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Willingness to pay for Nairobi National Park: An application of discrete choice experiment

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Nairobi National Park is a protected ecosystem where various types of wildlife find hiding place. The park has in the recent past experienced destruction through construction of a standard gauge railway (SGR) line and a highway called the Southern bypass. These developments raise concern with the possibility that their combined environmental cost being enormous. This study sought to determine the willingness to pay (WTP) for the restoration of the park attributes using discrete choice experiment. The focus was on the attributes of (1) wildlife population and diversity of species, (2) wildlife movement in dispersion and migration areas, (3) vegetation density and diversity, (4) security of wildlife and people, and (5) environmental safety and quality. The data used was collected from 93 students of Kisii University, Nairobi campus. A price attribute in form of an increase in gate fee was included to elicit WTP estimates. Multinomial logit regression estimates indicated that respondents were WTP for the restoration of all the attributes except attribute 4. Attributes 1 and 2 elicited the highest WTP and could be the most affected by the two projects. Middle-aged respondents with stable jobs were likely to pay more for the restoration of the attributes compared to students and the youth. Based on the findings, the government could consider relocating the park to a place with better environmental attributes.

Key words: Nairobi National Park, ecosystem, discrete choice experiment, willingness to pay, park attributes, Multinomial logit.

INTRODUCTION

Nairobi National Park (NNP) ecosystem provides numerous use benefits (direct and indirect) and non-use benefits that include existence, option and bequest values. The Millennium Ecosystem Assessment (2005) defines ecosystem as a complex and dynamic environment where living organisms (plants, animals and microorganisms) and non-living organisms interact and function as a unit. An ecosystem provides services to human beings that the World Resources Institute (2005) defines as benefits.

The park is Kenya's oldest dating back to 1946. It measures approximately 117 km^2 and is situated at 7 km south of Nairobi's central business district (GoK, 2012). Perhaps Kenya is the only country in the world with a national park in its capital city. According to the Kenya Wildlife Service (KWS), the park is home to over 100 mammalian species including the endangered black rhino, four of the big five wildlife (lion, buffalo, leopard

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and rhino) and over 400 species of migratory and endemic bird species. The park also, provides sites for wildlife and bird viewing, picnics, campsites and walking trails. The park currently charges gate fee of Ksh 430 to citizens and Ksh 4300 to foreigners. Approximately 278,700 tourists, both local and international, visited the park in 2017, this makes the park a significant contributor to the tourism industry (KNBS, 2018).

Nairobi National Park is protected and regulated by The Constitution of Kenya (2010), the Wildlife Conservation and Management Act (2013) and the Environmental Management and Conservation Act (1999). These statutes provide the legal framework for protection, sustainable management and use of the country's environment and natural resources (GoK, 1999, 2010, 2013).

The rapid growth in population and the ever increasing need for economic development has put pressure on the existing environmental resources. Some infrastructural projects are encroaching on protected areas. Perhaps the environmental cost of such projects outweighs their economic benefits.

From 2013, two development projects, the Standard Gauge Railway (SGR) and the Southern Bypass highway were made to pass through Nairobi National Park. The projects were expected to improve transport connectivity in the city, reduce traffic congestion, create employment and lower the cost of movement in the long run. However, the projects have altered the ecosystem conditions of the park. There is need to examine the potential environmental costs associated with the two projects. While the benefits are clearly calculated, the costs are not. Ambani (2017) says it is necessary to explicitly assess the tradeoffs involved in interfering with the Nairobi National Park ecosystem. This paper seeks to examine the environmental cost of interfering with the park with the aim of contributing to literature that will inform policy decisions on mitigating environmental impacts of future development projects that could threaten the provision of ecosystem services.

LITERATURE REVIEW

Environmental goods are to a large extent, public goods. Samuelson (1954) defines public goods as goods that are collectively consumed. They are characterized by non-rivalry and non-excludability. Further, they have limited or no market and do not have an explicit price. Thus, they cannot be traded. They require policy to regulate their provision. Valuation of environmental resources is critical in informing the design of policy tools that will promote the optimization of the provision and protection of the amenities (Ferraro and Kiss, 2002).

