Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.14, No.3, 2024 

# Effects of Oil Exploration on Wildlife Resources in Murchison-Semliki Landscape

Charles K.Twesigye[1*] Francis W. Nsubuga[2] Richard Raja[1] Paul Kato[1]
Department of Biological Sciences, Kyambogo University,
P.O. Box 1, Kyambogo, Kampala, Uganda
1. Department of Biological Sciences, Kyambogo University, Kampala, Uganda
2. Department of Geography, Kyambogo, University, Kampala, Uganda
*Correspondence Email: twesigyeck@yahoo.com

**Abstract**
The fresh water fish in the Albertine lakes and large mammals are under severe threats due to an increase in human population which has resulted in over fishing and poaching. In order to understand the effects of oil exploration on the local communities and natural resources, a total of 374 youths and 51 academic staff from eight (8) Vocational Training Institutions (VTIs) operating in the Albertine region were selected to participate in this study. Additionally, 28 graduate students on a Master of Science in Conservation and Natural Resources Management participated in group discussions focusing on effects of oil exploration on biodiversity conservation. Interviews were held with key informants selected from Uganda Wildlife Authority (UWA), International Oil Companies (IOCs) and the local community members selected from the study districts. Competing land uses that were identified through surveys in the study area included conservation, tourism, agriculture, timber extraction and oil exploration. There was clear evidence of Conservation interests competing with oil industry and human livelihoods. The study has shown that the positive impact of oil and gas exploration includes provision of health services, support for conservation agriculture and providing oil industry skills for the youth in Murchison-Semliki Landscape.
**Keywords:** Agriculture, Albertine Rift, Oil exploration, Wildlife resources, Biodiversity
**DOI:** 10.7176/JEES/14-3-02
**Publication date:** April 30th 2024

## 1. Introduction

Research in the Albertine region has mainly focused on the National Parks and very little work has been done at the landscape level. The wildlife reserves in conservation areas in the Albertine region have hardly been studied. The Albertine Rift is a biodiversity hotspot of Global importance due to the high level of endemism in the region. Protected areas in Africa are under threat due to the rapidly growing human populations (Salerno *et al*., 2017). Demand for more energy to meet human needs has resulted into looking for oil and gas in biodiversity hotspots which in most cases tend to overlap with oil and gas reserves (Harfoot *et al*., 2018).

In Africa, human disturbances have taken place in areas of biodiversity hotspots in a number of countries (Coghlan, 2014; Dowhaniuk, Hartter, Ryan, Palace, & Congalton, 2018; Prinsloo, Mulondo, Mugiru, & Plumptre, 2011; Rabanal, Kuehl, Mundry, Robbins, & Boesch, 2010). Anthropogenic disturbances affect wildlife at multiple scales (Weston, Maguire, Miller, & Christie, 2011). Oil and gas development involves several stages that may take decades to complete.

Recent research on impacts of human activities in protected areas have raised concerns globally (Akisiimire, *et al*.2022a, 2022b, Katswera *et al*. 2020, 2022a, 2022b, Sawyer *et al*. 2009, Rabanal *et al*. 2010). Effects of human activities on wildlife resources may be due to noise, loss of habitat, contamination of water sources due to oil and gas waste materials associated with drilling activities (Johnson *et al*. 2005, Sawyer *et al*. 2009). Change in behaviour of wildlife, as a result of human activities result into social and physiological changes that negatively affect productivity of individual animals as well as communities, populations and ecosystems and their services (Johnson *et al*. 2005). Effects of human activities on wildlife resources are not uniform and this calls for evidence based data to plan for protection and conservation of wildlife resources in areas of high risks such as oil exploration areas. Protected areas play a very important role in conserving wildlife resources and need to be supported by governments. Governments can only develop effective conservation policies if they have access to evidence based data (Katswera *et al*. 20220, 2022a, 2022b, Mena *et al*. 2006).

Human-wildlife conflict has been a great challenge in conservation of wildlife resources (Coleman, Schwartz, Gunther, & Creel, 2013; Sanei & Zakaria, 2011). Noise associated with human activities disrupts feeding and breeding behaviour of wildlife in both protected areas and beyond (Bee & Swanson, 2007; Blickley & Patricelli, 2010). These human activities have negative impacts on wildlife resources in both protected areas and the surrounding communities which have not been effectively investigated in the Albrtine Rift Landscapes. The recent migration of people to the Alberine Region seeking for employment in oil and gas industry has intensified the human-wildlife conflict. The number of wildlife animals killed, especially lions and other problem animals in

 

recent years has increased and this development affects the ecological integrity which conservation areas are supposed to protect (Katswera *et al*. 20220, 2022a, 2022b).

The rapid increase of human population in the Murchison-Semliki Landscape and the Albertine Rift as a whole, has resulted in environmental degradation in form of pollution of water, soil, air and destruction of forest resources that are critical in climate change mitigation and as sources of timber, fuel wood, construction materials for the local communities. Pollution of water resources, soil and air affects wildlife, domestic animals and people. The human activities associated with oil and gas are concentrated in the Delta region with large concentrations of wildlife, especially the herbivores, water birds and fishes due to the abundant water resources in the area. The situation described above calls for urgent mitigation based on scientific evidence. The main objective for this study is to analyze oil exploration effects on wildlife resources in Murchson-Semliki Landscape.

