Outdoor recreation in various hypothetical landscapes: Which site characteristics really matter?

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Abstract

In this paper, we introduce a methodology to better understand the role played by different site characteristics in influencing the choice of outdoor recreation destinations. Contrary to prior studies, we do not restrict the scope of this analysis to specific natural sites but intend to encompass various landscapes. Our experiment looks into a large diversity of landscapes (e.g. rural and natural) described using photomontages. We use a discrete choice experiment (DCE) that propose respondents to choose among hypothetical destinations described in terms of eight site characteristics. We study the trade-offs made by different profiles of respondents among those site characteristics, which lead to different destination choices. An important innovative aspect of this research is that the DCE attributes are spatially-explicit so that we are also able to represent the observed recreational patterns in the form of maps, using Geographic Information Systems (GIS). We conclude the paper by pointing to the implications of this research for land management policy-making.

Keywords: Bayesian Belief Network; Discrete choice experiment; Ecosystem services ; GIS; Hypothetical travel cost; Outdoor recreation

JEL Classification: Q20, Q26, Q51, Q57

1 Introduction

Outdoor recreation is becoming increasingly popular in peri-urban areas. For many people, the proximity to nature contributes to improving their health and well-being (de Vries et al., 2003; Matsuoka & Kaplan, 2008). Nature offers the opportunity to escape the stressful urban environment for a while, enjoy some free time and relax both physically and mentally. By ‘outdoor recreation’, we refer here to a leisure activity performed relatively near one’s home and implying a maximum of a one-day trip with no overnight stay at the destination site, contrary to ‘tourism’ that does imply an overnight stay (Neuvonen et al., 2007). We are therefore primarily interested in short-term exposure to nearby green spaces.

In the context of ecosystem services valuation, being able to value the benefits generated by *cultural* ecosystem services (Daniel et al., 2012; MEA, 2005), and outdoor recreation in particular, is important to support sustainable land management policy-making. Although outdoor recreation has largely been covered in the literature, prior valuation studies have generally specialised on specific nature areas, among which: forests (Christie et al., 2007; Jones et al., 2010), mountains (Hanley et al., 2002; Thiene & Scarpa, 2009), lakes (Parsons & Kealy, 1992; Schaafsma & Brouwer, 2013), rivers (Morey et al., 2002), coastal areas (Ghermandi & Nunes, 2013; Hynes et al., 2013) and national parks (White & Lovett, 1999). Little attention has been paid on the contrary to the eligibility of production landscapes, such as agricultural landscapes (Fleischer & Tsur, 2000) for recreation. Studies that propose to value both natural and production landscapes as recreational destinations remain scarce (van Berkel & Verburg, 2014).

Moreover, despite a large body of literature about destination attractiveness (Lee et al., 2010), the decision-making process involved in the choice of the recreational destination is still insufficiently treated in the context of nature valuation. The trade-offs made by recreationists among certain site characteristics when choosing to go to one site relative to another substitute site are not fully understood. In particular, the trade-off between distance (or travel cost), traditionally associated with a negative utility, and the characteristics of the destination site that determine its attractiveness. As recreation implies short trips (max. 1 day, no overnight stay), outdoor recreationists are likely to be highly constrained by their spatial environment. Because of the travel distance constraint, *a priori* less attractive sites may be deemed as more attractive by distance-averse recreationists. In peri-urban environments, agricultural landscapes and, more generally, sites with low naturalness may then become eligible substitutes to natural landscapes.

Valuation studies that account for preference heterogeneity by looking into different recreational activity groups are not frequent. One example is the study of Christie et al. (2007). They find that “specialist users” (e.g. rock climbers) attain a greater consumer surplus per trip from the provision of activity specific facilities compared to “non-specialist users” (e.g. dog walkers). However, specialist users traditionally represent a low number of users, so policy-makers should be aware of the trade-offs between maximizing benefits to individuals and maximizing the overall benefits that can be generated at one site. In addition, policy-makers need to better understand recreational behaviour to optimise resource allocation. In Flanders (Belgium), and probably in other regions, there is a lack of tools to predict outdoor recreation with regard to certain site characteristics.

In this paper, we present a methodology to investigate preferences for different site characteristics and to predict outdoor recreational behaviour in various landscapes in the Province of Antwerp (Belgium). Our research objectives are:

i. to bring evidence that production landscapes (e.g. arable lands) are also considered as recreational destinations by many recreationists and consequently hold a recreational value that make them substitutes for nature areas;
ii. to better understand the trade-offs made by recreationists among site characteristics when choosing to go to one site relative to a substitute site, especially the trade-off between the distance separating them from the site (travel cost) and the site characteristics that contribute to the attractiveness of the site.
iii. to map the recreational sites that generate the highest preferences for different profiles of recreationists.

We describe a technique called “hypothetical travel cost”. That method relies on a discrete choice experiment (Hoyos, 2010) to estimate preferences for different hypothetical recreation sites. One particularity is that we use distance (travel cost) rather than a direct cost (e.g. tax) as the payment vehicle; meaning that respondents have to trade off the distance they would be willing to travel to reach the hypothetical site with the other characteristics of that site. Another innovative aspect of this research is that all attributes (or site characteristics) used in the discrete choice experiment are spatially-explicit. That is, aside from estimating preferences for different sites characteristics, we also map those preferences for different groups of recreationists. We conclude the paper by drawing some useful implications of this research for land management policy-making.

2 Methods

2.1 Hypothetical travel cost method

As stated earlier, the hypothetical travel cost method is a variant of the discrete choice experiment (hereafter DCE). The DCE is a stated preference non-market valuation technique that was introduced by Louviere and Hensher (1982) and whose theoretical basis is grounded in Lancaster's (1966) consumer theory. It is used to elicit preferences for certain scenarios described in terms of their component attributes (Louviere et al., 2000). In ecosystem services valuation, the DCE is usually embedded in a survey inviting respondents to state their preferences for hypothetical environment-related policy scenarios. During the survey, respondents are presented with a series of choice tasks requiring them to choose between several alternatives described by attributes. Different combinations of attributes are shown on each choice situation. This allows the computation of preference parameters of an indirect utility function (Carson & Louviere, 2011). That capacity to understand the relative preference for certain attributes makes DCEs superior to other methods, such as the contingent valuation.

DCEs rely on the random utility theory (McFadden, 1974). In this context, the utility function of a consumer *i* (U_i) comprises a deterministic component (*V*), typically represented as a vector of attributes (X_{ijt}) associated with the *j* alternatives of a choice situation *t*, and random component (ε_{ijt}), which represents all other unobservable components influencing an individual's choice:

$$U_i = V\left(X_{ijt}\right) + \varepsilon_{ijt} = \beta X_{ijt} + \varepsilon_{ijt} \tag{1}$$

In such choice situation *t*, the probability that an individual *i* chooses an alternative *k* over any other alternative *l* means that the utility attached to alternative *k* is superior to that associated with any other alternative *l*, which translates into (Hanley et al., 2003):

$$P[(U_{ik} > U_{il}) \forall l \neq k] = [(V_{ik} - V_{il}) > (\varepsilon_{ik} - \varepsilon_{il})] \tag{2}$$

As the error term ε_{ijt} is typically assumed to be independently and identically distributed according to an Extreme Value Gumbel distribution (Louviere et al., 2000), the probability of an alternative k being chosen can then be expressed using the conditional logit model:

$$P[(U_{ik} > U_{il})\forall l \neq k] = \frac{\exp{(U_{ik})}}{\sum_j \exp{(U_{ij})}} \qquad (3)$$

The unit of analysis that we use for the rest of our analysis is the compensating variation (CV) in welfare that can be obtained using the following formula:

$$CV = -\frac{1}{\beta_C}(V_0 - V_1), \qquad (4)$$

where V_0 is the determined utility level corresponding to the reference state and V_1 is the utility level corresponding to the alternative state. The coefficient β_C is the coefficient of the cost attribute (here, distance).

