Citizens’ preferences and valuation of urban nature: insights from two choice experiments

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Abstract
Urban nature increases the liveability of cities and can improve their resilience to climate change. However, the value of urban nature often remains unknown, which results in its omission from urban planning decisions. Particularly the valuation of *small-sized* urban nature remains understudied. This study therefore employs a stated preference methodology to estimate the economic value of seven types of small urban nature and four associated ecosystem services. We perform two choice experiments: one with urban parks, urban forest and green corridors and another one with even smaller urban nature types (green roofs, green walls, street trees and green beds). The results of the choice analysis show that urban residents are willing to pay more for the former types of urban nature but not for the latter types. Urban parks are valued the most, followed by urban forests and green corridors. Within the category of the smallest urban nature types, street trees are valued most followed by green beds green walls, whereas green walls and green roofs are least valued. We discuss opportunities and barriers to implementing economic valuation results in urban planning practices. Several policy and future research recommendations are proposed.

Key Words:
economic valuation, stated preferences, nature-based solutions, Dutch cities, ecosystem services

1. Introduction

Increasing urbanisation of societies is accompanied by multiple urban challenges such as extreme urban heat, poor air quality and flood risks. Urban nature-based solutions (NBS) are being developed and are becoming increasingly relevant to address multiple challenges and help establish sustainable urban environments.. Policymakers and researchers agree that NBS create a wide range of public and private benefits (Gómez-Baggethun & Barton, 2013; Raymond et al., 2017) from a broad range of ecosystem services (ESS), including regulating ESS, habitat ESS and cultural ESS. However, urban nature, the ecosystem services it provides, and their value are poorly understood and articulated, resulting in their undervaluation and under-implementation by decision-makers (Duijndam et al., 2020; Koetse et al., 2017; Raymond et al., 2017). Valuing urban nature and its benefits offers a potential solution to this issue. This study analyses individual preferences of urban residents for different nature types, their attributes and, ultimately, the monetary valuation through willingness-to-pay.

The rationale of economic valuation and assigning monetary values to urban nature is widely recognised in academic literature and traditionally stems from the economic perspective of rational choice (Bočkarjova et al., 2020a; Koetse et al., 2017; Paulin et al., 2019). The monetisation of urban nature allows policymakers and other relevant participants to compare 'grey' and 'green' solutions through more objective methods, such as cost-benefit analysis. Therefore, the qualitative aspects and benefits of nature are made comparable to the other monetary or quantitative aspects of urban planning, like urban green project implementation and maintenance costs.

A wide range of monetary valuation studies on urban nature has been conducted to date (Bočkarjova et al., 2020a; Duijndam et al., 2020; Koetse et al., 2017; Paulin et al., 2019). Nevertheless, these studies lack information on two main aspects. First, the majority of studies focuses on the larger types of urban nature, thus devoting relatively little attention to 'small' urban nature types. For example, the recent meta-analysis of Bočkarjova et al. (2020a) identified 60 Stated-Preference (SP) valuation studies with only two studies on street trees in the United Kingdom and Poland (Giergiczny and Kronenberg, 2014; Mell et al., 2013) and a study on green facades and living walls in the UK (Collins et al., 2017). The other studies focus on larger types of urban nature of at least 22ha (Bočkarjova et al., 2020a). Second, literature provides little evidence on the effect of attributes of urban nature on citizens' valuation of urban nature, particularly regulating ESS. For example, water flow, air quality, or urban temperature regulations are widely recognised ESS of urban nature that provide important benefits to urban residents. Other valuation methods than stated preference valuation studies have been commonly applied to estimate values for regulating services. Examples of such approaches are the hedonic pricing and avoided damage costs methods. Still, existing studies mainly focus on cultural ESS and recreational in particular but hardly analyse citizen preferences for the regulating ESS of NBS. Our paper addresses these gaps by conducting a stated-preference valuation study of a wide range of urban nature types, including traditionally well-studied large urban nature types as well as smaller types. The research questions are:

1. What are the preferences of citizens regarding urban nature types and their characteristics?
2. What is the economic value of urban nature and its ecosystem services?

We employ original data that contains a choice experiment (CE) to analyse the value of urban nature in six major cities in the Netherlands: Amsterdam, Rotterdam, The Hague, Utrecht, Eindhoven and Groningen. The study focuses on cities because urban nature or urban NBS are most relevant in offering solutions to multiple urban challenges for highly urbanised areas, where nature is scarce (Lafortezza et al., 2018). Choice experiments are a state-of-the-art method in the literature on the economic valuation of ecosystem services to elicit the use and non-use value of nature (Brander & Koetse, 2011; Duijndam et al., 2020; Koetse et al., 2017). It allows the researcher to analyse preferences and, ultimately, the willingness-to-pay (WTP) for urban nature and its attributes. This study presents the elicitation of preferences of urban residents for seven different urban nature types and focuses on the valuation by urban residents of different characteristics of urban nature, including four ESS.

In addition, we conduct seventeen exploratory interviews with urban practitioners within the urban nature planning processes of Amsterdam and Utrecht and analyse the barriers and enablers for implementing economic valuation studies in urban nature planning. These interviews provide additional insights into the potential role of economic valuation results in urban nature planning and enable deriving the policy recommendations for this paper.

The remainder of this paper is structured as follows. Section 2 presents the research methodology. It discusses the choice experiment, the design and methods used for data collection and analysis. Section 3 describes the results of the choice analysis and the key insights of the interviews. Finally, section 4 presents the discussion and conclusion of this paper.

2. Methods and Materials

2.1 The economic value of urban nature: a stated choice analysis

The CE method is a well-established stated preference method of economic valuation applied in multiple areas of environmental studies in general and in the valuation of urban green space in particular (Bertram et al., 2017; Bočkarjova et al., 2020a; Fleischer & Tsur, 2009; Giergiczny & Kronenberg, 2014; Koetse et al., 2017;Tyrväinen, 2001). CE analysis offers an advantage to researchers in eliciting preferences and estimating economic values that urban residents place on nature and specific ecosystem services, tailored to a specific context and location. A CE consists of a number of choice sets with pre-defined alternatives, attributes and attribute levels (Hanley, Wright, & Adamowicz, 1998), which enables the researcher to obtain information on the influence of specific attributes of interest on the respondent's choices and their preferences. Thus, CEs are tailored to elicit respondent preferences for particular environmental goods and services, within a specific context.

This study employs a CE method to elicit citizen preferences for, and estimate the economic value of, urban nature in six major cities in the Netherlands (Amsterdam, Rotterdam, The Hague, Utrecht, Eindhoven and Groningen). We separated the larger- and smaller-scale urban nature into two CEs due to the differences in attribute levels for each urban nature type, which kept the statistical design for each experiment more compact (see Table 1). In both experiments, a choice set included two alternative options of additional urban greening in the city of residence and a Status Quo option, which acted as an opt-out, and represented the current situation without change, setting the prevailing level of flood risk and air pollution.

Table 1 provides an overview of all attributes of the CEs and their levels. The choice of the attributes describing alternative greening options, as well as their respective levels, was determined based on the urban nature development plans in Dutch municipalities, interviews with stakeholders in the urban nature planning processes, policy guidelines and previous studies (Gemeente Amsterdam, 2019; Arnhem,2018; Gemeente Eindhoven, 2019; Gemeente Groningen, 2018; Gemeente Nijmegen, 2018; Gemeente Rotterdam, 2018; Gemeente Utrecht, 2016).

