



EFFECTS OF OIL AND GAS EXPLORATION IN MURCHISON FALLS NATIONAL PARK ON WILDLIFE RESOURCES

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ABSTRACT: *This study investigates the impacts of oil and gas exploration on wildlife in the Albertine Rift biodiversity hotspots within Murchison falls National Park. We surveyed wild animals based on sightings along four well pad sites, which were selected for the study. The key variables include excavation activities, road construction, vehicle movements, land cover changes and spatial distribution of wild animals in the park during and after restoration. The number and species of wildlife sighted were recorded for each well pad site, and location coordinates marked using hand held GPS receiver. Data analysis describe frequency distribution of animal sightings and also compare mean population differences between sites, using SPSS version 16.0 for windows. The results show that oil and gas exploration caused land cover change, which in turn influenced the distribution of wild animals. Population mean of wild animals in the oil exploration sites was significantly lower than undisturbed sites within the National Park. Since oil and gas exploration is at the initial stages and will continue for some more years, a comprehensive understanding of likely ecological and environmental consequences might provide new insights and guide monitoring planning.*

KEYWORDS: Oil Exploration, Wildlife, Conservation, Habitat Change, Uganda

INTRODUCTION

The oil and gas exploration in Uganda have reached the production phase and is operational in an ecologically sensitive and biodiversity hotspot areas within the Albertine Rift, including Murchison Falls National Park (MFNP). The survey of Wildlife Conservation Society (WCS), shows that MFPA is rich in species and biodiversity. The conservation area is relatively biodiverse in the entire Albertine Rift region. While species richness and diversity are high, the number of species that are restricted range (Albertine Rift endemic) or globally threatened on the IUCN global red list are not so many and mostly restricted to the mammals, birds and plants. It is potentially possible that the amphibian species that are currently being identified using genetic material may prove to be species of conservation concern or even new species. Of the species they found for MFPA there are two endangered and four vulnerable mammal species; four Endangered and seven vulnerable bird species; two amphibians are Data Deficient, and eight Vulnerable and seven Albertine Rift endemic plant species.



The park is of high biological diversity value and a tourist hotspot in Uganda. The tourism sector's contribution to the economy in 2013 5.6 trillion (7.9 percent of DP) in 2013 and rose to 6.4 trillion shs (9.9 percent of GDP) in 2014 according to daily monitor report, P. Tajuba, 2015. Additionally, the sector contributed 592,500 jobs up from 551,100 in 2013. Maintaining the Conservation & Tourism Value of Protected Areas in Petroleum Development Zones of the Albertine Rift The exploration activities are likely to pose great environmental and socio-economic risks or negative primary and secondary impacts on ecosystems, biodiversity, as well as the quality of air, water and soil. The ecological risks are mainly associated with biodiversity loss as well as reduction in ecosystem services.

The northern section of the park contains savanna and borassus palms, acacia trees and riverine woodland. The south is dominated by woodland and forest patches. First gazetted as a game reserve in 1926, it is Uganda's largest and oldest biodiversity conservation area, inhabited by 144 species of mammals, 451 birds, 51 reptile species, 28 known amphibians' species and 755 plant species according to Plumptre et al (2015).

With the exception of Rhinoceros species, the park supports four of the Big Five. Evidently large herds of buffalos and elephants are particularly common features for those touring the park. There is a very healthy population of lions that often prey on the abundant Uganda kobs, and well camouflaged leopards. Other antelope found in the park are oribi, Jackson's hartebeest, grey duiker and bushbuck. Hyena is present but rare, and zebra is absent. It is also known for its giraffe population. Other species include waterbucks and warthogs, as well as resident crocodiles and hippos. Besides, there are migratory bird species which visit the park during the year; they usually nest in the riverine.

