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The Influence of Socio-Economic Factors on Population Trend and Distribution of Puku (*Kobus Vardoni* Livingstone) in Kilombero Game Controlled Area in Tanzania

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Abstract: This study was conducted to assess the influence of socio-economic factors on population trend and distribution of puku (*Kobus vardoni*) in Kilombero Game Controlled Area in Tanzania.Purposive sampling technique was used in the selection of the six villages out of 32 villages adjacent to KGCA. The number of respondents for each village was obtained from official lists of village households. Random sampling method was used to select households. The results indicate that socio-economic activities have a strong impact to the population trend and distribution of puku antelopes. It is concluded that the increase in anthropogenic activities is among the contributing factors which result into negative impact on puku population trend and distribution in Kilombero Game Controlled Area. The need of upgrading the status of Kilombero Game Controlled Area to be a Game Reserve is crucial to improve protection. Finally the use of land use plans and control of livestock population for the villages surrounding Kilombero Game Controlled Area is suggested.

Keywords: *Population trend, distribution, Kilombero Game Controlled Area, Kobus vardoni*

1.0 Introduction

Puku (*Kobus vardoni*) is an antelope of medium size that has a scattered distribution across southern and central Africa. Geographically the puku population is found in northern Angola, northern Botswana, Malawi, northern-east Namibia, southern Tanzania, Democratic Republic of Congo (DRC), Zambia and Zimbabwe (East, 1998). According to IUCN data, puku is an endangered species and therefore is of high conservation concern.

Puku have limited distribution in Africa, confined to the areas drained by tributaries of Zambezi River in Zambia and a few isolated pockets in Tanzania. According to (East, 1998; Rodgers, 2008) it is estimated that 75% of the total puku population in Tanzania is now restricted to the Kilombero valley, an area rich in agricultural potential and natural resources. In other places of Africa, the species is found mainly in moist savanna and floodplains containing rivers or marshes (Stuart, 1997) and some might be found in adjacent areas of light woodland (Nowak, 1998). In the past, puku antelopes were widely distributed across savannah grasslands and floodplains, but at present they are only found as isolated populations in wetland ecosystems (East, 1998).

Worldwide, antelope populations are under increasing threat of extinction from unsustainable hunting (Thirgood *et al*., 1994; Lushchekina *et al*., 1999) and habitat change (East, 1998; Hilton-Taylor, 2000). Antelopes are important because they play a vital role in the ecological function of forest and savanna habitats (Maddock, 1979; McNaughton, 1979; East, 1998) and also provide protein, skins and tourist attraction (East, 1998). Puku population is greatly reduced in some areas, notably Angola, Botswana and Democratic Republic of Congo (Goldspink *et al.*,

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1998). Studies in Kasanka National Park in Zambia found that male puku were especially vulnerable to poaching (Goldspink *et al.,* 1998). Anti-poaching control in Zambia revealed an increase in puku population in areas of unoccupied suitable habitats, providing hope for the recruitment of the species in areas where its numbers have been depleted (Goldspink *et al.,* 1998).

Of the eight countries in Africa in which puku population are found only in Tanzania contain a large population especially in Kilombero valley (East, 1998). The puku antelopes in the Kilombero valley are a unique natural heritage and resource of great importance nationally and globally. Kilombero valley is the largest fresh water wetland in East Africa and the third Ramsar site in Tanzania (East, 1998). Kilombero valley has the status of a Game Controlled Area (GCA), which only limits a few human activities.

Human activities such as agriculture and livestock keeping cause ecological impacts on natural ecosystems all over the world particularly in the third world countries. The accelerated decline of African wildlife species and populations is caused by increasing environmental disturbances, habitat deterioration, consumptive utilization and expansion of agriculture (Peter, 1996). In recent years, the expansion of human settlements, livestock grazing, agriculture and commercial forestry has increased the pressure on Tanzania's natural habitats (Kiss, 1996; East, 1998; Caro, 1999; Luoga, 2000). Pandey (1979) argues that the vulnerability of ecosystems is due to human interference through social and economic systems which include encroachment, overgrazing, illicit cutting of forest trees, fire, mining, poor fishing practices and quarrying. Surveys in the last two decades suggested that agricultural expansion, deforestation, and overgrazing had reduced the original wildlife habitats in Africa by over 65% (Kiss, 1990). These activities may contribute towards the distribution and abundance of puku in KGCA. However, in Kilombero valley it is not clear what factors influence the population trend of puku and its distribution.