Murchison-Semulki Landscape is a biodiversity hotspot and at the same time it is an area of intensive oil and gas exploration activities. The rich biodiversity in the Albertine Rift is attributed to variability of the environmental conditions created in the landscape due to the presence of ecological zones at different altitudes which support a variety of plants and animals as a result of a long history of adaption and evolution (Burgessa *et al*. 2006, Plumptre *et al*. 2007). The highest altitude is in the region of about 5,100 m above sea level at the highest peak. The region is also characterized by mountains at different heights, hills and valleys of different sizes, and associated vegetation types which include, forests and swamps. Also of great ecological importance are gorges, volcanic craters, waterfalls and hot springs that attract tourists. The level of endemism in the Albertine Rift is the highest in Africa (Plumptre *et al*. 2007). The aim of this research was to assess the effects of oil exploration on wildlife resources in the Murchison-Semliki Landscape.

## 2. Materials and Methods

*2.1Study area*

Data from youths in Buliisa and Hoima (Figure 1& 2) was collected using a structured questionnaire survey, and interview guides. The questionnaire was designed to get information about their knowledge on effects of oil exploration on wildlife resources in protected areas in the Murchison –Semliki Landscape and the benefits expected from oil industry development. They were also asked about their skillsets which are relevant to job opportunities presented by the oil and gas industry in Western Uganda. The questionnaire included questions on causes of human-wildlife conflict, possibility of co-existence between wildlife and the oil industry in protected areas for biodiversity conservation.

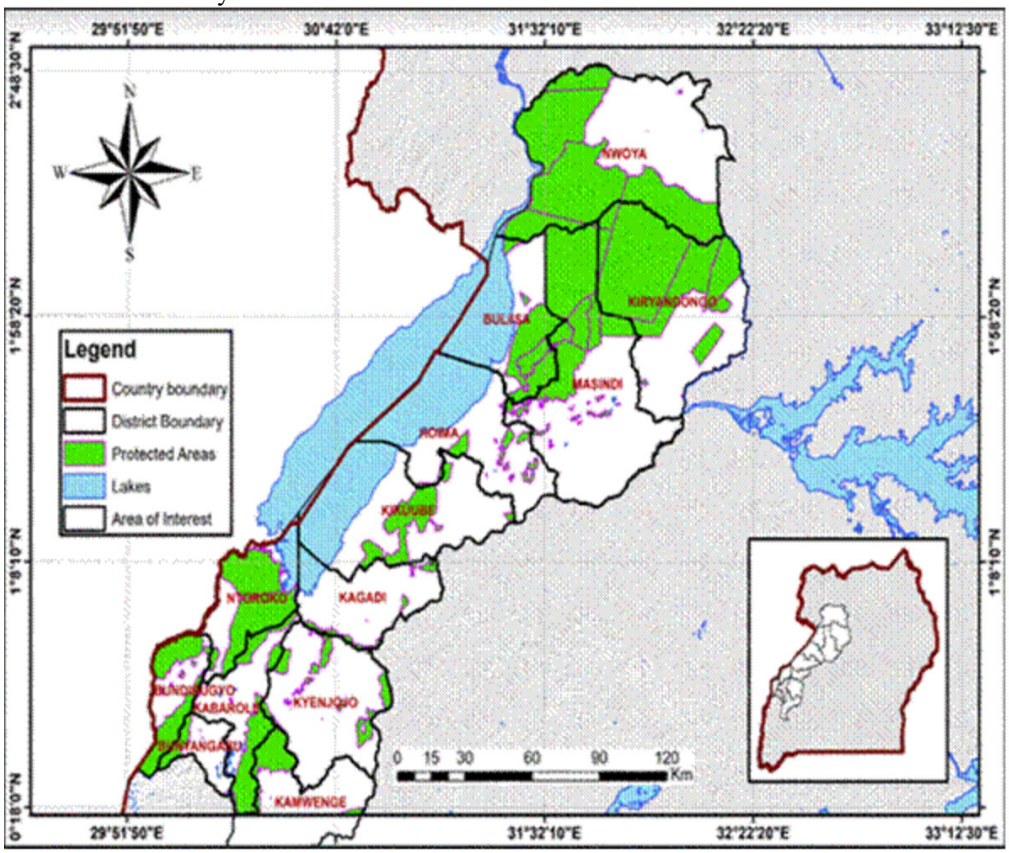

Figure 1: Study sites in Murchison-Semliki Landscape

 

The respondents were requested to make recommendations to government, UWA, IOCs and local leaders for mitigating human-wildlife conflicts. The study participants were requested to give benefits and disadvantages of allowing oil exploration and development in the most bio diverse region in Africa. A total of 8 Vocational Training Institutions (VTIs) were surveyed with an enrolment of 1,999 students in the Albertine Region (Figure 1& 2). A total of 273 males, 53 females and 48 invalid respondents participated in the youth survey which resulted in 84% for males and 16% for females. Out of the 51 members of the academic staff who participated in the study 13(21.7%) indicated that they were in the process of developing programmes for teaching oil and gas skills, while 37(61.7%) did not include specific units in their programmes on oil and gas. About 22% of the staff members from these vocational institutions acknowledged to be having a component of oil and gas training but still being developed. Uganda Technical College, Kichwamba was identified as one of the colleges to take a leading role in Skills Development for the Oil Sector. The research team held series of meetings with the Principals and Directors of VTIs and UTCs that were very informative regarding their current levels of enrolment, staffing position, teaching facilities, funding support by Government, IOCs and other funding agencies. The two IOCs operating in the Albertine Region have been supporting all the VTIs and UTCs in their efforts to train their students in oil and gas skills. Both academic staff and students admitted that there were benefits and challenges with the oil exploration in protected areas in Murchison-Semliki Landscape. As part of their social responsibility IOCs had improved health facilities and provided support to schools and improved water quality and means of transport by constructing roads where they never existent before. The major negative impacts associated with the oil exploration were increased human wildlife conflicts and displacement of local communities from their ancestral lands and destruction of their cultural heritage.

