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Environment and Health Perceptions in the Vicinity of Surface Mining Concessions in the Upper West Region of Ghana

Roger Antabe
The University of Western Ontario

Supervisor
Dr. Isaac Luginaah
The University of Western Ontario

Joint Supervisor
Dr. Godwin Arku
The University of Western Ontario

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Abstract

The emergence of a gold mining industry and the influx of Artisanal Small Scale Mining following recent discoveries of gold deposits in Northern Ghana have posed new socio-cultural, economic, environment and health challenges for residents in a dry savannah zone that is already facing negative consequences of environmental change. Yet, knowledge of the impact of this emerging industry on the health of local population, and the extent to which it makes such a stressed environment more uninhabitable, has been lacking. In addition, studies elsewhere, mostly in the southern part of the country where mining predominates, have largely concentrated on assessing the impact of mining activities on the physical environment (i.e. water bodies, soil/land and air). This thesis examines perceptions of residents on the impact of mining and environmental exposures on individual and community health and wellbeing in the Upper West Region of Ghana. The study utilised cross-sectional data (n=801) collected on household heads in fourteen mining communities in the region, and employed negative log–log and binary logistic regression analytic techniques to examine the impact of environmental exposures from mining on residents’ self-rated health and their desire to relocate from their traditional communities. The findings suggest that, in areas inundated with mining activities, residents closest to mining operations (impacted communities) who were either neutral or believed mining activities caused health problems were more likely to rate their health as poor compared to those who did not believe mining activities caused health problems (OR=2.01, p≤0.001 and OR=1.98, p≤0.001, respectively). Interestingly, only those who were neutral to the impact of odours on poor health in the affected communities were
more likely to rate their health as poor compared to those who did not believe it had a health impact (OR=1.53, p≤0.1). On the desire to relocate from the community however, residents who complained they were not adequately informed about the mining operations and those who were of the view that mining operations were not meeting environmental standards, were more likely to consider relocating from the community (OR=2.10, p≤0.001 and OR=1.61, p≤0.1, respectively). Furthermore, the study found that age, gender, education, wealth and religious beliefs have an influence on residents’ self-rated health and their desire to relocate in relation to mining exposures. The emerging mining industry potentially is exacerbating the already stressed environment, contributing to poor health, and forcing local populations to abandon their traditional communities. It also highlights the dichotomy between “expert” versus “lay” understanding of what constitutes substantial health risk during environmental exposures. It is recommended that, aside the urgent need to review Ghana’s Minerals Act and “expert” health risk assessments, there should be a strong enforcement of environmental best practices in mining operations and an effective engagement of communities for partnership in mining activities. Specialized health, environment and food security policies and intervention are recommended to reduce the vulnerabilities of mining communities in the Upper West Region of Ghana and in similar contexts in Sub-Saharan Africa.

**Key words:** Environmental Exposures, Artisanal Gold Mining, Health risks, Self-rated Health, Community Wellbeing, Upper West Region, Ghana
Co-Authorship Statement

This thesis is made up two papers which are at different stages of being processed for publication (Chapters 4 and 5). The research problem, objectives and how the two manuscripts are integrated have been outlined in the introductory chapters (1 and 2). The study methods are described in Chapter 3. Chapter 6 gives the summary and conclusion to the thesis and highlight its contributions to literature and methods, implications for policy and suggestions for future research. The research manuscripts are as follows:

**Chapter 4:** Antabe, R., Luginaah, I., & Godwin, A. Community health effects of surface mining in the Upper West Region of Ghana.

**Chapter 5:** Antabe, R., Luginaah, I., & Godwin, A. To move or not to move: community reaction to surface mining in the Upper West Region of Ghana.

While all the papers are co-authored with my thesis supervisors, their role was to guide the study and review drafts of the chapters and the entire thesis. As the first author, I conducted the actual research that involved problem identification, literature review, data collection and analysis, and writing.
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Chapter 1: Introduction

1.1 Background to the study

Mining involves the process of digging up or extracting naturally occurring minerals from the earth (Amponsah-Tawiah & Dartey-Baah, 2011; Whyte & Cumming, 2007). Where the orebody of interest is deposited extensively on or close to the surface and extends several metres in depth, open-pit/strip/surface mining techniques are commonly used. Where the mineral of interest is deposited as a vein or a seam and extends several metres in depth, underground mining techniques are employed in the extraction process (Whyte & Cumming, 2007). Mining is the second oldest industry after agriculture, and is currently the fifth largest economic activity globally (Amponsah-Tawiah & Dartey-Baah, 2011; Down & Stocks, 1977; Madeley, 1999). For instance, by the end of 2013, the gold mining industry through both direct and indirect economic impacts, is estimated to have contributed a total of $171.8bn to the global economy (World Gold Council, 2015). From 2000 to 2013, the sector’s contribution to global GDP had increased by 700%. The economic importance of gold mining especially to the low and lower-middle income countries is remarkable as 70% of all mining related expenditures are procured locally, acting as an economic stimulus to the local economy (World Gold Council, 2015). Accordingly, the gold mining industry employs over one million people directly, generating employment indirectly for another three million people in industries that depend on the gold mining sub-sector. Most of the socio-economic benefits of gold mining activities are reported in Africa and Asia with total earnings of $15bn and $20bn respectively in 2013 (World Gold Council, 2015). According to the World Gold Council (2015), the contribution of gold mining to the economic development of Ghana for
instance surpasses what is received through development assistance programmes from her development partners. This emphasizes the importance of the gold extraction industry in sustaining the economies of developing countries.

**Figure 1-1:** Direct Gross Value Added (GVA) of the gold mining industry from 2000 to 2013

Source: Adopted from the World Gold Council Report 2015

In sub-Saharan Africa, Ghana is the second largest exporter of gold after South Africa and estimated to contribute 5.7% to the country’s GDP (Aryee, 2001). The mining sector, dominated by gold production, contributes some 18.7% to direct tax revenue and 14.3% of total domestic revenue, representing roughly 1.1 billion Ghana cedis (Ghana Chamber of Mines, 2014). Between 1984 and 2005, the mining sector attracted foreign direct investment of around US$ 6 billion (Akabzaa, 2009). During the same period, total annual mineral export increased from US$115.3 million to US$995.2 million, with the sector accounting for over 30% of gross foreign exchange earnings. The gold subsector
accounts for over 90% of the total value of minerals exported (Akabzaa, 2009; Sweeting & Clark, 2000).

Figure 1-2: Mineral revenue in Ghana for 2013 (US$ million)

Source: Ghana Chamber of Mines, 2013

Mining activities (formal and informal) are estimated to employ close to 100,000 people across the country and serve as an alternative source of livelihood, particularly for residents in communities where mines are hosted (Aryee, 2001; Garvin, McGee, Smoyer-Tomic, & Aubynn, 2009). The mining sector accounts for 4% of total employment in the private sector (Bank of Ghana, 2007). Alongside livelihood creation and revenue generation, mining companies have contributed towards the socio-economic development of host communities, through corporate social responsibility (CSR) mandates which tend to complement the effort of central governments in the provision of social amenities and
infrastructure (Hilson, 2002c; Sweeting & Clark, 2000). By the end of 2013, the Ghana Chamber of Mines reports that mining companies invested a total of $12 million in corporate social responsibility targeted at improving the socio-economic conditions of host communities. In spite of the economic benefits of mining, it is associated with several environmental and health challenges (Malm, 1998; Ogola, Mitullah, & Omulo, 2002; Thornton, 1996). Consequently, there have been calls from International bodies such as the United Nations Environmental Program (UNEP) to regulate and reduce global environmental impacts of mining (see UNEP, 2011) and safeguard the health of residents in close proximity to mining operations. For instance, Armah et al. (2016) report that gold mining activities alone contribute 37% of annual emissions of atmospheric mercury. Mercury and other arsenic used in gold mining activities when ingested by humans have both short and long term health implications as it takes several years for mercury to be completely removed from the human body (Armah et al., 2016; Malm, 1998).

The degradation of the physical environment is one of the most visible side effects of mining operations for both large scale commercial mining and artisanal small scale mining (ASM). In Ghana, 58% of total forest cover in the Wassa West District of the Western Region was lost to mining activities between 1986 and 2002 (Schueler, Kuemmerle, & Schröder, 2011a). Similarly, 1,915 hectares of forest cover was destroyed between 2006 and 2009 in a gold production region of Peru (Swenson, Carter, Domec, & Delgado, 2011). Its impact on the hydrosphere is also widely reported and it is responsible for the pollution of both surface water (i.e. streams and rivers) and underground water (Akabzaa, Banoeng-Yakubo, & Seyire, 2009; Amonoo-Neizer,
Through mine effluents and tailing dams, leached arsenic contaminates sources of water for affected communities. Additionally, due to the massive removal of vegetation and earth material in surface gold mining, water bodies become silted posing danger to their longevity especially in catchment areas of mining operations (Akabzaa & Darimani, 2001). Where ASM activities are widespread, environmental pollution is rampant because of the dysfunctional policy sub-system that regulates their activities (Taabazuing, Luginaah, Djietror, & Otiso, 2012).