Oil was first discovered in western Uganda in the 1870s, but commercially viable oil was only confirmed in 2006 (Rwakakamba and Lukwago 2013). To intensify the situation, extensive amounts of oil and gas have been discovered in the same areas such as the Albertine Rift region, which is one of the most biologically diversified regions in Africa, is also endowed with oil and gas deposits. There are an estimated 2.5 billion barrels within the Ugandan Albertine Graben, which could generate more than \$2 billion in annual revenue, or 10-15% of Gross Domestic Product (GDP), for more than 20 years (Shepherd 2013). This has raised concerns about the impacts of industrial activities and the associated land cover change on wildlife. The effects of industrial activities on wildlife include individual interruption, habitat disturbance or enhancement, habitat avoidance, direct and indirect mortality and population impacts. However, the effect of a particular impact varies from species to species (Jalkotzy et al. 1997). By 2035, with fossil fuels likely to remain the largest source of energy (U.S Energy Information Administration, 2010). The increased global demand for energy has amplified the risks to biodiversity conservation from oil and gas exploration, development and production projects in different parts of the world. Four oil well construction sites were monitored in Murchison Falls National Park by WCS, using a system of transects that radiated away from the well pads and with the potential of widespread oil and gas exploration activities in the Albertine rift region, there is a need to manage the oil and gas industry across the region. Recognizing the high levels of biodiversity richness in MFNP, it is important to assess the potential impacts of oil and gas exploration on the wildlife in the park based on the various phases and to attempt to suggest ways of minimizing any disturbances caused by these activities.

MATERIALS AND METHODS

Study Area

Murchison Falls National Park (MFNP) was established in 1952. It is one of Uganda's first national parks. The park lies in the northern end of the Albertine rift that includes part of the valley floor and part of the eastern escarpment (2° 15' 0" N, 31° 48' 0" E). MFNP is the largest national park in Uganda that covers 3,893 km² in area with a high diversity of flora and fauna. Vegetation of MFNP comprises savannah grasslands, tropical woodlands, tropical deciduous forest, tropical evergreen forest and permanent swamps (Olupot et al. 2010). The climate is hot and humid, with relative humidity averaging 60%, while the temperature ranges from a mean minimum of 22 °C to a mean maximum of 29 °C. The study sites selected for data collection were located in the western part of the park with the predominate vegetation being the savannah grassland.