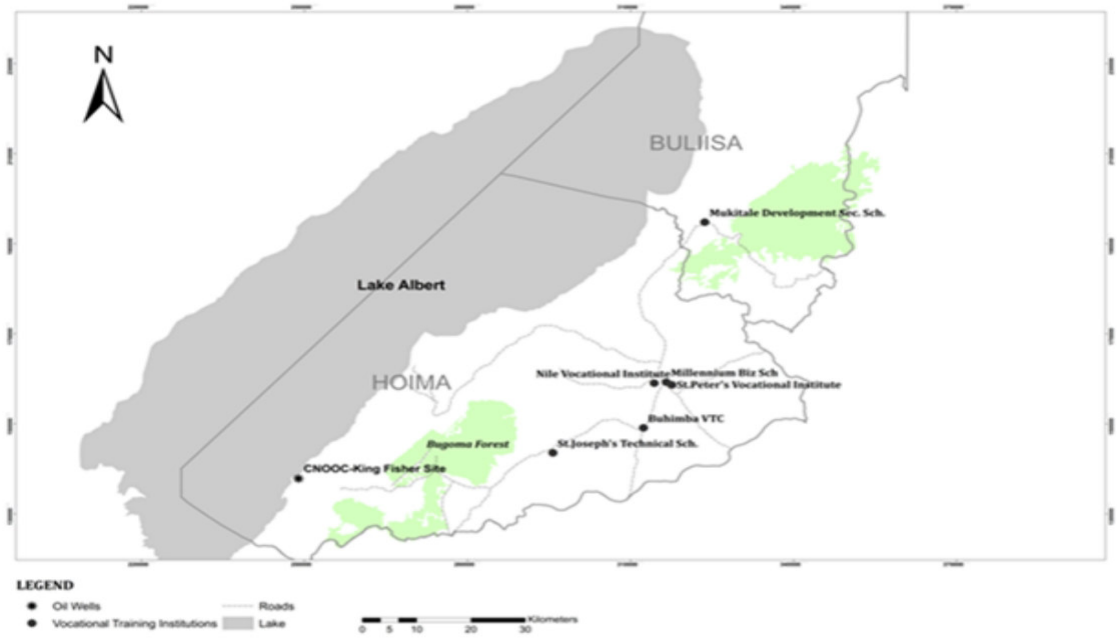


Figure 2**:** A map of Buliisa and Hoima Districts showing some of the VTIs.

*2.2. Academic staff survey***:**
A total of 51 staff members from 8 VTIs were selected to participate in the study on oil exploration. Over 90% of the academic staff are residents in the Albertine Region and are in close contact with the local community and understand their cultural values, aspirations, socio-ecological challenges, traditional knowledge and the origin of protected areas in Uganda and Africa as a whole.

*2.3 Interviews with Graduate Students of Conservation and Natural Resources Management*
A total of 28 graduate students were interviewed for their views on oil exploration in protected areas in Uganda. The interview guide included questions on causes of human-wildlife conflict, possibility of co-existence between wildlife and the oil industry in protected areas for biodiversity conservation. The study participants were requested to give benefits and disadvantages of allowing oil exploration and development in the most bio diverse region in Africa.

*2.4 International Oil Companies (IOCs)*
The interviews with representatives of IOCs focused on their strategies to minimize effects of oil exploration on

 

wildlife and the livelihoods of the local communities.

*2.5 Protected Areas Managers*

The questionnaire for UWA staff was developed to explore wildlife conflicts since the discovery of oil and gas in 2006 up to 2022 and on strategies to mitigate impacts of oil exploration and development on wildlife resources. Questions on strategies for climate change mitigation and adaptation were also included.

*2.6 Wildlife Surveys*

Systematic surveys were conducted using transects starting from well pads and roads. Transects were marked to make sure that the surveys are systematically done. Animal observations along transects were recorded in data books. Every effort was made to make sure that the animals are not disturbed during the surveys.

*2.7 Vegetation Surveys*

A pilot study was conducted before the main field work studies. Data were collected on plant species richness and vegetation cover.

*2.8 Data Analysis*

Data analysis was conducted using non-parametric statistics to analyze differences among species in study sites with different levels of disturbances attributed to oil and gas activities and the data collected from study participants.

## 3. Results and Discussion

*3.1 Data from field work surveys in Murchison-Semliki Landscape*

Bush land; forest; tree plantation; grassland; wetland; woodland; and oil exploration were the common forms of land use competing with conservation of wildlife resources in the study area. During the baseline study it was reported that the Vocational Training Institutions (VTIs) in the Murchison-Semliki Landscape work closely with the International Oil Companies (IOCs). We found it beneficial to involve the VTIs staff and students (Figure 2) in assessing the potential impacts of oil exploration on the wildlife resources because they were the most knowledge people on oil exploration activities among the local communities in the Landscape. The location of the VTIs which participated in the study are indicated in Fig 2.

Table 1**:** Students Enrolment Analysis for the eight (8) VTIs which participated in the Study

| | **Name of Institution** | **Male** | **Female** | **Total** | **Status** | **District** |
|---|---|---|---|---|---|---|
| 01 | St Simon Peter's VTC | 370 | 40 | 410 | Private | Hoima |
| 02 | Nile VTC | 249 | 118 | 367 | Private | Hoima |
| 03 | Millennium B. School | 10 | 61 | 71 | Private | Hoima |
| 04 | St. Josephs Muteme | 88 | 67 | 155 | Private | Kikuube |
| 05 | Buhimba Technical College | 93 | 35 | 128 | Public | Kikuuebe |
| 06 | Uganda Tech. College Kichwamba | 423 | 56 | 479 | Public | Kabarore |
| 07 | Lake Katwe Technical Institute | 189 | 25 | 214 | Public | Kasese |
| 08 | Kasese Youth Polytechnic | 155 | 19 | 174 | Public | Kasese |
| | TOTAL | **1400** | **531** | **1,998** | | |

Lake Katwe Technical Institute presented the highest number of participants (12) followed by Uganda Technical College Kichwamba(10). These were followed by Kasese Youth Polytechnic (9) and St. Simon Peter's VTC (8).

