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Assessment of the Effects of Uranium Exploration on Wildlife, Vegetation and Tourism in Tanzania

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ABSTRACT

Mineral resources are potential for economic development of any endowed country. However, mining is generally associated with serious negative impacts on existing ecosystems where operations are carried out. The objective of the study was to assess the effects of uranium exploration on wildlife population, vegetation, and tourists' visitation in Selous ecosystem in Tanzania. Data collection took place in different periods from 2016 to 2017 through household questionnaire surveys, key informant interviews, focus group discussions, direct observations, nested plots, and secondary data reviews. Quantitative data were analyzed using descriptive statistics in SPSS version 20 software. Qualitative data were analyzed using content analysis through systematic coding and theme identification. Findings show that poaching was a leading illegal activity (55%) in the area. Further effects reported and observed were habitat fragmentation, introduction of alien species, and noise pollution. About 478.57 trees (with dbh greater than 5 cm) per ha were removed to expand the main road to the mining site. However, the number of tourist visitation in the area was almost constant. This study recommends that the government, through its ministries, should address the weakness identified and put measures in place that will reduce adverse impacts during mining process.

Keywords: sensitive ecosystem - habitat fragmentation - environment – wildlife regulations - uranium exploration - Selous Game Reserve.

INTRODUCTION

Mineral resources play a significant role in many countries' economy throughout the world (Ten Kate and Wilde-Ramsing 2011). Although, most mining operations take small portion of land compared to other land uses such as industrial agriculture, wildlife conservation and forestry, their effects, if not well managed, have been so disastrous to the existing ecosystems (Kitila 2006, Makweba and Ndonde 1996, Noronha 2001). The negative impacts include; soil pollution, poor waste management, environmental destruction, noise visually unpleasant landscapes among others (Willis and Garrod 1999, Awudi 2002). In most cases environment around the mining operations is more affected than areas away from the mining site. In Tanzania, the extraction of different kinds of minerals for decades has been associated with large scale environmental pollution, land degradation and vegetation clearance (Kitula 2006, Gunson *et al.* 2006). According to Human Rights Watch (2014), mining activities tends to worsen environmental and social issues in mining communities (e.g., intense land destruction, off-site effects on community relocation, and health and safety issues). According to Awudi (2002) the extractive industries are primarily responsible for deforestation, waste management, land degradation and the release of chemicals in water streams and rivers, and diminishes water quality.

In Tanzania, mining activities have been undertaken following the established rules and regulations (URT 2009, URT 2019). According to URT (2019) mining activities is allowed to be undertaken in all areas in the country (in, and under or upon any land, rivers, streams, water courses throughout Tanzania, area covered by territorial sea, continental shelf or the exclusive economic zone). However, for a long time, mining operations in wildlife protected areas in Tanzania have been avoided due to dangers that might affect wildlife and their habitat in general. Nevertheless, the Wildlife Conservation Act No. 5 of 2009 allows mining in protected areas only if a proper environmental impact assessment (EIA) has been conducted and the mining company has shown clearly how environmental risks and other dangers would be taken care of (URT 2009). Based on this Act, the Government of Tanzania approved uranium mining in Selous Game Reserve (SGR), which is one of the World Heritage Sites after UNESCO World Heritage Committee approved a "minor boundary change", to exclude 200 km^2 (0.8%) of the protected land in 2012. Subsequently, the government formulated national regulations on uranium exploration, mining, milling and associated waste management to make sure that uranium mining activities will not lead to high levels of environmental pollution as well as public exposure to radioactivity (URT 2010, URT 2011).

Since then, there have been some studies conducted to follow up on how the project is adhering to the enacted laws and regulations especially on the area of environmental management and safety of the surrounding communities (Kideghesho and Abdallah 2010, Banzi *et al.* 2015, Banzi *et al*. 2016). For instance, Kideghesho and Abdallah (2010) assessed potential impacts of uranium mining and upgrading of the wildlife corridor road in the Selous-Niassa; Banzi *et al.* (2015) focused on distribution of heavy metals in soils in the vicinity of the Mkuju River Uranium Project, while Banzi *et al*. (2016) studied natural radioactivity in soil and its contribution to population exposure in the vicinity of Mkuju River Uranium Project. However, limited cross-sectional studies have been conducted to examine the environmental impacts of mining operations in the country. Uranium mining in protected areas is new to Tanzania; therefore, there is limited information on this subject. The objective of the study was to examine the effects associated with the uranium exploration activities in Selous Ecosystem on wildlife population, vegetation, and tourism. We argue that uranium exploration activities in the reserve lead to habitat destruction and fragmentation which in turn affects wildlife and tourism activities. These findings serve as a vital source of baseline information for policy and decision makers to minimize adverse impacts in the area during uranium mining phase.