Host communities in mining concessions are the first to experience the adverse impact on the environment. Their health, economic activities, culture and daily way of life are impacted but, residents’ perception of their environment and health are observed to be influenced by a number of factors (Baxter & Greenlaw, 2005; Elliott, Cole, Krueger, Voorberg, & Wakefield, 1999; Heyworth, Reynolds, & Jones, 2009). Generally, residents perception of the potential health risk to environmental exposures is informed by the nature and pattern of the exposure (Flynn, Slovic, & Mertz, 1994), duration of the community’s association with the exposure (Luginaah, Taylor, Elliott, & Eyles, 2000), the economic benefits of the exposure (Garvin et al., 2009), the distribution of the risk and benefits of the exposure (Heyworth et al., 2009), residents attachment to the community (Baxter & Lee, 2004), the social and cultural values of the community (Baxter & Greenlaw, 2005) and the general world view of the affected community (Baxter & Greenlaw, 2005). Researchers therefore posit that individual and community perceived health risk from environmental exposures are socially constructed. In theorising perceived health risk, researchers have advanced various paths through which residents
come to perceive exposures as potential health risks. These include the psychometric (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Slovic, Fischhoff, & Lichtenstein, 1985; Paul Slovic, 1987), econometric (Alhakami & Slovic, 1994; Baxter & Greenlaw, 2005; Starr, 1969), geographic (Burton, Kates, & White, 1968; Paul Slovic, Kunreuther, & White, 1974) and social/cultural (Baxter & Greenlaw, 2005; Broto, Burningham, Carter, & Elghali, 2010).

Originating from the works of Fischhoff et al. (1978) and Slovic et al. (1982), the psychometric theory of health risk perception uses a psychophysical scaling and multivariate analysis to examine responses to a number of hazards, which enable the researcher to make a judgement on perceived riskiness and desired regulation of each hazard by members of the community. According to Slovic et al. (1986), the scores from the quantitative measure are then compared to a number of factors associated with each risk, such as benefits, known fatalities for each hazard recorded per annum, severity of deaths associated with each hazard and how these compare to deaths from other sources. Thus, risk analysis using this approach constructs “cognitive maps” to represent individual and community attitude to risk and perceptions of risk.

The econometric theory on the other hand examines risk perceptions by assessing how residents perceive risk from a hazard based on the type of exposure (voluntarily or otherwise) and the associated socio-economic benefits (i.e. health, education and income) (Alhakami & Slovic, 1994; Baxter & Greenlaw, 2005; Starr, 1969). According to this theory therefore, where adverse health and environmental impact is perceived to outweigh community gains such as education, health and income, residents tend to rate such hazards as deleterious to their health. When residents perceive an overarching economic
benefit to the community, perceived health risk has been minimal (Alhakami & Slovic, 1994; Starr, 1969). Furthermore, Alhakami & Slovic (1994) in an analysis of perceived risk and benefits from exposures, discovered an inverse relationship between the two, where increased perception of community gains from a hazard exposure meant reduced perception of adverse health impact and vice versa. According to Baxter and Greenlaw (2005), the geographical theory of risk perception is rooted in cultural ecology and environmental risk research, both of which are used to study how residents adjust to natural disasters such as floods and earthquakes. Accordingly, when people are faced with uncertainties such as natural disasters or hazards, the potential risk is assessed based on a “limited cognitive” process, where affected residents are forced to simplify the risk, with subsequent decisions on the potential risk of the hazard being based on this cognitive process (Baxter & Greenlaw, 2005; Burton et al., 1968; Paul Slovic et al., 1974). However, attachment to the community or the sense of “place” for affected residents is known to also influence this cognitive process (Atari, Luginaah, & Baxter, 2011; Baxter & Greenlaw, 2005; Broto et al., 2010). This perhaps explains why residents in the same exposed community may assess potential health risk differently.

According to the social/cultural theory of risk perception, culture and socially inclined values of residents play a major role in determining which hazards are marked as potential health risks or otherwise. As residents are embedded in the community structure, their values, attitudes and worldviews are synched with that of the community. Their values and worldviews then become the cognitive filter for assessing potential health risk during environmental exposures (Douglas & Wildavsky, 1983; Rippl, 2002; Stern, Dietz, & Guagnano, 1995). Thus, hazards that disrupt the daily lives of residents and conflict
with their social or cultural values are selected for amplification, while those that are assessed to have minimal impact on these values are dismissed (Baxter & Greenlaw, 2005; Wildavsky & Dake, 1990). For instance, a community described as hierarchical will easily dismiss hazardous exposures as potential health risk once they have been assured by a government or a regulatory agency that the exposure does not constitute a substantial health risk. This assurance will be met with skepticism from an “egalitarian” community which harbors little trust for organized and hierarchical institutions such as government (Wildavsky & Dake, 1990). According to this theory therefore, people choose what to fear and even how to fear it based on their peculiar socio-cultural persuasions and worldviews (Wildavsky & Dake, 1990).

Residents’ environmental perceptions of mining activities are also intrinsically linked to perceived short and long term impacts on their health considering the fact that complaints from residents in host communities are often centred on health risks (Akabzaa & Darimani, 2001). Traditionally, mining companies and regulatory agencies have relied on “experts” to investigate the potential health risk of mining operations in affected communities. The conclusion from their findings is typically contentious between the mining companies and regulatory agencies on one side and the affected communities on the other, especially where such findings contradict the community’s own assessment (Kraus, Malmfors, & Slovic, 1992; Slovic et al., 1995). This development has been attributed to the difference between “expert” and “lay” pathways or methodology in environmental risk assessment. Although detecting possible health impact during environmental exposure remains largely uncertain due to a number of factors (see Anson, Paran, Neumann, & Chernichovsky, 1993; Luginaah et al., 2000; Sen, 2002), mining
companies and regulatory agencies continue to employ its use to declare mining operations as safe for affected communities.

The impact of mining on culture, social organization and the livelihood of residents have also been widely discussed in the literature. Indigenous people are often displaced and alienated from their culture and ancestral lands (Aubynn, 1997). In surface gold mining where large tracts of land is required for operations, indigenous people whose livelihood is mostly agrarian are left with limited options for subsistence farming, when lands are acquired by the state and leased to mining companies (Hilson, 2002a). Increased crime rates, rising cost of living and general social disorganization are some of the commonly found social impacts of mining activities (Akabzaa & Darimani, 2001; Aubynn, 2004)

This research aims to examine the impact of mining operations on fourteen (14) affected communities in two Districts in the Upper West Region of Ghana. In the midst of seizures of community farmlands, pollution of the rural landscape and mining activities that may be at variance with the culture of the people, residents’ perceptions are examined on the suitability of their communities as a place for human habitation.
1.2 Research Objectives

Given that gold mining in northern Ghana is an emerging activity, there is limited literature on how residents in this study area perceive mining activities to impact their health and environment. Moreover, as more mining companies continue to secure licensing to prospect for gold in the study area, this study seeks to examine factors influencing residents’ perceived health risks and attachment to their community. Residents are asked for a self-assessment of their health status and their readiness to evacuate the community due to the mining activities. This research is timely in this regard and findings will contribute to policy discourse which will help address health, social and environmental impacts of mining in this emerging mining cluster and other prospective...
host communities in northern Ghana and elsewhere. The study is guided by the following research questions:

1- How do residents in mining impacted and affected communities in the Upper West Region of Ghana rate their health in the midst of perceived environmental exposures?

2- How does the perceived impact of mining affect residents’ satisfaction with their community as a place to live?

3- Does relative social status, namely, education and income levels predict health and environmental perceptions in host communities in the Upper West Region of Ghana?

1.3 Thesis Structure

This thesis is organized into six (6) chapters. Chapter 1 gives a general introduction to gold mining including associated benefits and challenges. It justifies the need for this research by stating the research objectives and how this study will contribute to policy in mitigating the impacts of mining. Chapter 2 continues with a detailed account of the literature by discussing the work of researchers on the impact of mining on affected populations, ranging from health to environment, livelihood and culture. Chapter 2 further elaborates the concept of self-rated health, its importance in predicting morbidity and mortality of a target population and why it is adopted for this study. Chapter 2 concludes by situating this research in the broader field of the geographies of health.

Chapter 3 gives a detailed account of the research design and methods used for the study. There is an extensive discussion on selection of research sites, survey instrument,
sampling and the actual data collection in the field. It continues with the analysis of the data and the various theories adopted for the study and how they relate to this particular research. Chapter 4 is the first manuscript of the thesis which examines self-rated health in impacted and affected communities in the research area. Chapter 5 (the second manuscript), examines whether it is residents’ dissatisfaction with the mining activities that is likely to push them out of their communities. Chapter 6 provides a summary of the major findings of this research, its contribution to literature, methods, policy and highlights possible suggestions for future research.
1.4 References


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Ogola, J. S., Mitullah, W. V, & Omulo, M. A. (2002). Impact of gold mining on the environment and human health: a case study in the Migori gold belt, Kenya, (Figure 1), 141–158.


Chapter 2: History and Discourse on Gold Mining in Ghana

2.1 Introduction

This chapter reviews literature on mining with a focus on Ghana. While this section acknowledges the importance of mining to the local economy of Ghana, it highlights the associated adverse impacts of mining activities on affected populations. It begins by describing the pre-colonial, colonial and post-colonial gold mining in Ghana, elaborating on the key events that have characterized the industry. It continues with a review of the literature on its impact on the quality of the physical environment and health. Furthermore, the chapter assesses the literature on the economic and socio-cultural impacts which are key in the gold mining discourse. It concludes with a discussion of the perceived health of residents in exposed environments.

2.2 Mining in Ghana

Gold mining is one of the oldest human economic activities dating back to the earliest hunting period in ancient Egypt (Klemm and Klemm 2012, page 3). Globally, mining employs a significant number of local populations and sometimes assist with the provision of social amenities for the resource communities (Akabzaa and Darimani 2001; Aubynn 2004). Mining is considered a significant contributor to the economic development of many countries generating revenue for government and creating employment for residents in host communities. In Ghana, the importance of mining to local economies dates back several decades before the arrival of Europeans in 1471.