2.1.1 Experimental design

We initiated the design of this whole experiment in September 2013, in the context of a two-fold research. The first survey took place in February-March 2014 and the second part – the one related to this paper – took place in December 2014. Because of the combination of innovative elements present in this research, we went through a long testing process before the launching the survey. We organised two focus group discussions with Flemish citizens to identify the key elements to include in the questionnaire.

The choice experiment was designed so that respondents would face six times a choice situation (or *choice set*) involving two unlabeled options (hypothetical recreational sites) and an opt-out option (see Fig. 1). Each time respondents must decide to which site they would allocate their next five recreational trips or pick the option “I would not go to any of these sites”. A subsequent question was then asked to know the reason why they would not recreate to any of the proposed sites. The following reasons were proposed to the respondents:

- None of these two sites was attractive to me
- I don’t believe that sites with such characteristics could exist in Flanders
- Both sites were too far for me
- Other reason (please specify)
- No specific reason

Prior to the DCE exercise, a brief description of the choice situation was provided to ease the intellectual task of choosing among hypothetical scenarios. All choice attributes were explained by providing respondents with a summarised explanation in the form of a short description.

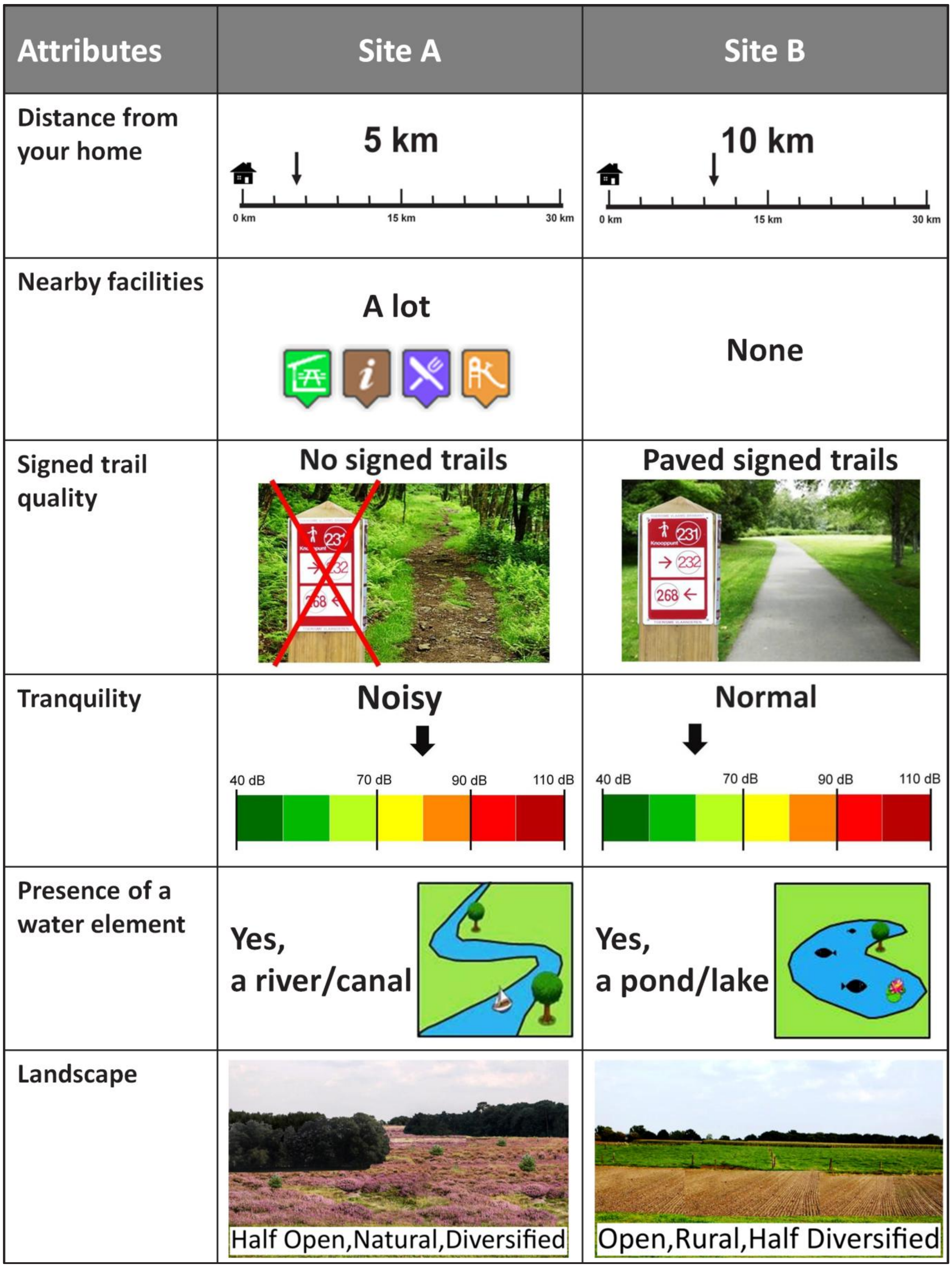

Fig. 1. Example of choice set.

The choice experiment contained seven attributes varying across three levels and a cost attribute (distance) varying across nine values (Table 1). The full factorial experimental design produced 19683 (=3^9) combinations, which was impossible to reach in practice. We decided to use a D-efficient main effects fractional factorial design (Louviere et al., 2000) consisting of 36 choice sets and generated using the Ngene software package.

Table 1. Attributes and levels using in the discrete choice experiment.

ATTRIBUTE	LEVEL	DESCRIPTION
Distance	1, 2, 3, 5, 7, 10, 15, 20, 30 km	Home-site distance to cover (travel cost)
Facilities	None	No recreational facilities present at the site
	A few	Limited supply of recreational facilities at the site: benches/shelter; information boards/Infocentre
	A lot	Large supply of recreational facilities at the site: benches/shelter; information boards/Infocentre; HORECA (e.g. bar/restaurant); playground/family-specific facilities
Signed trail quality	No signed trails	Site has no signed trails
	Unpaved signed trails	Site mostly covered with unpaved signed trails
	Paved signed trails	Site mostly covered with paved signed trails
Tranquility	Noisy	High noise level (>70 dB(A))
	Normal	Intermediate noise level (55-70 dB(A))
	Quiet	Low noise level (<55 dB(A))
Presence of a water element	None	No water element present at the site
	Yes, a river/canal	At least one river/canal present at the site
	Yes, a pond/lake	At least one pond/lake present at the site
Landscape openness	Closed	34.3 to 100% of landscape covered with high vegetation
	Semi-open	8.5 to 34.3% of landscape covered with high vegetation
	Open	0 to 8.5% of landscape covered with high vegetation
Landscape naturalness	Rural	0 to 9.4% of landscape covered with “nature”
	Semi-natural	9.4 to 45.4% of landscape covered with “nature”
	Natural	45.4 to 100% of landscape covered with “nature”
Landscape diversity	Low	0 to 55.4% of landscape diversity
	Medium	55.4 to 69.9% of landscape diversity
	High	69.9 to 100% of landscape diversity

The choice sets vary according to eight attributes:

