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Valuing Residents' Preferences for Improved Urban Green Space Ecosystem Services in Addis Ababa, Ethiopia

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Valuing Residents' Preferences for Improved Urban Green Space Ecosystem Services in Addis Ababa, Ethiopia

Dawit Woubishet Mulatu, Jessica Alvsilver, and Juha Siikamäki[1]

Abstract

The loss of ecosystems in cities may involve high long-term economic costs and severe impacts on social, cultural, and economic values. However, it is difficult to put a number on the benefits of urban green spaces. Limited research has been conducted on people's preference for urban green spaces in developing countries and how much they are willing to pay for these benefits. Thus, this research contributes to sustainable urbanization by considering preferences and the value that residents place on potential improvements to urban green spaces in Addis Ababa, Ethiopia. We found that residents would be willing to pay up to 64 Ethiopian Birr (ETB) per month (about USD 2.28) for availability of a large multi-use park close to their homestead. Residents are less willing to pay as park distance to a neighborhood increases. Their next preference was for access to a green walking or bicycling route that would give them the option to access the city without traffic congestion. For this, they would pay up to 6.8 ETB per kilometer per month. For development of spaces for urban agriculture practices, they would pay up to 4.4 ETB per month per percentage improvement. Residents also were willing to pay for urban nature restoration programs, up to 7.64 ETB per month for each percent improvement of urban forest cover. They prefer urban forest conservation to rivers and streams rehabilitation. Our results highlight that city planners should consider the variations in residents' preferences for urban green spaces and the services they provide.

JEL Codes: Q57, Q26, Q51

Key Words: urban green space, ecosystem services, nature restoration, willingness to pay, choice experiment, Ethiopia.

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1. Introduction

Sustainable Development Goal (SDG) 11 intends to “make cities and human settlements inclusive, safe, resilient and sustainable” (United Nations, 2015). Healthy urban ecosystems are the foundation for sustainable cities (TEEB 2011). Urban ecosystems provide ecosystem services with direct impacts on human health and security, such as air purification, noise reduction, urban cooling, and runoff mitigation (Gómez-Baggethun *et al.* 2013). Conserving and restoring ecosystem services in urban areas can reduce the ecological footprints of cities while enhancing resilience, health, and quality of life for their inhabitants (Gómez-Baggethun & Barton 2013). Improvement of urban green spaces and ecosystem services can promote urban sustainability (Tzoulas et al. 2007). Improving urban green areas has the potential to facilitate psychological relaxation and stress relief, provide opportunities for physical activity, and reduce exposure to noise, air pollution and excessive heat. In addition, providing equitable access to green space is an important goal of health-oriented urban policies (Braubach *et al.* 2017). Urban green spaces infrastructure planning can make urban areas more attractive for business investment and create better residential areas, which in turn can promote the clustering of economic activities. This study contributes to sustainable urbanization by using a Choice Experiment (CE) method to elicit residents’ valuation of potential improvements to urban green space ecosystem services in Addis Ababa, Ethiopia.

Over the next 50 years, a significant increase in urban population is anticipated in developing countries (UN 2008). In 2014, world population residing in urban areas reached 53% and this figure is expected to grow to 66% by 2050; in Africa, it is projected to be 56% (UNDESA 2014). In Ethiopia, urbanization has recently started increasing, especially in Addis Ababa, the capitol and by far the largest city in Ethiopia. About a quarter of the urban population in Ethiopia lives in Addis Ababa (Vandercasteelen *et al.* 2018). It is a diplomatic center for African and international politics, and more than 40% of large and medium scale manufacturing industries in Ethiopia are located in and around the city (Yohannes & Elias 2017). Thus, a study of green spaces and ecosystem services in Addis Ababa can yield important insights about urban sustainability in a context of rapid urbanization and industrialization.

The current growth trajectory of Addis Ababa is unsustainable due to extensive urban poverty, inadequate housing, severe overcrowding and congestion, and undeveloped physical infrastructure. These factors have placed green areas under extreme pressure; consumed the natural and scenic beauty of the landscape; and altered the attractiveness of the city, thereby threatening the ability of urban green areas to perform their basic ecological, social and economic functions (Mpofu 2013). The continuing growth of Addis Ababa has shrunk urban green areas to the extent that there is evidence of rising temperature and hot conditions in many neighborhoods (Abebe &

Megento 2016). The loss of ecosystems in cities may involve high long-term economic costs and severe impacts on social, cultural, and economic values associated with urban green space ecosystem services. However, valuation of urban green space ecosystem services remains one of the most difficult tasks in ecosystem services research.

The rest of the paper proceeds as follows: Section 2 presents a review of literature on urban ecosystem service valuation. In Section 3, we describe the data and our approach. Section 4 is devoted to results of the study, and Section 5 is the conclusion.

2. Review on Valuation of Urban Ecosystem Services

Valuing ecosystem services in a spatially explicit manner, and analyzing tradeoffs between ecosystem services, can help make natural resource management decisions more effective, efficient and defensible (Nelson *et al.* 2009). For instance, a meta-analysis of ecosystem services offered a mechanism to begin a conversation on the present and future role of parks within the life and the economy of Philadelphia, Pennsylvania (US) (PPA (2008). The considerable amount of empirical research to value urban ecosystem services can be roughly divided into valuation derived from market information (hedonic pricing) and non-market (stated preference) methods. [1] Regarding hedonic pricing, several studies have shown an increase in the value of properties with greater proximity to green areas and public parks, neighborhood tree cover, views of water, etc. Luttik (2000); (Tyrväinen & Miettinen 2000; Jim & Chen 2006); (Sander *et al.* 2010). In separate meta-analyses of the literature of both hedonic pricing and contingent valuation (a type of stated preference), Brander and Koetse (2011) found a significant relationship between the value of urban open space and population density and indicated important regional differences in preferences for urban open spaces. However, difficulty in identifying the neighborhood characteristics due to similarity in a specific neighborhood is one of the drawbacks of the hedonic price method. In addition (Els & Fintel 2008), As well, applying the hedonic pricing method is challenging in developing countries due to high transaction costs derived from the asymmetric information and involvement of several intermediaries in the housing market value chain, which distorts housing prices, while secondary data on housing price is usually not available in developing countries (Tsegaye & Dawit 2017).

[1] There are other methods as well. Hougner et al. (2006) applied production function (PF) and replacement cost (RC) approaches instead of stated preference methods to value key life support function in ecosystems and analysed the seed dispersal service performed by the Eurasian jay (*Garrulusglandarius*). Such an analysis called for detailed ecological information that is beyond the scope of this paper. Coles and Bussey (2000) identified the social value of urban woodlands by making comparisons with professional attitudes and conventional valuations and indicated that severe undervaluing of the social importance of woods by professionals in favor of general nature conservation guidelines resulted in failure to recognize the nature of urban woodland/community interaction. This is an interesting avenue that also is outside the scope of this paper.

In contrast to market-based valuation methods, a variety of stated preference techniques have evolved in environmental valuation literature. For instance, Lorenzo et al. (2000) assessed willingness to pay (WTP) additional taxes for urban forest preservation. When using stated preferences, the main choice is between choice modelling (CM) and the contingent valuation method (CVM). Each of these techniques has its own characteristics and hence capabilities. CVM has been used to examine willingness to pay for the recreational benefits of urban forests and tree cover (Bernath and Roschewitz (2008). The term choice modelling encompasses a range of stated preference methods (Bateman *et al.* 2002), including choice experiments. Nielsen *et al.* (2007) used a choice experiment to elicit people's willingness to pay for various choices in tree species composition, tree height structure, and presence of dead trees left for natural decay.

CVM should be chosen when the total WTP for the environmental goods and services is needed, and CM when WTP for individual attributes is required. CM is also useful if information is needed on the relative values for different attributes of an environmental good. Not all CM techniques are consistent with the underlying welfare theory; therefore, if consistent welfare estimates are needed, choice experiments are preferable (Bateman *et al.* 2002). A brief summarized review of literature related to preference for urban green space ecosystem services using a choice experiment approach is presented in Table 1.