Ever since, mining in Ghana has received extensive scholarly attention ranging from the effect of the Structural Adjustment Programme (S.A.P) on the mining industry (Hilson,

2.2.1 Mining in the pre-colonial period

Ghana has been associated with gold mining for several decades (Sweeting & Clark, 2000). Historians report of a thriving gold industry prior to colonization (Hilson, 2002a). Gold was extracted through alluvial and surface mining along the banks and beds of some of the major rivers in the country. Although alluvial mining was widespread, other forms of mining like shallow pits and deep shaft were also practised. The earliest recorded gold trade between tribal clans of pre-colonial Ghana and foreign traders were with the Moors and Phoenicians through the trans-Saharan trade routes (Anin, 1987; Aryee, Ntibery, & Atorkui 2003). The trans-Saharan trade became the first major influencing factor on gold mining activities in pre-colonial times. A pre-colonial gold extraction industry which hitherto was a part-time economic activity among the indigenes, quickly evolved into a full scale economic activity in response to the increased demand by foreign traders, leading to the extraction of 14.4 million ounces of gold between 1471 and 1880 when Europeans had joined the trade (Dumett, 1998; Sweeting & Clark, 2000).

The arrival of the Portuguese in 1471 (Annin 1992; Aryee, Ntibery, and Atorkui 2003) significantly changed the dynamics of gold mining in Ghana. Initially trading with individual tribes, Europeans merchants erected castles and forts along the coast which
coordinated the trade in gold. The colony was christened the “Gold Coast” when it came under the political control of the British Crown in 1874 (Aryee, Ntibery, & Atorkui 2003; Dumett 1998; Sweeting and Clark 2000). Due to the constant supply of gold from the colony to European markets by merchants, there was a heightened interest in commercial gold mining which led to a gold rush by European firms in the Tarkwa and Prestea areas in the South Western part of the colony (Annin, 1992; Dumett, 1998). However, the first mines to be owned by Europeans in the colony were located at the north of Komenda and at Aboasi in the Central region of Ghana. Both mines which relied on indigenous techniques had collapsed by 1636 through an earth tremor (Kesse, 1985; Kimble, 1963). Later, the gold trade in the Gold Coast became so lucrative that by the sixteenth century Portuguese traders had made a fortune of £60,000 through the sale of 8,153,426oz of gold from 1483 to 1600. This figure accounted for 35% of the total world production of gold during this era (Addy, 1998; Hilson, 2002b). After a prolonged period of stagnation in gold production in the Gold Coast due to the emergence of the slave trade, mining interest resurfaced with a French man named Pierre Bonnet known as the Father of Gold Mining in Ghana, who established the first Gold mining company called the African Gold Coast Company in 1878 (Rosenblum, 1972). Although the company never realized its dream to mine in the Cold Coast, it paved way for a number of European mining companies who took mining concessions in Tarkwa and Prestea in the Western Region and Obuasi in the Ashanti Region. By 1881/2 a total of seventy (70) mining concessions had been purchased with only five (5) actively mining and employing 2400 indigenous people to work on the mines (Hilson, 2002b; Silver, 1981).
The passing of the mining Concessions Ordinance in 1900, streamlined the gold extraction industry and paved way for large scale commercial mining interest with European technology and machinery in the Gold Coast (Hilson, 2002b). This also acted as the catalyst for modern industrial practices in Ghana (Aubynn, 2004). According to Tsikata (1997), among other things, the British Colonial administration sought to create a legal regime to regulate mining operations, specifically addressing problems that may arise between the mining firms and affected communities, and to secure revenue through the payment of royalties and taxes to the Colonial government. It also laid out the process of granting mineral rights and securing land title for European holders (Hilson, 2002b).

2.2.2 Mining in Post-Independent Ghana

At the time of Ghana’s political independence, there were a total of eleven (11) mines which were controlled by European Investors (Hilson, 2002b). In the immediate post-independence era, the new political administration aimed to nationalise all mining interest and exert total state control over all mining activities (Akabzaa and Darimani 2001). The establishment of the State Gold Mining Corporation (SGMC) in 1961 and the Ghana National Manganese Marketing Corporations (GNMMC) was to take over the management of some foreign controlled mining companies such as the Prestea, Bibiani Tarkwa, Dunkwa and Konongo gold mines and the African Manganese company at Nsuta (Akabzaa & Darimani 2001; Aryee 2001; Dumett 1998; Sweeting & Clark 2000).

This initiative was to secure jobs for Ghanaians and grant government direct access to foreign currency (Akabzaa & Darimani 2001). Because the overarching interest for nationalizing these mines was for revenue generation, job creation and access to foreign
currency, the mining companies became increasingly underfunded by governments with limited exploration of new and potential deposits. Mining equipment over time became obsolete and the once vibrant mining industry witnessed substantial decline with most of the mines operating at a loss (Akabzaa & Darimani 2001; Aryee 2001; Aubynn 2004; Dumett 1998; Sweeting and Clark 2000). According to Akabzaa & Darimani (2001), from the peak of gold production in the 1960’s, total production fell to 5.97 million oz in 1970, further declining to an estimated 3 million oz by the 1980. Gold production which had accounted for over 80% of the total foreign earnings from mineral sales for the country had significantly declined. This decline also contributed to the reduced supply of foreign exchange and general economic decline in the 1980’s.

After a series of government interventions between the 1960’s to 1980’s had failed to attract substantial private investment to revive the ailing mining sector (Akabzaa & Darimani 2001), the government opted for the Structural Adjustment Programme (SAP) and the Economic Reform Program (ERP) by the World Bank and the International Monetary Fund which was meant to revive the economies of economically struggling countries in sub-Saharan Africa with some emphasis on the mining sub-sector (Addy, 1998; Akabzaa & Darimani 2001; Aubynn, 2004). Among other things, the SAP and ERP were targeted at trade liberalization that allowed private participation in the mining sector with limited government participation and interference (Addy, 1998; Aryee 2001; Sweeting & Clark 2000). Trade liberalization associated with the implementation of the SAP, led to the collapse of local industries due to unfair competition from Western markets. Prominent among the collapsed industries were those that employed significant proportions of the population. The policy reforms in the agricultural sector, privatization
of essential services and the cut on social spending led to a fragile food security situation and a sharp increase in the cost of healthcare and education. Other effects were unemployment and limited access to essential services by the poor and rural populations who were disproportionately affected by the SAP (Akabzaa & Darimani, 2001; Garvin et al., 2009). The SAP and ERP although harsh in some of its recommendations, was successful in reviving the mining industry through the injection of much needed capital inflow from foreign investments (Hilson, 2004). The short term objective of the SAP was to reverse the rapid decline of gold production through the injection of capital, rehabilitate and replace broken down and obsolete equipment, introduce state of the art machinery, improve infrastructure, and the training of management staff on best practices in the mining industry (Akabzaa & Darimani 2001; Aryee 2001; Aubynn 1997; Aubynn 2004; Sweeting & Clark 2000). In the long term however, the SAP aimed to compel government to institute a new economic and legal regime that would attract foreign direct investment particularly targeted at expansion and exploration of minerals in the mining sector (Aryee, 2001; Aubynn 2004; Sweeting & Clark 2000). The establishment of the Ghana Mineral Commission in 1986 by the enactment of the PNDC Law 153 according to Aubynn (2004), was in response to reforming the mining sector by providing a “one-stop investment centre” for all mining related activities in the country. The law also made generous tax reductions, duty free imports on mining equipment, reduction in the rate of royalty payable to the state among other measures (Akabzaa & Darimani 2001; Aubynn, 2004; Sweeting & Clark 2000).

The changes led to a revitalization of the mining sector by reversing the decline and increasing investment (Aubynn 2004; Hilson 2002a). Subsequently, in 1994, gold
production had increased by 250% which was due to the massive capital investment of $4 billion (Aryee 2001; Hilson 2002a; Sutton-Pratt 1996). According to Hilson (2002a), from the 1980’s when the mining industry was at its downturn, gold production had increased by more than 700% from an annual production of 287,124 oz in the 1980’s to over 2 million oz per annum by 1998. Gold sale generated about 38% of total exports and 96% of total mining exports translating into an estimated value of $687 million in 1998 (Aryee, 2001). By 2001, the mining sector in general attracted 56% of total foreign investment to the country with 13% of the total surface area of Ghana designated for mining (Aubynn, 2004). The sector further expanded and attracted new mining interests over the years. By 2001, there were 154 Ghanaian and 83 foreign firms prospecting for gold and 11 that were at different stages of mining (Hilson, 2002a).

2.3 Small Scale Mining in Ghana

Globally, there are two forms of gold mining. Large scale commercial mining is marked by intensive capital investment, machinery and technology, while artisanal and small scale mining (ASM) is labour intensive, mostly unregulated, attracts limited capital investment and relies on simple technology and mercury (Aryee, Ntibery, & Atorkui, 2003; Aryee, 2001; Lawson & Bentil, 2014). ASM is predominantly practised in Africa, Latin America and Asia (Hilson, 2002c). It is a localised economic activity undertaken at the fringes of large scale commercial mining concessions with simple tools and technology by indigenes who are economically displaced (Aubynn, 2004; Hilson 2002b).

Globally, it is estimated that about 30 million people are directly engaged in small scale mining activities, which also serves as a source of livelihood for another 80 to 100 million
people (Armah et al., 2016). The large number of people involved in ASM has been attributed to the limited economic opportunities for indigenes in host communities as large scale mining companies take over community lands denying residents access to agrarian based livelihoods (Tschakert & Singha, 2007; Veiga, Baker, Fried, & Withers, 2004).

