Spatial variation in the willingness to accept payments for ecosystem services:

A case study on payments for wildlife conservation in the Kitengela plains, Kenya

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Abstract

This Bachelor thesis aims to investigate the spatial variation in willingness to accept payments for wildlife conservation in the Kitengela and Athi Kaputiei plains in Kenya. In 2000 the Wildlife Conservation Lease Program was implemented in the Kitengela. This program, designed to create an incentive to keep land open for wildlife and livestock, currently offers land owners a flat fee of 10 US$ per ha per year, irrespective of location. The willingness to accept payment (WTA) is likely to vary spatially and be lower closer to roads, towns and other lands with higher economic returns. In this thesis a model is presented describing how this variation in WTA relates to distances from road infrastructure, towns, rivers, as well as to annual precipitation and slope. This model was implemented in a GIS environment to display the spatial variation in the willingness of land owners to accept payments from the Wildlife Conservation Lease Program. The model reveals significant spatial variation in the willingness to accept payments for availing land for conservation, with more people who are willing to accept payments concentrated near the park and also in the south-eastern section of the Kitengela plains. The lease program aims to maintain open corridors for wildlife migration when fully implemented. However, the results suggest that the mobility of wildlife will be blocked by lands that are not open to migration due to an area with low WTA index in the proximity of towns and tarmacked roads. This thesis concludes that an effective strategy to keep the land open for migratory wildlife would need to consider the fact that there is significant spatial variation in the willingness to accept payment for land lease, and stratify the lease rates accordingly.

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1 Introduction

There is a rapid increase of interest in payment for ecosystem services (PES). This increased interest in PES stems from a concern over the rapid decline of ecosystem services raised in a seminal paper by Costanza *et al*. (1998). These concerns over loss of ecosystem services were further enhanced by the Millennium Ecosystem Assessment (MEA 2003). Payment for ecosystem services is advocated as one of the possible instruments to stop or reverse this decline.

Ecosystem services are also under pressure in the developing world where poverty leads to unsustainable resource utilization and environmental degradation. Increasingly, PES is seen as a way to overcome this as it has the potential of combining poverty reduction with positive change in environmental outcomes (Pagiola 2005, Rodriguez 2011, Bulte *et al*. 2008). In the developing world PES is thus seen as way to match agendas of poverty alleviation and sustainable natural resource management.

One of the most commonly used definitions of PES 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 different 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; some match all the five listed criteria, whereas others share fewer of the above criteria and are probably better termed PES-like schemes.

PES schemes differ according to the products delivered and the socio-political, economic and biophysical environments in which they are implemented. The type of service provided varies from carbon management, climate change mitigation, biodiversity conservation, landscape scenery and water management. Distinctions can also be made according to the ecosystem where PES is implemented (forests, wetlands, croplands, rangelands), the source of funding (public versus private sector funding or a mixture of both), and land tenure (public, communally owned or private lands).

Payment for ecosystem services is used as an instrument to achieve biodiversity conservation, among other uses *(*Smith 2007, Ferraro and Kiss 2002*)*. An example of payments for biodiversity conservation is the PES scheme for non-timber forest product extraction in Costa Rica, where landowners receive payments for providing biodiversity services in the form of forest conservation and reforestation (Jindal and Kerr 2007). Other examples of biodiversity conservation investments given by Ferraro and Kiss (2002) include PES schemes in sustainable agriculture, eco-tourism, watershed protection and carbon sequestration and payments for the breeding success of birds. Biodiversity conservation may require managing larger areas of land which are connected to allow migration of animals and plants. Connectivity (Bennett 1998) is an important element for lands managed for biodiversity conservation in general, but this requirement is all the more important in the case of migratory animal species, such as wildebeest and zebra in East Africa, which migrate seasonally over distances as long as a hundred kilometers or longer.

The recent surge in the number of projects implementing PES has led to a rapidly increasing interest in the effectiveness of PES schemes. There are various perspectives to approach the effectiveness of PES schemes, such as connectivity and the possibility for animals to migrate in case of migratory species but also economical, socio- cultural, socio-political perspectives. Significant attention has been given to the question of whether PES schemes deliver on their environmental outcomes. For example Wunder *et al.* (2008) examined how effective PES programs have been at achieving their

objectives of improving ecosystem service generation. According to them the success of a PES program can be judged according to four relevant factors. First, all the potential service providers must enroll in the program. Second, providers must comply with the terms of their contract, a condition which introduces the need for verification and monitoring of compliance. Third, compliance must result in a change in land use compared to what would have happened without the program. Fourth, the induced land-use changes must, in fact, 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 these 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. After examination of the cost-effectiveness of a number of PES schemes for conservation, which revealed ineffectiveness of indirect approaches, Ferraro and Simpson (2002) suggested that PES models must be designed to become more cost effective.

Quantifying these various cost factors is difficult and impossible to do prior to or in the early stages of PES implementation. Increasingly, certain techniques are being used to assess the willingness to pay (WTP) and the willingness to accept payment (WTA) for ecosystem services (Rodriguez 2011, Lewis *et al.* 2009). The willingness to accept is the amount that a person is willing to accept in return for a product or a service. An incentive for land owners to accept payments exists when they have no other opportunity costs.

Many PES schemes offer payments that are homogeneous in space. However, the willingness to accept payments will vary spatially, when the cost factors mentioned above, investment, opportunity and transaction costs, vary in space. WTA will be low when the costs equal or exceed the benefits from payments. Such situations exist in case of land uses which demand a high investment for the delivery of the service (e.g. removing build up infrastructure to allow service delivery), opportunity cost or transaction cost. This concurs with the observation made by Lewis *et al. (*2009) that voluntary incentive-based policies are often inefficient in achieving conservation goals for entire landscapes, which arises primarily from the inability of regulators to control the spatial pattern of landscapes, thus WTA is likely to vary in space.

This study aims to investigate the variation in willingness to accept payment for wildlife conservation in the Kitengela plains in Kenya, to develop a model describing how this variation in WTA relates to distance to road infrastructure and land use, and implement 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 which is implemented in the Kitengela plains. Chapter 2 provides an introduction to the Kitengela plains and the problems that have led to the development of the PES scheme in this area, chapter 3 describes the methods used to investigate and model the willingness to accept payments for this land lease program, chapter 4 describes the results which are discussed in chapter 5.

2 Case Study area Kitengela

2.1 Background information

The 114 km^2 Nairobi National Park, one of the three urban National Parks globally, is located 7 kilometer from the Centre of Nairobi (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 refuge areas, were thus declared as game conservation areas, but were never gazetted (Gichohi 2003).

