and experience are central to shaping nature perception amongst individuals (Backhaus 2011; Herzog et al. 2000; Sevenant and Antrop

[1] The availability of substitute sites (or "spatial substitution") should not be confused with "leisure activity substitution" (Peterson et al. 1984) as this study is not restricted to the sole direct use value of nature. The latter relates to the study of the socio-psychological processes involved in decision-making, which is not our objective here. Interested readers are referred to recent studies about that topic (León et al. 2014; León and Araña 2014).

2009; Van den Berg et al. 1998). Matsuoka and Kaplan (2008) argue that the presence of "nearby nature" is essential to the fulfilment of fundamental human needs contributing to well-being and are therefore highly valuable to people. Kaplan and Kaplan (1989) report higher neighbourhood satisfaction among residents having views of woods from their window, and generally surrounded by vegetation. The spatial context is consequently individual-specific, which may introduce distortions and complicate its approximation.

Third, can Geographic Information Systems (GIS) help solve the substitution question? Lately, GIS have appeared as a potentially helpful tool for improving benefit transfer by controlling for the spatial context of nature valuation (Bateman et al. 2002, 2011; Termansen et al. 2008, 2013). A remaining challenge relates to the correct approximation of the supply of relevant substitute sites when using selected GIS features. A narrow selection can overlook the possibility for other landscape elements to act also as eligible substitutes.

SP studies that estimate WTP for certain ecosystem services at one particular site without accounting for its spatial context face the risk to obtain highly biased estimates. Also, the marginal WTP attributed to the provision of additional nature remains questionable (Broekx et al. 2013). So, improving the benefit transfer methodology is essential but the question is to know whether including additional indicators for substitution effects can improve the accuracy of WTP estimates and their transferability. This points to three research objectives of this paper: (i) demonstrating how substitute sites, and distance-to-substitutes in particular, affect individuals' capacity to value nature in their vicinity; (ii) investigating whether adopting a respondent-centric approach helps solve the substitution question; (iii) exploring how GIS information can improve the transferability of value functions across sites.

Rather than considering substitute sites as competing destinations—which restricts them to their sole direct use value (e.g. recreation), we consider substitutes from a density perspective. Nature density can contribute to building a sense of living within a sufficiently natural neighbourhood. Therefore, we jointly consider the direct, indirect use and non-use values of nature in this research. This makes the whole valuation exercise more complex since the relative importance of these different values is still poorly understood in existing literature. In particular, non-use values are recognised as either insensitive to distance (Concu 2005) or at most presenting much lower discount rates than use values (Brown et al. 2002). As such, individuals living in a densely vegetated region are expected to show lower support for nature restoration scenarios taking place at a different site, further away from their home. Conversely, nature restoration supporters could also be the ones who live within a green neighbourhood due to their higher familiarity with nature.

Limited research has followed a nature density approach. One example can be found in Pate and Loomis (1997). The authors accounted for substitutes using acreage-based indicators representing the density of wetlands in four different states. They observed a detrimental effect of substitutes on WTP for two of their three environmental improvement programs. A distance parameter was included to control for distance-decay but the distance-to-substitutes effect was not controlled for. In other words, the density of substitutes was not weighted by distance.

In this paper, we present a methodology based on a comparison of three case studies. We rely on discrete choice experiments that explore preferences for different nature restoration scenarios taking place each time at one specific nature site. Using respondent-centric GIS distance buffers, we compute nature densities and apply spatial discounting factors to approximate different functional forms of the substitution effect. Finally, we use latent class models to account for individual-specific preference heterogeneity and discuss the implications stemming from our findings.

2 Methodology

2.1 Case Studies

We selected three case studies—Drongengoed, Lovenhoek and Turnhouts Vennengebied—to compare preferences for nature restoration scenarios across different geographic contexts in Flanders (Belgium) (Fig. 1).

The Drongengoed is an 860 ha-wide nature area located in the province of East-Flanders (Fig. 1, site A). The site used to be covered by moor and heather until monks converted it to farmland in the eighteenth century. However, most of the site was not suitable for crops and was therefore afforested, mostly with conifer plantations. Nowadays, the site is open to the public for recreation and a large part of it is protected under the European Union (EU) Habitat Directive. "Natuurpunt", a Flemish NGO concerned with nature conservation, is raising awareness about the need to restore the Drongengoed to a more diverse natural landscape (see De Valck et al. 2014).

The Lovenhoek is about 130 ha-wide and is part of a larger series of natural areas (500 ha) located in the province of Antwerp (Fig. 1, site B). The Lovenhoek consists of a mix of landscapes (broadleaved and coniferous woodland, heathland, etc.). Species of high biological value, such as the middle spotted woodpecker (*Dendrocopos medius*) or the variable bluet (*Coenagrion pulchellum*), can be observed by visitors. Rare plants species like the golden saxifrage (*Chrysoplenium oppositifolium*) or the marsh valerian (*Valeriana dioica*) indicate high quality wet woodlands. The coniferous part of the site, however, is gloomy and unattractive. Restoration works are being planned to modify that part of the site (∼65 ha) and enhance the overall landscape diversity.

With 550 ha, the Turnhouts Vennengebied is a natural site under development and is one of the largest heathlands in Flanders (Fig. 1, site C). It is covered with notable heath and fens. These biotopes host some endangered endemic species, such as the palmate newt (*Lissotriton helveticus*). About 67 ha (12 %) of the Turnhouts Vennengebied is still covered with conifers showing low biodiversity. To enhance the quality of the site, some restoration actions are planned. The intention is to convert the coniferous forest stand—a former forestry plantation—into a diversified mixture of landscapes (e.g. broadleaves, heathland, fens). The number and quality of trails might also be increased to improve site accessibility.

2.2 Data

For each case study, we collected data by means of online questionnaires. The questionnaires included three sections: (i) general questions on respondents' opinion about environmental matters, their perception of nature and recreational habits; (ii) the discrete choice experiment (hereafter "DCE"—see next section), (iii) demographic and follow-up questions (e.g. "How would you rate the complexity of the choice sets?"). We used Internet-based surveys because of their practicality, high time/cost efficiency, and lower odds of data entry errors. One disadvantage of Internet-based surveys is the low response rate but our results show comparable response rates as prior studies in Europe (Bliem et al. 2012; Deutskens et al. 2004).

The survey was managed by a marketing firm that used a panel of citizens representative of the Flemish population in terms of age, gender, education and income. Data were collected in several episodes between June and November 2011. The firm repeatedly sent the questionnaire to its panel members until the desired number of responses was reached. Respondents were sent an invitation email promising a chance to win a 10 € voucher as a reward for filling in the entire survey.