A desire to achieve economic growth, as evidenced by the rapid industrialization in developing countries, has threatened the provision of ecosystem services (McShane et al., 2011). Decision makers constantly face the hard choice between environmental conservation and economic growth. However, the choice is rarely evaluated explicitly. Projects that alter ecosystem conditions are undertaken without acknowledging the tradeoffs. Thus, the real, potential and perceived losses to the ecosystem remain unaccounted for. Valuation of environmental costs of projects is necessary and should be weighed against their benefits (De Groot et al., 2010).

Environmental valuation techniques are categorized into revealed preference and stated preference. Revealed preference methods involve inferring individual values for environmental resources from observed choices of related market goods. This implies that a person's actions in the market place reveal information about his preferences including those for public goods (Freeman et al., 2014). Revealed preference techniques have one disadvantage in that they lack independent variation in the amenity of interest from which to infer impact on consumer behavior and preference.

Stated preference methods are more popular due to their ability to derive value in instances where value cannot be derived from market transactions. They include contingent valuation methods (CVM) and choice modeling techniques (Carson, 2011). Stated preference methods involve the construction of a hypothetical market scenario where the environmental good or service in question can be traded. Using a survey instrument a researcher is then able to elicit respondents' preferences and welfare estimates for a hypothetical change in the level of provision of attributes of a public good. These methods are effective in deriving non-use values where individuals are thought to place value in an environmental amenity that they do not use actively. Such values are not tied to the use of a related market because they do not leave a foot print in the market place from which their value can be inferred (Freeman et al., 2014).

Choice modeling techniques are superior to CVM in environmental valuation, and more specifically in measuring passive use values (Hanley et al., 2001). They are used in the assessment of multiple attributes and emulate real market decisions that consumers are faced with when making choices (Hanley et al., 2002).

In choice modeling consumers are asked to select their most preferred option among a set of alternatives. The main approaches used in choice modeling are choice experiment, paired comparisons, contingent ranking and contingent rating. The contingent ranking approach requires the respondent to answer to a series of selected alternatives. In contingent rating respondents are provided a scale from which they score the alternatives. The paired comparison approach provides respondents a scale from which they score pairs of scenarios (Hanley et al., 2001). The main disadvantage of these approaches is that their estimates are not welfare consistent. Choice experiments are effective and appropriate in the analysis of welfare only when there are changes in the attributes of a given environmental resource (Adamowicz et al., 1994).

Choice experiments allow construction of a hypothetical market. Through a survey tool respondents are presented several choice sets of mutually exclusive alternatives. The alternatives are defined over different levels of an ecosystem's attributes from which the respondent is asked to choose. The choices represent tradeoffs that maximize a respondent's utility. By attaching a price to each attribute in the choice set, welfare estimates can be derived. The willingness to pay (WTP) estimates for changes in the levels of provision of a good's attribute can be converted into marginal utility estimates (Hoyos, 2010).

A discrete choice can be defined as a situation where a respondent makes a choice from a set of alternatives that are mutually exclusive, finite and exhaustive (Train, 1993). Discrete choice experiments (DCEs) have a wide application in the valuation of environmental amenities as seen in the works of Adamowicz et al. (2008), Hicks et al. (2009), Hoyos (2010), Chan et al. (2012), and more recently in developing countries in the works of Naidoo and Adamowicz (2005), Ulwodi (2011), Chaminuka et al. (2012) and Okumu and Muchapondwa (2017).

The discrete choice experiment (DCE) is founded on Lancaster's (1966) characteristics theory of value and random utility theory (RUT) (Ben-Akiva and Lerman, 1985).

METHODOLOGY

This study employed discrete choice experiment to estimate the environmental cost of interfering with Nairobi National Park. The study sought from the respondents what they would be willing to pay for the restoration of park attributes. A price attribute was used to elicit marginal willingness to pay (MWTP). This measure enabled the analysis of welfare change brought about by change in an attribute.

Choice experiment in valuation of environmental resources is consistent with the random utility theory. Following McFadden (1974), this study decomposed the indirect utility function for each respondent into two parts. The first part was the deterministic component which was defined as the linear index of observable specific attributes of the different alternatives in the choice set denoted by (W). The second part was a stochastic element which represented unobservable influences affecting an individual's choice denoted by (e).