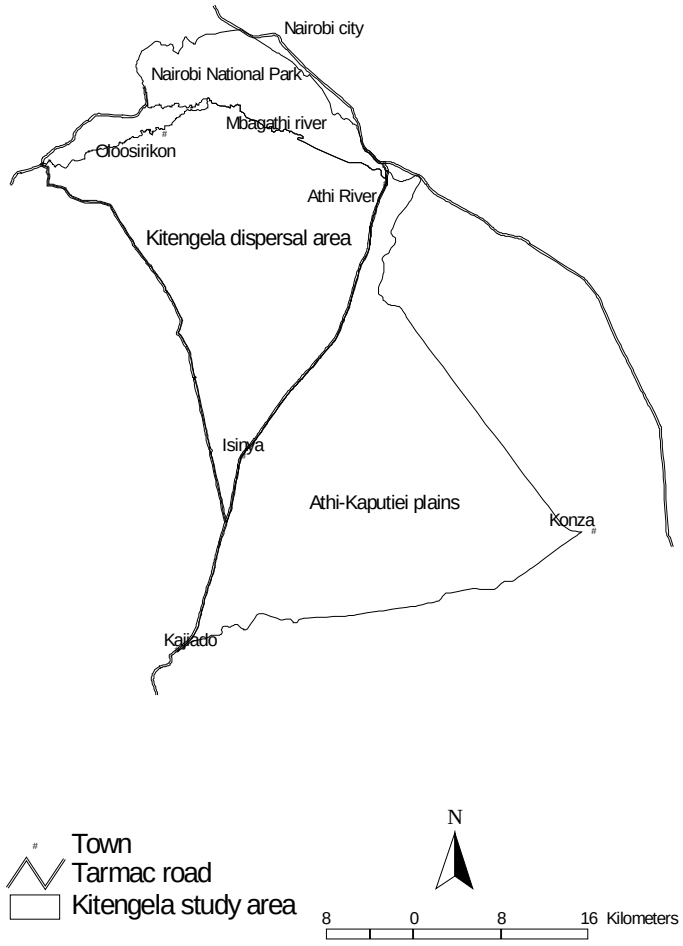

Figure 1: Map showing the Kitengela study area and Nairobi National Park

The park is a dry season (July - November) refuge for much of the area's wildlife (including black rhinos, lions, wildebeest, zebra and antelopes), because of the presence of water in the Mbagathi river. With the onset of the rains wildlife disperse outside the park into the Kitengela and Athi-Kaputiei plains during the wet season (March – May) (Rodriguez 2011). Figure 2 shows the distribution of wildebeest, cattle and zebra in the Athi-Kaputiei Plains in the 1990's. These maps confirm that the populations of wildebeest and zebra used to concentrate in the wet season in the Kaputiei plains, while they resided in the Nairobi National Park in the dry season. The Kitengela Plains was crucial in sustaining this unique migration as it is located between the dry season refuge, Nairobi National Park, and the wet season dispersal area, the Athi-Kaputiei plains, where calving traditionally took place.

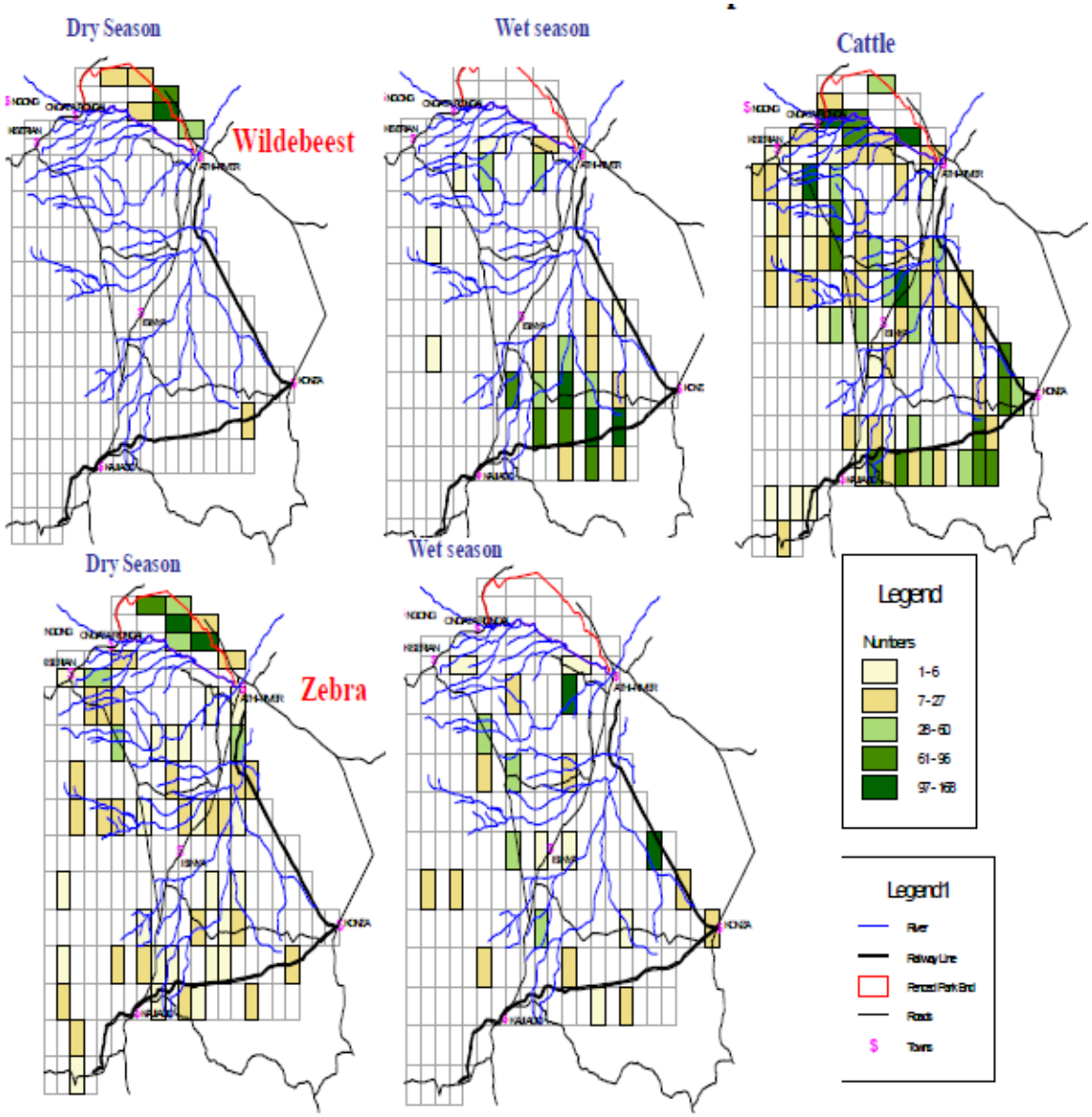

Figure 2: Distribution of wildlife and cattle in the wet and dry seasons in the Athi-Kaputiei plains (Source: Gichohi 2003).

2.2 Problems in the Kitengela

2.2.1 The DPSIR approach

This section reviews the problems in the Kitengela using the DPSIR (Drivers, Pressures, State, Impact and Response) approach, a conceptual framework frequently used to analyze environmental problems (Tscherning *et al.* 2012, Gabrielson and Bosch 2003). Below is a brief description of the drivers, pressure, state, impact and response in the Kitengela. The development of these various factors over time and their interactions will be described in the sections that follow.