Table 1: Attributes of the choice experiment for large nature types (experiment A) and for small nature types (experiment B)

Attributes	Exp.A Levels	Exp.B Levels	Status Quo
Area size Increase in area size of nature	5 ha 10ha 15ha 20ha 25ha	0.5ha 1.0ha 2.0ha 2.5ha 5.0ha	No change
Urban nature type	Urban Forest Urban Parks Green corridors	Green walls Green roofs Street trees Green beds	No Change
Biodiversity/ vegetation Uniform vegetation (monoculture) or biodiverse vegetation	Low biodiversity High biodiversity	Low biodiversity High biodiversity	No Change
Flooding regulation Yearly probability of flooding in cities due to extreme rainfall (level)	5% 10% 15%	5% 10% 15%	20% per year
Temperature regulation The contribution of urban nature to the local climate regulation in the summer / feel temperature (change)	1°C 2°C 3°C 4°C	0.5°C 1.0°C 1.5°C 2.0°C	No change
Air pollution (PM10) The average yearly particulate matter level	25 μg/m3 30 μg/m3 35 μg/m3 40 μg/m3	25 μg/m3 30 μg/m3 35 μg/m3 40 μg/m3	45μg/m3
Muncipal Tax The municipal tax increase per household per year	€10 €15 €25 €50 €100	€5 €10 €15 €25 €50	No change

The following attributes were included in the choice experiment: the area size of urban nature, four types of ecosystem services and the costs of an increased municipal tax connected to the implementation of urban nature projects. Experiment A describes larger types of urban nature (urban parks, forests and green corridors). These types have larger area sizes, higher local temperature regulation effects and higher municipal tax increases compared to experiment B, which describes smaller urban nature types (green roofs, green walls, street trees and green beds). The cost attribute for the two alternative urban greening projects was explained as the municipal tax increase per household per year. The four ESS of flood regulation, local climate regulation, air purification and biodiversity are selected because they are key attributes for improving the resilience of the cities to climate change and extreme weather events in the Dutch context (Escobedo et al., 2008; Gómez-Baggethun & Barton, 2013; Hardin & Jensen, 2007; Hoek et al., 2002;Morakinyo et al., 2018). Flood regulation was explained and measured as the probability of flooding in cities due to extreme rainfall because the presence of urban green areas directly affects water flow regulation and run-off mitigation. These systems intercept massive amounts of rainfall and percolate water in slower time frames, which reduces the pressure on urban drainage and minimises the chance of flooding in the city (Gómez-Baggethun & Barton, 2013; Pataki et al., 2011). Temperature regulation was explained as the contribution of urban nature to the local climate as the presence of urban green can regulate local temperature increases during warmer periods (Gómez-Baggethun & Barton, 2013; Hardin & Jensen, 2007; Pitman et al., 2015). Urban vegetation provides various cooling mechanisms, like offering shade and transpirational cooling through water vapour dissipation to the air (Morakinyo et al., 2018). Air purification was explained as the average yearly particulate matter level. Urban nature can reduce the concentration of pollutants and the amount of particulate matter in the air (Bočkarjova and Kačalová, 2021; Escobedo et al., 2008; Gómez-Baggethun & Barton, 2013). Biodiversity was presented to the respondents as either monoculture with uniform vegetation or biodiverse vegetation. Monoculture was characterised by a lack of animal species, and low biodiversity. On the other hand, biodiverse vegetation was characterised high floral biodiversity accompanied by a greater variety of fauna species.

Both CE's implemented an efficient fractional factorial design, which minimises both the correlation of attribute levels across choice sets and the standard error of model estimates (ChoiceMetrics, 2018). Furthermore, this design assumes that it is possible to estimate the asymptotic variance-covariance matrix of the parameters if they are known. Therefore, prior values of to-be estimated parameters are required to generate efficient designs, and were acquired from literature, previous estimations, and based on our pilot data. The design was generated using the software Ngene (4.0 version). Our final design of each of the experiments included a total of eighteen cards divided into three blocks of six cards, and did not include dominating or strictly unrealistic choice sets. Each respondent was randomly assigned to one of the experiments, and filled in 6 choice cards from one of the three blocks, randomised in order of appearance.

2.2. Data collection and representativeness

The survey, including the choice experiments, was conducted by making use of an online consumer panel of Kien Onderzoek in September 2020 (Kien Onderzoek 2022). The survey was completed by approximately 2,000 Dutch adults split evenly between the six largest cities of the Netherlands (Amsterdam, Rotterdam, The Hague, Utrecht, Eindhoven and Groningen). The sample is representative of the Dutch urban population stratified by the demographic characteristics of sex, age, education and the city of residence. In addition, respondents have further provided information on their current living situation, such as the type of house, type of area in terms of the presence of green attributes and the importance they attach to various aspects or benefits of urban nature. Table 2 shows the descriptive statistics.

2.3. Econometric model

This paper presents the Mixed Logit Model (ML) results in the main text and provides the Multinomial Logit (MNL) results in the appendix.

In the MNL model, each alternative (option A and B or the Status Quo alternative) is described by a utility function, which has a systematic component (V_i) and random error component, which is expressed as:

$$U_x = V_x + \varepsilon_x \quad (1)$$

The systematic observable component V_x can be rewritten as follows:

$$V_{xi} = \beta_{1V1xi} + \beta_{2V2xi_x} + \beta_{3V3xi} \dots . \beta_{mVmxi} \quad (2)$$

Where i is the respondent V_m the seven observable attribute components. The MNL function model assumes an independently and identically distributed (I.I.D) error term with a Gumbel distribution. In addition, every respondent is assumed to choose the alternative that maximises their utility. The probability that a respondent chooses an alternative is expressed as follows:

$$P_{ni} = \frac{\exp(\boldsymbol{\beta V_{ni}})}{\sum_j^i \exp(\boldsymbol{\beta V_{ni}})} \quad (3)$$

The i.i.d. and closed-form of expression of a multinomial logit model result in fixed parameters. Alternatively, mixed logit (ML) models are often preferred over the multinomial models, because they allow accounting for unobserved taste heterogeneity within a sample and the panel structure of the choice data (Hensher et al., 2015). This is possible because the ML model relaxes the strong i.i.d assumption of the standard multinomial model. It estimates random parameters and the correlation of the residual (E) between the choices of each respondent. The utility function of the ML model can be expressed as follows

$$U_x = \beta'_{xint} + \varepsilon_{int} \quad (4)$$

Where X_{int} is a vector of the chosen attributes and ε_{int} is again the random error term. The beta's (B_n) are the vector of coefficients for each attribute, and it assumes there exists a distribution of betas throughout the population $f(\beta|\theta)$.

Therefore, the probability function of the ML models is as follows:

$$P_{xi} = \int \left(\frac{e^{\beta' x_{ni}}}{\sum_J e^{\beta' x_{nj}}} \right) f(\beta) d\beta \quad (5)$$

Multiple distributions can be applied to estimate the mixed model parameters. However, common practice we follow here suggests using a uniform distribution for the binary variables (here: urban nature types and the biodiversity attribute) and a normal distribution for the continuous attributes (here: area size, flood probability, temperature regulation and air purification attributes) (Hensher et al., 2005). The cost parameter is usually estimated as fixed to avoid extreme WTP estimates. The ML models were estimated with 1,000 Halton draws (Ghosh et al., 2013; Hensher et al., 2015).

Finally, the citizen's WTP for every attribute can be calculated from the ratio between the coefficients of the attributes of interest and the price attribute, which is expressed as follows.

$$WTP = -\frac{\beta_i}{\beta_{price}} \quad (6)$$

Where β_i is the coefficient of the chosen attributes and β_{price} is the coefficient of the municipal tax per household per year.

We present estimates of two models: an attribute-only ML model with main effects (attribute-only models), and a ML model with covariate interactions. This study focuses on the effects of selected socio-economic variables (gender, income levels, and education level), and locational variables (the greenness of the neighbourhood) on respondent choices and can therefore help explain taste heterogeneity.