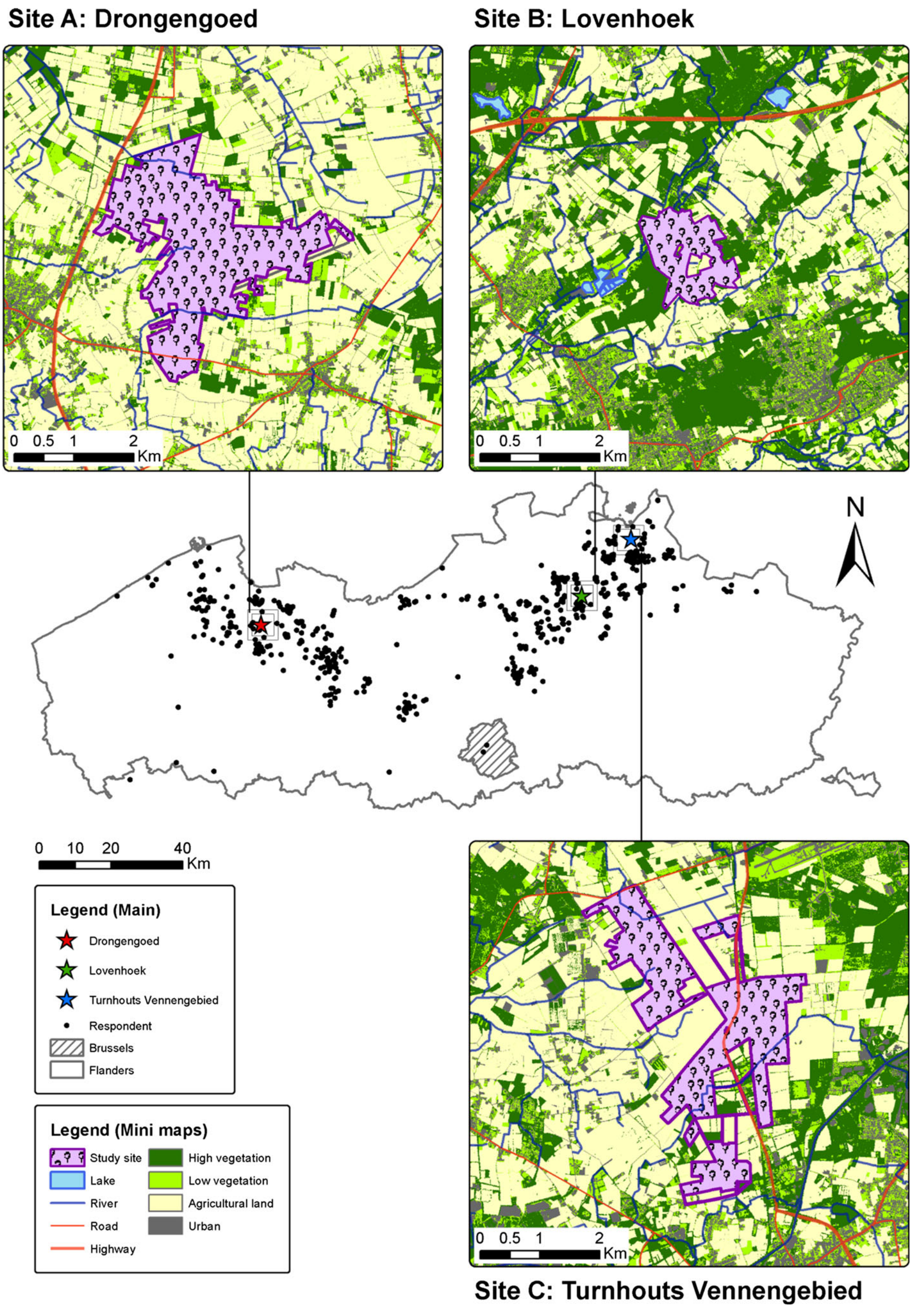

Fig. 1 Location of the three study sites and related survey respondents in Flanders (Belgium)

We obtained 1260 responses (Table 1), out of which 686 (54.4 %) were finally used for the analysis. Removed responses corresponded either to protesters or to incomplete responses. Incomplete responses referred to respondents who did not fill in the entire DCE or had to be

Table 1 Responses and descriptive statistics from the three surveys

	Drongengoed	Lovenhoek	Turnhouts Vennengebied
Sent questionnaires	2203	2088	2195
Responses (raw)	440	469	351
Response rate (%)	20.0	22.5	16.0
Protest zero bidders	26	26	23
Incomplete responses	196	178	125
Responses (final)	218	265	203
Choice observations	1308	1590	1218
Socioeconomic characteristics			
Gender (% male)	53.7	59.0	58.7
Age [mean (years)]	50.7	50.6	51.8
Education (% of higher education level)	47.7	57.9	46.0
Net monthly household income (€)	2431.8	2757.2	2745.9
Euclidian home-site distance [mean (km)]	17.6	19.5	18.8

removed from the final analysis because they did not provide their location or certain socioeconomic characteristics used later in the models. The remaining proportion of respondents in the final dataset could indicate a potential risk of self-selection bias, because respondents who started filling in the questionnaire could understand what the survey was about, gave up their chance to get the reward by not completing the survey till the end and may have left due to a lack of interest.

We identified 5.9 % of protest bidders and removed them. These respondents picked the opt-out alternative in all six choice sets and justified it each time by stating "I already pay too many taxes" in the subsequent motivation assessment question. Protest bidders are of no interest for further analysis as their presence would contribute to increase the error on the genuine zero bids.

2.3 The Discrete Choice Experiment (DCE)

The DCE is a preference elicitation technique originally developed by Louviere and Hensher (1982) and used in non-market valuation. DCEs rely on surveys involving the construction of a hypothetical market (Hoyos 2010). Respondents are presented multiple choice situations (or "choice sets") that comprise several hypothetical alternatives described in terms of their attributes. Respondents are asked to choose their preferred alternative.

To select the most relevant attributes to include in the DCE, we based ourselves on: (i) theoretical expectations from our own experience, (ii) literature review, (iii) discussions with experts from local public environmental agencies, and (iv) focus groups and pre-tests. In particular, we conducted two focus groups among Flemish residents to gauge their attitude and knowledge about the environment. Before the final launch of the survey, we also tested the choice sets (and the survey in general) several times. These pre-tests demonstrated a correct understanding of the DCE by respondents.

We used a D-optimal main-effects fractional factorial design (Louviere et al. 2000) to draw 24 different choice sets (Fig. 2), which were subsequently split into four blocks of six

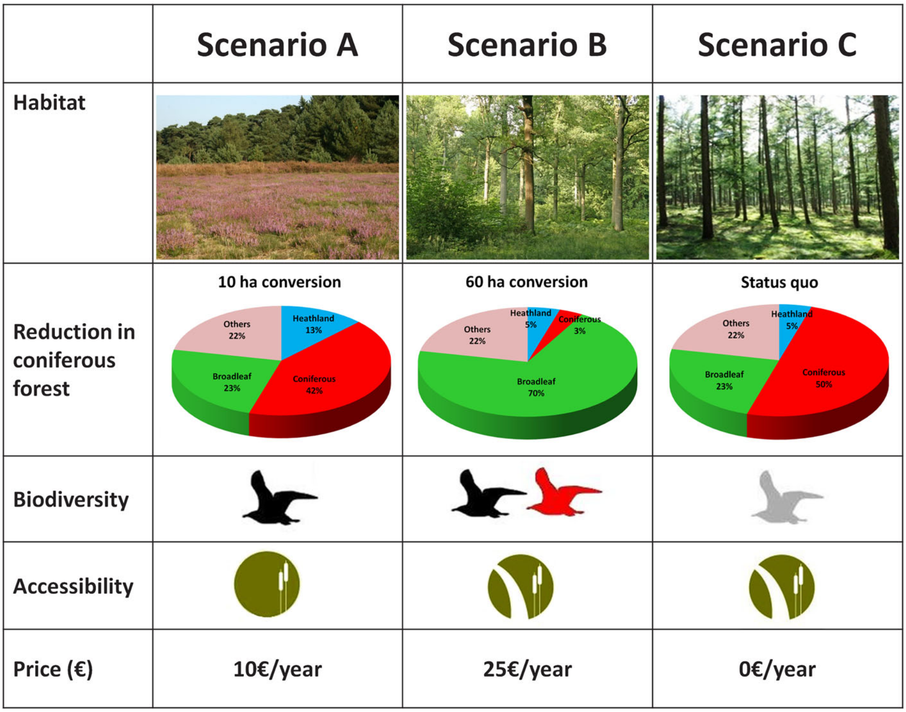

Fig. 2 Example of choice set

choice sets. In each case study, respondents were randomly allocated to one of the four blocks and presented six different choice sets containing three alternatives: two hypothetical nature restoration scenarios that implied the conversion of a part of the natural site and one "do nothing" (or status quo) option. The status quo represented the current situation at the site. It offered respondents a chance to indicate that under the circumstances described in the choice set they would not opt for any of the alternatives (zero bidding). The status quo alternative also acted as the reference to compare welfare changes associated with other choice alternatives (Carson et al. 1994).

Each alternative was described according to five attributes: habitat type (conifer trees, broadleaved trees or heathland), reduction in coniferous forest (small, medium, large), biodiversity level (low, moderate, high), accessibility level (accessible, not accessible) and finally, the price of the restoration scenario (10, 25, 50, 75, 125, 200 €/year). The payment vehicle used in the DCE represents a hypothetical annual tax that respondents would need to pay if the chosen scenario were to be launched (see De Valck et al. 2014).To account for differences in the local context, the status quo was slightly adapted across the three sites. In each case study the current situation included a coniferous forest stand (a former plantation), a low biodiversity level (few species) and a normal accessibility level. The starting proportion of the coniferous plantation was adjusted to match reality. That is, the coniferous plantation represented 250 ha (or 29 %) at the Drongengoed, 65 ha (or 50 %) at the Lovenhoek, and 67 ha (or 12 %) at the Turnhouts Vennengebied.

2.4 Defining the Potential Supply of Nature Substitute Sites

Defining the potential supply of nature substitute sites in this context was a sensitive matter. Although nature could refer to a large diversity of places (Kaplan and Kaplan 1989), we focused on places that appeared sufficiently *similar* to our three study sites. Similar places were to be found in “green areas” (Neuvonen et al. 2007) or natural areas recognised for their unmanaged aspect (Shrestha et al. 2007). Those landscapes are generally opposed to man-dominated landscapes (e.g. arable land). However, a layperson would also categorise man-dominated landscapes such as heathland or forest plantations as “nature”. The challenge was to keep a sufficiently broad definition of nature so that we did not hinder respondents’ imagination and perception of nature. Therefore, we decided to use a combination of two relevant nature-related GIS datasets publically available on the European Environmental Agency (EEA) website.

The main reasons for choosing the EEA database were: (i) reliability, (ii) interoperability, and (iii) recentness of the information. The EEA database is the EU’s official repository for environment-related GIS information. All datasets are controlled and maintained by the EU official authorities, ensuring their reliability. For interoperability reasons, environmental authorities in each EU Member State are committed to provide the EEA with GIS data complying with specific standards. These datasets are periodically reviewed and upgraded to guarantee up-to-date information.

The first GIS dataset that we used was the “Common Database on Designated Areas” or CDDA (European Environment Agency 2013a). “Nationally designated areas” embodied in that GIS dataset come from a periodic inventory started in 1995 under the CORINE programme of the European Commission (European Environment Agency 2013b). The CDDA dataset was a primary choice to represent nature substitutes as it included a wide range of protected areas. Using only protected areas to approximate the supply of nature substitute sites was, however, not sufficient because many “green” areas do not hold any official protection status.

