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Effect of Illegal Small-Scale Mining Operations on Vegetation Cover of Arid Northern Ghana

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Abstract: Illegal small-scale gold mining brings several benefits to developing countries like Ghana, manifested mainly as employment and revenue but simultaneously impacts negatively on the immediate environment. The study tested the hypothesis that density and diversity of key native tree and shrub species differ in the mined and unmined areas of Nangodi in the Talensi-Nabdam District of the Upper East Region, Ghana. A total of 20 plots (10×10 m) were studied in the mined and unmined areas. A total of 8 tree species and 9 shrub species were recorded. The extent of vegetation affected by the activities of illegal small scale miners was assessed. The Simpsons reciprocal diversity index of tree species at mined area was 8.33 as compared to 10.8 for the unmined area. For shrub species, the Simpsons reciprocal diversity index was 8.33 for the mined areas while that of the unmined was 10.2. Common trees and shrubs species were identified in both areas as designated by the calculated Jaccards similarity index of 0.6 for trees and 0.7 for shrubs. However low mean density of 2.4 individual trees per 100 m^2 and 5.6 individuals per 100 m^2 was recorded in the mined and unmined areas respectively. Shrubs species also recorded very low density figures of 1.4 and 2.6 per 100 m^2 in the mined and unmined areas, respectively. The null hypothesis that there is no significant difference of illegal small-scale mining on tree and shrub species density is rejected at the 0.05 significant level, indicating that mining significantly affected vegetation cover. It is suggested that efforts should be made to reclaim the degraded lands through reforestation.

Keywords: Galamsey, mined area, small-scale mining, unmined area, vegetation

INTRODUCTION

The presence of gold deposits discovered in Nangodi in the Nabdam traditional area has attracted a lot of unemployed youth and small-scale mining ventures to the area. The activities of illegal small-scale gold mining (locally referred to as "galamsey") in the community is causing serious environmental havoc and destruction. Surface mining (of which strip mining is one form) uncovers the minerals by removing the underlying vegetation cover, rocks and other strata. Enormous quantities of the vegetation cover are gouged out, inverted and buried converting the natural terrain into raw, bare, lifeless spoil banks (Greenwood and Edwards, 1979). Greater portions of the vegetation cover in the mined areas lose its properties to be used for any other purpose (Charis, 1994). Water, a vital necessity of life is affected both in quality and quantity by activities of the galamsey operators.

In Ghana, contaminations of surface and ground water bodies have particularly been experienced in gold mining communities (Davis *et al*., 1994), however, gold mining in recent times has become unpopular as it is regarded as a significant source of Hg, Pb and heavy metal contamination to the environment owing to activities such as mineral exploitation, ore transportation, smelting and refining, disposal of the tailings and waste waters around mines (Hilson, 2001; Hilson, 2002; Aryee *et al*., 2003; Essumang *et al*., 2007; Paruchuri *et al*., 2010). The principal environmental problems caused by small-scale mining activities are mercury pollution from gold processing and land degradation (World Bank, 1995). Cobbina *et al*. (2012) stated that generally, resident children and adults are at risk to exposure to mercury in shallow dug-wells and dugouts in the Nangodi area.

In recent times there has been reported cases of waterlogged pits, soil erosion (Hilson, 2002), pollution of fresh vegetables and food items (Essumang *et al*., 2007), rivers and other water bodies that served as a source of drinking water (Obiri *et al*., 2010; Paruchuri *et al*., 2010) for communities in mining areas. Communities downstream are seriously affected with water pollution because of the activities of illegal gold mining. Generally mineral exploitation creates environmental damage on a scale matched by only few other human activities. It is responsible for deforestation, soil erosion, water pollution and significant air pollution. The environmental impacts are particularly very severe in developing countries, which produce a large portion of the world's minerals. Surface mining scars large areas and creates enormous

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quantities of waste that erode into streams and lakes (Charis, 1994). Mining activities impact negatively on the environment and the severity of the impact depends on methods used and whether the mine is large or small (Bell *et al*., 2001).

