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Research Article

FACTORS INFLUENCING PEOPLE ENCROACHMENT OF PROTECTED AREAS IN TRANSFRONTIER CONSERVATION AREAS (TFCAS): A CASE STUDY OF SELOUS-NIASSA TFCA

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ABSTRACT

Eastern and Southern African countries' authorities managing terrestrial transfrontier conservation areas (TFCAs) have made an effort to establish wildlife corridors as a respond towards ecological and socioeconomic benefits of connected ecosystems. However these corridors face various socio-economic activities which degrade and fragment their habitats resulting to malfunction of corridors' management. The study aimed at examining root factors influencing encroachment of Selous-Niassa wildlife corridor (SNWC). Data were collected using questionnaire survey, key informants interviews, focus group discussions, direct observation and secondary materials. Collected data were contently and statistically analysed. Results indicated that natural forests dominated by villages accounted higher (52% (262 562 ha)) in Liwale district compared to central government which accounted higher in Nanyumbu district (97% (60 915 ha). These forests faces encroachments for livelihoods includes lumbering, timbering, building poles, fuelwood collection, charcoal burning, and other activities. Human population increased by 75% from 1988 to 2012 resulting to acceleration of corridor degradation and fragmentation. Regression analysis reveals that, among other socio-economic factors; respondents sex, years lived in a village, and size of land owned are statistically significant and positively influencing encroachment of wildlife corridor in Selous-Niassa TFCA at ($b=0.153$, $p<0.05$), ($b=0.161$, $p<0.05$) and ($b=0.484$, $p<0.05$) respectively. Some protected areas within the corridor of Selous-Niassa TFCA are inadequate conserved due to shortage of staffs and equipment especially forest reserves (Nyera-Kipelele, Angai, Lionja, Mchonda, Ndechela, Mbangala) within Liwale, Nachingwea and Nanyumbu districts in Tanzania's side of TFCA. The study concludes that, management of SNWC is fairly sustainable. It is recommended that, more understanding on resource use values to local communities is imperative. Furthermore; man power, field gears and financial support to protected areas within the corridor of Selous-Niassa TFCA are vital for effective management of biodiversity and sustenance of ecosystem services.

INTRODUCTION

Background information

Transfrontier Conservation Areas (TFCAs) can be defined as fairly large areas, on both sides of frontiers between two or more countries and cover large-scale natural systems encompassing one or more protected areas (Osofsky, *et al.,* 2005). TFCAs involve a unique level of international co-operation between the participating countries, particularly issues related to the opening of international boundaries and within each region. The history of transfrontier conservation areas (TFCAs) can be traced back to 1932 with the first one established between Canada and the USA (NCCARF, 2005). Since then a steady trickle of these collaborative conservation initiatives has emerged in almost all continents, but Africa TFCAs starts in 1990s (SADC, 2012). Africa has recognized TFCAs as worthy ventures with multiple potential benefits, but it will take political will to make this potential become reality (Laurance and Laurance, 1999). Many TFCAs in Africa are connected by wildlife corridors which extended in various ranges depending on conserved species (Mpanduji, 2004).

Wildlife corridors have been widely advocated in conservation planning as a way to help reduce effects of habitat fragmentation (Harris, 1984; Forman and Godron, 1986; Noss, 1987; Bennett, 1990; Saunders and Hobbs, 1991; Laurance and Laurance, 1999; Mpanduji, 2004). Habitat fragmentation can be natural (such as the distribution of alpine habitat) or human-induced, and may occur on many

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scales (MacDonald, 2003).The major effects of habitat fragmentation may be additional to those that occur from habitat loss, including increased external influences (such as invasion or predation), altered microclimate (e.g. associated with evapotranspiration, wind and hydrological cycles), and increased isolation from other areas of similar habitat (Andren, 1994; Saunders *et al.,* 1991; MacDonald, 2003).

Long-run destruction, reduction or fragmentation of the sizes of corridors around the protected areas threatens the persistence and viability of many protected species due to reduction in mobility (Mpanduji, 2004). Besides, damages or fragmentation and blockage of migratory corridors expose the large bodied migratory species such as elephants, which require large home range to extinction. Thus, appropriate management of wildlife corridors provides various ecological benefits to the wildlife. The benefits include returning the landscape to its natural connected state, allow species to migrate between core areas of biological significance, increase gene flow and reduce rates of inbreeding. All these benefits improve species fitness and survival (Schmitt and Seitz, 2002; Suter *et al.*, 2008). Corridors in particular despite allowing greater mobility (Andreassen *et al*., 1996 and Suter *et al.*, 2008), are potential for species to escape predation and respond to stochastic events such as fire. Additionally, corridors allow species to respond more easily to long term climatic changes (McEuen, 1993; Suter *et al*., 2008).

It is widely recognized that the decisions for allocation of land to protected areas (PAs) are based on three categories of reasons: *pragmatic, ecological and socioeconomic*. Pragmatic reasons for the establishment of PAs are based on factors such as low productivity and availability; the ecological reasons are based on naturalness, uniqueness, ecosystem diversity, integrity, and size while the socioeconomic reasons are based on social and economical principles (Mpanduji, 2004). The establishment of many PAs including wildlife corridors in Eastern and Southern Africa followed pragmatic and economical criteria (Sarunday and Ruzika, 2000 cited by Mpanduji 2004). Responding to the ecological and socioeconomic benefits of connected ecosystems, a wide range of TFCAs projects have been proposed or are currently being implemented. Selous-Niassa TFCA is among SADC TFCAs projects.

Problem statement

Wildlife corridors in Transfrontier Conservation Areas (TFCAs) face various socio-economic activities which degrade their habitats. Some of this activities include uncontrolled wildfires, uncontrolled resource use and unplanned and un-regulated conversion of land for agricultural exacerbated by high human population growth (Baldus and Hann, 2009). Most of these activities linked with encroachment of natural resources and are the main threats to the biodiversity within the corridors. These enrochements disturb the wildlife movements and lead to a dramatic reduction of wildlife populations and local extinction of some species (Baldus and Hann, 2009). Baldus and Hann (2009) and Baldus *et al*. (2003, 2006 and 2009) reported poaching to be extensive in Tanzania's wildlife corridors. Also, ribbon strip developments within the corridors increase human – wildlife conflicts due to blockage of corridors. Selous-Niassa wildlife corridor is not exempted from this scenario as the current socio-economic activities which impacts the corridor are not well known. Before enaction of Tanzania Wildlife Conservation Act No.5 of 2009, there was no legal ways of protecting the corridors. Selous-Niassa wildlife corridor is endangered to convert its' biological intact into cultivation due to uncontrolled, unplanned and un-regulated land uses (Baldus and Hann, 2009). Besides, there is scanty information on the root factors influencing encroachment of this corridor.