We added a selection of natural features from a second dataset to obtain a more realistic representation of the potential supply of nature substitute sites in Flanders. We used the CORINE Land cover 2006 version 16 (04/2012). We selected 19 land cover categories that were relevant for Belgium (Table 2). We used ESRI’s ArcGIS 10 software package to import and merge the two datasets. We only kept features located in Belgium and within a 200 km buffer zone beyond the Belgium borders.

Table 2 GIS layers used to represent the potential supply of nature substitutes

Dataset name	Version	GIS layers
Common database on designated areas (CDDA)	10 (upload: 10/2012)	“Nationally designated areas”
CORINE land cover 2006	16 (upload: 04/2012)	“Bare rocks”; “Beaches, dunes, sands”; “Broadleaved forest”; “Burnt areas”; “Coastal lagoons”; “Coniferous forest”; “Estuaries”; “Glaciers & perpetual snow”; “Inland marshes”; “Intertidal flats”; “Mixed forest”; “Moors & heathland”; “Natural grasslands”; “Peat bogs”; “Salines”; “Salt marshes”; “Sclerophyllous vegetation”; “Sparsely vegetated area”; “Transitional woodland-shrub”

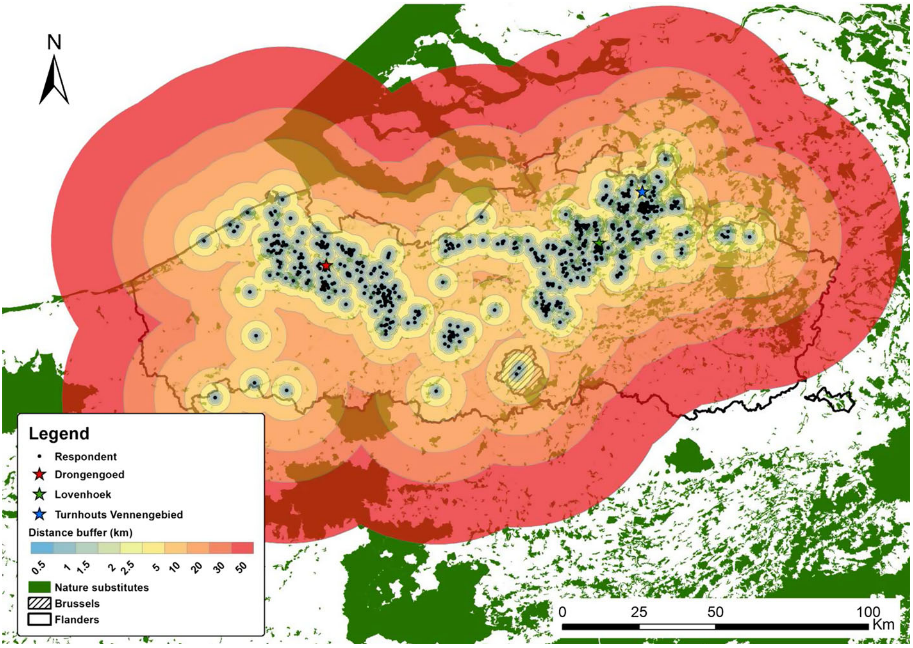

Fig. 3 Intersecting Respondent-Centric Distance Buffers with Nature Substitutes

We decided to keep the polygons corresponding to the three study sites in this dataset for exhaustiveness. An alternative was to extract the sites but we did not choose that option for the following reasons. First, removing the sites' polygons (Fig. 1) would induce a bias by underestimating the actual proportion of nature within respondents' neighbourhood, especially when respondents live next to the site. Second, the site can also be a substitute to itself here as the DCE scenarios aim at only converting a part of it. Third, the nature restoration scenarios are hypothetically defined so that the extent of the forest conversion effort and the geographic location of that conversion are not actually known.

2.5 Defining Respondent-Centric GIS Buffers

In order to discuss whether closer substitutes could be more influential on preferences than farther substitutes, we defined ten distance buffers around each respondent's location of residence. For the respondents that we could locate at the street level, the accuracy was of about 100 m (basically the sharpest resolution without compromising privacy). In case only the zipcode was provided, the respondent's location of residence was approximated using the centroid of the municipality corresponding to the zipcode.

Ten buffer distances were chosen: 500 m, 1 km, 1.5 km, 2 km, 2.5 km, 5 km, 10 km, 20 km, 30 km and 50 km. We used the Euclidian (or straight-line) distance separating each respondent's residence from potential substitutes to define circular buffers (Fig. 3). It is justified to use Euclidian distances rather than road distances in the context of observing nature substitutes from a *density* perspective, allowing for use and non-use values (Hanley et al. 2003), rather than from an *entity* perspective, focussing on direct use value (e.g. recreational destination).

In addition, the Flemish geographic context also justified that decision. Flanders is a heavily urbanised region, with one of the highest road densities in Europe. Differences between road and Euclidian distance estimations are consequently minimal. Furthermore, using a density approach to model nearby nature has the advantage not to require the definition of "entry points" to connect nature entities to the road network, which alone can be a complex issue. Finally, the additional complexity of accounting for different means of transport confirmed our decision to use Euclidian distances.

Using a respondent-centric approach to study the substitution effect is unusual. Previous research that attempted to account for substitutes used a site-centric approach instead (Jones et al. 2010). In a site-centric approach, substitute sites are assessed all at once and their relative attractiveness is compared by estimating visitation rates. This approach fits perfectly within the context of assessing the demand for outdoor recreational sites in a geographic region. This approach is less appropriate here because not only recreation values are to be accounted for.

In the context of stated preferences, the value of nature is determined by respondent-specific preferences. Therefore, substitutes also need to be respondent-specific. When asked about their preferences for converting a coniferous plantation into another nature type (hypothetical scenario), each respondent faces a question that goes beyond the choice of a recreational destination. Individual characteristics such as age, income and perception of nature, are likely to influence preferences. We account for this by including socioeconomic variables in our model. Similarly, the geographic context is also likely to shape preferences as the supply of nature substitutes differs according to respondents' home locations.

3 Empirical Approach

3.1 Random Utility Maximisation Theory

Discrete choices are traditionally modelled using a range of techniques grounded in McFadden's Random Utility Maximisation theory (1974). This theory assumes that a respondent r choosing an alternative i on a choice situation t, picks the one that yields the highest expected utility level (U_{rit}). In the present context, this can be represented as follows:

$$U_{rit} = \begin{cases} \mathrm{V}\,(ASC, X_{rit}, \beta) + \varepsilon_{rit}, & \text{if } j = 1, 2; \\ \mathrm{V}\,(X_{rit}, \beta) + \varepsilon_{rit}, & \text{if } j = \text{status quo}; \end{cases} \tag{1}$$

where V represents the deterministic part of utility, consisting of the ASC or alternative-specific constant, a dummy variable equal to 1 if the respondent is willing to move away from the status quo and equal to 0 in case they prefer the status quo, a vector X_{rit} of k observed attributes (k being the number of attributes) and β, the vector of preference parameters associated with the attributes. The second term ε_{rit} represents the random part of utility. In the simplest case of the conditional logit model, ε_{rit} is independently and identically drawn from a Gumbel distribution (Louviere et al. 2000). The random utility model can be specified in different ways depending on the assumption made about the distribution of the random error term.

A respondent r chooses the alternative i, when the utility attached to alternative i exceeds the utility attached to other alternatives $j \in J$ presented in the choice situation t. The probability of selecting alternative i is logit, which gives:

$$\mathrm{Pr(i)} = \frac{\exp\left(V_{rit}\right)}{\sum_1^{\mathrm{J}} \exp\left(V_{rjt}\right)}. \tag{2}$$

The conditional logit model is the typical method used to estimate Eq. 2.

3.2 Latent Class Model

Despite its inherent practicality, the conditional logit model comes with long-known limitations, such as the assumption of independence from irrelevant alternatives or IIA property (Luce 1959). For this reason, more advanced models have been developed (see Hoyos 2010 for an extensive review of these different models). Recently, one of them, the latent class model (hereafter "LCM"), has gained attention for its capacity to control for unobserved preference heterogeneity that follows complex distributions (Scarpa and Thiene 2005). We chose to use this model to account for different respondent profiles.

An early reference to LCMs in social sciences can be found in Langeheine and Rost (1988). LCMs are specific types of mixed logit models that use finite mixing distributions to grasp preference heterogeneity. LCMs assume that respondents can be grouped into a number of classes showing homogeneous, unobserved (or latent) preferences. In addition to an alternative choice probability equation, the derivation of the LCM also relies on a class-membership probability equation. Here again, if both equations present a Gumbel-distributed error term, they can be modelled using the conventional logit.