Drivers include change in land tenure policy, demographic growth, urbanization and change in lifestyle. These drivers lead to scarcity and an increased demand for land. These competing claims for land are the key pressure. This pressure is leading to a change in the state of the land, from open and accessible for livestock and wildlife, to a closed state, due to the development of real estate and fences around land uses non compatible with grazing animals. These fences and other obstacles to animal migration impact the possibility of wildlife and livestock to migrate, with the loss of biodiversity and social benefits from livestock, as the main result. A variety of responses have been

designed and implemented to reverse the above trend; this review focuses on one of these responses, the Conservation Land Lease Program that was developed to halt and reverse the transition from an open to a closed system.

2.2.2 Drivers, Pressure and State

The areas outside the park are inhabited by the Kaputiei Masaai who have used the land since the pre-colonial times. The area 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 Maasai members, who collectively owned 18,292 ha of land. Thereafter followed further policy changes which favored the privatization of land. The land was subdivided in 1986-1988 in parcels of roughly 80 ha; these were allocated to each of the 215 households that were members of the group ranch (Nkedianye 2009).

Once the land was privatized land sales in Kitengela started, with owners subdividing and selling parts of their plots (Nkedianye 2009). Also, large scale irrigated schemes and quarrying enterprises have been established in the area since privatization began. As a result, land prices have risen spectacularly, particularly in areas with good soils and high annual precipitation, where returns from agriculture out-compete those from livestock (Norton-Griffiths and Said 2010). Land prices increased even more in areas near tarmac roads, rivers, trading centers, and close to the park. Land in Kitengela has appreciated at a rate of over 11% per annum over the last 10 years, which compares well with the average ten-year returns from Treasury Bills (Norton-Griffiths and Said 2010). Due to its proximity to Nairobi, industrialization and migration of people occurred. During the 1980s and throughout the 1990s, the towns of Athi River and Kitengela grew rapidly with industries and an export-processing zone established in the area (Nkedianye 2009). The population started to increase, leading to more settlements and more fencing (Reid *et al.* 2008).

The subdivision of land has thus facilitated a rapid change in land use with economic diversification from the traditional pastoral livestock keeping to cropping-based agriculture, including irrigated crops and flower farms, quarrying, and development of industrial estates and permanent settlement. Many of these land uses were incompatible with animal migration and landholders started fencing their lands. The establishment of fences and the development of real estate have gradually changed the rangelands of the Athi Kaputiei and 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.

2.2.3 Impact

The transition of the rangelands from an open to an increasingly closed state, which started in the 1990s was associated with a rapid decline on wildlife numbers, a trend which was already apparent by the middle of the 1990's (Gichohi 2003). Counts showed that from 1977-2002, wildlife populations fell by as much as 72% in the area outside the National Park (Reid *et al*. 2008: Owino *et al.* (2011) more recently confirmed continuation of the declining trend for the migratory wildebeest and the residential Grant's gazelle and Impala in Nairobi National Park. This decline is largely attributed to the changes in land use described above which have adversely affected the ecological, economic and social integrity of the rangelands due to landscape fragmentation, declining rangeland productivity; diminishing corridors for migratory wildlife, wildlife numbers and species diversity and cultural and economic diversification linked to immigration (Gichohi *et al.* 1996). The competition between livestock and wildlife for water and forage and frequent incidences of livestock depredation and injuries caused by large carnivores, have also resulted in increased human-wildlife conflicts. Landowners have no incentive to let wildlife graze on their land, because they do not benefit from wildlife in any way and derive higher returns from agriculture or selling their land.

A policy brief issued by Reto-o-Reto (2007) indicates some further impacts of the increased pressure on land. First, this pressure has had a negative effect on the pastoral way of life. Many Maasai, who, attracted by the cash sold parts of their land, found themselves squeezed into remnants too small to support pastoralism. The policy brief further suggests 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 Maasai families to abandon their traditional pastoral way of life, and diversify their livelihood options. The policy brief also mentions that Maasai have become increasingly 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 (GEF 2006).

2.2.4 Response - The Wildlife Lease Program

In the 1990s community-based conservation projects which also aimed at the development of ecotourism were established to address these issues. These projects have largely failed because the income earning opportunities have proven 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 (GEF 2006). Therefore, a new approach was developed to motivate and enable the landowners to maintain wildlife habitats on their land (GEF 2006). A group of partners came together in an attempt to reverse the negative trends and started the Wildlife Conservation Lease Program.

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 protection of the Wildlife Conservation Lease Program some critical steps had to be taken. “Land must be confirmed to lie within the primary wildlife migration/dispersal area. Titles are checked to verify clear ownership. Physical verification is undertaken and measurements of areas around houses and livestock enclosures that will not be used by wildlife are taken into account (Gichohi 2003)”. Although participation of the program has been voluntary, many landowners have been eager to join the program. According to David Nkedianye (pers comm.) 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.

When land is brought under the Wildlife Lease Program landowners receive 10 US$ per ha per year. Thus, a household, which on average initially owned a 100 ha, would receive 1000 US$ a year. In 2004, the program included 118 families with a total of 3500 ha (Reid *et al*. 2008). The program relies on external funding sources and plans were launched to raise 1 million US dollars to bring at least 24281 ha of critical land under conservation management in the early 2000s (Gichohi 2003).

The Wildlife Foundation (TWF) makes payments three times a year, coinciding with the opening of schools when parents are due to pay the fees for their children to attend. The coincidence of payments with the school season is deliberately chosen, to support parents to send their children to school. The payments also serve other purposes, 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).

Osano and colleagues (in prep) looked at the expenditures from the people who joined the program. They found that more than 80% of the money received from the lease program is supposedly spent on education. The PES scheme is designed to promote the use of the money primarily on education, so that their finding confirms what indeed is happening. The landowners are typically paid just a day before schools open when they need money for fees and other school expenses, which encourages using the PES money on educational expenses. In addition, the landowners are encouraged by administrators and donors to invest the money in educating their children.

3 Methods & Materials

3.1 Willingness to accept and enrollment in the land lease program

Given the limited time available for this BSc thesis there was no time to directly interact with land owners and conduct interviews and quantify their willingness to accept payments for leasing their land. Instead, a proxy was used which reflects the WTA based on the long-term data collected by ILRI and its partners in Kitengela. The two groups, landholders on the waiting list and landholders in the lease program, are obviously willing to accept the payments, and the parcels of land that these people do bring in, or are willing to bring in, are considered to represent locations for which land owners are willing to accept the 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 considered to reflect lands where people are not willing to accept payments from the land lease program; they are referred to as WTA-. This resulted in a binary data set of parcels of land with and without interest for enrollment in the scheme, and thus with and without willingness to accept payments. We used this dataset with a number of explanatory variables in further 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. Land owners 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 land owner 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 variables which might affect 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 park boundaries for 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 and those that are on the waiting list have been mapped by local Maasai who were trained by Shem Kifugo, an ILRI GIS analyst. Use was made of a GPS and all fenced parcels in the Kitengela and the non-fenced parcels that are in the land lease program have been mapped, most recently in 2010. The field surveyors also recorded information on land use, such as the presence of rain fed and irrigated crops, quarries and the presence of built-up infrastructure. Spatial datasets were derived on rainfall, slope and distances to roads, rivers, park boundaries and towns in Arc GIS format. The data, available in vector formats, was converted to raster format, and resampled to a common spatial resolution of 100×100 m^2 that was used in spatial modeling and display.