Justification of the study

Significance of the study findings

The Study findings will help stakeholders of wildlife corridors especially Selous-Niassa wildlife corridor to reveal problems of habitat destruction resulted from socio-economic activities and factors influencing encroachments of the corridor. These stakeholders include the public, researchers, natural resources extension officers, agriculturalists, policy makers, planners, decision makers, game wardens, park rangers, conservators and all other environmental related experts. Furthermore, the study findings will be useful to stakeholders for knowledge generation and proposing solutions at local, national and international levels on issues related to management of wildlife corridors and Trans-Frontier Conservation Areas (TFCAs) like Selous-Niassa ecosystem.

Why study wildlife corridor of Selous – Niassa ecosystem

The study were done in wildlife corridor of Selous-Niassa ecosystem due to the following reason: First, scanty information of study area interests which is eastern part of the corridor also known as Selous –Masasi compared to western part; second, huge area coverage in Africa as the largest trans-boundary natural dry forest eco-regions covering approximately 154 000 km^2 with a critical gap between these protected areas that stretches for about 120 – 180 km and extending across southern Tanzania and the Mozambique border. Through a network of protected areas of various categories of protection, an area of 110 000 km^2 of this ecosystem is presently under conservation (Baldus and Hahn, 2009); third, wildlife migration and richness as it constitutes one of the largest elephant ranges in the world and contains half of the world remaining wild dog population, besides, supports a large number of other globally significant, threatened and CITES listed fauna and flora species (Baldus *et al*., 2003); fourth, there was no legal protection of wildlife corridors before enactment of the Wildlife Act of 2009; fifth, there was no signed memorandum of understanding between Tanzania and Mozambique concerned with protection of the ecosystem before May 2015; and last, established wildlife management areas (WMAs) which act as a buffer zone to core protected areas to help conservation of wildlife corridor by involving local communities. WMAs established are bordering Selous, Msanjesi and Lukwika-Lumesule game reserves (MAGINGO WMA, NDONDA and MCHIMALU proposed WMAs respectively) within Liwale, Nachingwea/Masasi and Nanyumbu districts respectively in

Tanzania whereas people are living inside Niassa national reserve in Mozambique (Pesambili, 2003).

Objectives of the study

Main objective

The main objective of this study was to examine factors influencing people's encroachment to Selous-Niassa wildlife corridor.

Specific objectives

The specific objectives were to

1. examine ecosystem influencing people's encroachment to Selous-Niassa wildlife corridor.
2. examine management factors influencing people's encroachment to Selous-Niassa wildlife corridor.
3. examine demographic factors influencing people's encroachment to Selous-Niassa wildlife corridor.
4. examine socio-economic factors influencing people's encroachment to Selous-Niassa wildlife corridor.

Conceptual framework

Figure 1 explains the conceptual framework of the study. It explains that Population growth increase demand for resources (raw materials, building materials, space for settlement, agriculture and livestock keeping). Poverty also increase demand of domestic energy from natural resources and land for agriculture which lead to wildlife habitat loss as a result of human-wildlife interaction either for good or worse. In order to deal with those problems and enhance sustainable wildlife corridors management, there is a need to develop strategies which ensure outstanding resource values of the wildlife corridors, acknowledge knowledge of indigenous people, awareness creation, increase participation of local people, enhance land tenure systems, provide economic incentives, control population growth and monitor poverty dynamic of local people living within the corridor.

METHODOLOGY

Description of the study area

Location

The study were carried out in Selous-Niassa wildlife corridor (SNWC) which extends across southern Tanzania into northern Mozambique between 10^0S to 11^0 40'S with north-south length of 160 to 180 km (Figure 2). SNWC comprises of two parts, western part (administratively passes in Namtumbo and Tunduru districts of Ruvuma regions in southern Tanzania) and eastern part (administratively passes in Liwale, Nachingwea, Masasi, and Nanyumbu districts).

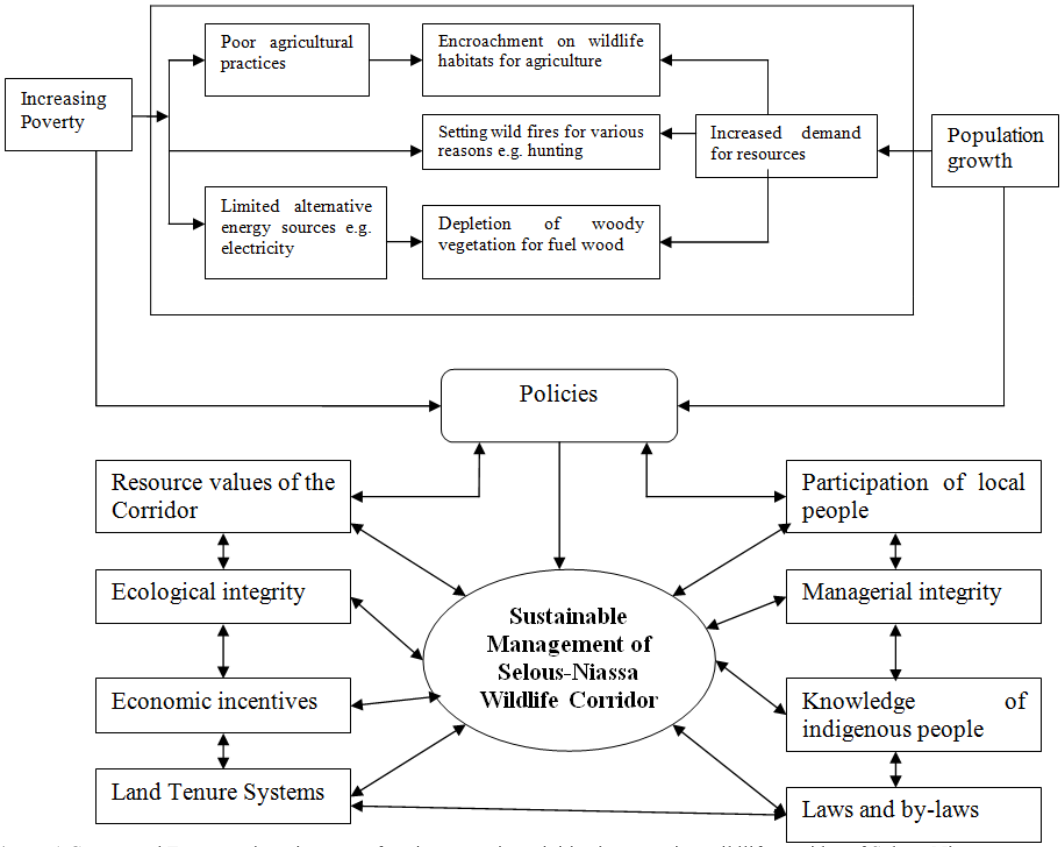

Figure 1 Conceptual Framework **on** impacts of socioeconomic activities in managing wildlife corridor of Selous-Niassa ecosystem