An advantage of the LCM is the possibility of explaining membership probability by including socioeconomic characteristics (Boxall and Adamowicz 2002). Class c membership probability is calculated in the following way (Hynes et al. 2008):

$$\Pr(\mathrm{i} \in c) = \frac{\exp\left(\alpha_c + \gamma_c \chi_c\right)}{\sum_1^C \exp\left(\alpha_c + \gamma_c \chi_c\right)}, \quad \text{with } c = 1, 2, \ldots, C, \sum\nolimits_{c=1}^{C} \alpha_c = 0 \tag{3}$$

where α_c is a class-specific constant and γ_c is a class-specific vector of parameters associated with χ_c socioeconomic characteristics. Once the class-membership probability is calculated, the alternative choice probability can be calculated as well, conditionally on class c. This leads to a new expression that is very similar to Eq. (2):

$$\Pr\left(i|c\right) = \frac{\exp(V_{rit}|c)}{\sum_1^J \exp(V_{rjt}|c)}. \tag{4}$$

Based on previous research (De Valck et al. 2014), we decided to use four socioeconomic variables to inform class membership in our model (see Table 3): income (HIGHINC), membership of an ecofriendly non-governmental organisation (ECOFR), age (RETIRED) and perception of nearby nature (NPROX5KM). This information originates from the socioeconomic questions asked during the survey.

The final step in developing the model was to determine the number of classes needed. There is no universal method for this particular task and it is up to the analyst to decide on the most appropriate number of classes. As suggested by Scarpa and Thiene (2005), we examined goodness-of-fit statistics for a realistic number of potential classes (ranging from 2 to 6). The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were used for guidance and supported the option of a model based on two classes.[2]

[2] Note that in De Valck et al. (2014), the LCM calculated for the Drongengoed was done using three classes. An attempt to compare the three case studies using 3-class LCMs showed poorly interpretable results because of a large number of insignificant variables in the two other case studies. Therefore, we opted for a comparison based on 2-class LCMs. This has for sole impact to merge two of the three classes of the Drongengoed case study.

Table 3 Model variables

Attributes	Description
ASC	Dummy. 1 if respondent willing to move away from the status quo, 0 if they prefer the status quo
PRICE	Cost of the different scenarios: 10, 25, 50, 75, 125, 200 €/year, 0 €/year if status quo
BROAD	Dummy. 1 if switch to broadleaf habitat, 0 if switch to heathland
*S*100(30)	Dummy. 1 if coniferous forest decreased by 100 ha[a] (or 30 ha[b]), 0 if by 50 ha[a] (or 10 ha[b])
*S*200(60)	Dummy. 1 if coniferous forest decreased by 200 ha[a] (or 60 ha[b]), 0 if by 50 ha[a] (or 10 ha[b])
*BROAD*S100(30)*	Interaction term between *Broadleaf* and *Size100*(*30*)
*BROAD*S200*(*60*)	Interaction term between *Broadleaf* and *Size200*(*60*)
RARESP	Dummy. 1 if more species, including rare ones, 0 if more common species
NOACC	Dummy. 1 if poor accessibility to the area, 0 if good accessibility
Spatial discounting factors	
*GISNP*ASC*	Unweighted substitutive nature
*NPABD*ASC*	Substitutive nature weighted by average buffer distance
*NPSQABD*ASC*	Substitutive nature weighted by squared average buffer distance
*LNNPABD*ASC*	Substitutive nature weighted by the natural logarithm of average buffer distance
Socioeconomic variables	
HIGHINC	Dummy. 1 if income > €3500, 0 otherwise
RETIRED	Dummy. 1 if respondent's age ≥65 years, 0 otherwise
ECOFR	Dummy. 1 if member of an ecofriendly NGO (e.g. WWF), 0 otherwise
NPROX5KM	Dummy. 1 if individual feels sufficiently surrounded by nature in his 5 km vicinity, 0 otherwise (based on scores 5, 6 or 7 on a seven-point Likert scale ranging from 1 = 'strongly disagree" to 7 = 'strongly agree")

[a] Drongengoed case study
[b] Lovenhoek and Turnhouts Vennengebied case studies

3.3 Model Variables

All model variables are presented in Table 3 below. Our model contains eight dummy-coded attributes and an alternative specific constant (ASC). The ASC captures the change in utility affecting a respondent who chooses to move away from the status quo (current situation) and that cannot be explained by any of the covariates present in the model. When using dummy-coding, the ASC captures both the utility of moving away from the status quo and the utility of the base level of the dummy-coded attributes (Mark and Swait 2004).

PRICE is the only non dummy-coded attribute. It is the cost of each scenario, represented by a hypothetical annual tax that would be used specifically to finance the restoration project. PRICE has six different values: 10, 25, 50, 75, 125, 200 €. As keeping the site as it is now does not incur any cost, PRICE equals 0 € for the status quo.

BROAD describes the type of habitat conversion. BROAD takes the value 1 in case of a conversion of the current coniferous forest plantation into a broadleaf habitat, and value 0 in case of a conversion into heathland. The welfare change associated with a conversion of the current coniferous forest plantation to heathland is consequently conveyed into the ASC term. A conversion to broadleaved forest requires adding the BROAD term.

The S100(30) and S200(60) attributes refer to the size of the conversion effort. The conversion can be basically described as "small", "medium" or "large" but we made it specific to the different case studies. A "small" conversion refers to a 50 ha-switch at the Drongengoed site, and to a 10 ha-switch at the two other sites. This small conversion represents the base level conversion and, as such, is included within the ASC term. A "medium" conversion refers to S100 or a 100 ha-switch at the Drongengoed, and to S30, a 30 ha-switch at the two other sites. Finally, S200 symbolises a "large" or 200 ha-conversion at the Drongengoed and S60 a large or 60 ha-conversion at the two other sites.

BROAD*S100(30) and BROAD*S200(60) are two interaction terms that are added to the model to compare preferences for medium and large conversions towards heathland with medium and large conversions to broadleaf habitat.

RARESP is a variable symbolising the presence of rare species at the site. RARESP takes the value 1 if there are more species, including rare ones, than in the current situation at the site, and the value 0 if there are only more common species compared to the current situation. Here again, a low number of common species is the base level and is included in the ASC term.

NOACC represents a potential reduction in the number of footpaths and trails at the site, due to the conversion scenario. NOACC takes the value 1 in case of reduced accessibility to the area, and value 0 in case the current accessibility level is maintained.

3.4 Spatial Discounting

By analogy with time discounting, spatial discounting is a way to gradually discounting the utility gained by an individual consuming a good or service by the distance separating that individual from the good or service in question (Perrings and Hannon 2001). The mechanism by which utility decreases with distance is called the "distance-decay effect" (Smith 1975). The evident trade-off between distance (often representing a travel cost) and the utility gained by recreating somewhere, led to the introduction of spatial discounting in many recreational studies (Brainard et al. 2001; Concu 2007). However, spatial discounting has been a less common practice for the estimation of non-use values (Brown et al. 2002) and to control for the impact of distance of substitute sites on preferences for nature valuation. As stated earlier, our intention was to account for both use and non-use values in this research.

We decided to test several simple spatial discounting factors to observe whether systematic preference patterns were present in the three case studies. The objective of this paper was to investigate whether distance-to-substitutes had an effect on the valuation of specific sites rather than defining a sophisticated spatial model to explain this potential effect. We defined four different spatial discounting factors, namely: GISNP, NPABD, NPSQABD and LNNPABD (Fig. 4).

GISNP represents the "unweighted substitutive nature". In this specification, we solely look into the influence of nearby nature substitutes on preferences for nature restoration. So, GISNP is a respondent-specific index calculating the proportion of nature within ten GIS buffers drawn around that respondent's location of residence, which gives:

$$GISNP = \sum_{1}^{10} n_{rb}, \tag{5}$$

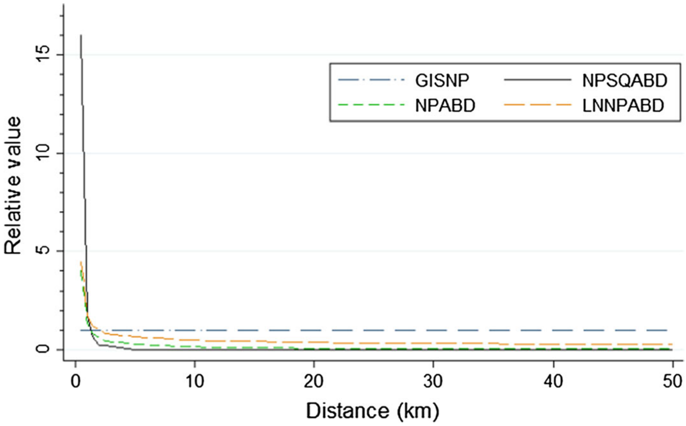

Fig. 4 Four spatial discounting factors and associated distance-decay effects

where n_{rb} represents the density of nature within each buffer zone b for a respondent r. Note that GISNP assumes that far substitutes are valued equally to close ones, which may be interpreted as a situation where the non-use value of nature overshadows its use value.