3.4 Cartographic visualization

Several maps were designed in ArcView using the data acquired from ILRI. The map of the land use activities (Figure 3) shows the distribution of different land cover and use categories, like pastoral land use of open grasslands, cropping, quarrying, build-up areas and fenced grasslands. This land use map also displays the roads, towns, rivers and the Nairobi National Park. A second map (Figure 4) shows the distribution of the parcels that are in the land lease program, fenced areas, roads, Nairobi

National Park and rivers. A set of six buffer maps (Figure 5) display the predictor variables that are used in the statistical analyses below. Finally, figure 6 shows the probability of the willingness to accept payments from the lease program as predicted by the statistical model described below.

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 household characteristics. An analysis of the willingness to accept the land lease program would thus ideally include information on parcels and households. For the purpose of this study I was 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 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, 2006). 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 3 shows the land use in the Kitengela and 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 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.

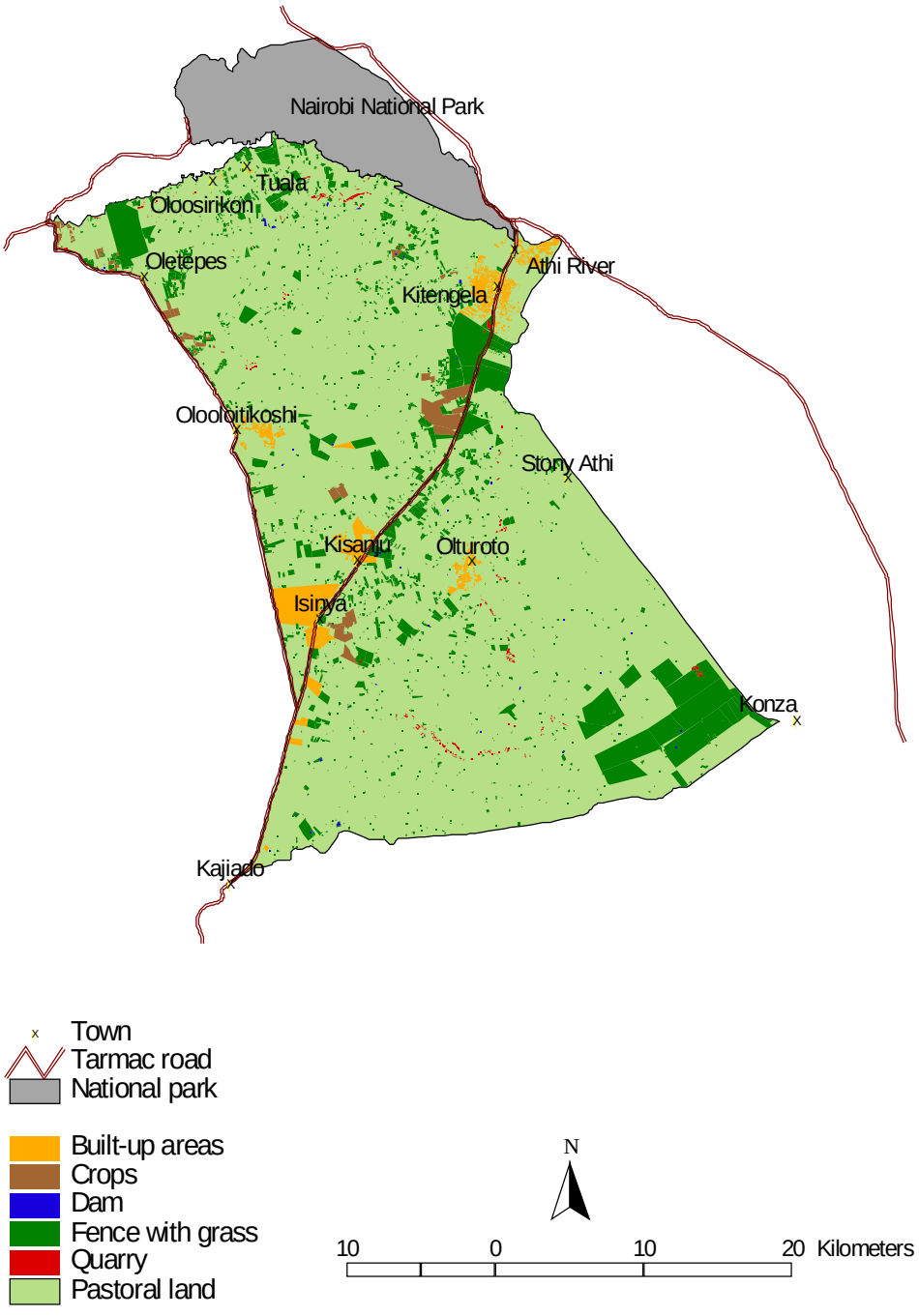

Figure 3: Land use according to field surveys by ILRI in 2009 and 2010

Figure 4 shows the parcels that were fenced in 2010. This category includes 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 are located mostly near towns and roads. The density of fences around the road from Athi River to Kajiado is particularly dense, and the figure suggests that there are few spaces left where livestock and wildlife are 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.