Thus, an individual's indirect utility function when selecting alternatives was represented as follows:

$$U_i = U(W_{j,}e_j) \tag{1}$$

The choice experiment considered an individual's choice of attributes of Nairobi National Park and assumed that the utility depended on choices made from a set of alternatives. An individual's choice was presented as a utility function in the form:

$$U_i = W_j + e_j \tag{2}$$

where W, represented the observable part of the indirect utility function that individual i derived in choosing alternative *j* of the park's attributes and e_j was the unobservable part of the utility function. Further, an individual's utility was considered as the sum of some base level utility β_0, the sum of utilities from choosing park attributes and a stochastic component that is unobservable as shown in Equation 3. Thus, β_j coefficients show the contribution of each attribute of the park to total utility of an individual.

$$U_i = \beta_0 + \sum\beta_j W_j + e_j \tag{3}$$

The probability of choosing one alternative over another was calculated using multinomial logit following McFadden (1974) as shown in Equation 4. C is the choice set.

$$Prob(j) = \Pr j|y \{W_j + e_j > W_y + e_y \; ; \; \forall \, j \in C\} \tag{4}$$

Assuming type I extreme value Gumbell distribution of the error term with scale parameter, the probability of choosing an alternative was as shown in Equation 5:

$$Prob(j) = {exp^{\mu wj}} \Big/ {\sum exp^{\mu wy}} \tag{5}$$

The observable part of the conditional indirect utility function $W(.)$ was assumed to be linear and its functional form when an individual chooses an alternative *j* was as given in Equation 6. The price attribute P_j was included to derive WTP estimates for changes in attribute levels (Hoyos, 2010).

$$V_{ij} = \beta_x' W_j + \beta_p P_j \tag{6}$$

Equation 6 was expanded to a linear- in- parameters utility function as follows:

$$V_{ij} = \beta_0 + \beta_1 W_1 + \beta_2 W_2 + \beta_3 W_3 + \beta_4 W_4 + \cdots + \beta_k W_k + \beta_p P_j \tag{7}$$

where β_0 the intercept was an alternative specific constant which represented the mean effect of unobserved factors in error terms of each alternative. β_i (*i=1..k*) were coefficients of the attributes, W_i β_p was marginal utility of money. The choice of attributes by respondents reflects their true preference (Train, 1986). In the study, the identified attributes were population and diversity of species $(WILDPOPN)$; wildlife movement in dispersal and migration area $(WILDSPACE)$; vegetation density and diversity (VEG); security of wildlife and people $(SECUR)$, and environmental quality $ENVQUA$ in addition to the price attribute, P_j. Equation 7 was re-written as Equation 8.

$$V_{ij} = \beta_0 + \beta_1 WILDPOPN + \beta_2 WILDSPACE + \beta_3 VEG + \beta_4 SECUR + \beta_5 ENVQUA + \beta_p P_j \tag{8}$$

where β_k (*k*=1…5) coefficients show the contribution of each attribute of the park to total utility of an individual. Equation 8 is a multinomial logit equation that was estimated using maximum likelihood method. After obtaining parameter estimates, a WTP compensating variation was derived for each attribute. The marginal value of each attribute when moving from the initial state (status quo) to the alternative state captured the willingness to pay (WTP). As shown in Equation 9, WTP was the ratio of β_k, the coefficient of an attribute, and β_p the coefficient of price attribute.

Table 1. Choice sets for NNP as presented to respondents.

Attribute	Option 1	Option 2	Option 3	Status quo (no change option)
Wildlife population and diversity of species	High population of wildlife with high diversity of species	High population of wildlife with low diversity of species	Low population of wildlife with high diversity of species	Low population of wildlife with low diversity of species
Price (Increase in gate entrance fee from KSh 430 to-)	KSh 1500	KSh 1000	KSh 500	KSh 430
Choose one option (tick where applicable)				
Wildlife movement in dispersal and migration area	Free movement	Minimal restriction of movement	Restricted movement	
Price(An Increase in gate entrance fee from KSh 430 to-)	KSh 1500	KSh 1000	KSh 430	
Choose one option (tick where applicable)				
Vegetation density and diversity	Thick cover of high diversity	Thick cover of low diversity	Thin cover of high diversity	Thin cover of low diversity
Price(Increase in gate entrance fee from KSh 430 to-)	KSh 1500	KSh 1000	KSh 500	KSh 430
Choose one option (tick where applicable)				
Environmental quality	No noise, air or solid waste pollution	High noise and air pollution but no solid waste pollution	No noise or air pollution but high solid waste pollution	High noise, air and solid waste pollution
Price(Increase in gate entrance fee from KSh 430 to-)	KSh 1500	KSh 1000	KSh 500	KSh 430
Choose one option (tick where applicable)				

