

Population dynamics and health hazards of small-scale mining activity in the Bolgatanga and Talensi-Nabdam districts of the upper east region of Ghana

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Abstract

Recently, there has been an upsurge of small-scale mining activity in the Bolgatanga and Talensi-Nabdam districts of the Upper East Region following the discovery of gold bearing rocks around the Nangodi and Pelungu areas of the districts. This study attempts to relate population size and health hazards in the study area to the activity of small-scale mining. Based on the findings from field work it was deduced that the prevailing increase in population size and spread of communicable diseases as documented in the Regional Bio statistics service are related directly and indirectly to the activities of the small-scale mining.

Keywords: Small-Scale mining, population dynamics, Health hazards, Bolgatanga and Talensi Nabdam

Introduction

Small-scale mining is currently seen globally as a source of subsistence for the poor, especially developing countries, and as a determinant of environmental degradation and resource depletion in areas where such precious minerals are mined (Barry, 1996; United Nations, 1996). The term small-scale gold mining refers to all formal and informal, manual and mechanized mining that uses crude methods to extract gold from secondary and primary ore bodies (Heemskerk, 2002).

The activity of small-scale gold mining in Ghana is said to have preceded the advent of large-scale industrial gold mining especially in the Ashanti and Western Regions where both surface and alluvial gold was exploited using varying crude techniques and methods (Agbesinyale, 1990). Ironically, with the emergence of large-scale contemporary commercial gold mining industries shooting in, mostly from European countries, the activities of small-scale mining were banned and made illegal with mining concessions exclusively given to metropolitan companies by the then colonial Governments. This was an action in an attempt to make cheap labour supply more accessible to the large expatriate mining companies and simultaneously to ensure that the monopoly position of these large metropolitan mining companies was firmly affixed regarding the prospecting, exploration, mining and marketing of gold and other precious minerals (Agbesinyale, 1990; Hilson, 2001). Arguably, the people who were previously engaged in small-scale mining were ex-miners and laborers from the already established large-scale mining.

Small-scale mining of gold, which has traditionally played an important role in the economy of Ghana, has also received attention under the new liberalized mining environment. Under the minerals sector restructuring reforms, the government legalized small-scale mining activities through the enactment of PNDC Law 153 the

small-scale gold mining law in 1989. Under this law, the Mining and Mineral Commission was made responsible for the registration and supervision of small-scale miners in the country (Hilson, 2001).

Gold was mined during the colonial days within the Nangodi environs of the Talensi-Nabdam district, about 24 km from Bolgatanga, but was abandoned in the late 1930s for political reasons. With the recent legalization relating to small-scale mining activities under the Mining and Mineral law (PNDC 153) in the early 1989, and the redundancy of mining workers in major mining corporations in the south, notably, Ashanti Goldfields in the Ashanti Region and Tarkwa Mines in the Western Region (Blench, 2006), small-scale mining activities became rampant in most communities in the Talensi-Nabdam district especially at Nangodi, Duusi, Pelungu, Sekoti, Datuku, and Sheaga, and more recently, at Sherigu in the Bolgatanga Municipality. There is currently one legalized small-scale underground mining concession in the study area located at Duusi, with original statutory concession size of 72 km² (PNDC 153) in the 1990 which has been encroached in recent times. Illegal small-scale surface mining sites are located at Nangodi, Sekoti and Sherigu (Bolgatanga District Assembly Report, 2002).

Small-scale mining, mostly in the Talensi-Nabdam district is highly subdivided with a hierarchy of workers with different labour relations based on a combination of ethnicity, gender, migrant status and access to capital. These include sponsors (financiers), buyers of gold (who are also often sponsors), ghetto owners (pit owners), and the different classes of workers-dynamiters, "loco boys" (who transport the blasted ore from the pit to the surface, "kaimen" (who pound the ore in the metal mortars with metal pestles), and "shanking ladies" (who sift the pounded rock with a scarf to separate powder from chippings (Awumbila & Tsikata, 2004). Whereas sponsors, buyers, dynamiters and chisellers are migrants