The Wildlife Policy of Tanzania (URT, 1998) gives direction on conservation and advocates sustainable use of wildlife resources for the benefit of the present and future generations. However, unprecedented human activities coupled with poor law enforcement have continued to put pressure on the remaining puku populations. Furthermore, studies linking socio-economic factors to the decline in wildlife population, particularly of puku are scarce. Such studies are important in development of appropriate conservation measures to enhance the existence of the species. This study was conducted with the objective of exploring socio-economic factors relating to conservation of puku (*Kobus vardoni*) in Kilombero Game Controlled Area.

2.0 Methodology

2.1 Study Location and Climate

This study was carried out in Kilombero Game Controlled Area (KGCA) which is located between 036°10'E and 08°40'S in Ulanga and Kilombero Districts in Morogoro region. KGCA is located between Udzungwa Mountains and Mahenge escarpment, which form part of the Eastern Arc Mountains. KGCA covers a total of 4 000 km^2 which is within Kilombero valley. The temperatures in the study area range between 22^0 to 41^0C and the mean annual rainfall ranges from 1 000 to 2 000 mm (WWF, 1992). The Kilombero valley consists of a seasonal flood plain, miombo woodland and fragments of Eastern-Arc ever-green mountain forest rich in

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biodiversity. The large part of the area is dominated by the Kibasila Swamp, and Kilombero River, which forms part of Africa's largest river basin joining the Great Ruaha, Rufiji and Luwegu rivers (East,1998).

There are five vegetation types in the study area namely; wooded grassland, teak plantation, riverine forest, multi-layered evergreen forest and miombo woodland. The miombo woodland is a matrix of open woodland dominated by *Brachystegia spiciformis* trees combined with smaller dense areas of riverine vegetation. There is a sparse under storey of tall *Panicum maximum* grasses. The miombo mid-storey consists mostly of small trees e.g. *Dalbergia melanoxylon* (Lovett and Pócs, 1993). The lowland forest area had suffered the effects of timber extraction and has uneven canopy cover. The teak plantations established adjacent to the study area comprise very dense sapling undergrowth layer of various genera such as *Alchornea*, *Cassipourea*, *Dichapetalum*, *Harrisonia* and *Markhami*. The multi-layered evergreen forest with high biological diversity is also found within a smaller area.

2.2 Research Design and Data Collection

Purposive sampling technique was used in the selection of the six villages out of 32 villages adjacent to KGCA. The number of respondents for each village was obtained from official lists of village households. Random sampling method was used to select households. The sampling was conducted after obtaining a list of households from each village with assistance village executive officer. The list then acted as a sampling frame from which the households to be interviewed were selected randomly using random numbers from a scientific calculator. From the six villages selected, a sample size of 220 households was found sufficient to allow reliable analysis for the time allocated for the study. Boyd *et al*. (1981) and Kajembe and Luoga (1996), have shown that significant population representation is achieved when a random sample of at least 5% is taken. The human population, number of households, number of sampled households and sample size of the study area are presented for each village in Table 1.

The qualitative and quantitative data consisted of original information which was collected from communities in the course of the research. The researcher used structured questionnaires for interviews, focus group discussion, direct observation, and checklist to gather information from the village communities, tourist hunting companies and local government staff. Secondary data was obtained through a review of relevant documents. Several literatures were visited and relevant information related to the study was collected. In order to elicit more information, open ended and closed-ended questions were used. Open ended questions help to get the respondent's views regarding the problem under study; while in the closed-ended interview, respondents were provided with alternative answers.