MATERIALS AND METHODS

The study area

The uranium exploration activities took place at different areas in Selous Ecosystem; However, major deposits were found at Mkuju River. The Mkuju River Uranium Project (MRP) is located in SEKA Zone, which was one of eight administrative zones in SGR (now part of Nyerere National Park) situated in the South-eastern Tanzania in Namtumbo District, in Ruvuma Region between latitudes 9° 59' 50" to 10° 07' 15" S and longitudes 36°30' 00"to 36° 37' 55"E (Figure 1). The MRP area covers about 200 km^2 which is 0.8% of the total area of the former SGR (54,600 km^2). The vegetation is dominated by deciduous miombo woodlands. According to the Mantra Resources Limited (2010), the area hosts a viable uranium deposit of sandstone type of about 25,200 tU, with an estimated production of 1,600 tU in a year at its maximum capacity over a minimum of 12 years.

Uranium exploration activities began in the Mkuju River escarpment in 2005 and the permitting process was registered on 2009, where approval of the operations was done in 2015. Four companies were engaged to undertake uranium exploration in various locations in the Selous Ecosystem. These companies were Western Metal Ltd, the Uranix (T) Ltd, the Resource Frontiers Ltd and the Mantra Resources Ltd. The Uranium One (Canadian mining company) and its shareholder, JSC Atom redmetzoloto acquired the Mantra Resources (Mantra) for $1.16bn and became the operator of Mkuju River Project.

Figure 1: The map showing the location of the Mkuju River Uranium Project

The EIA certificate was issued in October 2012 and a special mining license was awarded on April 5, 2013 which was expected to end after 15 years in 2028. An official contract between the government and the Mantra Tanzania Limited (operating as a subsidiary of Uranium One) was signed on the 22 October 2015 (The Citizen 2020). The study sites included SEKA Zone in SGR, Mbarang'andu Wildlife Management Area (WMA), and two adjacent villages i.e., Mchomoro and Likuyu Sekamaganga

Data collection

Data collection was conducted in different periods between 2016 and 2017 and it entailed two approaches namely: vegetation sampling and social-economic surveys. The former was applied along the newly constructed roads and other developments associated with the mining activities; while the later was applied to the communities from the nearby villages of Mchomoro and Likuyu Sekamaganga. The surveys were performed in form of focus group discussions, interviews with key informants, as well as conducting formal and informal discussions with different individuals such as Mantra Tanzania Ltd., district staff, political leaders, Mbarang'andu WMA leaders, village leaders and other individuals who have stayed in the area for a long time.

a) Vegetation sampling

The vegetation along the two sides of the main road was sampled to represent the cleared vegetation. The sampling plots were placed as close as possible to the affected section of the road to ensure that the sampled vegetation is the true representative of the cleared flora. Fourteen nested plots measuring 20 m x 20 m, 5 m x 5 m, and 1 m x 1 m and which were positioned within 20 m away from the road boundary to avoid edge effect associated with trampling and soil erosion during road construction were used to record vegetation data as follows: Tree with dbh greater than 5 cm were sampled in 20 m x 20 m plots, saplings were regarded as trees with dbh less than 5 cm and these were sampled in 5 m x 5 m plots, and within 1 m x 1 m plots, the ground cover due to grasses, seedlings and herbs was estimated. In judging ground cover, the percentage of the soil surface covered by grasses, herbs and seedlings was estimated visually (Mueller-Dombois and Ellenberg 1974). The attributes measured were tree circumferences at breast height using measuring tape then converted into diameters, and tree heights which were estimated visually. To estimate heights of taller trees, a mark was placed at a three-meter position on the tree and then the entire height was obtained by counting the multiples of this mark on the tree. The sampled area was equivalent to 5% of the cleared area. During construction of a 22 km main road, about 2.5 m in each side of the existing road was cleared. This is equivalent to 110, 000 m^2 i.e., 11 hectares.

b) Socio-economic data

A total of 106 questionnaires were administered to household heads in two villages namely Mchomoro (55) and Likuyu Sekamaganga (51). A household in this sense is defined as one person living on his/her own or those living together, sharing eating arrangements and working and contributing to the household income. The household head is the individual or person who takes responsibility of the entire household collective matters on behalf of the other members, including himself or herself, and can be a male or female. The information collected included effects of the uranium exploration activities on wildlife, vegetation, wildlife habitat and tourism e.g., illegal activities and habitat destruction, among others.