First, the income level is likely to resemble decreasing marginal returns, resulting in decreasing marginal utility of money for each additional unit of income and thus increasing marginal willingness to pay for additional urban nature. This hypothesis was tested by interacting a dummy for lower-income levels with the tax attribute, defined as a net income of

3000 euro or less (LOW_INCOME). We note that 17% of respondents were unwilling to report their income. A dummy (NO_INFORMATION) controls for this group. Second, Pearson et al. (2017) show that women are more environmentally aware compared to men. Therefore, we test this hypothesis by interacting the dummy for gender with the biodiversity attribute. Third, respondents with higher education levels are often more environmentally aware and are more concerned with climate change-related issues (Pearson et al., 2017). Therefore, it is likely that highly educated citizens have a higher appreciation of the ecosystem services of urban nature since these limit climate change impacts. Additionally, Koetse et al. (2017) show a positive correlation between the area size of nature and the level of education. Therefore, a dummy for higher education level (University degree) is interacted with the four ecosystem services attributes and the area size attribute. Finally, the locational variable of the perceived greenness of the neighbourhood is expected to affect the individual valuation of urban nature. Two hypotheses are tested here. The first hypothesis assumes decreasing marginal returns of nature, which implies that respondents with perceived abundant urban nature present in their neighbourhood would place lower value on additional nature in their city compared with respondents who live in areas with less perceived abundant nature. The second hypothesis assumes a selection effect, which implies that respondents who value urban nature higher, select greener neighbourhoods to live in, therefore favouring more green in their city. These two hypotheses are tested by interacting the alternative specific constant (ASC) with a dummy for the respondent perception of the greenness of a neighbourhood (answer options in the survey were ‘very green’, ‘somewhat green’ and ‘predominantly grey’; no further explanation was provided in the survey).

3. Results

3.1 Model estimation

3.1.1 Descriptive statistics

The survey includes 2009 Dutch adults split over two experiments. Table 2 shows the descriptive statistics of the sample split by experiment and reveals its socio-economic characteristics. The sample was stratified according to sex, age, education and city of residence. Therefore, the breakdown of the sample on these variables matches the census data of each city. 1.94% of the respondents in our sample were classified as protest voters[1] following a four-eye procedure and a careful examination of the answers to the open-ended questions. These respondents were excluded from the sample. We have thus analysed the data from 975 respondents in experiment A and 988 respondents in experiment B. To increase CE credibility (Welling et al., 2022), we have provided respondents with extensive information about the choice setting and the attributes (see Supplementary material for an original sample card with pop-ups). Besides, we have monitored possible perceived unrealistic choice sets and perceived correlations between attributes, using the follow-up questions. Due to the limited number of responses pointing at these (10 out of 1973

[1] Respondents were classified as protests when they explicitly indicated they oppose the tax, additional tax payment or the setting of the experiment in general.

respondents), we have assumed that respondents viewed the attribute levels as independent and the choice cards as realistic.

Table 2: Descriptive statistics

		Experiment A		Experiment B	
		Mean	**Std.**	**Mean**	**Std.**
Gender	Male	0.49	0.5	0.46	0.5
Income	No information	0.16	0.37	0.17	0.37
	€0-€3000	0.51	0.5	0.53	0.5
	€3000+	0.32	0.47	0.31	0.46
Education	Vocational or lower	0.22	0.41	0.22	0.41
	High school	0.34	0.47	0.36	0.48
	University degree	0.44	0.5	0.43	0.49
Age	18-29	0.26	0.44	0.26	0.44
	30-49	0.32	0.47	0.36	0.48
	50+	0.42	0.49	0.37	0.48
Cities	AMSTERDAM	0.16	0.37	0.16	0.37
	ROTTERDAM	0.16	0.36	0.17	0.38
	DEN HAAG	0.18	0.38	0.16	0.36
	UTRECHT	0.16	0.36	0.17	0.38
	EINDHOVEN	0.18	0.39	0.16	0.37
	GRONINGEN	0.16	0.37	0.18	0.38
Neighbourhood	VERY GREEN	0.48	0.5	0.46	0.5
	LITTLE GREEN	0.44	0.5	0.48	0.5
	GREY	0.08	0.27	0.06	0.23
Presence of nature types	URBAN PARK	0.67	0.47		
	URBAN FOREST	0.22	0.41		
	GREEN	0.05	0.21		
	GREEN ROOFS			0.04	0.19
	GREEN WALLS			0.04	0.2
	STREET TREES			0.75	0.43
	GREEN BEDS			0.62	0.49
Sample	**Respondents**	**975**		**995**	
	Observations	**17750**		**17784**	

About half of the sample in each experiment is male (49% and 46%). The lower-income group (net monthly household income €0-€3000) accounts for about 50% of the sample. In addition, 17% of the respondents did not provide information on their income. The effect of including this group in the estimates of the socio-economic model will be discussed in section 4. 44% of the respondents have a university degree of bachelor or higher. This group is relatively big compared to the national average but accounts for the higher education levels in cities. 26% are young adults up to the age of 29, about a third of the sample is aged 30-49, and about 40% are 50 or older. The neighbourhoods are mostly very green (48%) or at least a little green (44%). Only 8% of respondents live in a neighbourhood that contains primarily grey areas. Urban parks are the most commonly reported type of nature among the larger urban nature types, whereas street trees and green beds are the most common green pieces of nature reported among the smaller urban nature types. Green walls and roofs are the least frequently reported urban nature in the neighbourhood among the respondents in our sample.

3.1.2 Mixed Logit models: Attribute-only model

The results from the Choice Experiment are analysed to examine the citizens' preferences and to obtain the WTP for the urban nature attributes (area size, urban nature type and ESS). As described in the method section, the study distinguished between experiment A and B, where experiment A analysed the larger types of urban nature and experiment B analysed the smaller types of urban nature. The results of the attribute-only Mixed Logit models are presented first and are followed by the Mixed Logit models with covariates to examine the effect of socio-economic variables (gender, income levels, and education level), and locational variables (the greenness of the neighbourhood) on choices. WTP estimates are calculated based on the attribute-only models.

The attribute-only models of experiments A and B are presented in Table 3. All coefficients of random parameters in both models are statistically significant at a 5% level, except for the dummy coefficient for green walls in experiment B. The area size attribute (AREA) is positively valued for larger and smaller urban nature types (experiment A). The estimates reveal that urban parks (PARK) and urban forests (FOREST) are significantly more preferred compared to green corridors (the reference group) in experiment A. The model of experiment B shows that street trees are valued significantly higher followed by green beds in comparison with green roofs (reference group). The coefficient for green walls is insignificant, indicating that respondents' preferences for green walls and green roofs are statistically the same. All included ecosystem services significantly affect respondent choices in both experiments in the expected manner. The coefficients of biodiverse vegetation (BIODIVERSITY) and temperature regulation (COOLING) are positive. These coefficients imply that biodiverse vegetation is preferred to monoculture, and additional urban nature that decreases the local temperature has a positive effect on respondents' utility. The coefficients of flooding risk (FLOODING) and air pollution (AIR_POLLUTION) are negative in both experiments, meaning that higher flooding risks, and higher average yearly particulate matter levels are valued negatively, while decreases in flood risk and airborne pollution levels are valued positively. The non-random variable Tax (TAX) has a negative coefficient in both experiments, as expected, and so reflects marginal disutility for the tax payments. Finally, the alternative-specific constants (ASCs) are positive in both experiments, reflecting that the two alternatives proposing the placement of additional green in Dutch cities are preferred in both experiments to the current situation.

The models provide evidence of the presence of taste heterogeneity (dispersion parameters, Table 3) in eliciting individual preferences for most attributes included in the model at a 5% significance level. For example, there are significant differences in individual valuations of the additional area of urban nature, and ecosystem services that it provides to urban residents. Concerning the urban nature types, Dutch urban residents do not differ significantly in their preferences for urban parks and forests (experiment A) or for urban trees (experiment B). Interestingly, they do differ significantly in their preferences for green beds and green walls. Besides, respondents place significantly different valuations on the ASCs, implying that some respondents prefer alternative solutions, while others prefer preserving the current situation without change.