In Ghana, large scale commercial mining is dependent on foreign capital investment, a development linked to economic reforms (SAP and ERP) in the 1980’s (Akabzaa & Darimani 2001; Aubynn 2004). ASM is estimated to contribute 20-30% of global gold output (UNEP, 2006) and in Ghana, it accounted for 23% of total production by 2010 (Tetteh, 2010). Small scale mining became legal in Ghana through the passage of the Small Scale Gold Mining Law in 1989 (i.e. PNDC Law 218, 1989). Among other things, it requires prospective small scale miners to register with the Minerals and Mining Commission, offering the regulating agency the opportunity to monitor and implement environmental best practices while providing the necessary training and technical assistance where needed (Aryee et al., 2003). However, scores of ASM miners have decried the registration process as too laborious and bureaucratic making many small scale miners resort to mining illegally, a practice commonly referred to as “galamsey” (Hilson, Hilson, & Adu-Darko 2014). “Galamsey” mining constitute 90% of all ASM activities in the country (Tschakert, 2009).

ASM in Ghana is thought to have roots in small scale mining during the pre-colonial era where simple tools and techniques were used by miners to extract gold (Aubynn, 2004; Hilson 2002a), except for the use of chemicals like mercury for gold amalgamation (Dumett 1979; Hilson 2002b; Silver 1981). Currently, while large scale commercial
mining in Ghana employs only 20,000 people across the country, ASM is estimated to engage over 80,000 people (Aryee 2001; Aubynn 1997; Aubynn 2004). Between 1989 and 2000, ASM activities had produced some 870,000 ounces of gold with a value of $280 million (Aryee et al., 2003). Although most ASM activities are illegal, it is the biggest employer in the gold mining sub-sector (Aryee, 2001; Aubynn 2004; Suglo 1999).

Increasingly, ASM does not only attract indigenes displaced from their lands and livelihoods as posited by the mining literature, but locals from non-mining communities and more recently other foreign nationals, particularly Chinese (Hilson, Hilson, & Adu-Darko 2014).

Hilson (2002) contends that, although ASM is an economic force within the mining sub-sector creating employment for indigenes, it comes at an environmental cost due to a number of factors including i) low safety awareness and level of training, ii) poor exploitation of resources due to the selective extraction of rich ores, iii) low wages and chronic shortage of capital, iv) absence of environmental standards and v) utilization of inefficient equipment. Subsequently, ASM activities globally accounts for 37% of annual atmospheric mercury emissions (Armah et al., 2016). The deposition of mercury in the ecosystem could be irreversible or difficult to remove, and considering its potential health risk, it has become the most dangerous agent of ASM activities (Amonoo-Neizer et al., 1996; Bernhoft, 2012; Obiri, Mattah, et al., 2016). Additionally, considering the fact that most mining host communities are rural and largely depend on rivers and streams as sources of water for agricultural and domestic purposes, it poses a grave health threat to residents in host communities (Amonoo-Neizer et al., 1996). Surprisingly, although artisanal gold miners are at the greatest health risk from mercury exposure, most tend to
be ill-informed about its environment and health impacts (Armah et al. 2016; Paruchuri et al. 2010).

According to Hilson (2002), due to ASM’s migratory status, it is associated with the removal of vegetation leading to massive deforestation in communities where the practice is rampant. Specifically in Ghana, ASM encroach on mining concessions of large scale commercial mining companies pilfering the ore and leaving the landscape totally degraded without reclamation as required by law (Aryee, Ntibery, & Atorkui 2003; Hilson, Hilson, and Adu-Darko 2014). Aryee et al. (2003), categorize the impact of small scale mining into three, namely the impact on the lithosphere where small scale miners leave behind a “moon-like” landscape where excavations and pits covering large tracts of barren land consisting of degraded vegetation is left unattended becoming a receptacle for water and eventually breeding mosquitoes. Uncovered mine pits become death traps for residents in affected communities. Second, it impacts greatly on the hydrosphere where due to the extensive removal of vegetation and topsoil, the streams and rivers in addition to being polluted with arsenic and mercury become heavily silted. The unsafe handling of tailings also contributes to this siltation with long term implication for access to quality water and drainage patterns of affected communities. Finally, its impact on the atmosphere is associated with the removal of topsoil and processes that introduce dust and other pollutants such as mercury (Armah et al. 2016; Obiri et al. 2016). Consequently, even though ASM generates economic benefits to indigenes who are displaced by large scale mining operations, its health and environmental cost often outweighs the recorded gains (Hilson, 2002; Armah et al., 2016).
2.4 Impacts of Mining

2.4.1 Environmental Impact

2.4.1.1 Impact on Water Sources

The impact of mining operations, especially surface gold mining on the physical landscape, water bodies, soil/land, and water have been well documented (see Akabzaa and Darimani 2001; Balfors et al. 2007; Owusu-Koranteng 2008; Serfor-Armah et al. 2006). Besides residents’ concerns over the health implication of mining operations, the damage to the physical environment remains a primary source of grievance and has resulted in confrontations between mining companies and their host communities. Specifically in Ghana, several researchers have recorded the deleterious effect of mining activities on the physical environment some of which are deemed irreversible (see Akabzaa & Darimani 2001; Amonoo-Neizer, Nyamah, and Bakiamoh 1996; Asante et al. 2007; Smedley, Edmunds, & Pelig-Ba 1996). For instance, Akabzaa & Darimani (2001) highlight ways through which mining activities within Tarkwa impact the hydrosphere namely, i) the leaching of chemicals from mine tailings, dams and heap leach which pollutes surface and ground water sources, ii) siltation through increased sediment deposition in surface streams/rivers, iii) increased faecal matter in water and iv) dewatering. Effluents from mine processing plants which are high in arsenic are released into streams and rivers which predispose residents in affected communities to diseases and infections because they drink directly from them. Furthermore, arsenic deposited on the surface gets leached contaminating underground water which is accessible for domestic use through shallow wells and boreholes (Zhou et al., 2007). During mining...
operations, reaching gold bearing rocks involves the removal of large tracks of earth material which serves as a reservoir and a recharger for underground water sources causing a reversal in the direction of flow, while lowering the water table (Akabzaa and Darimani 2001). Formal mining activities combined with ASM lead to siltation and the decreasing levels of quality and quantity of both surface and underground water (Akabzaa & Darimani 2001; Amonoo-Neizer, Nyamah, & Bakiamoh 1996; Asante 2016). Since most host communities are rural and depend on rivers, streams and shallow wells as sources of drinking water, access to quality drinking water is becoming challenging as more lands are leased by the State to mining companies (Akabzaa & Darimani 2001; Akabzaa 2009). In spite of this evidence of possible health impacts of mining activities on residents through contamination of drinking water, impact assessments by regulatory agencies in mining environs in Ghana has been discouraging. As residents continue to bemoan the effect of mining activities on their physical health, its impact on their subjective health has been overlooked by researchers.

2.4.1.2 Impact on Ambient Air Quality

The ambient air quality of host communities is also affected by mining activities with health implications for residents. Mining activities have been associated with the release of sulphur dioxide, nitrogen dioxide, carbon dioxide and black smoke which has long term health implication for residents especially those with arthritis and asthma (Akabzaa & Darimani 2001; Boamponsem et al. 2010). Site clearing for mining activities, haulage of rock and earth materials, crushing and grinding of rock for gold extraction, rock and earth dams, roasting of sulphur ores in the process of refining the gold are the common sources of air pollution in host communities (Adriano 2013; Boamponsem et al. 2010;
Henyo 2011; Ntim M., Owusu-Boateng, 2013). González-Carrasco et al. (2011), reports that, in a community associated with both large scale and small scale mining in Ecuador, a test of ambient air quality revealed that levels of suspended mercury was alarmingly above levels considered safe for humans. In Prestea and Tarkwa areas of the Western Region of Ghana, Akabzaa & Darimani (2001), observed that, most affected communities had made several complaints to the local government office about dust pollution and the presence of smoke from mine sites in their homes. In test of lung function in two communities (i. e. Paboase & Akoti) in the concessional area of Chirano Mining Company in the Western Region of Ghana, participants were found to have a lowered lung function compared to the accepted level of function; suggesting a heightened level of air pollutants in these communities. Additionally, residents are affected by the constant noise pollution and vibration that emanates during the blasting of rocks (Akabzaa & Darimani 2001; Erdiaw-Kwasie & Mabunyewah 2012). In addition to the effect of the deafening noise and vibration on the health of the community, residents are also worried about its impact on their buildings, evident in the numerous cracks on the walls of their houses which pose physical danger to their lives (Erdiaw-Kwasie & Mabunyewah, 2012). Yet researchers continue to rely on “expert” assessment which totally ignores the subjective understanding of how these mining activities are impacting on health of the community. Combined with possible health impacts emanating from air pollution, the physical danger posed by rock blasting has the potential to push residents out of their communities.
Given the environmental problems posed by mining operation especially surface gold mining, many researchers and environmentalists have questioned the ability of lands leased out for mining operations to be able to support life and ecosystem after the mines have been decommissioned (Tetteh, Ampofo, & Logah 2015). There are reservations about biodiversity and the ability of the ecosystem to be reversed to its state prior to the commencement of mining activities. Ghose (2004) reports that, where mining firms are required by law to reclaim mined lands, due to the duration and process of storage, the soil becomes biologically unproductive; unable to support regeneration of the ecosystem. Other studies have revealed that, where the top soil may exist in mining concessions, erosion and other activities related to mining operations render the top soil skeletal and lacking in the necessary soil nutrients such as organic matter and nitrogen that are essential for plant growth (Wong, 2003). In concessions where top-soil exists, it may be heavily polluted by arsenic, mercury, lead, nickel, zinc, manganese which has implications for the abundance, diversity and interaction of soil organisms whose presence and activities enhance soil fertility and plant growth. By the end of mining activities, the presence of mine tailings, ponds, dams, leach heaps etc. delay the process of land regeneration implying it may take several decades for the land to support ecosystems and agriculture (Tetteh, Ampofo, & Logah 2015). In assessing the ecosystem structure by examining the physical and chemical properties, arbuscular mycorrhizal fungal (AMF), plant diversity and community composition of a pasture reclaimed mined land and non-mined pasture field, Levy & Cumming (2014) conclude that, reclaimed mine lands significantly alters the ecosystem. In addition to the presence of invasive
plants on the reclaimed mine lands, the soil physical property, the AMF and the plant communities were either incomplete or not recovered (Levy & Cumming, 2014). Therefore, reclaimed mined lands may not be able to support or regenerate the ecosystem to a state prior to the mining activities. Considering that most host communities are agrarian, the inability of reclaimed lands to support substantial plant growth will have implications for livelihoods in the future when mining operations in host communities comes to a close.