Four focus group discussions with 8-10 people (two groups from each village) and interviews with key informants were conducted. Formal and informal discussions with different individuals such as Mantra Tanzania Ltd., district staff, political leaders, Mbarang'andu WMA leaders, village leaders and other individuals who have stayed in the area for a long time were also conducted. Data collected included the illegal activities in the reserve, waste disposal, storage of soil samples, vehicle entry in the reserve, and effect of uranium exploration on vegetation and tourism. A number of secondary literatures such as published and unpublished studies, reports, and other relevant materials were also reviewed.

Data analysis

a) Vegetation data

The number of trees and saplings recorded in each plot were converted into stems per hectare by dividing the total number of stems by the size of the plot and then the resulting figure was multiplied by the number of hectares cleared due to road construction to obtain the total number of trees and saplings per study area (the cleared area which has been estimated to cover 110, 000 m^2 i.e., 11 hectares). These figures were equated to represent the trees that were removed. The conversion of ground cover to obtain the total area of the grasses, herbs and seedling cleared followed the same procedure by equating the 1 m x 1 m subplots into hectare.

The volume for trees with dbh greater than 5 cm was calculated by multiplying tree basal area (g), height (h), and a form factor (f) of 0.5 for natural forests (Sawe *et al.* 2014). A total of 52 bigger trees with dbh > 20 cm that were measured from the 20 m x 20 m plots were selected to calculate the stand volume of trees that have reached commercial harvest size. Only trees with dbh > 20 cm were considered in calculating the stand volume of the trees since bigger trees with dbh above that size are the ones that are mainly targeted for logging. The basal area (g) was calculated from diameter at breast height (dbh) by the following metric formula:

$$g = (\pi/4*10000)*dbh^2$$

Where:

G = basal area per tree in square meters
dbh = the diameter at breast height in cm
π = the constant equal to 3.14.

b) Socio-economic data

Content analysis technique was used to analyse qualitative data collected through discussions, observations and interviews. The field notes were structured to suit the objectives of the research in order to enhance easy analysis. The quantitative data through questionnaires were coded and analysed through the Statistical Package for Social Science (SPSS). For the purpose of this study, descriptive statistics was used.

RESULTS AND DISCUSSION

Effects *of uranium exploration on wildlife resources*

i) Poaching and other illegal activities

Poaching was mentioned as the leading illegal activity (55%) followed by tree cutting (23%). Other illegal activities mentioned include charcoal burning (10%), encroachment (expansion of farming areas towards the protected area) (6%), lumbering (4%), and firewood collection (2%). The findings from key informants show that the trend of illegal activities in the reserve is increasing. The results from questionnaire survey showed that causal labourers working in the mine (60%), villagers and outsiders (40%) were involved with the illegal activities area. The main factors leading to the increasing of illegal activities was the population increase (39.9%) and the road that has increased accessibility to inner parts of the reserve (30%) (Table 1). Similar observation was made by the Uranium Project Chief who said *"...The poachers took advantage when we built a road to the deposit*" (The Moscow Times 2012).

Table 1: Factors leading to illegal activities

Factors leading to illegal activities	Frequency	%
Road that makes an area easily accessible	16	30.2
Population increases in the area	21	39.62
Unemployment (lack of reliable source of income)	6	11.32
Quick and easy income from illegal activities	10	18.86
Total	**53**	**100.0**

Roads that run through protected areas may encourage or facilitate poaching for personal consumption but also for selling to third parties. Various interviews with game rangers revealed that many wild animals' carcases were found nearby the research sites than other areas (Plate 1 below) and the main cause of mortality was poaching. This might be due to the fact that the game rangers were able to visit these sites more often due to roads (accessibility) thus it was possible to locate the carcasses. Another possible reason might be that human population increase in and near the Reserve gave the opportunity to people to give information to poachers where to locate elephants.

