

The Impact of Mining Activities on Forest Resources In Nyamongo Gold Mine, Tarime District, Tanzania

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Abstract

This study aims to evaluate the impact of mining and provide information on the extent of natural forest resources degradation and loss due to gold mining in Nyamongo area, using both qualitative and quantitative research designs. Data was obtained through questionnaires, interviews, observations, resource mapping, documentary review and Geographical Information System analysis. The findings indicate that poor working practices and inferior technologies used by small-scale miners have greatly affected natural forest resources in the area. It further revealed that the Nyamongo gold plant has not only displaced local people, but also deprived them of income related to small-scale mining without providing alternatives. The study also revealed that charcoal and brick-making activities are carried out to supplement incomes from small-scale mining and agricultural activities. The findings further revealed that the forestland declined by 93.8% from 1960s to 2006. The impact on forest resources was more significant in Mrito village where only a small part of Miriminsi forest remains today (about 2% of the total forestland). The study recommends that the government implement land use and town planning for Nyamongo, especially in Nyangoto and Matongo villages, where settlements are not planned.

Introduction

The mining industry has been, and continues to be, an important contributor to both national and regional economies of many countries—the USA, Canada, Australia, Sweden, Botswana, Malaysia and Indonesia—including Tanzania (Auty, 1993). Mining, and the industries it supports, is among the basic building block of modern society of most developing countries, particularly in Africa. Today, large and small-scale mining still play a significant role in the overall socio-economic and physical development of many countries. In the SADC region, for example, the mining sector continues to be the backbone of most economies. The average contribution to the total foreign exchange earnings in the region's economy is 60%. The major mining nations in SADC are Botswana, Zambia, Tanzania, South Africa and Zimbabwe. Most of these countries use large-scale mining companies that have their own marketing sources (Landner, 1995).

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Mining of minerals in developing countries, particularly African countries, has often produced adverse impacts during the exploitation and processing phases. Mackenzie (1995) puts it clear that one of the problems associated with mineral production in developing countries is that it is not sustainable and often perpetuates environmental problems. Generally, the environmental impacts that arise from mining operations include both physical and chemical impacts. The physical impacts include destruction of river channels and water catchment areas, resettlement of people, destruction of forests and game reserves and loss of biodiversity; whereas the chemical impacts include water and air pollution, dust, noise and vibrations (Hangi, 1996).

Mining activities have negative impacts on forest resources due to the fact that the activity is carried out in various stages, each involving specific impacts on forest resources. During the prospecting phase, there is preparation of routes of access, topographic and geological mapping, establishment of camps and auxiliary facilities, geophysical works of hydro-geological research, opening up of reconnaissance trenches and pits, taking of samples: all of which have an impact on forest resource (URT, 2003).

During the exploitation phase, trees are cleared to allow space for mining as well as for fuel wood. This leads to the loss of primary forests. The hazardous chemicals used in various stages of metal processing and in drainage system cause alteration and contamination of water cycles, with serious side effects to the surrounding ecosystems, especially forests and to people (Mann & Chatterji, 1978). Air pollution caused by dust generated from mining activities causes respiratory troubles to people, and asphyxia of plants and trees. The deafening sound of machinery used in mining and blasting cannot be considered as minor impacts either because they create conditions that may become unbearable for the local population and forest wildlife (Landner, 1995; Mruma, 1995; URT, 1997).

From normal experiences, mining operations tend to have destructive impacts on the surrounding physical environment. With the ongoing small-scale and large-scale mining activities in Nyamongo gold deposits, it is expected that there will be several environmental impacts arising from mining development and operations. This study, therefore, intends to document such environmental impacts, with a focus on forest resources degradation and loss in Nyamongo area.

Research Objectives

The main objective of this study was to assess the extent to which natural forests have been degraded and lost as a result of gold mining activities in Nyamongo area. The specific objectives were to:

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1. Examine the factors responsible for natural forest resources degradation and loss in Nyamongo area;
2. Assess the level to which natural forest resources have been degraded and lost in Nyamongo area; and
3. Evaluate the measures and strategies taken to solve the problems of natural forest resources degradation and loss in Nyamongo area.

Research Methods and Materials

The Study Area

The study was conducted in Nyamongo area in Tarime district, Mara region. Nyamongo lies within $34^{\circ} 30'$ to $34^{\circ} 35'E$ and $1^{\circ} 25'$ to $1^{\circ} 35'S$ in Tarime district, Mara region (Fig.1). Nyamongo area was selected due to the following reasons. Firstly, it is only in Nyamongo area in Tarime district where gold mining activities have been carried out for more than 40 years involving small-scale miners whose impacts on forest resources have not been documented.