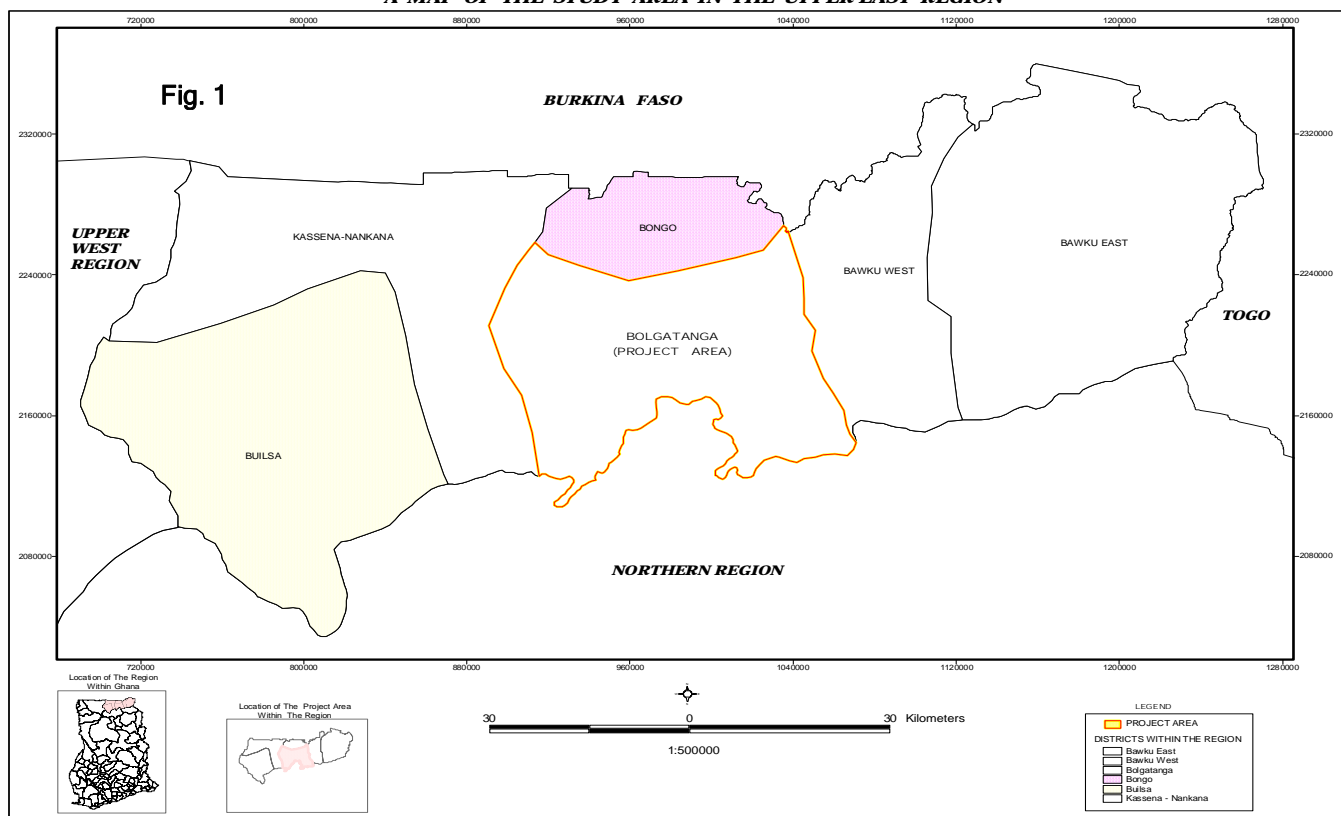
from outside the study area, most of the workers at the lower scale (loco boys, kaimen and shanking ladies) tend to be locals. Among the categories of mine workers, the shanking ladies who are women were the lowest in the hierarchy of labour relations with the lowest returns. Thus labour relations are linked to ethnic, migrant status and gender identity (Awumbila & Tsikata, 2004).