Focus group discussion aimed at validating information gathered through other research tools as well as clarifying controversial issues that rose during interview session (Koda, 2000). This technique has been found valuable in gaining insight into the dynamic relationship of altitudes, opinions, motivations concerns and problems related to the area of research. The focus group in this study involved village government leaders, prominent people in the village (preferably old people), members of the Village Natural Resources Committees (VNRCs) and youths. Each group was required to be represented by three members. In this study Key

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informants that were visited included the District Game Officer (DGO) of Ulanga District Council (UDC), tourist hunting company camp managers of Wildfoot prints and Miombo afaris, District Natural Resources Officer (DNRO) and retired game officers. These people were interviewed to get their professional view on the issue to be researched. This information was used in explaining the population trends of puku. Participant observation was used to collect qualitative data such as household activities and real situation in the field. The method enabled to connect together different information collected by other methods.

Secondary data were gathered from published and unpublished information/data on puku management and conservation from different sources including local government offices, i.e. Ulanga District Council (UDC) and Kilombero District Council (KDC), Tanzania Wildlife Research Institute (TAWIRI), Sokoine University of Agriculture (SUA) library and various materials from electronic sources using the internet.

2.3 Data Analysis

Primary data were summarized and coded and descriptive statistics was used in the analysis. Focus group discussions and data from key informants were used in clarification of information obtained from household survey.

3.0 Results and Discussions

3.1 Trends of Puku since 1975 in KGCA

From the secondary data and information obtained from UDC, KDC, TAWIRI and SUA, and respondent's information through focus group discussion, population trend of puku was developed and linked to socio-economic factors. 75.9% of the respondents reported a decrease in puku population, 11.8% of the respondents were not aware of the puku trend; while 9.1% claimed that puku population is increasing and the remaining 3.2% claimed the population of puku to be constant (Fig.1).

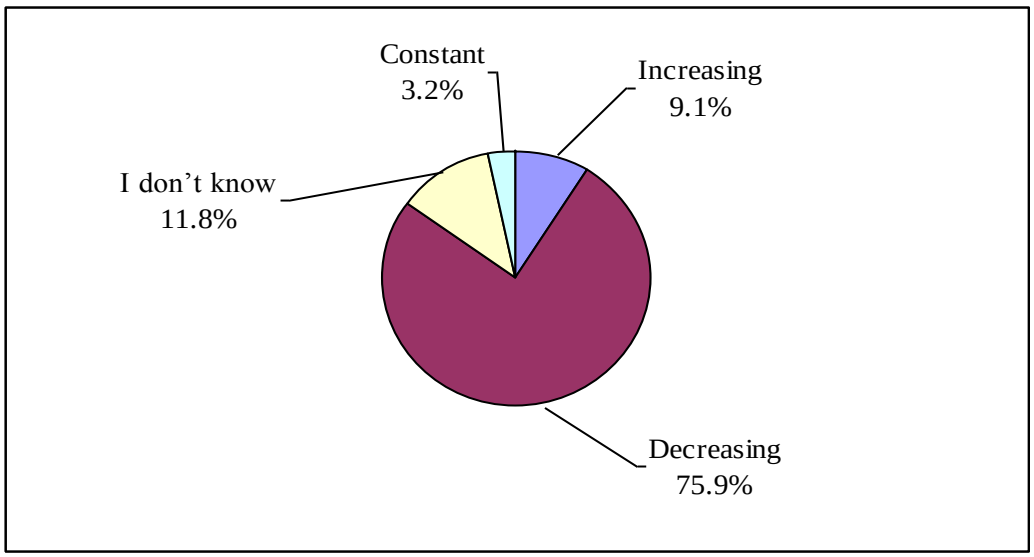


Figure 1: Respondents' opinions on the trend of puku from 1975-2007

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From the findings, it was revealed that, the main reasons for decrease in puku population were livestock keeping and poaching (54.5%), followed by farming (25.5%). Other activities contributing to the decrease of puku include migration into the block (KGA) (9.7%) and a combination of farming, livestock and poachers (6.6%) while others did not know (3.7%) (Fig.2). Caro *et al*. (1998) suggest that poaching activity in Tanzania was high in areas used by legal hunters, but not patrolled by guards. Therefore poachers move into the same areas after the end of the hunting season. This implies that increasing socio-economic activities including poaching contributed to the puku decline to some areas in KGCA.