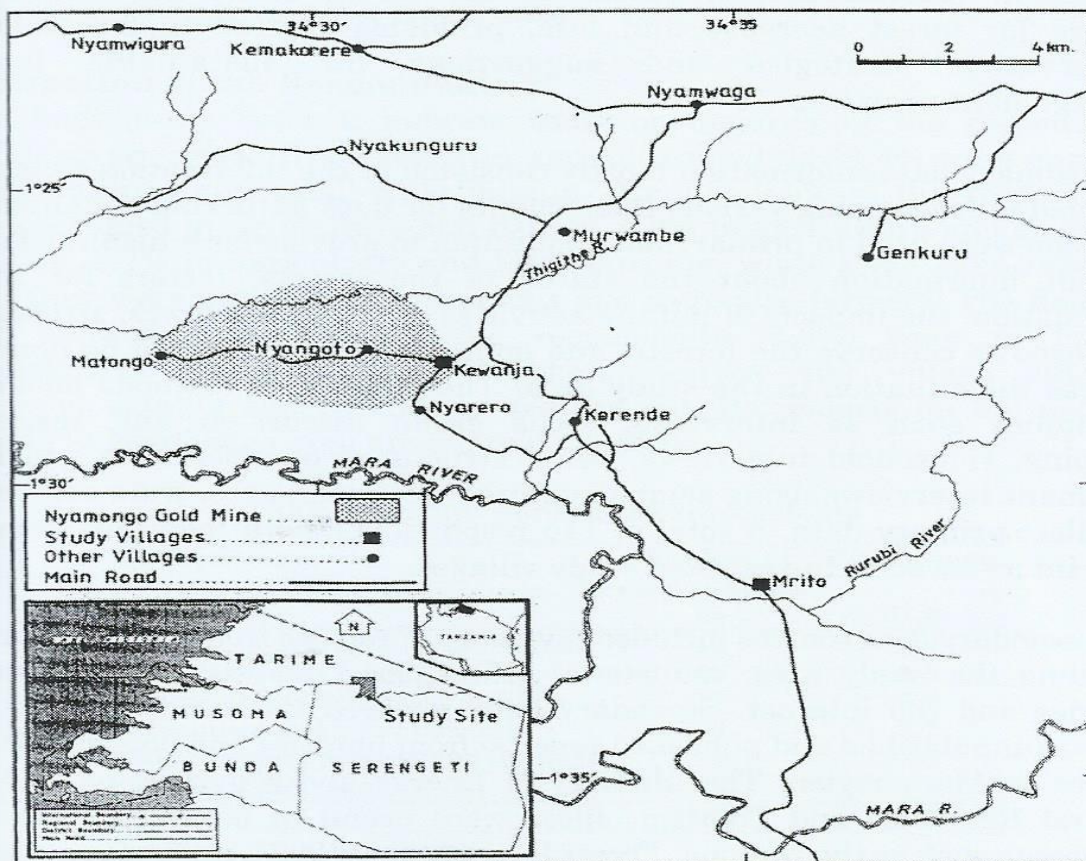


Figure 1: The location of the study area in Tarime district

Source: URT, (1975)

Secondly, the commissioning of large-scale miners led to the displacement of local people and loss of access to mining areas by small-scale miners who in turn resorted to charcoal making and bricks burning, in the process impacting negatively on the natural forest resources in the area. Two villages -- Mrito and Kewanja -- were selected from Kemambo ward, basing on two aspects: the spatial aspect (i.e., the village closer to the large mining centre), and the newly settled village (occupied by the displaced population from the mining centre). The villages were expected to give out a comparative analysis on the impacts of mining activities on the natural forest resources in Nyamongo area.

Data collected included the background of the study area. This included the economic activities undertaken in the study villages, environmental management activities, as well as experiences and perceptions on forest degradation. Information collected from households and key informants entailed information on household characteristics such as age, level of education, marital status, status of the forest (increase/ decrease), factors for forest decrease and loss, problems related to forest loss, conservation strategies and suggestions for sustainable forest management practices.

The primary data information mostly consisted of the information from the sampled villages using various instruments for data gathering. Qualitative methods were used in primary data collection to provide both historical and current information about the status of the forests, factors for their degradation, the impacts of mining activities on forest resources, strategies employed to conserve the forests, and opinions on what should be done to redress the situation in the study area. The qualitative methods included techniques such as interviews, focus group discussion and resource mapping. Household interviews, using structured questionnaire and key informant interviews using semi-structured questionnaires, were also used to collect primary data. A total of 115 respondents, both men and women, were interviewed in the selected study villages.

The secondary data sources included inventory of records from various sources including the study area, ministerial offices, local institutions, university libraries and the internet. Secondary data involved the review of existing reports (unpublished and published reports) from libraries and documentation centres in Mara region. The Ministry of Energy and Minerals, as well as Natural Resources and Tourism offices were useful in providing essential documents such as the National Forest Programme of 2004, mining guidelines, the mining policy of 1997, and the trends of mineral exports.

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Results and Discussion

Village Profile

In the two surveyed villages the total population and number of households varied significantly (Table 1). The high population in Mrito village (3,873 people) indicated a high demand of land for settlements and agricultural activities. Household size has some implication on resource use and conservation since most people depend on ecosystems for their livelihood. Thus, the more the population in a certain location, the more the pressure exerted on the ecosystem. Since it was a newly resettled village by people who have to give room for mining operations, the land that was forcibly cleared to meet their demands was the forested area.