$$WTP_k = -\frac{\beta_k}{\beta_p} \quad (9)$$

The data was collected through face to face interviews with a sample of 93 randomly selected students of Kisii University, Nairobi campus. The park attributes and their possible levels of provision as shown in Table 1.

RESULTS AND DISCUSSION

The results were generated using STATA 14 software. Table 2 shows the socioeconomic and demographic information of the respondents. Seventy one percent of the respondents were aged between 18 and 35 years. Females made up 69.9%t of the sample. A majority of the park users were single and came from households with below 4 members. Further, 30.1% of the respondents earned below Kshs 10, 000 per month, 8.6% between Kshs 10,001 and 20,000, and 23.7% above Kshs 50, 000. While 41.9% of the respondents lived between 11 and 20 km from the park, 23% lived beyond 20 km. Only 14% of respondents lived less than 5 km from the park. Table 3 shows estimates of marginal willingness to pay for park attributes.

The possibility of improving the park from status quo so as to have high population of wildlife with high diversity increased the respondents' likelihood of paying Ksh 500 above the gate fee for this development by 40%. Improving the park from status quo so as to have high population of wildlife but of low diversity in species increased the

Table 2. Socioeconomic and demographic information of the respondents.

Variable	Category	Frequency	Percentage	Obs	Mean	Std. Dev.	Min	Max
Age group	18-35	66	70.97	93	0.3011	0.48421	0	2
	36-55	26	27.96					
	Above 55	1	1.08					
Gender	Male	28	30.11	93	0.6989	0.4612	0	1
	Female	65	69.89					
Marital status	Not married	55	59.14	93	0.4086	0.4942	0	1
	Married	38	40.86					
visit NNP	No	32	34.41	93	0.6559	0.4776	0	1
	Yes	61	65.59					
Hh size	Below 4 members	39	41.94	93	3.9570	2.2356	1	11
	Between 4 and 5 members	34	36.56					
	Above 5 members	20	21.51					
Employment status	Employed	66	70.97	93	0.7097	0.4564	0	1
	Not employed	27	29.03					
Income group	Below 10,000	28	30.11	93	2.3548	1.9762	0	5
	10,001-20,000	8	8.60					
	20,001-30,000	15	16.13					
	30,001-40,000	9	9.68					
	40,001-50,000	11	11.83					
	Above 50,000	22	23.66					
Proximity to NNP	Less than 5 km	13	13.98	93	1.7527	0.9742	0	3
	6km to 10 km	19	20.43					
	11 km to 20 km	39	41.94					
	Over 20 km	22	23.66					

Source: Authors

respondents' likelihood of paying Ksh 500 above the gate fee by a lower margin of 16%. This showed that people who valued the park were more likely to pay for its full rather than partial restoration. In its natural state, the park has high population of wildlife of high diversity.

Free movement of wildlife in dispersal and migration area was quite important to those who valued the park. A shift from status quo to free movement increased the likelihood of respondents paying Ksh 1000 more in gate fee by 32%. A minimal relaxation of movement restriction increased the likelihood of respondents paying Ksh 1000 more in gate fee by a lower margin of about 19% underscoring the desire for full rather than partial restoration of park services.

The respondents did not appear to favor thick vegetation of high diversity in the park. Under natural conditions the park has sparsely distributed or pockets of shrubs and trees in an otherwise open grassland. Thus, the possibility of changing the open grassland to thick vegetation of high diversity reduced the likelihood of respondents paying Ksh 1000 more in gate fee by 25%, and the likelihood of paying Ksh 1500 more in gate fee by33%. A shift to a thin cover of high diversity reduced the likelihood of likelihood of paying Ksh 1500 more in gate fee by 20%. Clearly, people valued the park more in its natural vegetation.