Source: Adopted and modified from Kideghesho *et al.* (2006)

This study will concentrate in eastern part. In eastern SNWC, migration of elephants, buffalos and zebras has been observed (Pesambili, 2003; Ntongani *et al*., 2007). Two migratory routes have been identified as follows:

1. From Selous through Nahimba, Nakalonji, Mbondo, Kilimarondo, Matekwe and Kipindimbi proposed game reserve (GR) in Nachingwea district and then via Msanjesi, Mkumbalu, Sengenya, Nangomba and Nanyumbu in Nanyumbu district to Lukwika-Lumesule GR and then crosses Ruvuma River to the Niassa GR.
2. From Selous to Kiegei, Namatumu, Kilimarondo in Nachingwea then along Mbangala and Lumesule rivers to Mchenjeuka and Mitanga in the Lukwika-Lumesule GR, from where they cross the Ruvuma River to the Niassa Reserve.

These routes forms SNWC called Selous-Masasi corridor includes the Msanjesi (2,125 ha) and the Lukwika-Lumesule (44,420 ha) GRs in Masasi and Nanyumbu districts respectively and areas of Liwale, Nachingwea, Masasi and Tunduru districts.

The study area comprise wildlife management areas (WMAs) bordering Selous, Msanjesi and Lukwika-Lumesule game reserves (MAGINGO WMA, NDONDA and MCHIMALU proposed WMAs respectively) which are within Liwale, Nachingwea/Masasi and Nanyumbu districts respectively. In this study 2 villages namely Mpigamiti and Mpombe within MAGINGO WMA and MCHIMALU proposed WMA were purposely selected for the study.

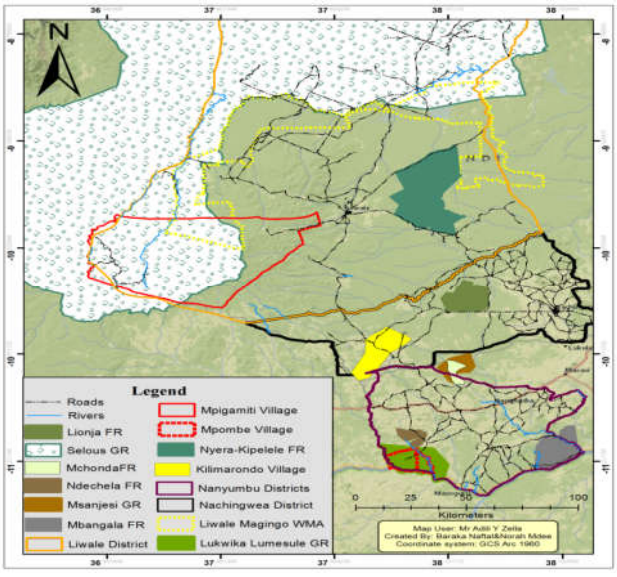

Figure 2 The Map showing Selous-Niassa Wildlife Corridor (Eastern corridor (Selous-Masasi))

Geology

In general the northern part is hilly while the area towards the Ruvuma River is slightly undulated to flat with isolated hills, some of them having prominent rock outcrops (inselbergs). Mtungwe Mountain (1284m a.s.l.) in the centre of the corridor is the highest elevation. From the North the plateau slightly slopes to the Ruvuma River which reaches its lowest level of about 460m a.s.l. in the southeastern corner of the Corridor. The soils are generally very sandy and washed-out. Two drainage basins exist in the SNWC. North of the watershed, located along the Lake Niassa – Indian Ocean Highway, the rivers drain into the Rufiji River while the area south of the watershed is part of the Ruvuma drainage basin. Some of the major tributaries like Mbarangandu, Lukimwa, Luchulukuru, Luego or Msanjesi are usually permanent watercourses.

Climate

The corridor has the typical unimodal rainfall system of the miombo woodland ecosystem. The southeast monsoons, bearing moisture from the Indian Ocean, are responsible for the rainy season chiefly occurring from mid-November to mid-May. The rainfall generally decreases from the northern part with about 1200-1300 mm rainfall per year towards the south having a mean annual rainfall of about 800 mm along the Ruvuma River. The mean annual temperature is about 21°C.

Vegetation

The wide variety of its wildlife habitats – miombo woodland dominated by *Brachystegia spp., Julbernardia spp. and Isoberlinia spp.,* wooded grasslands, open savannahs, granite inselbergs, seasonal and permanent wetlands and riverine forests along numerous perennial and seasonal streams - account for globally significant biodiversity. Although vegetation studies are still in progress about 500 plant species including one tree species (*Xylopia sp. nov*.), which has been never described before, have been identified. A number of these plant species are either CITES listed or are of the IUCN category for threatened species and endemic to Tanzania (Baldus *et al*., 2009).

Wildlife

Several dry season aerial censes were carried out simultaneously in both countries at intervals of three years - the latest in 2012 (TAWIRI, 2012). Accordingly the total elephant population of the entire Selous – Niassa ecosystem seems to be less than 70,000 as reported in 2006, with the majority in Tanzania. Globally significant populations of Lichtenstein's hartebeest *(Alcelaphalus buselaphus lichtensteinii)*, African buffalo *(Syncerus caff er)*, Niassa wildebeest *(Connochaetes taurinus cooksoni)*, Eland *(Taurotragus oryx)*, Greater kudu *(Tragelaphus strepsiceros)*, Common waterbuck *(Kobus ellipsiprymnus)*, Bushbuck *(Tragelaphus scriptus)*, Common Reedbuck *(Redunca arundinum)*, Zebra *(Equus burchelli)*, Impala *(Aepyceros melampus)* and Klippspringer *(Oreotragus oreotragus)* are linked by the corridor. Their distribution and occurrence varies substantially depending on the rainy or dry season and their location in the corridor. Large numbers of Roosevelt's sable antelope *(Hippotragus niger roosevelti)* are widespread throughout the corridor. Beside these species both reserves and the corridor are home of a variety of large carnivores including African wild dog *(Lyacon pictus)*, Lion *(Panthera leo)* and Leopard *(Panthera pardus)* and Spotted hyaena

(Crocuta crocuta). Other wildlife includes Crocodile *(Crocodilus niloticus)* and Hippopotamus *(Hippopotamus amphibius)*. The highly endangered Black rhino (*Diceros bicornis)* is still found in both reserves and the corridor, but numbers are low. The ecosystem has also a rich diversity of bird life. Migratory birds use the Ruvuma River area as a nesting or resting place on the fly way route from Northern Europe to South Africa.

