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Communities' perceptions regarding the impact of Hoima-Tanga crude oil pipeline on the loss of biodiversity in Swagaswaga Game Reserve, Tanzania

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This study was conducted to evaluate perceptions of communities surrounding the Swagaswaga Game Reserve regarding the impact of the proposed Hoima-Tanga crude oil pipeline on biodiversity loss. The pipeline will transect the game reserve and some of the neighbouring villages. The study involved 156 randomly selected respondents from four purposefully selected villages located at 0 to 10 km and 11 to 20 km from the game reserve. The respondents comprised 55 females and 101 males, aged between 20 and 70 years. Semi-structured questionnaire was used. Only 57% of the respondents were aware of the proposed project, and the majority of these respondents reside in villages located closer to the game reserve. Their major concern was loss of biodiversity, which was more frequently expressed by those living close to the game reserve (58.3%) than by those living further away (5%). Respondents also expressed concerns about the lack of clarity regarding land compensation. The latter was expressed significantly more frequently by respondents residing close to the game reserve. This study demonstrates the lack of community awareness about the project. The study concluded that, comprehensive community engagement in project planning coupled with technical capacity building will be a key to guaranteeing community involvement in conservation activities.

Key words: Biodiversity loss, communities' perceptions, oil pipeline, Swagaswaga Game Reserve.

INTRODUCTION

The efficiency of ecosystem function is important for the survival of biodiversity (Haines-Young and Potschin, 2012). Human activities certainly have a substantial influence on changes in environment, alteration of ecosystem functioning and biodiversity loss (Gunderson et al., 2012; Pecl et al., 2017). In most cases, these activities are particularly those related to habitat degradation and ecosystem instability (Metzger et al., 2006). For instance, although the exploitation of natural gas and oil has had immense positive impacts on

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national economies and the social well-being of mankind in many countries (Haggerty et al., 2014; Weber, 2012); oil infrastructure construction which usually include clearing of land, development of roads and the digging of terraces (Brittingham et al., 2014), have often been linked to environmental destruction and degradation. Studies in Tanzania have also shown that the presence of offshore hydrocarbons (Kuwayama et al., 2015) in marine parks of Mafia Island and Mnazi Bay have been linked to notable environmental risks (Souther et al., 2014). Generally, oil and gas production activities have often been associated with negative ecological impacts; including loss of biological diversity (Pelletier and Coltman, 2018) and limited ecological functioning (Copeland et al., 2009).

More specifically, the construction of oil pipelines in previously undisturbed natural habitats and protected areas has often generated various negative impacts on environmental stability (Laurance et al., 2009), as such pipelines provide easy access to pristine habitats, habitually resulting in habitat loss and conversion (Finer et al., 2008). Such activities have also been linked to various threats to wildlife (Scholte, 2011; Thirgood et al., 2004), stemming in part from the destruction of water catchment areas, streams and rivers (Kuwayama et al., 2015). Indeed, Craigie et al. (2010) reported that the population of large mammals in African protected areas has been halved since 1970 due to the negative effects of various forms of anthropogenic activities, notably in West Africa's protected areas. Additionally, the world's total biomass of wild mammals relative to humans and their allies (livestock, poultry, etc.) has drastically declined over previous decades (Bar-on et al., 2018).

Furthermore, oil spills from damaged or poorly maintained pipelines, which have occurred in some countries, often release highly toxic hydrocarbons, such as benzene and polynuclear aromatic hydrocarbons, into soil and water sources (Taylor et al., 2011), affecting the survival of aquatic and terrestrial organisms (Jones et al., 2015). Likewise, noise pollution emanating from pipeline construction activities has also been shown to interfere with foraging behaviour, reproductive success, parental investment and predation risk (Shannon et al., 2015). Dust generated during construction of infrastructure is also known to reduce vegetation quality by rendering it less palatable as a result of being avoided by ungulates (Ndibalema et al., 2008).