NPABD symbolises the "substitutive nature weighted by average buffer distance". NPABD weights the proportion of nature falling into each buffer by the average distance separating the respondent's location of residence from that buffer. This gives:

$$NPABD = \sum_{1}^{10} \frac{n_{rb}}{d_{rb}}, \tag{6}$$

where n_{rb} represents the density of nature within each buffer zone b for a respondent r and d_{rb} represents the average distance measured for each buffer zone b and for a respondent r. In this specification, the value of nearby nature substitutes is depreciated proportionally to distance. Closer substitutes (up to about 1.5 km) are given a higher value than with GISNP, while farther substitutes are given a lower value than with GISNP (Fig. 4).

NPSQABD is the "substitutive nature weighted by squared average buffer distance". NPSQABD is similar to NPABD, except that nature substitutes are weighted by the squared average buffer distance to simulate a more rapid discounting effect:

$$\text{NPSQABD} = \sum_{1}^{10} \frac{n_{rb}}{d_{rb}^2}, \tag{7}$$

where n_{rb} represents the density of nature within each buffer zone b for a respondent r and d_{rb}^2 represents the average distance measured for each buffer zone b and for a respondent r. NPSQABD assumes that substitutes located in respondents' direct neighbourhood are valued more highly than farther substitutes but value rapidly decreases with distance and therefore farther substitutes get almost no value at all (Fig. 4).

LNNPABD represents the "substitutive nature weighted by the natural logarithm of average buffer distance". We use a logarithmic transformation of the average buffer distance to test another potential specification of the distance-decay effect on nature substitutes:

$$LNNPABD = \sum_{1}^{10} \frac{n_{rb}}{\ln(1 + d_{rb})}, \tag{8}$$

where n_{rb} represents the density of nature within each buffer zone b for a respondent r and d_{rb} represents the average distance measured for each buffer zone b and for a respondent r. Similarly to NPABD, LNNPABD assumes a higher value for closer substitutes with a gradual distance-decay effect. However, the overall effect is smoothed out here: nature substitutes are still more valued than with GISNP up to 2 km, then they get a lower value but even far substitutes still get a much higher value than with NPSQABD.

We interacted each spatial discounting factor with the ASC term (Table 3). This must be interpreted as the effect of substitutes on respondents' preference to move away from the status quo, which is why we did not include the spatial discounting factor with the other class membership variables. We did not explore the effect that nature density had on preferences for the site in its current configuration. Instead we studied the effect of substitutes on respondents' decision to support forest conversion for nature restoration.

4 Results

We ran four LCM[3] analyses (each with a different spatial discounting factor) for the three case studies, so a total of 12 models whose results are presented in Tables 4, 5, 6 and 7 below. For clarity, we summarise the principal results and tendencies observed through the 12 models in Table 8. We did not pool the data into one dataset because the current nature composition, the foreseen restoration works and the surrounding environment differed across cases, making it difficult to combine certain model variables.

We observe that the squared average buffer distance (NPSQABD*ASC) is the only spatial discounting factor that shows significant results across the three case studies (Table 6). The type of discounting applied to the density of nature substitutes in this configuration caused respondents to associate a much higher value to closer nature sites than to farther substitutes (Fig. 3). Yet, the sign of this term varies through the different case studies so that it always has the opposite sign of the ASC term.

This antagonism can be explained by the combination of this spatially-discounted substitution effect with the preference heterogeneity associated with the diversity of respondent profiles. A positive ASC with a negative substitution term suggests that respondents are supportive of nature restoration, but that more substitutes in their vicinity leads to less support for nature restoration. A negative ASC with a positive substitution term suggests that respondents are not supportive of nature restoration, but if there are more substitutes in their vicinity (i.e. the greener their living area), they are then less 'unsupportive' (i.e. the less they dislike nature restoration). This confirms our hypothesis that preferences for nature restoration are influenced by spatial and individual characteristics at the same time.

For each case study, we observe that the use of different spatial discounting factors has little effect on the behaviour of the model variables. Apart from a few exceptions, variables show stable patterns through the four models. They remain either insignificant or with similar signs and levels of significance within each latent class. This suggests that the latent classes constructed for each model are robust in defining both of the two different respondent profiles.

For Drongengoed, respondents of the two classes are both supportive of the nature restoration scenarios. The ASC term is positive and significant in each of the four models. The socioeconomic variables that explain class membership illustrate that respondents' profiles differ, however, between the two classes. Compared to Class 2, Class 1 members tend to

[3] In a preliminary stage, we also ran the same set of analyses using mixed logit models. Latent class models, however, appeared systematically more powerful so we chose to report the latent class results exclusively.

Table 4 Comparing latent class models for three case studies—unweighted substitutive nature

	Drongengoed				Lovenhoek				Turnhouts Vennengebied			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Variables												
ASC	0.995**	0.461	2.764***	0.386	−3.102***	0.500	5.822***	0.687	2.300***	0.568	0.332	0.588
GISNP*ASC	−0.700	0.447	0.528	0.431	2.110***	0.252	−3.755***	0.388	0.146	0.300	−0.295	0.299
RARESP	0.048	0.300	0.493***	0.117	0.476***	0.121	0.082	0.144	0.662***	0.119	−0.028	0.301
NOACC	−0.830***	0.318	−0.430***	0.125	−0.031	0.143	−0.438***	0.162	−0.826***	0.132	−1.544***	0.337
BROAD	0.215	0.397	−0.483**	0.203	0.650***	0.204	0.892***	0.254	0.242	0.215	−0.070	0.412
S100(30)	0.073	0.414	−0.684***	0.172	−0.034	0.170	0.028	0.21	−0.317*	0.190	−0.956*	0.535
S200(60)	−1.070*	0.621	−0.294	0.198	−0.521**	0.238	−0.638**	0.281	−0.082	0.234	−0.238	0.447
BROAD*S100(30)	−0.484	0.649	1.121***	0.339	−0.039	0.298	−0.427	0.379	0.580*	0.330	1.165*	0.699
BROAD*200(60)	0.988	0.790	0.066	0.297	0.133	0.316	−0.345	0.386	0.126	0.308	−0.451	0.744
PRICE	−0.061***	0.009	−0.014***	0.001	−0.014***	0.002	−0.012***	0.002	−0.013***	0.002	−0.031***	0.005
Socioeconomic variables												
HIGHINC	0.208	0.399	–	–	0.311	0.356	–	–	0.750**	0.370	–	–
ECOFR	−1.424***	0.399	–	–	0.251	0.303	–	–	0.585	0.389	–	–
RETIRED	−1.175**	0.458	–	–	−0.291	0.361	–	–	0.084	0.365	–	–
NPROX5KM	0.707**	0.352	–	–	0.714**	0.337	–	–	−0.086	0.408	–	–
CONSTANT	−0.425	0.327	–	–	−0.528	0.334	–	–	0.000	0.382	–	—
Class share (%)	41.0		59.0		52.3		47.7		55.3		44.7	
N	3924				4770				3654			
LL (null)	−1437.0				−1,747.0				−1,338.1			
LL (model)	−915.6				−1,344.3				−859.8			
AIC	1881.3				2738.6				1769.7			
BIC	2038.2				2900.4				1924.8			
Pseudo-R^2	0.363				0.230				0.357			

* 10, ** 5, *** 1 % significance levels

Table 5 Comparing latent class models for 3 case studies—substitutive nature weighted by average buffer distance

	Drongengoed				Lovenhoek				Turnhouts Vennengebied			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
Variables												
ASC	0.672*	0.364	3.055***	0.249	−0.872	0.540	1.659***	0.217	2.388***	0.285	0.277	0.453
NPABD*ASC	−0.672**	0.337	0.346	0.298	−0.047	0.270	−0.179	0.148	0.105	0.187	−0.642	0.411
RARESP	0.052	0.296	0.494***	0.118	0.477	0.447	0.282***	0.092	0.653***	0.119	−0.059	0.315
NOACC	−0.820***	0.316	−0.428***	0.125	−0.791*	0.471	−0.121	0.107	−0.825***	0.132	−1.643***	0.371
BROAD	0.219	0.393	−0.486**	0.204	1.071**	0.462	0.680***	0.166	0.280	0.214	−0.171	0.434
S100(30)	0.096	0.412	−0.689***	0.173	−1.00	0.690	0.069	0.130	−0.305	0.189	−0.960*	0.546
S200(60)	−1.056*	0.617	−0.297	0.198	−1.067	0.770	−0.489***	0.181	−0.070	0.233	−0.260	0.454
BROAD*S100(30)	−0.494	0.644	1.124***	0.340	−0.746	1.002	−0.063	0.242	0.570*	0.327	1.138	0.725
BROAD*200(60)	0.946	0.789	0.071	0.298	−2.070	1.573	0.033	0.246	0.099	0.307	−0.323	0.768
PRICE	−0.061***	0.009	−0.014***	0.001	−0.038***	0.010	−0.012***	0.001	−0.013***	0.002	−0.031***	0.005
Socioeconomic variables												
HIGHINC	0.198	0.400	–	–	−0.758**	0.385	–	–	0.754**	0.373	–	–
ECOFR	−1.433***	0.399	–	–	−0.486	0.312	–	–	0.564	0.391	–	–
RETIRED	−1.190**	0.460	–	–	−0.050	0.354	–	–	0.058	0.365	–	–
NPROX5KM	0.720**	0.352	–	–	0.588*	0.348	–	–	−0.052	0.408	–	–
CONSTANT	−0.422	0.327	–	–	−0.888***	0.333	–	–	0.006	0.382	–	–
Class share (%)	41.2		58.8		33.7		66.3		55.7		44.3	
N	3924				4770				3654			
LL (null)	−1437.0				−1746.8				−1338.1			
LL (model)	−914.3				−1263.6				−858.2			
AIC	1878.7				2577.2				1766.4			
BIC	2035.5				2738.9				1921.5			
Pseudo-R^2	0.364				0.277				0.359			