Table 1: A Summary of Selected Valuation Studies on Urban Green Spaces and Amenities using a Choice Experiment

Urban amenities, UES and green areas	CE Attributes	Measurement	Source
Attributes for green spaces and forest in urban areas	Distance to forest	In Km	(Abildtrup *et al.* 2013)
	Distance to park/garden	In Km	
	Scenic view to green space	In Km	
	Size of house (m^2)	% (+/-)	
Attributes for cultural heritage	Conservation level	Label	(Mazzanti 2001)
	Access for public (open hours)	Hour	
	Additional services (multi-media services and additional temporary exhibitions)	Label	
Preferences for urban green spaces and peri-urban forests	Distance to peri-urban forest	In Km	(Tu *et al.* 2016)
	Distance to park	In Km	
	Scenic view of green spaces	Label	
	Size of the house (M^2)	% (+/-)	
Attributes to value street trees in urban settings	Upgrading a maximum of 8 km of streets from ‘‘Medium’’ to ‘‘High’’	(+/-) in Km	(Giergiczny & Kronenberg 2014)
	Upgrading a maximum of 20 km of streets from ‘‘No trees’’ to ‘Medium’’	(+/-) in Km	
	Upgrade from “No trees” to Islets (by creating islands in the parking places or on the road)	(+/-) in Km	
Valuing local environmental amenity (this can be applied in many country settings)	Amount (number) of outdoor community facilities	in number	(Lanz & Provins 2011)
	Street cleanliness	Label	
	Improvements to public areas	Label	
	Green routes	Km	
	Location of improvement	Label	
	Improvement in open spaces	ha	
	Restoration of derelict properties or areas	in number	
Preferences for and willingness to pay for Public Rights of Way (PROW)	Physical characteristics and structures	Label in %	(Morris *et al.* 2009)
	Signposts and information	Label in %	
	Path facilities	Label in %	
	Local importance	Label in %	
The benefits of urban green space and the built environment (green space attributes or component characteristics of these locations)	Size of the green spaces	All presented in label form	(Bullock 2004)
	Maintenance of the green space		
	Tree cover		
	Water body availability inside the green space		
	Availability of playing facilities		
	Facilities within the green space		
	Green space crowding		

CE is still limited in developing countries. We employ a choice experiment to assess households' preferences for various attributes of proposed improvements to urban ecosystem services. Thus, this study contributes to the limited research in valuation based on preferences in a developing countries context. We considered two choice program scenarios: (1) an urban green areas and economic space development program for urban agriculture and (2) a nature restoration program.

3. Background, Data and Methods

3.1 Background

Addis Ababa has urban forest stretching from the northwest to northeast of the city, but it faces the challenges of built-up area expansion. The city has very low public park coverage, corresponding to $0.7m^2$/person (BPCDAA 2017). There are a total of 11 public parks with a total area of 122 ha. An additional 342 ha of land is planned to be allocated for public parks.

About ~5120 hectares (ha) of land potentially could be used for urban agricultural practices, to improve the life of the urban poor, as a source for biomass fuel, and to absorb CO2 emission. At present, only ~300 ha of land are used for urban agriculture (CLUVA 2012).

The city has a total of seven big rivers, with six medium-sized and 75 small rivers forming a network in the city. These have the potential to provide irrigation for urban agriculture. However, the presence of illegal settlement, urban population growth, and pollution from different sources is threatening the biodiversity and ecosystem of these rivers (CLUVA 2012).

Addis Ababa's land use plan has identified 41% of the total land (about 22,000 hectares) for green area facilities and development. The plan's environmental and climate considerations are reflected in the decision to construct 15-meter buffer zones intended to protect residents from flooding and to clean the rivers.

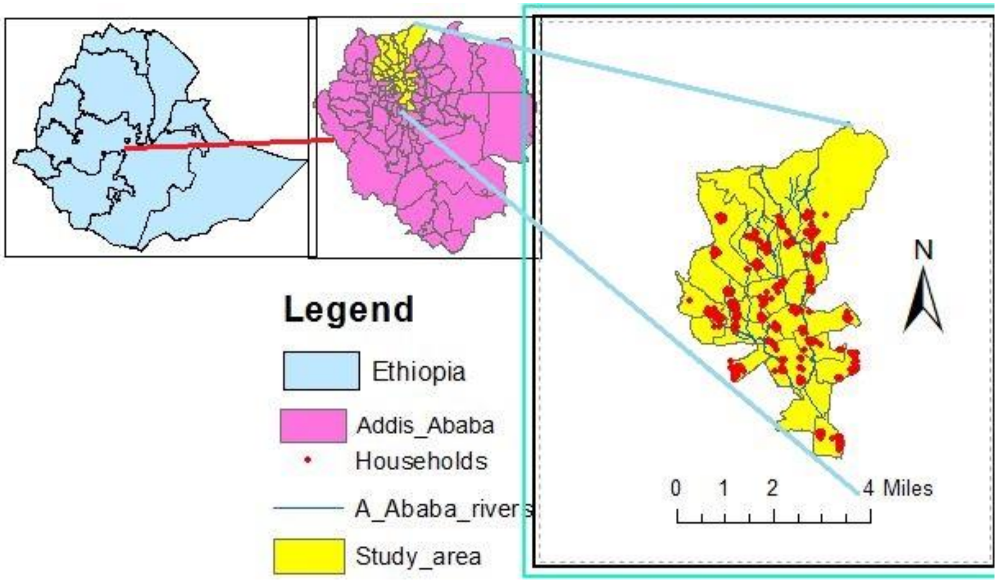

Figure 1: Study Area

Recently, the city administration established a new program to address urban green space challenges, including cleaning up rivers, riverside development, and climate change adaptation. The program aims to remedy the serious environmental effects of pollution and habitat degradation of rivers and riversides in Addis Ababa and plays a significant role in the realization of the vision of a livable city. Improvements to access and availability of parks, green-belts, green routes and open spaces are also part of this program. The program plans to adopt a community development approach: that is, facilitating people to discuss, recognize and define their needs and priorities, and involving them in planning and implementation of alternative interventions. Creating an enabling environment is a main piece of this program, in order to motivate the community, mobilize resources, and improve institutional capacity. We use the proposed interventions in this program as foundational for both choice experiment programs to elicit resident preferences for urban green spaces. The improvements proposed in the choice experiment focus on improving green areas, economic space development (including green walking/biking routes and urban agriculture), nature restoration, and rehabilitation of the main river lines and sources of the rivers in the city.

3.2 Data

The survey was conducted around the center and northern part of Addis Ababa during October-November, 2016. This area constitutes five sub-cities, which comprise twenty-one districts of the sub-cities. The area covers the major part of the city, including the main river lines and sources of the rivers in the city, namely the ‘BanteYiketu’, ‘Kechene’, ‘Kurtume’, and ‘Kebena’ rivers.

A stratified multistage and random sampling technique was applied to select sample households. In the first stage of sample selection, 700 primary sampling units, consisting of Enumeration Areas (EAs) in the five sub-cities, were drawn from the Addis Ababa sampling frame database of the 2007 Population and Housing Census of Ethiopia. 237 EAs were identified within the buffer area of the major rivers and river lines identified above. To conduct our survey, 40 EAs were randomly selected out of the 237 EAs. On average, an enumeration area contains a range of 150-200 households. In each of these sampling domains, the sampling units were drawn with a probability proportional to their size, and households were drawn with an inverse probability such that the sample is self-weighted within the domain. Prior to setting the number of sample households, a design effect (DEFF) was conducted to estimate the minimum sample size required for this survey, and we found a minimum of 633 households should be surveyed for this study. Thus, we determined to sample 640 households.

In the second stage, an equal probability systematic selection of sixteen households per enumeration area was carried out using a random walk pattern approach, which was conducted during the main survey. A sampling starting point within each enumeration area was purposefully selected in order to have sufficient representation in the sample from all four quadrants of the enumeration area. The identification of the sample starting point in the enumeration area was performed by taking a GPS coordinate point around the central part of the enumeration area and visualizing the selected X and Y coordinates to plot a point on the map. The selection procedure was: for densely populated enumeration areas ≥ 175 households, the walk pattern was considered the skip for every 15^{th} household. For less densely populated enumeration areas < 175 households, the walk pattern was considered the skip for every 10^{th} household.

The household questionnaire was prepared and pre-tested through a pilot survey that was conducted on twenty households. The pre-test results were discussed with enumerators and supervisors, and necessary changes were made following the households' response before the final survey. The local language, choice cards, and illustrative pictures were used to explain the survey questionnaires and the choice sets. To complement the experimental data, a survey was conducted to collect data on socioeconomic characteristics of the respondents. The survey included questions related to urban ecosystem services in the city.

3.3 Choice Experiment Method

The choice experiment method has its theoretical grounding in Lancaster's model of consumer choice (Lancaster 1966), and its econometric basis is a Random Utility Model (RUM) (McFadden 1974). Under random utility theory, it is assumed that the utility function is comprised of two parts: a deterministic or "observable" and a random or "unexplained" component (Hanley *et al.* 2001). To illustrate the basic model behind the choice experiment presented in this study, consider a respondent's choice for an urban green space ecosystem services improvement scenario and assume that utility depends on choices made from a set C, which includes all the possible urban green space ecosystem services improvement scenario alternatives. Following Lancaster's model of consumer choice, the respondent's utility function (U_{ij}) for individual *i* and alternative *j* can be explained as:

$$U_{ij} = V(E_j, S_i) + \varepsilon(E_j, S_i) \tag{1}$$

The utility function is decomposed into the observable component *V* (.), i.e., the attributes of improvement in urban ecosystem services (E_j), the socioeconomic characteristics of the respondent (S_i), and the unobservable influences on individual choice ε. The presence of the random component permits probabilistic statements about respondents' behaviour. Choices made between alternatives will be a function of the probability that utility associated with particular option is higher than other alternatives (Rolfe *et al.* 2000; Greene 2003). An individual *i* will choose option *j* over some other option *k* iff$U_{ij} > U_{ik}$ for all $k \neq j$. This leads to the expression for the probability of a choice:

$$P_{ij} = P(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik});\ \forall\ \mathrm{k} \in \mathrm{C} \tag{2}$$

where *k* is any option in a given choice set (i.e., choice set C). Different assumptions about the distribution of the random component yield different models. The model in Equation 1 can be estimated using a conditional logit (CL) model. The CL model assumes that the random components are distributed independently and identically (IID) with a Weibull distribution and choices are consistent with the independence of irrelevant alternatives (IIA) property (Train 2003). The IIA property states that the relative probabilities of two options being chosen are unaffected by the introduction or removal of other alternatives (Greene 2003). As a result, the CL model to be estimated for the probability of an individual *i* choosing option *j* takes the following form:

$$P_{ij} = \frac{\exp(V(E_{ij}, S_i))}{\sum_{k \in C} \exp(V(E_{ik}, S_i))} \tag{3}$$