Table1: Human population and number of households

Village	Total population	Number of households
Mrito	3873	560
Kewanja	3679	490
Total	7552	1050

Source: Village Council (2006)

Occupation of the Respondents

The findings in Table 2 indicate that the majority of the respondents (61.9%) were primarily engaged in agriculture, while 11.4% were engaged in agriculture and small-scale mining. Another 9.5% of the respondents were occupied in agriculture and fishing, 6.6% in agriculture and charcoal-making, 5.7% in agriculture and brick-burning, while some 3.0% reported that they were petty business persons and were also farmers. The findings also showed that some of the respondents (1.9%) were in formal employment. These included teachers, nurses and village officials. Although mining activity did not feature out, its impacts on the natural forests in Nyamongo area are of great concern.

Table 2: Occupations of the respondents

Occupations	Number of respondents	Percentage
Agriculture	65	61.9
Agriculture and small-scale mining	12	11.4
Agriculture and fishing	10	9.5
Agriculture and charcoal making	7	6.6
Agriculture and brick burning	6	5.7
Petty business persons and farmers	3	3.0
Formal employment	2	1.9
Total	105	100

Source: Field data (2006)

Extent and Rate of Forest Degradation and Loss

A majority of the respondents pointed out during the interviews that the general vegetation cover in the area has decreased much in recent years compared to the 1960s. The respondents, however, could not mention exactly the extent of decrease. Although there was no actual estimate on the extent and rate of forest decrease from the respondents, the information provided indicated the knowledge that local people have on different landscapes and land use changes overtime. The actual rate of forest degradation that was not known by the respondents might be due to lack of monitoring systems. The results summarized in Table 3 were compiled from the land use map (1963) and the EIA results of the Gokona-Nyabigena proposed enlargement project in the study area (Tambila & Catherine, 2005; EAGM, 2005).

Table 3: General vegetation cover decrease in the study area in the 2000s

Vegetation type	Approximate ha within the study area (1963)	Approximate ha within the study area (2005)	Difference in vegetation cover (1963-2005)
Woodland	443	12	-431
Wooded grassland	718	27	-691
Grassland	1220	20	-1198
Thicket on rocky outcrops	456	28	-428
River fringe forest remnants	20	2	-18
Cultivation and others	1434	4	-1404
Total	4291	70	4170

Sources: URT (1963), EAGM (2005)

Table 4: Land use change in Mrito village 1960-2006

Land uses	Area covered				Land use change (1960-2006)	
	1960s		2006		Areas in ha	%
	ha	%	ha	%		
Forests	65	25	4	2	-61	-27
Settlements and cultivated area	59	23	172	67	113	50
Valley plain	67	26	54	21	-13	-6
Mountain ranges	28	11	27	10	-1	-0.4
Uncultivated land	38	15	0	0	-38	-17
Total	257	100	257	100	226	100

Source: Field data (2006)

The analysis done using the GIS also shows that the former dense Miriminsi forest in Mrito village has decreased dramatically, and only a small part of it remains today (Table 3, Figs. 2 and 3). The results from GIS analysis (Table 4; Figs. 2 and 3) enabled the study to underscore the actual extent of forest degradation and loss particularly in Mrito village. Table 4 indicates that there is change in land use pattern in the study area. Settlement and cultivated areas increased significantly (67%) at the expense of forestland, valley plains and uncultivated lands.

