Spatial variation in the willingness to accept payments for conservation of a migratory wildlife corridor in the Athi-Kaputiei Plains, Kenya

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Abstract – Payments for ecosystem services (PES) are increasingly being used as a tool to promote sustainable ecosystem services. The success of PES depends on the willingness of target landowners to accept the payments. In particular, to be effective in promoting the conservation of wide-ranging migratory wildlife, the potential recipients of PES must be willing to accept the payments for ecosystem services along the entire migratory corridor to enable wildlife movements. This may be difficult and expensive to achieve where costs of providing the service vary along the corridor. This paper investigates spatial variation in willingness to accept payments (WTA) made by a Wildlife Conservation Lease Program in the Kitengela and Athi Kaputiei plains of Kenya. The program, designed as an incentive to keep land open for wildlife and livestock, currently (2012) offers land owners a flat fee of 10 US$ per ha per year, irrespective of location. We present a model relating WTA to distances to road infrastructure, towns and rivers, as well as to annual precipitation and slope. The model was implemented in GIS to display the spatial variation in the willingness of landowners to accept payments from the Wildlife Conservation Lease Program. The results reveal significant spatial variation in the willingness to accept payments for availing land for conservation, with higher willingness to accept payments concentrated away from roads and also in the south-eastern section of the Kitengela plains. The results further suggest that the movements of wildlife will be blocked by lands currently not open to migration due to low WTA in the proximity of towns and tarmacked roads. An effective strategy to keep the land open for migratory wildlife should take the significant spatial variation in the willingness to

accept payment for land lease into account, and it is suggested to consider spatially stratifying the lease rates to reflect the underlying variation in WTA.

Key words: PES, willingness to accept payment, habitat connectivity, migration corridor, wildlife conservation

Word count: 5157

1 Introduction

Ecosystems provide highly valuable services (Costanza *et al*. 1998), but are rapidly deteriorating, with adverse consequences for human well being, especially for the poor in developing countries (MEA 2005). Payment for ecosystem services (PES) has become a popular tool for managing ecosystems to safeguard and sustain their services, but is also increasingly being viewed as a potential pathway for reducing poverty in rural areas in developing countries (Bulte, Lipper, Stringer, & Zilberman, 2008; Lipper, Sakuyama, Stringer, & Zilberman, 2009; Pagiola, Arcenas, & Platais, 2005).

The most widely used definition of PES currently is the one proposed by Wunder (2005): "PES is a voluntary conditional transaction with at least one seller, one buyer and a well-defined environmental service". Wunder (2005) pointed out that PES schemes are characterized by five salient criteria: a PES is (i) a voluntary transaction where, (ii) a well-defined ecosystem service is (iii) being 'bought' by a (minimum one) ecosystem service buyer, (iv) from an (minimum one) ecosystem service provider (v) if and only if the ecosystem service provider secures ecosystem service provision". There are a wide variety of schemes that use the term PES; not all of which satisfy all the five criteria, and thus are probably better termed PES-like schemes (Wunder, Engel, & Pagiola, 2008).

The actual implementation of PES depends on the prevailing socio-political, economic and biophysical environments (Jack, Kousky, & Sims, 2008) and therefore is likely to vary with the prevailing socio-ecological context. Furthermore, the type of ecosystem service supported through PES can vary widely and range from carbon management, climate change mitigation, biodiversity conservation, landscape scenery and water management, to a "bundle" or mixture of these services (Wunder, 2005). Additionally, PES can also be distinguished by the ecosystem where it is implemented (forests, wetlands, croplands, rangelands); the source of funding (public versus private sector funding or a mixture of both); the land tenure (public, communally owned or private lands); and the scale of implementation (local, national and global)(Farley & Costanza, 2010).

PES in the form of direct payments is increasingly being adopted to promote the conservation of biodiversity especially in private lands outside protected areas (Ferraro & Kiss, 2002). An example of payments for biodiversity conservation within agricultural landscapes is the Regional Integrated Silvo-pastoral Ecosystem Management Projects (RISEMP) implemented in Colombia, Costa Rica and Nicaragua to support farmers to adopt silvi-cultural practices on their farms (Pagiola, et al., 2004). PES for biodiversity can support conservation of individual species or management of ecosystems and landscapes (Milne & Niesten, 2009). In wildlife biodiversity conservation, PES is commonly applied to mitigate human-carnivore conflicts (Dickman, Macdonald, & Macdonald, 2011; Nelson, 2009) or to prevent loss or deterioration of habitats critical to conservation by supporting conservation-friendly land uses (Milne & Niesten, 2009; Pagiola, 2003).

A critical aspect in biodiversity conservation is to ensure that land is managed to provide landscape connectivity (Rouget, Cowling, Lombard, Knight, & Graham, 2006). Connectivity (Bennett 1998) is an important characteristic of lands managed for biodiversity conservation in general, but is all the more important in the case of migratory mammals, such as wildebeest (*Connochaetes taurinus*) and zebra (*Equus burcheli*) populations in East African savannas, various antelope species in South Sudan, and the Mongolian gazelle (*Procapra gutturosa*) in East Asia, all of which migrate seasonally over distances as long as a hundred kilometers or longer. These large mammal species are negatively affected by land uses that fragment landscapes, thereby impeding their migration and disrupting their life cycles that involve seasonal utilization of different parts of the landscape.