Socio-economic activities

The economy of the corridor communities in Liwale and Nanyumbu districts is based on subsistence agriculture (95%). Staple crops grown are maize and cassava, cash crops predominantly cashewnut, sesame, sunflower, rice and groundnuts. Livestock is mostly restricted to goats, sheep and chicken. Cattle are rare due to the presence of Tsetse in the region (Schuerholz and Bossen, 2005). Currently, high immigration of livestock and livestock keepers are experienced in the area.

Dependency on natural resources by corridor dwellers is rated as "very high". Natural products collected regularly include poles for house construction, grass for thatching, reeds, firewood, wild fruits, mushrooms, traditional medicines and (legally or illegally) fish and bush meat. Firewood is the main source of domestic energy for cooking for over 96 percent of all households with no affordable energy alternatives in the foreseeable future (Smith, 2005).

Ethnicity

Ngindo, Yao, Mwera, Makua and Matambwe tribes are common in eastern part of the corridor. Ngindo are commonly found in Liwale district, Mwera in Nachingwea district, Makua, Yao and Matambwe in Masasi and Nanyumbu districts. Historically these tribes were hunters and gathers. Thus, living adjacent or within wildlife protected areas for this ethnicity is inexorable (Schuerholz and Bossen, 2005).

Research design

A cross sectional survey design was employed. This type of research design utilizes different groups of people who differ in the variable of interest, but share other characteristics such as socioeconomic status, educational background, and ethnicity (Kothari, 2004). Cross sectional survey design has various merits includes (i) it takes place at a single point in time, (ii) does not involve manipulating variables, (iii) allows researchers to look at numerous things at once (age, income, gender) and (iv) often used to look at the prevalence of something in a given population.

Sampling procedure and sample size determination

Sampling procedure

Mpigamiti and Mpombe villages in Liwale and Nanyumbu districts respectively were purposively selected as those found within eastern wildlife corridor of Selous-Niassa ecosystem. The study villages selected because (i) both are within the corridor, (ii) both are members of wildlife management areas (Mpigamiti – MAGINGO WMA and Mpombe - MCHIMALU proposed WMA) and (iii) Mpigamiti is within the start of the corridor while Mpombe is within the destination of the corridor in Tanzania.

A list of all households from the updated village register book in the study villages was the sampling frame. Sampling unit for this study was a household. Household was defined as a group of people living together and identifying the authority of one person the household head, who is the decision maker for the household (Katani, 1999). Simple random sampling was used to identify the sample units. In this method every household has an equal chance of being selected. Where a candidate happened to come from the same household, one was dropped (Kaswamila, 2009).

Sample size determination

The sample size for each study village was 30 households whereby 10 households were drawn from each income group (low, medium and high) as described in village's fact sheet. Sample size in socio-economic studies can be decided by the researcher depending on the nature of study but should be at least 30 units as supported by many scholars (Bailey, 1994, Boyd *et al.*, 1981; Kajembe and Luoga, 1996; Mbwambo, 2000; and Kaswamila, 2009). Judgmental/purposive sampling technique was used to obtain 12 key informants. The distributions of sample size are shown in Table 1.

Table 1 Respondent sample composition

Category of respondent	District	Villages		Total
		Mpigamiti	Mpombe	
Households	-	30	30	60
Village Executive officers (VEOs)	-	1	1	2
Village Natural Resources Officers(VNROs)	-	1	1	2
Project Manager of LLM (PLLM)	1	-	-	1
District Game officers (DGOs)	2	-	-	2
Sector warden of SGR (SWS)	1	-	-	1
Village Development Officers (VDOs)	-	1	1	2
WMA Chairpersons (WCs)	2			2
Total	**6**	**33**	**33**	**72**

Pilot Study

Prior before actual data collection pilot study was conducted so as to provide a general picture of the study area and testing of the questionnaire in order to verify if the questions could be understood by the respondents. Questionnaire pilot-testing was done in Majonanga village which is within Selous-Niassa wildlife corridor in Ndonda proposed WMA in Nachingwea district and is adjacent to Msanjesi GR aimed to test questionnaire wording, sequencing and layout; and to estimate response rates and time.

Data collection

The research consisted two phases of data collection whereby primary and secondary data were collected.

Primary data

Primary data for this study were collected using survey (household questionnaire survey and key informants interview); participatory rural appraisal (focus group discussion and direct observation). Both quantitative and qualitative data were acquired.

Household questionnaire survey

Semi-structured questionnaires were administered to the sampled households. This type of questionnaires can be used with informants who are illiterate, blind, bedridden or very old and when a respondent does not understand the question the researcher can translate and elaborate to bring the right meaning as explained much by Gillham (2005); Miler & Wilson (1983); and Kaswamila (2009).

The household questionnaire survey was useful in acquisition of quantitative information for statistical analysis, acquiring much social economic information quickly. Both pre-testing and pilot-testing of questionnaires were exercised. During questionnaires preparation, pre-testing was done to MNMA staffs and students. Pre-testing was used to assess whether the questions are clear, specific, answerable, interconnected and substantially relevant (Kaswamila, 2009). Before administering the questionnaires one task was accomplished, this is training of two local research assistants including questionnaire pilot-testing as part of training. The use of local research assistants aiming at reducing researcher or experimental bias effect (Miller & Wilson, 1983; Kaswamila, 2009), to exploit local people's willingness to provide information to a person they know. During research assistants training, questionnaire pilot-testing was done in Majonanga village which is within Selous-Niassa wildlife corridor in Ndonda proposed WMA in Nachingwea district. The instrument was self-administered to 10 respondents following procedures described by White (2002) and Mauch *et al. (*2003).