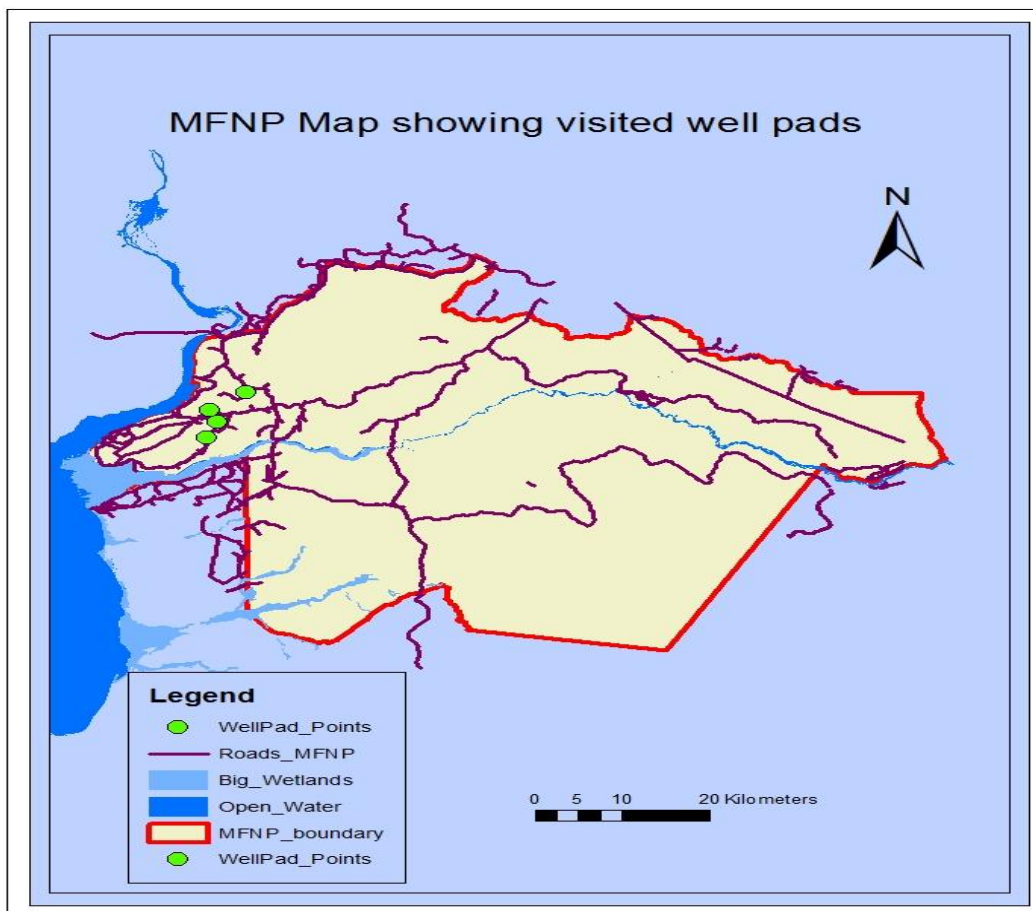


Figure 1: The Map of Murchison Falls National Park showing well pads



Research Design

For this study the researcher used survey design to collect both qualitative and quantitative data with mixed methods. The two data sets complemented each other to enrich our understanding of the multiple challenges associated with oil and gas exploration in conservation area. Direct observation of phenomena under investigation and interviews with selected respondents were the two methods relied upon during data collection. A survey was conducted at various pad sites in the park on the impacts of oil and gas exploration on wildlife and their natural habitat. The data collected from interview questions administered to Uganda Wildlife Authority (UWA) Staffs like wardens and rangers at the park, Wildlife Conservation Society (WCS) staff conducting longitudinal studies on the sites, as well as the key staff of Murchison Falls National Park (MFNP). Participant's observations adequately complemented the research data collection process.

Sample Population

The target respondent population was drawn from the chief park Warden, warden for oil and gas, warden for research and monitoring at well pad sites in MFNP. The list also included workers involved in oil exploration activities with knowledge about the park before and during oil exploration activities. Further information was obtained from two oil companies involved in the exploration and UWA administrators. The main variables included the sightings of wildlife species, wildlife habitat characteristics and animal distribution between undisturbed and disturbed areas.

Data Collection

Data were collected from primary and secondary sources. Primary data was obtained through direct observation at four different sites, which were approximately 4 km apart. We observed and recorded number of vehicles accessing the well pad sites and the type of animals and their distribution. An interview guide with both closed ended and open-ended questions was used in a face-to-face interaction with key informants. Key variables like land cover change, animal species sightings, sighting frequency and numbers per sighting, as well as animal distribution between well pad sites and undisturbed habitats. Secondary data on similar variables was acquired from the existing environmental reports regarding oil and gas exploration at MFNP and publications.

Data Analysis

Data were cleaned, sorted and entered into Excel sheet before exporting to SPSS version 21 for statistical analysis. Descriptive analysis focused on mean frequencies and standard deviation, whereas Pearson correlation tests measured association of wild animals with each of the four sites. The sites are fully characterized on the basis of disturbed versus intact habitat for better interpretation and understanding of the effects of oil exploration on wildlife within MFNP.

RESULTS

The results obtained in this study describe demographic characteristics of the study respondents, and major findings on land cover changes associated with oil and gas exploration. The latter is presented together with the effects of oil and gas exploration on wild animals' distribution and abundance in well pad sites.