Table 2: Analysis of academic staff participation per institution

| **Name of Training Institution** | Frequency | Percent |
|---|---|---|
| Buhimba Technical Institute | 3 | 6 |
| Kasese Youth Polytechnic | 9 | 17.6 |
| Lake Katwe Technical Institute | 12 | 23.5 |
| Millennium B. School | 3 | 6 |
| St. Joseph's Vocational Training Institute | 5 | 9.8 |
| St. Joseph's VTI Teco Munteme | 1 | 2 |
| St. Simon Peter's VTC | 8 | 15.6 |
| Uganda Technical College Kichwamba | 10 | 19.5 |
| Total | 51 | 100.0 |

 

The number of females (9) was significantly lower than males (42). Buhimba Technical Institute (Figure 4) had the best teaching facilities for oil industry skills and Agriculture. Interviews with the staff and students of the institute had positive attitudes towards the oil and gas industry in the Murchison Semliki Landscapes and had high hopes for job employment in the industry.

Table 3: Gender distribution among academic staff study participants

| Name of Training Institution | Gender | | | Total |
|---|---|---|---|---|
| | | Female | Male | |
| Buhimba Technical Institute | 0 | 0 | 3 | 3 |
| Kasese Youth Polytechnic | 0 | 3 | 6 | 9 |
| Lake Katwe Technical Institute | 0 | 2 | 10 | 12 |
| Millennium B. School | | 1 | 2 | 3 |
| St. Joseph's Vocational Training Institute | 0 | 1 | 4 | 5 |
| St. Joseph's VTI Teco Munteme | 0 | 0 | 1 | 1 |
| St. Simon Peter's VTC | 1 | 0 | 7 | 8 |
| Uganda Technical College Kichwamba | 0 | 2 | 8 | 10 |
| Total | | 9 | 42 | 51 |

Figure 4**:** Research Team interacting with a Mechanical Workshop Instructor at Buhimba Technical Institute

 

Table 4. Skills in Oil and Gas Engineering

| | Frequency | Percent |
|---|---|---|
| Neutral | 1 | 1.7 |
| No we don't | 37 | 61.7 |
| Yes we do | 13 | 21.7 |
| Total | 51 | 100.0 |

Out of the 51 members of the academic staff who participated in the study 13(21.7%) indicated that they were in the process of developing programmes for teaching oil and gas skills, while 37(61.7%) did not include specific units in their programmes on oil and gas.

*3.2 Summary of interviews with UWA Staff*

The interviews with UWA staff showed that the large mammals, especially the carnivores are most affected by human-wildlife conflict. However, lions in Uganda are threated because of the human-wildlife conflicts associated with the increased interaction between wildlife and domestic animals that come to graze in protected areas which increases risks of being attached by the lions and as a result the lions being killed by spearing or poisoning by the farmers

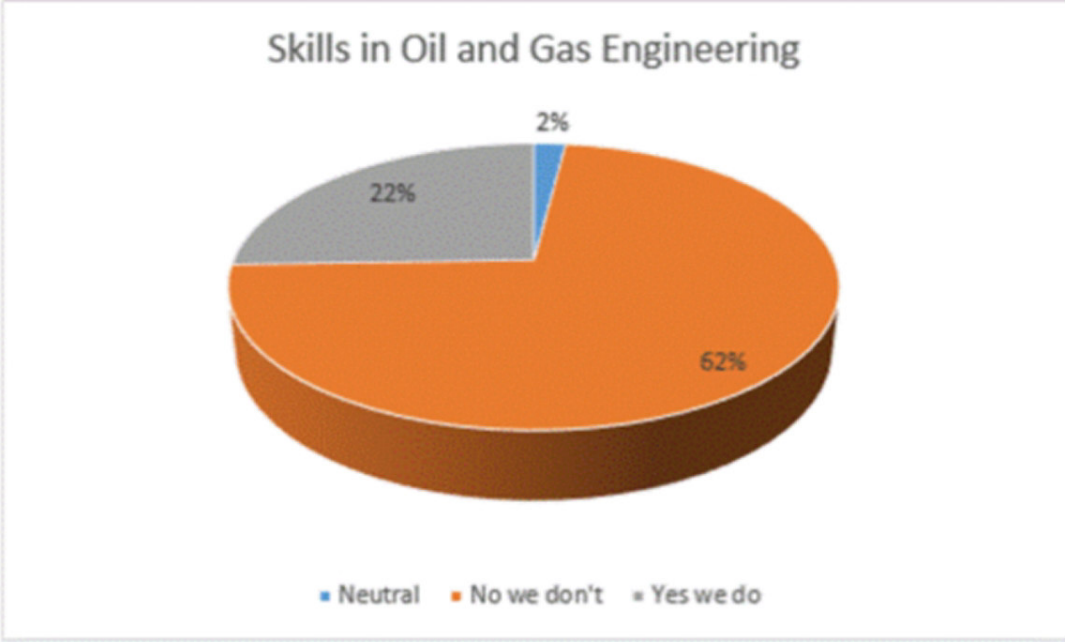


Figure 4: Showing status of training in oil and gas engineering skills in the participating VTIs

*3.2 Summary of interviews with UWA Staff*

The interviews with UWA staff showed that the large mammals, especially the carnivores are most affected by human-wildlife conflict. However, lions in Uganda are threated because of the human-wildlife conflicts associated with the increased interaction between wildlife and domestic animals that come to graze in protected areas which increases risks of being attached by the lions and as a result the lions being killed by spearing or poisoning by the farmers.