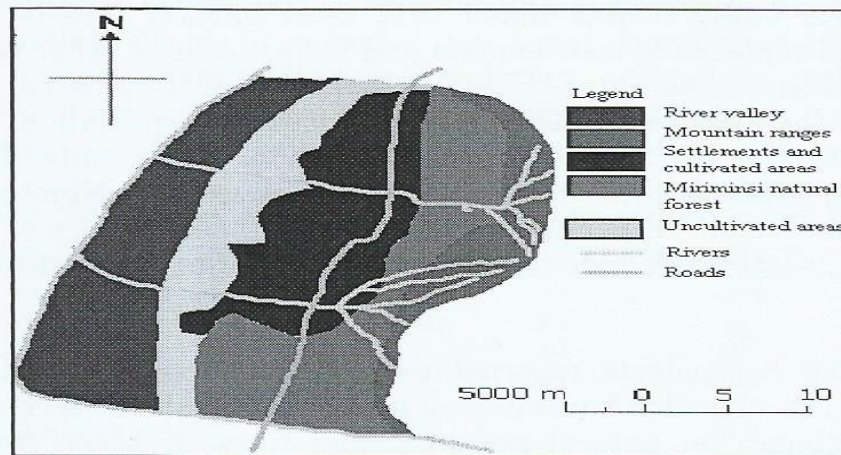


Figure 2: Mrito village before forests degradation during 1960s

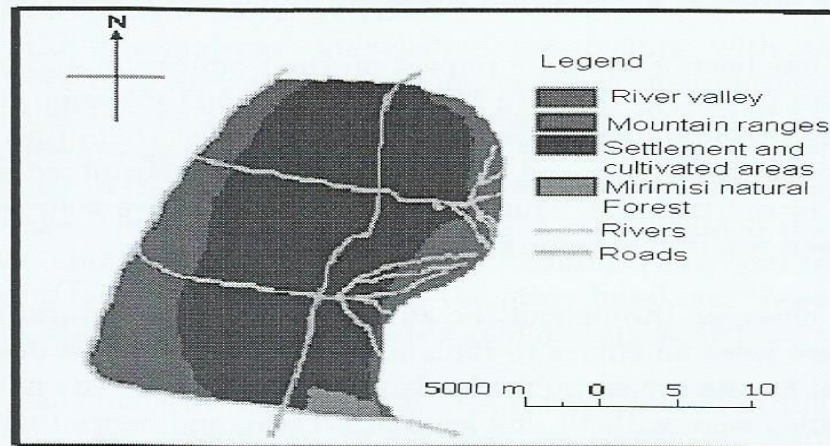


Figure 3: Mrito village after forest degradation in 2006

Settlement and cultivated areas increased from 59ha in the 1960s to about 172ha in 2006 with an increase of 113ha (50%). On the other hand, forestland area decreased from 65ha (25%) in the 1960s to 4ha (2%) in 2006, with a loss of 61ha. Also, valley plains decreased from 67ha (26%) in the 1960s to 54ha (21%) of the total area in 2006. The uncultivated areas decreased significantly from 38ha in the 1960s to nothing in 2006. The mountain ranges experienced insignificant change with a decrease of 1ha only by 2006. This may be attributed to the nature of mountain ranges, which comprises steep slopes, and are thus not suitable for settlements or agriculture. From the GIS analysis the rate of forest degradation and loss per year in the study area stands at 6.1%.

During field study it was noted that most natural forests have been cleared and replaced by settlements and farms. Among other reasons, the level of education and nature of economic activities in the area might have influenced the extent and rate of forest resources degradation. Most male respondents (29.5%) have primary education, while only 21% of the female respondents have the same level of education. Nineteen percent (19%) of the female respondents have not attained any formal education, and only 1.9% of the female respondents reported to have attained college education.

None of the respondents reported to have attained advanced secondary education. The education levels had an implication on the forest resources due to great reliance on natural resources and ways in which the available resources are utilized and managed. Since there has been a 'gold rush' in Nyamongo area, a number of young people -- especially boys -- have abandoned education in favour of quick money available through artisanal mining.

The result has been a negative impact on their education and employment opportunities in the North Mara Mine. It was noted that some young people have received training sponsored by EAGM to assist them find alternative income, though not many, and there has not been guaranteed employment at the end of the training. Thus the desired alternative sources of income have not been realized for many of the villagers.

It was also observed throughout the study that once the natural forests were cleared, there were no efforts to replant them. This might be due to the fact that natural forests are on public lands. In the study area the natural forests on public lands were without any legal protection, and hence their utilization was without any control. Therefore, there was heavy pressure for conversion of the natural forests to other competing land uses such as agriculture, livestock grazing, settlements, mining and other development activities.

The non-gazetted forestland is considered to be a common pool resource which, according to Geoffrey et al. (2001), private property rights have not or cannot be allocated. Sadly, this meant that the incentive for individuals who use these resources is to overexploit them without concern for the long-term survival of the resources. Each becomes engaged in a race to exploit. Even when widespread over-exploitation and degradation of the resource becomes evident, individuals continue to increase their exploitation because the whole community shares the costs of their actions, while benefits are appropriated individually. In this manner, the common property resource is eventually destroyed.

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Forest Resources Degradation and Loss in Nyamongo Area

The study findings (Table 5), revealed that forest degradation and loss is a function of many factors, including population, agriculture and livestock grazing, mining activities, charcoal and firewood (fuel), brick burning and building poles.

Table 5: Major Factors for Natural Forests Degradation and Loss

Factors	Frequency	Percentage
Settlements (population)	30	28.5
Agriculture and livestock grazing	25	24
Charcoal and firewood (fuel)	20	19
Mining	14	13.3
Brick making	6	5.7
Building poles	10	9.5
Total	105	100

Source: Field data (2006)

Mining Activities in Nyamongo Area

Relying on the respondents' knowledge, the factors with the highest percentage were used as the main factors for forest degradation. It should, however, be understood that what the respondents regarded as the major factor (population) was the immediate factor; in reality the underlying factor was gold mining in the area. Immediate factors are those that directly cause land use change. The immediate factors in this case included the expansion of agriculture and settlements, fuel wood, building poles and overgrazing. The underlying factors (root causes), on the other hand, are those that drive the process of change; in this case it is the gold mining activities.