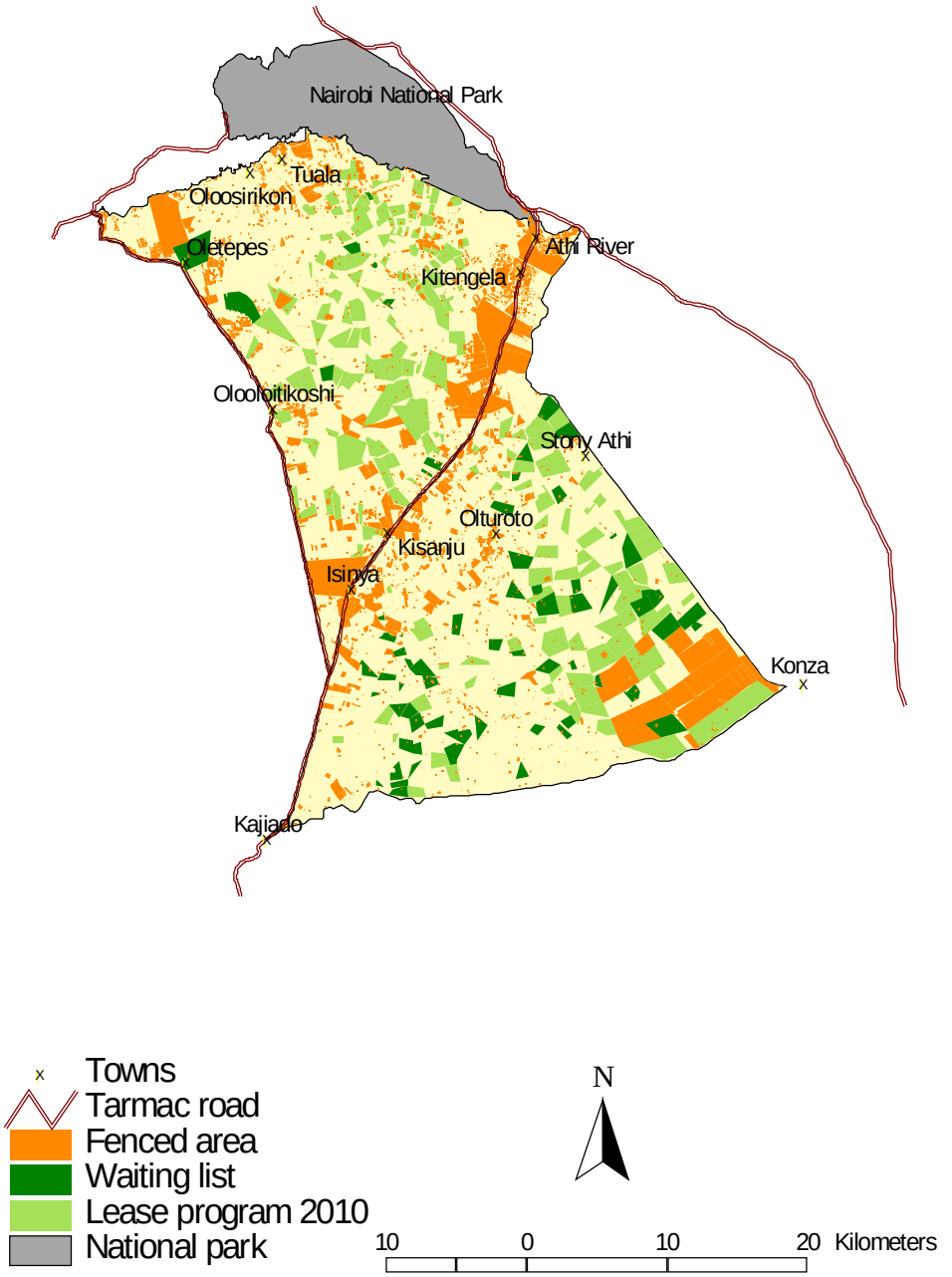

Figure 4: Distribution of fenced areas and land under the land lease program and on the waiting list for the land lease program.

Figure 4 also shows the WTA+ parcels; those 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 land owners are willing to accept payment from the land lease program. Note that this willingness is 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 is higher in the Southern area than in the Northern area.

4.2 Statistical model

Figure 5 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 significant area of land has been sold to private owners who construct houses, and hence less land is under pastoralism or available for 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.

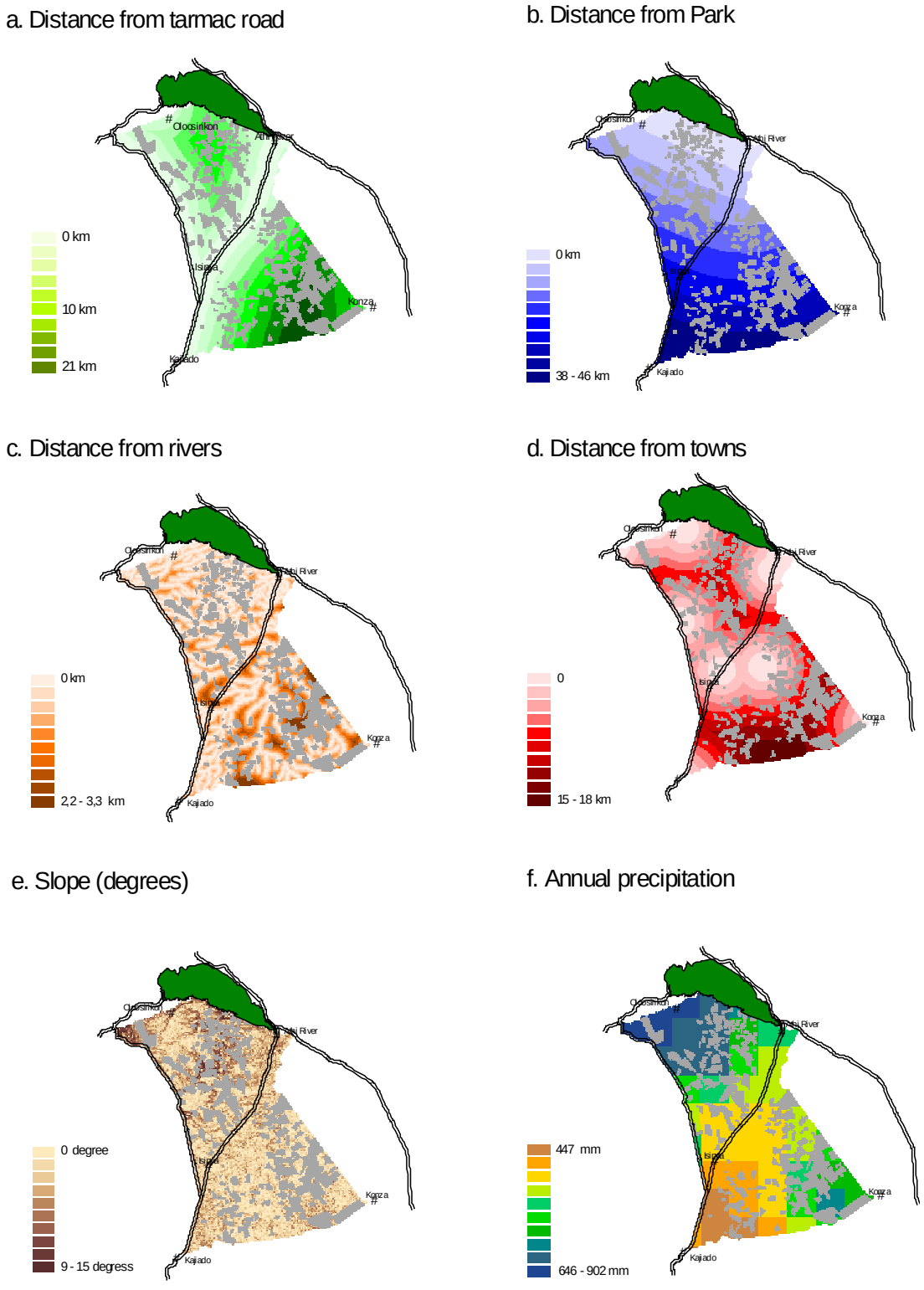

Figure 5: Buffer maps for the six predictor variables and the distribution of lands with owners willing to accept payment of 10 US $ per ha per year.