A number of PES schemes for wildlife have been developed to prevent the loss of critical habitats that serve as migratory corridors or dispersal areas for wildlife. Examples of PES schemes used to promote the conservation of wildlife corridors and dispersal areas include the Meso-America Biological Corridor which spans eight countries from Mexico to Panama (Kaiser, 2001) and the Terrat PES scheme in the Simanjiro plains, a key wildlife dispersal area for the Tarangire National Park in Tanzania (Nelson, et al., 2010). Nevertheless, preliminary evaluation of PES for wildlife conservation in developing countries suggests limited effectiveness (Pattanayak, Wunder, & Ferraro, 2010), leading to concerns and calls for wider evaluation of their conservation impact (Ferraro & Pattanayak, 2006). There are various approaches to assessing the effectiveness of PES schemes (Ferraro & Pattanayak, 2006). For example, Wunder *et al.* (2008) examined how effective PES programs have been at achieving their objectives of improving ecosystem service generation. They suggest four relevant criteria against which effectiveness of a PES program should be judged. First, all the potential service providers must enroll in the program. Second, providers must comply with the terms of their contract, a condition that introduces the need for verification and monitoring of compliance. Third, compliance must result in "additionality"; that is lead to a change in land use that would not have happened without the PES intervention. Fourth, the induced land-use changes must generate the desired ecosystem services.

From an economic perspective, the payments for delivery of an environmental service should create sufficient incentive to motivate the service providers to change their land use to deliver the desired ecosystem services. Delivering an ecosystem service typically involves investment, transaction costs and opportunity costs (Ferraro 2007), and the payment for the service should at least compensate for the ensemble of these costs. A key part of PES implementation is therefore how to determine the "price" of the ecosystem services desired (Barbier, 2011) to avoid over- or underpayments, which would lead to inefficiencies and ineffective outcomes (OECD, 2010; Wunder, 2007). Quantifying these various cost factors is difficult prior to or in the early stages of PES implementation. This is complicated by information asymmetries that allow providers to give an overestimated picture of their opportunity costs of providing ecosystem services (Ferraro, 2008). Increasingly, contingent valuation methods are being used to estimate the willingness to pay (WTP) on the side of ecosystem service buyers, and the willingness to accept payment (WTA) for ecosystem services providers (Rodriguez 2011, Lewis *et al.* 2009).

The willingness to accept payment for an ecosystem service is the amount that a person is willing to receive as compensation to forego certain land uses on their land. The difficulty in estimating how much to pay, coupled with secondary objectives such as poverty alleviation in PES schemes means that many biodiversity PES schemes offer flat payments (OECD, 2010) that are homogeneous in space. This generates two problems leading to PES ineffectiveness. First, flat payments do not account for the heterogeneity of ecosystem services across the landscape (Wünscher, Engel, & Wunder, 2008). Second, it also does not account for spatial variation in opportunity costs among providers, which is both a function of landscape diversity, and the nature of PES schemes, which determines the level of the transaction costs; with 'asset-building' PES schemes requiring higher investments than 'use-restricting' PES schemes (Engel, Pagiola, & Wunder, 2008). This concurs with Lewis *et al. (*2009) who observed that voluntary incentive-based policies are often inefficient in achieving biodiversity conservation goals for entire landscapes, which arises primarily from the inability of regulators to control for variation of costs across landscapes.

This study aims to investigate the variation in willingness to accept payment for wildlife conservation in the Kitengela plains in Kenya. This is achieved by developing a model describing how this variation in WTA relates to distance to the nearest road infrastructure and other landscape variables, and implementing this model in a GIS environment to display the spatial variation of the willingness among land owners to accept the payment for the land lease implemented in the Kitengela plains. After introducing the Kitengela plains and stating the problems that motivated the development of the PES scheme in this area, we describe the methods used to collect data on and model willingness to accept payments for this land lease program.

2 Study area

2.1 Background

The 114 km^2 Nairobi National Park, one of the three urban National Parks globally, is located 7 kilometer from the Centre of Nairobi metropolis (Rodriguez 2011). The Park is fenced on three sides, but the southern boundary, marked by the Mbagathi river, is open and allows the movement of wildlife into private lands located in the 390 km^2 Kitengela and the larger 2456 km^2 Athi-Kaputiei plains (Nkedianye 2009). When the Nairobi National Park was gazetted in 1946 it was recognized that it was too small to meet the ecological requirements of the migratory wildlife, which was still significant by then. The Kitengela plains and the Ngong Hills, which acted as drought refuges for wildlife, were thus declared as game conservation areas, but were never gazetted (Gichohi 2003).