Manaf (1999) suggested that, despite its significance to economic development, mining posed serious environmental challenges, the most widespread being land degradation, water pollution leading to ill health of people. Gold mining has however played a significant role in the socioeconomic life of Ghana for the past hundred years (Akabzaa *et al*., 2005). The advent of small-scale mining has changed the land-use practices of the people who have virtually abandoned their traditional livelihood activities in exchange of mining. Traditionally, Nangodi is a farming community where the people were mainly engaged in small scale farming, rearing of livestock and fishing. Farming was the major livelihood activity and was centred on food crop (millet, sorghum, cereal and legume) production. The influx of the activities of illegal small-scale gold miners in the 1980s led to a restructuring of livelihoods in the community. As a result illegal gold mining has become important for obtaining money for investment in other livelihood activities, improving the living standards and attracting people back to the area.

Mining as an industrial activity, takes place on the natural environment, disturbing areas around where it occurs. Research has posited small-scale mining as a subsistence activity which is generally mechanized and carried out by poor people (Kesse, 1985; Heemskerk, 2002). However, Anane (2003) alluded to the fact that surface mining in particular involves the clearing of large tracts of forest and agricultural land, resulting in serious land and forest degradation. Mining activities also cause frequent destruction of farm lands without adequate compensation being paid to the affected farmers (Akabza *et al*., 2005).

This research seeks to investigate the effect of small-scale gold mining on the woody vegetation of the Nangodi community in the Talensi-Nabdam district of the Upper East region of Ghana. The specific objectives of this study were to:

- Compare the tree species of the unmined area to that of the mined area.
- Compare the grass species of the unmined area to that of the mined area.

MATERIALS AND METHODS

Study area: Nangodi is located in the Talensi-Nabdam District of the Upper East Region (UER) of Ghana. The community is located in the eastern belt of the Nabdam Traditional areas. The district lies between latitude 10º15′ and 10º60′ north of the equator and longitude 0º31′ and 1º05′ and west of the Greenwich meridian (Fig. 1).

The area experiences a uni-modal rainfall pattern with mean annual rainfall figures range between 855 and 1269 mm Adugbire *et al*. (2010). The vegetation is savannah consisting of short deciduous, widely spread fire resistance trees and shrubs. The grasses which vary in height are susceptible to bushfires during the long dry season over the years. The soil is predominantly light in texture on the surface horizon, with low inherent fertility due to the deficiency in organic matter contents, nitrogen and potassium content

The mining activities in the study area are of two different types namely, the open pit mining and deep pit mining (Fig. 2a and b).

Sampling techniques: Ten 10×10 m square quadrats were laid on the minned and unmined areas respectively. The first quardrat was laid at random and the subsequent once were laid 15 m from each other. All trees and shrubs were identified and the number of occurrence of each species within the quadrat counted. Identification of trees and shrubs were made with the assistance of a Taxonomist with reference to literature (Arbonnier, 2004; Hawthorne and Jongkind, 2006).

Data handling and analysis: The data collected were analysed using ANOVA on the Genstat Software to compare the means of species on the mined and unmined areas.

The density of the woody species was calculated using Eq. (1):

Density of woody species = (Number of woody species)/(Area sampled) (1)

Species diversity for the mined and unmined areas was calculated using the SIMPSON'S diversity index (Magurran, 1988) using Eq. (2) and (3):

$$D = \frac{\sum \left(ni(n-1)\right)}{N(N-1)} \quad (2)$$

Simpsons reciprocal diversity index = 1/D (3)