In general, the conditional indirect utility function is estimated as:

$$V_{ij} = \beta + \beta_1 E_1 + \beta_2 E_2 + \ldots + \beta_n E_n + \delta_1 S_1 + \delta_2 S_2 + \ldots + \delta_m S_m \tag{4}$$

where β is the alternative specific constant (ASC) which captures the effects on utility of any attributes not included in choice specific attributes (Hanley *et al.* 1998; Birol *et al.* 2006). The vectors of coefficients β_1 to β_n and δ_1 to δ_m are attached respectively to the vector of urban ecosystem service improvement scenario attributes (E) and the vector of socioeconomic characteristics (S). If the IIA property is violated, then the CL model result will be biased and hence a discrete choice model that does not require the IIA property should be applied – for instance, the heteroskedastic extreme value (HEV) model, random parameter logit (RPL) or mixed logit (MXL) model, or generalized multinomial logit (GMNL) model (Hanley *et al.* 2001; Train 2003; Hole 2007). The mixed logit model accounts for preference heterogeneity, does not exhibit the IIA property, and explicitly accounts for correlations in unobserved utility over repeated choices by each respondent (Revelt & Train 1998; Hoyos 2010). Because the mixed logit model is not restricted by the IIA assumption, the stochastic part of the utility may be correlated among alternatives and across the sequence of choices via the common influence of τ_i. Treating preference parameters as random variables requires estimation by simulated maximum likelihood. The mixed logit model to be estimated for the probability of an individual *i* choosing option *j* takes the following form, and Equation (3) now becomes:

$$P_{ij} = \frac{\exp\left(V\left(E_j(\beta+\tau_i), S_i\right)\right)}{\sum_{k \in C} \exp\left(V\left(E_k(\beta+\tau_i), S_i\right)\right)} \tag{5}$$

Individuals' preference weights may also be subject to 'scale' heterogeneity whereby some individuals make more random choices compared to others. Generalized multinomial logit (GMNL) models have recently been developed to deal with such heterogeneity (Louviere *et al.* 2008; Fiebig *et al.* 2010). The GMNL model is a more general case that nests mixed logit (MIXL) and 'scale heterogeneity' multinomial logit (SMNL) models. It allows for both preference and scale heterogeneity. In a MIXL model, the attribute coefficients are assumed to be randomly distributed, indicating preference heterogeneity, meaning that heterogeneity in responses is due to an individual having a strong preference for some attributes, compared to other respondents. Researchers argue that much of the heterogeneity in attribute weights is accounted for by a pure scale effect (i.e., across consumers, all attribute weights are scaled up or down in tandem) (Fiebig *et al.* 2010). This implies that choice behavior is simply more random for some respondents than others (i.e., holding attribute coefficients fixed, the scale of their error term is greater). This leads to a "scale heterogeneity" multinomial logit model (S-MNL), a much more parsimonious model specification than MIXL (Gu *et al.* 2013). In the S-MNL model, it is assumed that, for some respondents, their responses in general are more random compared to other respondents, such that, with attribute coefficients fixed, preference heterogeneity is assumed to be due to differences in the scale of the idiosyncratic error term (scale heterogeneity) (Gu *et al.* 2013). Therefore, to account for both preference and scale heterogeneity, we estimated the S-MNL, MIXL and G-MNL models on proposed choice experiment programs in Addis Ababa, Ethiopia. Accounting for scale heterogeneity enables us to account for "extreme" respondents who exhibit nearly lexicographic preferences, as well as respondents who exhibit very "random" behavior (Fiebig *et al.* 2010).

The assumption of a fixed cost/payment or willingness to pay coefficient is made because keeping at least one parameter constant facilitates estimation. In that case, the distribution of the marginal willingness to pay (MWTP) is then simply the distribution of the random parameter (Birol *et al.* 2006; Asrat *et al.* 2010). Once the parameter estimates have been found, a compensation variation (CV) or welfare measure in CE studies which validates to demand theory can be derived (Hanemann 1984; Bateman *et al.* 2002). A welfare measure can be estimated as:

$$CV = \beta_y^{-1} \ln \left\{ \frac{\sum_{j \in C} \exp(V_j^1)}{\sum_{j \in C} \exp(V_j^0)} \right\} \tag{6}$$

where CV is the welfare measure, and (V_j^0) and (V_j^1) represent the indirect utility functions before and after the optional changes in urban ecosystem services. The coefficient β_y gives the marginal utility of income and is the coefficient of the cost/monetary attribute in the CE. It is then straightforward to show that, for the linear utility index of Equation 1 (Hanley *et al.* 2001), the marginal value of a change in a single urban green space ecosystem service attribute can be represented as a ratio of coefficients, where Equation (6) reduces further to:

$$MWTP = -1\left(\frac{\beta_E}{\beta_y}\right) \tag{7}$$

where β_E is the coefficient of any of the attributes of the urban green space ecosystem service; these ratios are often known as implicit prices and show the MWTP for a change in any of the attributes to improve urban ecosystem services. The implicit prices are useful to demonstrate the trade-off between attributes. A comparison of the implicit prices of attributes affords some understanding of the relative importance that respondents hold for them. On the basis of such comparisons, policy makers are better placed to propose alternatives interventions in green space development in cities and to understand the effect of policy changes.

3.4 Choice Experiment Design

In choice experiments, respondents are presented with a number of choice sets consisting of a menu of alternatives. They are asked to choose their preferred alternative from each of these choice sets. In order to construct the choice set, we employed both demand side and supply side approaches (Sangkapitux *et al.* 2009). Under the supply-driven approach, attributes were identified from what policy-makers and researchers perceive to be factors that can be influenced by policy measures. We explored the available policy and research documents on urbanization, climate resilient green economy, urban green infrastructure development, proposed master plan of the city, and policy and strategy documents to maintain parks and green spaces in Addis Ababa (CLUVA 2012; FDRE 2012; Mpofu 2013). Experts, practitioners and city planners were also involved in the development of the choice attributes. For the demand side approach, four focus group discussions (FGDs) were conducted with the residents, experts and practitioners in Addis Ababa in four different places.

Eventually, we developed two program scenarios. The first is improved access and facilities for urban green areas (parks), green walking/bicycling routes plus economic space development for irrigated urban farm plots that make use of the cities' rivers. We call this the "parks, paths and plots" program. The second is a "nature restoration and conservation program" that includes both forest conservation and river rehabilitation. The valuation scenarios and attributes were presented to respondents before the choice exercise using a scenario description that clearly explained the proposed programs.

For the "parks, paths and plots" program, four attributes were selected: local parks, large multi-use parks, walking and cycling routes, and urban agricultural space. Four levels were proposed for each attribute; for instance, Level 1 would be a nearby park, Level 2 somewhat farther, etc. The status quo of 'no improvement' was also included as a choice (Hanley *et al.* 2001). In addition, a cost/payment attribute was presented at four different levels (plus zero cost for the status quo); this is required to estimate welfare changes. To design the final CE for parks, paths and plots, the combination of all attributes and their levels resulted in a full factorial of 216 ($2*3^3*4$) different alternatives. However, it is obvious that the full factorial combination is more than respondents can be expected to cope with (Hanley *et al.* 2001). The selected attributes and their levels are reported in Table 2. Given the attributes and their levels, a total of 16 choice sets were constructed using D-efficiency, with the D-error sufficiently low, using statistical software package-STATA 14.0®. The choice sets consisted of only the main effects and are independent of two-factor interactions (Table 2). These choice sets were randomly assigned into two groups and presented to respondents where each household had to make eight choices. Three alternatives, plus the status quo, were presented to respondents in each choice set. Figure 2 is an example of a choice set that was presented to respondents for the parks, paths and plots scenario.

Similarly, for the urban nature restoration and conservation program, two attributes (forest conservation and rivers and streams rehabilitation) were presented to respondents, at four possible levels of these amenities (plus the status quo), along with different levels of cost. The combination of all attributes and their levels resulted in a full factorial of 36 (3^2*4) different alternatives. The selected attributes and their levels are reported in Table 3. A total of 8 choice sets were constructed using D-efficiency with the D-error sufficiently low, using STATA 14.0®. Again, the choice sets consist of only the main effects and are independent of two-factor interactions. These choice sets were randomly assigned into two groups and presented to respondents, where each household had to make four choices. Three alternatives were identified and presented to respondents in each choice set. An example of a choice set for an urban nature restoration and conservation program is presented in Figure 3.