On environmental quality, a premium was put on cleanliness. A shift from status quo to a clean park devoid of noise, air or solid waste pollution increased the likelihood of park users paying Ksh 500 more in gate fee by about 18%. A shift status quo to the other environmental attributes had inconsistent results probably because of the way the attributes were framed. Considering socio economic and demographic factors as

Table 3. Multinomial logistic regression estimates of Marginal Willingness to Pay for Park attributes.

Dependent variable	(Option 1)	(Option 2)	(Option 3)
WTP	**Marginal effects**	**Marginal effects**	**Marginal effects**
Park attribute			
Wildlife population and diversity of species			
High population of wildlife with high diversity of species (A)	-0.1267 (-1.59)	-0.0418 (-0.33)	0.3967*** (4.94)
High population of wildlife with low diversity of species (B)	0.0037 (0.04)	-0.1765 (-1.38)	0.1587*** (3.45)
Low population of wildlife with high diversity of species (C)	0.2518 (1.52)	-0.2022 (-1.16)	-0.0217 (-0.94)
Wildlife movement in dispersal and migration areas			
Free movement (A)	-0.0430 (-0.38)	0.3178*** (3.01)	-0.0686 (-0.88)
Minimal restriction of movement (B)	-0.1125 (-1.41)	0.1885* (1.86)	0.1494 (1.26)
Vegetation			
Thick cover of high diversity (A)	0.1022 (0.65)	-0.2512** (-2.40)	0.0236 (0.13)
Thick cover of low diversity (B)	-0.3319*** (-4.40)	0.1757 (1.37)	-0.0447 (-0.43)
Thin cover of high diversity (C)	-0.2000** (-2.15)	0.1168 (1.07)	-0.1233 (-1.20)
Security of wildlife and people			
No Insecurity of wildlife or people (A)	0.0065 (0.06)	-0.0917 (-0.62)	0.0619 (0.42)
Insecurity of wildlife but not people (B)	0.0128 (0.12)	0.0730 (0.56)	0.0388 (0.35)
Insecurity of people but not wildlife (C)	0.1146 (0.66)	-0.0478 (-0.27)	0.1312 (0.92)
Environmental quality			
No noise, air or solid waste pollution (A)	-0.1787 (-1.39)	-0.0268 (-0.32)	0.1790* (1.72)
High noise and air pollution but no solid waste pollution (B)	-0.3342*** (-3.13)	0.3630*** (3.78)	-0.1072 (-1.59)
No noise or air pollution but high solid waste pollution (C)	-0.4557*** (-4.12)	0.5091*** (4.61)	0.0032 (0.04)
Number of observations		93	
LR Chi^2 (81)		138.43	
Prob > Chi^2		0.0001	
Log likelihood		-53.983781	
Pseudo R^2		0.5618	

***1% level of significance, **5% level of significance, *10% level of significance. Base outcome = status quo in Table 1.
Source: Authors computations.

covariates in the model, the study found that age increased the likelihood of paying more in gate fees for restoration of park attributes. Individuals aged between 36 and 55 years were 16.4% more likely to pay higher fees for the restoration of the attributes compared to users aged between 18 and 35 years. Marriage also increased the likelihood of paying more in gate fee for the restoration of park attributes by 39%. Respondents with income levels of between Kshs 10,001 and 30,000 were 25% less likely to pay more for the restoration of park attributes. However, respondents earning over Ksh 30,000 were 27 percent less likely not to pay or to pay less for the restoration of park attributes. Closer proximity to the park of less than 20 km increased the likelihood of paying more for restoration of park attributes by 35%.

Conclusion

The construction of the SGR railway and the Southern by pass highway has significantly altered the ecosystem conditions of Nairobi National Park. The park users were willing to pay above the gate fee Ksh 500 for the restoration of wildlife population, diversity of species and environmental cleanliness; and Ksh 1000 for free wildlife movement in dispersal and migration areas and to prevent alteration of vegetation. The respondents had the highest willingness to pay for free movement of wildlife and preservation of natural vegetation. These were the attributes that the respondents valued most and which might have been affected most by the two development projects. The management of environmental goods and resources need to pay attention to the tradeoffs involved when development projects alter ecosystem conditions. As a policy direction, the government needs to consider relocating NNP to a different site with suitable attributes.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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