Table 3: Attribute-only Mixed Logit models for experiments A and B

	Experiment A		Experiment B	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
Random parameters				
AREA	0.0429***	0.0053	0.04130**	0.0200
FOREST	0.2313***	0.0535		
PARK	0.4414***	0.0554		
GREEN BEDS			0,20588***	0.07054
GREEN_WALLS			0.07124	0.0810
STREET_TREES			0.43968***	0.0738
BIODIVERSITY	0.4769***	0.0515	0.49806***	0.0604
FLOODING	-4.7381***	0.5642	-5.3234***	0.6729
COOLING	0.1858***	0.0215	0.3184***	0.0416
AIR_POLLUTION	-0.041***	0.0054	-0.0134***	0.0049
ASC	1.1309***	0.2551	1.8578***	0.2116
Non- random parameters				
TAX	-0.0198***	0.0012	-0.036***	0.0022
Dispersion				
NsAREA	0.0419***	0.0073	0.2184***	0.0023
UsFOREST	0.1693	0.3701		
UsPARK	0.0019	0.2563		
UsGREEN_BEDS			0.9845***	0.2427
UsGREEN_WALLS			0.8722**	0.3741
UsSTREET_TREES			0.1415	0.3833
UsBIODIVERSITY	1.0233***	0.1267	1.7707***	0.126
NsFLOODING	6.996***	1.0199	10.8323***	1.0245
NsBCOOLING	0.2199***	0.0387	0.3235***	0.1028
NsBAIR_POLLUTION	0.0306***	0.0111	0.0517***	0.0087
NsASC	3.929***	0.2451	3.4718***	0.2272
Estimation statistics				
Observations	5850		5970	
Log-Likelihood	-4637.91177		-4947.41	
LR chi^2	3577.94023		3222.6189	
McFadden Pseudo R^2	0.2783574		0.2456	
AIC	9315.8		9932.8	
AIC/N	1.592		1.664	

**** and ** correspond to p-value ≤ 1% or 5%, respectively*

The ML model (Table 3) was run to test for taste heterogeneity in eliciting individual preferences. To analyse this heterogeneity, several ML models with interactions were estimated. The resulting socio-economic ML models with the selected statistically significant socio-economic variables (gender, income levels, and education level), and locational variables (the greenness of the neighbourhood) are found in Table 4. The socio-economic ML models perform similar or better than the attribute-only ML models in terms of goodness of fit, as witnessed by both the AIC/N and the log-likelihood. All attribute coefficients are significant with the same sign as the ML models in experiment A, whereas the area size coefficient becomes insignificant in experiment B.

Table 4: Socio-economic Mixed Logit models with covariates for experiments A and B

	Experiment A		Experiment B	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
Random parameters				
AREA	0.0423***	0.0053	-0.0144	0.0272
GREEN_BEDS			0.2073***	0.0685
GREEN_WALLS			0.0629	0.0796
BIODIVERSITY	0.2632***	0.0712	0.2535***	0.0836
FLOODING	-4.7527***	0.5687	-2.7401***	0.9346
COOLING	0.1282***	0.0311	0.3232***	0.0407
AIR_POLLUTION	-0.0411***	0.0053	-0.0126***	0.0048
ASC	1.7949***	0.2998	2.3055***	0.2595
Non-random parameters				
FOREST	0.2428***	0.0539		
PARK	0.4491***	0.0559		
STREET_TREES			0.4301***	0.0725
TAX	-0.0172***	0.0016	-0.0315***	0.0033
TAX x LOW_INCOME	-0.0046***	0.0017	-0.0065*	0.0039
TAX x NO_INFORMATION	-0.002	0.0022	-0.0034	0.0054
Interaction results				
Education				
BIODIVERSITY x EDU_HIGH	0.3781***	0.0873	0.3929***	0.1058
COOLING x EDU_HIGH	0.0968**	0.0376		
AREA x EDU_HIGH			0.0903***	0.0343
FLOODING x EDU_HIGH			-4.1765***	1.1980
Greenness of the neighbourhood				
ASC x VERY_GREEN	-2.4306***	0.6634	-1.0382***	0.2899
Dispersion				
NsAREA	0.0418***	0.0074	0.205***	0.0381
UsGREEN_BEDS			0.8675***	0.2742
UsGREEN_WALLS			0.898**	0.3579
UsBIODIVERSITY	1.0415***	0.1262	1.6892***	0.1228
NsFLOODING	7.0564***	1.0292	10.2264***	0.9902
NsBCOOLI	0.2341***	0.0371	0.2824**	0.1202
NsBAIR_POLLUTION	0.0281**	0.0110	0.0489***	0.0092
NsASC	3.6389***	0.2348	3.2996***	0.2118
Estimation statistics				
Observations	5850		5970	
Log-Likelihood	-4637.2671		-4923.4224	
LR chi^2	3579.2296		3270.5858	
McFadden Pseudo R^2	0.2784		0.2493	
AIC	9316.5		9894.8	
AIC/N	1.593		1.657	

**** and ** correspond to p-value ≤ 1% or 5%, respectively*

Education

Estimated models suggest that respondents with a university degree have stronger preferences for area size (AREA) of smaller urban nature types (experiment B), but not for the area size of larger types of urban nature (experiment A, interaction not reported due to non-significance). These results may partially explain the statistically significant dispersion of preferences for smaller sized nature types in the attribute-only model (Table 3). However, unobserved heterogeneity for area size remains significant also in the socio-economic model for both larger and smaller nature sizes (Table 4). The interaction terms with the four ecosystem services show that the education level affects their preferences for biodiverse vegetation in both experiments, with higher educated respondents placing a greater value on urban biodiversity. The education level also affects the respondents' preferences for local temperature control (COOLING) in experiment A, and for reducing flooding risk (FLOODING) in experiment B, reflecting a stronger preference of the higher educated group for a cooling effect and flood risk reduction.

The greenness of the neighbourhood

The estimated ASC coefficient is positive and significant in both experiments, which indicates that respondents prefer placing additional urban nature above the current situation. The interaction between the greenness of the neighbourhood dummies and the ASC reveals a negative and significant coefficient for the residents of "very green" neighbourhoods, who have a stronger preference for the status quo, and thus are less likely to choose alternative plans with additional nature in their city.

Income

The dummies for the low-income group and the group who did not report their income were interacted with the tax attribute. Both coefficients are negative, but only the interaction with the low-income group is statistically significant in experiment A. This indicates that respondents who were unwilling to respond to the income question have a similar marginal disutility of every euro spent in taxes compared to the reference group (i.e., the higher-income group). The results show that the marginal disutility of paying taxes is only different for the low-income group when making choices about larger types of urban nature.

Gender

The interactions of biodiversity with the gender dummy were tested but proved insignificant in both experiments (models not reported here but available upon request). Therefore, our study does not provide evidence of a difference in preferences between men and women regarding urban nature and its characteristics.

Presence of specific types of urban nature

The dummies of the presence of various identified urban nature types were interacted with the respective attribute of the CE. All interaction coefficients appeared to be statistically insignificant (models not reported here but available upon request). Our results thus reveal that the presence of specific urban nature types in the direct vicinity of respondents has no effect on their valuation of additional nature in the city of residence.

3.2 WTP estimates

The estimated models enable us to estimate the average yearly willingness to pay in euros per household per year for additional urban nature and its characteristics. The results of the ML models (Table 3) reveal that the respondents of both experiments are willing to pay for urban nature and the four ecosystem services. Table 5 presents WTPs derived from the ML models for both experiments, Table 6 provides baseline attribute levels for the obtained WTP, and Table 7 includes two illustrative examples of new urban nature per experiment. WTP estimates of an alternative greening scenario compared to status quo option reveal how much Dutch urban residents are willing to pay for additional urban nature in the place of their residence that includes larger and smaller pieces of nature with the specified baseline characteristics (Table 6). These estimates are obtained by dividing the ASC coefficient by the tax coefficient (as defined in formulae 6). WTP for a larger piece of urban nature is thus estimated at €57.02 per year per household for an urban green corridor of 15ha in size with uniform vegetation that would correspond to the yearly risk of local flooding of 10%, local (feel) temperature decrease of 2.5C and the concentration of air pollutants of 32.5mg/m3 (experiment A); and €51.62 per year per household for a small urban nature plan with green beds of 2.75ha in size with a uniform vegetation that would correspond to the risk of local flooding of 10%, local (feel) temperature decrease of 1.25C and the concentration of air pollutants of 32.5mg/m3 (experiment B). We recall that all WTPs are stated per household per year.