Table 2: Description of Attributes and Levels used in the CE for "Parks, Paths and Plots" Program

No	Attributes	Description of the Attribute	Status quo	Level I	Level II	Level III	Level IV
1	Availability of large multi-use parks (LMUP) in your district (per district)	Large multi-use parks are areas covered with grass, trees, shrubs or other urban vegetation and green spaces that people can use for activities such as walking, picnics, cycling, sunbathing and relaxed games. ○ Featuring sports facilities, kids' play areas, benches for relaxation, tree and open green areas ○ Has basic removal of litter and toilet facilities ○ The size of the park may vary by location, but will be on average five football fields ○ Upkeep of grass and planted areas (e.g. regular cutting).	None that meet criteria of LMUP Parks are only available with limited facilities and access	1 park per district	2 parks per districts		
2	Access to neighborhood or nearby parks (NHP) (in minutes)	Refurbish (or build new neighborhood park if it does not exist) ○ Located near residential areas ○ Has basic toilet and litter and waste bin facilities ○ Featuring kids' playground, trees and open green areas, and benches for relaxation, picnic areas and lighting ○ The size of the park is similar to a football field ○ Neighborhood park's expected proximity to your home in minutes	There are NHP within 10 minutes walk from home but the facilities are not in place	15 minutes	20 minutes	30 minutes	
3	Availability and access to Green Routes (GR) for walk and cycling route (per kilometer)	○ Green route is for travel between home, shops, schools, and workplaces, or as a means of leisure and recreation ○ It provides access to other areas along paths that are bordered by trees and other plants ○ It is free from traffic congestion ○ It enables increased access and amount of walking and/or cycling on paths that avoid busy roads and have easy access to different places within the city.	Zero Km	2.5Km	5 Km	12 Km	
4	Accessible land for urban irrigated agriculture practices (UAP) (per ha, percentage)	○ Availability of areas for fruit and vegetable farm (gardens) ○ Production using irrigation around the rivers and riversides of Addis Ababa ○ Creating spaces for livelihood activities as well as consumption	~300 Ha (About 7%)	450 Ha (About 10%)	730 Ha (About 17%)	1100 Ha (About 26%)	
5	Monetary attribute (Ethiopian Birr[2] per month[3])	Payment to access and for improvements of the local environment will be paid by the city council. Payments will ensure that the improvements are maintained and the urban green space ecosystem services will be provided sustainably. Payments will be additional – i.e. on top of – the current payment for city trash pick-up services any costs residents incur during park visits in Addis Ababa. The proposed mode of payment will be collected with the monthly water bill.	No-payment/cost (Zero)	10	25	40	75

[2]The exchange rate during the survey was 1 US Dollar=22.8 Ethiopian Birr
[3] We found the ranges for the values for the monetary attribute from the four FGDs. We used an average from each FGD and level.

Urban green amenities attributes	**Illustrative pictures**	**Choice 1**	**Choice 2**	**Status quo**
Availability of large multi-use parks (LMUP) in your district		Two LMUP	One LMUP	No Program
Access to neighborhood or nearby parks (NHP)-per minute		20 Min Walk from home	30 Min Walk from home	
Availability and access to Green Routes (GR) for walk and cycling route (per Kilo meter (Km)		12 Km	2.5 Km	
Accessible land for urban agriculture practices: (Urban_agri_per- Hectare)		730 Ha (About 17%)	1100 Ha (About 26%)	
Monetary attribute (Ethiopian Birr per month)		40 Birr	75 Birr	
Choice 1 ☐	Choice 2 ☐		Status quo ☐	

Figure 2: Example of a Choice Set for ”Parks, Paths and Plots” Program

Urban nature restoration attributes	**Pictures to be added**	**Choice 1**	**Choice 2**	**Status quo**
Urban forest conservation and restoration		About 20% (1140 ha)	About 5% (285 Ha)	**No Program**
Rivers and streams rehabilitation and conservation		About 20% (800 Ha)	About 10% (420 Ha)	
Monetary attribute (Ethiopian Birr per month)		50 Birr	25 Birr	
Choice 1 ☐	Choice 2 ☐		Status-quo	☐

Figure 3: Example of a Choice Set for Urban Nature Restoration and Conservation Program

Table 3: Description of Attributes and Levels used in the CE for Urban Nature Restoration and Conservation Program

Attributes		**Level I**	**Level II**	**Level III**	**Level IV**
Urban forest conservation and restoration	Currently, based on the current master plan of Addis Ababa, about 22,000 ha or 41% of the total area of Addis Ababa is reserved for green space, of which more than half (about 12,500 ha) is foreseen for forestry. Of the total 22000 ha proposed for urban greenery, about 10000 ha are being used for other purposes. On average about ~5700Ha of forest area are currently used for other purposes in Addis Ababa. All other forest areas currently used for other purposes (about 5700 hectares) could benefit from this restoration and improved conservation program. At the maximum, the program is considering targeting about 20% (about 1140 hectares) of all forests currently in need of restoration and conservation. The program would select the forests in greatest need of improvements.	5% 285 ha	10% 600 ha	20% 1140 ha	
Rivers and streams rehabilitation and conservation	The current area of rivers and streams in Addis Ababa is about 4,200 hectares and total length of 600 kilometers. No rivers and streams are currently sufficiently rehabilitated and conserved. Therefore, all rivers and streams could benefit from rehabilitation and improved conservation. At the maximum, the program would target about 20% (about 800 hectares and 120 kilometers) of all rivers and streams in need of restoration and conservation. The program would select rivers and streams in greatest need of improvements.	5% 200 Ha	10% 420 Ha	20% 800 Ha	
Monetary attribute (Ethiopian Birr per month)	Payment to improve the nature areas of the city will be paid for by the city council. The proposed mode of payment will be collected with your monthly water bill.	10	20	25	50

4. Results

4.1. Descriptive Statistics

The overall socioeconomic, living conditions and housing characteristics of the households that took part in the survey are presented in Table 4. A few salient points are that about 85% were literate (whether they had formal or informal education) and that about 86% of the respondents had lived in the area for more than five years. About 74% of the houses did not have access to a landscape view.

Table 4: Socioeconomic, Living Condition and Housing Characteristics of the Households

No	Description	Percentage	
1	Head of the household		
	Male		57.3
	Female		42.6
2	Marital status		
	Married		49.5
	Divorced or widowed		34.5
	Never Married		10.3
	Married but not living together		4.8
3	Respondents		
	Head or spouse of the household		72
	Not head but decision maker of the house		28
4	Education level		
	Formal education		76.8
	Informal education (they can read and write)		7.8
	Illiterate		15.4
5	Toilet facility		
	Flush toilet		6.6
	Pit-latrine, private		26.6
	Pit-latrine, shared		66.4
6	Houses with main construction materials are wood, mud and cement		90.4
7	Households that have done renovation work to their house (in the last five years)		60
8	Access to piped water		91
9	Access to private electricity meter		80
		Mean	**SD**
10	Family size	4.67	2.11
11	Household member under 18 years old	1.21	1.21
12	Household member over 65 years old	0.33	0.56
13	Separate rooms per household	2.72	1.62

Most of the households (~91%) had access to piped water and their major system to eliminate solid wastes was pick-up by the municipality. This is important because the proposed costs of the new amenities were framed in relation to the current costs and bills for these services. However, sanitation services are limited, and have an impact on urban ecosystem services related to the rivers. Only 12% of the households have a separate bathroom facility. Only 5.8% have a flush toilet. About 26% had a private pit latrine and 67% used a shared pit-latrine. About a third of the respondents use the rivers to dispose of solid and liquid waste; in fact, only 36% said they used the river for any purpose, and waste disposal was the purpose for 96% of river “users”. When asked about the impacts of living near a river, the impacts cited were overwhelmingly negative. About 69% of all respondents complained of a bad smell from the river. Flood risks, landslides, and a hiding place for criminals were also concerns.

About 85% of the respondents believed in the importance of having easy access to information about green spaces. However, about 27% of the households did not visit park areas and about 53% visited parks less than once per month. This suggests that distance is an important attribute; in fact, 96% of the respondents preferred to have more parks nearby. More than 93% of the respondents preferred a maximum 30 minutes' walking distance to reach the nearest park and green areas. About 18% of the respondent proposed that human interference should be restricted to reduce the negative impacts of urban residents on rivers and riversides and nearly 72% of the respondents suggested that rivers and riversides should be secured areas for urban ecosystem services.

4.2 Empirical Results

The responses were free from protest respondents; all respondents were willing to participate and to pay for the proposed program interventions to bring improvements to the urban environment. The respondents choose one of the proposed alternatives in most cases. The no-program option (status-quo or base alternative) was chosen in only 2.4% of the cases in the choice set for the urban green areas and economic space development program and 2.1% of the cases in the choice set for the nature restoration program. The validity of the IIA assumption was tested using the Hausman test and the result presented in Table 5, with a restricted number of choices and with the full number of choices for the two programs. The IIA assumption test result revealed that excluding the choice was not accepted in all the models, except in cases when the status quo option was dropped for the "parks, paths and plots" program, indicating that the IIA property was violated in many of the cases (Hensher *et al.* 2005). Accordingly, we applied a model that does not exhibit the IIA property, the mixed logit model (Greene 2003; Birol *et al.* 2006). To account for scale and preference heterogeneity using different model specifications, we also estimated a generalized multinomial logit model. Allowing such heterogeneity leads to a further substantial improvement in model fit and estimation (Fiebig *et al.* 2010).