where,

n_i = The number of individuals in the ith species

N = The total number of individuals

The higher the calculated value, the greater the diversity

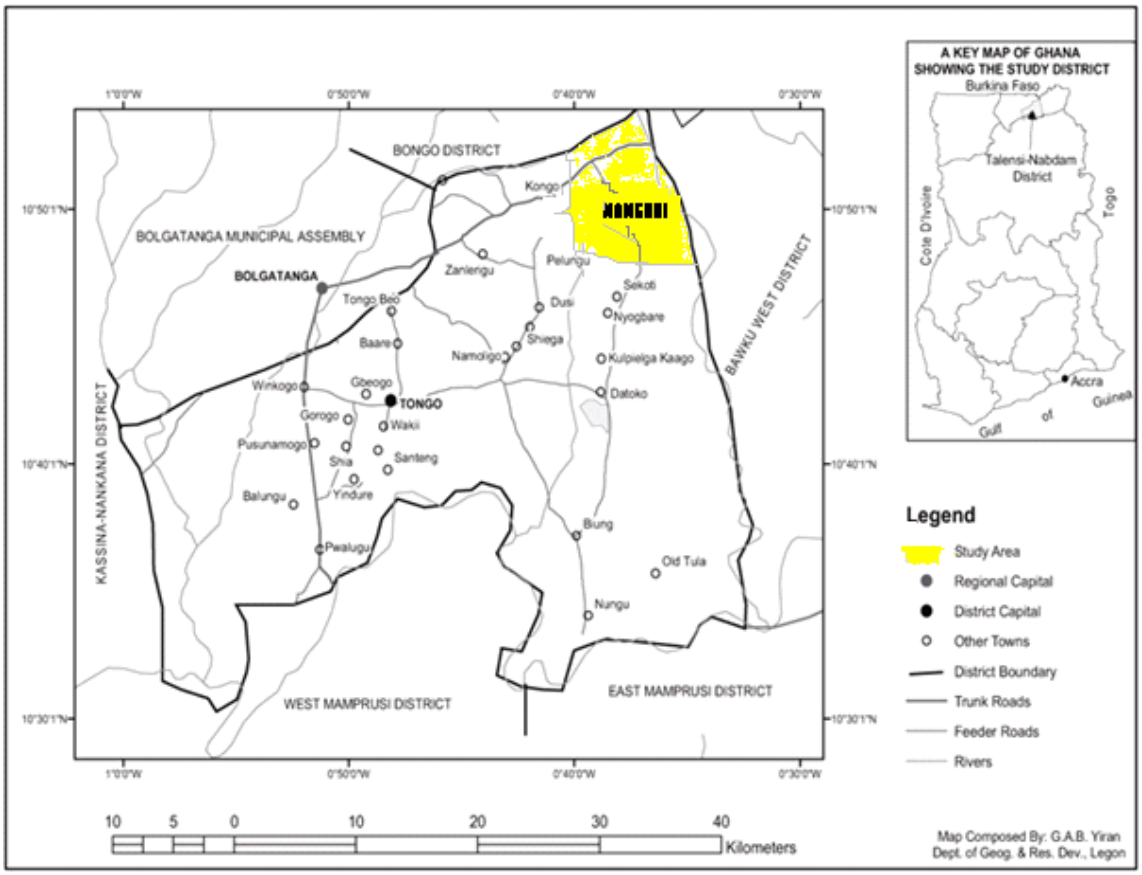

Fig. 1: Map of the Talensi Nabdam district showing the Nangodi community

(a)

(b)

Fig. 2: (a) Open pit gold mining area, (b) deep pit gold mining at Nangodi

To assess the similarity between trees and shrubs in the mined and unmined sampled areas, the Jaccards similarity index (Magurran, 1988; Blanc *et al*., 2000) using Eq. (4):

$$\text{Jaccards index} = (c) / (N1+N2 - c) \quad (4)$$

where,
N1 = The number of shrubs in the mined area
N2 = The number of shrubs species in the unmined area
C = The number of shrub species common to both sites

The Jaccard's index is equal to zero for two sites that are completely dissimilar and one indicates sites that are completely similar.