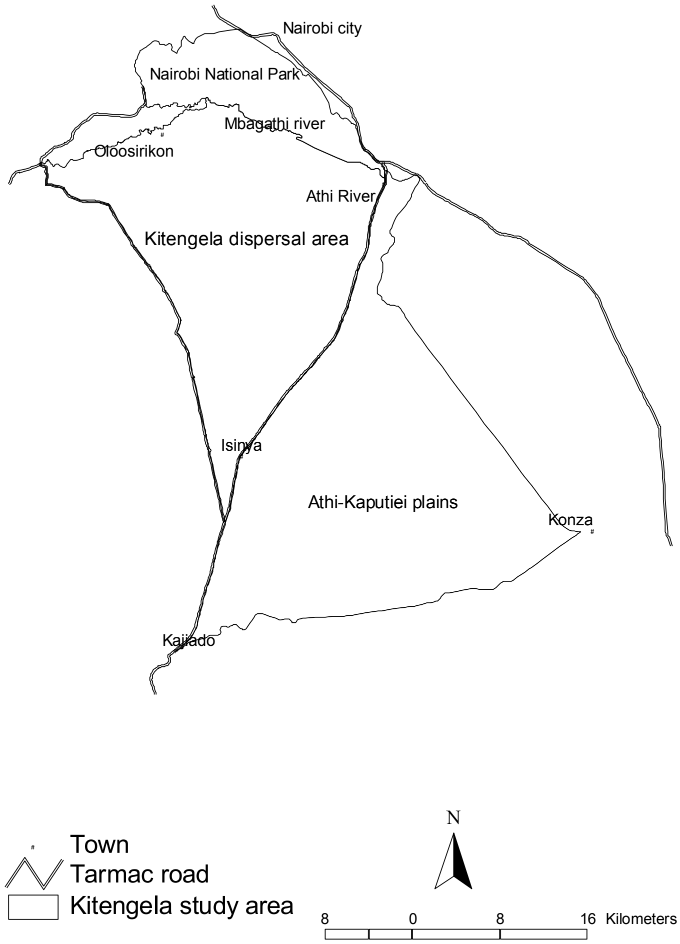

Figure 1: Map showing the Kitengela study area and Nairobi National Park in the Athi-Kaputiei Plains

The park is a dry season (July - November) refuge for much of the area's wildlife (including black rhinos (*Dicornis biceros*), lions (*Panthera leo*), wildebeest, zebra and antelope species), because of the presence of water in the Mbagathi River. With the onset of the rains, wildlife disperses to areas outside the park located on the Athi-Kaputiei plains, which include the Kitengela plains, during the wet season (March – May) (Rodriguez 2011).

2.2 Mounting pressure

The areas south of the park, which are inhabited by the Kaputiei Masai, started to change following land tenure policies introduced in the late 1960s and early 1970s that promoted the creation of group ranches. For example, in the mid 1970's the Kitengela group ranch was created with 215 registered Masai members, who collectively owned 18,292 ha of land. Further policy changes favoring the privatization of land led to subdivision of these group ranches in 1986-1988 into parcels of roughly 80 ha each and allocated them to 215 households (Nkedianye 2009).

Land sales, which started once the land was privatized, led to the conversion of rangelands to rain fed and irrigated agriculture and quarrying, as well as settlements and urbanization along major roads. Further, the establishment of an export-processing zone spurted industrialization in Athi River and Kitengela (Nkedianye 2009). As a result land prices have risen spectacularly in areas with good soils and high annual precipitation and even more where settlement and urbanization started near tarmac roads and close to the park (Norton-Griffiths and Said 2010).

Many of these land uses are incompatible with animal migration, because landholders started fencing their lands. The establishment of fences and the development of real estates have gradually changed the rangelands of the Athi Kaputiei, most especially the Kitengela plains, from a state which is open for animals to migrate to one where fences and other obstacles increasingly block the migration of animals, livestock and wildlife alike, and restrict their access to forage and other resources (Reid *et al.* 2008).

The transition of the rangelands from an open to an increasingly closed system was associated with a rapid decline in wildlife numbers. The declining trend was first reported by Gichohi (2003) and has continued ever since (Reid *et al*. 2008, Owino *et al.* 2011). This decline is largely attributed to the changes in land use described above. The changes, including landscape fragmentation, cultural and economic diversification linked to immigration, have adversely altered the ecological, economic and social integrity of the rangelands, leading to declining rangeland productivity, constriction or blockage of corridors for migratory wildlife and declining species diversity besides the dwindling wildlife numbers (Gichohi *et al.* 1996; Reid *et al.* 2008).

A policy brief issued by the Reto-o-Reto project team (2007) highlight further impacts of the increased pressure on land. First, many Masai, who sold part of their land found themselves squeezed into remnants too small to support pastoralism. The brief notes that this eroded the pastoral livelihoods because the growth of the pastoral population without a matching increase in the number of livestock has led to a decline in the number of livestock *per capita* to a level where people can no longer survive on livestock alone. This has forced many Masai to abandon their traditional pastoral way of life, and diversify their livelihoods. The policy brief also mentions that the Masai have become less tolerant towards depredation of their livestock by wild carnivores because they can no longer afford such losses given their meager livestock holdings. This has shifted local attitudes towards wildlife resulting in increased harassment and even killing of large carnivores (World Bank 2006).

2.3 Response - The Wildlife Lease Program

In the 1990's community-based conservation was established to address these issues. These projects have failed largely because the income earning opportunities were insufficient to stabilize the forces driving land sales, subdivision and conversion. However, surveys conducted by the International Livestock Research Institute (ILRI) and the African Conservation Centre (ACC) undertaken around 2000 revealed that most landowners were willing to keep their land open in exchange for monetary gain (World Bank 2006). Therefore, a new approach was developed to motivate and enable the landowners to maintain wildlife habitats on their land (World Bank 2006).

Launched in 2000, the Wildlife Conservation Lease Program was implemented to encourage and help pastoral landowners to (i) retain ownership of their land, (ii) leave their land open, uncultivated and un-subdivided, (iii) graze livestock sustainably, (iv) share both pasture and water among livestock and wildlife and, (v) allow free movement of livestock and wildlife (Reto-o-Reto *2006*). The project depended on institutions interested in conservation of the greater ecosystem as well as conservation minded individuals in the community.

Before land is brought under the Wildlife Conservation Lease Program some critical steps are taken (Gichohi 2003) to fulfill a number of conditions. The first is that the land must lie within the primary wildlife migration/dispersal area. Second, titles are checked to verify clear ownership. Third, physical verification is undertaken and measurements of areas around houses and livestock enclosures that are not used by wildlife made.