*3.3 Summary of interviews with graduate students of CNRM Programme*

Two out of 28 graduate students of Master of Science in Conservation and Natural Resources Management (MSc. CNRM) stated that it was a bad idea while two declined to comment because of their job security. The remaining 24(86%) stated that as long as the oil exploration companies follow the UWA and NEMA guidelines, it is possible for biodiversity conservation and the oil industry to co-exist in protected areas according to recent research findings(Akisiimire *et al* 2022a & 2022b) in Murchison Falls National Park(MFNP).

 

Table 5: Vegetation Diversity at oil pads and control areas

| Oil pads transects | *H value* | *H max* | *E value* | Control areas transects | *H value* | *H max* | *E value* |
|---|---|---|---|---|---|---|---|
| Jobi4 ET | 2.05 | 2.48 | 0.83 | CA1 ET | 1.83 | 2.20 | 0.83 |
| Jobi4 ST | 2.16 | 2.56 | 0.84 | CA1 ST | 2.47 | 2.71 | 0.91 |
| Jobi4 WT | 1.89 | 2.40 | 0.79 | CA1 WT | 1.42 | 1.95 | 0.73 |
| Jobi4 NT | 1.78 | 2.20 | 0.81 | CA1 NT | 1.38 | 2.08 | 0.66 |
| JE7 ST | 1.61 | 2.20 | 0.73 | CA2 ST | 1.63 | 2.30 | 0.71 |
| JE7 WT | 1.93 | 2.40 | 0.81 | CA2 WT | 1.63 | 2.20 | 0.74 |
| JE7 NT | 1.91 | 2.48 | 0.77 | CA2 NT | 1.60 | 2.40 | 0.67 |
| JE7 ET | 1.86 | 2.20 | 0.85 | CA2 ET | 1.72 | 2.20 | 0.78 |

JE7-Jobi East 7, H value- Shannon Weiner vegetation index, H max- Maximum species', E value- Species' equitability. ET-East transect, ST- South transect, WT- West transect, NT- North transect, CA1- Control area 1, CA2- Control area 2.( **Source**: Akisiimire *et al.* 2022)

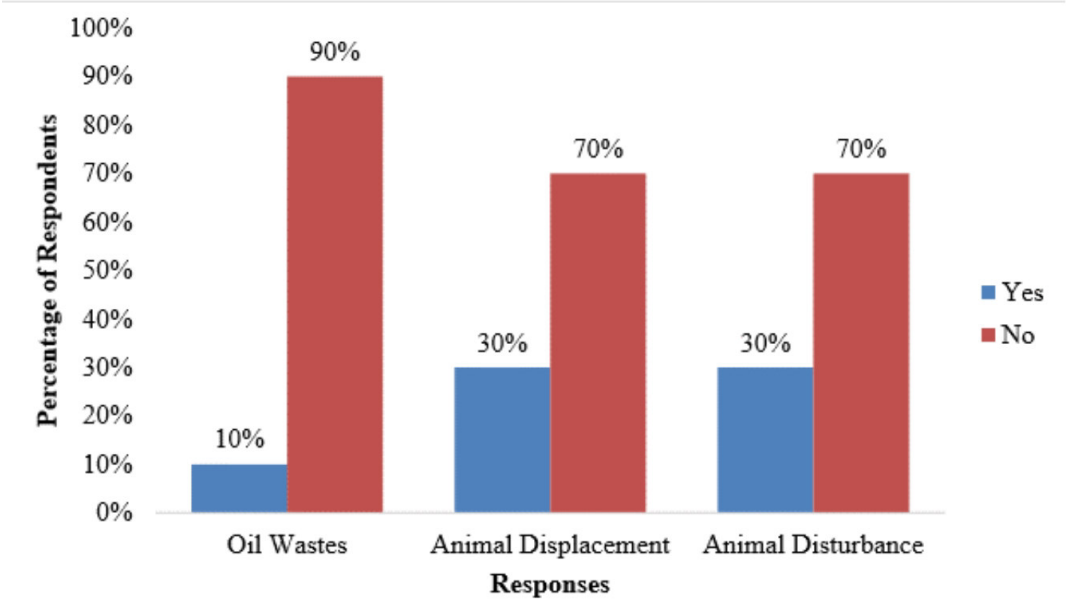


Figure 5: Percentage of respondents dissatisfied with compliance standards as suggested by study participants (**Source:** Akisiimire *et al* 2022)

The number of respondents( Figure 5) who feel that animal displacement and disturbance are a result of oil operations in the park are significantly different from the number of respondents that disagree ($\chi^2=8$, d.f=1, $p<0.05$). The views of

*3.4 Compliance standards of oil operations*

In a survey conducted by Akisiimire *et al*.2021 showed that that 64% of the respondents (n=50) think oil operations in the park meet the regulatory compliance standards while most respondents (90%) indicated that oil waste management is being done in a satisfactory manner( Figure 5).

*3.5 New agriculture technologies to support the increasing human population in the Albertine Region.*

Aquaponics is one of the agriculture technologies introduced to provide food for the growing population in the oil industry region (Figure 6).

 

Figure 6: Research Team Interacting with Aquaponics Farmer feeding Cat fish in Aquaponic System

Modern banana plantations based on Agriculture Conservation Principles have been established to support the campaign for improved food production for the growing population associated with the oil industry in the Albertine Region ( Figure 7a and b).