The zeal in investigating into the tendency of an area endowed with natural resources to attract people from all parts to itself and the effect the exploitation has in causing environmental health hazards has been brought to the fore by many people. Hilson (2001) observed that there is the tendency for an area endowed with natural resources to attract high numbers of people to the community with the aim of exploitation. This sometimes lead to overcrowding and environmental related problems such as poor sanitation, water and air pollution, land degradation and health related problems. This article argues in this line that there is direct relation between small-scale mining activity and population size and health hazards.

Bolgatanga district into two administrative districts, namely Bolgatanga and Talensi-Nabdam with Bolgatanga as the regional capital (Crawford, 2004). They are located on the north-eastern corridor of Ghana between longitude 1°W and 0°E and 10°N and 11°N and cover an area of 1,509 km² or 16.7% of the 8,842 km² of the Upper East Region of Ghana. The estimated population is 229,768 or 24.8% of the population of the Region which was 917,251 in 2000 according to the Population and Housing Census for 2000 (Ghana Statistical Service, 2000).

The area falls within the Dickson and Benneh (1988) Guinea savannah zone that lies between 8° N and 13° N and corresponds to the tsetsefly zone known as the “middle belt” of West Africa. It is part of the tropical continental climatic zone characterised by pronounced dry and wet seasons (Benneh *et al.*, 1990). Rainfall is usually infrequent, discrete and largely unpredictable. The peak rainfall period is usually late August and early September with 60% of it occurring within the months of July to September (IFAD, 1990). Periods of dry season usually last for 5 to 6 months, from November to late

A MAP OF THE STUDY AREA IN THE UPPER EAST REGION



Profile of study area

The area of this study consists of the Bolgatanga and Talensi-Nabdam districts of the Upper East Region of northern Ghana (Fig.1) are described as one of the most deprived and degraded areas of Ghana. The districts were created through the splitting of the former

March, with occasionally droughts at the beginning of rainy season (Bolgatanga Meteorological Service, 2003).

Its soils are characterized by shallow, low in organic matter content and coarse in textured luvisols in the north eastern portion of the study area with ample evidence of the presence of minerals, especially gold. Soils are

formed out of the rock types and the underlying geology which is mostly granite, birrimian rocks and sandstone producing loamy sand, sandy loam and sandy clay loam through weathering processes (Senaya *et al.*, 1998).

The surface relief is characterized by flat to gentle slope with uplands of an average elevation of about 300m above sea level which are mostly found in the Tongo and Pwalugu areas of Talensi-Nabdam district. The main rivers are the White and Red Volta and their tributaries. Drainage is mainly by the White, Red Volta, Sissili, Kulubiliga, Owon and Kuldage Rivers (Upper East Coordinating Unit, 2003) with Kulubiliga and Kuldage as the main tributaries of the White Volta.

The study's area population has risen from 183,800 in 1990 to 229,768 in 2000 with 20,416 houses and average household size of 5.8 compared to the 1990 of 5,432 houses with average household size of 3.7. Population density, as at 2000 was 174 persons/ km², as against 1990 of 140.1 persons/ km², with the sex ratio of 48% males and 51% females compared to 1990 sex composition of 56% and 44% respectively (Ghana Statistical Service, 2000). On population structure, it is estimated that 1 out of every 8 persons is a child below the age of 5 compared to the 1990 where the estimated figure was 3 out of every 8 persons. It is also estimated that 19% of the population as at 2000 were youths of age between 15-19 years as against 10% in the 1990s. The percentage population by age between 20 to 55 years is about 45% of the entire population as at 2000 as against 32% in the 1990s. The older population of 65 and above forms the smallest portion of the entire population of about 9% as against 17% in the 1990s (Ghana Statistical Service, 2000).