These findings are supported by those of Perinchery (2018) who found out that human population and roads reduced effectiveness of protected areas, and the deforestation was 88% lower for protected forests farther from roads. However, the poaching statistics from SEKA Zone show that in 2015/2016 there was only one elephant carcass observed by rangers in the mining area (Table 2). However, during the rainy season in 2016, nine elephant tusks were caught at SEKA Zone. This shows that there were several incidences of elephant poaching in the year, but carcasses were not found by Game Rangers. But, decrease in number of elephants killed, partly might be associated with inability to find the carcasses, and the effect of increased anti-poaching measures in the reserve since 2015. With regard to court cases on poaching, SGR representative stressed that *"...poaching cases are very hard to deal with as a person can be caught and taken to court but you will not know how the case ended; within a short time, the same person will be caught poaching somewhere else"* (Interview no. 1, July 2017).

Table 2: Elephants poaching incidences at SEKA zone

Year	Elephant poaching (carcasses)
2010/2011	Data not available
2011/2012	7
2012/2013	12
2013/2014	28
2014/2015	22
2015/2016	1
2016/2017	Data not available

Table 3: Other poaching activities (SEKA zone)

Year	Fishing (without permit)	Poaching for meat
2011	Data not available	2
2012	2	Data not available
2013	Data not available	Data not available
2014	6	5
2015	25	Data not available
2016	19	19
2017	17	6

The Government statistics shows number of elephants in Tanzania dropped from 109,051 in 2009 to 43,330 in 2014. Since 2009, at least 45 tonnes have reached the international black market from Tanzania, making it Africa's largest source of poached ivory (Mathiesen 2015). In the Selous Reserve, which has previously been identified as poaching hotspot, the elephant numbers dropped from 45,000 to around 15,000 (Mathiesen 2015).

A report of the Elephant Trade Information System (2013) shows that there was a steady annual increase of seized ivory in Tanzania from 264 kg (1%) in 2008 to 8,254.8kg (47%) in 2013.

Table 4: Six-year summary of ivory seized in Tanzania

Year	Kilogram	Percentage
2008	264.0	1
2009	1,623.0	9
2010	2,036.0	11
2011	2,757.0	16
2012	2,809.0	16
2013	8,254.8	47

Source: Elephant Trade Information System report, 2013.

Table 5: A five-year data of elephant mortality per game reserve

Poaching	2009	2010	2011	2012	Total
Selous GR	47	106	141	140	434
Ugala GR	40	48	19	3	110
Rungwa GR	15	14	32	40	101
Rukwa/Lukwati GR	-	12	2	22	36
Moyowozi-Kigosi GR	1	18	18	4	40
Total	**102**	**198**	**212**	**209**	**721**

Source: MNRT-Elephant Mortality report, 2012

A total of 721 elephants were reportedly killed by poachers in five game reserves from 2009 to 2012. In SGR, Jackman (2014) reported that between 2009 and 2013 poaching was a serious problem whereby about 25,000 elephants (66% of the reserve's population) were killed. However, due to inaccessibility to most areas, the total figure of killed elephants is estimated to exceed the figures presented above. Nonetheless, Selous Reserve had the highest number of mortalities mainly due to poaching.

ii) Noise and destruction of wildlife habitats

The findings from interviews show that the noises from drilling machines, people, and cars disrupted wild animals. The researchers observed very few, small body size wild animals in areas where exploration activities were taking place compared to areas away from the site during the day. Signs (such as hooves, dung) of big body size animals e.g., elephants, buffalo, zebra and eland were vivid in the area. The night camera traps placed by the mining Company on trees at different parts of the exploration site captured wild animals such as elephants, lions, hyena, and leopards. This situation can be linked to low level disturbance during the night time (c.f. Mancera *et al.* 2017). These findings concur with Berger-Tal *et al.* (2019) that noise pollution can increase stress levels of animals, affect their ability to find mates and/or avoid predators, and hinder inter- and intraspecific communication among individuals. The animals sighted at the exploration site during the day are shown in Table 6.