Plate 7a: A case of conservation Agriculture by conserving water moisture through mulching and shade trees

 

Figure 7a: Improved banana growing in Hoima District

**Figure 7a & b:** Conservation Agriculture reducing pressure on wildlife resources in the Albertine Region ( Miika Estates Company LTD)-Photo by AM )

This farmer in Hoima District (Fig.7 a and b practices conservation agriculture through mulching and irrigation to conserve soil and water. Conservation agriculture is being promoted in all VTIs in Uganda to support Sustainable Development Goals (SDGs).

*3.6: Biodiversity in Murchison-Semliki Landscape*

MFPA is home to four of the "Big Five" huge mammals, with buffalo and elephants being particularly common. The lions, who have a very healthy population, enjoy eating the plentiful Uganda kob while the Hippos enjoy the water ecosystem. The Victoria Nile, which is overflowing with crocodiles and hippos, attracts wildlife. Chimpanzees can be found in the adjacent Budongo Forest Reserve. The park is home to numerous Rothschild's giraffe herds. It was founded in the year 1952. It is best known for the most powerful waterfall in the world. The park is home for large populations of Elephants, Buffalos, Lions and Leopards. It is also the only park which is the original home of giraffes. There is little rain during the Dry season (December to February).

*3.7 Effects of combined oil exploration and climate changes on wildlife resources*

The following plates (1-8) illustrate combined effects of oil exploration and climate change in Murchison Falls National Park (MFNP).

 

**Plate 1**: Total Energies Gazzeted area for well pad

**Plate: 2** A pride of Lioness resting after hunting in MFNP

 

**Plate 3:** Effects of climate change in MFNP

**Plate 4**: Breeding area for lions. This type of habitat is decreasing in Murchison National Park.

 

**Plate 5:** Roads in the park

**Plate 6:** A wide road to support oil and gas exploration being turned into tarmac (Plate 6), which is disrupting the natural environment, especially by separating the breeding grounds, mating places, and migrating corridors. The park rangers claim that because wildlife is being pushed out of its natural habitat to dwell in communities, human-animal conflicts are becoming more common in the area. Animal behavior is impacted by the use of large machinery in the park. Tthe construction of well pads and roadways, affect elephant behavior, which is sensitive to vibration and noise. Elephants were not seen in most parts of the park close to the oil exploration sites during this field study period. The conservation of the park is seriously threatened by the discovery and exploitation of oil and gas. The habitat for wildlife is currently being destroyed by the widespread clearing of vegetation to make room for the installation of oil infrastructure. Additionally, murram roads are being replaced with tarmac (Plate 6), which is disrupting the natural environment, especially by separating the breeding grounds, mating places, and migrating corridors. The park rangers claim that because wildlife is being pushed out of its natural habitat to dwell in communities, human-animal conflicts are becoming more common in the area. Animal behavior is impacted by the use of large machinery in the construction of well pads and roadways, particularly elephant behavior, which is sensitive to vibration and noise. Elephants were not seen in most parts of the park close to the oil exploration fields during the study period.

 