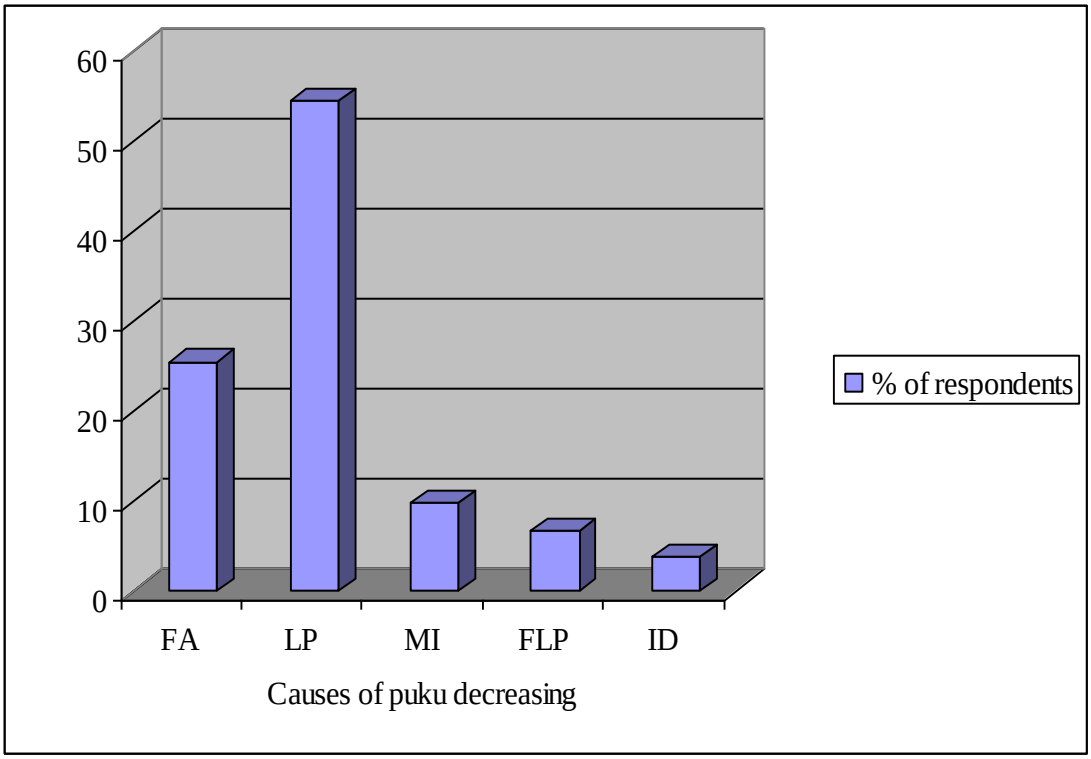


Figure 2: Reasons for decreasing of puku in KGCA
KEY: FA = Farming activities; LP= Livestock keepers and poachers; MI= Migrated to the intact block; FLP= Farming, livestock and poachers, ID= I don't know

The sustainability and distribution of wildlife populations in the partially protected areas such as KGCA is threatened by several factors including commercial poaching for trophies, poaching for bushmeat and other wildlife products for household consumption, and habitat destruction as a result of changed land use. Caro *et al*. (1998) argue that the hunting quotas should be reduced for some species with restricted geographical ranges, which include puku.

3.2 Factors Contributing to Distribution of Puku

Understanding the ecological parameters that influence animal dispersal can provide insight of the areas which are important for that animal population (Foley, 2002). Fryxell and Sinclair (1988) stated that a characteristic of the African savannah ecosystem is the spatial and temporal variation in resource availability that forces savanna wildlife to shift to the areas where food and

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water can be obtained. In this study, it was found out that the overall puku density was not evenly distributed to all the three blocks (Fig. 3).