Table 5: Hausman Test for IIA Assumption

Conditional logit model for	**Choice dropped**	**Chi.Sq (5) (χ^2)**	**P-value**
"parks, paths and plots" program	Choice 1	46.71	0.000
	Choice 2	13.38	0.037
	Status-quo	-11.29[4]	
Nature restoration program	**Choice dropped**	**Chi.Sq (3) (χ^2)**	**P-value**
	Choice 1	108.91	0.000
	Choice 2	76.87	0.000
	Status-quo	241.11	0.000

The mixed logit model and generalized multinomial logit models are estimated with simulated maximum likelihood, using Halton draws with 500 replications (Hensher & Greene 2003; Train 2003), using the statistical package STATA version 14.0. In the models estimation, all choice attributes except for cost/payment attribute were specified to be normally distributed (Carlsson et al. 2003). The ASC for the status-quo alternative has been included in the model as a dummy variable, coded as one for the status-quo alternative, and zero otherwise (Train 2003). It is highly significant and has a negative sign, indicating that utility improves in any move away from the status-quo and people were more likely to prefer the choice alternatives than the status-quo option. This result indicated that the average effects of factors other than the urban green areas and economic space development attributes on individual household behavior are captured.

[4]We cannot reject the IIA assumption when the status-quo option is dropped for the urban green areas with the economic space development program for green routes and urban agriculture, implying there is no evidence that the IIA assumption has been violated in this case.

Table 6: MIXL and GMNL Models Estimate for "Parks, Paths and Plots" Program [5]

Variables	**MIXL (M1)**	**Scale Heterogeneity S-MNL (M2)**	**Random Effect S-MNL (M3)**	**Correlated random coefficients**		
Mean Parameters				**GMNL (M7)**	**GMNL With Random ASC(M8)**	**GMNL With Fixed ASC (M9)**
ASC	-4.222***(0.169, 0.000)	-6.062***(0.291, 0.000)	-10.346***(1.273, 0.000)	-	-18.001***(2.726, 0.000)	-6.899***(0.443, 0.000)
Availability of large multi-use parks (LMUP)	0.470***(0.053, 0.000)	0.228***(0.043, 0.000)	0.427***(0.044, 0.000)	1.060***(0.071, 0.000)	2.803***(0.541, 0.000)	1.663***(0.271, 0.000)
Access to neighborhood parks (NHP)	-0.029***(0.0044, 0.000)	-0.038***(0.004, 0.000)	-0.028***(0.0035, 0.000)	-0.010***(0.005, 0.000)	-0.166***(0.030, 0.000)	-0.092***(0.014, 0.000)
Access to Green Route (GR)	0.047***(0.006, 0.000)	0.028***(0.006, 0.000)	0.0427***(0.024, 0.000)	0.097***(0.008, 0.000)	0.129***(0.028, 0.000)	0.074***(0.013, 0.000)
Economic spaces for urban agriculture practices (UAP)	0.0253***(0.0001, 0.000)	0.0015***(0.004, 0.000)	0.021***(0.018, 0.000)	0.060***(0.005, 0.000)	0.138***(0.026, 0.000)	0.053***(0.008, 0.000)
Payment/cost	-0.026***(0.0001, 0.000)	-0.0419***(0.0001, 0.000)	-0.0287***(0.002, 0.000)	-0.0193***(0.0016, 0.000)	-0.110***0.017, 0.000)	-0.073***(0.008, 0.000)
Standard deviation (SD)						
Availability of large multi-use parks (LMUP)	-0.898***(0.06, 0.000)	-	-			
Access to neighborhood parks (NHP)	0.068***(0.005, 0.007)	-	-			
Access to Green Route (GR)	0.067***(0.011,0.000)	-	-			
Economic spaces for urban agriculture practices	0.074***(0.005, 0.000)	-	-			
ASC			5.265***(0.798, 0.000)			
/111				0.087***(0.013, 0.000)	0.138***(0.032, 0.000)	-0.085***(0.015, 0.000)
/121				0.027**(0.011, 0.016)	0.103***(0.019, 0.000)	-0.069***(0.011, 0.000)
/131				-0.308***(0.104, 0.000)	-0.041(0.126, 0.743)	-0.372***(0.099, 0.000)
/141				-0.017(0.013, 0.182)	-0.131***(0.034, 0.000)	0.029**(0.010, 0.004)
/151				-	-0.389(0.547, 0.477)	-
/122				0.068***(0.008, 0.000)	0.106***(0.020, 0.000)	0.099***(0.016, 0.000)
/132				-0.161(0.100, 0.106)	3.481***(0.609, 0.000)	1.134***(0.176, 0.000)
/142				-0.038***(0.011, 0.000)	-0.168***(0.036, 0.000)	-0.086***(0.015, 0.000)
/152				-	-0.018(0.540, 0.973)	-
/133				-0.676***(0.074, 0.000)	-0.539***(0.117, 0.000)	-1.765***(0.242, 0.000)
/143				0.087***(0.010, 0.000)	0.112***(0.024, 0.000)	0.066***(0.013, 0.000)
/153				-	-4.130***(0.716, 0.000)	-
/144				0.009(0.023, 0.678)	-0.018(0.020, 0.364)	0.125***(0.020, 0.000)
/154				-	5.751***(0.920, 0.000)	-
/155				-	0.468(0.637, 0.462)	-
tau (τ)	-	1.68***(0.090, 0.000)	0.943***(0.13, 0.000)	0.518***(0.059, 0.000)	2.017***(0.138, 0.000)	1.546***(0.101, 0.000)
Wald Chi2 (4)	-	561.19	271.70	492.23	55.33	245.28
Number of respondents	640	640	640	640	640	640
Number of Obs.	15360	15360	15360	15360	15360	15360
LL	-3421.12	-3425.00	-3371.84	-3866.63	-3172.31	-3217.08
AIC Akaike Information Criterion)	6862.24	6864.01	6759.68	7765.26	6388.62	6468.16
BIC (Bayesian Information Criterion)	6938.64	6917.49	6820.80	7887.49	6556.69	6598.03

[5] We also estimated the uncorrelated random coefficients with different specification as Models M4, M5, M6, presented in Appendix 1 for reference.

*Significant at * 10%, ** 5% and *** 1%. The standard errors and p-value are presented in parentheses. The sign of the estimated standard deviations is irrelevant: interpret them as being positive.*

Table 7: Marginal Willingness to Pay (Ethiopian Birr/month and equivalent USD/month) for each Model Estimates of "Parks, Paths and Plots" Program

	MIXL (M1)		**Scale Heterogeneity S-MNL (M2)**		**Random Effect S-MNL (M3)**		**Uncorrelated GMNL (M4)**		**Uncorrelated GMNL With Random ASC (M5)**	
Program attributes	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month
Availability of large multi-use parks (LMUP)/district	18.09*** (2.08; 0.000)	0.79	5.45*** (0.898; 0.000)	0.23	14.86*** (2.133; 0.000)	0.65	63.68*** (0.898; 0.000)	2.79	23.27*** (1.603; 0.000)	1.02
Access to neighborhood parks (NHP)/minute	-1.14*** (0.173; 0.000)	-0.05	-0.92*** (0.173; 0.000)	-0.04	-0.98*** (0.128; 0.000)	-0.042	-0.376 (0.297; 0.206)	-0.016	-0.857*** (0.119; 0.000)	-0.037
Access to Green Route (GR)/Km	1.84*** (0.263; 0.001)	0.08	0.67*** (0.131; 0.000)	0.02	1.48*** (0.215; 0.000)	0.064	6.83*** (0.622; 0.000)	0.299	1.39*** (0.160; 0.000)	0.06
Economic spaces for urban agriculture practices (UAP)	0.97*** (0.177; 0.000)	0.042	0.0377*** (0.097; 0.000)	0.0016	0.747*** (0.141; 0.000)	0.032	4.04*** (0.370; 0.000)	0.177	1.003*** (0.125; 0.000)	0.043

	Uncorrelated GMNL With Fixed ASC (M6)		**Correlated GMNL (M7)**		**Correlated GMNL With Random ASC (M8)**		**Correlated GMNL With Fixed ASC (M9)**	
Program attributes	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month
Availability of large multi-use parks (LMUP)/district	19.35*** (1.60; 0.000)	0.84	54.84*** (3.84; 0.000)	2.40	25.27*** (1.74; 0.000)	1.10	22.52*** (1.72; 0.000)	0.98
Access to neighborhood parks (NHP)/minute	-1.11*** (0.137; 0.000)	-0.048	-0.534*** (0.305; 0.000)	0.023	-1.49*** (0.136; 0.000)	-0.065	-1.25*** (0.134; 0.000)	-0.054
Access to Green Route (GR)/Km	1.25*** (0.214; 0.000)	0.054	5.04*** (0.537; 0.000)	0.221	1.16*** (0.081; 0.000)	0.050	1.01*** (0.161; 0.000)	0.044
Economic spaces for urban agriculture practices (UAP)	0.940*** (0.133; 0.000)	0.041	3.14*** (0.292; 0.000)	0.137	1.247*** (0.133; 0.000)	0.054	1.004*** (0.115; 0.000)	0.044