Recently, Ugandan and Tanzanian authorities have agreed on the construction of an oil pipeline from Hoima in Uganda to Tanga Port in Tanzania (Byaruhanga, 2018). The proposed Hoima-Tanga crude oil project is 1410 km-long oil pipeline running from Buseruka sub-county in Hoima District in Uganda's Western Region through Bukoba in Tanzania, looping around the western shores of Lake Victoria and traversing through Shinyanga, Singida and Dodoma, finally ending at Tanga Port along the Indian Ocean (Barlow, 2020). The pipeline transects various wilderness habitats, such as protected areas, and underutilised land parcels. In Central Tanzania, the proposed oil pipeline route is constructed while overlapping the Swagaswaga Game Reserve (SGR) and some villages surrounding this game reserve (TPDC Unpublished Report, 2016). Although the route of the pipeline has already been planned, much information on how biological diversity in the game reserve are going to be impacted by the project are not known. Similarly, there was no community engagement in planning the project, this situation may have negative impact on natural resources conservation. Therefore, the aim of this study was to investigate the general awareness, opinions and perceptions that communities had about the proposed pipeline project on loss of biodiversity in Swagaswaga Game Reserve.

MATERIALS AND METHODS

Study site

This study was conducted in four villages surrounding Swagaswaga Game Reserve (Figure 1). Swagaswaga Game Reserve is found between Chemba and Kondoa Districts in Dodoma Region. It was entitled to be a Game Reserve in 1997 with total coverage of 871 km^2. It combines the former Songa Forest Reserve (187 km^2), Simbo, Swagaswaga and Handa forests (400 km^2) and other forest areas adjacent. The area is dominated by miombo woodlands, which offer habitats for a number of wildlife species, such as Lions (*Panthera leo*), Leopards (*Panthera pardus*), Spotted hyenas (*Crocuta crocuta*), Black backed jackals (*Canis mesomelas*), Cape buffalos (*Syncerus caffer*), Greater kudus (*Tragelaphus strepsiceros*), African elephants (*Loxodonta africana)*, Hippopotamuses (*Hippopotamus amphibius*), Bush pigs (*Potamochoerus larvatus*), Warthogs (*Phacochoerus africanus*), large snakes, Buffalos (*Bubalus bubalis*), among many others (TAWIRI Unpublished Report, 2009).

Study villages selection criteria

The study involved four selected villages that border the game reserve. Two villages (Swagaswaga and Serya) were located within 0 to 10 km from the game reserve, whereas the other two (Isari and Hondomairo) were within 11 to 20 km from the game reserve. Selection criteria based on the confirmation that the pipeline route will pass through Swagaswaga and Serya villages, however the exactly location was not yet identified since surveys were still ongoing during our study. We also made the assumption that communities residing in these villages would have increased access to the game reserve as a result of the improved road network and that the negative consequences of pipeline construction on their farm and grazing land than those further away (Lawuo et al., 2014). Thus, in general, distance from the game reserve and the presumed pipeline route provided the major criteria for selection of the villages for study.

Selection of respondents

Respondents from the four villages were randomly selected from the list of households in each village, comprising approximately 10% of the total households per each study village. A total of 156 respondents from Swagaswaga (n = 43), Serya (n = 50), Isari (n = 31) and Hondomairo (n = 30) participated in the study. The total