RESULTS AND DISCUSSION

General findings: A total of 18 woody species made up of 14 plant families was recorded in the study with a species density of 4 per 100 m^2 in the mined areas and 8.2 species per 100 m^2 in the unmined areas. Leguminosae was the largest family, recording a total of 29%. A similar

study in the Bolgatanga Municipality recorded a total of 14 woody species (Atugbire, 2010). The low number of woody species in the study is characteristic of the region (Gyasi *et al*., 2006). Similar studies in the savannah zones of Ghana has recorded higher species diversities (Asase and Oteng-Yeboah, 2007; Asase *et al*., 2009), but the Nagodi area partly falls within the sudan savanna (Dickson and Benneh, 1988) which is a poorer version of savannah.

Trees: A total of 9 tree species were recorded in this study which compares well with the 12 recorded in Bolgatanga (Atugbire, 2010). The tree species recorded in the two areas were similar as indicated by the calculated Jaccards similarity index of 0.6.

The tree species were not distributed in any identifiable pattern, but were mixed up over the entire area. As a result, the composition of trees in each quadrat varied from the others.

As shown in Fig. 3 there were more individual tree species on the mined area than the unmined area. Three tree species *Diospyrous mespiliformis*, *Pakia biglobosa* and *Datarium microcarpum* were not recorded at the mined areas. The total of eight tree species recorded in this study indicates a low diversity which is characteristic of the savannah zone where vegetation degradation is prominent. Small-scale gold mining uncovers the desired minerals by removing the underlying vegetative cover (Greenwood and Edwards, 1979).

The calculated density of trees in the mined site was 2.4/100 m^2 while unmined site recorded 5.6/100 m^2, however the results analysed with the Simpson's reciprocal diversity index revealed the diversity of tree species at the mined and unmined to be 8.33 and 10.80, respectively. Appiah-Brenyah and Antwi (2003), asserted that surface mining in particular involves the clearing of large tracts of vegetation, resulting in serious land and forest degradation and deforestation (Peterson and Heemskert, 2001; Hilson, 2002; Rodrigues *et al*., 2004).

The null hypothesis that there is no significant difference of illegal small-scale mining on tree species density is rejected (F = 0.08) at the 0.05 significant level, indicating that mining significantly affected tree densities.

The trees composition at the mined and unmined areas were analysed and the results displayed on a graph (Fig. 4).

Shrubs: A total of 9 shrub species were recorded in both mined a nd unmined areas which is substantially higher than the 2 shrub species recorded in Bolgatanga (Atugbire, 2010). The shrub species in both areas were very similar as indicated by the calculated Jaccards similarity index of 0.70. Figure 5 shows the distribution