Table 6: Animal observed during the day

	Name	Number
Direct observation		
1.	Dik-dik	56
2.	Monkeys	8
3.	Monitor lizard	1
4.	Squirrel	1
Indirect Observation (hooves/ dung)		
5.	Elephants dung	One
6.	Lions' hooves	Many
7.	Zebra's hooves	Few
8.	Buffalo hooves	Many
9.	Eland hooves	Few

Records from SGR show that the number of cars entering the reserve has increased tremendously since 2010. The number of cars contribute to noise pollution that can affect wild animals' behaviour. Table 7 below represent the number of cars registered by the Selous' gate entering the Reserve (the Mantra Tanzania Ltd. and SGR cars are not included in the statistics below because of high frequency of entering the reserve for work related purpose).

Table 7: Number of vehicles entering SGR through Seka Gate

Year	Number of vehicles
2010	9
2011	28
2012	41
2013	38
2014	50
2015	67
2016	39
2017	45

iii) Effect of stored soil samples on wildlife

There were soil samples packed in plastic bags stored in the research sites (Plate 2), holding uranium exploration samples conducted for more than 8 years. Also, there were several holes drilled and in each hole a plastic pipe was inserted. The plastic bags and pipes take many years to degrade. Given the wildlife presence in the area, it is estimated that a single bag can kill more than one animal as plastics take between 20-1000 years to break down in most environments.

Plate 1: Soil samples awaiting disposal

Plate 2: Some skulls of dead elephants

Effects on vegetation and environment

Introduction of exotic species

Several exotic species were observed in the three exploration sites (i.e. Uranix, Western Metal and Mantra Resources) which were pepper, pumpkins, cucumber, water melons, amaranthus spp., pawpaw, oranges and castor oil plant (Plate 3 & 4). There were also nine exotic species planted as flowers in the mining camp.

According to CBD (2005) exotic species is the second worst threat to biodiversity. Although some exotic species seems to be beneficial e.g., increase in diversity of species in an ecosystem, removing toxins from the soil, regulating erosion, and controlling undesirable species, some species can be very detrimental when they outcompete the indigenous species leading to decline or extinction. For instance, before the 1970s, Lake Victoria contained 350 - 500+ cichlid species; introduction of Nile perch led to the extinction of 200 species of fish.

Vegetation clearing

The vegetation was cleared for various purposes such as trials for *in-situ* leach mining, accommodation, road construction (Plate 5-10). Although *in situ* leach mining is less destructive to the environment, it leads to the removal of vegetation and ground cover in the process of drilling wells. At the drilling site, the researchers observed tree cutting and clearing of ground cover for the trial of this technology.

Plate 3: Flower Garden

Plate 4: Flower Garden

(Exotic spp.) at Nyota Camp (Uranium One)


Plate 5: In-Situ Leaching test


Plate 6: Road at MKRP


Plate 7: Camping sites


Plate 8: Play ground


Plate 9: Open area


Plate 10: Workshop

Findings revealed that an area of about 400 m x 50 m (20,000 m^2) was cleared for an airstrip construction, but the proposed airstrip had a faulty. The Key Informant Interview (KII) revealed that the company requested for a new suitable area to construct an airstrip but the request was not approved. The Company was required to plant trees on cleared area before another permit can be granted for an airstrip construction. The finding further revealed that: i) it was not clear who were the actual beneficiary of the airstrip (either SGR or Uranium One); and ii) the airstrip was very close to the mining camp while the main aim for the airstrip was to facilitate anti-poaching activities in the reserve.

For about 10 years, the company expanded an existing road of 22 km road from Namtumbo through SGR to the mining camp from the width of about 3 m to 8 m. The Tanzania's protected area roads are normally 2-3m wide. The researchers wanted to quantify the vegetation cleared on the 22 km road in the protected area. The results show that an average of 628.57 saplings per ha were removed equivalent to 6914.28 saplings for the entire cleared area i.e., 11 ha. The number of trees with dbh greater than 5 cm removed per ha was 478.57 which was equivalent to 5264.28 trees removal in the entire cleared area. Figure 2 shows the distribution of trees by diameters classes for trees with dbh greater than 5 cm. The trend of distribution of trees along diameter classes showed an inverted J-shaped structure. On the other hand, about 40.57% of an area previously covered by herbs, grasses, and seedling equivalent to 4.46 ha of the 11 ha affected section of the road was found cleared.