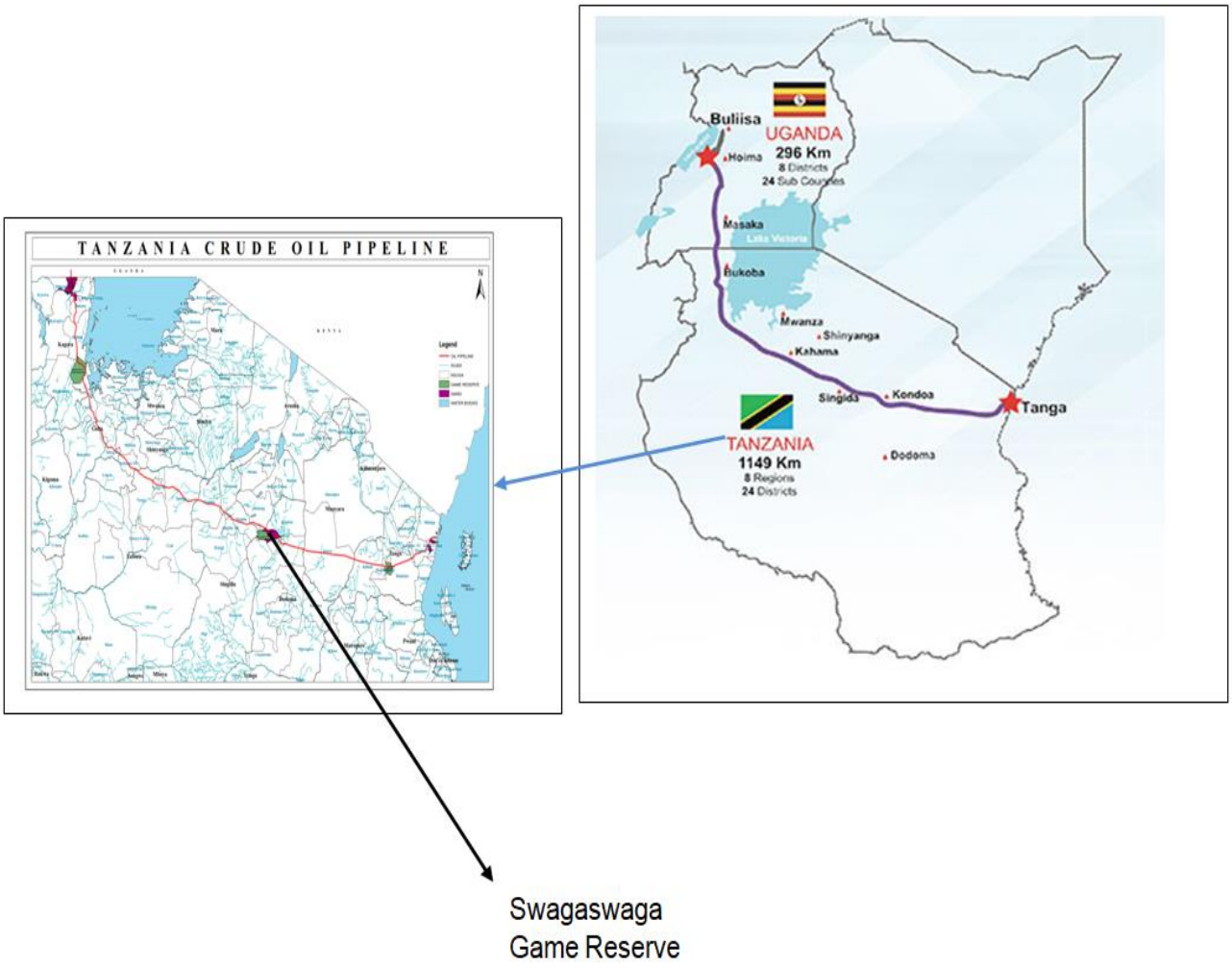

Figure 1. A map of the proposed crude oil pipeline route (red line) passing through several game reserves including Swagaswaga Game Reserve in Tanzania.
Source: The Tanzania Petroleum Development Corporation (TPDC), 2016.

comprised 55 females and 101 males aged between 20 and 70 years. Selection of sample size was determined by the concept of information power and principle of saturation. According to Malterud et al. (2016), in qualitative research the more the number of participants leads to more data rather than information (principle of saturation). In addition Malterud et al. (2016) revealed that in order for the research study to have an information power, it should hold the lower sample size (N).