The selected multiple logistic regression model 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 bay the absolute t value (Table 1). These results suggest that proximities 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	StdErr	t Value	P value
Intercept	-25,5199	1,162446	-21,95	<.0001
Annual precipitation	0,07395	0,004051	18,25	<.0001
Annual precipitation^2	-6,4E-05	3,49E-06	-18,46	<.0001
Mean slope (deg)	0,109802	0,013681	8,03	<.0001
Mean slope (deg)^2	-0,01556	0,00187	-8,32	<.0001
Distance to road	0,223033	0,006968	32,01	<.0001
Distance to road^2	-0,0024	0,000543	-4,42	<.0001
Distance to river	-0,49919	0,062153	-8,03	<.0001
Distance to river^2	-0,45888	0,022755	-20,17	<.0001
Distance to town	0,468069	0,011919	39,27	<.0001
Distance to town^2	-0,02161	0,001129	-19,13	<.0001
Dis to road * dis to town	-0,00498	0,001104	-4,51	<.0001
Ds to river * dis to town	-0,04065	0,005947	-6,84	<.0001
Distance to park	0,100601	0,003789	26,55	<.0001
Distance to park^2	-0,0034	9,24E-05	-36,75	<.0001
Dis to river * dis to park	0,060293	0,002316	26,04	<.0001
Dis to road * dis to park	-0,00182	0,000247	-7,39	<.0001
Dis to town * dis to park	0,001836	0,000422	4,35	<.0001

†DF = 114559

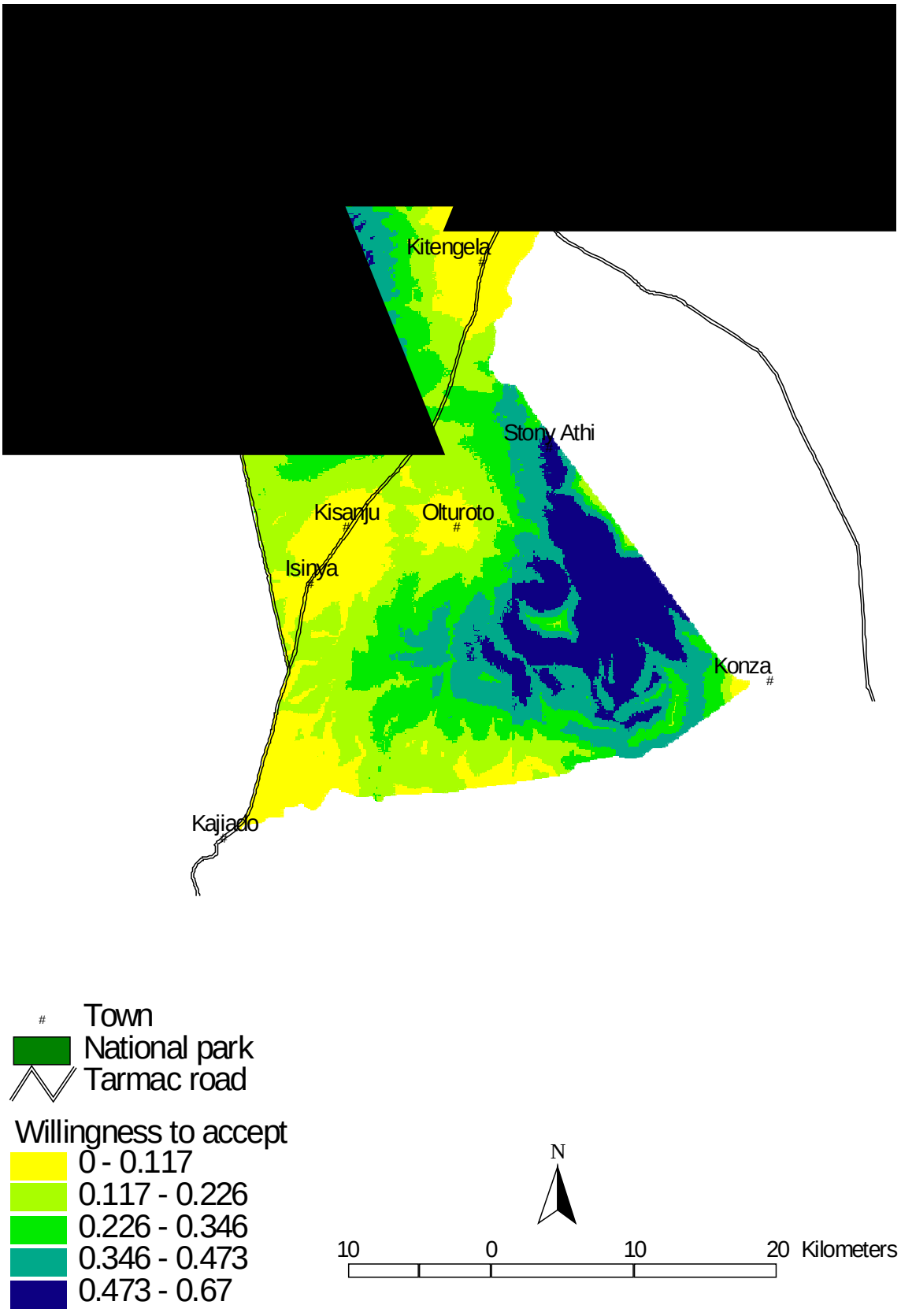

Figure 6 – Map of the spatial distribution of the probability of land owners in the Athi-Kaputiei plains to accept a payment of 10 US $ per ha per year in compensation for leaving their land open to wildlife and livestock.

5 Discussion:

5.1 Spatial differences in Willingness to Accept payments

The research presented here reveals significant variation in the willingness to accept payment for availing land to a PES scheme targeting wildlife conservation in the Kitengela 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, with low WTA close to settlements, an observation corresponding to my prior assumptions. WTA also showed a strong association with distance to roads, with high WTA values evident further away from roads and lower values apparent near roads. These results are depicted in Figure 5, showing the distribution of WTA+ parcels. WTA was only weakly associated with distance to rivers as well as with the average terrain slope.

The model, when implemented in a GIS environment, revealed significant spatial variation in willingness to accept payment. Figure 6 revealed two clusters with WTA exceeding 40% corresponding to areas where a large minority or even the majority of land owners considers the current fee for leasing their land attractive. 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.

What does this model tell 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 a 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.

5.2 Payments

My results 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 the current payment of 10 $ per ha per year.

The lease program started in 2000. In 2001 there were 66 households with 2,076 ha under lease program. In 2008, 148 households with 4,616 ha were enrolled in the land lease program and a further 118 households on a waiting list to join (Reto-o-Reto, 2006). In 2010 the enrolment rate was 357 households with 16,774 ha and only 70 households (Osano *et al*. in prep). Since 2008 there has

been a large increase people enrolling for the land lease scheme (Figure 7). The TWF intentions were to increase the land under lease to about 60,000 ha by 2012.

There is thus a need to stratify the plains according to the payments that would be required to keep the land open. The analysis presented in this paper was a 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 throughout the study area. Detailed geographically stratified surveys would be required to develop this, and more research would need to be undertaken to develop the requisite models and elicit such nuanced insights.