- *Distance*: Rather than using a direct cost (e.g. entrance fee, tax), we decided to use the distance travelled from home to the site as the payment vehicle in this research, which is a relatively uncommon practice (Christie et al., 2007). The idea was use another type of value than the usual monetary value, assuming that the recreation choice-making process could be more easily affected by the mental perception of distance than by an actual travel cost[1]. We assumed that the negative utility commonly associated with travelling would produce a coherent and probably more appropriate alternative to a regular cost in the context of choosing hypothetical sites for outdoor recreation.
- *Facilities*: The presence of certain recreational facilities at the site may be influential on an individual's destination decision process (Tapsuwan et al., 2012). From the two focus groups that we organised prior to the survey, we observed that the provision of four types of facilities looked particularly important. Those facilities were: (i) benches/shelters, (ii) information boards/Infocentre, (iii) HORECA (e.g. bar/restaurant) and (iv) playground/family-specific facilities. We included two levels of provision of these facilities in the DCE.
- *Signed trail quality*: The presence of signed trails deemed to be an important characteristic for the participants to our two focus groups. However, we noticed diverging preferences regarding trail quality expectations. So with this site attribute, we wanted to test whether recreationists held rather positive or negative preferences for paved and unpaved trails. We added the characteristic of having signboards marking those trails to also check the added value of signed trails relative to standard, unsigned paths.
- *Tranquility*: Engaging in outdoor recreation is often motivated by the need to relax and escape the stressful city environment by going to a peaceful nature area (). Here, we restricted the context of tranquility to the noise level at the site. Studies have shown that noise, especially coming from traffic and industrial activity, could be a large source of disturbance for the appreciation of landscape (de Vries et al., 2007).
- *Presence of a water element*: Previous studies about landscape preferences have demonstrated that the presence of water generated high preference scores (Dramstad

[1] If one wants to estimate preferences in term of their actual monetary value, a possibility can be to convert that "willingness-to-travel" to the site by applying a cost per kilometre (e.g. car usage costs). In this paper, we did not convert preferences into willingness-to-pay values.

et al., 2006; Kaltenborn & Bjerke, 2002). Kaplan and Kaplan (1989) explain such preference in their information-processing theory, revealing that human’s positive attitude towards water could originate from evolutionary adaptation. Preferences for linear features or waterways (e.g. rivers, canals) over locally-defined features (e.g. lakes, ponds) are unclear, though. For these reasons, we added a DCE attribute about the presence of such water elements in the landscape.

- *Landscape*: Considered as one of the most essential elements involved in the destination choice process, the type of landscape was represented according to three dimensions: (i) openness, (ii) naturalness and (iii) diversity. Landscape complexity is, however, hard to translate in layman’s term, which is why we opted for photomontages. The photomontages were created in Adobe Photoshop using a technique called digital image editing. Digital image editing is long-known in the landscape preferences literature (Johnson et al., 1994; Tyrväinen & Tahvanainen, 1999; Tyrväinen et al. 2003) but is application to DCEs is relatively new. Arnberger and Haider (2007) used that technique to study the influence of social factors on intended displacement. Another example is the study from Landauer et al. (2012), which used photomontages to investigate preferences for cross-country skiing resorts.
  Here, the photomontages depicted different combinations of the three landscape characteristics (see Appendix 1). Some combinations were not kept because they were counter-intuitive or too difficult to represent adequately. One additional difficulty came from the constraint of producing photomontages that were technically accurate so that they translated adequately the different GIS thresholds. Those thresholds ensured that preferences for landscape characteristics could be mapped afterwards while representing reality appropriately. Landscape openness refers to the degree of vegetation that can be observed in the picture and that is supposed to block someone’s view. The degree of openness was calculated using the proportion of pixels representing trees in the useful part of each picture. Landscape naturalness was estimated in a similar way, calculating the proportion of certain landscape features referred as “natural” relative to “rural” features. Landscape diversity was estimated by combining different landscape elements in various proportions. For instance, using 100% of similar “rural” features in an image led to a “monotonous” landscape while using other proportions could increase the degree of diversity.

2.2 Case study

The study area selected for this research is the province of Antwerp, one of the ten Belgian provinces located in the middle of Flanders (northern Belgium). This province possesses a good mixture of landscapes, ranging from farmlands to forests, heathlands, moors and wetlands. As such, it offers a compromise between the flat lands (*polders*) in the west and the dense forests of Limburg in the east.

The proximity of the city of Antwerp makes this province an interesting place to study preferences for outdoor recreation. For the past decades the province of Antwerp has undergone large landscape modifications because of the expansion of the city and port of Antwerp (3rd busiest port in Europe), resulting in increased urbanisation. An increasing number of Antwerp citizens are now searching for green spaces to recreate in peri-urban areas. The Campine (or "De Kempen" in Dutch), which is the natural region that covers the largest part of the province, is consequently flooded by more and more recreationists willing to escape the city and reconnect with nature.

To respond to this increasing demand for outdoor recreation, local authorities are developing a well-connected network of trails for hikers, cyclists and horse riders. A strategic plan has been launched for the period 2013-2019 to promote local tourism and recreation in the Campine region (Provincie Antwerpen, 2013). Local policy-makers hope that these decisions will improve the quality of life of the local residents and satisfy the needs originating from a large variety of stakeholders.

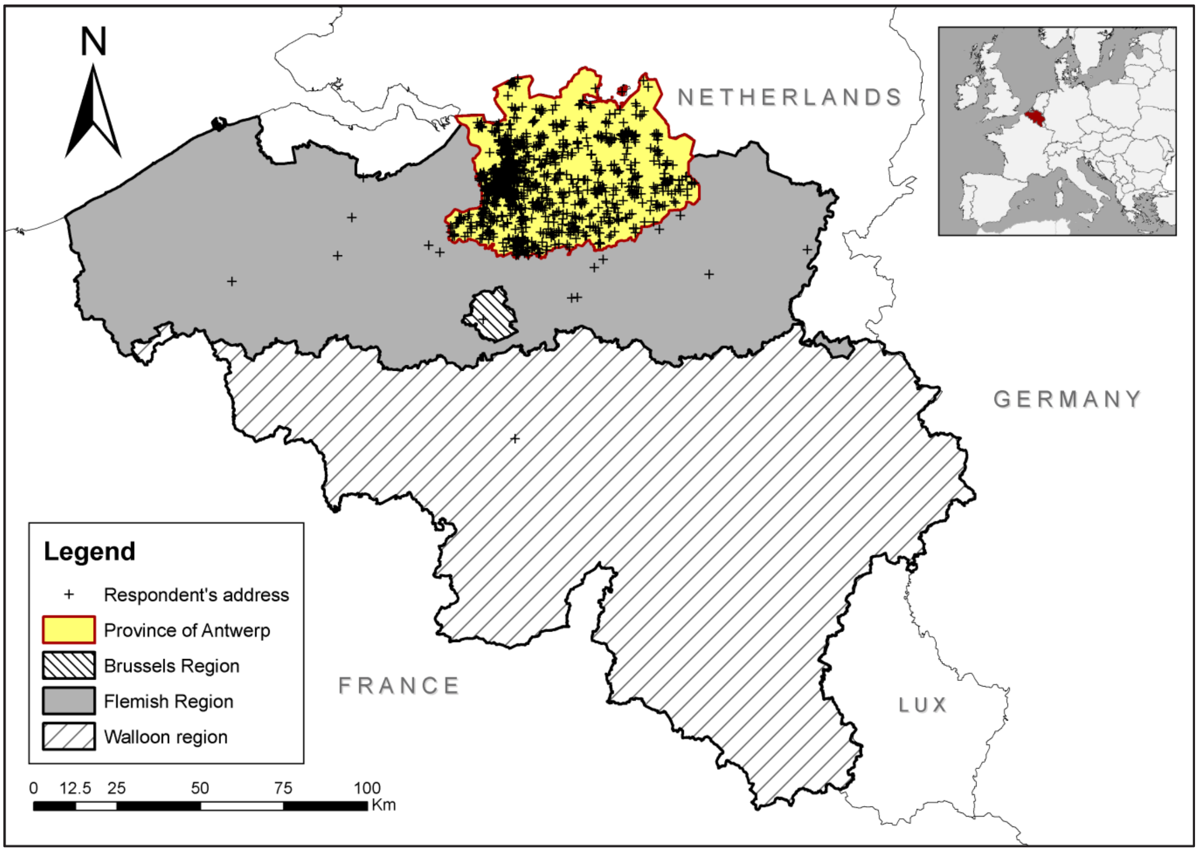

Fig. 2. Locating the study area (Province of Antwerp, Belgium) and the survey respondents

2.3 Data collection

The survey questionnaire included three sections: (i) warm-up questions; (ii) the discrete choice experiment (see next section) and (iii) follow-up questions. The warm-up questions covered respondents' socio-demographic characteristics (e.g. age, income) and recreational habits. The follow-up questions controlled for the general understanding of the survey by the respondents.