Developed tools for the study

During this study, qualitative research methodology where semi-structure interview and focus group discussion were employed to allow the researcher to make a detailed study on the theme, that is, how the pipeline project will have an impact on their livelihood as well as to the natural resources. Hay (2016) notes that qualitative research is concerned with clarifying human environments and human experiences within a variety of conceptual frameworks. According to Hadi and Closs (2016) qualitative research is more explanatory in nature seeking to provide insight on how individuals understand the matter on discussion.

The questions assessed their awareness (Are community aware of the proposed project?), opinions (what are their views regarding the project? Are they accepting or rejecting the project?), perception (what are their attitude on the project toward the loss of biodiversity? will the project influence illegal hunting and how?) and what will be the impacts of the project to habitat quality?

Questionnaire pilot testing, validation and ethical issues

Questionnaires were developed in accordance with the main objective of the study. Generated questions aimed at answering research questions. Face and content validation methods were used to validate the questionnaire whereby expert people in the topic under study were involved in evaluating whether the questions capture the topic under investigation. The pilot study was conducted in order to study the population characteristics, to check acceptability of the study, to correct the questions and pre-testing the questionnaire whether they are relevant and easily understood by respondents. Ethical issues were taken into consideration where all information given by respondents were considered confidential; during interview, each questionnaires were assigned with number

Table 1. A binary logistic regression analysis with respondents" „"awareness, opinions and perceptions ‘’ of the project toward the biodiversity loss as response variables and respondent’s age, gender and education level as explanatory variables.

Predictor	Awareness $Wald_a$	p≤	Opinion $Wald_o$	p≤	Perception $Wald_p$	p≤	Poaching $Wald_l$	p≤
Distance to PA	36.268	0.0001	27.59	0.0001	44.835	0.0001	25.485	0.000
Age	0.01	0.921	0.008	0.927	1.604	0.205	1.676	0.195
Gender	0.023	0.88	0.003	0.956	0.017	0.895	6.854	0.009
Education level	0.002	0.966	0.463	0.496	4.802	0.028	0.107	0.743
Constant	10.713	0.001	2.468	0.116	7.161	0.007	0.006	0.939

“$Wald_a$, $Wald_o$, $Wald_p$ and $Wald_l$"" are Chi-square coefficient for awareness, opinions, perceptions and influence in illegal hunting (poaching). „"P"" represents the level of statistical significance.

not respondent name. Furthermore, redundant questions and those which required private or sensitive information were avoided.

Data analysis

Descriptive statistics were used to generate means and percentages. Chi-square tests were used to identify significant differences at $p < 0.05$. Finally, we used generalized linear regression or binary logistic regression analysis to identify the best predictors.

RESULTS

Socio-demographic characteristics

Overall, 156 respondents were interviewed, of which 64.7% (*n = 101*) males and 35.3% (*n= 55*) were females. The respondents were of different ages, ranging from 20 to 70 years. Majority (*n* = 137) of the respondents had completed at least primary school education, whereas the rest (*n*= 19) had no formal education. The majority (*n* = 151) earned their livelihood from crop and/or animal agriculture, and only (*n* = 5) respondents were public servants.

Awareness of local community regarding the crude oil pipeline project

When respondents were asked if they were aware of the pipeline project, 57.1% of the respondents were aware (however there was no official information given to them). A binary logistic regression was conducted with “awareness/no awareness’’ as a dependent variable, and distance to protected area (PA), respondents’ age, gender, and education level predictors. Distance to PA was the only significant variable ($Wald = 36.3$, $p < 0.001$), respondents’ age, gender and education level were not significant factors (Table 1).

Local communities’ opinions toward the project

Most of the respondents expressed a positive opinion on the project (53.2%). A binary logistic regression was conducted with the “accepting/rejecting the project’’ as a dependent variable and distance to PA, respondents’ age, gender, and education level as independent variables. Distance to PA was the only significant variable ($Wald = 27.59$, $p < 0.001$), while the other three variables were not significant (Table 1).