Currently (2012), landowners receive 10 US$ per ha per year. In 2004, the program included 118 families with a total of 3500 ha (Reid *et al*. 2008). Although participation has been voluntary, many landowners have been eager to join the program. This is not only because of the payments but also because the program helps them to continue the traditional way of life; raising livestock and sharing the land with wildlife (David Nkedianye, pers comm.).

The Wildlife Foundation (TWF) makes payments three times a year, coinciding with the opening of schools when parents are due to pay school fees for their children. The payments are deliberately made when schools are in session to support parents sending their children to school. The payments also serve other purposes, however. For example, during the drought of 1999-2000, when the Kitengela community lost more than half of their livestock, the income from the lease program amounted to nearly 80% of the household income of the participants (Reto-o-Reto 2006).

3 Methods and Materials

3.1 Willingness to accept and enrollment in the land lease program

Limited time precluded interviewing landowners to help quantify their willingness to accept payments for leasing their land. As a result, a proxy was used which reflects the WTA based on the long-term data collected by ILRI and its partners in Kitengela. The landholders on the waiting list and in the lease program, are obviously willing to accept the payments, and the parcels of land that they bring, or are willing to bring to the program, are taken to represent the locations at which land owners are willing to accept payment. These parcels are referred to as WTA+. No interest was expressed for all other parcels of land, notwithstanding the fact that the land lease scheme is very well known in the Kitengela. These parcels are assumed to reflect lands where people are not willing to accept payments from the land lease program and are referred to as WTA-. This resulted in a binary data set of parcels of land with owners interested or not in enrolling in the scheme, and thus willing or unwilling to accept payments. We used this dataset and several predictor variables to perform the spatial and statistical analyses as described below.

3.2 Explanatory variables

WTA payments for leasing the land for wildlife conservation are likely to be affected by the value of land and the opportunity cost of leaving the land open for migratory livestock and wildlife (Norton-Griffiths and Said 2010). Leaving lands open is however incompatible with a number of other land uses, such as cropping, quarrying, and settlement. Landowners may also lose interest in the land lease program for lands with a high potential value achievable under modified land use, for example the parcels of land close to roads, towns, rivers and close to the park, which are in high demand for housing and commercial buildings. The contractual arrangements for the land lease program would restrict the freedom of the landowner to develop these lands. Other factors like the amount of rainfall and the terrain slope of the terrain could also affect enrollment in the program. Thus, slope, rainfall, distance to roads, rivers, the park boundary and towns were used as covariates, which might predict the WTA payment for leasing land.

3.3 Data

Data on the current enrollment of land in the lease program and the parcels on the waiting list as well as the rainfall, slope and the location of roads, towns, rivers and the boundaries of the Kitengela and Athi-Kaputiei plains were acquired from ILRI and The Wildlife

Foundation. The boundaries of the parcels that are enrolled in the program or are in the waiting list were mapped by the local Masai with technical and logistical support from ILRI. GPS was used to map all fenced parcels in Kitengela and all non-fenced parcels in the lease program in 2004 and 2010. During the field mapping exercise, information on land use, such as the presence of rain fed and irrigated crops, quarries and the presence of built-up infrastructure were recorded. Spatial datasets were derived for rainfall, slope and distances to roads, rivers, park boundaries and towns in Arc GIS format. The data, in a vector format, were converted to a raster format, and resampled to a common spatial resolution of 100 × 100 m^2 for use in spatial modeling and display.

3.4 Cartographic visualization

Several maps were designed in ArcView using the data acquired from ILRI. A map of land use activities showing the distribution of different land cover and use categories, like pastoral land use of open grasslands, cropping, quarrying, build-up areas and fenced grasslands was developed (Figure 3). The land use map also displays the roads, towns, rivers and the Nairobi National Park. A second map (Figure 4) was developed to show the distribution of the parcels that are in the land lease program, fenced areas, roads, Nairobi National Park and rivers. A further set of six buffer maps (Figure 5) display the predictor variables that are used in the statistical analyses below. Finally, the probability of the willingness to accept payments from the lease program as predicted by the statistical model described below is shown in Figure 6.

3.5 Statistical modeling

The decision regarding whether to enroll in the land lease program is a function of the characteristics of the land parcels and the households. An analysis of the willingness to accept payment from the land lease program would thus ideally include information on parcels and households. For the purpose of this study, however, we were only able to access information on the parcels of land only, and therefore decided to develop a statistical model that does not consider household characteristics.

A Multiple Logistic Regression (MLR) model was used to evaluate the significance of the factors influencing enrollment in the land lease program. The MLR model was used to estimate coefficients of the predictor variables with the presence or absence of willingness to accept enrollment as the response variable. First, a separate model containing each of the predictor variables was fit to the data and the Corrected Akaike Information Criterion (AICC) for each model computed. Next, the model with the predictor having the smallest AICC value was selected and predictor variables with the next smallest AICC values plus their interactions with the predictors already in the model added sequentially to this base model. New predictors and their interactions with variables already in the model were retained in the model only if their addition reduced the AICC value of the model but were otherwise dropped from the model. This procedure was repeated until all the predictors had been considered. The final model, with the smallest AICC, was chosen as the best approximate model (Burnham and Anderson 2002). All the models were fitted in SAS (SAS Institute, 2011). The spatial distribution of the probability of enrollment in the land lease program predicted by the AICC-selected best statistical model was mapped in ArcView to produce Figure 6.

4 Results

4.1 Land use, fences and the land lease program

Figure 2 shows the land use in the Kitengela and the Athi Kaputiei plains in 2010 according to data collected by ILRI. Grassland is by far the most important land cover type in the area and pastoralism is the main land use, with a significant area of the grasslands in the North used for wildlife conservation. Part of the grasslands has been fenced, and continues to be under grazing land use. Other land uses include crop production, open mining or quarrying and settlements.