Key informants interview

Checklist of questions was used to guide interview with 12 key informants as shown in Table 1 above. Key informant interviews are advantageous because they often provide data and insight that cannot be obtained with other methods. They provide flexibility to explore new ideas and issues that is not being anticipated in planning the study but are relevant to its purpose (Pratt and Loizos, 1992 cited by Lusambo, 2002). Type of data to be collected was involved current socio-economic activities that affects Selous-Niassa wildlife corridor, factors influencing people's encroachment of Selous-Niassa wildlife corridor, and related studies done in the area. At that time researcher recorded the relevant information which relate with the study.

Focus group discussions (FGDs)

Two focus group discussions in each study village with villagers were organised. Each discussion group comprised 6-12 people (Mikkelsen, 1995; Charmaz, 2005; and Lusambo, 2009). A checklist of questions was used to cover discussion themes, which hinged on major socio-economic activities that destruct Selous-Niassa wildlife corridor, and factors influencing encroachment of Selous-Niassa wildlife corridor. FGDs have an advantage over interviews in that, participants are allowed to give their opinion and talk in detail about their beliefs and feelings and also ensure that views of the minority groups are captured (Cooksey and Lokuji, 1995; Kaswamila, 2009; Tribe and Summer, 2004; Denscombe, 2003). In the discussions, the researcher acted as a facilitator, tape recording and ensures that everyone have a say. The age group of discussants were at least 18 years of age as they are familiar with the study area and issues concerning management of wildlife corridor.

Direct observation

As the data collection being carried out, direct field observation method was used to supplement data collected from social surveys and focus group discussion. A researcher and assistants together with some villagers and key informants were randomly site observing major socio-economic activities that destruct wildlife habitat within Selous-Niassa wildlife corridor as identified during focus group discussion. The assistants undergo training on the critical issues of the study to be captured. The obtained information enabled the researcher to discuss with respondents (households, key informants and focus groups) for triangulation purposes. Again, this tool was used for generation of first hand data which is not interfered by other factors standing between researcher and respondent.

This covered the gaps left by other data collection instruments for example cross checking whether what was claimed to be facts and actual facts were compared. A checklist contained issues for cross checked was used in recording the observed data. Also, digital camera was used to take photographs relevant to the study.

Secondary data

Secondary data was collected using literature surveys. Both quantitative and qualitative data were acquired.

Literature surveys

Archive information for this study was published and unpublished obtained from SGR, LLM, Village, and or District offices, libraries and internet. Data accessed were in the form of reports, manuscripts, books, journal papers and other documents found in office files and other collections. Documented information in related to land uses in Selous-Niassa wildlife corridor; factors influencing encroachments of Selous-Niassa wildlife corridor, and effectiveness of existing management strategies were accessed. Similar information was also sought from Village experts (agriculture, wildlife and community development). This information was used to supplement data collected from interviewed households.

Data analysis

Quantitative data from questionnaire was analysed statistically. Qualitative data from focus group discussions (FGDs) and key informants were analysed through content analysis. Content analysis is useful in analyzing details of the components of verbal discussions held with key informants and FGDs (Kajembe, 1996 cited by Kijazi, 2006).

Statistical analysis

The Statistical Package for Social Sciences (SPSS) and Microsoft Excel were employed. Two types of statistical analysis namely, descriptive and inferential statistical analyses were carried out.

Descriptive statistical analysis

Analysis of quantitative data by descriptive statistics was involved frequencies, percentages, means, and standard deviations of variables such as age, marital status, sex, education level, household size and income. Also examining relationship between two variables by the use of cross tabulation method was employed.

Inferential statistical analysis

Inferential statistical analysis was involved application of multiple regression model used to determine the existence of correlation between socio-economic factors influencing encroachment of wildlife corridor. Multiple regression model has been successfully employed in social sciences, biostatistics and demographic issues (Pallant, 2005). Multivariate regression analysis was run to assess the influence of independent variables on dependent variable. Giliba *et al.* (2011) argued that, applications of multivariate regression analysis depend on the nature of the dependent variable of the particular study inquiry. Significant value should be less than 0.05 (Pallant, 2005 and Akankali and Chindah, 2011). The model was expressed as follows:

$$Y_i = ß_0 + \sum_{i=1}^{i=j} ß_i X_i + e_i$$

Where:

Y_i = encroachment of wildlife corridor

ß's = coefficients to be estimated

B_0 = constant coefficient (intercept of the equation)

X_i= independent variables

i=1,2, 3……j

$e_{i=}$ error term

The hypotheses tested were:

H_o: $\beta_i = 0$ that is regression coefficients are equal to zero implying that socio-economic factors (independent variables) have no significant influence on encroaching SNWC ($p<0.05$)

H_a: $\beta_i \neq 0$ that is regression coefficients are not equal to zero meaning that socio-economic factors have significant influence on encroaching SNWC ($p<0.05$)

From the above, the variables included in the regression model were:

X_1= Age

It was hypothesized that age of respondents influence encroachment of SNWC. Young respondents (≤ 35 years), middle-aged (36–45 years) and respondents over 60 years old (commensurate with Tanzania's mandatory retirement age of 60) differed in the level of encroachment in SNWC. Young people depended more on natural resources extraction for their survival compared to older people who were more likely to have income from wages, salaries or pensions, and less income from natural resources. Therefore, age has negative regression coefficient (-).

X_2= Sex

This could have positive coefficient (+) in the sense that sex influence encroachment in SNWC as male are more destructive compared to women as almost most poachers arrested in SNWC are male.

X_3= Education level

This could have a negative coefficient (-). It was hypothesized that respondents with higher education has low influence on encroachment of SNWC compared to respondents with low education. The reason behind is that, respondents with higher education can be employed in various private and government sectors operating in districts where SNWC lies.

X_4= House hold size

The regression coefficient for household size was expected to be positive (+). The reason behind is that large household size have many mouths to feed resulting in increasing food production and other necessities. This scenario accelerates encroachment of SNWC as ethnicity of the area encourages polygamy.

X_5= Household income

Household income could have positive coefficient (+) as higher income families mostly employed or business oriented respondents compared to low income families who engage in illegal extracting natural resources to supplement necessities. Furthermore low income families are easier to corrode with outsiders of SNWC to encroach valuable natural resources.

X_6= Years lived in a village

This could have positive coefficient (+). It was hypothesized that large number of years (≥ 05 years) lived in a village influence encroachment of SNWC as the respondent familiarity with the area and knows different trading techniques for encroached natural resources. The reason behind is that no one is able to extract any resource within the area without in-depth knowing of its status or using the indigenous people.

X_7= Size of land owned by a household

Size of land owned by a household was expected to have positive regression coefficient (+). The reason behind is that insufficient land for agriculture, settlement and livestock keeping accelerates encroachment of SNWC as people will extend to PAs as a result of destruction and fragmentation of the corridor.

RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents

The study population comprised of males and females with different ages, family size and education background (Table 2). Of the household heads interviewed, 83.3% were at least 25 years old. This was important to the management of Selous-Niassa wildlife corridor (SNWC) because they understand the historical trend of their areas as well as existing indigenous technical knowledge (ITK).

The study villages were found to have large household sizes. Results show that 53.3% have 1-5 persons per household and 46.7% have more than 5 persons. This is due to the culture of marrying many wives (polygamy) which results into a lot of dependents to feed and take care of. Education background of the surveyed population was at most primary education (85.0%), very few had at least secondary education (3.3%). This is due to shortages of schools especially primary school resulting into children walking long distances to school. There was no nearby secondary school in Mpigamiti or Mpombe villages. This implies that, low education level provides low payment employment opportunities to tourism industry within SNWC.

Table 2 Socio-demographic characteristics of respondents

Information	Study villages		Overall
	Mpigamiti n=30	Mpombe n=30	N=60
Age class:			
18-24 Years	5(16.7)[1]	5(16.7)	10(16.7)
25-35 Years	6(20.0)	11(36.7)	17(28.3)
36-44 Years	9(30.0)	8(26.7)	17(28.3)
45-65 Years	8(26.7)	3(10.0)	11(18.3)
> 65 Years	2(6.7)	3(10.0)	5(8.4)
Sex:			
Male	16(53.3)	13(43.3)	29(48.3)
Female	14(46.7)	17(56.7)	31(51.7)
Education background:			
Informal education	6(20.0)	11(36.7)	17(28.3)
Basic adult education	6(20.3)	5(16.7)	11(8.3)
Primary	12(40.0)	11(36.7)	23(38.4)
Secondary	4(13.3)	3(10.0)	7(11.7)
> secondary	2(6.7)	0(0.0)	2(3.3)
Household size:			
1-5Persons	14(46.7)	18(60.0)	32(53.3)
6-10Persons	13(43.3)	9(30.0)	22(36.7)
11-15Persons	3(10.0)	2(6.7)	5(8.3)
> 15Persons	0(0.0)	1(3.3)	1(1.7)
Income per month:			
Below TZS30,000	5(16.7)	4(13.3)	9(15.0)
TZS30,000-59,000	9(30.0)	9(30.0)	18(30.0)
TZS60,000-89,000	9(30.0)	8(26.7)	17(28.3)
TZS90,000-119,000	3(10.0)	3(10.0)	6(10.0)
TZS120,000-149,000	3(10.0)	3(10.0)	6(10.0)
TZS150,000-179,000	1(3.3)	1(3.3)	2(3.3)
TZS180,000-209,000	0(0.0)	1(3.3)	1(1.7)
>TZS209,000	0(0.0)	1(3.3)	1(1.7)

The study villages found to have low income per month resulted mostly from small-scale farming compared to standard living cost needed in the study area. Results show that 73.3% have income less than TZS. 90 000, and 26.7% above TZS90 000, whereas 45.0% below TZS. 60 000 which means below TZS. 2,000 per day (See Table 2). This shows that those employed villagers have high income compared to non-employed (Table 3) which shows that 57.1% of employed villagers have income per month above TZS. 150 000 compared to unemployed villagers 73.3% have an income per month below TZS. 90 000.

[1] Figures outside and inside the parentheses are frequencies and percentages respectively.

Also the results show that the study population has 11.7% of employed villagers while 88.3% are unemployed. Mostly those villagers who are employed work in Tourism industry, and those who are not employed are likely to engage themselves in other socio-economic activities including encroachment of wildlife and forest resources. Those unemployed people are the one who are poor compared to employed villagers.

Table 3 Income level of respondent per month

Income per month:	Employed n=7	Unemployed n=53	Overall N=60
Below TZS30,000	0(0.0)[1]	9(17.0)	9(15.0)
TZS30,000-59,000	0(0.0)	18(34.0)	18(30.0)
TZS60,000-89,000	0(0.0)	17(32.1)	17(28.3)
TZS90,000-119,000	0(14.3)	6(11.3)	6(10.0)
TZS120,000-149,000	3(42.9)	3(5.7)	6(10.0)
TZS150,000-179,000	2(28.6)	0(0.0)	2(3.3)
TZS180,000-209,000	1(14.3)	0(0.0)	1(1.7)
> TZS209,000	1(14.3)	0(0.0)	1(1.7)

$\chi^2 = 45.445$, **P** 0.001
*** Statistically significant at 0.001 level of significance

[1] Figures outside and inside the parentheses are frequencies and percentages respectively.

The study villages observed to have large household size with low income of her people as a result concentrates on utilizing wildlife and forest resources in the protected areas. Alternatively, if considers employments in tourism industry, it has seen foreigners paid much compared to locals and this is common in many tourism companies includes Tanganyika Wildlife Safaris (TAWISA), Bushman Hunting Safaris and Tanganyika Wildlife company Ltd (TAWICO) which have invested in Selous Game Reserve. Furthermore, the chi-square test indicated statistical significance (**P** 0.001, i.e χ^2 = 45.445) on monthly income of employed and unemployed households (Table 3). This implies that, affirmative action policies may need to be adopted for a period of time to improve the conditions of the excluded and to enhance equitable access to job opportunities.

Ecosystem factors

Eastern Selous-Niassa wildlife corridor in Lindi and Mtwara regions endowed with abundant natural resources in terms of forestry and wildlife. The Liwale and Nanyumbu districts have about 639 782 hectares and 164 772 hectares of natural forests respectively, which serves as habitat for wild animals. These forests are mainly miombo woodland consisting of species such as *Pterocupas anglensis, Afzelia quanzesis, Dalbegia melanoxylone, Euphorbia candelabrum,* and *Brachstegia speciformis*. The distribution of forests ownership is shown in Figure 3 and 4. Timber, charcoal, poles, and fire- wood are the chief products extracted for commercial and local consumptions. The products are harvested from Open Village Lands though some of them; especially timber is illegally obtained from the Reserves. No legal harvesting takes place in the reserves at this time. Other products from the Reserves and Open Village Lands are roots for traditional treatments, withes, fruits, grass and mushroom.