Socio-Demographic Characteristics of Respondents

The results obtained for demographic characteristics describe the respondents according to Gender, Age, and Education level. Fig. 1 below summarizes the age and sex of respondents who were residing around the wildlife habitats of Murchison Falls National Park as at the time of this study. Overall, the youth who participated in this study were only 35% compared to 65% mature adults. Of these, 35% (49/140) were females and 65% (91/140) males. However, majority of female respondents, 61.2% (30/49), were aged 35 years and below compared to their male counterparts who had only 35.2% (32/91) aged 35 years and below.

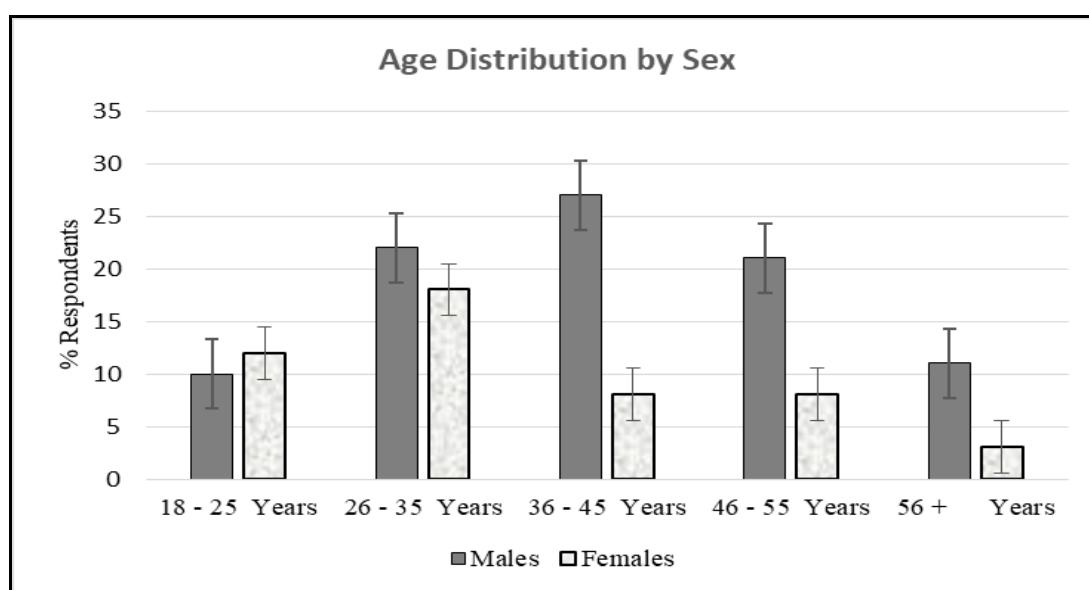


Figure 2: Demographic Characteristics of the Respondents who took part in the Study

From Table 1 below only 9.3% (13/49) of the respondents had obtained academic degrees. Among the graduate respondents about 53.8% (7/13) were females and only 46.2% (6/13) were males. Compared to their male counterparts, 44.9 (22/49) females had attained tertiary level of education, while only 38.5% (35/91) males achieved tertiary level of education. Overall, the study respondents had fairly good levels of education, which enabled them to understand our study objectives and participate generously by providing the necessary information.

**Table 1: The Education Level of Respondents**

Education level	Gender				
	No	Males	%	Females	%
Degree	13	6	6.6	7	14.3
Diploma	44	29	31.9	15	30.6
Certificate	83	56	61.5	27	55.1
Total	140	91	100	49	100

The research findings showed that the highest percentage of certificate holders showed that they well know the impacts of oil and gas exploration on wildlife habitats in Murchison Falls National Park with a various number of people who are a little bit educated and the researcher recommended that such people should go for further education.