Table *5*: Unit value WTP estimates based on the ML models *(*WTP in euros per household per year*)*

	WTP for larger urban nature types	**WTP for smaller urban nature types**	**Unit**
	Experiment A	*Experiment B*	
GREEN CORRIDOR (baseline)	57,02		€/year
FOREST	68,68		€/year
PARK	79,27		€/year
GREEN ROOFS (baseline)		51,62	€/year
GREEN_BEDS		57,34	€/year
GREEN_WALLS		53.60	€/year
STREET_TREES		65,46	€/year
AREA	2.16	1.15	€/ha/year
BIODIVERSITY	24.05	13,84	€/year
FLOODING	2.39	1,48	€/1% decrease of flooding risk/year
COOLING	9.37	8,85	€/1°C of local cooling/year
AIR_POLLUTION	2.07	0,37	€/1µg/m3 decrease in concentration/year

The WTP for every additional area of urban nature is valued at €2.16 per ha for larger pieces of nature and €1.15 for smaller urban nature types Urban residents are willing to pay an additional €24.05 for the presence of biodiverse vegetation if larger pieces of nature are to be added, and about a half of that, €13.84, if smaller pieces of nature are to be added, in addition to the baseline value. The WTPs for flood risk reduction and decrease in air pollution are also higher in experiment A compared to experiment B, and for bigger nature types equal €2.39 per 1% and €2.07 per µg/m3, respectively. For the smaller nature types, WTP for flood risk reduction is €1.48 per 1%, and WTP for the decrease in air pollution is €0.370 per µmg/m3. WTP for local temperature regulation is about the same size in both experiments and amounts to €9.37 and €8.85 per 1C of perceived cooling, respectively. Besides, urban residents have an outspoken preference for specific types of urban nature; they are willing to pay an additional €11.66 for placing an urban forest and €22.25 for placing an urban park, compared to a green corridor. Similarly, Dutch urban residents are willing to pay an additional €12.22 for placing street trees and €5.72 for placing green beds, compared to green roofs.

Table 6: Baseline characteristics for WTP calculations

	Baseline attribute values at estimation	**Baseline attribute values at estimation**
	Experiment A	*Experiment B*
Baseline urban nature type	Green corridors	Green Roofs
Area size:	15ha	2.75ha
Biodiverse vegetation:	NO	NO
Probability of flooding (*level*)	20%	20%
Local cooling (*change*)	2.5C	1.25C
Concentration of PM10 (*level*)	32.5 µg/m3	32.5 µg/m3
WTP per household per year	**€57.02**	**€51.62**

Table 7: Examples of WTP estimates for specific types of nature and ecosystem services

	Example 1		**Example 2**	
	Experiment A		*Experiment B*	
Urban nature type	Urban park	€ 79.27	Green roofs	€ 51.62
Area size:	25ha	€ 21.65	1ha	€ -2.01
Biodiverse vegetation	YES	€ 24.05	YES	€ 13.84
Probability of flooding (*level*)	15%	€ 11.94	20%	€ 0.00
Local cooling (*change*)	3C	€ 4.68	1C	€ -2.21
Concentration of PM10 (*level*)	25 µg/m3	€ 15.52	35 µg/m3	€ -0.93
Total WTP per household per year		**€ 157.11**		**€ 60.31**

WTP estimates as above provide information on the relative values that citizens place on each additional unit of urban nature and the four ecosystem services. Examples 1 and 2 as in Table 7 illustrate citizen WTP for a particular project or intervention with a specific set of characteristics. For example, we can infer that respondents are willing to pay €157.11 for an urban park of 25ha in area size, with biodiverse vegetation, reducing flooding risk to the level of 5%, cooling the local temperature by 3C and decreasing the concentration of particulate matter (PM10) to 25 µg/m3. Meanwhile, respondents are willing to pay €60.31for green roofs of 1ha size, with biodiverse vegetation, reducing flooding risks to the level of 10%, cooling the local temperature by 1C and decreasing the concentration of particulate matter (PM10) to 35 µg/m3. The implications of these WTP estimates in urban planning are discussed in the following section.

4. Discussion

4.1. Discussion of results and caveats

The results of the CE analysis show that citizens are willing to pay for urban nature and the fourESS included in the experiments: temperature regulation, reducing flooding risks, reducing air pollution and increasing biodiversity. The WTP estimates of the four ESS align with previous studies but are difficult to compare in exact terms due to differentiating units, definitions, locations and time. (Borzino et al., 2020 ; Chui & Ngai, 2016 ; Collins et al., 2017 ; Yoo et al., 2008).

It is, however, possible to convert the estimates of several previous studies and roughly compare these to the general WTP results of our study[2]. First, the WTP estimates of the study of Koetse et al. (2017) show that Dutch citizens are willing to pay €75.9 euro for a forest of 200ha or smaller in area size, at 1 km distance, low fragmentation and accessible. Our estimates show that Dutch citizens are willing to pay €68.78 for a forest of 15ha with the specified baseline characteristics[3]. Second, the analysis of Bertram (2017) reveals that citizens in Berlin are willing to pay €208.9 during the week and €288.8 during the weekend for an urban park of 10ha-50ha with medium maintenance and cleanliness in the park. This estimate is relatively higher than our estimates, indicating a willingness to pay €79.37 for an urban park of 15ha. Third, the study of Collins et al. (2017) estimated that citizens are willing to pay €70.23 for green walls that increase biodiversity. Our estimates show that citizens are willing to pay €65.46 for a green wall with biodiverse vegetation and the other baseline characteristics (see table 6). Last, Badura et al. (2021) estimate a WTP for biodiverse vegetation for small-scale NBS interventions of €11 (specified as Species 2). Comparable alternative scenarios were proposed in experiment B in this study, and resulted in WTP for biodiverse vegetation of €13.84.The WTP estimates of the four studies are challenging to compare because the attributes, locations and time deviate. Nevertheless, the converted WTP estimates suggest that the results for the urban forest and the urban walls are similar to the studies of Koetse et al. (2017) and Collins et al. (2017), and WTP for biodiverse vegetation in our case is comparable to the estimates of Badura et al. (2021). For the estimates of Bertram (2017), we see substantially higher WTP for urban parks in Berlin. The difference is probably caused by locational, methodological, time or demographic factors. For example, Bertram et al. (2017) focuses on the recreational value, cleanliness, and maintenance of urban parks, which are not occurrent in our experiment.

The socio-economic models reveal that citizens' preferences and WTP estimates partly depend on education level, income levels and the location variable greenness of the neighbourhood. In contrast, gender has no significant effect on the citizens' preferences in

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[2] The estimates of the studies are converted to a yearly WTP in 2020 euro's.
[3] See table 6 and 7 for the specified baseline characteristics

the experiment. This means that our estimated socio-economic model does not substantiate the hypothesis that women are more environmentally aware and willing to pay more to regulate ESS. The expected decreasing marginal disutility for income levels is only found for larger types of urban nature. No significant differences in marginal disutility were found for the smaller urban nature types across respondents with different income levels, likely due to the lower level of a municipal tax associated with smaller urban nature types. We found an effect of education on stronger preferences for the area size of smaller urban nature types for a higher educated group. In contrast, no similar effect was found for larger urban nature types. These results are remarkable because Koetse et al. (2017) show that this effect is also significant for larger urban nature types (2, 6 or 16 km2). We may speculate that this has to do with greater aesthetic appreciation of small nature by higher educated respondents (Tian et al., 2020), but further investigation is required. In addition, we have found the presence of significant unobserved heterogeneity in taste towards the area size in both cases. Our findings further suggest that the effect of education on the preferences for the four ESS varies per urban nature type. Higher education level positively affects the preferences for biodiverse vegetation in both experiments. In addition, higher education levels only affect the respondents' preferences for local temperature control in larger urban nature types and for reducing flooding risk in smaller urban types. Lastly, the perceived greenness of the neighbourhood is negatively affecting the preference for adding similar urban nature in both experiments. These results support the hypothesis of decreasing marginal returns for additional urban nature. In particular, respondents with perceived abundant urban nature in their neighbourhood place a lower value on additional nature in their city. We note that perceived urban greenness may deviate from actual levels of green nature in the neighborhood, but remains relevant as perceptions are often found to be important determinants of individual preferences (Aoshima et al., 2018; Tian et al., 2020).