According to the Bolgatanga District Assembly Report (2002), the area received its highest proportion of Ghanaian migrants during late 1990s; most of them were between 20 to 55 years and mostly from southern Ghana. According to the Population and Housing Censuses for 2000 (Ghana Statistical Services, 2000), about 65% of the total Ghanaian migrants come from the southern regions of Ghana and mostly from the Ashanti and Western Regions. Migrants from outside Ghana make up of 7.9% of which about half of them are Fulani herders from neighboring Burkina Faso, Mali and Niger. About 20% of the total workforces in the study area are migrant workers. In the Bolgatanga Township, about 40% of the populations are Ghanaian migrants of which 15% are aged between 20 to 45 years, thus very different from the 1990 population figures, where migrant workers were 5% of the total workforce and were mostly civil servants. The two adjacent regions (northern and upper west) do not appear to be a significant pulling factor for migrants into the study area as they account for about 22% of the migrant forces.

The area is predominantly rural (with about 85% of the indigenous population concentrated in the rural areas in 2000 compared to 97% in the early 1990s) with less

economic and infrastructural development. Most of the rural communities are found in the Talensi-Nabdam district which, over the years, has received less infrastructural and developmental projects and attracted very few migrant populations. In essence, the rate of urbanization in the Bolgatanga districts, for the 14 year period of study, far exceeds that of the Talensi-Nabdam district. Major economic and infrastructural developments that have occurred since 1990, mostly in the Bolgatanga district, and include social facilities, electricity, international communication centre, hospitals, schools, hotels and a sport stadium (Bolgatanga District Assembly Report, 2002).

There has been a great change in the number of ethnic groups in the area for the 14 year period of study. The original ethnic tribes in the area are Gurunne (Frafra) from Bolgatanga and the Nabte of the Talensi-Nabdam. Other ethnic migrant groups from the other areas in the north include the Builsa, Busanga, Kasena, Kusaasi, Mamprusi, Moshi, Sissalas, Wangaras, Busangas, Dagaaba, Dagarti0073, Mossis, Dagomba and Nankani. There are also a number of migrants from other regions of the country, especially the Asantes, Bonos, Ewes and Fantes few of whom are government workers with the majority engaged in the informal sector. Other migrants are from the neighbouring Togo, Mali, Nigeria and Burkina Faso (Bolgatanga District Assembly report, 2002). The influx of migrants started in the early 1990s shortly after the economic recovery programme that saw the initiation and implementation of major infrastructural development coupled with the legalisation and promulgation of the small-scale gold mining activities (Ghana Statistical Service, 2000).

The two major forms of extractive activities in the area are mining (at the small-scale level) and quarrying (at the commercial level) that attract 4.5% of the total workforce of whom 80% are migrant workers from the Ashanti and Western Regions of Ghana. The two commercial quarries, situated in the Talensi-Nabdam district, are the Upper Quarry Limited, located at Pwalugu, and the Granite and Marbles Company Limited, located at Tongo. The former produces granite chippings for the construction industry whilst the latter cuts rocks in the form of bricks for export. About 90% of the unskilled workers are local with very few unskilled and skilled migrant workers most, of whom are technicians and supervisors. The unskilled workers are originally from the surrounding communities of Tongo, Pwalungu and Winkogo of the Talensi-Nabdam district. Sand winning and stone cracking is another major source of income for most women and children in the communities especially in the Talensi-Nabdam district. According to the Bolgatanga District Assembly Report (2000), the activity has, recently, attracted more women as a result of poverty and lack of employment for most of the women in the area (Bolgatanga District Assembly Report, 2002).