Local communities’ perceptions on the project towards loss of biodiversity

Majority (63.5%) of respondents near the game reserve and those with formal education (77%) were having a negative perception on the proposed crude oil pipeline to biodiversity loss. A binary logistic regression analysis was conducted with “the project will cause loss of biodiversity/no loss of biodiversity’’ as a dependent variable, and distance to PA, respondents’ age, gender, and education level as explanatory variables. Distance to PA and education level were the only significant variables ($Wald = 44.84$, $p < 0.001$) and ($Wald = 4.80$, $p < 0.05$), respectively, the other factors were not significant (Table 1). The potential loss of biodiversity within and outside the game reserve has been thought to stem from habitat loss and its associated effects (35.5%), improved road network and pollution (18.6%) and increased human population growth (6.4%).

The influence of crude oil pipeline construction on illegal hunting (poaching)

The proposed pipeline was also thought to potentially result in the increased illegal hunting of wildlife (63.5%). A binary logistic regression analysis was carried out with ‘’the project will increase illegal hunting/the project will not increase illegal hunting’’ as a dependent variable, and distance to PA, respondents’ age, gender, and education level as predictors. Nevertheless, distance to PA ($Wald = 25.49$, $p < 0.001$) and respondents’ gender ($Wald = 6.85$, $p <0.05$) were the only significant variables. Other variables were not significant (Table 1). The potential

Table 2. A stepwise logistic regression analysis with vegetation status before the project as a dependent variable, and distance to PA, respondents' age, gender, and education level as independent variables.

Predictor	B	Wald	p≤
Distance to PA	-0.025	0.381	0.537
Age	0.398	2.568	0.109
Gender	1.195	4.315	0.038
Education level	-0.418	0.224	0.636
Constant	-3.861	6.301	0.012

Table 3. A stepwise logistic regression analysis with vegetation status during the project as a dependent variable, and distance to PA, respondents' age, gender, and education level and as independent variables.

Predictor	B	Wald	p≤
Distance the PA	0.376	44.131	0.000
Age	0.047	0.024	0.877
Gender	0.325	0.189	0.664
Education level	-0.813	0.422	0.516
Constant	-4.554	4.205	0.040

drivers of increased illegal hunting include easy access to the protected area as a result of newly opened habitats (73.7%), rapid human population growth (11.5%) and increased fuel availability (7.1%) for motor vehicles and bikes.

Vegetation status before and during the project

Local communities were asked on the current vegetation status and if they think there will be changes during the project construction. Vegetation considered was large trees and shrubs. The majority (86%) of respondents claimed that there are still many miombo trees and shrubs in the game reserve. A binary logistic regression conducted with "trees status before the project" (many or few)" as a dependent variables and distance to PA, respondents' age, gender, education level and as independent variable. Respondents' gender differed statistically significant in tree status before the project (Wald = 4.32, $p < 0.05$), while the other three factors were non-significant (Table 2).

Expected vegetation status during the project

Again, majority of respondents (59%) claimed that the pipeline project will reduce vegetation cover. A stepwise logistic regression was conducted with "the project will destruct the vegetation cover "(yes, no)" as a dependent variable and distance to PA, respondents' age, gender, and education level as independent variables. Distance to PA was the only significant variables (Wald = 44.13, $p < 0.001$), while other three factors were non-significant (Table 3).

DISCUSSION

Despite of the fact that the proposed regional oil pipeline has often been the subject of national discussion in which the national socio-economic gains and those of the villages involved in the project have been highlighted; the welfare of biological diversity in the game reserve also needs a critical attention since the national and local economy gain may come with the expenses on natural habitats and biodiversity (Mason et al., 2015). Relationship amongst project development, communities' livelihood and conservation appears intrinsic to be considered simultaneously. It is important to find a way to improve and strengthen this relationship for future sustainable conservation.