Despite the fact that gold mining activities ranked fourth in the responses (Table 5), they are considered to be the root cause of natural forests degradation in Nyamongo area. Before 2002, small-scale miners dominated the exploitation and extraction of minerals in Nyamongo (as indicated in Plates 1 and 2). The reasons for low responses on mining might be due to the fact that the gold rush in Nyamongo began in the 1980s and continued into the early 1990s as both the Nyabigena and Nyabirama deposits were exploited. By 1995, however, the decline in small-scale mining at both deposits was substantial. Again, in 2002 the mine deposits were commissioned to Barrick Company. The large scale mine has impacts on both the environment and the local community in the area as indicated in Plates 1 and 2. Consequently, the majority of small-scale miners have left the villages, and this was shown by the low percentage in the age groups of 21-30 and 31-40 (11.4% and 13.3%), respectively, which indicated that most of the energetic youths who were engaged in small-scale mining before commercialisation of the mines have left the villages to other mining sites, or they have migrated to towns to seek other employment alternatives.

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Specifically, most youths who are facing difficulties to secure areas for mining have either migrated to Buhemba Gold Mine (in Musoma rural) or some have remained in the village engaging in large-scale charcoal making activities and subsistence farming and some have opened up new small-scale scattered mines in Kerende and Mrito villages. It is argued that part of the reason why the people of Tarime have migrated and are found in large numbers in some parts of Dar es Salaam such as Kitunda is because of seeking alternative employment and settlements as land has become congested in Tarime district in general.

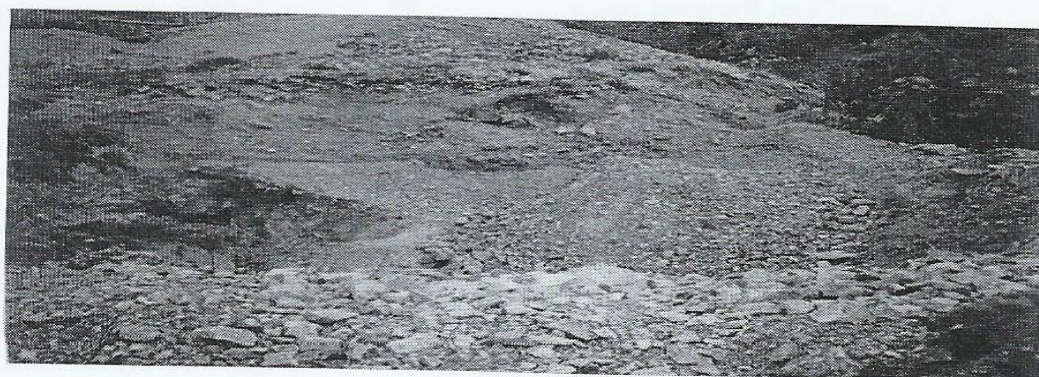


Plate 1: *Leftovers of stones after gold extractions in Mrito village. Extractions of gold have exacerbated forest degradation and loss.*

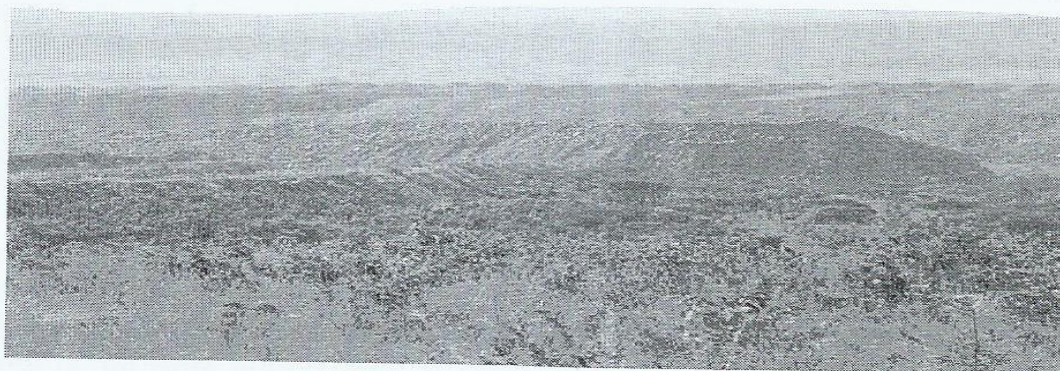


Plate 2: *Hills of heaped stones left by the large-scale miners in Nyamongo*

The small-scale miners cleared the land and trees were cut down so as to ease the work of drilling pits. In the study area it was found that the miners used simple crude tools for ore extraction. As a result, the pits were abandoned once the tools could not mine deep in favour of new areas with more potential gold ores. Due to the behaviour of abandoning pits, trees and forests were cleared especially on the mountain ranges and valley bottoms; as a result quality and quantity of natural forests have decreased much.

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The local people in the area pointed out that the hills experiencing great forest loss due to small-scale mining activities included *Rorya Mrito*, *Nyamatiryo*, *Kenyasagati*, *Geterere*, *Byantang'ana*, *Kengoka*, *Nyambeho*, *Nyamagunchara*, *Kegati*, *Nyankoba*, *Msege* and *Gesausau* hills. These are the hills with potential gold deposits in Nyamongo. The dense natural forests that covered these mountain ranges before 1980s have decreased, and only light and scattered trees could be seen on these hills today as indicated in Plate 3.