Data sourcing

The population universe of the study area has an estimated population of 229,768 (Ghana Statistical Service, 2000) making it impossible to involve the entire population in the study. As such, it became sensible to sample a number of individuals and groups of people such that their views, opinions and perceptions would represent the larger population group from which they were selected. To achieve this, purposive sampling technique (Cameron, 2000) was used based on participants' local ecological knowledge, knowledge on environmental degradation and small-scale mining activity. Selection was done with the initial consultation with the district assemblies planning officers through the districts chief executives and the village leaders. The interview and discussion protocols ensured that the same questions were given to all participants and also provided flexibility to the participants to allow the emergence of new issues of relevance. All together 8 interviews and 8 focus group discussions were conducted. Key informants selected included representatives from the following organization and agencies: Regional Coordinating Council (RCC), Bolgatanga; Environmental Protection Agency; Mining and Mineral Commission, Bolgatanga; Lands Commission; Upper East Regional House of Chiefs; Talensi-Nabdam District Assembly; Bolgatanga Municipal Assembly and; Surveying Department in Bolgatanga. Eight focus groups were purposefully selected as follows: Concern Youth Group (Bolgatanga), Women's Association (Bolgatanga), Farmers Association (Bolgatanga, Talensi-Nabdam Communities), representatives from Pwalugu and Tongo communities, heterogeneous community focus group, heterogeneous organisations focus group, small-scale legal underground miners at Duusi in the Talensi Nabdam District and small-scale illegal surface miners at Nangodi near Tilli of the Bawku West district.

Location of small-scale mining sites: GPS survey

Participants' responses to the identification, locations and spatial coverage of small-scale mining activities were validated during GPS transect walk where point coordinates of the identified land uses were measured.

Participants' perceived that there has been recent encroachment of small-scale mining activities in the study area and indicated the intensity of such extractive activities on the natural and social environment. It was observed that of the total 1,509 km² of the study area, approximately 367.4 km² or 24% of it is currently used for small-scale underground mining and have operated within the Mining and Mineral law (PNDCL 153) which was originally a 72 km² concession site and located in the south-eastern of Bolgatanga in the Talensi-Nabdam

Table 1. Spatial extent of identified and measured land uses

Human activities	Spatial extent (km ²)	Percentage (%)
Small-scale underground mining	82	5.4
Small-scale illegal surface mining	258	17

District near Duusi. The contradictory size of 82 km² as against the original 72 km² concession site pre-supposes that an additional 10 km² have been encroached by some unscrupulous miners. As noted by one key informant, the encroachment of the site for mining activity is due to the influx of miners from the south. What is happening in the study

area is not different from what is pertaining in other mining areas in Ghana such as Agogo, Obuasi, Tarkwa, Prestea, Bibiani and Konongo. Studies done by Agyapong (1998) at Tarkwa in the Western Region of Ghana for example, show similar experience as underground illegal miners have encroached vast areas of vegetative lands and have rendered them derelict through their crude and unsustainable mining operations.

Also evident in Table 1 is the small-scale illegal surface mining that covers 258 km² or 17% of the study area. The encroachment of the sites as noted by a few key informants is attributed to the influx of mining workers from the south and the perceived cheap labour in the north. The assertion by Aubynn (1999) that the nature of small-scale surface mining activities tends to impact severely on the natural and social environment reflected participants' views, as most of them, with the exception of the small-scale miners, saw the activity as exerting much pressure on the environment. Observation made during the GPS coordinates readings and interactions with research participants contradicted the assertion made by Griesbach and Sanders (1998) that land users, especially miners, unintentionally, degrade the environment from which they make their living, as the opposite is true in the study area where miners indiscriminately and intentionally degrade the environment with the aim of acquiring more wealth.

Another issue raised during discussions and interviews was the comparative analysis between surface mining and underground mining and their impacts on the natural and social environment. Most participants noted that underground mining poses a serious threat to the environment compared to surface mining. Acquah (1992) in his study on mining and environmental impact in Ghana observed otherwise as he concluded in his report that small-scale, illegal surface mining is more threatening to the environment than the underground small-scale mining, because of the former's reflectivity on the surface, and pollution of water and air. Other authors have also argued that surface mining is more spatially destructive and that the activity produces more waste than underground mining (UNEP, 1993; Ripley, *et al.*, 1996). Aubynn (1999), in his research findings at Wassa West District of western Ghana, concluded that at Tarkwa and Prestea, underground mining is less significant in

terms of degradation compared to surface mining where degradation is usually phenomenal and tends to affect large areas. Similar observations were made at Obuasi in the Adansi West District of the Ashanti Region where surface mining have led to a vast area of land derelict (AGC, 1992).