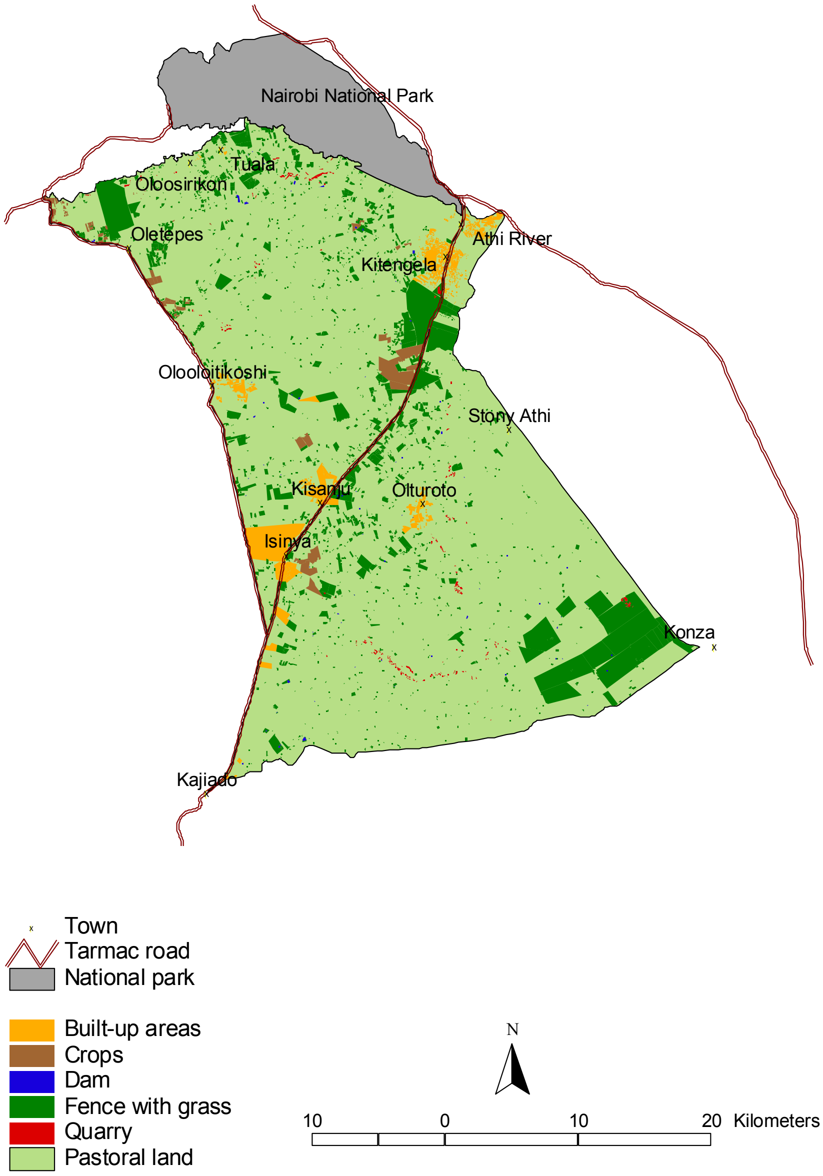

Figure 2: The distribution of land use types in Kitengela Plains based on field surveys conducted by ILRI in 2009-2010

Figure 3 shows the parcels that were fenced in 2010. This category included settlements or isolated built-up infrastructure, areas used for crop production, dams and quarries and grasslands that have been fenced. The figure reveals that fenced lands were located mostly near towns and roads. The density of fences around the road from Athi River to Kajiado was particularly dense, and the figure suggests that there were few spaces left where livestock and wildlife were still able to migrate from the North West to the South East and vice versa. Further, near Konza large properties have been fenced to reduce the pressure to sub divide the land.