We acknowledge that introduction of additional green areas may indeed have spillovers on the real estate markets, such as house price or rent rises (see for example Bočkarjova et al, 2020b addressing the related green gentrification aspect). Our data shows however no evidence in favor of association between the greenness of neighborhood and the income level in the six Dutch cities. In this study we have estimated the non-market value that residents place on urban nature. In this way, we contribute to the articulation of the social value of urban green, which can signal urban stakeholders the need of taking action on large-scale greening of urban environments, for example, by means of nature-based solutions that combine multiple functions and bring about multiple benefits to urban populations (Bočkarjova et al., 2022).

4.2. Use of valuation in urban planning

As a follow-up to our CE study, we have attempted to identify this study's value for urban planning. For this purpose, we interviewed seventeen urban planners, property developers, researchers, urban ecologists, and policy officers in two of the six cities central to this paper, namely Amsterdam and Utrecht. These cities were chosen because they are known for their ambitions to enhance urban nature (Gemeente Amsterdam, 2017; Gemeente Amsterdam, 2020; Kalkman, 2018). Using semi-structured interviews, we identified several barriers and opportunities to the use of economic valuation studies in urban nature planning.

Practitioners and planners see the most potential in using economic valuation studies as an instrument to convince other stakeholders and form alliances for a more effective greening of urban areas. At the same time, they indicate being reluctant to use these studies in standard urban planning processes because these processes are challenging to rationalise and are sceptical about the validity and usefulness of objectifying the decision-making processes through economic valuation studies.

The most practical benefit is that expressing citizens' valuation of urban nature in monetary terms can help overcome funding problems of maintenance and management of urban nature, where development and maintenance budgets are separated, and are managed by different municipal units. A property developer illustrates this problem: "Unfortunately, we also have many practical experiences of cooperating with municipalities, where we notice that we transfer a few million to the municipality, but that the same municipality has difficulties with including 50,000 euros in extra management and maintenance costs." The WTP estimates provided by this study are especially relevant for maintenance budgets because they indicate a direct societal benefit of urban nature, and so pave the way for a solution for this budget issue. In particular, this study can help convince specific stakeholders to capitalise on the value of urban nature through, for example, higher monthly contributions for the owners' associations. Alternatively, additional resources can be raised by raising municipal taxes, as on average, urban residents are willing to pay for additional green spaces in their cities. When considering the latter option, it is important to consider such aspects as distributional effects on various groups of the population, and low-income groups in particular, as well as the unpopularity of taxes overall as a financing mechanism for public projects.

However, for economic valuations to be useful for urban planners, a majority of our interviewees stressed they see several methodological limitations and implementation barriers. The most emphasised methodological limitations are the context-sensitivity of the estimated values of urban nature that lack transferability to other contexts and the hypothetical bias of the CE. The latter is been well recognised in the literature and hypothetical bias mitigation approaches are broadly practiced (Haghani et al., 2021a and 2021b). In addition, several barriers to the implementation of economic valuation of urban nature in urban planning were mentioned. First, some interviewees questioned the validity of the obtained valuations because of the stated preference approach biases (as mentioned above) and argued that citizens' preferences are less meaningful if they are not underpinned by the relevant expertise and knowledge about important aspects of urban nature planning. Second, other, more qualitative methods are used and preferred to incorporate citizens' preferences in urban planning, such as citizen consultations, which enable an open dialogue about both preferences and concerns and are a leverage for interest groups. An urban planner formulated this as follows: "So residents have quite a lot of power in the sense of, if they really want to, they can complicate such processes for a very long time. So you actually try to involve people in the planning for our process through residents' evenings." Third, valuations are only considered meaningful if they are aligned to the discourse and serve as a useful measure in urban nature planning. The interviewees stated that quantitative presentations of urban nature are only helpful if it helps to convince other stakeholders to get involved in a green project.

To bridge the gaps between the valuation and its practical use, we shall reflect on the limitations and barriers identified by the interviewed urban planners and practitioners. While hypothetical bias will remain inherent to stated preference methods including CEs, much is being done in academic practice to screen and minimise it through improved best practices such as survey protocols and estimation techniques (Haghani et al., 2021b). For example, good provision of information to the respondents and CE based on a specific project will provide more meaningful and context-specific valuations compared to a purely hypothetical setting of a CE. This touches on the other mentioned limitation of context-sensitivity and, as a result, transferability. While 'generic' estimates of urban green from studies made in 'very different places from the one where the valuation might be applied can indeed be problematic4, valuations of 'very specific' projects in a particular area may help decision-makers and planners. In particular, researchers and urban planners may collaborate in setting up joint valuations that are of meaning and purpose in a specific context. Co-designing a CE will create engagement of urban planners and practitioners and create more trust in the obtained results of a valuation.

Bridging the barriers to implementation, informedness of citizens is mentioned first. Indeed, as our study also indicated, a small part of the respondents indicated they were insecure when making a choice (2.73% of the sample) because they were not aware of how the planning and implementation of additional urban green projects work. This is a relevant concern; however, in many instances, the general public is not aware or does not have expert knowledge about inside procedures and processes but has an opinion which is still relevant in public debate and decision-making, even if it lacks the background knowledge or perception about knowledge. To mitigate this barrier, public information campaigns can be used to inform the broader public, in combination with citizen engagement activities with the residents directly affected by a particular project. This is related to barrier two, where the interviewees indicated using alternative, qualitative citizen engagement methods. Indeed, citizen consultation sessions can be of additional value to the citizens and the public authorities, as they allow a direct exchange of information, as well as opinions and concerns relevant to a specific project or context. It is important to note here that such citizen consultation activities, though useful, may not be representative of the relevant population, attracting predominantly socially active participants and leaving others behind in this important process. If used complementary to citizen engagement, CE and other stated preference methods can ensure representation of the relevant population, and supplement qualitative information with documented quantitative information on urban resident preferences. This may also be used to convince a broader range of stakeholders to engage in the implementation of urban green and blue projects, thus building an alliance for a social business case. This also addresses the third barrier of discourse alignment for various stakeholders and allows expanding the potential of urban greening projects beyond the public domain.

[4] (consider differences in climate between North-South; cultural differences; differences in the urban fabric of narrow - broad streets, and landscape like flat-hilled)

5. Conclusions

This study estimated the economic value of urban nature and its characteristics, including four ecosystem services. The study applied a choice experiment (CE) that surveyed citizens in the six largest cities of the Netherlands (i.e., Amsterdam, Rotterdam, The Hague, Utrecht, Eindhoven and Groningen). The results of the CE analysis show that citizens are willing to pay for urban nature and the four ESS included in the experiments: temperature regulation, reducing flooding risks, reducing air pollution and increasing biodiversity. Urban residents are willing to pay in particular for more extensive areas of larger urban nature types (parks, forests, green corridors), In addition to that, urban parks are valued the most after urban forests and green corridors as bigger pieces of urban nature. Within the smaller urban nature types, street trees are valued the most after green beds and green walls, whereas green roofs are valued the least. Urban residents are willing to pay the most for the increase in urban biodiversity and the cooling capacity of urban nature. The ability of urban green to decrease flood risk and improve air quality is valued substantially lower. The socio-economic models reveal that the citizens' preferences and WTP estimates depend on socio-economic characteristics, namely, education level, income levels and the location variable greenness of the neighbourhood.