### 2.4.2 Health Impacts

The environmental impacts of mining translate into health problems in surrounding communities. Several studies on community perceptions of mining operations, reveal how residents perceive mining operations to be deleterious to human health (Balfors et al., 2007; Mensah & Okyere, 2014; Yeboah, 2008). However, findings from epidemiological studies on the effects of exposures in mining communities have been mixed. For instance, a comprehensive study of the mining literature by Stephens and Ahern (2001), reveal many epidemiological studies have linked both workers and residents in gold mining concessions to mercury intoxication and poisoning with recorded fatalities over time due to over exposure. In Ghana, residents in Tarkwa have elevated prevalence of diseases such as respiratory tract diseases, pulmonary tuberculosis and silicosis, skin infections, acute conjunctivitis, and mental health problems that are associated with exposures to environmental toxins (Akabzaa and Darimani 2001; Armah, Luginaah, and Obiri 2012). Eisler (2003), reports that, such ailments and morbidity associated with gold mining is disproportionally higher among residents who may be directly involved in the gold mining activities. Other researchers have made similar findings (Armah, Luginaah, and
Obiri 2012; Armah et al. 2012; Hendryx 2009; Wright et al. 2014). However, other studies such as Higgins et al. (1969) and Rojas et al. (2001) observed that there was no difference between residents who were directly engaged in mining activities and other community residents in the incidence of coronary heart infections and other diseases.

During the gold extraction process, traces of arsenic are deposited in the tailings dams, ponds and mine effluents which are eventually absorbed by plants/food crops, game and fish when leached into the ecosystem (Adimado & Baah, 2002; Akagi, Castillo, Cortes-Maramba, Francisco-Rivera, & Timbang, 2000; Donkor, Bonzongo, Nartey, & Adotey, 2006; Kim & Kim, 1996). The consumption of contaminated food crops, game and fish from streams and rivers lead to the direct ingestion of arsenic and mercury into the blood and body tissue of residents (Amonoo-Neizer et al., 1996; Boamponsem et al., 2010; Obiri, Dodoo, Okai-Sam, Essumang, & Adjorlolo-Gasokpoh, 2006). Other sources of arsenic and mercury contact for residents is through the inhalation of polluted air, dermal contact with toxins (Bernhoft, 2012; Armah, Luginaah, & Obiri 2012; Obiri, Mattah, et al. 2016) especially amongst residents directly engaged in ASM activities (Mensah & Okyere 2014; Paruchuri et al. 2010; Veiga et al. 2014). Exposure to mercury is associated with several health implications including neurodevelopmental problem in unborn babies and younger children (Bernhoft, 2012). Others are failure of the human organs, motor control deficits, impaired vision, cardiovascular complication, immune system effects and even death (Bernhoft, 2012; Hilson 2002c; Karagas et al. 2012). Health problems such as cancers of the skin, upper respiratory infections, impaired growth, kidney damage, hyperpigmentation, increased blood pressure, psychological disturbances and headaches
have also been associated with exposures to arsenic and lead (Armah, Luginaah, & Obiri 2012; Hendryx & Ahern 2008; Wright et al. 2014).

In spite of the health implications of mercury, concentrations of mercury above the W.H.O recommended levels have been found in the blood and body tissue of residents in mining communities in Ghana (see Armah, Luginaah, & Obiri 2012; Serfor-Armah et al. 2006). For instance, Armah et al. (2012) report that, residents in Tarkwa had arsenic levels eighteen (18) times above the W.H.O recommended level of 0.002 mg L\(^{-1}\). Exposed residents were sometimes (forty) 40 times more likely to be infected with diabetes mellitus, hyperkeratosis or pigmentation among others (Armah et al., 2012). Arsenic and mercury are also transmitted to the blood and body tissue of young infants through breastfeeding from mothers with high concentrations (Bose-O’Reilly, Lettmeier, Roider, Siebert, & Drasch, 2008). It is therefore not surprising residents continue to blame mining operations for the plethora of health problems in their communities (Balfors et al., 2007; Mensah & Okyere, 2014; Yeboah, 2008). Therefore understanding how residents’ perceive their subjective health in the midst of these exposures is central in explaining the actions or remedies taken to minimise their exposure. This will also invariably help frame policy in addressing mining related conflicts with affected residents.

2.5 Socio-economic Impacts

2.5.1 Impact on Community Livelihood

Although mining has been touted as important for economic development, it can also hinder other livelihoods such as agriculture and hunting in host communities (Akabzaa & Darimani 2001; Aubynn 2004). This is particularly the case in surface mining where large
tracts of agricultural lands are compulsorily acquired by the state for mining purposes, leaving residents without alternative sources of livelihood since most of them directly depend on the land. Thus, farmlands are increasingly becoming difficult to access, a situation which has directly altered the land tenure system in host communities (Akabzaa & Darimani 2001; Erdiaw-kwasie & Mabunyewah 2012; Schueler, Kuemmerle, & Schröder 2011). Aubynn (2004), in a study of residents perceptions of mining activities in host communities in the Western Region of Ghana, observed unavailability of farmlands for agricultural activities as a recurring concern across all the host communities in the study area. Although one community was offered alternate land for agriculture, residents still complained about the distance of the farmland from their community, citing the difficulty for aged farmers to walk prolonged periods to access their farms. As the economy of host communities are largely dependent on agriculture and hunting, the loss of land to mining operations create unemployment (Akabzaa & Darimani 2001; Aubynn 2004). Although the mining rhetoric has been socio-economic improvement and job creation, available evidence suggest mining employs only 0.7% of the working age population while agriculture employs 55% of this number (Akabzaa, 2009).

The impact of mining on agriculture as a form of livelihood for residents can be both short and long term. Given that 40-60% of lands originally designated for mining are used for the construction of mine sites/camps, damns and heap leach, there is growing concern about the future economic viability and sustainability of host communities since some of the lands are permanently lost to mining even when operations have ended (Akabzaa & Darimani 2001; Schueler, Kuemmerle, and Schröder 2011). In the Wassa West District of the Western Region of Ghana, the scarcity of farmland is driven by the designation of
70% of total lands in the area for mining purposes leaving only a meagre 30% for agriculture and other activities (Garvin et al., 2009). Where farmlands may be available, there is a lesser yield per acre and food crops may be highly polluted with arsenic and other heavy metals with severe health implications when consumed (Adomako, Deacon, & Meharg, 2014; Z. Chen et al., 2014; Lin et al., 2005; Schueler et al., 2011b).

2.5.2 Impact on Cost of Living

The sudden increase in the population of host communities due to the influx of mine workers and other people seeking economic opportunities have implications on cost of living (Stephens & Ahern, 2001). In Ghana, the living expenses in host communities are known to be above the national average (Akabzaa & Darimani 2001; Awuah-Nyamekye & Sarfo-Mensah 2012). For instance, Akabzaa & Darimani (2001) reported that, the price of a bag of rice in Tarkwa was 21% higher than the same bag of rice in Accra the national capital where goods and services are generally expensive. Given that most farmlands in the community have been taken over by mining operations coupled with the high population inflow, the populace of Tarkwa has to depend on food from outside the district.

Additionally, the price of accommodation, health access, water and other basic needs are exceedingly difficult for residents who may not be directly employed by the mining company. Both expatriates and local employees of mining companies are paid in international work rates which are hefty by local living standards. This disparity between the salary and emoluments of mine workers and that of non-mine based employees create income inequality in the host community. This results in price hikes making it extremely
difficult for residents who are either unemployed or not directly engaged in mining activities to afford basic needs such as food and shelter (Akabzaa & Darimani, 2001; Aubynn 2004; Erdiaw-kwasie & Mabunyewah, 2012). Extreme economic hardships and desperation leads to other social problems such as prostitution and drug abuse.