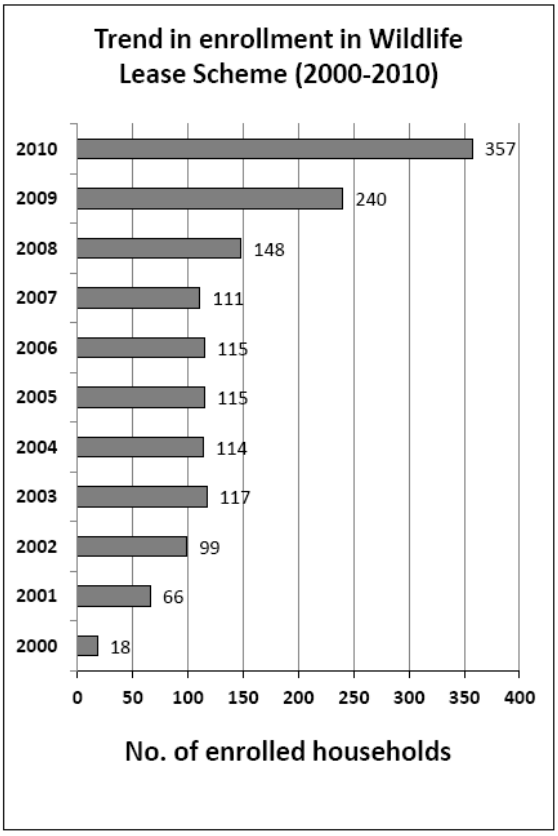

Figure 7. Development of the number of households enrolled in the land lease scheme in Kitengela from 2000 till 2010 (Source of information: Osano et al. in prep)

In the Masai Mara region of Kenya the land owners are paid between US$ 30 and 40 to keep their land open for wildlife and this figure is higher than the returns that they would get from crop farming (Norton-Griffiths and Said 2010). Future studies should attempt to make more realistic assessments of the willingness to accept payments. This is not a trivial issue, as a previous study undertaken by Mwangi & Warinda (1999) suggested that 68% of the land owners were willing to accept a fee of 2078 US$ (US $ rate of 2000) per ha per year, corresponding to 5037 $ per hectare per year in 2012. This may suggest an extreme overestimation of the WTA for keeping the land open, since by 2010 many land owners were still willing to accept a fee of 10 US $.

5.3 Opportunity costs

The current Wildlife Lease program offers a fee of 10 $ per ha per year. Enrolled landowners apparently consider this sufficient, while those with higher opportunity costs tend not to enroll in the

program. The land lease program thus effectively targets those landowners with relatively low opportunity costs. As can be seen in Figure 4 pastoral land still covers a large area and most of the landholders who practice pastoralism are willing to accept the payments. Other land use activities such as cropping and queries have higher opportunity costs.

Land located in the middle of the Athi-Kaputiei plains now sells at between $9000 – $12000 per hectare (Norton-Griffith 2008). Landholders who want to maintain pastoral or wildlife production on such land are likely to lose out because the land is simply too valuable. The reasons for the relatively low returns from wildlife conservation to landholders include a combination of policy, institutional and market failures. Therefore the opportunity costs for landholders with high valued land, such as land located near roads, towns, the park and rivers are already too high and continue to rise. The income they could earn from selling their land far exceeds the benefits offered by the Lease Program. Norton-Griffiths and Said (2010) argue that the different net returns to pastoral landowners from agricultural, livestock and wildlife production offer the clearest explanation to date for the widespread and comprehensive loss of wildlife throughout Kenya's rangelands. Our results show how tenuous the situation is and will likely continue to be if not addressed urgently with the right incentives.

Norton-Griffiths (2008) concluded that a land lease of $ 5 per hectare is not enough to motivate the owners to lease their land. This thesis shows that a rate of $ 10 per hectare per year is sufficient for a significant part of the landowners to decide to accept the payment. The argument suggested by Norton-Griffiths focuses more on the economic while there could as well be other important factors that the community considers in deciding whether to accept payments. The payments for the lease program in Kitengela is done 3 times a year to coincide with school terms. It is quite possible that the decision to accept the payments from the lease program is more motivated by an acute need for money to pay fees for children enrolled in schools, the increasing importance parents attach to educating their children and a strong attachment to pastoralism than by a rational economic assessment of what a realistic price for leasing the land would be.

5.4 Future of the Kitengela

When talking about the future of the Kitengela two scenarios could be sketched. The business without constraints scenario for the Kitengela in 2026, say, is that the human population will more than double and urbanization will expand. The Maasai will sell their land which will fundamentally transform their livelihood, and culture. Large areas of land will be brought under urban and peri-urban use thus constraining possibilities for agriculture or livestock, let alone wildlife. Conflicts over land and water use will intensify between settlements, industry, pastoralists and farmers. Wildlife will become extinct on the plains outside the Nairobi National Park (NNP) and NNP will become an island, too small for most species to survive even if protected (Reto-o-Reto, 2007). This scenario has been portrayed by a leading environmentalist as follows*: "In 50 years the Kitengela will have reached its full potential for housing estates, industry, intensive horticulture and NNP will at last be securely fenced and run like a Safari park!"*

The alternative scenario currently pursued by a number of stakeholders, keeping the land open for wildlife migration, would require either stringent land use planning which effectively limits further development, or alternatively, in combination with financial incentives sufficiently attractive to stimulate land owners to use their land in ways that are compatible with the conservation of wildlife corridors. The current Wildlife Conservation Lease Program is not capable of achieving this for a number of reasons. The payments are insufficient to prevent land use change in areas with higher economic potential, enrollment is voluntary, which complicates the goal of conserving larger areas of land. The extent of the lease program and how long it lasts will further limit the possibility of conserving larger areas of land for longer periods, if not in perpetuity.

Further research should be done to compare costs and benefits of different potential scenarios in the Kitengela. When designing a cost-benefit analysis for the Kitengela two scenarios would be especially worth investigating.

1) Transforming Nairobi National Park into a safari park with closure of the Southern border. The Kitengela study area will transform into different land use activities like urbanization and cropping, quarrying and other land use activities that are profitable.
2) Current state with migration of wildlife and the Wildlife Lease program.

Comparison of both scenarios using cost-benefit analysis alongside other considerations such as sustainability and policy objectives could assist in identifying the more preferable scenario. Such an analysis might well reveal that an open eco-friendly future for the Kitengela may not be the optimal one from a cost-benefit perspective. However, other factors might also play a role, including policy objectives favoring biodiversity conservation and urbanization towards a city with green open spaces within the urban environment. Achieving such goals would require regulation of land use and effective enforcement to complement the lease program. This would require the coordinated action of three important actors as depicted below;

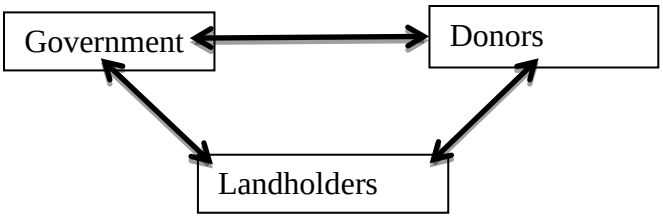

Figure 8: Interactions at different levels

Such a framework and strong policy on land use and planning would seem necessary to counter the current negative trends of rapid urbanization and rising land prices (Reto-o-Reto, 2006). Also, likely to be useful in this regard is setting aside part of the tourism revenue earned in NNP and investing it in supporting the lease program. In conclusion, strong political, community and donor support are all necessary and urgently required to ensure the continued viability of wildlife populations and migration in the Athi-Kaputiei Plains in the context of a rapidly expanding Nairobi metropolis.