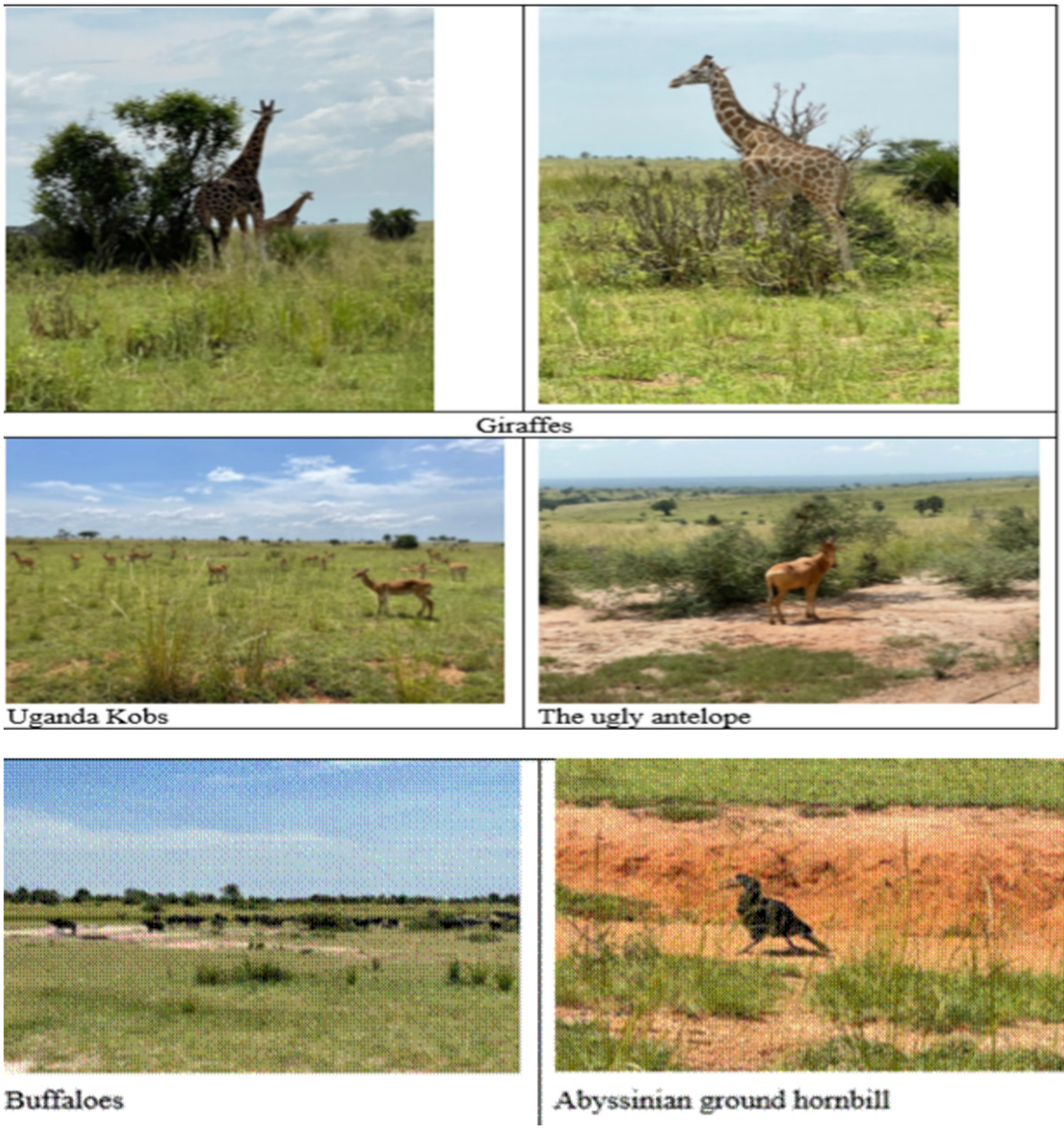


**Plate 7**: Effects of climate change in Murchison Falls National Park

 

**Plate 8:** The second game drive way being turned into tarmac.

The introduction of heavy machinery results into noise and vibration thus driving elephants away due to their sensitivity to noise and vibrations. A road being constructed in the middle of the park to facilitate oil activities (Plate 8). The conservation of the park is seriously threatened by the discovery and exploitation of oil and gas. The habitat for wildlife is currently being destroyed by the widespread clearing of vegetation to make room for the installation of oil infrastructure. Additionally, murram roads are being replaced by tarmac roads.

*3.8. Semliki Delta wetlands*

Environmental degradation in Semliki wetlands has been aggravated by climate change effects. The different habitats that do exist in the Albertine Rift and the associated landscapes such as Murchison-Semliki landscape are responsible for the biodiversity hotspots that require urgent documentation for planning and management before too much damage has been done on these critical wildlife resources that have sustained human communities in this region over generations. The protection of these wildlife resources which include rare plants and animals require joint research efforts from the regional governments that share these wildlife resources and the international community because of the important roles they play in sustaining sustainable development through tourism, forestry, agriculture, provision of water sources, medicine, opportunities for research for both regional and global initiatives and for ecosystem services (Brooks *et al*. 2001, Olson *et al*. 2001, Kuper *et al*. 2004 , Burgessa *et al*. 2006, Plumptre *et al.* 2007).

The gap in knowledge in this region is greatly attributed to the high level of insecurity since the 1970s in the case of Uganda. It is hoped that the recent development with DRC joining the East African Community, we now have improved chances of protecting the wildlife resources that are shared between Uganda and DRC. It has been observed and noted by various researchers that the Albertine Rift is a region of great endemism that makes the Albertine Rift very important for studying evolutionary biology, conservation genetics, genomics, ecology and biodiversity conservation and conservation biology. Furthermore, the Albertine Rift has a very high diversity for bird species (Plumptre *et al.* 2007).

*3.9. Contribution of International Oil Companies (IOCs) to Conservation Efforts*

During the baseline study it was reported that the Vocational Training Institutions (VTIs) in the Murchison-Semliki Landscape work closely with the International Oil Companies (IOCs). If a good number of these students are employed, it will result in a reduction of the youth involved in traditional agriculture which is not sustainable.

## 4. Conclusion

Oil exploration during active access road construction and well drilling causes disturbance to wildlife in protected

 

areas and degrades the habitat in some areas hence forcing the migration of wild animals such as elephants to other areas. However, after restoration wildlife return to their habitats. The delta which is a biodiversity hotspot is where the oil deposits are thus affecting breeding and mating of animals. Conservation of national parks is key to sustenance of wildlife in their natural habitats. The study has shown that the positive impact of oil exploration includes training of youths in oil skill sets, provision of health services, and support for conservation agriculture. It is true that oil exploration in the Murchison-Semliki Landscape is competing with conservation of wildlife resources and livelihoods. However, if all regulations and guidelines for minimizing the impacts of oil exploration wildlife resources, it is possible for biodiversity conservation and oil industries to co-exist in Murchison-Semliki Landscape.

**Acknowledgments**
We thank all study participants and local leaders for their participation and help.

**REFERENCES**

Akisiimire , H.,Tinzaara, W., Tumwebaze, K., Twesigye, C.K.(2022).Assessment of vegetation in Murchison Falls National Park five years after the completion of oil and gas exploration. East Afr. J. Biophys. Comput. Sci. Vol. 3, No. 1, 43-57

Hindrah Akisiimire , William Tinzaara , Keneth Tumwebaze and Charles K.Twesigye(2022) Mammals' Population Abundance and Distribution Post Oil and Gas Exploration In Murchison Falls National Park, Uganda. *African Journal of Education, Science and Technology*, June, 2022, Vol. 7, No. 2

Ayebare, S. (2011). Influence of industrial activities on the spatial distribution of wildlife in Murchison Falls National Park, Uganda (Master's thesis). Retrieved from Digital Commons. Paper 112.

Bates, D., M. Maechler, and B. Bolker. (2012) lme4: Linear mixed-effects models using S4 classes. Version 0.999999-0 Available at http://cran.r-project.org/package=lme4.