Plate 3: Part of the remaining Miriminsi forest with light forest and scattered grasses in Mrito village

The establishment of camps, mine sites and building of auxiliary facilities by large-scale miners has intensified forest degradation and loss in Nyamongo area. This has been due to the fact that there is a large influx of people who are employed on the mine or are seeking ancillary opportunities. Due to high concentration of people in the area there has been an increase in tree cutting in the few wooded areas outside the mine site.

Generally, both large and small-scale miners caused deforestation and vegetation disappeared completely in the areas of mines because most of the trees are cleared and cut down. Specifically, this study has found that mining activities have negative effects on forest resources and landscape due to the nature of the mineral work and the methodology used. The pits were abandoned as soon as the minerals are exhausted and the miners move to more lucrative sites, without refilling these pits. It is important, therefore, to emphasize that mining should be carried out properly so as to minimize to the fullest extent possible these destructive effects. This can be done through careful planning, effective village governance, modern technology and sensitive management of mining activities.

Human Settlements and Agriculture

The mining activities have displaced people (about 200 households) who have had to acquire new areas for settlements and agricultural activities (Plates 4 and 5). The population was high in Mrito village (Table 1) as compared to

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Kewanja. Large amount of cultivable land (a newly resettled village) and the resumed artisanal mining activities in Mrito has attracted a large number of people into the village. With increasing number of people in Mrito village, there is negative implication on land uses, especially on natural forest resources use and management in the village since the local people are cultivators and cattle keepers, and overgrazing is common. Cutting trees for firewood, charcoal and building is also unavoidable. The vegetation has responded to these pressures in different ways in this village.

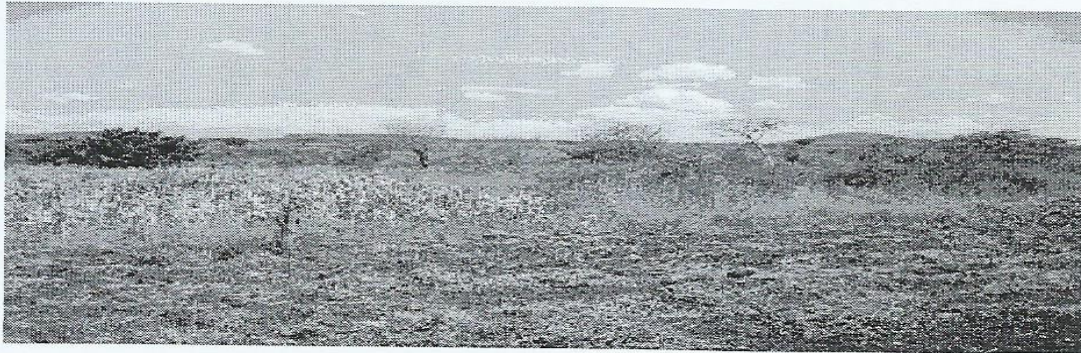


Plate 4: *Crop cultivation and forest degradation in Mrito Village*

The impact of population on forest resources has been an indirect impact of mining activities in the area as the displaced population became relocated to other places so as to leave room for mining activities. From the map of the 1960s the areas that were formerly covered by the dense natural forests in Mrito village have been converted into settlements and agriculture. Villages such as *Rorya*, *Kumichongoma*, *Kegati* and *Maabera* centre have been established in the once dense Miriminsi natural forest, and only a small part of this forest remains. Today, light natural forests are only seen on the hills and mountain valleys. Local people indicated that even the vegetation has changed because the papyrus grass species that dominated the lowlands have decreased, and cultivation has replaced these grasses in the lowlands.

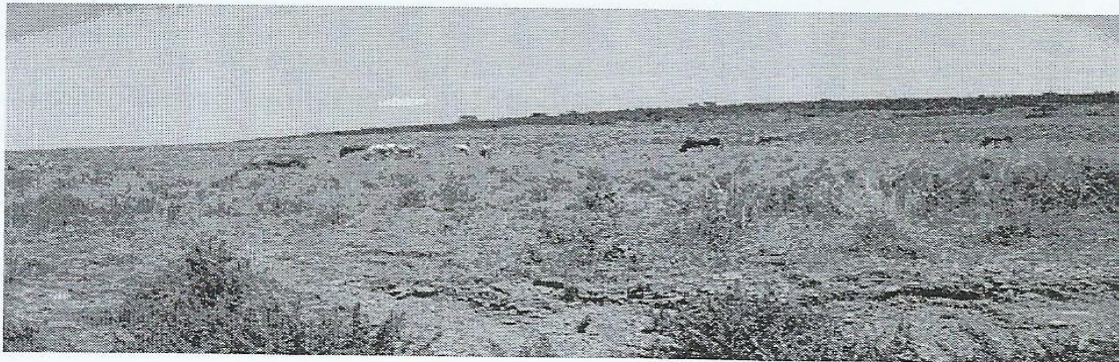


Plate 5: *Animal rearing has an impact on the natural forest in Nyamongo area*

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During interviews elders pointed out that uncovered pits left by miners reduce the potentiality of arable land, thus people avoided such areas by opening up new settlement areas and farms in other reliable areas. Some people had to migrate in search of farmland, while others were relocated or resettled by the mining companies. Consequently, the growing displacement of communities in mining areas has resulted not only into forest destruction, but also in increased migration of youths to towns.