In November 2014, we pre-tested the survey on 115 respondents to check the general behaviour of the model. We used the model coefficients of that pre-test as new priors in the definition of the survey design to improve the accuracy of the model. Between the 1st and the 22nd of December 2014, we hold the official survey. We collected data through a research firm specialised in online surveys. About 11,000 invitation emails containing a link to the online questionnaire were sent to panel members. Panel members were representative of the target population (province of Antwerp) in terms of age, gender, education and income.

We obtained a total of 1906 observations, indicating a response rate of 17.3% in line with the literature (Bliem et al., 2012; Chen et al., 2014). Low response rates are common for such online surveys (Bryman, 2008).

3 Results

3.1 Descriptive statistics

Out of 1906 respondents who took part in the survey, only 1403 respondents completed it entirely, which means 503 respondents (26.4%) dropped before the DCE. Socioeconomic characteristics are presented for the whole survey sample, including all respondents that dropped before the choice experiment (Table 2).

Table 2. Descriptive statistics

Socioeconomic characteristics	Sample	Province of Antwerp[a]
Age (mean, in years)	48.8	47.6[b]
Gender (% male)	44.5	49.6
Income (mean, in €)	2,768.9	2,588.6[c]
Education level (% of higher education level)	49.6	35.0
Favourite outdoor recreational activity (%)	Walking/hiking: 49.7 Cycling: 21.0 Walking the dog: 11.1 Jogging/fitness: 6.5	/
Outdoor recreation frequency (%)	1+ per month: 15.8 Once per 2-3 months: 14.5 1+ per week: 14.3 Once per month: 12.9	/

[a] Studiedienst van de Vlaamse Regering, 2014; [b] Based on the same population segment as the one reached in the survey, i.e. 17–85 years; Actively working (not student, not jobless); [c] Belgian Federal Government, 2013.

Interestingly, 14.3% of the respondents preferred not to mention their income. The sample statistics slightly differ from the target population. We observe an overrepresentation of elder respondents, with higher education and higher income. The sample has also a slightly larger proportion of female respondents. Such minor sampling biases are common for studies that use Internet-based survey panels to collect information (Brown et al., 2014; Marta-Pedroso et al., 2007). We acknowledge this sampling bias as a potential limitation of this research.

Concerning people's recreational behaviour, walking/hiking (49.7%) is by far the most popular activity, followed by cycling (21%), walking the dog (11.1%) and jogging (6.5%), which confirms prior findings for that same study area (De Valck et al., 2015). The frequency of visits is highly variable. A large majority of respondents (87.9%) have recreated at least once in nature over the past 12 months. This research is therefore highly relevant for land management policies willing to address the question of outdoor recreation.

3.2 Group-specific DCE results

We computed four different mixed logit (MXL) models (Table 3). We observe interesting differences in preferences across the four main recreational activity groups. It is important to note that a squared term had to be added to the distance term (payment vehicle). Distance was not significant when expressed as a linear term. When adding this squared distance term ($DIST^2$), we observe a reverse U-shaped pattern common to all activity groups. That is, respondents seem to associate a positive utility to the action of travelling for recreational purposes but only up to a certain distance. Prior studies (Cheshire & Stabler, 1976) already postulated the existence of a positive utility associated with travelling for recreation, especially in the case of specific activities for which the enjoyment comes from the journey itself.

However, after crossing a certain distance threshold which slightly differs across activity groups, respondents seem to associate a negative utility to travelling further away. At a certain distance, respondents are not willing to travel the extra kilometre. This supports prior findings, such as the theory of Bateman et al. (2006), about the definition of a 'market extent' diagnosed by the threshold where respondents' marginal WTP reaches zero.

Table 3. Mixed logit models for the four main recreational activity groups

	HIKERS		CYCLISTS		DOG WALKERS		JOGGERS	
Attributes	Mean (s.e.)	Std. Dev. (s.e.)	Mean (s.e.)	Std. Dev. (s.e.)	Mean (s.e.)	Std. Dev. (s.e.)	Mean (s.e.)	Std. Dev. (s.e.)
DIST	0.094*** (0.014)		0.131*** (0.024)		0.095*** (0.028)		0.107*** (0.039)	
DIST²	-0.003*** (0.001)		-0.004*** (0.001)		-0.003*** (0.001)		-0.004*** (0.001)	
ALOT_FACIL	0.392*** (0.077)	0.803*** (0.121)	0.512*** (0.120)	0.719*** (0.204)	-0.005 (0.151)	0.806*** (0.224)	0.394** (0.198)	0.654* (0.336)
AFEW_FACIL	0.155** (0.067)	0.505*** (0.142)	0.290* (0.112)	0.737*** (0.193)	0.171 (0.122)	-0.097 (0.480)	0.048 (0.177)	0.055 (0.522)
PAVTRAIL	0.225*** (0.067)	0.180 (0.301)	0.197* (0.110)	-0.361 (0.281)	0.031 (0.129)	0.068 (0.292)	-0.256 (0.201)	0.023 (0.315)
UNPAVTRAIL	0.301*** (0.068)	0.410** (0.167)	0.407*** (0.109)	-0.432 (0.271)	0.166 (0.128)	0.043 (0.444)	-0.435** (0.193)	0.007 (0.459)
N_QUIET	0.173** (0.072)	-0.140 (0.250)	0.135 (0.117)	0.476* (0.243)	0.136 (0.137)	-0.036 (0.393)	0.310 (0.197)	-0.304 (0.580)
N_NORMAL	0.274*** (0.083)	1.112*** (0.124)	0.260** (0.042)	1.072*** (0.195)	0.344** (0.158)	0.957*** (0.254)	0.940*** (0.214)	-1.024*** (0.323)
LAKE	-0.009 (0.070)	0.619*** (0.124)	0.089 (0.118)	0.844*** (0.185)	0.081 (0.127)	0.225 (0.467)	-0.122 (0.176)	0.025 (0.670)
RIVER	0.021 (0.068)	-0.196 (0.259)	-0.088 (0.110)	0.010 (0.277)	0.086 (0.134)	-0.033 (0.229)	-0.098 (0.189)	0.081 (0.449)
OPEN	0.340*** (0.093)	0.052 (0.513)	0.102 (0.152)	0.503** (0.210)	0.304* (0.184)	-0.035 (0.443)	0.350 (0.256)	0.083 (0.265)
HALFOPEN	0.293*** (0.098)	0.629*** (0.115)	0.336** (0.155)	0.507** (0.212)	0.171 (0.185)	0.026 (0.285)	0.187 (0.265)	0.407 (0.340)
NATURAL	-0.105 (0.068)	0.196 (0.303)	0.070 (0.108)	0.166 (0.372)	-0.174 (0.130)	0.048 (0.340)	-0.030 (0.185)	0.266 (0.631)
HALFNAT	0.202** (0.091)	1.007*** (0.158)	0.621 (0.152)	1.079*** (0.264)	0.277* (0.159)	0.239 (0.586)	0.024 (0.262)	1.233*** (0.396)
DIVERS	0.366*** (0.071)	0.402** (0.160)	0.348 (0.114)	-0.306 (0.317)	0.251* (0.145)	-0.564** (0.236)	0.386* (0.205)	0.779** (0.336)
HALFDIVERS	0.305*** (0.079)	1.003*** (0.111)	-0.039 (0.123)	0.864*** (0.176)	0.469*** (0.164)	1.147*** (0.212)	0.758*** (0.185)	0.591 (0.366)
Log-likelihood	-3651.9		-1493.9		-840.5		-496.0	
Pseudo R²	0.149		0.170		0.133		0.164	
AIC	7363.8		3047.7		1741.0		1052.0	
BIC	7584.9		3242.7		1917.4		1213.7	
Observations	11718		4914		2646		1620	
Sample size	651		273		147		90	

3.2.1 Hikers group

With 651 respondents, the hikers group is the largest group of recreationists. Hikers show a clear positive attitude towards the presence of additional recreational facilities at the site. We observe that these respondents also significantly value a situation with a lot of facilities over only a few facilities.