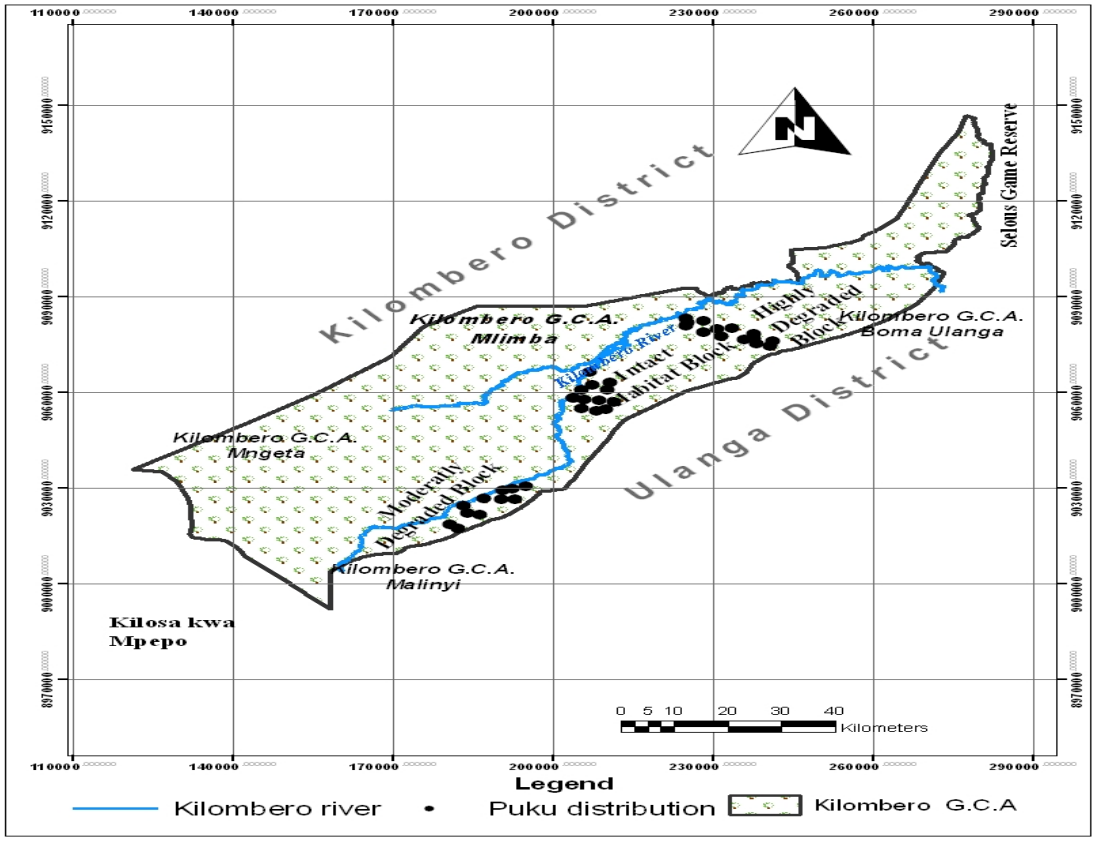


Figure 3: Map of KGCA indicating puku distribution in the study blocks

The reason for such differences can be due to various factors including habitat loss and degradation, competition for water between livestock and wildlife, occurrence of wild fire, establishment of teak commercial plantations and poaching.

3.3 Habitat Loss and Degradation

Any given species is considered to have a preferred area or territory in the habitat. Many activities associated with human habitation of an area cause loss of the habitat of this area and the decrease in the carrying capacity of the land for that species. Wildlife habitat degradation in KGCA results from expansion of agricultural activities and increased number of livestock as observed during the field survey. During focus group discussions it was confirmed that the expansion of agricultural activities, increased number of livestock and human settlements in KGCA over thirty years (1975 – 2007) caused wildlife habitat loss and degradation. In addition, the focus group discussion participants reported that in the previous years puku were evenly distributed all over the KGCA but now puku are found in the area with an uneven distribution. This happened because of an increase in poaching activities, human population increase and their socio-economic activities which extended in the wildlife partially protected areas (Pas). This observation concur with the finding by Songorwa (2004), who identified two major problems

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facing the wildlife conservation in Tanzania, namely encroachment into wildlife areas, resulting from human population increase. The situation is also aggravated by immigration. Human population increase in communities surrounding these Pas may accelerate encroachment (Songorwa, 2004). WWF (1992) argue that the local human population increased markedly in the beginning of 1970s and as a result the demand for land has grown and the density of livestock has increased in wildlife areas.