Population dynamics

The Population and Housing Census for 2000 (GSS, 2000) of the Upper East Region estimated the increasing trend of population growth in the study area to be 183,800 in 1990 to 229,768 in 2000 with a projected figure of 303,332 in 2010 (Table 2). Participants interviewed perceived the increasing population numbers and density in the study area as a key factor related to the recent small-scale mining activity in both districts. Most of the key informants attributed the observed population growth to rising birth rates, decrease in mortality rate and the influx of small-scale mining migrants. Their view was in contrast to the focus group participants who attributed recent population growth in the two districts only to the influx of small-scale mining migrants from southern Ghana. According to the latter, their communities have been flooded by outsiders who, because of free movement, internal politics and weak tenure systems, have recently come from other communities in the north, from southern Ghana and other neighboring countries like Togo, Burkina Faso and Nigeria to engage directly or indirectly in the small-scale mining that disregard the fragility of the ecosystem. Most of the key informants interviewed, argued otherwise as they convinced themselves that high birth rates (natural increment) are largely responsible for increases in population growth in the study area. One of them commented in the local Akan dialect: "Yεεmo wo dodo" meaning "they like giving birth". One was of the opinion that the current traditional beliefs in most of the rural communities in the study area encourage child birth as children are seen as wealth to the parents, especially to the father as one of the achievements in life is partially measured by the number of wives and children one possesses. In most communities studied, it is a taboo to be barren and couples without children are not given any respect and are sometimes treated as outcasts. Despite their stand on the natural birth is responsible for increase population growth in the study area; key informants did not rule the influence of migrant small-scale miners as contributing factor

The focus groups, except for the miners, cited several instances where people who have migrated from the south mining communities, especially from Tarkwa, Prestea, Nsuta and Obuasi, first settled in the regional capital of Bolgatanga and later on moved to the peri-

Table 2 Population growth and density in the study area

Year	Population Growth	Area (km ²)	Population density/km ²
1960	34,275	1509	26.1
1970	95,010	1509	72.4
1984	146,658	1509	111.7
1990	183,800	1509	140.1
2000	229,768	1509	174.0
2010*	303,332	1509	231.0

* *Projected population growth and population density for 2010.*

Source: Population and Housing Census for 2000 of the Ghana Statistical Services (2000)

urban, rural communities in search of gold and other precious minerals. They further cited permanent return mining migrants as one of the major contributing factor to population growth in the study area. According to them these mining pensioners after living and working for several years in most mining communities in the south, returned home with their families and engaged in small-scale mining to make a living.

This trend of population growth, as perceived by most of the research participants has led to increased pressure on land resources for farming, mining and settlements that have all contributed, in one way or the other, to the observed degradation and resource depletion in the study area. Other participants, mostly focus groups, commented on the migration of small-scale miners who, when faced with the downsizing and closure of their previous mining stations in the south, migrate northward, sometimes with their families, and engage in similar mining operations they are used to in the study area. Other participants cited temporary migrant traders for various petty trading activities in the mining communities of the study area (buying and selling). These issues raised by participants were similar to Kane (1995) and Myers (1997) who hypothesized that people are forced to migrate from their original areas to other destinations as a result of economic conditions in their areas of origin.

As argued in Malthusian theory, population growth is seen as direct threat to the environment (Ehrlich & Ehrlich, 1977; De Sherbinin, 1993; Gilbert, 1999). Boserup (1980) acknowledged that population growth and economic ventures create more demand for natural resources leading to environmental degradation. Geist and Lambin (2001) also asserted that population growth can affect changes in land-cover types through natural increments in terms of the number of people seeking land to cultivate, fuel wood or other economic ventures, labour markets, demand for agricultural and savannah forest products and institutional change. According to them, the larger population, the more intensive the exploitation of the environment by people to satisfy their basic needs for survival as large numbers exert more pressures on the environment through their direct use of the natural resources. The same is particularly true of the study area as most of the research participants perceived that the observed changes on the environment were due to an increase in population growth and scarce natural resources.