Interestingly, hikers do perceive the presence of signed trails as positive but the difference between paved and unpaved trails is deemed as less relevant. The model reveals though that preference heterogeneity is associated with preferences for unpaved signed trails. This could be explained by the existence of different profiles of hikers, i.e. one group of more adventurous hikers who differentiate itself from other hikers by their search for unpaved, wild-looking trails contributing to their craving for exploration.

Another important finding relates to the tranquillity that hikers search for when engaging in outdoor recreation. We observe a clear preference for an intermediate noise level (55 to 70 dB(A)) over a higher noise level (>70 dB(A)). On the contrary, it seems that hikers do not necessarily require a really quiet place over a normal one. This seems logical to think that many people would be detrimentally affected by a noise level higher than normal, but that they are not actively looking for a quiet place either.

Regarding the landscape characteristics, respondents seem to value openness. This is confirmed by a t-test revealing that they prefer an open landscape over a half-open one. This finding may explain why agricultural landscapes are also appreciated by recreationists. The preferences for ‘landscape naturalness’ seems less obvious. A half-natural environment is preferred over a rural one but respondents seem indifferent about a natural environment compared to a rural one. By contrast, landscape diversity is appreciated: a t-test reveals that a diversified landscape is preferred over a monotonous one, and also over a semi-diversified one. Still, the model reveals heterogeneous preferences for most of these landscape characteristics. This suggests that people’s perception of these characteristics varies largely, even within that same activity group (Kaplan & Kaplan, 1989).

3.2.2 Cyclists group

With 273 respondents, cyclists represent the second largest activity group. Cyclists perceive the presence of recreational facilities as positive. They also prefer sites with signed trails, but surprisingly, they seem to prefer unpaved trails over paved trails.

Interestingly, cyclists show no preference for a quiet place over a noisy one. Even though they do prefer an intermediate noise level over a noisy place, cyclists seem less affected by the noise level than hikers, for instance. An explanation to this phenomenon may be that cyclists usually cross the recreational site much faster than other recreationists. Their exposure time to noisy places is therefore much shorter so that they are less affected by the noise level. Also, cyclists generally do a round-trip from their home and consequently cross various landscapes (urban, rural...) with different noise levels. It might be harder for them to conclude on a preferred average noise level for their whole recreational trip.

Regarding the most important landscape characteristics, it appears that a semi-open landscape is preferred over a closed landscape. In addition, cyclists also prefer semi-natural landscapes over rural landscapes. Finally, they show clear preferences for diversified landscapes over monotonous ones. These three elements together suggest that cyclists enjoy crossing landscapes that offer a good mix of features. Some websites like RouteYou.com or Fietsroute.org are already helping cyclists to look for cycling routes that have something special to offer: e.g. historical routes (heritage value), challenging routes (with large variations in height), discovery routes (various types of landscapes) or family routes (adapted to all ages and physical conditions).

3.2.3 Dog walkers group

Dog walkers (n=147) represent a smaller group of recreationists. They seem to be indifferent about the presence of recreational facilities, the presence of signed trails and the presence of water elements at the site such as a lake or a river. Intuitively, this may be explained by the purpose of this recreational activity. Walking the dog outside is mostly motivated by sanitary reasons. That type of person is thus less likely to look for specific landscape features. As these people generally do a round-trip in their neighbourhood, it may be difficult to really isolate themselves from surrounding noises, which would explain their indifference for quiet places. However, sites with an intermediate tranquillity level remain preferred over noisy places.

Open landscapes seem to be favoured over closed landscapes for this group. The level of naturalness of the landscape seems on the contrary less of a necessary site characteristic. Semi-natural sites are preferred over rural ones. Here again, this may simply indicate that finding 'natural' landscapes in the neighbourhood may be difficult for most respondents. Semi-natural landscapes may be good enough for that type of activity. Regarding landscape diversity, dog walkers appreciate a diverse landscape over a monotonous one. But their preferences between diverse and semi-diverse landscapes cannot be distinguished.

3.2.4 Joggers group

Joggers (n=90) represent the fourth largest activity group. Their clear preference for a site with a lot of recreational facilities compared to a site with no facilities seems logical. This type of recreationists are typically sport-oriented so that they may appreciate the presence of facilities along their jogging route as part of their sport routine (e.g. gym apparatus, fitness exercises). The presence of benches and shelters may be also useful for having a break or in case of sudden shower.

Joggers seem to be relatively indifferent to the presence of signed trails to engage in their activity. They show a dispreference for the presence of unpaved signed trails over no signed trails and are indifferent to the presence of paved signed trails. Alike dog walkers, joggers are generally practicing in their neighbourhood. For respondents who live in an urban area, it may be difficult to find trails devoted to their recreational activity and they may use regular roads, sidewalks or various types of pathways to perform that activity. Also, as the purpose of their trip is generally not to explore and discover a new place, the presence of signed trails is probably less relevant for this group.

A similar conclusion can be drawn from their preference for an intermediate tranquillity level over a higher noise level. As these people tend to remain in their neighbourhood to engage in their activity, finding really quiet places nearby is probably impossible for a large majority of respondents. In addition, many joggers do listen to music while practicing, which may also explain their lower concern for site quietness.

Another important finding relates to their preferences for certain landscape characteristics. Landscape openness and naturalness seem to have no real influence but landscape diversity seems to be much more important. Diverse and semi-diverse landscapes are both preferred over monotonous landscapes but no actual significant gain in utility can be observed from a diverse landscape over a semi-diverse landscape.

3.3 Preference maps

Based on the preferences calculated earlier for the four main activity groups, we were able to map the most suitable recreational sites within the study area (Fig.3). As stated earlier, one of the innovative aspects of this research is that the DCE attributes were selected not only for their relevance in this context but also in order to produce preference maps in a later stage. Site attributes were made GIS-explicit by looking first for their availability in the OpenStreetMap database. If these attributes were available and considered sufficiently relevant for the DCE exercise, they were kept for the analysis. Few prior studies combined the estimation of stated preferences for ecosystem services with the mapping of these preferences in a second stage (Campbell et al., 2009; Johnston & Ramachandran, 2013).

The formula that was used to predict the probability of choosing a particular site (given the characteristics of the site and the distance to home) is the following:

$$P(choose\ site) = \beta_A A + \beta_{D1} D + \beta_{D2} D^2, \qquad (5)$$

where A is the vector of non-distance related attributes, β_A the corresponding coefficients and D the home-site travel distance. As the distance parameter behaved in a non-linear way (see Table 3), we had to include both a linear and a quadratic term to model the influence of distance. This formula was applied to every single cell of a raster. It was based on the spatial location of the selected attributes (see Appendix 2).

These maps provide a visual illustration of the differences in site preferences that exist between recreational activity groups. We observe that hikers (Group A, Fig.3) could more easily find suitable sites for their activity in the south of Antwerp and the north-east part of the province. By contrast, the Antwerp City area clearly appears as a zone with low attractiveness for cyclists (Group B, Fig.3).

The most suitable sites for dog walkers (Group C, Fig.3) appear as relatively similar to the sites suitable for hikers. However, differences in suitability are more evident for dog walkers, probably due to the home proximity constraint.