Effects of Oil and Gas Exploration on Flora and Fauna of MFNP

Reported experience and perceptions of respondents indicate that human activities at the oil well pad sites affected the distribution of animals. In Table 2 below, all respondents concurred that oil and gas exploration in Murchison Falls National Park resulted in animals' population decline at the selected sites. Indeed, 57.1% respondents were emphatic that rehabilitation of the affected areas has not borne any fruits as far as animal behavior towards the affected areas was concerned. However, 35.8% respondents were rather optimistic that rehabilitation of the well pad sites has attracted some more animals, raising the numbers of different animal species higher above what was experienced during oil exploration activities.

Table 2: Animal Encounter Rates after Rehabilitation of well pad sites

Responses	Frequency	Percentage (%)
Visibly decreased during and after oil exploration	80	57.1
Slightly increased after rehabilitation	50	35.8
Same as during drilling activities	10	7.1
Total	140	100

Although this study does not report animal population data before the commencement of oil and gas exploration activities, the animal data collected after the rehabilitation of the sites reveal low population densities below what was expected, especially for relatively abundant animal species in MFNP like Uganda cobs and elephants. Table 3 shows that mean population of Uganda cobs was the highest, with Jackson heartbeest having the least population mean.

**Table 3: Mean Population of Animal Species Sighted at the Affected Areas**

Animal spp.	n	Minimum	Maximum	Mean \pm SD	P-value
Uganda kob – <i>Kobus kob</i>	12	1	25	11.8 \pm 6.1	0.291
Elephants – <i>Loxodonta africana</i>	12	0	13	6.5 \pm 4.1	0.024
Giraffes – <i>Giraffidae giraffa</i>	12	0	30	6.5 \pm 8.6	0.016
Buffaloes- <i>Syncerus cafer</i>	12	0	21	6.1 \pm 7.2	0.001
Oribi – <i>Ourebia ourebi</i>	12	0	11	4.7 \pm 4.1	0.024
Hartebeest- <i>Alcelaphus bucelaphus</i>	12	0	7	1.4 \pm 2.2	0.742

The low animal population mean after the rehabilitation was perceived as resulting from various factors. Loss of original vegetation cover and altered growth patterns of re-planted vegetation were listed as the major components of a disturbed wildlife habitat. Table 4 provides multiple responses by the respondents, which shows that more than 78% of all respondents perceived loss of original vegetation cover as the main cause for animal migration and slow return to the affected sites. Over 56% of the respondents see this migration as a normal behavioral response to disturbances caused in animals' habitats by oil exploration activities. A few incidences of animals' death were also reported by less than 8% respondents as resulting from disruptions caused by oil and gas exploration in Murchison Falls National Park.

Table 4: Respondents' Perceived Effects of Oil Exploration Activities on Wildlife Habitat

<i>Effects</i>	<i>Respondents</i>	<i>Percentage (%)</i>
Loss of vegetative cover	31/140	22.1
Disturbed vegetation growth patterns	110/140	78.6
Change of vegetation types	20/140	14.3
Created patches of bare ground	20/140	14.3
Animals' migration to other locations	79/140	56.4
Loss of animal's life	11/140	07.9

Awareness of Biodiversity Conservation Regulatory Framework

The study respondents demonstrated a good level of knowledge regarding existing oil and gas exploration standard measures to safeguard the integrity of the environment during exploration.

**Table 5. Respondents' Knowledge on Regulations and Measures to Conserve Biodiversity**

Variables	Frequency	%
Respondents' Knowledge		
Oil and gas drilling Regulations	40	28.6
Endangered Species Decree	20	14.3
Adopt all practicable precautions, including the provision of up-to-date equipment, to prevent pollution	30	21.4
Maintain all installations in good repair and condition in order to prevent the escape or avoidable waste of oil	50	35.7
Respondents' Suggestions		
Adequate control measures needed to safeguard animals	35	25
Use modern exploration methods to reduce impacts	50	35.7
Maintain low traffic on roads to reduce noise and dust pollution	15	10.7
Temporarily relocate natives residing near exploration sites	40	28.6