Although some residents may complain about destruction of farmland and high cost of living in their community, they still perceive mining to have a positive impact on local employment (Aubynn, 2004). To these residents, the high earnings of residents who are employed by the mining companies have a multiplier effect on the local economy which prior to the commencement of mining activities was wholly agrarian. Despite the loss of their lands to mining interests, communities are initially welcoming of mining companies with the promise of jobs and economic transformation for the indigenous population during the explorative stage, but this promise is never materialised during full scale mining operations and residents feel betrayed with worsening economic fortunes (Akabzaa & Darimani 2001; Armah et al. 2011; Aubynn 2004; Lawson & Bentil 2014). High unemployment rates, increased cost of living and limited economic opportunities lead to an insurgence in illegal artisanal gold mining by displaced residents (Hilson Banchirigah 2009; Hilson & Yakovleva 2007). While studies elsewhere like Carrington et al. (2008) found mining impacted residents were migrating due to a number of factors including increased cost living, related studies on affected communities in Ghana has been nascent. Though studies affirm the dissatisfaction of affected residents due to the increased cost of living, how this combines with health and environmental impacts of mining to compel them to abandon their ancestral communities has also been missing.
2.5.3 Impact on Education and Community Wellbeing

Other social impacts of mining activities are well documented. Out-migration of residents from mining host communities is not only linked with the rising cost of living, but decreased community acquaintanceship and increased crime rates (Carrington, Hogg, & McIntosh, 2011). While studies such as Aubyn (2004) have observed some positive social impacts of mining such as increased school enrolment due to the construction of modern school infrastructure to increase access for affected communities, and the general perception that formal education is a prerequisite to be recruited by the mining companies, others such as Akabzaa and Darimani (2001) observed that mining activities had a negative effect on education and other social structures of affected communities. Due to the increased cost of living, children of school going age drop out of school to engage in economic activities to sustain themselves and support parents especially where ASM activities are widespread (Tschakert & Singha, 2007). Others however drop out in order to make quick money from the mining activities. Mining communities report increase in crime rates and other social vices due to the influx of people with no social or cultural attachment to the community and the shift of social values to materialism (Garvin et al., 2009; Tschakert & Singha, 2007). Andrew (2003), also identified rivalries and conflicts, increase rates of communicable and sexually transmitted infections like HIV/AIDS, and militarization of some illegal artisanal gold miners due to the frequent inflow of firearms. Outside Ghana, similar social impacts have been reported in Tanzania and Australia (see Carrington, Hogg, & McIntosh 2011; Kitula 2006).

The host community’s sociocultural wellbeing is also impacted by mining activities including displacement from ancestral lands, relocation and resettlement, which in turn
creates social risk for the affected communities (Kitula, 2006; Owen & Kemp, 2015). Marginalisation of the affected communities through the neglect of their rights by government and mining corporations, disrespect for customs, beliefs and practices, forceful evictions, arbitrary arrest and inadequate compensations are some of the common social impacts (Jul-Larsen, Kassibo, Lange, & Samset, 2006; Kitula, 2006; Lawson & Bentil, 2014). Social tension is common in host communities and has been associated with loss of livelihoods, poverty, environmental degradation and conflict with mining companies over ownership and use of land (Abuya, 2013; Hilson, 2002a; Lawson & Bentil, 2014).

**2.7 Environmental Exposures and Geographies of Health.**

The importance of contextual factors in understanding the health of a population preceded the emergence of health geography from the field of medical geography (Dixon, 2014; Kearns & Moon, 2002; Luginaah, 2009). Thus, unlike medical geography which was focused on the biomedical approach in examining the spatial distribution of diseases, health geography incorporates a broader definition of health which may include context-specific concepts of health such as self-rated health. Additionally, the interaction between socio-cultural factors and the physical environment, and how this may inhibit or predispose a target population to diseases is examined by health geography (Gatrell & Elliott, 2014). Historically, geography has investigated health disparities in relation to disease ecology, focused on examining the spatial diffusion and distribution of diseases across space and time (Dixon, 2014; Eyles, 1993; Yiannakoulias, Karosas, Schopflocher, Svenson, & Hodgson, 2007). This approach is informed by biomedical understanding of disease and wellbeing, where the presence of disease is assessed as a deviation from a
normal biological function or a universally recognised standard of balance in the human body (Dixon, 2014; Luginaah, 2009). Secondly, geography also looks at access to health facilities and services within a given geographical space based on locational variables and how the presence or absence of facilities and services stalls or enhances improved health outcomes among the population (Brown, McLafferty, & Moon, 2009; Comber, Brunson, & Radburn, 2011; Luginaah, 2009). The outcome of both studies is important in the siting of health facilities and use of specific health intervention strategies deemed appropriate in tackling the given health challenge or problem.

However, health geography compared to medical geography, emphasizes “place” over “space” as it has a unique influence on the concept of health which is deemed highly fluid and changes over time and space to reflect the subjective meaning of health and wellbeing among different people from varying cultural backgrounds (Eyles, 1985; Luginaah, 2009). According to Luginaah (2009, page 92), “.....health geographers have reconceptualised the notion of “place” as a complex cultural symbolic phenomenon constructed through relationships between people and their settings, rather than mere sites where observations are located.”. The spatial interaction between individuals, culture, social beliefs and relations of power are therefore instrumental in defining health for individuals who are resident within this “place” (Eyles, 1985; Luginaah, 2009).

During environmental exposures such as mining, residents are unduly exposed to environmental toxins, pathogens and carcinogens that predispose them to disease, infections and a decline in general wellbeing (Akabzaa & Darimani, 2001; Armah et al., 2016). While all residents may be exposed to the same environmental toxins, measuring adverse health effects through a biomedical approach ignores residents’ subjective
attachment to the land and how the degradation of this familiar environment or place contributes to a deterioration of their sense of health and community wellbeing (Brown et al., 2009; Curtis & Jones, 1998). Power relations among the exposed population is also highly influential in dictating the most affected or exposed group to the environmental toxins in the community. Other structural issues related to governmental policy also informs how residents access healthcare in the midst of environmental pollution. Furthermore, among affected residents, exposures to environmental toxins may have varying impacts on health beliefs based on the degree of attachment to the community and the benefits that may be associated with the exposure, such as employment in the mining company, improved access to social infrastructure and general socio-economic improvement (Baxter & Greenlaw, 2005; Elliott et al., 1999; Heyworth et al., 2009). The concept of self-rated health (SRH) is therefore important in capturing the individual subjective meaning of health in a surface gold mining concession. SRH give residents the opportunity to rate their own health based on their social constructs of health, which is known to take into account the peculiar context of “place” (Idler & Benyamini, 1997; Jylha, 2009). Respondents in rating their health also incorporate measures from the biomedical approach which relates to the presence of ailments, infirmities, or disease. SRH also captures other cognitive processes that are essential to respondents on their personal meanings attached to the concept of health.

The theoretical construct of self-rated health, social determinants of health, political ecology and socio-cultural theory of risk perceptions are important in measuring residents assessment of the impact of mining activities on their health, environment and in what
ways their concept of health may differ or be aligned to residents in similar and different environmental settings.

2.8 Study Context

The Upper West Region (UWR) of Ghana is located to the north-western part of the country — sharing a border with Burkina Faso to the north and west, and with the Upper East and Northern Regions to the east and south respectively. It is specifically located between latitudes 9° 30’ and 11° 00’ N and longitudes 1° 25’ and 2° 45’ With a total land area of 18,476 square kilometers which represents roughly 12.7% of the total land area of Ghana (Ghana Statistical Service, 2013). It has a dry semi-arid climate for most of the year and is covered by the Guinea savannah vegetation. The region is the least populated with a total of 702,110 people which represents only 2.8% of the national population (Ghana Statistical Service, 2013). It has eleven (11) administrative districts with Wa as the regional capital. The region suffers from endemic poverty with seven (7) out of every ten (10) residents classified as poor (Ghana Statistical Service, 2014). The major ethnic groups in the region include the Dagaaba, Waala, Sissala and Birifor. There are a number of migrants from other parts of the country especially the two neighbouring regions to the south who constitute 2.3% of the total population in the region (Ghana Statistical Service, 2013). The two districts namely Nadowli/Kaleo and Wa East Districts which are affected by mining activities have been classified as rural by the Ghana Statistical Service (Ghana Statistical Service, 2013).

Roughly 70% and 89% of the residents in the Nadowli and Wa East Districts respectively are involved in subsistence agriculture. Despite the high involvement of residents in
agriculture within the region (Inkoom & Nanguo, 2011; Songsore & Denkabe, 1995), 16% of the population is considered food insecure (WFP, MOFA, & GSS, 2012). Farming activities are concentrated between the months of May and August each year when northern Ghana experiences its annual rainfall (Kuuire, Mkandawire, Arku, & Luginaah, 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). Yet rains are increasingly becoming erratic and unreliable (Armah et al., 2011). After the rain season, the rest of the year is generally dry with little or no farming and other economic activities for residents (Kuuire et al., 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). The high incidence of food insecurity in the region may be partly explained by an over-reliance on rain-dependent agriculture and declining farm yields which has been observed in the region in the last three decades (Kuuire et al., 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). The region has an illiteracy rate of 59.5% which is more than twice the national average of 25.9% (Ghana Statistical Service, 2013). The study districts, Nadowli/Kaleo and Wa East, have literacy levels of 41.8% and 24.2% respectively. Wa East is predominantly Muslim (57.9%), while Nadowli is mostly Christian (60.8%).
Figure 2-1: Map of Upper West Showing the Study Communities

Source: Cartographic Section, Department of Geography, Western University, 2016

By 2010, Ghana’s mineral commission had given reconnaissance and prospecting licenses to Azumah Resources Limited, Phoenix Resources Limited and Newmont Ghana Limited in the Region. Currently Azumah Resources is heavily present in the two affected districts and is in advanced stages of mining activities where large tracts of land have been acquired for surface mining activities. The company has been given a license to mine a total land area of 2,800 km$^2$. By 2015, all feasibility studies had been completed and the company will be producing 90,000oz of gold per annum spanning several years.