* 10, ** 5, *** 1 % significance levels

Table 6 Comparing latent class models for three case studies—substitutive nature weighted by squared average buffer distance

	Drongengoed				Lovenhoek				Turnhouts Vennengebied			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
Variables												
ASC	0.614*	0.354	3.135***	0.242	−1.266***	0.444	1.541***	0.204	2.921***	0.288	−1.352***	0.308
NPSQABD*ASC	−0.266*	0.136	0.088	0.099	0.119**	0.059	0.080	0.099	−0.663***	0.114	0.623***	0.062
RARESP	0.037	0.290	0.501***	0.119	0.675*	0.364	0.294***	0.093	0.591***	0.129	0.531***	0.204
NOACC	−0.796**	0.309	−0.427***	0.126	−0.280	0.374	−0.118	0.108	−0.805***	0.143	−1.219***	0.224
BROAD	0.204	0.388	−0.495**	0.205	1.082**	0.420	0.647***	0.168	0.160	0.230	0.167	0.317
S100(30)	0.100	0.406	−0.697***	0.174	−1.44**	0.688	0.091	0.131	−0.350*	0.208	−0.450	0.337
S200(60)	−1.016*	0.600	−0.299	0.199	−1.185	0.766	−0.498***	0.183	0.058	0.255	−0.430	0.381
BROAD*S100(30)	−0.467	0.632	1.137***	0.342	0.492	0.828	−0.119	0.246	0.673*	0.357	0.699	0.495
BROAD*200(60)	0.891	0.775	0.076	0.299	−2.119	1.450	0.060	0.248	0.090	0.330	−0.020	0.524
PRICE	−0.060***	0.008	−0.014***	0.001	−0.038***	0.008	−0.012***	0.001	−0.013***	0.002	−0.020***	0.003
Socioeconomic variables												
HIGHINC	0.186	0.401	–	–	−0.769**	0.388	–	–	0.236	0.352	–	–
ECOFR	−1.427***	0.398	–	–	−0.580*	0.312	–	–	0.350	0.374	–	–
RETIRED	−1.206***	0.459	–	–	−0.125	0.353	–	–	0.395	0.366	–	–
NPROX5KM	0.716**	0.352	–	–	0.701**	0.349	–	–	−0.354	0.405	–	–
CONSTANT	−0.401	0.327	–	–	−0.865***	0.333	–	–	0.053	0.380	–	–
Class share (%)	41.5		58.5		34.9		65.1		48.9		51.1	
N	3924				4770				3654			
LL (null)	−1437.0				−1746.8				−1338.1			
LL (model)	−914.4				−1264.3				−891.4			
AIC	1878.8				2578.6				1832.8			
BIC	2035.6				2740.4				1987.9			
Pseudo-R^2	0.364				0.276				0.334			

* 10, ** 5, *** 1 % significance levels

Table 7 Comparing latent class models for three case studies—substitutive nature weighted by the natural logarithm of average buffer distance

	Drongengoed				Lovenhoek				Turnhouts Vennengebied			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
Variables												
ASC	0.741**	0.373	3.003***	0.264	−0.898	0.579	1.704***	0.234	2.366***	0.326	0.356	0.495
LNNPABD*ASC	−0.490*	0.251	0.279	0.231	−0.012	0.206	−0.134	0.107	0.093	0.157	−0.412	0.277
RARESP	0.053	0.297	0.493***	0.118	0.482	0.448	0.282***	0.092	0.656***	0.120	−0.047	0.312
NOACC	−0.825***	0.317	−0.429***	0.125	−0.786	0.478	−0.121	0.107	−0.825***	0.132	−1.607***	0.374
BROAD	0.221	0.394	−0.484**	0.204	1.071**	0.462	0.679***	0.166	0.268	0.216	−0.137	0.432
S100(30)	0.093	0.413	−0.687***	0.173	−1.014	0.693	0.069	0.130	−0.308	0.189	−0.959*	0.543
S200(60)	−1.062*	0.619	−0.296	0.198	−1.067	0.773	−0.489***	0.181	−0.074	0.234	−0.255	0.452
BROAD*S100(30)	−0.498	0.647	1.122***	0.340	−0.721	1.011	−0.064	0.242	0.571*	0.328	1.147	0.719
BROAD*200(60)	0.960	0.790	0.069	0.297	−2.100	1.575	0.032	0.246	0.107	0.308	−0.368	0.767
PRICE	−0.061***	0.009	−0.014***	0.001	−0.038***	0.010	−0.012***	0.001	−0.013***	0.002	−0.031***	0.005
Socioeconomic variables												
HIGHINC	0.201	0.400	–	–	−0.758**	0.385	–	–	0.753**	0.373	–	–
ECOFR	−1.432***	0.399	–	–	−0.485	0.312	–	–	0.571	0.390	–	–
RETIRED	−1.186**	0.459	–	–	−0.049	0.354	–	–	0.066	0.366	–	–
NPROX5KM	0.718**	0.352	–	–	0.589*	0.349	–	–	−0.063	0.409	–	–
CONSTANT	−0.424	0.327	–	–	−0.891***	0.333	–	–	0.004	0.382	–	–
Class share (%)	41.1		58.9		33.6		66.4		55.5		44.5	
N	3924				4770				3654			
LL (null)	−1437.0				−1746.8				−1338.1			
LL (model)	−914.5				−1263.5				−858.5			
AIC	1879.1				2577.0				1767.0			
BIC	2035.9				2738.8				1922.1			
Pseudo-R^2	0.364				0.277				0.358			

* 10, ** 5, *** 1 % significance levels

Table 8 Summary of the principal results and tendencies

	Drongengoed		Lovenhoek		Turnhouts Vennengebied	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Spatial discounting factors						
GISNP	Ø	Ø	+	–	Ø	Ø
NPABD	–	Ø	Ø	Ø	Ø	Ø
NPSQABD	–	Ø	+	Ø	–	+
LNNPABD	–	Ø	Ø	Ø	Ø	Ø
Model variables						
ASC	+	+	–; Ø	+	+	Ø; –
Price	–	–	–	–	–	–
Other attributes	Negatively affected by reduced accessibility	Positively affected by increased biodiversity Negatively affected by reduced accessibility Conversion to heathland preferred over broadleaved forest Negatively affected by medium conversion size	Conversion to broadleaved forest preferred over heathland	Conversion to broadleaved forest preferred over heathland Negatively affected by large conversion size	Positively affected by increased biodiversity Negatively affected by reduced accessibility	Negatively affected by reduced accessibility

Table 8 continued

	Drongengoed		Lovenhoek		Turnhouts Vennengebied	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Socioeconomic variables	Younger	Older	Lower income	Higher income	Ø	Ø
	Not eco-friendly	Eco-friendly	Satisfied with nearby nature	Unsatisfied with nearby nature		
	Satisfied with nearby nature	Unsatisfied with nearby nature				
		"Nature restoration supporters"				
Class description	"Supporters affected by substitutes"	"Nature restoration supporters"	"Income-constrained"	"Supportive non-users"	"Nature restoration supporters"	"Indifferent direct users"

+: significant coefficient with positive sign; −: significant coefficient with negative sign; Ø: not significant represent the younger respondents who perceive the natural environment in their neighbourhood as very important. Howbeit they seem less likely to donate to environmental-friendly NGOs for restoring another nature site. For Class 2, the ASC is also positive and significant and generally more than three times higher than for Class 1. Class 2 respondents are "nature restoration supporters": they tend to actively support nature restoration, value an increase in species richness at the site, and are about four times less negatively impacted by the cost of the proposed nature restoration scenarios.

Concerning the substitution effect, it clearly needs to be interpreted for each class of respondent separately. In Class 1, the substitution term is significant for the three models that actually discount nature substitutes by distance. This suggests that the hypothesis that respondents equally value far and nearby substitutes does not hold when respondents clearly indicate that they have enough nature in their neighbourhood. In Class 2, the substitution term is never significant, suggesting that the presence of nature around respondents' home may not be influential on their preferences for nature restoration. So, about 41 % of the Drongengoed respondents (i.e. Class 1) are detrimentally affected in their preferences for nature restoration by the presence of substitutes while the rest of the respondents are apparently not affected.