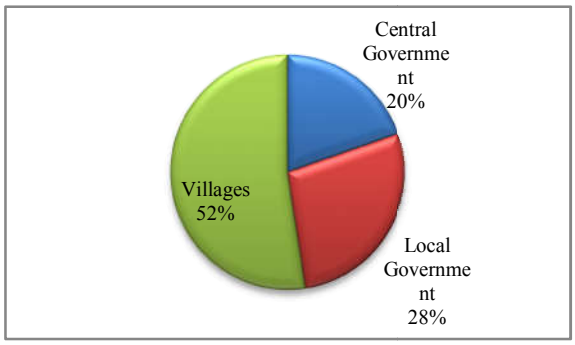

Figure 3 Liwale district forest by ownership

Source: LDC office, 2016

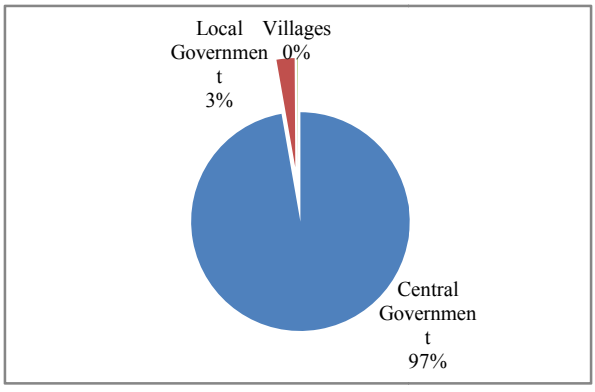

Figure 4 Nanyumbu district forest by ownership

Source: NDC office, 2016

Therefore cutting down trees for lumbering is a huge activity for businessmen from outside the district but are using village members and leaders to allow engaging in illegal timber harvesting and thereof destroying wildlife habitats. The prime income of the villagers is farming for both food and commerce and the average income per month of the residents of study villages is almost. 48,000/=.

During focus group discussions in both study villages reported outsiders to be engaging in lumbering and timber business. However, locals and leaders show the outsiders the areas with valuable wood trees mainly "Mninga" and "Mkongo" scientifically known as *Pterocarpus angolensis* and *Pseudolachnostylis maprouneifolia,* respectively. In both Mpigamiti and Mpombe villages lumbering or timber harvesting was not allowed for years (2012 to 2016). Yet illegal harvesting experienced in the areas as evidenced by confiscation of 581 timbers in Mpigamiti village in the year 2014 by Selous GR staffs in collaboration with Village game scouts and District forest officer. Also, confiscated of 500 timbers by PCCB (Prevention and Combating Corruption Bureau) in collaboration with Selous GR staffs in the year 2014 within Selous-Niassa wildlife corridor.

Plate 1 Illegal timber harvesting within Msanjesi GR is one of the main drivers of habitat destruction in SNWC

Source: LLM office, 2016

Management factors

83.9% of Liwale district land (32 231.4 km^2) and 67.1% of Nanyumbu district land (3 403. 7 km^2) has been included into protected areas network of Selous-Niassa wildlife corridor ecosystem. However, some areas, which are critically important for survival of wildlife population and are within the PAs network of SNWC like wetlands, riverine forests, dispersal areas etc, have long remained unprotected or partially protected. Recently, there have been some efforts to accord adequate conservation status to these areas made by WWF to recognize the area and plan for management strategies suitable for adoption. Also, forest reserves like Angai and Nyera/Kipelele which are within the SNWC ecosystem have a good living habitat for wildlife and have abundant number of wildlife but living at risk because there is no any protection in the area whereas timber harvesting and poaching is evidenced (*Personal observation*, 2016).

The critical habitats found in study villages are miombo woodlands. These woodlands are at risk due to increase in lumbering and loggings especially inside wildlife management area (WMA) for Mpigamiti village. In Mpombe village, lumbering is practiced in area proposed for WMA. This happens because of little security to the area resulted from understaffed, underfunded and unequipped of WMAs and respective districts councils as whole disdain protection of natural resources.

Unreserved land of study area can be used for productions that are economic rewarding and environmental friendly to

offset reserved areas for conservation of wildlife and forest resources. The study villages found to have alternative livelihood strategies to be adopted in unreserved land area. Among the strategies is conservation agriculture which is the new concept to villagers and seemed practiced in Mpigamiti village. If this strategy accepted as the districts agenda towards protection of biodiversity and land degradation will answer the problem of deforestation and wildlife destruction. Additionally, Mpigamiti village in collaboration with WWF and SGR have constructed three fish dams/ponds for fish farming. Every villager interested in fish farming should construct their own dams and take fish seedlings to those three dams following the established procedures. These farming supplement proteins hence reduce pressure on bush meat (Plate 2 and 3).

Plate 2: Fish dam in Mpigamiti village **Plate 3:** Fishes found in the dam ready to eat

As Emerton (2001, cited by Kideghesho, 2006) observes, "if there is no domestic economic gain associated with wildlife, then there will be insufficient arguments – as well as insufficient local incentives – either for conserving it or for communities becoming involved in conservation activities". The choice made by villagers living adjacent to forest reserves and wildlife management area within SNWC shows that, people continue encroaching into these areas for wildlife and forest resources specifically bushmeat and timber harvesting because they get the tangible benefits. For example in Mpigamiti village is a good conservator of elephants for applying non-lethal deterrents to their farms but the SGR game scouts arrests 509 timbers harvested in WMA land between July to October, 2015 (SGR-South eastern sector office reports, 2016). Owing to inadequate staffs in forest sector in districts councils to support conservation of forests for instance there are four forest staffs with insufficient field gears serve for Liwale district council. Additionally, there is weak law enforcement in WMAs, open areas and core protected areas (Game reserves) because of insufficient staff, field gears, and limited fund.

Moreover, many people invade in WMAs land and engage themselves in rice farming nearby the source and along rivers; for instance Liwale River which is the only source of water in the Liwale district (VEO office report, 2016). This implies that, benefits accrued from conservation of wildlife habitat and environment as whole is not tangible to individuals a results force them to engage in activities that are environmental destructive but economic rewarding for short term without considering long term impacts which is more detrimental to their livelihoods.

Demographic factors

According to 2012 National population census, Liwale had a population of 91 380 people and Nanyumbu 150 857 people. Population density is 02 people and 30 people per square kilometer in Liwale and Nanyumbu districts respectively. The sustainability of SNWC and its associated PAs must go perpendicular with human population density whereby the intercensal (1988 -2012) shown in Figure 5 found Liwale district to had the annual growth rate of 2.8%, compared to the total Tanzania growth rate of 2.9%. While in Nanyumbu district the situation is worse due to her population density and residents dependence on natural resources for their livelihoods since her establishment in 2005. The population growth rate increases in study area due to immigrations of pastoralists and other land users seeking livelihood opportunities such as mining, business, agriculture and timber makers. Thus, like other areas within and adjacent to PAs, Liwale and Nanyumbu are confronted with various resource use conflicts, which are partly due to high population density. However, the unreserved land of Liwale and Nanyumbu districts which are 6 148.6 km^2 and 1 667.81 km^2 found to have population density (population/km^2) of 14.9 and 90.5 respectively.