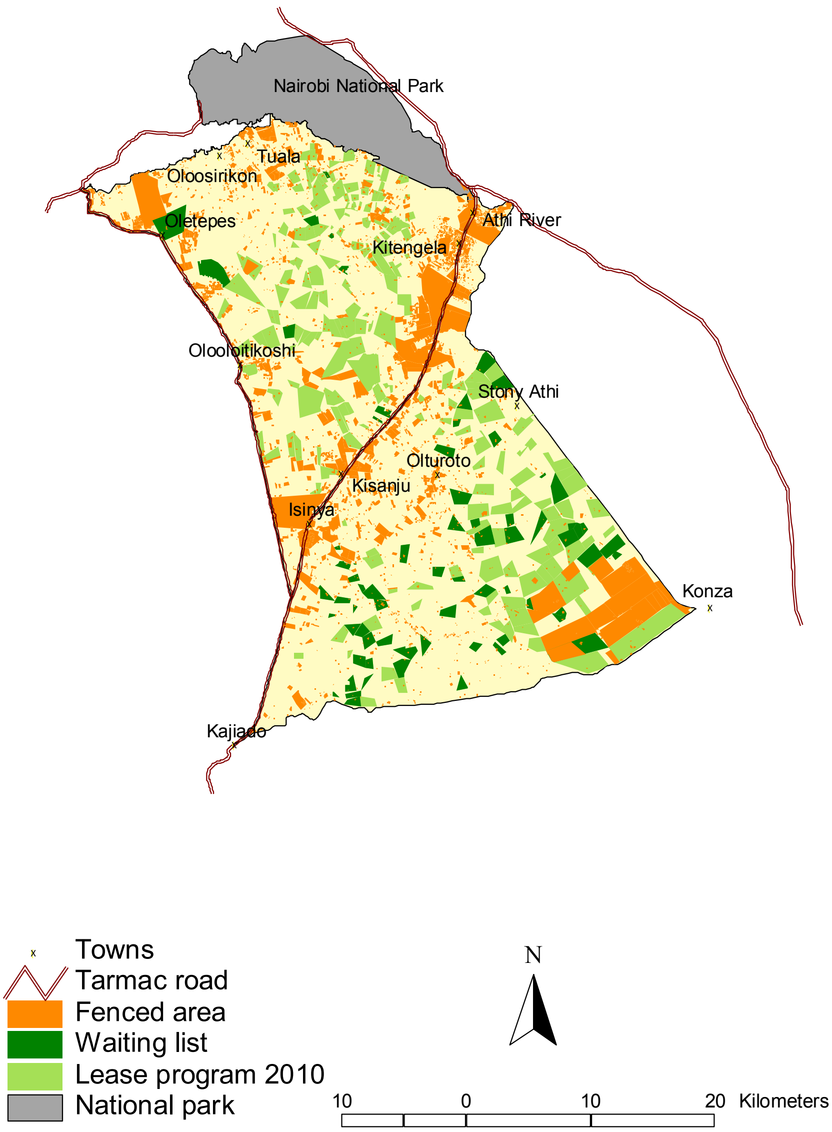

Figure 3: Distribution of fenced areas and land under the land lease program and on the waiting list for the land lease program.

Figure 3 also shows the WTA+ parcels that were enrolled in 2010 and the land on the waiting list for the land lease program. These are the parcels of land where the landowners were willing to accept payment from the land lease program. Note that this willingness was high in areas away from the tarmac roads but low closer to the roads and near towns. The density of parcels of land on the waiting list was higher in the Southern area than in the Northern area.

4.2 Statistical model

Figure 4 shows the distribution of the WTA+ parcels in relation to the spatial variation of the six explanatory variables that were used in the statistical model. Figure 5a indicates that WTA+ is more frequent further away from tarmac roads. Figure 5b shows little variation in WTA+ with distance from the park boundary. However, parcels in the lease program close to the park tend to be smaller in size. Near the park a significant area of land has been sold to private owners who have constructed houses, and hence leaving less land available for pastoralism or the lease program. Figure 5c reveals a number of leased land parcels located at intermediate distances away from rivers. Figure 5d however, shows a strong variation in WTA+ with distance to settlements. Steeper slopes dominate in the North West, but there is little evidence for a relationship between WTA+ and slope steepness. The last map (Figure 5d) shows fewer WTA+ in the higher rainfall areas, which might be explained by the fact that the higher rainfall areas are more suitable for crop production.