For Lovenhoek, the opinion regarding the conversion scenario diverges between the two classes of respondents. While the ASC term shows stable, positive and significant results through the four models in Class 2, it gets negative or insignificant in Class 1. In Class 1, the substitution term is either negative and significant (GISNP*ASC and NPASQABD*ASC) or insignificant. Class 1 respondents dislike the proposed nature restoration scenarios, or at least demonstrate a dispreference for moving away from the status quo. This is confirmed by the NPROX5KM class membership variable which remains positive and significant for Class 1 across all models. Class 1 respondents are satisfied with the amount of nature in their neighbourhood and want to keep it as it is. For three of the four models, Class 1 respondents also appear about three times more affected by the cost of the nature restoration scenarios. This combined with the negative and significant HIGHINC variable for the same models, we can conclude that Class 1 respondents tend to earn a lower income, which may significantly impact their willingness to pay for the proposed scenarios.

Class 2 respondents, on the contrary, support nature restoration. The substitution term is negative and significant, but only in the first model. In opposition to the Drongengoed case study, this could mean that distance does not affect preferences for nature substitutes in that group. In turn, this suggests that the non-use value of nature outweighs its use value for Class 2 respondents. This is corroborated by the accessibility of the site under valuation captured by the NOACC variable. Except in the first model, NOACC is always insignificant in Class 2. NOACC is, however, after PRICE the most stable variable through all case studies, models and classes. Whatever the class, Drongengoed and Turnhouts Vennengebied respondents all value negatively a reduction of accessibility to the site.

Another interesting observation about Lovenhoek compared to the other case studies is that the presence of broadleaved trees seems particularly influential as both classes favour a conversion towards a broadleaved forest rather than towards heathland (BROAD is positive and significant in both classes and through the four models). Since the Campine region (where Lovenhoek is located) is already extensively made of open landscapes (heathlands, moors, and wetlands), this seems to indicate a preference for landscape diversity.

Regarding Turnhouts Vennengebied, the spatially-discounted substitution term is only significant in the third model (NPASQABD*ASC), suggesting that respondents may be highly influenced by the density of nature in their direct neighbourhood. Compared to the two other case studies, we observe that one of the two classes of respondents (Class 2) is indifferent or unsupportive of the restoration scenarios proposed in the DCE. Class 1 respondents are, on the contrary, systematically supportive of the nature restoration scenarios. Class 1 respondents tend to have a higher income, which may explain their supportive behaviour. In all four models, Class 2 respondents are more detrimentally affected by a possible reduction in site accessibility and about three times more affected by the cost of the restoration scenarios. Those respondents are more likely to be actual recreationists who pay little attention to the type of natural environment they cross.

5 Discussion

In this research, we have investigated an alternative, respondent-centric approach to control for the spatial context, and for substitutes in particular, in SP studies. This in order to improve the transferability of value functions across different sites. Our methodology has demonstrated that GIS data could provide insightful information about the spatial context of natural sites, even when considering a large spectrum of natural habitats.

The nature density approach showed a significant influence of substitute sites. We have also proven the influence of the distance-to-substitutes. The significance of NPSQABD, the spatial discounting factor giving the largest weight to near substitutes relative to distant ones, indicated that respondents were heavily affected by the presence of nature substitutes in their vicinity but that the substitution effect rapidly faded away with distance, suggesting a spatial hierarchy among substitutes.

These results, however, must be interpreted relative to the specific context of this experiment. From a methodological point of view, we opted for an LCM, which only captures part of the preference heterogeneity. Recent work from León et al. (2015) proved that other model specifications, such as the Mixed of Normals Mixed Logit (MN-MNL), an LCM that accounts for class-specific heterogeneity, were superior.

Although we applied the same methodology through the three case studies, each of the three study sites still comes with its own specificity (e.g. size, dominant habitat, geographic context). In particular, the density of nature substitutes differs among case studies. Theoretically, selecting fully comparable sites (i.e. surrounded with an equal amount and similar characteristics of nature) is desirable to ensure statistical consistency but is hardly achievable in practice.

Also, the type of GIS layers used to represent "nature substitutes" may be questioned. Any other assumption regarding eligible nature substitutes is likely to lead to different results. This, however, points to a much larger question, that being the assessment of what respondents actually consider as substitutes for nature sites. Solving this particular question was, however, out of the scope of this study.

Another possible GIS limitation relates to the geometrical extent of the natural sites valued in this research. For instance, the Turnhouts Vennengebied is a scattered natural site. We explicitly asked respondents to value a specific part of it but they may have valued the entire natural region when trading off the different choice alternatives. Brown and Duffield (1995) refer to this as the "part-whole bias". The cognitive gap between reality and people's projection of reality is potentially responsible for large biases. Further investigation is therefore needed to better understand this phenomenon.

Our results suggest that the spatial context is highly driven by individual-specific characteristics. The different groups of respondents identified by the LCM showed that accounting for individual characteristics was essential to better understand preferences for nature restoration. We observed supporters and non-supporters of the nature restoration scenarios and even indifferent respondents. Some supporters of nature restoration were negatively affected by the presence of near substitute sites. On the contrary, other supporters were not affected by the presence of substitute sites because for these individuals the non-use value of nature outweighed its use value. Non-supporters were always positively affected by the presence of near substitute sites, demonstrating the benefit of a green environment even for individuals indifferent about nature restoration.

Finally, the importance of socioeconomic characteristics, such as income, for certain respondents was made obvious with regard to shaping their preference for nature restoration. This sends another important message related to the correct application of value transfer: finding comparable nature sites is not sufficient. One also needs to understand how individuals differ across the study site and the policy site as these differences will also influence preferences.

6 Conclusion

In this paper, we explored the influence of the spatial context in environmental valuation. We used a combination of GIS and econometric techniques to investigate the effect of distance to nature substitutes on preferences for nature restoration. Our approach tackled the substitution question by using a respondent-centric approach rather than a site-centric approach and thus offered a complementary alternative to most prior studies. We also examined nature substitutes in a non-discriminatory way, by using nature density instead of a selection of predefined substitute sites. Use and non-use values were consequently taken into account. To test different configurations of the decreasing influence of distance-to-substitutes, we created four spatially-discounted substitution factors. We repeated the experiment at three different sites in Flanders to test the robustness of the results.

From this research, we are able to draw three main conclusions. First, the availability of substitutes affects individuals' capacity to value nature in their vicinity, but near substitutes are much more influential than distant ones. The marginal impact of 'distance-to-substitutes' falls as distance increases. Second, using a respondent-centric approach does help solve the substitution question. Respondents show individual-specific perceptions of their surrounding environment and different sensitivities to substitutes originating in their personal background. Future benefit transfer excercises should therefore control for the individual-specific dimension of the spatial context with the inclusion of accurate information about respondent's profile and attitude towards nature. Third, GIS data can improve the transferability of value functions across sites by providing accurate spatially-explicit information about a particular site. Once compared with the local characteristics of another site, it can correct for contextual differences effectively. As such, our method can improve the process of aggregating benefits at a higher scale by accounting more adequately for the effect of substitute sites. Biases due to the wrong definition of the jurisdiction upon which to aggregate benefits are therefore less likely to occur (Bateman et al. 2006).

The role and the essence of substitutes remain, however, not yet fully understood, which explains why we did not control for their presence in the design of the DCE. Understanding the role played by substitutes is even more important if one wants to add distance-to-substitutes as a DCE attribute. Further work is needed before a respondent-specific, spatially-explicit substitution term that fully controls for the presence of substitutes can be properly added to the value function. Recent research on heterogeneous distance decay functions could, for instance, open new possibilities to control for the spatial context and reduce biases attached to more classic value functions (León et al. 2015).

Also, one should examine the eligibility of candidate substitutes and what contributes to their relative attractiveness compared to other substitutes. This study used a supply of nature substitutes based on the assumption that features from two GIS layers could represent substitutes adequately. However, the discrepancy between the physical description of geographic entities and individuals' cognitive perception about these entities, makes a pure GIS-based approach insufficient. Ideally, individuals' knowledge and perception of their environment should also be exploited to inform what can actually be considered as eligible nature substitutes.