Awareness of communities regarding the Hoima-Tanga crude oil pipeline construction project

The study revealed that only 57.1% of the residents in the study area were aware of the project. The majority of the respondents who had any knowledge of the pipeline were located within 10 km from the game reserve. This is because the proposed pipeline route was planned also to

be constructed passing through some parts of village's vicinity to the game reserve hence increasing the fear of losing their possessions (farms, grazing lands and homes). However, there was neither formal information nor community involvement in planning the project. This finding indicates that communities in the study sites, despite of being primary stakeholders to the proposed pipeline project, have yet to be adequately engaged and informed to establish their political buy-in and to garner the needed collaboration and cooperation necessary both during and after the construction of the pipeline. The engagement of these residents is central in minimising social agitation, guaranteeing maximal cooperation while reducing exploitation pressure to the natural resources in the game reserve (Sharareh and Badaruddin, 2015). This lack of awareness therefore calls for the need to develop a strategic plan for community engagement and advocacy. Community participation approach is crucial since actively involvement of local people in planning projects can reduce sabotage of infrastructures and improve their involvement in protected areas management activities (Amrita and Sarmistha, 2015).

Local communities' opinions toward the project

Majority of villagers (53.2%) closer to the game reserve were having a negative opinion because the project brought with it land acquisition for the pipeline itself, services road and other amenities like camps for workers. There were no specified clear terms of compensation for land loss which terrified the local people. From the local peoples' perspective, this impact is alarming rather than bringing prosperity to the local society and biological diversity since it has consequences for the longer-term sustainability of the local community both as a socioeconomic resource base and as a natural ecosystem (Amrita and Sarmistha, 2015). It has been proved elsewhere in Africa for example; that oil and gas exploitation, production and transportation has led to alienation of land use right from the local communities' ownership with no clear terms of compensation and/or even negotiation (Kuenzer et al., 2014).

Kuenzer et al. (2014) study in Niger Delta discovered that oil infrastructures were major source of land alienation and poverty in the region leading to low productivity per person and increased landlessness while leaving local people with no option for their livelihood hence persistent poverty (Sarrasin, 2013). Rural economy of local communities closer to Swagaswaga Game Reserve depends immensely on land for agriculture and grazing. These activities provide them with vital products for domestic and market consumption hence making natural environment such as land beneficial to the community. For this reason, land acquisition will not compromise local communities that depend on the region's land for their well-being.

Alienation of land will leave them with no option for their livelihood hence forcing poor farmers to degrade more environments for settlement, grazing land and agriculture; moreover, intensifying illegal exploitation of wildlife for food and income generation (Sarrasin, 2013).

Local communities' perceptions on the crude oil pipeline construction project towards loss of biodiversity

Majority (63.5%) of villagers residing close to the protected area and those with formal education (77%) had negative perceptions of the project due to the threat of the potential loss of biodiversity within the game reserve. Local people in the vicinity of the game reserve had negative perception due to the fact that change in land use would have an influence on overharvesting of natural resources in the game reserve for their livelihood. Education positively influenced local people perception toward loss of biodiversity whereas respondents with formal education were having negative perception on project towards loss of biodiversity. This may be due to the fact that they are able of reading different articles, documents and magazines that are related to conservation. Also, they may be involved in different training and meeting aimed at natural resources conservation. Some of the factors they thought that would contribute biodiversity loss were reduce habitat quality in the game reserve since it plays a big role in determining species distribution patterns, and population viability (Mortelliti et al., 2010).