As the company is using a surface mining technique in their operational areas, the clearing, preparation and removal of earth material and movement of vehicles and other machinery has been associated with dust emission/pollution in an already dry savanna
region. While residents continue to deal with the environmental pollution through dust emissions, they have been denied access to their farmlands while other forms of livelihood like hunting and the collection of wild shea nut fruits by women processed into shea butter is greatly affected (see Moomen & Dewan, 2016). This is against the background of limited employment opportunities for affected residents as the company claims to be at the initial stages of mining and can therefore not engage many members of the community but promises to do so as mining in the community progress. In addition to the environmental challenges by Azumah Resources, there have been further invasion of the affected communities by Artisanal Small-Scale Mining (ASM) activities by some residents and people from other parts of the region which have contributed to the pollution of water bodies and the introduction of odours and dust that are associated with their activities (see http://www.ghananewsagency.org/economics/activities-of-illegal-miners-discourage-company-89637). While the Nadowli/Kaleo and Wa East are currently the only two districts in the region that have to deal with the serious environmental impacts of mining, other districts like Lawra, Nandom, Wa West, Jirapa and Sissala West also located within the Wa-Lawra Greenstone Belt with potential gold deposits (see Amponsah et al., 2016), could be affected in the near future as these areas are currently being prospected by gold mining companies.

Consequently, in September 2014, the Upper West Regional House of Chiefs, a constitutionally recognised body which represents the Traditional Authority in the region in a press conference/statement registered their dissatisfaction with the central government and the mining company by reporting that their communities were neither consulted nor adequately informed on the leasing of community lands for mining
activities. Among other things, they complained about economic hardships due to land seizure, desecration of religious sites, increased school drop-outs, increase in crime, disrespect for their customs, depletion of biodiversity in the fragile ecosystem, diseases and general decline in wellbeing of residents in affected communities. This study makes a contribution to the mining literature by examining residents’ satisfaction with their community as a place to live amidst the economic, social, environmental and health effects of surface mining activities.

2.9 Summary

This chapter reviewed the literature on mining in Ghana with its economic contribution to the country dating back to pre-colonial periods when mining operations had minimal health and environmental impact. From the colonial to the post-colonial periods however, researchers have tried to quantify the health and environmental impact of mining operations on host communities in Southern Ghana which has been host to the gold mining industry until the recent discovery of gold deposits in northern Ghana. The approach to these studies however, has been biomedical where residents are tested on the presence of pollutants in their bloodstream and the prevalence of diseases in host communities. Thus a biomedical approach which reduces health to the absence of ailments in the human body has been limited in its approach of gauging possible health impacts of mining activities on host communities. Some of the difficulties stem from the uncertainty in establishing causation between exposures and adverse health impacts due to challenges of multiple causation, thresholds, confounders and duration (Luginaah et al., 2000; Sen, 2002). Another limitation of the biomedical approach is that due to its claim to universal applicability, it ignores “context” and the concept of “place” which play a
unique role in understanding what constitutes adverse health effects in mining affected communities. It is therefore not surprising residents have had course to reject studies that have used the biomedical approach and purport mining activities not to have adverse health impacts on residents. Self-rated health on the other hand is able to measure subjective and objective (biomedical) health of residents making it a consistent tool in predicting morbidity and mortality. Unlike the biomedical approach, it takes into account “context” and “place” and other subjective understanding of health which makes it a good measure of how residents perceive mining activities to be impacting their health and environment. Interestingly the mining discourse and policy in Ghana is without recourse to how residents perceive environment and health risks from mining activities. Again self-rated health as a tool in measuring health effects of mining activities to the best of my knowledge has never been used in the context of Ghana. Based on the strength of the tool and research gap, the study uses the concept of SRH to estimate perceived health and environment risks from mining activities in the Upper West Region of Ghana. The findings of this research will contribute significantly to the mining literature in Ghana and elsewhere, because unlike the widely used biomedical approach, it places residents’ subjective health at the core of the research. The next chapter discusses the methodological design of the study.
2.10 References


Asante, K. (2016). Assessment of heavy metal contamination in water, sediment and fish from the Jimi Reservoir, Obuasi.


Chapter 3: Research Design, Methods and Data Sources

3.1 Introduction

This chapter explains the research design and methods in this thesis and how it links back to the ontology and epistemology of understanding environment and health perceptions in surface mining affected communities in the Upper West Region of Ghana. Moreover, based on the style of this thesis, the research stands the risk of being inferred in fragments considering the limitation of articles based on journal style and requirements. Also, the entire thesis was conceptualized as one unit and this section expands on, and links the methods in the two manuscripts. Furthermore, measuring environment and health perceptions is complex and researchers employ varying ontological, epistemological, theoretical and methodological approaches to understand the phenomenon in light of the complexity.

3.2 Philosophy and Epistemology

According to Packer and Goicoechea (2000) ontology is involved with the consideration of “being”, and the nature of “existence” or “reality”. Reality is seen as “subjective” or “objective” based on how the process of knowledge derivation is conceptualized by the researcher (Lincoln, Lynham, & Guba, 2011; Packer & Goicoechea, 2000). With “subjective reality”, knowledge is assumed to be made-up or created based on our lived experiences, environment and interactions with the world (Lincoln et al., 2011; Sandberg, 2005). This is contrasted with “objectivism” or “objective reality” where knowledge is seen as a direct derivation from nature devoid of human manipulation and subjective experiences (Weber, 2004). According to objectivism therefore, knowledge exist outside
our lived experiences. Following the dualism of ontology, epistemology involves the identification of what is admissible as knowledge, broadly classified into positivism and interpretivism. From the positivist perspective, knowledge can be observed and objectively measured from nature through the human sensory system and then interpreted through logic and reasoning (Weber, 2004). In contrast, an Interpretivist epistemology posits that, people’s experiences and interactions with the world shape their understanding of what they hold as knowledge. In this thesis, I adopt a post-positivist approach in the study of environment and health perceptions. While all positivists believe reality or knowledge is objective and exists outside our lived experiences, post-positivists admit this objectivity can be influenced by our experiences and bias (Clark, 1998). With regards to the assumptions of the post-positivist epistemology, during environmental exposures, resident’s perceptions of health and environmental impacts are also influenced by socioeconomic conditions, gender, education, age, wealth and even cultural beliefs.

Furthermore, coming from a post-positivist epistemology, the research adopts an extensive methodology (how we deduce information from reality) in both data collection and analysis. Sayer (1992), posits that, research viewed from the qualitative-quantitative perspective dwells on the end product of the research while ignoring the broader contextual assumptions, as well as the research goals and objectives. Against this background, Sayer (1992), suggests that, describing research as either “extensive” or “intensive” focuses more on its assumptions and expected outcomes. Informed by the desire to make the findings of this research generalizable, I adopt an “extensive” methodology in the study design. While intensive research focuses on investigating the process of change or the underlying factors responsible for change in a given context,
extensive research is primarily concerned with how widely apart or similar different segments within the population are to each other (Sayer, 1992). Though the study of “perceptions” in environmental exposures have mostly adopted the intensive approach in study design, studies such as Luginaah et al (2000, 2002) and Moffat & Zhang (2014) have used extensive methodology in community health risk perceptions with generalizable results. Following the expected outcomes of this study, the findings will be generalized to similar context in Ghana and elsewhere.

3.3 Theoretical Underpinnings

Varying theories have emerged in an attempt to capture the complexities surrounding health and environmental perceptions during environmental exposures. According to Hesse-Biber (2003. p 3), “Theory can be broadly defined as an account of an aspect of the social world that goes beyond what is empirically known…” The importance of theory lies in its ability to help generate findings that can be generalizable to other context (Bohrnstedt, 1994; Hesse-Biber, 2003). For instance, Baxter and Greenlaw (2005) categorise theories of risk perceptions into econometric, psychometric, geographic and cultural. While all these theories attempt to explain the differences among groups regarding risk perceptions, the econometric, psychometric and geographic theories have been critiqued for being overly focused on the nature of the risk/exposure and not the persons perceiving the risk. Earlier studies like Sjoberg (2000, 2001) had made similar observations on the theories of risk perception.

Following from Baxter and Greenlaw’s work, the first manuscript in this thesis adopts the cultural/social theory of risk perception. In explaining why a group of people may view a
particular exposure as a health risk or otherwise, their social relational inclinations such as hierarchic, egalitarian or individualistic in addition to their cultural beliefs that may support such social relations or worldviews, plays a distinctive role in what the community may perceive as risk in relation to their health or environment (Wildavsky and Dake, 1990). Accordingly, community reaction or amplification of perceived risk is defined by whether it threatens its world view and the daily way of life of residents (Cutter, 1995; Baxter & Greenlaw, 2005). Given that residents in the research context are mostly agrarian, mining activities will impact greatly on their source of livelihood. The compulsory acquisition of land by the central government for the mining firms denies farmers access to their lands and with limited compensation, the agrarian base of most of these communities is going to be displaced. Other sources of employment for the communities, especially shea nut collection from the wild by mostly women will be equally affected as they are equally denied access to lands (Moomen & Dewan, 2016).