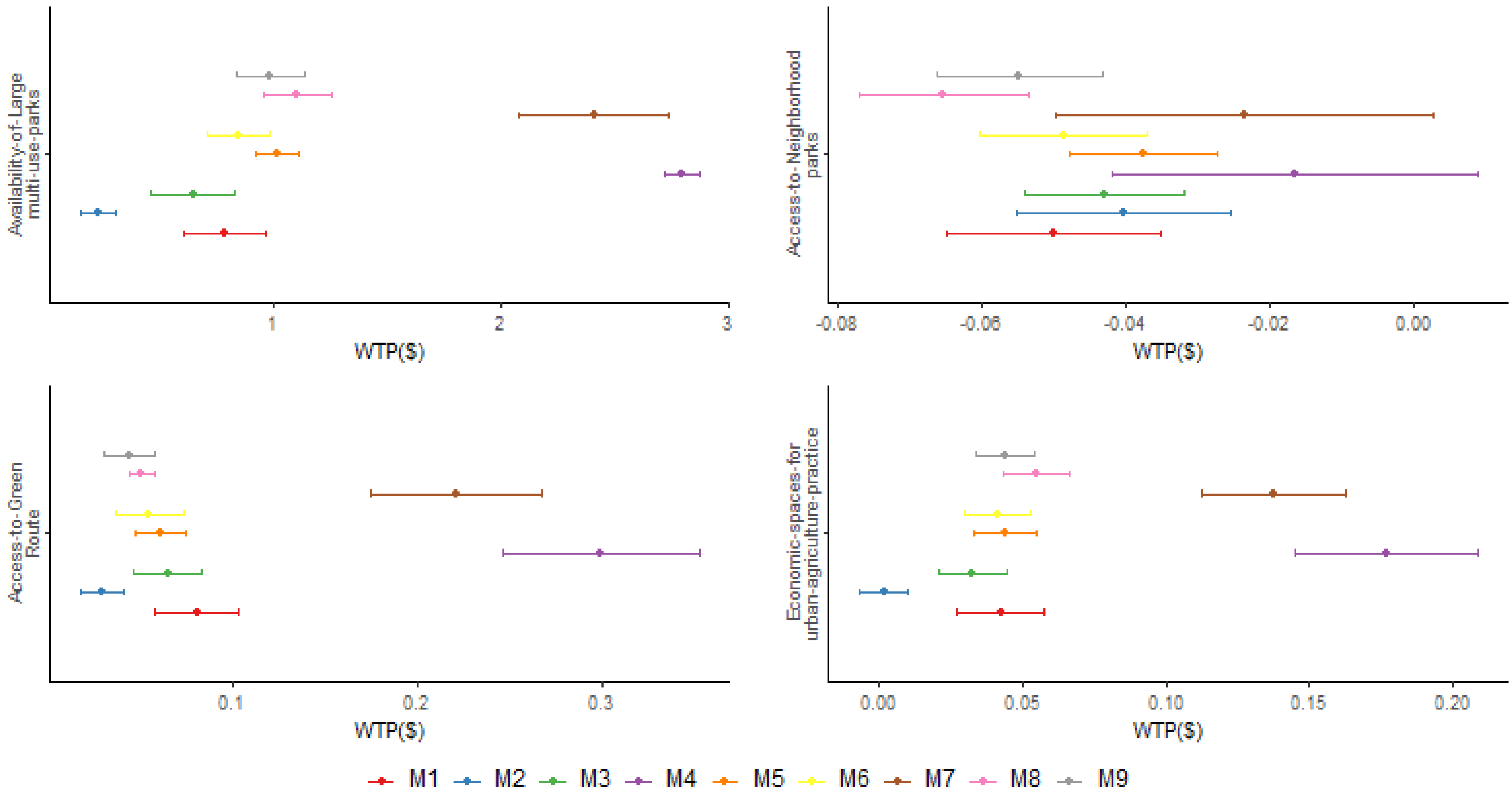

Figure 5: Equivalent USD ($)/Month Value of MWTP for each Model Estimates of "Parks, Paths and Plots" Program

To account for scale and preference heterogeneity, we estimated the GMNL models with numerous specifications. The results are presented in Table 6. The significance of tau (τ) in each GMNL model estimates revealed a presence of scale and preference heterogeneity. The results of the S-MNL model (i.e. M3) with heterogeneity in the ASC improve the estimates as compared to the MIXL model and S-MNL model with fixed ASC; scale heterogeneity parameter tau (τ) falls from 1.68 to 0.94 but is still significant. This supports the presence of heterogeneous preferences by means of different error variances for each respondent. Restricting residual heterogeneity to be independent across attributes leads to a decline of the log-likelihood (i.e. the uncorrelated GMNL model)(Fiebig *et al.* 2010). The AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) results prefer the GMNL models with correlated preference heterogeneity, indicating a substantial degree of scale heterogeneity observed, even after allowing for correlated random coefficients (i.e. the last three model estimates (M7, M8, and M9)). The result revealed that respondents' preferences for all non-cost attributes are varying and also reflected by the standard deviation. The estimated standard deviations for all non-cost attributes are significant in all model estimates, also signifying heterogeneity among the respondents' preferences. The relative magnitude of the standard deviations implies that there is a probability that the respondents might have the reverse preference for a particular attribute; this is reflected by a neighborhood park attribute result that has a negative sign. The highest standard deviation is observed for availability of a large multi-use park, signifying that preference is the most heterogeneous one for this attribute.

Except for the neighborhood parks attribute, the sign was as expected for all other attributes. The cost/payment attribute has shown the expected negative sign. The sign of the cost/payment coefficient indicated that the effect on utility of choosing a choice set with a higher payment level is negative. All of the urban green areas and economic space development attributes are significant in the choice of the program scenario, and ceteris paribus a higher level of any single attribute increases the probability that a proposed program scenario is selected. In other words, respondents prefer those program scenarios which result in a higher level of availability of large multi-use parks within a district, access and availability to green routes, availability of economic space for urban agriculture practices, and proximity of neighborhood parks.

The implicit prices or the marginal value of willingness to pay, obtained by applying Eq. (7), along with their standard errors and significance levels, are presented in Table 7. These values stand for the minimum amount of money that individuals are willing to pay per month and calculated in dollar value to the specified urban ecosystem service attributes. Considering scale and preference heterogeneity revealed higher MWTP estimates for all attributes in both programs. This is similar to the findings of Lanz and Provins (2011) that indicated a positive willingness to pay for improvements of the local environment that increase the amount of outdoor facilities available. The findings indicated that residents would be willing to pay up to 64 Ethiopian Birr (ETB) per month (about USD 2.28) for availability of a large multi-use park close to their homestead. Residents are less willing to pay as park distance to a neighborhood increases. This finding is consistent with other studies (Abildtrup *et al.* 2013; Tu *et al.* 2016) that revealed scale heterogeneity and residents' preferences to pay more for nearby access to public parks and gardens. Their next preference was for access to a green route that would give them the option to access the city without traffic congestion. For this, they would pay up to 6.8 ETB per kilometer per month. For development of spaces for urban agriculture practices, they would pay up to 4.4 ETB per month per percentage improvement.

We conducted a similar approach for the urban nature restoration and conservation program. The two attributes of the nature restoration program are forest conservation and rivers and streams rehabilitation. The choice attributes were presented as percentage of level of improvement: zero for the status-quo, lower level (5%), moderate level (10%) and high level (20%) restoration of the natural environment. The IIA test was also conducted for this program and the result indicated that the IIA property was violated, implying that models that do not exhibit the IIA property should be applied (Table 5). Thus, we estimated a mixed logit model and GMNL models with different specifications and the result presented in Table 8. The ASC is highly significant and has a negative sign in the models, indicating the average effects of factors other than the nature restoration program attributes on individual household behavior are captured. The choice attributes and payment coefficients have the expected sign and are highly significant.

Our result is consistent with a positive willingness to pay for urban forest conservation and improvement that has been highlighted by studies (Lorenzo *et al.* 2000; Nielsen *et al.* 2007) and preference heterogeneity for nature restoration by De Valck *et al.* (2014). Similar to the findings of Abildtrup *et al.* (2013) and Tu *et al.* (2016), our results highlight that scale heterogeneity should be considered in analyzing preferences for urban green space ecosystem services. Likewise, the significance of tau (τ) in the GMNL models estimate for the nature restoration and conservation program show scale and preferences heterogeneity, this result is also confirmed by the lowest BIC value for the S-MNL model estimate. The MWTP estimate result highlighted a relatively higher value for a percentage improvement of forest conservation than for river and stream rehabilitation, as indicated in Table 9. Residents were willing to pay for urban nature restoration programs, up to 7.64 ETB per month for each percent improvement of urban forest cover. Similar to other valuation studies on urban green and nature areas (Wolf 2004; Giergiczny & Kronenberg 2014; Tu *et al.* 2016), this finding shows that valuation of urban green spaces and nature areas is vital to support planning and management efforts.