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References

Adamowicz W, Louviere J, Williams M (1994) Combining revealed and stated preference methods for valuing environmental amenities. J Environ Econ Manag 26(3):271–292

Adamowicz V, Naidoo R, Nelson E, Polasky S, Zhang J (2011) Nature-based tourism and recreation. In: Kareiva P, Tallis H, Ricketts TH, Daily GC, Polasky S (eds) Natural capital: theory and practice of mapping ecosystem services. Oxford University Press, Oxford

Backhaus N (2011) Landscapes, spatial totalities or special regions? Proc Soc Behav Sci 14:193–202

Bateman IJ, Brouwer R, Ferrini S, Schaafsma M, Barton DN, Dubgaard A, Hasler B, Hime S, Liekens I, Navrud S, De Nocker L, Ščeponavičiūtė R, Semėnienė D (2011) Making benefit transfers work: deriving and testing principles for value transfers for similar and dissimilar sites using a case study of the non-market benefits of water quality improvements across Europe. Environ Resour Econ 50(3):365–387

Bateman IJ, Day BH, Georgiou S, Lake I (2006) The aggregation of environmental benefit values: welfare measures, distance decay and total WTP. Ecol Econ 60(2):450–460

Bateman IJ, Jones AP, Lovett AA, Lake IR, Day B (2002) Applying geographical information systems (GIS) to environmental and resource economics. Environ Resour Econ 22(1):219–269

Bliem M, Getzner M, Rodiga-Laßnig P (2012) Temporal stability of individual preferences for river restoration in Austria using a choice experiment. J Environ Manag 103:65–73

Borgers A, Timmermans H (1987) Choice model specification, substitution and spatial structure effects: a simulation experiment. Reg Sci Urban Econ 17(1):29–47

Boxall P, Adamowicz W (2002) Understanding heterogeneous preferences in random utility models: a latent class approach. Environ Resour Econ 23:421–446

Brainard J, Bateman I, Lovett A (2001) Modelling demand for recreation in English woodlands. Forestry 74(5):423–438

Broekx S, Liekens I, Peelaerts W, De Nocker L, Landuyt D, Staes J, Meire P, Schaafsma M, Van Reeth W, Van den Kerckhove O, Cerulus T (2013) A web application to support the quantification and valuation of ecosystem services. Environ Impact Assess Rev 40:65–74

Brouwer R (2000) Environmental value transfer: state of the art and future prospects. Ecol Econ 32:137–152

Brown TC, Duffield JW (1995) Testing part-whole valuation effects in contingent valuation of instream flow protection. Water Resour Res 31(9):2341–2351

Brown G, Reed P, Harris CC (2002) Testing a place-based theory for environmental evaluation: an Alaska case study. Appl Geogr 22(1):49–77

Burt O, Brewer D (1971) Evaluation of net social benefits from outdoor recreation. Econometrica 39:812–827

Cadwallader M (1981) Towards a cognitive gravity model: the case of consumer spatial behavior. Reg Stud 15(4):275–284

Carson RT, Louviere JJ, Anderson DA, Arabie P, Bunch DS, Hensher DA, Johnson RM, Kuhfeld WF, Steinberg D, Swait J, Timmermans H, Wiley JB (1994) Experimental analysis of choice. Mark Lett 5:351–368

Cesario FJ, Knetsch JL (1973) A recreation site demand and benefits estimation model. Reg Stud 10:97–104

Colombo S, Calatrava-Requena J, Hanley N (2007) Testing choice experiment for benefit transfer with preference heterogeneity. Am J Agric Econ 89(1):135–151

Concu GB (2005) Are non-use values distance-independent? Identifying the market area using a choice modelling experiment. Murray Darling Program Working Paper M05_6. University of Queensland, Brisbane
Concu GB (2007) Investigating distance effects on environmental values: a choice modelling approach. Aust J Agric Resour Econ 51(2):175–194
De Valck J, Vlaeminck P, Broekx S, Liekens I, Aertsens J, Chen W, Vranken L (2014) Benefits of clearing existing forests to restore nature? evidence from a discrete choice experiment in Flanders,Belgium. Landsc Urban Plan 125:65–75
Deutskens E, De Ruyter K, Wetzels M, Oosterveld P (2004) Response rate and response quality of internet-based surveys: an experimental study. Mark Lett 15(1):21–36
European Environment Agency—EEA (2013a) Nationally designated areas (CDDA). http://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-7
European Environment Agency—EEA (2013b) Corine land cover types—2006. http://www.eea.europa.eu/data-and-maps/figures/corine-land-cover-types-2006
Fotheringham AS (1983) A new set of spatial-interaction models: the theory of competing destinations. Environ Plan A 15:15–36
Fotheringham AS (1986) Modelling hierarchical destination choice. Environ Plan A 18:401–418
Hanley N, Schlapfer F, Spurgeon J (2003) Aggregating the benefits of environmental improvements: distance-decay functions for use and non-use values. J Environ Manag 68(3):297–304
Herzog TR, Herbert EJ, Kaplan R, Crooks CL (2000) Cultural and developmental comparisons of landscape perceptions and preferences. Environ Behav 32(3):323–346
Hoehn JP, Loomis JB (1993) Substitution effects in the valuation of multiple environmental-programs. J Environ Econ Manag 25(1):56–75
Hoyos D (2010) The state of the art of environmental valuation with discrete choice experiments. Ecol Econ 69:1595–1603
Hunt LM, Boots B, Kanaroglou PS (2004) Spatial choice modelling: new opportunities to incorporate space into substitution patterns. Prog Hum Geogr 28(6):746–766
Hynes S, Hanley N, Scarpa R (2008) Effects on welfare measures of alternative means of accounting for preference heterogeneity in recreational demand models. Am J Agric Econ 90(4):1011–1027
Jones A, Wright J, Bateman I, Schaafsma M (2010) Estimating arrival numbers for informal recreation: a geographical approach and case study of British Woodlands. Sustainability 2:684–701
Kaplan R, Kaplan S (1989) The experience of nature: a psychological perspective. Cambridge University Press, Cambridge
Langeheine R, Rost J (1988) Latent trait and latent class models. Plenum Press, New York
León CJ, Araña JE, de León J, González MM (2015) The economic benefits of reducing the environmental effects of landfills: heterogeneous distance decay effects. Environ Resour Econ. doi:10.1007/s10640-014-9874-9
León CJ, Araña JE, Hanemann WM, Riera P (2014) Heterogeneity and emotions in the valuation of non-use damages caused by oil spills. Ecol Econ 97:129–139
León CJ, Araña JE (2014b) The economic valuation of climate change policies in tourism: impact of joint valuation, emotions, and information. J Travel Res. doi:10.1177/0047287514559034
Loomis JB (2000) Vertically summing public good demand curves: an empirical comparison of economic versus political jurisdictions. Land Econ 76(2):312–321
Louviere J, Hensher D (1982) Design and analysis of simulated choice or allocation experiments in travel choice modelling.Transp Res Rec 890:11–17
Louviere J, Hensher D, Swait J (2000) Stated choice methods, analysis and application. Cambridge University Press, Cambridge
Lovett AA, Brainard JS, Bateman IJ (1997) Improving benefit transfer demand functions: a GIS approach. J Environ Manag 51(4):373–389
Luce RD (1959) Individual choice behavior: a theoretical analysis. Wiley, New York
McFadden D (1974) Conditional logit analysis of qualitative choice models. Front Econom 1(2):105–142
Mark TL, Swait J (2004) Using stated preference and revealed preference modelling to evaluate prescribing decisions. Health Econ 13(6):563–573
Matsuoka RH, Kaplan R (2008) People needs in the urban landscape: analysis of landscape and urban planning contributions. Landsc Urban Plan 84:7–19
Neuvonen M, Sievänen T, Tönnes S, Koskela T (2007) Access to green areas and the frequency of visits—a case study in Helsinki. Urban For Urban Green 6(4):235–247
Pate J, Loomis J (1997) The effect of distance on willingness to pay values: a case study of wetlands and salmon in California. Ecol Econ 20(3):199–207

Pearce D, Özdemiroglu E (2002) Economic valuation withstated preference techniques: Summary guide. Department for Transport, Local Government and the Regions, London. http://www.communities.gov.uk/documents/corporate/pdf/146871.pdf

Pellegrini PA, Fotheringham AS (2002) Modelling spatial choice: a review and synthesis in a migration context. Prog Hum Geogr 26(4):487–510

Perrings C, Hannon B (2001) An introduction to spatial discounting. J Reg Sci 41(1):23–38

Peterson GL, Stynes DJ, Rosenthal DH, Dwyer JF (1984) Substitution in recreation choice behavior. In: Recreation choice behavior symposium, Missoula, MT, 22–23 March 1984

Scarpa R, Thiene M (2005) Destination choice models for rock-climbing in the North-Eastern Alps: a latent-class approach based on intensity of participation. Land Econ 81:426–444

Schaafsma M, Brouwer R (2013) Testing geographical framing and substitution effects in spatial choice experiments. J Choice Model 8:32–48

Schaafsma M, Brouwer R, Gilbert A, van den Bergh J, Wagtendonk A (2013) Estimation of distance-decay functions to account for substitution and spatial heterogeneity in stated preference research. Land Econ 89(3):514–537

Sevenant M, Antrop M (2009) Geography cognitive attributes and aesthetic preferences in assessment and differentiation of landscapes. J Environ Manag 90:2889–2899

Shrestha RK, Stein TV, Clark J (2007) Valuing nature-based recreation in public natural areas of the Apalachicola River region, Florida. J Environ Manag 85(4):977–985

Smith TE (1975) An axiomatic theory of spatial discounting behaviour. Pap Reg Sci 35(1):31–43

Soini K (2001) Exploring human dimensions of multifunctional landscapes through mapping and map-making. Landsc Urban Plan 57:225–239

Termansen M, Zandersen M, McClean CJ (2008) Spatial substitution patterns in forest recreation. Reg Sci Urban Econ 38:81–97

Termansen M, McClean CJ, Jensen FS (2013) Modelling and mapping spatial heterogeneity in forest recreation services. Ecol Econ 92:48–57

Van den Berg AE, Vlek CAJ, Coeterier JF (1998) Group differences in the aesthetic evaluation of nature development plans: a multilevel approach. J Environ Psychol 18:141–157