Joggers (Group D, Fig.3) are, as expected, very constrained by their environment, resulting in a lot of the study area not being suitable for that activity. Interestingly, suitable sites seem to be correlated with the road network and the urban areas.

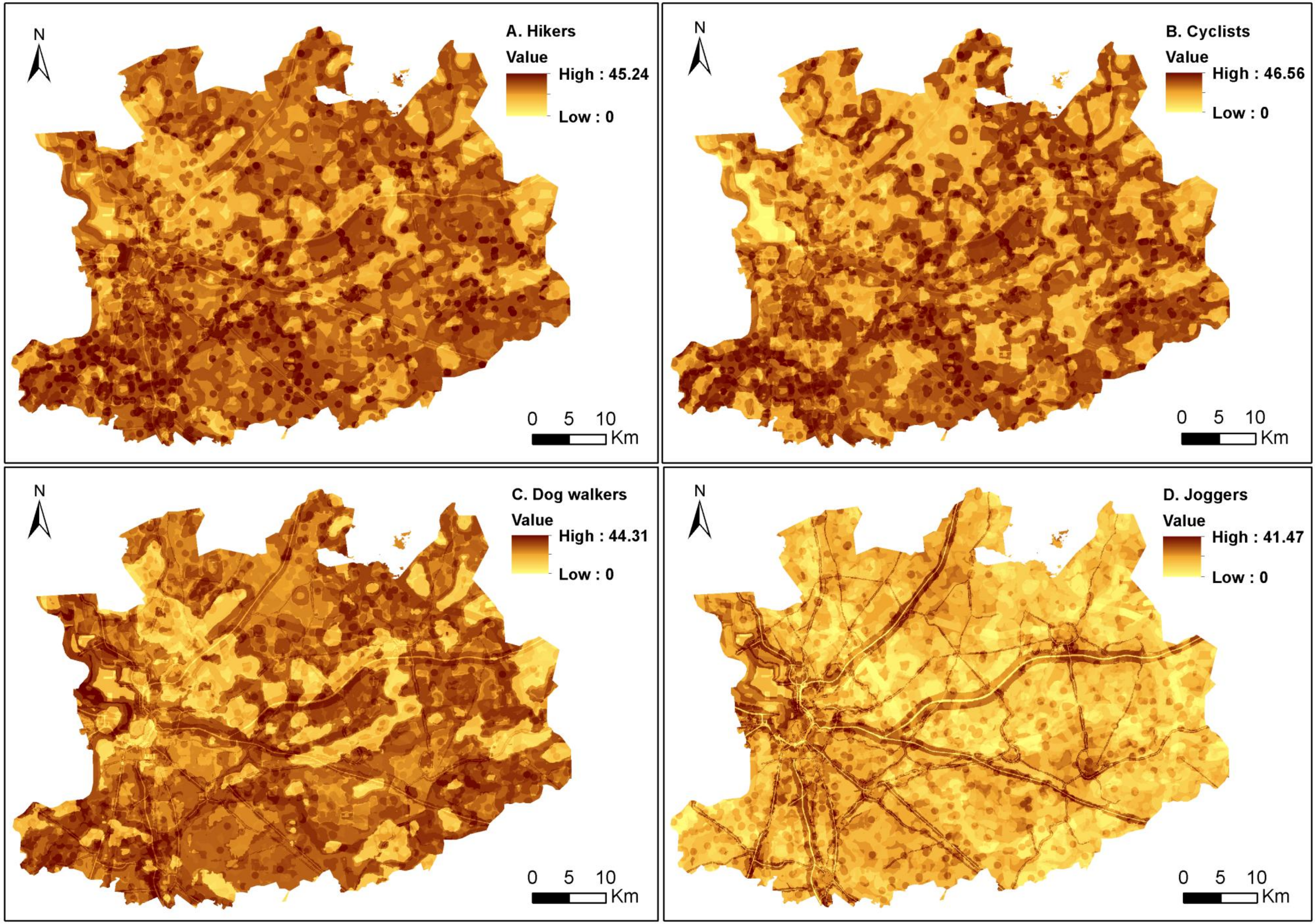

Fig. 3. Value maps for four recreational activity groups: (A) Hikers, (B) Cyclists, (C) Dog walkers, (D) Joggers

4 Discussion

We would like to point out that the results presented in this paper are at this stage only provisional. A more in-depth analysis is planned and additional work is still in progress to improve the results from this research. That being said, we are already capable of pinpointing a few contributions of this study. Aside from that, we also need to acknowledge several limitations of this study.

Our results provide new insights on the question of valuing outdoor recreation as an ecosystem service that can be provided in various quantities from different types of landscapes. Prior research about outdoor recreation in the same study area had demonstrated that not all recreational sites were equal in terms of their substitutability (De Valck et al., 2015b). In that study, the collective social value of outdoor recreation for the citizens of the province of Antwerp was assessed using public participation GIS (PPGIS) and showed that certain sites were considered as “unique” by recreationists and could therefore not be easily substituted for another destination. Here, we add more precision to these previous findings by providing insights on the site attributes that are actually traded off by recreationists during their destination choice-making process. Also, by mapping sites that are more or less suitable for outdoor recreation for distinct profiles of recreationists, we provide policy-makers with specific information about sensitive areas.

Another contribution of this research relates to the study of substitutes in the context of stated preference studies (De Valck et al., 2015a; Schaafsma & Brouwer, 2013; Schaafsma et al., 2013). Unlike most prior studies on that topic, we study the possibility for production landscapes to be substitutes for natural landscapes. Hare again our results show that the respondent’s profile is important in influencing preferences. The general findings seem, however, to advocate that most respondents would consider both production landscapes and natural landscapes as potential recreational destination. The type of recreational contributes to giving more important to certain site characteristics relative to others, which eventually produces different landscape preferences and substitutability patterns.

We want to acknowledge several limitations of this research, although some of them could still be reduced in a later version of this paper. First, the interpretation of the distance attribute remains a bit difficult. The reverse U-shape behaviour of distance is rather surprising and could suggest a much more complex influence of distance on the destination decision process. Nevertheless, that reverse U-shape behaviour also suggests that respondents may get a positive utility from the action of travelling towards their recreational site, but only up to a certain distance. After a certain threshold, distance seems to be associated again with a negative utility that can be explained by the increasing travel cost for each extra kilometre away from home. At a certain distance, respondents are not willing to travel the extra kilometre, which suggests the existence of a market extent for outdoor recreation. Further work is needed to clarify the exact effect of distance on each individual.

A second possible limitation relates to the interpretation of the three different landscape dimensions through the photomontages provided in the DCE. Our results seem to show diverging patterns among respondents and we wonder whether those pictures were sufficiently clear and understood by everyone. For some photomontages, we had to trade off a bit of visual realism to make that combination of landscape characteristics interpretable in GIS afterwards. This may have caused some clarity issues for certain respondents.

Also, at this point, we only present preference results that were not converted into an actual monetary value. So we cannot infer willingness-to-pay (WTP) values, for instance. This is, however, our intention in a later stage to provide WTP estimates and make further use of the frequency of visits stated by each respondent to propose as well some predictive visitation maps.

Finally, regarding the preference mapping exercise, we still need to add further complexity to make it more realistic. At this point, that quadratic dimension of distance is not included yet so the current maps only provide part of the story. Also, preferences should be weighted by population density to make it more realistic. We are in the process of controlling for this by adding population density information measured at the pixel (raster cell) level.

5 Conclusions

In this paper, we provided evidence that production landscapes are consistently valued by recreationists and can be substitutes for more natural landscapes. We demonstrated some of the trade-offs made by respondents when choosing a destination for an outdoor recreational trip. As such, we provided further information about the key factors that matter to recreationists, depending on the type of recreational activity they engage in. Using a combination of econometrics and GIS, we mapped the recreational value of nature in the Province of Antwerp (Belgium). We also presented prediction maps of recreational visits in the case of different policy scenarios.