Charcoal and Firewood

In the study area, the large mine has deprived community members income accrued from small-scale mining without providing alternatives. Prior to the investors, the villagers had access to the mining areas where they earned money for their livelihood. Due to lack of access to mining most people are now engaged in charcoal making (Plate 6) business as an alternative source of income since it was the second alternate income earning activity after mining. Informal interviews with some charcoal burners in Mrito village showed that they were compelled to engage in that activity so as not to return to farming, which would take months before harvests, contrary to mining which earned them money daily. The respondents added that although charcoal-making activity was labour intensive, it did not require high initial capital investment to start, so they could easily cope with it.

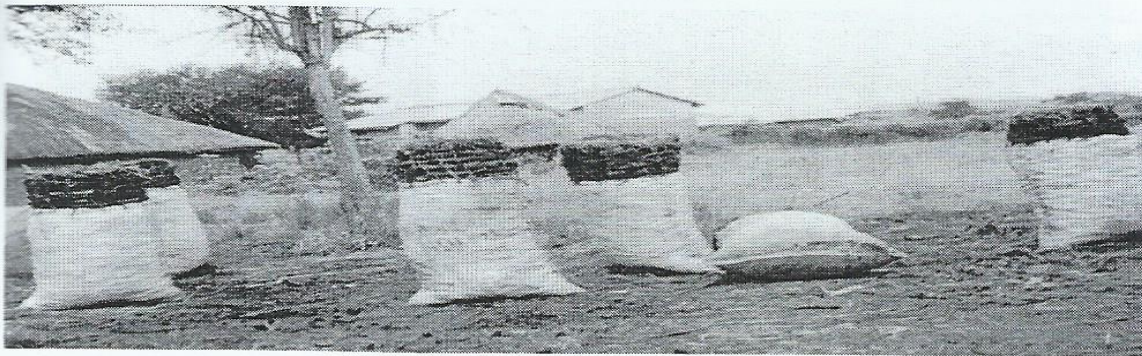


Plate 6: *Sacks of charcoal in Mrito Village ready for transporting to the market*

The study findings have further revealed that charcoal making also involved people from Gibaso, a nearby village, which borders the Miriminsi forest in Serengeti district. Also involved in charcoal making in Mrito village were small-scale farmers and unemployed persons, who did this to supplement inadequate incomes derived from agriculture. Charcoal making has contributed, and continue to contribute, to loss of forest cover in Nyamongo. Timber was cut for firewood and charcoal, and there is very little left. The area is now experiencing acute scarcity of wood products, especially fuel wood, which is the main source of domestic energy to the majority of the rural population.

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problems as they had to obtain water from only one drilled well that was some distance from the area of construction. Interviews with village elders revealed that the majority of the small-scale miners had a transition from their traditional homesteads to modern houses built of burnt bricks as a sign of wealth during the boom.

Impacts Related to Forest Degradation

Respondents in Nyamongo identified a number of environmental and social problems related to forest degradation and loss in their area. As noted by the respondents (23.8%), drought was seen as the most serious problem associated with forest resource degradation. Respondents indicated that forest degradation and loss was one of the main factors influencing rainfall distribution in their area, and that it had resulted in decreased rainfall amount and duration. The forests are sources of rainfall and catchment areas for streams in the study area. It was indicated, for example, that the forests provided the catchment for Mara River, and even the streams they used in the villages have their catchment area from the nearby forest.

Elders pointed out that due to deforestation their land, which was formerly covered with greenish and good environment, was changing to a desert. They added that although they were in areas that received plenty of rains, the situation has greatly changed. Respondents (9.0%) mentioned desertification to be among the impacts of forest degradation, as the area that was formerly covered by dense forests was now bare, while some parts were covered with few shrubs. Also, elders complained of the loss of cultural practices that helped them to conserve forests, as one elder sadly put it thus:

In those days we used to worship in dense forests as they were believed to be homes of our tribal ancestors; trees were not cut down. Because of this strong belief trees were not cut, and forests were not degraded. Today our community is experiencing a number of social problems such as aridity conditions as a result of forests degradation.

The elders' views showed that there was a strong belief that trees and forests should remain as natural as possible because they were important sites where their gods rested. Today things have changed and the area was degraded, thus bringing in misfortune.