Figure 5 Population growth in Liwale district

Source: 1988, 2002 and 2012 Census

Socio-economic factors influencing people encroaching SNWC

In this study, socio-economic factors influencing people encroaching of SNWC were strived to reveal their significance statistically. Towards revealing the statistically significance of socio-economic factors influencing encroachment of SNWC, a multiple regression model was employed. The socio-economic factors revealed in the study area were entered sequentially in the multiple regression model, checked and the insignificant factors were removed from the prediction model. The explanatory variables that were accommodated in multiple linear regression model were; age, sex, education level, household size, household income, years lived in a village and land size owned by a household. The model was purposely employed to assess the significant socio-economic factors influencing encroachment of natural resources in the study area.

Results of the multiple regression model

The multiple regression model was used to determine the effects of explanatory variables on encroachment of natural resources in the study area. The model summary in Table 4 shows that the independent variables fit well in the regression model in that R square was 0.537.This means that the fit explains 53.7% of the total socio-economic factors influencing people encroaching wildlife corridor were explained by the tested factors. The R and adjusted R square of 0.773 and 0.475 respectively show that there is correlation between encroachment and explanatory variables.

Table 4 Model summary for socio-economic factors influencing encroachment of SNWC

Model	R	R Square	Adjusted R Square	SE
	0.773	0.537	0.475	0.226

The model reveled ANOVA results as follows, with F value of 8.621 estimated at 7 and 52 degrees of freedom and a standard error of 0.226, gave a p value of 0.000 (Table 5).This imply that at a significance level of 5% the explanatory variables are statistically significant in explaining the involvement in encroachment of wildlife corridor.

Table 5 ANOVA for socio-economic factors influencing encroachment of SNWC

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	3.080	7	.440	8.621	.000
Residual	2.654	52	.051		
Total	**5.733**	**59**			

Table 6 summaries the socio-economic factors influencing encroachment of SNWC. The result shows that, some explanatory variables influences encroachment of SNWC significantly. Of the seven independent variables used in the model only three variables are significant at 5% significance level (α).

Table 64 Multiple regression results for socio-economic factors influencing encroachment of SNWC

Model	B	Std. Error	Beta	T	Sig
(Constant)	.827	.254		3.251	.002
Age	-.010	.028	-.038	-.359	.721NS
Sex	.153	.068	.247	2.250	.029*
Education level	-.026	.031	-.095	-.863	.392NS
Household size	.061	.043	.140	1.409	.165NS
Household income	.000	.021	.002	.017	.986NS
Years lived in a village	.161	.059	.275	2.719	.009*
Size of land owned	.484	.070	.706	6.894	.000*

* = Statistically significant at α = 0.05; NS = statistically not significant at α = 0.05

Sex

The results in Table 6 suggest that sex of household head influence encroachment of SNWC positively and significantly (b=0.153, p<0.05). This implies that males are exponentially engaged with encroachment activities like commercial poaching, logging, mining, charcoal making, extensive crop faming, livestock keeping and others compared to females who concentrates with subsistence farming, fuelwood collection. The results are consistent with Ntongan *et al*, (2007) and Noe (2003).

Years lived in a village

Respondents' years lived in a study village influence encroachment of SNWC positively and significantly (b=0.161, p<0.05) (Table 6). This implies that, those respondents' stays longer in a village equipped with indigenous technical knowledge and experience in wildlife migrations seasons, routes used, species involved and different valued miombo trees species location and concentrations. The situations accelerates sabotage of the respondents with poachers and businessmen comes outside the district for illegal harvesting of natural resources within SNWC as explained much by Pimbert, and Pretty (1995), Mbwambo (2000), and Pesambili (2003).

Size of land owned

Findings also revealed that size of land owned by a household influence encroachment of SNWC positively and significantly (b=0.484, p<0.05) (Table 6). This implies that as household size increases also size of land owned by a household need to be increased so as to supplement the need of increased members as a result of encroaching SNWC. An explanation behind the observed relationship is that the encroaching land within SNWC for livelihood is violating village land use plan and extended area for food production, building materials, settlement area and other socio-economic activities which hamper biodiversity conservation and ecosystem services of fauna and flora as supported much by Pinter-Wollman (2012).

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The study demonstrated factors that influencing people encroaching Selous-Niassa wildlife corridor (SNWC) includes poverty, population growth, inadequate conservation status of some critical habitats, and failure to compete effectively with alternative land uses. There is a myth says, poor people are agents of environmental degradation or wildlife resources destruction. Actually, human survival is critical if forces threatening the protected areas ecosystem are to be halted. It is illogical for anyone to accept a scenario where preservation of wildlife resources implies starvation. To reduce the pressures on wildlife and its habitats, alternative strategies capable of reducing the necessity of encroaching into wildlife habitats should be adopted. The exponential growth of human population reduces the benefits per capita accrued from SNWC. Further reduction of the benefits may corrode local support for conservation on the basis of 'no profit, no conservation' scenario.

However, the value of wildlife-induced damage to crops and life is considerable higher than the wildlife-related benefits. Illegal hunting does not reduce the costs related to damage. Problematic animals control is a controversial issue in the communities, especially for elephants and carnivores like lions, which cause damage to livestock and can be an issue of fear and safety to humans. Similarly, in communities where the risk of property damage and loss of life by wildlife is perceived to be significant, local communities may be hostile to wildlife and oppose conservation programs.

Recommendations

Based on these findings, this study recommends the following:

1. Control of income and non-income poverty by improving economic incentives of communities which will help production of beneficial farming activities that are environmental friendly such as vegetables and fruits farming, fish farming etc are important so as to avoid dependence of natural resources available in protected areas.
2. Population control is crucial so as to reduce number of dependence and pressure on available natural resources.
3. Protection of forest reserves within SNWC like Nyera/Kipelele and Angai forest reserves should be enhanced by increasing forest staffs and working facilities.
4. Enhance awareness to communities on importance of protecting forest reserves.
5. Exercise inventory of miombo woodlands in district villages so as to ensure effectiveness before granting license/permit for harvesting forest products.
6. Promoting alternative land uses of unreserved land to reduce encroachment in SNWC.

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