3.4 Wild Fire

The high and growing human population adjacent to the KGCA leads to intense pressure in the KGCA with anthropogenic fire being one of the main threats to this ecosystem. The local farmers adjacent to the KGCA practice traditional subsistence farming and use fire as a management tool. Furthermore, fire is used for hunting, honey collection and charcoal burning. Some of these fires cause significant ecological and socio-economic impacts and if fire enters dense dry tall grasses and high forest then it can cause considerable damage to the wildlife. During the key informants' discussion, the respondents claimed that wildfires are among the threats to the wildlife habitat particularly the young puku in KGCA. The major sources of fires reported by key informants and focus group discussions were clearing land for agriculture, hunting of small animals, clearing pathways for poaching, scaring wild animals done by fishermen as they pass across the KGCA and agro-pastoralists who set uncontrolled fire in order to get fresh grasses for their livestock. According to Sarre and Goldammer (1996), wild fires are world-wide problems and uncontrolled or misused fire wreaks havoc on society and the environment, destroying property and natural capital, depleting nutrient pools, polluting water supplies, reducing biodiversity, increasing emission of greenhouse gases, disrupting communities, decimating livestock and even killing wildlife. Furthermore, fire contributes in changing the landscape structure and species composition including grasslands, savannah, closed forests and woodlands (Christensen, 1985; Goldammer, 1990).

Table 1: Human population and households in the study villages

Villages	Population	Total Number of Households in the Village	Number of Sampled Households	Sample Size (%)
Igawa	5 448	720	36	5.0
Malinyi	5 945	602	36	6.0
Itete Minazini	4 057	609	36	5.9
Itete Njiwa	5 350	723	36	5.0
Lupiro	5 729	708	36	5.1
Igumbiro	6 871	842	40	4.7
Total	**33 400**	**4 204**	**220**	**5.2**

3.5 Livestock Keeping in the Study Area

The majority of the respondents (65.5%) in the study area were not livestock keepers. Only 34.5% of the respondents were agro-pastoralists and almost all of them were migrants from Shinyanga region who came to the area searching for livestock pasture and suitable land for agriculture. It was observed that the majority of the respondents (87.0%) had no area for their livestock and still 89.6% of the respondents claimed that the area for grazing is not enough. For the livestock keepers interviewed 92.8% reported to be grazing their livestock inside KGCA. Livestock keeping within KGCA could cause spread of diseases from domestic animals to wildlife and vice-versa. During focus group discussion and discussion with key informants it was

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reported that the outbreak of conjunctivitis type of infection in puku which occurred in 1999 was related to cattle, therefore, increased number of cattle in KGCA may pose a serious threat to wildlife populations. Meanwhile, an increase in livestock keeping in the KGCA also increases the potential wildlife-human interaction and consequently the possibility of poaching.

This study showed that livestock keepers kept large herds of animals. The mean number of cattle which is about 230 is thought to exceed the carrying capacity of the area (Table 2). The present findings are in agreement with those by Ngowe (2003) who reported that expansion of agriculture close to wildlife areas, increasing livestock numbers, poaching and lack of community participation in the wildlife management are among the potential threats to wildlife conservation.