The other factors were population growth especially during the construction leading to various forms of natural resources harvesting (Laurance et al., 2009). Likewise, the transformation of heterogeneous habitats to pave way for the pipeline, also thought to have substantial impacts on biodiversity, environmental degradation and wildlife survival. A study by Souther et al. (2014) revealed that homogeneous small patches support few species, which in turn deter gene flow between population resulting into alteration of genetic diversity and structure overtime therefore reduced ability to adapt environmental changes (Keinath et al., 2017). In addition, like in many countries, oil pipelines may be associated with various forms of pollution (Bilen et al., 2008) and often leaving behind toxic materials and a depleted environment that threatens ecosystem health. This has been proven in Niger Delta whereas accidental oil spills have frequently had negative impacts on the environment and biodiversity (Osuji and Nwoye, 2007).

Influence of the project to illegal hunting (Poaching)

The study also revealed that local people near the game reserve (63.5%) and female (74.1%) were concerned

about an increase in illegal hunting of wild animals influenced by the project. Being closer to the game reserve, these local people may have experienced different factors that had led to illegal hunting before; for instance, change in habitat quality, weather extreme and others. Female respondents were very honest compared to male; this may be due to the factor that they are less involved in illegal hunting activities compared to men. On the other hand, male respondents stayed reserved due to the factor that they either had hidden information on illegal hunting or they were directly involved in such activities.

Causes for illegal hunting as described by local people

As a consequence of the project, improved access to the protected area was described to influence illegal hunting. Clearance of vegetation and opening of thick, intact forests and shrubs in the game reserve will usually leave the areas more open and easily accessible by poachers and hunters (Wilkie et al., 2000). In West and Central Africa for example, the Congo basin which contains 20% of world's tropical forests (Joppa et al., 2008) has been found to lose most of the gorillas through poaching escalated by vegetation clearing and improved road network (Nellemann et al., 2010). Human population growth during the construction of the pipeline was projected to be higher near the game reserve (due to immigration) while increasing bush meat demand among the population. Families will afford purchasing bush meat due to increased income. Likewise, income generated from employment and small-medium scale enterprises will make it easier for bush meat transporters to access energy sources for their vehicles.

Vegetation status before and during the project

According to the local peoples' perspective the status of vegetation cover is still intact. Local people with the age of 45 and above stated that there are still many large trees especially "miombo", and shrubs in the game reserve. This may be due to the factor that being living near this game reserve for many years they know the trend and status of vegetation cover. Again, when they were asked if the project will destruct the vegetation cover which play a big role as habitats for wild animals, local people near the game reserve were having perceptions that the project will harm the vegetation especially lager trees and reduce its abundance. Being living closer to the protected area they may be seeing other anthropogenic activities that are taking place in the game which have negative effects on vegetation abundance. Therefore, making them to conclude that the crude oil pipeline construction project will have such effects.

Existence of ecological system viability depends much on preservation of ecological composition, structure, function, processes and interactions (Parrish et al., 2003). Alteration of biological processes and functions caused by habitat destruction consequently reduces biological diversity and composition (Waters et al., 2016). According to Waters et al. (2016), fossil fuel extraction all around the world has been responsible for habitat destruction especially when extraction and oil infrastructures lie deep into protected areas. Taking an example of Amazonian rainforest which is the earth's diverse place whose habitat has been destroyed much by oil extraction activities through deforestation, clearing for accessible road (Scanes, 2018) while threating species. Thus, this study discovered that the crude oil pipeline construction through SGR will lead into impaired habitat and degraded environment which will reduce its capacity to accommodate wild species.

CONCLUSION AND RECOMMENDATION

The expressed concerns call for pipeline project proponents and protected area authorities to partner with ward and village governments to properly engage local communities. While it is important for authorities to devise community-based strategies for engagement and advocacy to ensure the optimal cooperation of communities, it is essential that they are also technically empowered in areas of innovative land use patterns, crop and animal husbandry practices, environmental management and wildlife protection to improve their livelihoods. Introduction of mandatory education to oil projects owners to enhance knowledge and awareness on environmental issues and the damage caused by the pipeline projects on ecological biodiversity is of importance for their conservation.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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