Acknowledgments

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List of Tables

List of Figures

Appendix 1

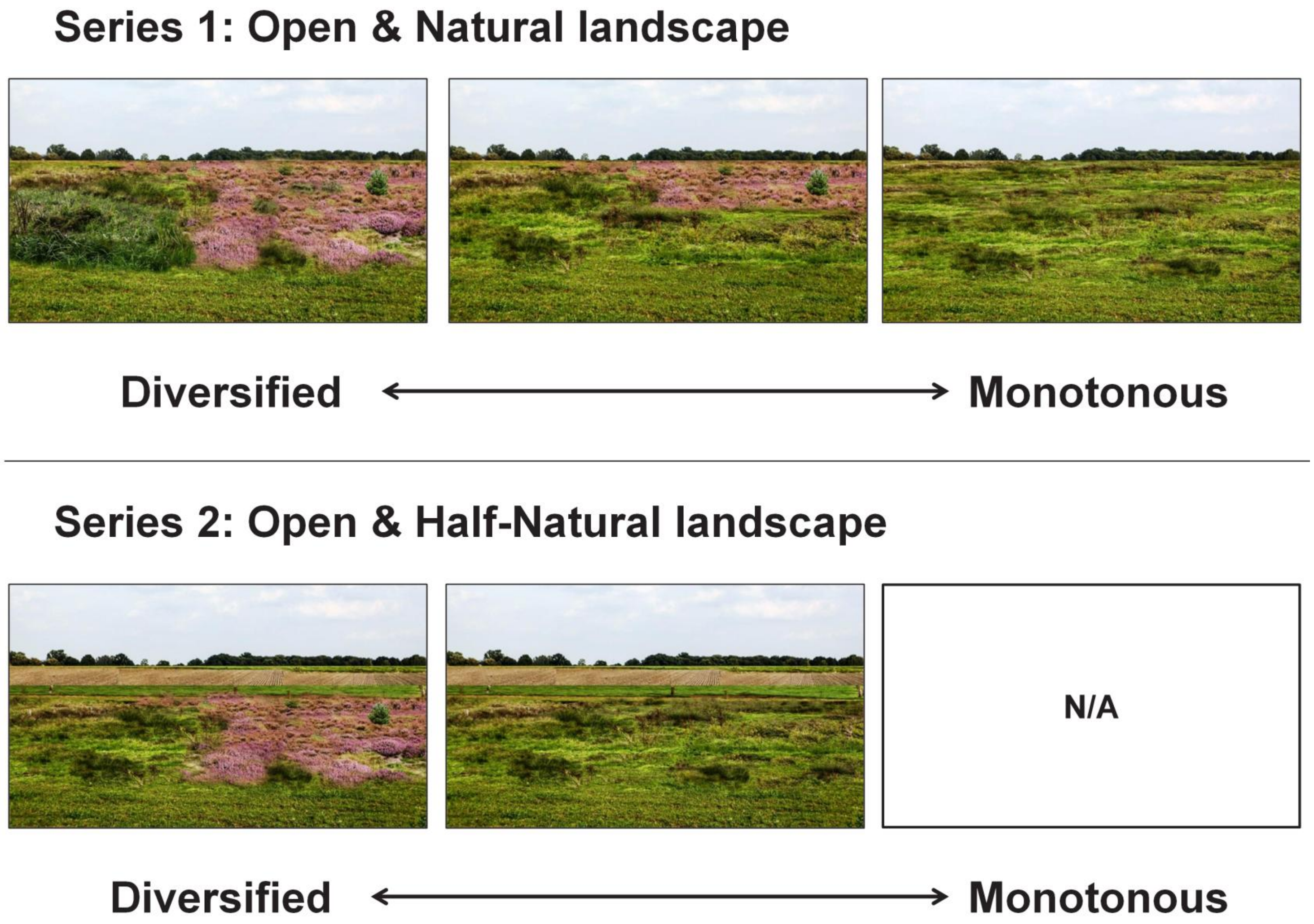


Fig. 4. Photomontages used to define the landscape openness, landscape naturalness and landscape diversity DCE attributes.

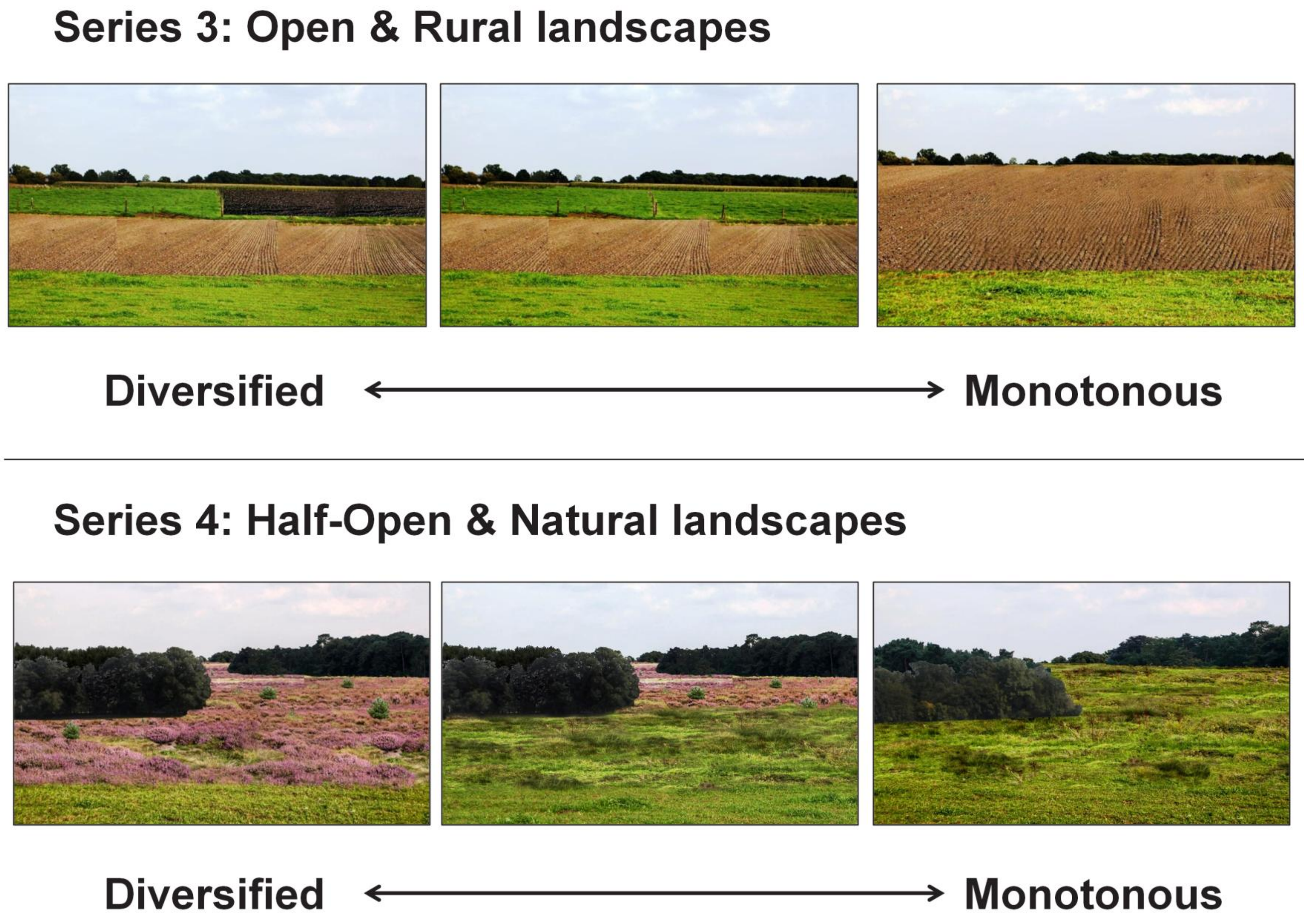


Fig. 4. (continued)