In response to the nature of migration, most participants noted that migrant mining workers are permanently staying in some of the study communities without any thought of returning to their place of origin. In

addition, they cited some small-scale miners who have originated from the south mostly from the Ashanti and the Western region, and have permanently acquired land, through unscrupulous means, for mining activities. Most of the miners interviewed explained that they moved because of depressed social conditions at their place of origin. According to them, moving away from home would somehow earn them respect and social recognition especially when they later return home with capital. Others had migrated in response to recent economic opportunities in the north. Key informants disclosed that the influx of mining workers is partly due to the promulgation and legalization of the small-scale mining industry that has attracted most migrants to the study

area. Most women working in the surface and underground mining sites are wives and concubines of small-scale miners who have migrated to join their partners. Others are merely pay day mining workers and are local women. None of the participants interviewed pointed out the issue of community neglect in their places of origin as a motivation of movement to the north as hypothesized by Nabila (1986) as one major reasons of rural-urban migration.

Participants also made comments on the direction of movements and commuting. Some migrants initially move directly to the mining areas while others initially get settled at Bolgatanga and later move to other areas in search of menial jobs. Movements have also been observed from other parts of the Upper East regions, such as Bawku West, East Mamprusi, West Mamprusi, Bongo and Kasena Nankana to the study area for mining and trading purposes. Others migrate from neighbouring Upper West and Northern Regions but according to participants, such movements are temporary as migrants usually return to their places of origin when alternative jobs are found. It was also observed that some mining migrants from the south initially settled at Tamale in the northern Region and later migrated to the Upper East Region in search of menial jobs.

Participants, mostly focus groups, also discussed the issue of internal migration or commuting especially from the densely populated Bolgatanga community to peripheries of the study area. As most of them observed, such movements are temporary and for petty trading, firewood collection, hunting, farming and sometimes mining. The same is not true of the migrant mining workers who, after settling in the Bolgatanga community,

later move permanently to the mining communities. This was validated during interactions with the miners' focus groups. It is not the usual case of the migrant small-scale mining workers, who have migrated from the Bolgatanga community and have permanently settled in the mining sites. Reactions from most of the participants revealed that these internal migrants and their activities, apart from the small-scale miners, have minor effects on the natural and social environment as their numbers are few and most of them are farmers.

Health hazards

Insights into opinions on health risks associated with the small-scale mining activities were sought by requesting participants' responses on a number of issues relating to common diseases perceived to have resulted from small-scale mining activity. Diseases viewed to be directly associated with the small-scale mining activities are infectious respiratory diseases (common among those living in the environs of the quarrying factory in Pwalugu and sand and stone winning at Kongo), skin diseases, outbreaks of malaria, typhoid and cholera (exacerbated by water-trapped in the deep trenches of the small-scale underground mines). Table 3 shows the rate of incidence of prevalence diseases in the study area perceived to be directly related to small-scale mining.

There is an increasing trend of reported cases of malaria from 16,636 representing 9% of the population in the 1990 to 74,697, representing 29.4% of the population in 2004. The incidence of reported cases of respiratory tract infections has also increased from 4,356, representing 2.4% of the population in 1990 to 8,760, representing 3.5% of the population in 2004. Reported cases of skin diseases also increased from 1,677, representing 0.9% of the population during the 1990 to 7,551, representing 2.9% of the population in 2004 and tuberculosis with an increase from 133, representing 0.07% of the population in 1990 to 143, representing 0.05% of the population in 2004.

Most of the research participants commented that the small-scale legal underground mining is partially responsible for the increase in malaria incident in the study area. According to them, the nature and operations of the underground mining activities promote modifications of the land-cover that favour malaria vector development. The activities create water trapping trenches, divert watercourses and promote bodies of stagnant water especially during the rainy season that have been instrumental in the spread of malarial vectors; anopheles mosquito egg development.

Respiratory infection, through constant inhaling of dust particles, was also found to be more pronounced in areas such as Kongo, Pwalugu, Tongo, Winkogo and Nangodi where sand and stone winning, quarrying and small-scale illegal mining activities are common.