DISCUSSION

Oil and gas exploration at Murchison Falls National Park has in recent years been driving a range of land cover and land use changes, influx of people and development of roads. The changes caused by these activities in selected well pad areas have affected animals which are residents in Murchison Falls National Park (MFNP) beyond the exploration sites boundaries. The fact that animals migrated from the affected sites suggest that there could be some parts within the park which are experiencing high animal density. Such sudden changes are likely to cause long term impacts on flora and fauna populations in MFNP in general. Among factors that negatively affected the wild animal species around the oil well pad sites were noise pollution. Noise pollution was pointed out by the respondents as causing animals to avoid areas where drilling was occurring and potentially changed animal behavior due to noise interference with vocalization and hearing (including mating and alarm responses). Previous studies have shown that several mammal species tend to avoid areas affected by human activities up to 2 km away from *active* drill pads in Murchison Falls Conservation Area (Plumptre et al., 2015; Prinsloo et al., 2011),

Light pollution at the well pad sites potentially interfered with visual stimuli, leading to confusion and unfavorable conditions for grazing/browsing activities (Schroer and Hölker, 2016). This confusion might have increased the likelihood of mortality for some herbivore species which may have been disoriented only to be preyed on by the predators. On avoidance behavior exhibited by animals during exploration activities, a study by Holker et al (2010) has shown that light which spills over wild animals' routine grazing and play grounds often affect animal behavior. Thus, the avoidance behavior of animals was one of the survival mechanisms. Such animal reaction to light should be expected since most mammals are nocturnal (Gerkema et al, 2013).



Increase of motor vehicles in a protected area also increased the likelihood of feeder-road kills. In addition, linear developments such as roads and pipeline rights-of-way can affect wildlife by creating travel corridors for predators such as wolves. The potential of oil exploration and associated activities to block animal movements is not a recent discovery. A pioneer study by Child (1973) reported this as one of the environmental effects of oil exploration which has received a widespread attention in the developed world.

The observations made during the study showed that the vegetation replanted at the various sites were not the original types and the landscape layout was not the same. Though the animals are gradually returning to the rehabilitated sites, their distribution was apparently affected, and change in vegetation types is a major factor. Comparison between high spatial resolution imagery acquired in 1968 and 2011 indicates that 10.8% of the area showed a decrease in vegetation cover due to oil and gas development and associated logging activities (Mugiru and Plumptre, 2011). For instance, Mugiru and Plumptre (2011) explained that water logging points along linear structures and vehicle tracks were evident near the oil and gas well pad site.

CONCLUSION

Oil and gas exploration in Uganda have impacted, degraded and altered the original vegetation cover, and plant community growth patterns in the affected sites. These changes in the land-cover have important implications for wild species of animals in terms of animal feeding habits, breeding and playing grounds. The harmful effects of oil exploration on the environment are many, including dust, light and noise pollution, loss of habitats in well pad sites and in areas where roads have been constructed, as well as the risk of animal getting run over by a moving vehicle. Observed animals' reactions included avoidance, migration and a few cases of death. Indeed, our findings showed that limited number of animals were sighted near well pad sites and only on very rare occasions, suggesting that oil and gas exploration created unsuitable conditions in their natural habitat. Factors affecting such important animal activities could have far reaching impacts on the population distribution of animals in Murchison Falls National Park (MFNP). Already on a global scale some of the big five found in this study area are listed as endangered species, including elephants and the lions. Human induced environmental conditions which might further expose the remaining portion of world's elephants and lions should be discouraged where possible and appropriate measures taken to reverse the situation. The practice should be extended to benefit other species of flora and fauna found in MFNP like Uganda kobs, Jackson heartbeest and buffaloes. As oil and gas development is expected to continue, a more comprehensive understanding of the ecological and environmental consequences is crucial to the sustainability of fragile Albertine Rift biodiversity hotspot areas within the MFNP ecosystems.

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Conflict of Interest

The authors declare that they do not have any conflict of interest

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