Table 2: Livestock keepers interviewed and the type of livestock kept

Livestock kept	Minimum	Maximum	Mean	S.E.
Cattle	3	550	229.9	11.6
Goats	5	150	44.8	3.2
Sheep	3	200	43.0	4.1

3.6 Livestock-Wildlife Competition for Water

The study revealed the dry-out of some water points which were previously used by wild animals throughout the year. This may be due to an increase of human activities especially the increased number of livestock, the expansion of agricultural activities and climatic factors due to global warming cause some water points to become completely dry during dry seasons. Increase in number of livestock and expansion of agricultural activities have also contributed much to the disappearing and/or distribution of puku in some areas in KGCA apart from poaching activities as revealed during focus group discussion. In the conservation areas, most of the wildlife species concentrate around water points (Owen-Smith, 1996).

Competition for grazing lands and water resources between livestock and wildlife could be a possible reason for uneven distribution of puku in KGCA. According to Prins (1992), livestock husbandry could wipe out wildlife as a result of competition for resources. It has also been reported that kangaroos avoided areas close to water points which were intensively used by sheep in Australia (Andrew and Lange, 1986). However, gradients of utilization pressure develop around water points, with the greatest impact near the water point and decreasing pressure as distance away from the water point increases (Brits *et al*., 2002). As a result, grazing species that are unable to meet water requirements solely from forage, concentrate around permanent water supplies during dry seasons. In the dry and open savannah, wildlife tends to aggregate and reduce their home range, in response to poaching or to the threat from human hostility (Poole, 1996).

3.7 Land Tenure and Agricultural Activities in the Study Area

Land tenure is a system whereby an individual or institution can acquire and maintain rights over a given piece of land. Land tenure system in Tanzania is governed by the Land Act (URT, 1999) in which the land is divided into three categories: village lands, general lands, and reserved lands. The KGCA falls within the reserved land where some human activities such as cultivation, agro pastoralists farming and settlement are allowed. The village lands are owned under

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customary land tenure and the one owned by Kilombero Valley Teak Company (KVTC) is under statutory land tenure.

Based on customary land tenure system, the majority (65.9%) of the respondents acquired and own land that had been cleared from KGCA for agriculture, indicating the shrinkage of KGCA, while 16.3% of the respondents inherited it. Only few households (8.2%) were given land by the village government. Others (9.6%) acquired land through renting and buying while some acquired the land both in KGCA and inheritance. Although this study indicated that the majority of population occupied land from KGCA, the demand for land is still high since the majority of the respondents (64.6%) said they could get more through clearing land from KGCA and 23.6% from village government. Others said they could rent and purchase, i.e. 10.2% and 1.6% respectively. In the recent past, increasing subsistence demands of land for agricultural activities, livestock keeping and establishment of teak plantation within the KGCA have led to destruction of wildlife habitats and blocking of wildlife migration routes along the Kilombero corridor.

The community adjacent to the KGCA practices activities that block the wildlife migratory routes which is an instinctive movement that takes place daily due to water and pasture needs or annually due to climatic changes. These activities have led some of wildlife species like puku to be unevenly distributed in KGCA while others move from one area to another to secure area with no human disturbances or areas with high protection against human activities particularly poaching.

According to the key informants discussions it was reported that expansion of agricultural activities in KGCA is a widespread problem as well as illegal over-exploitation of puku. The Kilombero corridor which provides link between Selous Game Reserve and KGCA in Ulanga District has been blocked due to conversion of natural forest, mainly sub-humid miombo woodlands to monoculture of teak (*Tectona grandis*) plantation. This corridor had been blocked by KVTC through installation of electric fences surrounding their teak plantations to avoid large mammals like elephants which damage the young growing teaks. By doing so, this causes wild animals including puku along the corridor spread around human settlements (Makota, J.F. personal communication, 2007). This study further revealed that, insecurity of land tenure over land occupied by household especially immigrants has significantly increased the temptation of expanding unplanned farms towards KGCA. Usually, insecure pieces of land which are occupied without title deeds or certificate of occupancy are not normally respected by the occupier. This situation might have been the cause of poor land use practices like shifting cultivation and expansion of agriculture farms unnecessarily as observed during the field survey in the study area.