The decrease in number of stems with increase in diameter class shown in Figure 2 is an indication that the removed trees were in a state of regenerating natural forest. Moreover, since the SGR is dominated by deciduous miombo woodlands, the number of stems per hectare found removed was in the range of tree stands per ha recorded by other studies conducted in other healthy miombo woodlands of Tanzania (e.g., Mwakalukwa *et al.* 2014, Lupala *et al.* 2015). The range of tree stands per ha reported in many miombo woodlands of Tanzania varies between from 495 to 1047 stems per ha (Lupala *et al.* 2015).

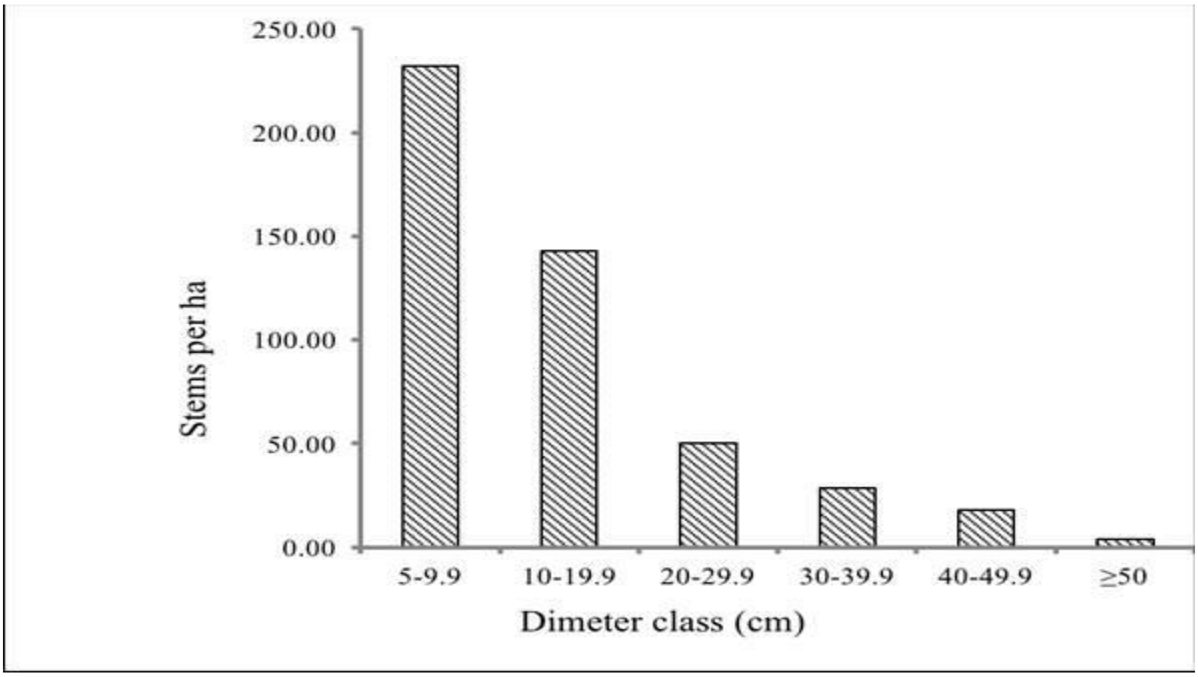

Figure 2: Distribution of stems per ha in each diameter classes for tree with dbh greater than 5 cm.

Generally, this study has revealed that the damage caused by the main road construction activities is of great concern as the section cleared was composed chiefly of the natural regenerating forest as revealed under Figure 2. On the other hand, following the fire-climax vegetation in the Selous, the soil of the reserve is usually subjected to erosion during heavy rains, therefore the 4.46 ha cover of herbs, grasses and seedlings, and the 6914.28 saplings as well as the 5264.28 trees cleared poses enormous implication in terms of ecology and hydrology of the reserve. Other forms of cleared areas were for playgrounds (football and basketball). One playground is located at rangers post and the second one at Nyota camping site. The area cleared for the play grounds was about 2,590 m^2. In addition, there was levelling of steep slopes especially in ridges before drilling, a process that led to clearing of trees. Estimation of cleared area to establish facilities such as sample yard, workshop, fuelling station, offices, and accommodation was about 2 km^2. Also, there were more than 532 drilling points of 4x5 m and 56 boreholes to monitor the quality of water. Similar studies on the impact of mining on vegetation and environment have been reported by Kuffour et *al.* (2020), Huang *et al.* (2015), Nzunda (2013) and Ako *et al.* (2014) among others. The researchers observed that the roads that were no longer in use after drilling process were closed but not planted with indigenous trees. The interview with the Company representative stated that they will plant indigenous trees as permanent rehabilitation during the mining process. According to the Mantra Tanzania Ltd. Environmental Officer, complete regeneration of the site will take not less than fifteen years.