The study also revealed that abandoned pits and piles of rubble left behind by mining activities led to accelerated soil erosion either by wind or water. Furthermore, respondents (17.1%) indicated that there was lack of building materials (timber) as a result of forest degradation. It should be noted that these people used trees for building houses, and that prior to mining activities they easily secured building materials a few kilometres from their

homesteads. Due to forest degradation, however, they no longer obtained these materials nearby, hence they had either to use the small trees that did not guarantee durable houses, or buy poles. Loss of wild animals also featured as one of the impacts of forest degradation. Respondents (9.0%) indicated that prior to forest loss, the area was rich in wildlife such as antelopes and zebras, which had now disappeared to the Serengeti National Park for their safety.

Another forest degradation related problem mentioned by respondents (5.0%) was the disappearance of natural tree species. This was an indication that local people in the study area had knowledge of tree species. Some of the notable species mentioned to have disappeared included *emerogo*, *amategete*, *ichinsisya*, *memange*, *misisi*, *bilela* and *mike*. Some of these species have disappeared because they were hugely exploited either for charcoal, building poles, firewood, or were cleared for mining activities. Traditionally, local communities in the study area believed that the *Ficus* species were a 'life force' because of their milky sap, and thus were conserved. However, due to declining supply of wood-related resources, these species are no longer values; instead they are being cut for timber and building poles. Furthermore, due to forest degradation and its resultant desertification and drought impacts, rainfall has decreased, and hence the presence of these *Ficus* species have been associated with inability to attract rainfall in the area; and therefore they are being cut like any other tree species in the area.

Strategies to Reduce Forest Degradation

There are laws, by-laws and regulations that govern the utilization of forests under general lands (public), forest resources and game reserves. Most respondents confirmed that they were aware of such laws and regulations. The most popularly known protection strategies related to afforestation: these were tree planting campaigns using a slogan 'cut a tree replace it with a tree'. Others were laws and regulations that prohibited putting forest on fire and cutting trees indiscriminately; and strategies for better management, law enforcement, consumption management and setting of fines to those who disobey environmental regulations and rules. All these strategies appear to be quite sound, and if properly implemented may reduce or halt forest degradation and loss in the area (Mbonde, 1996; Timbala & Catherine, 2005; Wangwe, 2005).

To facilitate the protection and management of the forest, the District Forest Office has formulated village by-laws that required people to plant tree nurseries; and prohibit tree cutting, charcoal-making and burning without a permit from the village government. Efforts are also currently

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underway to plant trees to compensate the loss of natural forests. The work is being carried out by WWF, Barrick Gold Company, VI Agroforest, Tarime Rural Development Fund and villagers. School children are also involved in the project.

Despite the various efforts being made to manage these resources, the unplanned mining activities by small-scale miners is further threatening the existence and sustainability of forests in the area. The continuous illegal charcoal-making and farm extensions that are on the increase also threaten the existence of forests. Decisions such as forbidding local people to collect firewood and charcoal-making could be effective only if alternative sources of energy were given, short of which the demand for charcoal and firewood will continue to threaten the existence of the forests.

Conclusion and Recommendations

The Nyamongo case study is a vivid example of how rapidly natural forests on public land are degrading. The findings of the study show that the gold rush in the area that occurred between 1980s and mid-2002 has threatened the existence and sustainability of these forests. As a result, areas that were covered by dense natural forests of varied species in the early 1960s are now completely degraded. The mining methods and technologies used by small-scale miners, and the displacement of the local communities by the large-scale mines are the major underlying factors that have negatively impacted on forest resources. Other factors such as human settlements, agricultural activities, charcoal- and brick-making contribute greatly to forest degradation.

Settlement and cultivated areas, for example, increased from 59ha in the 1960s to about 172ha in 2006, with an increase of 113ha (50%) in Mrito village. On the other hand, forestland area decreased from 65ha (25%) in the 1960s to 4ha (2%) in 2006, with a loss of 61ha. Also, valley plains decreased from 67ha (26%) in the 1960s to 54ha (21%) of the total area. The uncultivated areas decreased significantly from 38ha in the 1960s to nothing in 2006. With the commercialization of the Nyamongo gold mine, the local people were not only displaced but also deprived of income related to small-scale mining without providing alternatives. As such, the local people resorted to making charcoal, burning bricks and extending farms into forested lands.

Efforts are being made to facilitate the protection and management of the remaining forests. The district forest office has formulated village by-laws that require community-based management of the forests, especially in the adjacent villages of Mrito and Gibaso. The district forest office also requires

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people to plant tree nurseries at village and family levels, prohibits tree cutting, charcoal-making, burning of forests and harvesting products from the forests without a permit from the village government.

The study recommends that small-scale miners should be provided with proper guidelines and awareness on well-planned mining activities. Also, the government should implement land use and town planning for Nyamongo, especially in Nyangoto and Matongo villages where settlements are not planned. Similarly, there is a need to have an integrated forest management approach at the local level by involving the local people in Mrito and Gibaso villages, who are the direct beneficiaries of the Miriminsi forest. Furthermore, priority should be given to working with communities and government services to improve agricultural output so as to reduce unnecessary farm expansions into natural forests. Lastly, a study on pollution levels associated with mining activities and illegal fishing by using chemicals should be carried out for the purpose of avoiding pollution of the water in Mara River.

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