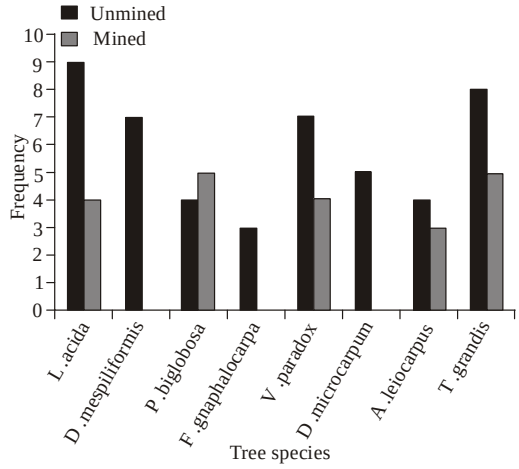

Fig. 3: Individual tree species at the mined and unmined areas

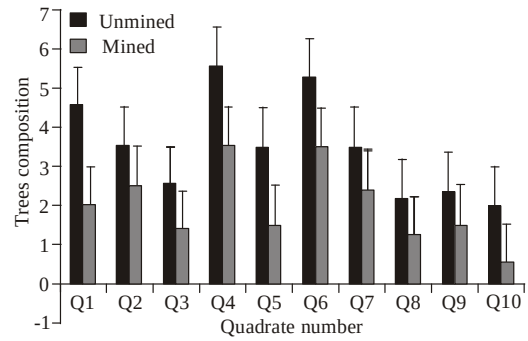

Fig. 4: Impact of galamsey activities on tree species at the mined and unmined

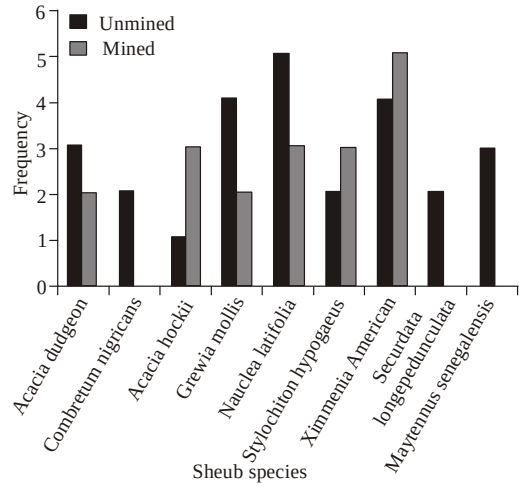

Fig. 5: Individual shrub species at the mined and unmined areas

of individual shrub species in the mined and unmined areas. Like the tree species, three shrub species (*Combretum nigricans*, *Securidata longepedunculata* and

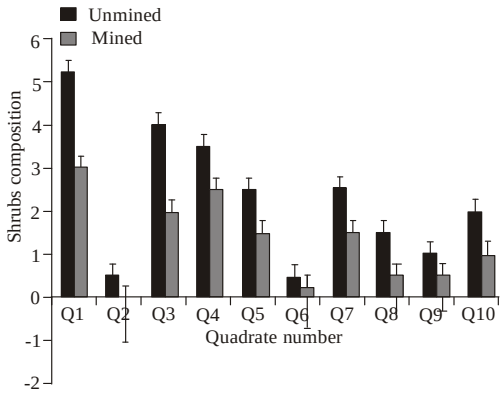

Fig. 6: Impact of galamsey on shrub species at the mined and unmined

Maytenuss senegalensis) were absent on the mined areas. Interestingly however, three shrub species (*Acasia hockii*, *Stylochaeton hypogaeus* and *Ximmenia american*) were more abundant in the mined area than the unmined areas.

The null hypothesis that there is no significant difference of illegal small-scale mining on shrub species density is rejected (F = 0.09) at the 0.05 significant level, indicating that mining significantly affected shrub densities (Fig.6).

The calculated density of shrubs at the mined site was 1.6 per 100 m^2 while unmined site recorded 2.6 per 100 m^2 while, the Simpson's reciprocal diversity index revealed the diversity of shrubs species at the mined and unmined to be 8.33 and 10.20, respectively.

Land degradation: The activities of illegal small-scale miners in Nagodi have resulted in land degradation through loss of vegetation and soil erosion. Figure 7 shows the level of vegetation destructions as a result of the activities of illegal gold miners. Generally research (Barry, 1996; United Nations, 1996; Heemskerk, 2002) suggest small-scale gold mining as gaining global importance both as a source of subsistence for the poor and as a cause of environmental degradation. Akabza (2005) however, suggested that the concentration of mining activities in an area results in the environment undergoing rapid degradation and its immense economic value diminishing from year to year.

The Upper East Region of Ghana, is highly degraded with the resultant loss of vegetation cover, fertile top soil and wild faunal species as a result of adverse climatic trends and negative factors influencing environmental degradation such as small-scale gold mining (Gyasi *et al.*, 2006). Desertification and land degradation are two closely interrelated processes; Land degradation refers to the progressive loss of the intrinsic or natural quality of the land and if this process occurs in arid or semi-arid areas, it is called desertification (Gyasi *et al*., 2006).

Fig. 7: Destructed vegetation at mined site

CONCLUSION AND RECOMMENDATIONS

A total of 18 similar woody species representing 14 plant families were recorded in both the mined and unmined areas. Small scale gold mining activities in Nangodi is having a significant effect on shrubs and tree species numbers and diversity resulting in environmental degradation. It is therefore recommended that vegetation recovery be implemented by the District Assembly by way of levelling the mined areas. Reforestation of degraded lands (mined areas) should be carried out to help reclaim the vegetation cover and elevate the densities of tree species.

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