The exploratory interviews in Utrecht and Amsterdam reveal that practitioners and planners are most likely to use the results of this study as an instrument to convince other stakeholders and form more effective alliances for greening projects in urban areas. Several policy and future research recommendations can be proposed. First, survey-based studies unveil citizen preferences, and provide specific information for the practitioners about the selected urban nature attributes. Practitioners can use this information to optimise their urban nature plans. Second, economic valuation studies could show how certain stakeholders can capitalise on the value of urban nature. Funding for maintenance and management of urban nature for instance, regularly mentioned as a barrier to investing in urban nature, can be facilitated if valuation studies show that citizens are willing to pay for urban nature. This opens an opportunity for prioritising budget spending or raising additional revenues through higher monthly contributions for the owners' associations. Consequently, this study can be useful for a design of a social business case for urban green management and maintenance, where different stakeholders may join forces. In particular, this could facilitate engagement of the public, accommodating the benefits that each stakeholder is willing to receive, as well as distributing the costs, whether in money terms or in kind. Lastly, it is essential to notice the importance of the context of the valuations and the limited domain where the preferences and valuations are meaningful. This paper already provides evidence of different choice- behaviours among the citizens regarding the socio-economic variables (income levels and education level) or locational variables (the greenness of the neighbourhood). These models improve the transferability of the results but capture only a portion of the potential heterogeneity in choice behaviours. Moreover, future research could explore several other context-related factors that are essential for urban planners and practitioners. This implies that the following CEs should be co-designed by researchers, urban planners and urban practitioners to minimise the potential implementation barriers and maximise the meaningfulness of the valuation studies.

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Author contributions

JAP: design of the work; analysis and interpretation of data; drafting and revision
MB: conception and design of the work; analysis and interpretation of data; drafting and revision.
WJBB: conception and design of the work; interpretation of data; drafting and revision.
HACR: conception and design of the work; interpretation of data; drafting and revision.

Data availability

Data is available upon request.

Competing interests

We have no conflicts of interest to disclose.

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Supplementary materials

Figure S1. Sample choice card (in Dutch) screenshot of the choice card in the final survey

			Voorstellen	
Kenmerken		Plan A	Plan B	Huidige situatie
Toename in oppervlakte van natuur (ha)		15 ha	10 ha	Geen verandering
Type natuur		Groene corridor	stadsbos	Geen verandering
Type beplanting		Monocultuur (één soort beplanting); Lage biodiversiteit	Wilde beplanting (meerdere soorten beplanting); Hoge biodiversiteit	Geen verandering van huidige beplanting
Kans op wateroverlast in de stad bv. door extreme regenval		Gemiddeld 10% per jaar	Gemiddeld 10% per jaar	Gemiddeld 20% per jaar; Geen verandering
Bijdrage aan stadsklimaat lokale temperatuurdaling in de zomer		Gemiddeld 3°C koeler	Gemiddeld 2°C koeler	Geen verandering
Luchtkwaliteit gemiddelde jaarlijkse fijnstofgehalte, μg/m3 (PM10)		Gemiddeld 30 μg/m3	Gemiddeld 30 μg/m3	Gemiddeld 45 μg/m3; Geen verandering
Toename in gemeentelijke belasting euro's per jaar per huishouden		75 euro	50 euro	Geen toename, huidige belasting blijft hetzelfde

Figure S2. Sample original choice card (in Dutch) – screenshot with a pop-up explaining biodiversity attribute in the final survey

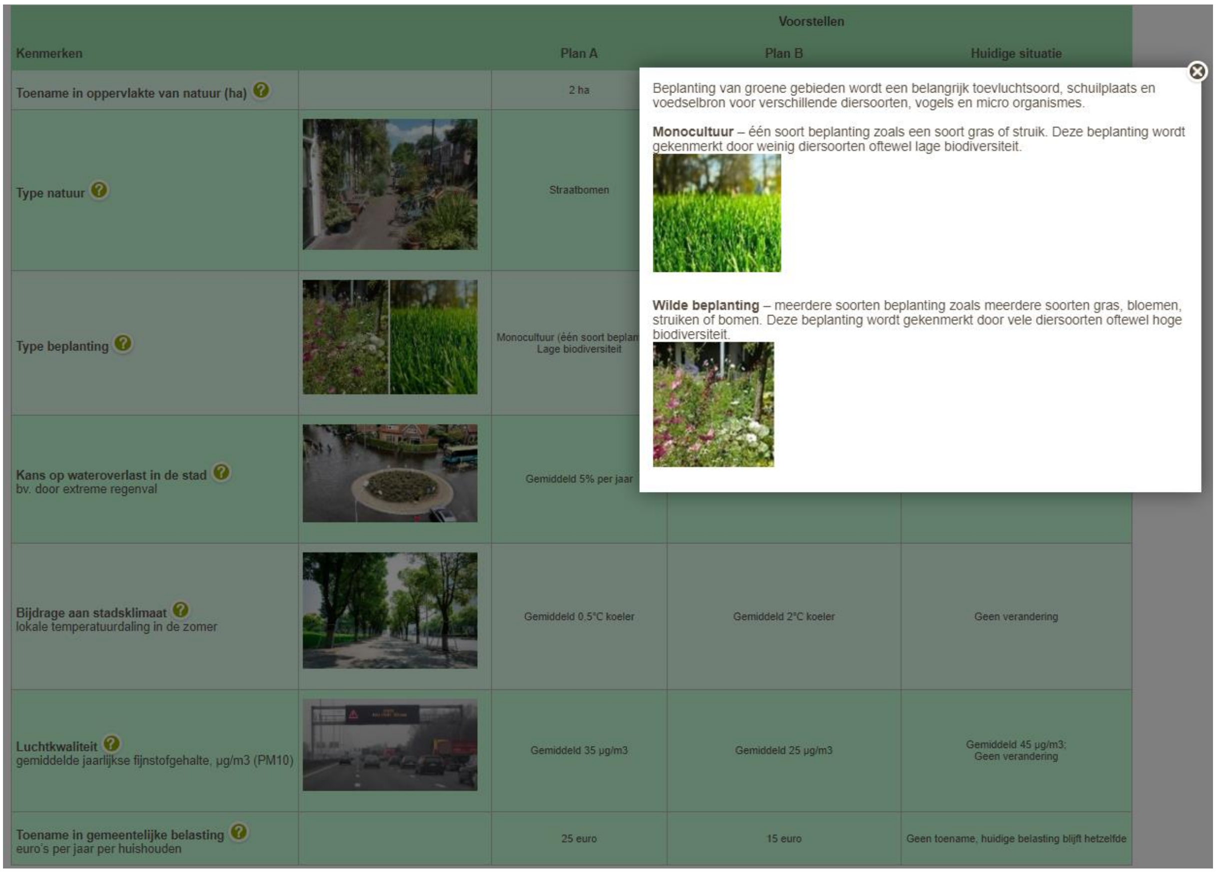

Table S1: ML models, including the protest voters

	Experiment A			Experiment B		
Variable	**Coefficient**	**SE**	**WTP**	**Coefficient**	**SE**	**WTP**
Random parameters						
AREA	0.0431***	0.0053	€2.18	0.0425**	0.0191	€1.20
FOREST	0.2321***	0.0531	€11.75			
PARK	0.4403***	0.0552	€22.24			
GREEN_BEDS				0.2127***	0.0694	€5.99
GREEN_WALLS				0.0817	0.0809	
STREET_TREES				0.4408***	0.0735	€12.42
BIODIVERSITY	0.4791***	0.0515	€24.25	0.5009***	0.0599	€14.11
FLOODING	-4.7421***	0.5564	€2.40	-5.0943***	0.6661	€1.43
COOLING	0.1858***	0.0214	€9.41	0.317***	0.0407	€8.93
AIR_POLLUTION	-0.0418***	0.0053	€2.12	-0.0125***	0.0049	€0.35
ASC	1.1458***	0.2641	€57.87	1.7058***	0.2092	€48.12
Non- random parameters						
TAX	-0.0198***	0.0012		-0.0355***	0.0022	
Dispersion						
NsAREA	0.0412***	0.0078		0.1951***	0.0421	
UsFOREST	0.0111	0.4356				
UsPARK	0.0121	0.2439				
UsGREEN_BEDS				0.9282***	0.2629	
UsGREEN_WALLS				0.8899**	0.3575	
UsSTREET_TREES				0.1245	0.4126	
UsBIODIVERSITY	1.0163***	0.1261		1.7339***	0.1272	
NsFLOODING	6.597***	1.0737		10.9538***	1.0017	
NsBCOOLING	0.22***	0.0391		0.227	0.1649	
NsBAIR_POLLUTION	0.0274**	0.0113		0.0536***	0.0087	
NsASC	4.3916***	0.2694		3.7704***	0.2295	
Estimation statistics						
Observations	5988			6066		
Log-Likelihood	-4729.1834			-4994.7952		
LR chi2	3698.6139			3338.7739		
McFadden Pseudo R2	0.2811			0.2505		
AIC	9492.4			10027.6		
AIC/N	1.585			1.653		