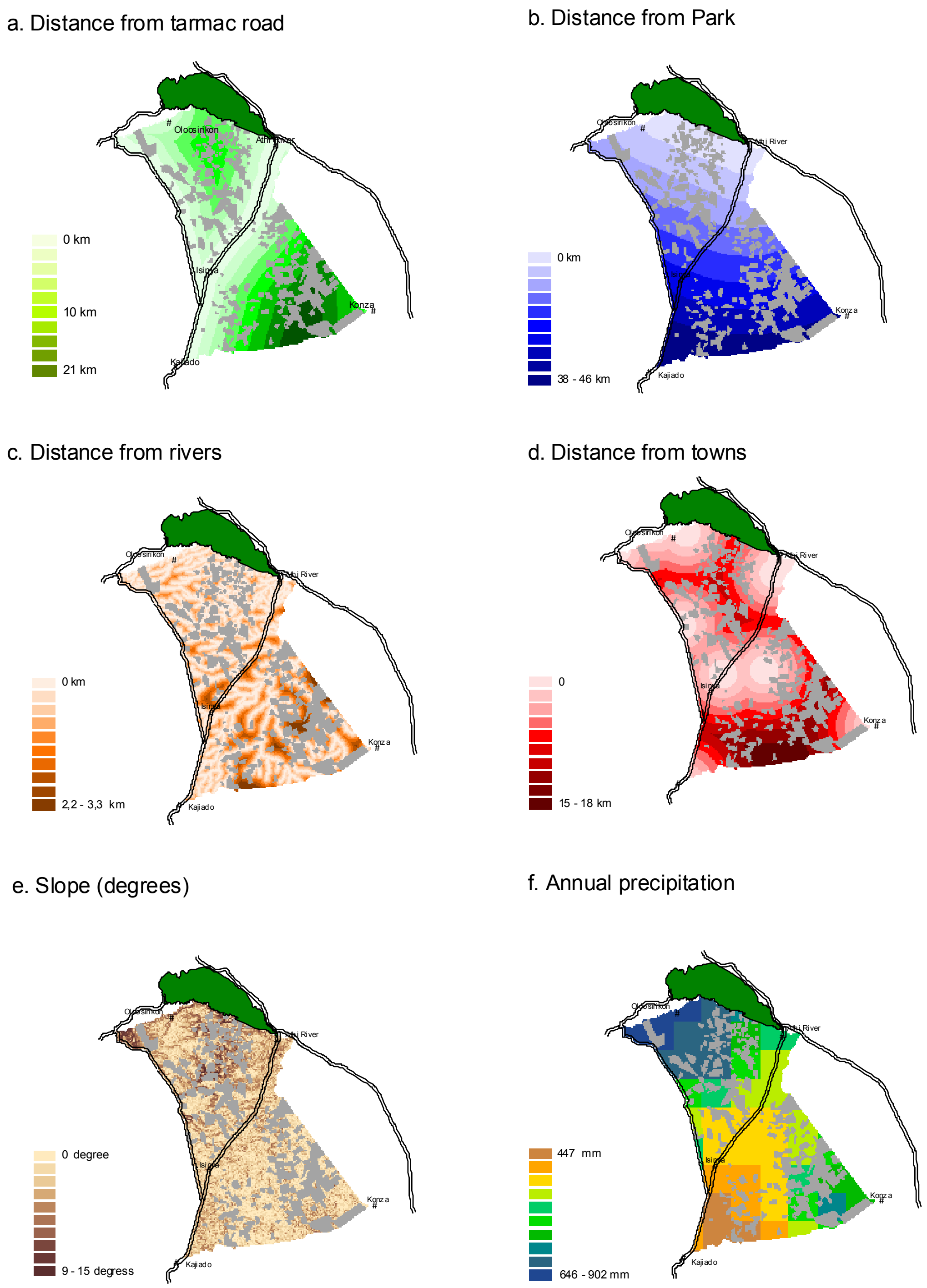

Figure 4: Buffer maps for the six predictor variables and the distribution of lands with owners willing to accept a payment of 10 US $ per ha per year.

The selected multiple logistic regression models included 17 out of the initial total of 27 variables and interaction terms that were entered in the model (Table 1). Distances to the nearest town, park boundary and road were strongly supported, annual precipitation made moderate contribution to the model whereas slope steepness made an even smaller contribution to the overall model as judged by the absolute t value (Table 1). These results suggest that proximity to roads and towns are the two most important variables influencing the WTA in Kitengela.

Table 1. Results of the multivariate logistic regression of the probability of enrollment of land parcels in the lease program against biophysical predictor variables for the Athi-Kaputiei ecosystem.

Effect	**Estimate**	**SE**	**T**	**P>|T|**
Intercept	-25.5199	1.16245	-21.95	<0.0001
Annual precipitation	0.07395	0.00405	18.25	<0.0001
Annual precipitation^2	-6.4×10^{-5}	3.49×10^{-6}	-18.46	<0.0001
Mean slope (deg)	0.10980	0.01368	8.03	<0.0001
Mean slope (deg)^2	-0.0156	0.00187	-8.32	<0.0001
Distance to road	0.2230	0.00697	32.01	<0.0001
Distance to road^2	-0.0024	0.00054	-4.42	<0.0001
Distance to river	-0.4992	0.06215	-8.03	<0.0001
Distance to river^2	-0.4589	0.02276	-20.17	<0.0001
Distance to town	0.4681	0.01192	39.27	<0.0001
Distance to town^2	-0.0216	0.00113	-19.13	<0.0001
Dist to road × dis to town	-0.0050	0.00110	-4.51	<0.0001
Dst to river × dis to town	-0.0407	0.00595	-6.84	<0.0001
Distance to park	0.1006	0.00379	26.55	<0.0001
Distance to park^2	-0.0034	9.24×10^{-5}	-36.75	<0.0001
Dist to river × dis to park	0.0603	0.00232	26.04	<0.0001
Dist to road × dis to park	-0.0018	0.00025	-7.39	<0.0001
Dist to town × dis to park	0.0018	0.00042	4.35	<0.0001

†DF = 114559

The model when implemented in a GIS environment revealed significant spatial variation in willingness to accept payments. Figure 5 reveals two spatial clusters with WTA exceeding 40%, corresponding to areas where a large minority or even the majority of landowners respond to the current fee for leasing their land. The Southernmost cluster with high WTA corresponds to the traditional dispersal area where wildebeest and zebra give birth to and nurture their young calves during the wet season. This southernmost cluster is disconnected from the national park by an area of low WTA that surrounds the tarmac road connecting the Athi River and Kajiado towns as well as a areas of low WTA surrounding towns.