References:

Bennett, A. F. 1998. *Linkages in the landscape. The role of corridors and connectivity in wildlife conservation.* World Conservation Union, Gland, Switzerland.

Bulte, E. H., L. Lipper, R. Stringer, and D. Zilberman. 2008. *Payments for ecosystem services and poverty reduction: Concepts, issues, and empirical perspectives.* Environment and Development Economics 13:245–54.

Burnham, K.P., and D.R. Anderson. 2002 *Model selection and multimodel inference: a practical information-theoretic approach*., 2nd Edition. Springer-Verlag, New York USA.

Costanza, R., d'Arge, R., de-Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neil, R., Paruelo, J., Raskin, R., Sutton, P., van den Belt, J., 1998. *The value of ecosystem services: putting the issues in perspective.* Ecological Economics. 25 (1), 67–72.

Ferraro, P., and R. Simpson. 2002. *The cost effectiveness of conservation payments.* Land Economics 78 (3):339-353.

Ferraro, P., and A. Kiss. 2002. *Direct payments to conserve biodiversity*. Science, November 29, 2002., 1718-1719.

Ferraro, P. J. 2008. *Asymmetric information and contract design for payments for environmental services.* Ecological Economics 65 (4): 810–821.

Gabrielson, P. Bosch *Environmental indicators: typology and use in reporting*. Internal Working Paper, European Environmental Agency (2003), pp. 1–20

Gichohi H.W 1996. *The ecology of a truncated ecosystem: The Athi-Kapiti Plains*. PhD thesis, University of Leicester, U.K.

Gichohi, H.W, Gakahu C. and Mwangi E. 1996. *Savannah ecosystems. In: McClanahan T.R. and Young T.P. (eds.), East African Ecosystems and their conservation*. Oxford University Press, Oxford, UK. Pp 243-270.

Gichohi, H., (2003) *Direct Payments as a Mechanism for Conserving Important Wildlife Corridor Links Between Nairobi National Park and its Wider Ecosystem: The Wildlife Conservation Lease Program.* Conference Paper, 5th World Parks Congress, Durban, South Africa.

Lewis, D. J., A. J. Plantinga, E. Nelson, and S. Polasky. 2009. "*The Efficiency of Voluntary Incentive Policies for Preventing Biodiversity Loss,"* Agricultural & Applied Economics - Staff Paper No. 533

Jack BK, Kousky C, Sims KRE (2008) *Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms.* Proc Natl Acad Sci USA 105:9465–9470.

Jindal, R., Kerr, J., *Payments for biodiversity* (2007) USAID PES Brief 2.3

Millennium Ecosystem Assessment (2003) *Ecosystems and Human Well-Being: A Framework for Assessment* (Island Press, Washington, DC).

Mwangi, A. and E. Warinda. 1999. *Socio-economic dimensions of sustainable wildlife*

conservation in the Kitengela Dispersal Area. African Conservation Center, Nairobi, Kenya

Nkendianye DK, Radeny M, Kristjanson P, Herrero M. 2009. *Assessing returns to land and changing livelihood strategies in Kitengela.* In: Homewood K, Kristjanson P, Trench P, editors. Staying Massai? Livelihoods, conservation and development in East Africa rangelands. New York (NY): Springer.

Norton-Griffiths, M., 2008 *A note of the Economic and Social Incentives in Kenya to sub-divide Land Under Group or Communal Tenure. mng5.com*

Norton-Griffiths, M., and Said, M., 2010 The future for wildlife on Kenya's rangelands: an economic perspective. In du Toit, J., Kock, R., Deutsch, J. (ed). *Wild Rangelands: conserving wildlife while maintaining livestock in semi-arid ecosystems,* 367-392. Wiley Interscience.

Osano, P., (2011) *Life at the crossroads: How climate change threatens the existence of the Maasai* - Africaportal No. 9

Owino, A.O., Lekishon, M., Webala, P., Andanje, S., Omondi, P.O., *Patterns of Variation of Herbivore Assemblages at Nairobi National Park 1990-2008.* Journal of Environmental Protection, 2011, 2, 855-866

Pagiola, S., Arcenas, A., & Platais, G. (2005*). Can payments for environmental services help reduce poverty?* World Development, 33(2), 237–253

Reid, R.S., Gichohi, H., Said, M.Y., Nkedianye, D., Ogutu, J.O., Kshatriya, M., Kristjanson, P., Kifugo, S.C., Agatsiva, J.L., Adanje, S.A., Bagine, R., (2008) *Fragmentation of a peri-urban savanna, Athi-Kaputiei Plains, Kenya.* In: Galvin, K.A., Reid, R.S., Behnke, R.H., Hobbs, N.T.(Eds.), Fragmentation in Semi-arid and Arid Landscapes: Consequences for Human and Natural Systems. Springer, Dordrecht, pp. 195–224.

Reto-O-Reto Policy Brief 1 (2006) – *Conservation in Kitengela : keeping land open for people, livestock and wildlife.* ILRI Nairobi (Kenya)

Reto-O-Reto Policy Brief 2 (2007) – *Kitengela transforming. Will pastoralists and wildlife survive?* ILRI Nairobi (Kenya).

Reto-O-Reto Policy brief 3 (2007) – *Losing ground in the Mara: fast but not inevitable.* ILRI, Nairobi (Kenya).

Rodriguez Luis C., Pascual, U., Muradian, R., Pazmino, N., Whitten, S., 2011 *Towards a unified scheme for environmental and social protection: Learning from PES and CCT experiences in developing countries.* Ecological Economics 70 , 2163-2174

Rodriguez, L.C., Henson, D., Herrero, M., Nkedianye, D., Reid, R., (2011) *Private farmers' compensation and viability of protected areas: the case of Nairobi National Park and Kitengela dispersal corridor*, International journal of Sustainable Development & World Ecology.

Sokal, R. R., and F.J. Rohlf. 1995. Biometry: *The principles and practice of statistics in biological research*., 3rd edition. W.H. Freeman, New York.

Smith, K., 2007 *Payments for biodiversity.* Andrew Young School of Policy Studies, Department of Economics.

Tscherning, K., Helming, K., Krippner, B., Sieber, S., Gomez y Paloma, S., 2012 *Does research applying the DPSIR framework support decision making?* Land Use Policy Vol. 29 (1) 102-110

World Bank – GEF; *Medium Sized Project Proposal* (2006) WWW-WDS.WORLDBANK.ORG

Wunder S., 2005. *Payments for Environmental Services: Some Nuts and Bolts.* Occasional Paper No. 42. CIFOR, Bogor.

Wunder, S., Engel, S., Pagiola, S., 2008. *Taking stock: lessons learnt for the design of payments for environmental services programs.* Ecological Economics 65, 834–852
http://www.tradingeconomics.com/kenya/consumer-prices-index-average-imf-data.html