*** and ** correspond to p-value ≤ 1% or 5%, respectively*

Table S2: ML models excluding the respondents with problems understanding the CE

	Experiment A			Experiment B		
Variable	**Coefficient**	**SE**	**WTP**	**Coefficient**	**SE**	**WTP**
Random parameters						
AREA	0.0434***	0.0053	€2.18	0.0348	0.0201	
FOREST	0.2373***	0.0541	€11.94			
PARK	0.4461***	0.0561	€22.44			
GREEN_B				-0.1953***	0.0715	€5.46
GREEN_WALLS				0.0735	0.0825	
STREET_TREES				0.4427***	0.0751	€12.38
BIODIVERSITY	0.4806***	0.0519	€24.18	0.5014***	0.0619	€14.02
FLOODING	-4.6496***	0.5689	€2.34	-5.2636***	0.6873	€1.47
COOLING	0.1864***	0.0218	€9.38	0.3075***	0.0422	€8.6
AIR_POLLUTION	-0.0409***	0.0054	€2.06	-0.0145***	0.005	€0.40
ASC	1.1485***	0.2582	€57.71	1.6976***	0.2044	€47.41
Non- random parameters						
TAX	-0.0199***	0.0012		-0.0358***	0.0023	
Dispersion						
NsAREA	0.0422***	0.0073		0.2384***	0.0386	
UsFOREST	0.1529	0.3549				
UsPARK	0.001	0.2536				
UsGREEN_BE				0.9041***	0.2783	
UsGREEN_WALLS				0.8338**	0.4217	
UsSTREET_TREES				0.0001	0.4629	
UsBIODIVERSITY	1.0203***	0.1283		1.7797***	0.1287	
NsFLOODING	6.8991***	1.0429		11.2625***	1.0413	
NsBCOOLING	0.2235***	0.0388		0.2809**	0.1156	
NsBAIR_POLLUTION	0.0323***	0.0107		0.0526***	0.0094	
NsASC	3.9102***	0.2472		3.3307***	0.216	
Estimation statistics						
Observations	5718			5790		
Log-Likelihood	-4563.8960			-4809.1675		
LR chi2	3435.9382			3103.5951		
McFadden Pseudo R2	0.2735			0.2439		
AIC	9161.8			9656.3		
AIC/N	1.602			1.668		

*** and ** correspond to p-value ≤ 1% or 5%, respectively*

Table S3: Sensitivity analysis with different mixing distributions experiment A

	Uniform		Triangular		Normal	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Random Parameters						
AREA	0.0423***	0.0054	0.0396***	0.0058	0.0429***	0.0053
FOREST	0.233***	0.0542	0.2466***	0.0597	0.2307***	0.0534
PARK	0.4427***	0.056	0.4109***	0.0636	0.4406***	0.0553
BIODIVERSITY	0.4858***	0.0533	0.6489***	0.0621	0.4735***	0.0513
FLOODING	-4.7037***	0.577	-5.5232***	0.6489	-4.7254***	0.5634
COOLING	0.185***	0.0219	0.1734***	0.0244	0.1857***	0.0214
AIR_POLLUTION	-0.0406***	0.0055	-0.0412***	0.0056	-0.0409***	0.0053
ASC	1.615***	0.342	1.2981***	0.2654	1.1346***	0.2545
Non- random parameters						
TAX	-0.0199***	0.0012	0.0267***	0.0019	-0.0198***	0.0012
Dispersion						
Us/TS/NsAREA	0.074***	0.0126	0.1227***	0.0196	0.0414***	0.0074
Us/TS/NsFOREST	0.0215	0.4193	0.1759	0.7478	0.105	0.2061
Us/TS/NsPARK	0.0005	0.2704	0.1927	0.6555	0.0044	0.1496
Us/TS/NsBIODIVERSITY	1.0382***	0.1283	1.8385***	0.1981	0.5957***	0.0773
Us/TS/NsFLOODING	12.6628***	1.7658	17.2064***	2.92	6.9872***	1.0147
Us/TS/NsBCOOLING	0.3973***	0.0675	0.6942***	0.1007	0.2183***	0.0385
Us/TS/NsBAIR_POLLUTION	0.059***	0.0185	0.0682**	0.0333	0.0304***	0.0112
Us/TS/NsASC	7.004***	0.5422	9.5419***	0.5832	3.9186***	0.2459
Distribution	**Uniform**		**Triagular**		**Normal**	
Observations	5850		5850		5850	
Log-Likelihood	-4689.4219		-4673.47		-4671.98	
LR chi2̂	3474.9199		3506.817		3509.808	
McFadden Pseudo R2̂	0.2703		0.2728		0.2731	
AIC	9412.8		9380.9		9378	
AIC/N	1.609		1.604		1.603	

*** and ** correspond to p-value ≤ 1% or 5%, respectively*

Table S4: Sensitivity analysis with different mixing distributions experiment B

	Uniform		Triangular		Normal	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
AREA	0.0374*	0.0203	0.0397**	0.0193	0.0417**	0.0194
GREEN_BEDS	0.2167***	0.0732	0.2198***	0.07	0.2046***	0.0704
GREEN_WALLS	0.073	0.0856	0.0587	0.0815	0.0656	0.0809
STREET_TREES	0.4642***	0.0763	0.4438***	0.0738	0.442***	0.0735
BIODIVERSITY	0.5155***	0.0633	0.4973***	0.0601	0.4855***	0.0602
FLOODING	-5.2907***	0.7192	-5.3956***	0.6774	-5.28***	0.6683
COOLING	0.319***	0.0441	0.3209***	0.0419	0.3197***	0.0414
AIR_POLLUTION	-0.0118**	0.0051	-0.013***	0.0049	-0.0136***	0.0049
ASC	1.9456***	0.2526	1.9492***	0.2233	1.8605***	0.2141
Non-Random parameter						
TAX	-0.0366***	0.0023	-0.0361***	0.0023	-0.0359***	0.0022
Dispersion						
Us/TS/NsAREA	0.4017***	0.0631	0.5247***	0.0911	0.2162***	0.0397
Us/TS/NsGREEN_BEDS	1.1011***	0.2316	1.3034***	0.3841	0.5737***	0.1391
Us/TS/NsGREEN_WALLS	1.1147***	0.322	1.3735***	0.4614	0.5135**	0.2095
Us/TS/NsSTREET_TREES	0.0848	0.4091	0.1886	0.5512	0.0788	0.2312
Us/TS/NsBIODIVERSITY	1.8774***	0.1315	2.5762***	0.1892	1.0578***	0.0801
Us/TS/NsFLOODING	20.5402***	1.6358	25.9022***	2.3973	10.7811***	1.0224
Us/TS/NsBCOOLING	0.6926***	0.1728	0.8219***	0.2383	0.2985***	0.1091
Us/TS/NsBAIR_POLLUTION	0.1021***	0.0145	0.1267***	0.0216	0.0496***	0.0085
Us/TS/NsASC	5.7905***	0.398	8.509***	0.5361	3.4835***	0.2242
Distrubution	**Uniform**		**Triagular**		**Normal**	
Observations	5970		5970		5970	
Log-Likelihood	-4963.7709		-4952.1215		-4809.1676	
LR chi2̂	3189.8889		3213.1877		3103.5951	
McFadden Pseudo R2̂	0.2432		0.245		0.2440	
AIC	9965.5		9942.2		9656.3	
AIC/N	1.669		1.665		1.668	

*** and ** correspond to p-value ≤ 1% or 5%, respectively*