Series 5: Half-Open & Half-Natural landscapes

Diversified ⟷ **Monotonous**

Series 6: Half-Open & Rural landscapes

Diversified ⟷ **Monotonous**

Fig. 4. (continued)

Fig. 4. (continued)

Appendix 2

GIS representation of choice card attributes

1. Landscape

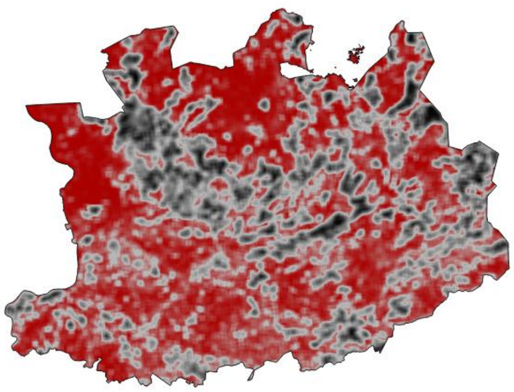
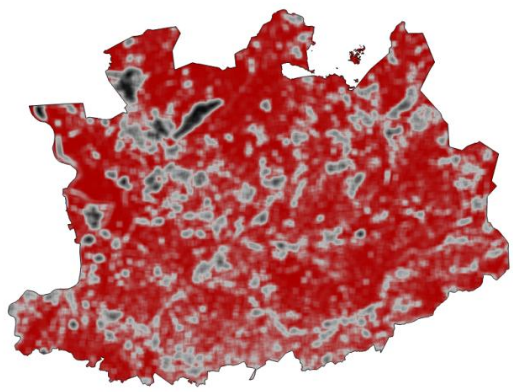
GIS data:

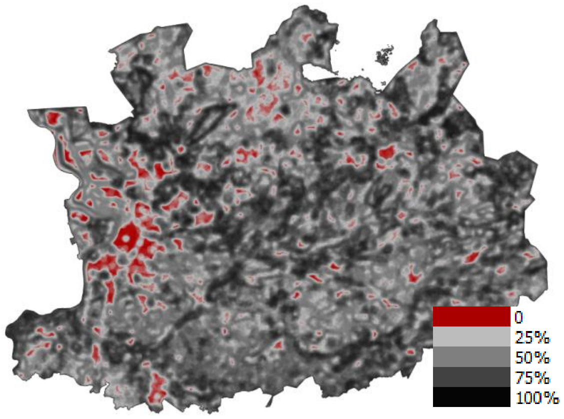
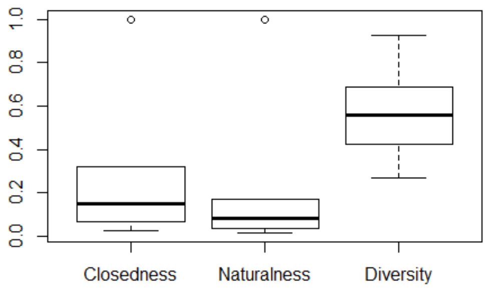
- Land use map (VITO)

Indicators:

- *Openness*: Percentage of land covered with high green within the landscape. For each pixel, landscape was defined as the land within a radius of 500m.
- *Naturalness*: Percentage of land covered with natural land use (open space without agriculture, urban green, plantation forests and water) within the landscape.
- *Variability*: Based on Simpson's diversity index which specifies the probability of not detecting two pixels with a similar land use in a predefined radius ($SDI = 1 - \sum p_i^2$ with p_i the relative frequency of a land use i). To account for undesirable variability (e.g. variability due to diverse urban land uses), similar land cover types were grouped (different crop types in one group, different urban land uses in one group) before calculating the Simpson's diversity index.

Visualisation of indicators for the study area:

Openness	**Naturalness**
	

Simpson's diversity index	Boxplots
	

2. Presence of water element

GIS data:

- Land use map (VITO)
- Vector layer of Flemish rivers (Vlaamse Hydrografische Atlas (VHA))

Indicators:

- Presence of river/canal in 500m radius
- Presence of lake/pond in 500m radius
- Absence of water element in 500m radius

Visualisation of indicators for the study area:

Presence of river/canal within 500m	Presence of lake/pond within 500m
	

3. Trail quality

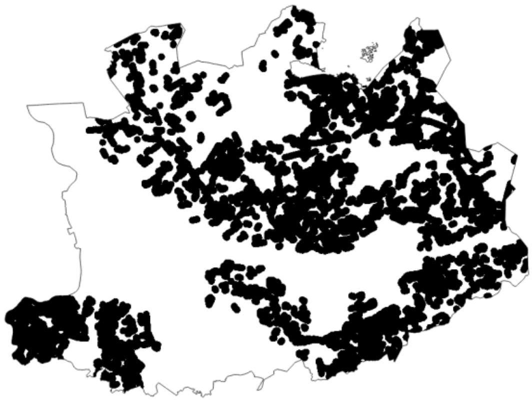
GIS data:

- Vector layer of walking and cycling trails in the province of Antewerp (ref)

Indicators:

- Presence of unpaved, signed trails within a radius of 500m
- Presence of paved, signed trails within a radius of 500m
- Absence of trails

Visualisation of indicators for the study area:

Presence of unpaved trails	Presence of paved trails
	

4. Tranquility

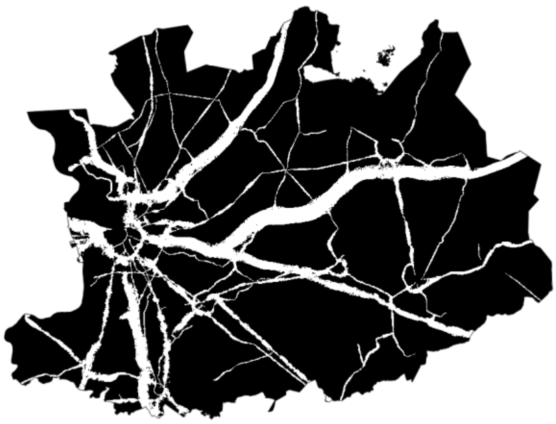
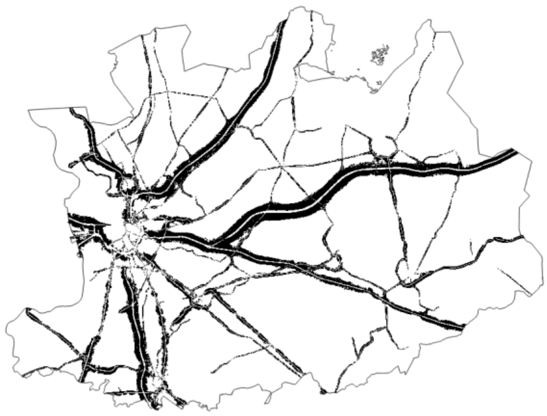
GIS data:

- Vector layer of daily weighted annual mean noise levels in Flanders

Indicators:

- *Quiet:* Daily weighted annual mean noise levels between 0 and 55 dB
- *Normal:* Daily weighted annual mean noise levels between 55 and 70 dB
- *Noisy:* Daily weighted annual mean noise levels above 70 dB

Visualisation of indicators for the study area:

Quiet	Normal
	

5. Nearby facilities

GIS data:

- Vector layer indicating locations of horeca, benches, playgrounds and information points (OpenStreetMap.org)

Indicators:

- *No facilities*: No facilities present within a radius of 500m.
- *Few facilities*: Presence of only benches or information points within a radius of 500m.
- *A lot of facilities*: Presence of horeca and playgrounds within a radius of 500m.

Illustration of data availability on OpenStreetMap:

Few facilities	A lot of facilities