Table 8: MIXL and GMNL Models Estimate for Urban Nature Restoration and Conservation Program[6]

Variables	MIXL (M1)	Scale Heterogeneity S_MNL (M2)	Random Effect S_MNL (M3)	Correlated random coefficients		
Mean Parameters				**GMNL (M7)**	**GMNL With Random ASC (M8)**	**GMNL With Fixed ASC (M9)**
ASC	-2.87*** (0.190, 0.000)	-2.277*** (0.150, 0.000)	-8.648*** (1.552, 0.000)	-	-7.99*** (1.172, 0.000)	-3.281*** (0.264, 0.000)
Forest conservation	0.068*** (0.006, 0.000)	0.121*** (0.026, 0.000)	0.101*** (0.020, 0.000)	0.102*** (0.008, 0.000)	0.130*** (0.029, 0.000)	0.135*** (0.042, 0.000)
River rehabilitation	0.062*** (0.005, 0.000)	0.102*** (0.023, 0.000)	0.083*** (0.016, 0.000)	0.097*** (0.007, 0.000)	0.108*** (0.023, 0.000)	0.114*** (0.032, 0.000)
Payment/cost	-0.019*** (0.0022, 0.000)	-0.020*** (0.003, 0.000)	-0.018*** (0.002, 0.000)	-0.013*** (0.002, 0.000)	-0.032*** (0.007, 0.000)	-0.036*** (0.007, 0.000)
Standard deviation (SD)						
Forest conservation	0.084*** (0.008, 0.000)	-	-			
River rehabilitation	0.069*** (0.008, 0.000)	-	-			
ASC			4.67*** (0.796, 0.000)			
/l11				0.046*** (0.011, 0.000)	0.122*** (0.034, 0.000)	0.125*** (0.020, 0.000)
/l21				-0.015 (0.013, 0.232)	0.0.39** (0.015, 0.012)	0.055*** (0.011, 0.000)
/l22				0.002 (0.018, 0.897)	0.053** (0.019, 0.007)	0.043*** (0.007, 0.000)
/l31				-	-0.487 (0.602, 0.419)	
/l32				-	1.534** (0.557, 0.006)	-
/l33				-	-4.146*** (0.704, 0.000)	
tau (τ)	-	1.68*** (0.255, 0.000)	1.477*** (0.248, 0.000)	0.599*** (0.107, 0.000)	1.280*** (0.280, 0.000)	1.248*** (0.321, 0.000)
Wald Chi2 (4)	-	241.10	74.49	232.42	57.77	266.48
Number of respondents	640	640	640	640	640	640
Number of Obs.	7680	7680	7680	7680	7680	7680
LL	-1765.48	-1783.42	-1718.64	-1935.02	-1699.50	-1727.34
AIC	3542.98	3576.86	3449.28	3884.05	3421.01	3470.69
BIC	3584.65	3611.59	3490.67	3932.67	3497.42	3526.26

[6] Significant at * 10%, ** 5% and *** 1%. The standard errors and then the p-value are presented in parentheses. The sign of the estimated standard deviations is irrelevant: interpret them as being positive. We also estimated the uncorrelated random coefficients with different specifications as Models M4, M5, and M6, presented in Appendix 2 for reference.

Table 9: Marginal Willingness to Pay (Ethiopian Birr/Month and Equivalent USD/Month) for each Model Estimate of Urban Nature Restoration and Conservation Program

	MIXL (M1)		**Scale Heterogeneity S-MNL (M2)**		**Random Effect S-MNL (M3)**		**Uncorrelated GMNL (M4)**		**Uncorrelated GMNL With Random ASC (M5)**	
Program attributes	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month	Ethiopian Birr/month	Equivalent $ value/month
Forest conservation (for a percentage improvement)	3.51*** (0.438; 0.000)	0.15	6.04*** (0.599; 0.000)	0.26	5.49*** (0.715; 0.000)	0.24	7.64*** (1.185; 0.000)	0.33	3.91*** (0.363; 0.000)	0.17
River rehabilitation (for a percentage improvement)	3.23*** (0.412; 0.000)	0.14	5.09*** (0.656; 0.000)	0.22	4.55*** (0.693; 0.000)	0.19	7.29*** (1.153; 0.206)	0.31	2.95*** (0.240; 0.000)	0.12
Program attributes	**Uncorrelated GMNL With Fixed ASC (M6)**		**Correlated GMNL (M7)**		**Correlated GMNL With Random ASC (M8)**		**Correlated GMNL With Fixed ASC (M9)**			
Forest conservation (for a percentage improvement)	3.14*** (0.296; 0.000)	0.13	7.56*** (1.174; 0.000)	0.33	3.95*** (0.561; 0.000)	0.17	3.76*** (0.631; 0.000)	0.16		
River rehabilitation (for a percentage improvement)	2.50*** (0.266; 0.000)	0.10	7.15*** (1.135; 0.000)	0.31	3.31*** (0.478; 0.000)	0.14	3.18*** (0.465; 0.000)	0.13		

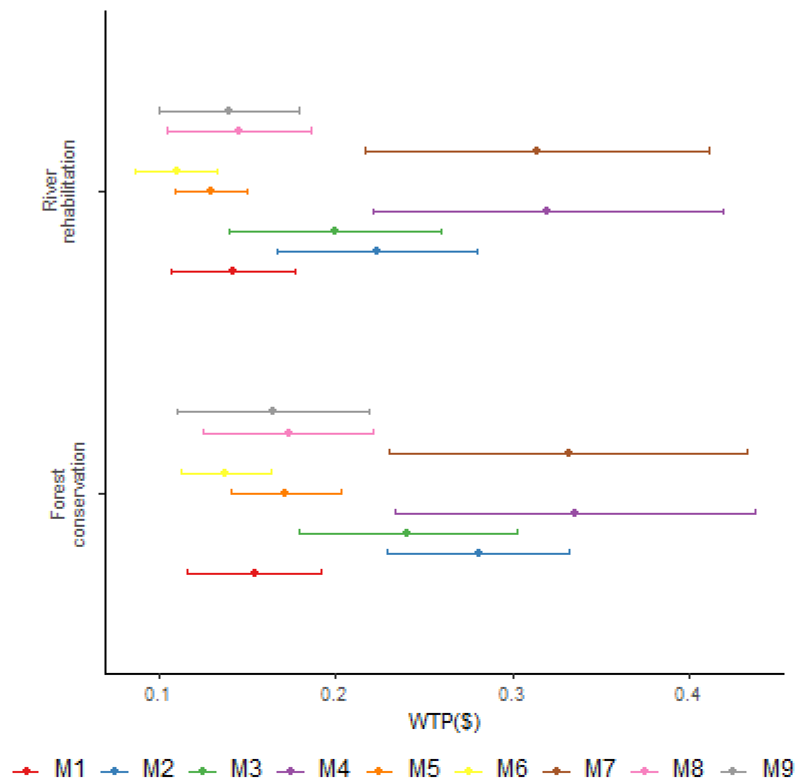

Figure 6: Equivalent USD ($)/Month Value of MWTP for each Model Estimates of Urban Nature Restoration and Conservation Program

5. Conclusion

A decline in availability of and access to green and natural areas for urban residents may have detrimental effects on human health and economies. This study contributes to the limited research in urban ecosystem services valuation a using choice experiment approach in developing countries. We identified two program scenarios: an urban green area and economic space development program (including parks, green paths, and urban agriculture) and a nature restoration and conservation program (for forest cover and rivers) for the design of the choice experiment.

In the first scenario, we observed the highest marginal willingness to pay for availability of large multi-use parks close to the homestead, followed by access to green routes that can give residents the option to access the city without traffic congestion, and then economic space development for urban agriculture practices. In contrast to the above attributes, the MWTP value for neighborhood parks is negative, indicating that residents consider the proximity of neighborhood parks and are less willing to pay as the distance increases from the homestead. For the nature restoration and conservation program, residents had a relatively higher marginal willingness to pay for urban forest conservation as compared to rivers and streams rehabilitation.

As compared to the MIXL model, the GMNL model that accounts for scale and preference heterogeneity is preferred, bearing in mind both the Akaike Information Criterion and Bayesian Information Criterion. Thus, accounting for scale and preference heterogeneity is important for better estimates in environmental valuation exercises.

The empirical research on urban ecosystem services in developing countries is limited, generally focusing on one aspect of the urban ecosystem, and has major valuation challenges. However, our study explored both urban amenities and nature restoration in a developing city, by providing two program scenarios in valuation exercises. We also evaluated different estimation models by taking into account scale and preference heterogeneity. Overall, the findings indicate that ecosystem services within an urban area have substantial impact on human well-being, and that understanding the variation of residents' preferences for improved urban green space services is vital to prioritizing alternative interventions.