This observation concurs with findings by Kikula (1997) that security of land tenure had a direct link with sustainable farming practices which, in turn, enable sustainable wildlife management and conservation. Land use and related rights play a key role in determining the use and sustainable management of land resources since they specify accessibility of using resources. Kikula (1997) reported further that people are willing to invest their scarce resources if they are sure that they will reap benefits. Insecurity of tenure is one of the stumbling block hindering loan accessibility of the rural poor from financing institutions. The title deed over the land could help the rural poor to borrow and raise financial ability to purchase farm inputs and improve

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agricultural productivity. This would have enabled them to enhance resource use instead of shifting from one piece of land to another looking for the fertile soil in the protected area.

3.8 Teak Plantation Establishment

Establishment of teak plantations by Kilombero Valley Teak Company (KVTC) along the wildlife corridors and installation of electric fences around the teak plantations lead to sparse and uneven distribution of wildlife particularly puku in KGCA (Emanuel, B. personal communication, 2007). It was revealed that during the rain season puku move from the lower floodplain to the high altitude areas but unfortunately these high altitude areas are the ones where teak plantations were established. The situation of changing natural habitats allows poachers to kill puku very easily due to the fact that puku fail to hide themselves because their natural habitat changed through the establishment of teak plantations. The teaks have been planted in a matrix design consisting of many small plantation fragments. However, IIED (1992) report that the absolute percentage loss of woodland which is replaced by teak plantation in Kilombero valley is not considered a major threat to wildlife but the location of the plantations may interfere with the seasonal movements of large mammals. In this case, the establishment of teak plantations has direct implications for wildlife species distribution and their survival.

3.9 Poaching

The illegal hunting of puku particularly in the highly degraded and moderately degraded blocks is high due to inadequate wildlife protection against poachers. According to the key informants discussions the trend of poaching will result into puku extinction in the study area. The puku extinction might occur due to excessive killing of puku illegally. Excessive wildlife killing occurs whenever hunting is at a rate greater than the reproductive capacity of the population being exploited.

Harvesting of game meat is one of the foremost issues confronting the management of the protected areas and the communities adjacent to the protected areas. During the discussion group it was revealed that the majority of the community in the study area use bush meat as a source of protein and income for their daily lives.

Also through the focus group discussion, it was revealed that agro-pastoralists used their domestic dogs to kill puku as a source of meat for them and their dogs. Moreover, poachers used modern weapons such as guns, local weapons such as clubs and torch in the night to kill puku for bushmeat for the local black market in the villages. Poachers are pretend to be fishermen passing across the game controlled area in the morning while in fact they are illegal hunters who carry weapons such as short guns for killing puku and other wildlife species. This has resulted into increased demand for bushmeat in the study villages. These findings could be compared to the ones in the studies done by Arcese *et al.,* (1995) and Baldus (2001) who report that poaching is widespread, uncontrolled, and mostly at unsustainable levels. Poaching for trade, meat, skins, feathers, and trophy, is a threat to the survival of many wildlife species. In view of the increasing trend of favouring bush meat as a delicacy, it is likely that after several years, puku will disappear in KGCA.

According to Haule *et al.* (2002) wildlife and forests provide important services to local people in KGCA and the most important benefit is the access to cheap meat. For example, the responses

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from primary school pupils in Kilombero valley on most recent bush meat meal showed that buffalo ranked the highest followed by puku and hippopotamus. It was further observed that the local illegal hunting of puku is mainly undertaken in the wet season as puku move from flooded grassland up into the higher areas. Furthermore, this migration brings puku into contact with human settlements whereby illegal hunting takes place using a variety of methods but rifles and snare traps seem to be the most common.

4.0 Conclusion and Recommendations

Increased human activities in KGCA including migration of agro-pastoralists with their large herds of livestock into the area, expansion of agricultural land in area formerly occupied by wild animals, illegal hunting by local people are the main threats to the puku conservation and management in the study area. Most of the communities adjacent to KGCA who are thought to be involved in the conservation of wildlife are not aware of the importance of puku conservation. Further research on general participation of local people in wildlife conservation and management, mapping of wildlife resource in order to determine specific area for wildlife species and the interaction of wildlife and puku feeding habits and their reproduction

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