Table 3. Prevalence common diseases in the area (1990, 2000, and 2004)

Common diseases	1990 and % by population	2000 and % by population	2004 and % by population
Malaria	16,635 (9%)	71,207 (30.9%)	74,697 (29.4%)
Respiratory infection	4,356 (2.4%)	8,520 (3.7%)	8,760 (3.5%)
Skin diseases	1,677 (0.9%)	4,764 (2.1%)	7,551 (2.9%)
Tuberculosis	133(0.07%)	118 (0.05%)	142 (0.05%)

Source: Regional Bio-Stats Office, Bolgatanga

Skin diseases which were also observed to be common in the study area especially in the mining communities were the result of the crude use of mercury in the washing and processing of gold ore. Most of the research participants, with the exception of the miners, attributed the high incidence of skin diseases to the nature and operations of small-scale mining activities.

Migrant workers have the potential to transfer diseases between the locations they work. The local groups interviewed expressed concerns that the migrant workers have contributed to the increase of sexually transmitted diseases (STDs) and diarrhoea. According to the statistics obtained from the Regional Bio-Stat office at Bolgatanga, in 1990, the monthly reported cases of diarrhoea incidence in 1990 was 139 as against 245 in 2004. Sexually transmitted diseases have also assumed an increasing trend in the area, according to participants, even though statistics were not made available to us to substantiate the claims.

There was no evidence, during the interactions with the participants, to suggest that health risks associated with the various human activities were misunderstood, even among the small-scale miners, thus contradicting the earlier assertion made by Barry (1997) and Rawana (2000) that small-scale miners are unaware of the health implications of their activities. During discussion, a small-scale illegal miner at Nangodi had this to say: *"the operation is risky in terms of health and my plans are to return home to rest and undertake medical treatment"*. Another small-scale illegal miner commented: *"Your health is always more important, that is why one should not stay here for far too long"*. These comments thus suggest the pre-knowledge of the health implication of the small-scale mining by miners in the study community.

Research participants and their perception of their environment

This study, among others, demonstrated the value research participants attach to their natural environment. It was revealed, during interviews and focus group discussions, that most of the research participants were quite knowledgeable on matters relating to their immediate environment and prepared to share ideas on the nature and causes of environmental degradation and what ought to be done to realize a better environment. All the key informants and focus group participants who that took part in the interviews and discussions appreciated that their environment had, over the years, deteriorated and attributed that not only to the prevailing harsh climatic conditions, but also to various identified social driving forces and human activities that have continuously exerted pressures beyond the carrying capacity of the environment.

An interesting aspect of the findings was that as most of key informants attributed the cause of the observed environmental changes to indirect causes such as economic policies, mining and mineral policies and

migration; most focus group participants attributed the problem to poverty and attitudinal changes. Other inconsistencies observed were the differences in opinions among the key informants concerning the promulgation of the Mining and Mineral law (PNDCL 153). As most of the key informants attributed the influx of migrant workers to the legalization of the small-scale mining (PNDCL 153), others were of the opinion that the influx has nothing to do with the PNDCL 153 but as a result of current infrastructural development in the region. Most of the focus group participants, with the exception of the small-scale miners, regarded the environment as their own entity and attributed the observed changes on the environment to poverty, attitudinal changes and migration.

Clues for policy makers on the use of the research findings

This section elaborates how policy makers can make use the results of this research.

- the information gathered can help decision makers to know the socio-cultural implications of environmental problems and take more holistic steps in solving them;
- The PNDCL 153 that tends to legalize, unreservedly, the activities of small-scale mining, in the country could be amended based on the findings of this study. The case of illegal small-scale mining in the study area serves as an example of how environmental regulations and laws, regardless of how good they are on paper can leave communities more vulnerable, in terms of population size and health hazards, than before;
- The findings of the study will help policy makers to come to the realization that a healthier environment cannot be achieved without adequate involvement of local people who are agents and sufferers of environmental problems. This is important as environmental protection depends not only on government policies and regulations but the people who live in the environment, depend on natural resources for sustenance and expect benefits from it;

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