Blickley, Jessica L. and Patricelli, Gail L.(2010) 'Impacts of Anthropogenic Noise on Wildlife: Research Priorities for the Development of Standards and Mitigation', Journal of International Wildlife Law & Policy, 13: 4, 274 — 292

Bee, M. A., & Swanson, E. M. (2007). Auditory masking of anuran advertisement calls by road Traffic noise. Animal Behaviour, 74(6), 1765–

Benıtez-Lopez, A., R. Alkemade, and P. A. Verweij. 2010. The impacts of roads and other infrastructure on mammal and bird populations: a meta-analysis. Biol. Conserv. 143:1307– 1316.

Brooks, T. M., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., Rylands, A. B., Konstant, W. R., and Hilton-Taylor, C. (2002). Habitat loss and extinction in the hotspots of biodiversity. Conservation biology, 16(4), 909-923.

Bull, J. W., K. B. Suttle, A. Gordon, N. J. Singh, and E. J. Milner-Gulland. 2013a. Biodiversity Offsets in theory and practice. Oryx 47:369–380.

Burgessa, N.D., Hales. D.J, Ricketts, H.T., and Dinerstein, E. 2006. Factoring species, non-species values and threats into biodiversity prioritisation across the ecoregions of Africa and its islands. Biological Conservation 127, 383–401.

Dowhaniuk, Nicholas Hartter, Joel Ryan, Sadie Michael Congalton, Russell (2018): The impact of industrial oil development on a protected area landscape: demographic and Social change at Murchison Falls Conservation Area, Uganda VL - 39,

Katswera, J., Mutekanga , N. M. , & Twesigye , C. K. (2022). Community Perceptions and Attitudes towards Conservation of Wildlife in Uganda. *Journal of Wildlife and Biodiversity*, *6*(1).Retrievedfromhttps://wildlife-biodiversity.com/index. php/jwb/article177.

Katswera J., Mutekanga N, Twesigye C.K (2020) Biodiversity conservation and threat reduction in Kibale and Queen Elizabeth conservation areas, Uganda. East Afr. J. Biophys. Comput. Sci. (2020), Vol. 1, Issue 1, 1 – 22

Kuper, W., Sommer, H.J., Lovett, C.J., Mutke, J., PeterLinder, H., Beentje, J.H., Van Rompaey, R.A.S.R., Chatelain, C., Sosef, M., and Barthlott, W. 2004. Africa's hotspots of biodiversity redefined. Annals of the Missouri Botanical Garden 91(4), 525–535

Harfoot, M. B. J., Tittensor, D. P., Knight, S., Arnell, A. P., Blyth, S., & Brooks, S., … Burgess, N. D. (2018). Present and future biodiversity risks from fossil fuel exploitation. Conservation Letters, e12448,

Johnson, L. (2007). Assessing the impacts of energy developments and developing appropriate mitigation in the Uganda portion of the Albertine Rift. Wildlife Conservation Society and Uganda Wildlife Authority, Kampala, Uganda.

Hartter, J. (2017). Park isolation in anthropogenic landscapes: Land change and livelihoods at park boundaries in the African Albertine Rift. Regional Environmental Change, 18, 913–928.

Jones, K. R., Venter, O., Fuller, R. A., Allan, J. R., Maxwell, S. L., Negret, P. J., & Watson, J. E. M. (2018). One-

 

third of global protected land is under intense human pressure. Science, 360, 788–791.

Lee, C. B., Chun, J. H., Song, H. K., and Cho, H. J. (2013). Altitudinal patterns of plant species richness on the Baekdudaegan Mountains, South Korea: mid-domain effect, area, climate, and Rapoport's rule. Ecological research, 28(1), 67-79.

Olson, D.M., Dinerstein, E., Wikramanayake, D.E., Burgess, D.N., Powell, N.V.G., Underwood, C.E., D'amico, A.J., et al. 2001. Terrestrial ecoregions of the world: A new Map life on Earth. BioScience 51(11), 933–938

Plumptre, A.J. S. Ayebare, D. Segan, J. Watson and D.Kujirakwinja(2016). *Conservation Action Plan for the Albertine Rift*. /www.researchgate.net/publication/322722311

Plumptre, A. J., Davenport, T. R., Behangana, M., Kityo, R., Eilu, G., Ssegawa, P., and Peterhans, J. K. (2007). The biodiversity of the Albertine Rift. Biological conservation, 134(2), 178 194.

Prinsloo, S., Mulondo, P., Mugiru, G. and Plumptre, A.J. (2012). Measuring responses of wildlife to oil exploration operations in Murchison Falls National Park. Report of USAID WILD Program

Prinsloo, S., Mulondo, P., Mugiru, G., and Plumptre, A. J. (2011). Measuring responses of wildlife to oil operations in Murchison Falls National Park. Wildlife Conservation Society and Uganda Wildlife Authority.

Rabanal, L. I., Kuehl, H. S., Mundry, R., Robbins, M. M., & Boesch, C. (2010). Oil prospecting and its impact on large rainforest mammals in Loango National Park, Gabon. Biological Conservation, 143, 1017– 1024. https://doi.org/10.1016/j.biocon.2010.01.017

Salerno Jonathan, Jacob Mwalyoyo, Tim Caro, Emily Fitzherbert, and Monique Borgerhoff Mulder (2017): The Consequences of Internal Migration in Sub-Saharan Africa: A Case Study

Sanei A. and Zakaria M. 2011. Distribution pattern of the Persian leopard (Panthera pardus saxicolor) in Iran.

Sawyer, H., Kauffman, M. J., and Nielson, R. M. (2009). Influence of well pad activity on winter habitat selection patterns of mule deer. The Journal of Wildlife Management, 73(7), 1052 1061.