The interviews and field observation revealed that after the exploration activities in the area, one of the four companies did not dispose its solid waste properly. Instead, the company dumped the waste in an area near to the village (Plate 11 &12).

Plate 11

Plate 11

Disposal of waste by the Western Metal company

Findings revealed that villagers from Mchomoro Village were afraid that uranium deposits in the waste could leak to water sources and affect their health. Mchomoro Village get their domestic water from the rivers and wells. Also, they were afraid that the dust might be carried by wind and affect their health. Studies (e.g., Makoni 2015, Tutu 2012) show that mining activities have potential of water pollution as well as causing mortality to wild animals and livestock. An interview with a representative from Mantra Tanzania Ltd. revealed that the Company has set precautionary measures to protect people from possible effects of uranium, also they usually clean the environment particularly in areas where visitors access.

Effects on Tourism

The tourist statistics from 2010-2015 for SEKA Zone show that the number of tourists was constant but dropped in 2015. For the WMA's hunting block (Game Frontiers of Tanzania – GFT), number of tourists was almost constant. This might be related to the type of tourism taking place in the areas i.e., hunting tourism, which was not largely affected by the exploration activities. Other forms of tourism such as nature-based tourism tends to be sensitive to environmental impacts of mining and other large-scale industrial activities. This type of tourism usually focuses on natural features such as landscapes, quality of nature and natural phenomena as key attractions unlike hunting tourism. A study by Ganlin (2008) show that nature-based tourists usually do not enjoy a trip with smoke and noise from mineral processing, or a landscape with miners.

Table 8: Number of hunting tourists

SGR SEKA Zone		WMA – GFT hunting block	
Year	**Number of hunting tourists**	**Year**	**Number of tourists**
2010	22	2010	Data not available
2011	23	2011	Data not available
2012	Data not available	2012	4
2013	24	2013	3
2014	25	2014	4
2015	16	2015	3
2016	Data not available	2016	3

The interviews showed that in the first five years of Mantra Tanzania Ltd operation in Selous, GFT had a tender of shuttling Mantra Tanzania Ltd visitors and workers from Dar es Salaam to the mining site through its three aircrafts three times a week

(Monday, Wednesday, and Thursday), an exercise that gave the company enormous amount of revenue.

Further findings showed that the GFT allowed Mantra Tanzania Ltd. to conduct uranium exploration in its hunting block during hunting off-season. GFT claimed that there was an overlap of minerals exploration activities with the hunting block that led to business loss. The Mantra Tanzania Ltd. used to pay $150,000 annually for compensation. However, the GFT was sued by Mantra Tanzania Ltd and court ordered the Company to compensate for money allegedly received through invalid agreement (James, 2021).

CONCLUSION AND RECOMMENDATIONS

This study explored uranium exploration effects on wildlife resources, vegetation and tourism. Effects on wildlife include wildlife poaching, habitat fragmentation, noise from drilling machines, people, and vehicles which disrupt wild animals' behaviour. The vegetation and environment were affected through tree cutting for roads construction, charcoal burning and other development in the area. Various exotic species such as pepper, pumpkins, cucumber, water melons, amaranthus spp., pawpaw, oranges and castor oil plant were introduced in the area. Less effects were observed on tourism, because hunting tourism does not need very beautiful land scape like other forms of tourism such as photographic tourism.

Based on the findings from the present study, we recommend further studies to monitor the uranium impacts in particular radioactivity pathways during the mining operations. It is very important so as to reduce possible negative effects on human and wildlife. This study further recommends that the Government of Tanzania, through its ministries and departments, address the weakness identified in this study. The findings from this study can serve as a baseline data for future studies.

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