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Appendix 1: MIXL and GMNL Models Estimates for "parks, paths and plots" program

Variables	**MIXL (M1)**	**Scale Heterogeneity S-MNL (M2)**	**Random Effect S-MNL (M3)**	**Uncorrelated random coefficients**			**Correlated random coefficients**		
Mean Parameters				**GMNL (M4)**	**GMNL With Random ASC (M5)**	**GMNL With Fixed ASC (M6)**	**GMNL (M7)**	**GMNL With Random ASC (M8)**	**GMNL With Fixed ASC (M9)**
ASC	-4.222*** (0.169, 0.000)	-6.062*** (0.291, 0.000)	-10.346*** (1.273, 0.000)	-	-10.467*** (1.216, 0.000)	-6.347*** (0.378, 0.000)	-	-18.001*** (2.726, 0.000)	-6.899*** (0.443, 0.000)
Availability of Large multi-use parks (LMUP)	0.470*** (0.053, 0.000)	0.228*** (0.043, 0.000)	0.427*** (0.044, 0.000)	0.949*** (0.060, 0.000)	1.646*** (0.233, 0.000)	1.095*** (0.138, 0.000)	1.060*** (0.071, 0.000)	2.803*** (0.541, 0.000)	1.663*** (0.271, 0.000)
Access to Neighborhood parks (NHP)	-0.029*** (0.0044, 0.000)	-0.038*** (0.004, 0.000)	-0.028*** (0.0035, 0.000)	-0.005 (0.004, 0.204)	-0.060*** (0.009, 0.000)	-0.063*** (0.008, 0.000)	-0.010*** (0.005, 0.000)	-0.166*** (0.030, 0.000)	-0.092*** (0.014, 0.000)
Access to Green Route (GR)	0.047*** (0.006, 0.000)	0.028*** (0.006, 0.000)	0.0427*** (0.024, 0.000)	0.101*** (0.008, 0.000)	0.098*** (0.014, 0.000)	0.070*** (0.013, 0.000)	0.097*** (0.008, 0.000)	0.129*** (0.028, 0.000)	0.074*** (0.013, 0.000)
Economic spaces for urban agriculture practices (UAP)	0.0253*** (0.0001, 0.000)	0.0015*** (0.004, 0.000)	0.021*** (0.018, 0.000)	0.060*** (0.005, 0.000)	0.070*** (0.011, 0.000)	0.053*** (0.008, 0.000)	0.060*** (0.005, 0.000)	0.138*** (0.026, 0.000)	0.053*** (0.008, 0.000)
Payment/cost	-0.026*** (0.0001, 0.000)	-0.0419*** (0.0001, 0.000)	-0.0287*** (0.002, 0.000)	-0.0149*** (0.001, 0.000)	-0.070*** (0.007, 0.000)	-0.056*** (0.004, 0.000)	-0.0193*** (0.0016, 0.000)	-0.110*** (0.017, 0.000)	-0.073*** (0.008, 0.000)
Standard deviation (SD)									
Availability of Large multi-use parks (LMUP)	-0.898*** (0.06, 0.000)	-	-	0.442*** (0.059, 0.000)	1.870*** (0.214, 0.000)	1.467*** (0.261, 0.000)			
Access to Neighborhood parks (NHP)	0.068*** (0.005, 0.007)	-	-	0.062*** (0.006, 0.000)	-0.133*** (0.015, 0.007)	0.109*** (0.013, 0.007)			
Access to Green Route (GR)	0.067*** (0.011,0.000)	-	-	0.050*** (0.014,0.000)	-0.058*** (0.013,0.000)	0.107*** (0.017,0.000)			
Economic spaces for urban agriculture practices	0.074*** (0.005, 0.000)	-	-	0.060*** (0.006, 0.000)	-0.147*** (0.016, 0.000)	0.100*** (0.012, 0.000)			
ASC			5.265*** (0.798, 0.000)	-	3.837*** (0.553, 0.000)	-			
/111							0.087*** (0.013, 0.000)	0.138*** (0.032, 0.000)	-0.085*** (0.015, 0.000)
/121							0.027** (0.011, 0.016)	0.103*** (0.019, 0.000)	-0.069*** (0.011, 0.000)
/131							-0.308*** (0.104, 0.000)	-0.041 (0.126, 0.743)	-0.372*** (0.099, 0.000)
/141							-0.017 (0.013, 0.182)	-0.131*** (0.034, 0.000)	0.029** (0.010, 0.004)
/151							-	-0.389 (0.547, 0.477)	-
/122							0.068*** (0.008, 0.000)	0.106*** (0.020, 0.000)	0.099*** (0.016, 0.000)
/132							-0.161 (0.100, 0.106)	3.481*** (0.609, 0.000)	1.134*** (0.176, 0.000)
/142							-0.038*** (0.011, 0.000)	-0.168*** (0.036, 0.000)	-0.086*** (0.015, 0.000)
/152							-	-0.018 (0.540, 0.973)	-
/133							-0.676*** (0.074, 0.000)	-0.539*** (0.117, 0.000)	-1.765*** (0.242, 0.000)

/143							0.087*** (0.010, 0.000)	0.112*** (0.024, 0.000)	0.066*** (0.013, 0.000)
/153							-	-4.130*** (0.716, 0.000)	-
/144							0.009 (0.023, 0.678)	-0.018 (0.020, 0.364)	0.125*** (0.020, 0.000)
/154							-	5.751*** (0.920, 0.000)	-
/155							-	0.468 (0.637, 0.462)	-
tau (τ)	-	1.68*** (0.090, 0.000)	0.943*** (0.13, 0.000)	0.431*** (0.133, 0.000)	1.512*** (0.116, 0.000)	1.352*** (0.085, 0.000)	0.518*** (0.059, 0.000)	2.017*** (0.138, 0.000)	1.546*** (0.101, 0.000)
Wald Chi2 (4)	-	561.19	271.70	337.86	95.22	315.80	492.23	55.33	245.28
Number of respondents	640	640	640	640	640	640	640	640	640
Number of Obs.	15360	15360	15360	15360	15360	15360	15360	15360	15360
LL	-3421.12	-3425.00	-3371.84	-3926.73	-3238.99	-3276.42	-3866.63	-3172.31	-3217.08
AIC	6862.24	6864.01	6759.68	7873.46	6501.98	6574.85	7765.26	6388.62	6468.16
BIC	6938.64	6917.49	6820.80	7949.86	6593.65	6658.88	7887.49	6556.69	6598.03

Appendix 2: MIXL and GMNL Models Estimates for Urban Nature Restoration and Conservation Program

Variables	**MIXL (M1)**	**Scale Heterogeneity S_MNL (M2)**	**Random Effect S_MNL (M3)**	**Uncorrelated random coefficients**			**Correlated random coefficients**		
Mean Parameters				**GMNL (M4)**	**GMNL With Random ASC (M5)**	**GMNL With Fixed ASC (M6)**	**GMNL (M7)**	**GMNL With Random ASC (M8)**	**GMNL With Fixed ASC (M9)**
ASC	-2.87*** (0.190, 0.000)	-2.277*** (0.150, 0.000)	-8.648*** (1.552, 0.000)	-	-8.22*** (1.305, 0.000)	-3.12*** (0.208, 0.000)	-	-7.99*** (1.172, 0.000)	-3.281*** (0.264, 0.000)
Forest conservation	0.068*** (0.006, 0.000)	0.121*** (0.026, 0.000)	0.101*** (0.020, 0.000)	0.100*** (0.008, 0.000)	0.308*** (0.068, 0.000)	0.190*** (0.048, 0.000)	0.102*** (0.008, 0.000)	0.130*** (0.029, 0.000)	0.135*** (0.042, 0.000)
River rehabilitation	0.062*** (0.005, 0.000)	0.102*** (0.023, 0.000)	0.083*** (0.016, 0.000)	0.095*** (0.006, 0.000)	0.232*** (0.048, 0.000)	0.151*** (0.037, 0.000)	0.097*** (0.007, 0.000)	0.108*** (0.023, 0.000)	0.114*** (0.032, 0.000)
Payment/cost	-0.019*** (0.0022, 0.000)	-0.020*** (0.003, 0.000)	-0.018*** (0.002, 0.000)	-0.013*** (0.002, 0.000)	-0.078*** (0.016, 0.000)	-0.060*** (0.015, 0.000)	-0.013*** (0.002, 0.000)	-0.032*** (0.007, 0.000)	-0.036*** (0.007, 0.000)
Standard deviation (SD)									
Forest conservation	0.084*** (0.008, 0.000)	-	-	0.050*** (0.010, 0.000)	0.300*** (0.061, 0.000)	0.208*** (0.049, 0.000)			
River rehabilitation	0.069*** (0.008, 0.000)	-	-	0.005*** (0.023, 0.000)	0.076*** (0.019, 0.000)	0.067*** (0.014, 0.000)			
ASC			4.67*** (0.796, 0.000)	-	-4.58*** (0.700, 0.000)	-			
/111							0.046*** (0.011, 0.000)	0.122*** (0.034, 0.000)	0.125*** (0.020, 0.000)
/121							-0.015 (0.013, 0.232)	0.0.39** (0.015, 0.012)	0.055*** (0.011, 0.000)
/122							0.002 (0.018, 0.897)	0.053** (0.019, 0.007)	0.043*** (0.007, 0.000)
/131							-	-0.487 (0.602, 0.419)	
/132							-	1.534** (0.557, 0.006)	-
/133							-	-4.146*** (0.704, 0.000)	
tau (τ)	-	1.68*** (0.255, 0.000)	1.477*** (0.248, 0.000)	0.5*** (0.121, 0.000)	2.08*** (0.192, 0.000)	1.629*** (0.226, 0.000)	0.599*** (0.107, 0.000)	1.280*** (0.280, 0.000)	1.248*** (0.321, 0.000)
Wald Chi2 (4)	-	241.10	74.49	241.87	47.82	264.30	232.42	57.77	266.48
Number of respondents	640	640	640	640	640	640	640	640	640
Number of Obs.	7680	7680	7680	7680	7680	7680	7680	7680	7680
LL	-1765.48	-1783.42	-1718.64	-1935.49	-1700.86	-1741.24	-1935.02	-1699.50	-1727.34
AIC	3542.98	3576.86	3449.28	3882.99	3417.72	3496.48	3884.05	3421.01	3470.69
BIC	3584.65	3611.59	3490.67	3924.67	3473.29	3445.10	3932.67	3497.42	3526.26