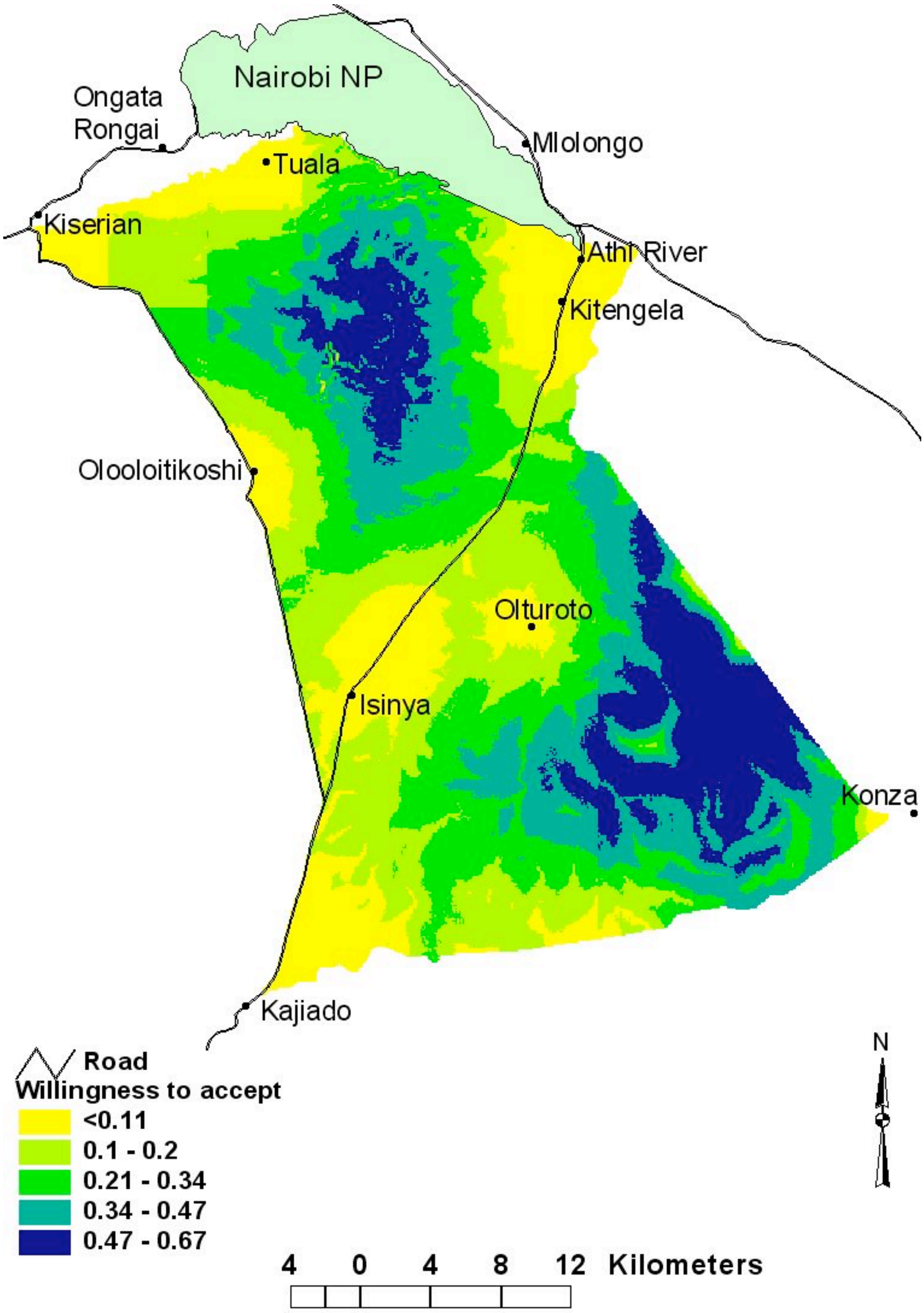

Figure 5 – Map of the spatial distribution of the probability that land owners in the Athi-Kaputiei plains are willing to accept a payment of 10 US $ per ha per year as compensation for leaving their land open to wildlife and livestock.

5 Discussion

The results reveal significant variation in the willingness to accept payment for availing land to a PES scheme targeting conservation of a corridor for migratory wildlife in the Athi-Kaputiei Plains of Kenya. A multiple logistic regression model was used to relate the probability of enrolling land in the lease program to a suite of predictor variables, including in order of statistical importance; distance to the nearest town, distance to the nearest road, distance to the Nairobi National Park boundary and distance to the nearest river as well as annual precipitation and average terrain slope. WTA revealed a strong association with distance to towns and roads with low WTA close to settlements and tarmacked roads, an observation consistent with our prior assumptions. WTA was weakly associated with distance to rivers as well as with the average terrain slope.

What does this model tells us about the effectiveness of the lease program to keep the land open to animal migration and thus keep the wildlife populations in the national park connected to the dispersal areas where they have historically reproduced? The lease program assumes that when fully implemented it would be able to maintain an open corridor which would allow wildlife populations to migrate between the national park and the dispersal areas. Achieving this goal is likely to be hampered by the two low WTA areas which would potentially restrict or complicate development of a corridor of land that would remain open and allow continued wildlife migration as envisaged. Recent information on radio collared wildebeest by Colorado State University and Kenya Wildlife Services indicate that the wildebeest are confined within their dry and wet season ranges because of the blockage of routes through dense fencing. The flat rate of 10 US $ per ha per year currently offered by the land lease program is apparently sufficient to enroll land owners in two isolated areas remote from towns and roads, but insufficient to achieve enrolment of land owners along the whole length of the desired corridor.

Our results thus indicate that a payment of 10 US $ per ha per year suffices in some areas, but not in other areas that are also required to maintain a viable corridor. Higher payments for the service of keeping the land open are apparently required to include landholders in those intermediate areas with low WTA than the current payment of 10 $ per ha per year. There is thus a need to stratify the plains according to the payments that would be required to keep the land open. This analysis is the first attempt at achieving this goal. The analysis does however only indicate whether the current payment is a sufficient incentive for land owners to enrol. It does not answer the question what level of payment would be required to trigger a higher level of enrolment in areas with low willingness to accept the current payment.

The fee of 10 $ per ha per year. is relatively low considering that land located in the middle of the Athi-Kaputiei plains was already being sold at $9000 – $12000 per hectare by 2008 (Norton-Griffith 2008) and that the prices have continued to rise. However, an important consideration regarding the payments by the lease program in Kitengela is that they are designed to coincide with the three school terms in each year. It is likely that the decision to accept payments from the lease program is motivated by the desire of parents to educate their children and the need for a reliable source of money to pay fees for the school-going children, than by a narrow and rational economic assessment of what a realistic price for leasing the land would be at present.

Detailed and geographically stratified surveys would be required to develop insights into what level of payment would be effective in each locality. This is non-trivial, as earlier research (Mwangi & Warinda. 1999) has estimated that land owners were willing to avail their land at a fee of US$ 2078 (at 2000 US $ rate) per ha per year, which would seem too high given that many land owners were still willing to accept a payment of US$ 10 to keep their land open by 2010. Further research is needed to refine these models and elicit more nuanced insights.

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