For the second manuscript, I adopt a political ecology theoretical framework to explain how unequal power relationship between the State and residents in mining affected communities in the Upper West Region of Ghana leads to a change in the use of the ecosystem without a meaningful input from residents in spite of their resistance to the mining activities in their communities. According to Bryant & Bailey (1997), political ecology is focused on stakeholders with different value perspectives in the use and exploitation of physical environmental resources although they exercise unequal power in shaping the process and outcome of the exploitation. Specifically, it assesses how unequal power relations among different stakeholders and actors impact environmental outcomes (Hitch, 2006). Some authors have argued that because actors have varying values attached
to the ecosystem, those that exercise the greatest power are able to influence the discourse on the ecosystem and determine the environmental outcomes (Kronenberg, 2013; Martínez-Alier, 2009). Even though residents in host communities suffer the long term effects of environmental pollution from mining, the influence of the state and mining corporations subdue community interest and values in how their environment is exploited and managed. Consequently, powerful multinational businesses and the state solely determines which population is exposed to environmental hazards (Bryant & Bailey, 1997; Hitch, 2006).

According to Blaikie (1985), “place based” actors are residents in communities directly affected (environment, health, social, economic) by the exploitation of the ecosystem. “Non-place-based” actors on the other hand, are the externals (business corporations and the central government) to the local environment who are not directly affected by its exploitation yet; yield the power to decide on how it is exploited albeit resistance from the local population and civil society. Little attention is therefore paid to the environment, health and economic concerns of residents as corporations seek to maximise profit. In the study context, although residents are not as powerful as the state and mining corporations, affected communities through the assistance of non-governmental organizations such as Centre for Indigenous Knowledge and Organizational Development (CIKOD) and community leadership have engaged other stakeholders on the impact of mining activities in their community. There is also a coalition of NGO’s, civil society organizations, chiefs, traditional authority, community groups and journalists into a bigger group known as “Upper West Coalition on Mining, Food, Water and Sacred Natural Sites” which aims to give a mouthpiece to communities affected by mining activities in getting them to
participate in how their environment should be managed. In the affected communities, residents report of making complaints to the Nadowli/Kaleo district assembly about fears of mining activities negatively impacting their health as well as the denial of access to their farmlands by the mining company. Frustrated by their inability to get the central government’s attention about the impacts of mining on their communities, the Upper West Regional House of Chiefs organised a press conference to inform and bring pressure to bear on the government to heed to their call for their involvement in the mining activities. Affected residents who are continuously denied access to their farms for their livelihood have ventured into artisanal gold mining on the concessions of Azumah resources and continue to defy arrest by security forces guarding the concessions of Azumah Resources.

According to political ecology scholars, integration of the economies of former colonies into the Capitalist West dominated economic order through the export of raw materials for European and American markets, makes third world countries more vulnerable to resource exploitation and environmental degradation. Thus, poor countries especially in the Global South continue to be treated as a raw material reserve for Western markets (Mart’inez-Alier, 2003 p. 10). With limited capital, poor states are unable to invest in the exploitation of their own natural resources, leaving multinational businesses to dominate and control natural resource exploitation. In Ghana, due to the inherited colonial module of state resource control, and the influence of a hegemonic capitalist market, the state sanction policies which specifically favours multinational mining businesses by compulsorily acquiring lands from locals who appear helpless against the coercive force of the state (Owusu-Koranteng, 2008). Although the mining sector in Ghana and
elsewhere has been projected as an avenue for job creation and improvement in the socio-economic status of affected communities (place based actors), there is ample evidence to suggest communities derive limited benefits, yet they are afflicted with multiple environmental, social and health related problems while the state and foreign mining companies (non-placed based actors) maximise revenue and profit from the exploitation (Bryant & Bailey, 1997). In place of the current arrangement by the state and multinationals in resource identification, exploitation and development, some political ecologist (Robbins, 2011, p. 13) have suggested a social justice approach where the place based actors who are directly affected by the resource exploitation are empowered to determine the use and exploitation of the environment in a way that is aligned to their own values and attachment to the ecosystem. Therefore, limited participation of indigenous populations in the use of their environment due to unequal power relations with the state has resulted in community dissatisfaction with their environment and a sense of alienation from their ancestral lands (Akabzaa & Darimani, 2001; Aubynn, 1997).

The once peaceful rural communities are being confronted with odour and air pollution which disrupts the serene environment residents experienced. Given this interference in the lives of residents in affected communities, it is likely their self-rated health, perceived risk, and satisfaction with their community as a place to live due to exposures will be influenced by the undesirable experiences. These theoretical persuasions informed the framing of questions in the survey instrument as well as the selection of outcome and key independent variables in both manuscripts. The discussion and conclusion in both manuscripts and chapter 6 is also based on the adoption of these two theories.
3.4 Study Design

The process in this thesis involves stages that are sequentially linked. The first stage involved field data collection, the second involved data preparation and analysis and was finally followed by manuscript writing and thesis formatting. My foremost interest in environment and health was heightened when I took courses on natural resource exploitation and management at my undergraduate level at the University of Ghana. My curiosity centered on how resource exploitation especially mining, had a long term effect on the physical environment, livelihoods and the health of residents in host communities. I started exploring this research possibility during my interaction with one of my then potential supervisors, Dr. Isaac Luginaah. We finally settled on a potential thesis topic and the scope of the study paving way for the study design and implementation. Going through the literature during the research design and proposal writing stage, it became obvious that there was a gap in the literature as most studies on health impacts of mining in the context of Ghana used a biomedical approach without due consideration for community perception of health risk and environment. Another limitation was the concentration of the existing literature on mining communities in Southern Ghana with very little in the Northern Regions of Ghana. These gaps informed the choice of study context and design.

During data collection, ten (10) Research Assistants (RAs) were recruited. They comprised undergraduate and graduate students from the University for Development Studies (UDS) at the Wa Campus in the Upper West Region of Ghana. The RAs had previously been involved in data collection with students from the University of Western Ontario, London, Canada who were in the region at different times in the past to collect
their field data. Despite their previous experience, they were taken through a two day intensive training on the survey instrument. Each question was thoroughly explained to the RAs to give them an in-depth understanding of the import of the questions on the survey. They were taken through privacy and ethics related issues as prescribed by the University of Western Ontario Tri-Council. Before commencing field work, each RA was made to sign an undertaking of secrecy in order to protect the rights and privacy of respondents. Prior to administering the survey in selected communities, there was a familiarization visit to each community to meet with the chief and opinion leaders in the community to seek their consent and explain the nature of the exercise we were going to conduct in their community. All RAs were deployed to one community at a time until the designated quota of surveys for the community had been administered to the target respondents.

In all, fourteen communities in two districts have either been impacted or affected by the mining activities in the region. These communities are Danyookora, Jongfiang, Chagu-Paane, Busa, Manwe and Duu within the Wa East district. The rest are Chari-Saan, Chari-Sanpina, Chari-Gabili, Nadowli, Nanga, Tangasia, Kalsegra and Yiziri in the Nadowli district. According to the 2010 Population and Housing Census, the total population of impacted communities is 65,000. Communities closest to the mining activities are the most impacted through the destruction of farm lands, pollution of sources of drinking water with arsenic, dust and sound pollution (Adimado & Baah, 2002; Armah, Luginaah, et al., 2012). Therefore, communities that are within 5 kilometre radius of a mining activity were classified as “impacted” and those above 5 to a 10 kilometre radius were
classified as “affected”. This classification is in line with that of the mining firm in the region, Azumah Resources and the Government of Ghana.

Surveys were distributed based on a probability sampling that ensured that distribution of surveys was not biased towards a particular community or respondents (Ross, 1978). Household heads, aged 18 years or over were interviewed. Since they bear the burden of providing for the nutritional and health needs of household members, they were best placed to assess the full impact of mining within the household. Both male and female household heads were sampled and disaggregated. Because communities closest to mining activities were worse impacted, most respondents (70%) were sampled from these “impacted” communities. The rest of the respondents (30%) were sampled from the affected communities that are farther away from the centre of the mining activities. Given a population of 65000 for the study communities, a minimum estimate of 382 respondents would have been needed for the study to be statistically robust at 95% confidence level and 5% margin of error. With the constraints of time and other resources, 820 surveys were issued and with 801 collected that further strengthened the power of the study. Out of the 240 (30% of 801) surveys allocated to “affected” communities, the actual population size of individual communities was used in calculating the total surveys administered in the community. For instance, out of the total population of 31000 recorded for the affected communities, Nadowli had 15000 inhabitants representing 48% of the affected population. Therefore, Nadowli was issued with 116 out of the 240 surveys allocated to affected communities. The same formula was used to calculate the number of surveys to be issued in each community.
3.5 Data Collection Tools

The study adopted the Quick Environmental Exposures and Sensitivity Inventory (QEESI) and the DUKE health profile surveys respectively. The QEESI was developed by Miller and Prihoda and published in 1999. It has a four point scale (i.e. symptoms severity, chemical intolerance, other intolerance and life impact) used in measuring chemical intolerance among populations in cases of environmental exposures (see Hojo, Kumano, Yoshino, Kakuta, & Ishikawa, 2003; Skovbjerg, Berg, Elberling, & Christensen, 2012). The survey is based on the respondent’s self-rated health and how they perceive their health or general wellbeing after an environmental exposure. Among other things, the instrument captured respondent’s self-assessment of their health condition in the midst of an environmental exposure. The DUKE health survey instrument is also widely used in capturing the self-rated health of respondents. It has a total of 17 questions that measures respondents perceived physical, mental, social and general health. Subsequently, respondents were asked to rate their health compared with that of their peers and how they think environmental pollutants associated with their community might be impacting their health. The survey also covered respondents’ satisfaction with the community in the presence of environmental pollution. It enquired from respondents whether they have ever contemplated moving out of the community because of the mining activities and how conducive they perceive the community for habitation despite the perceived level of pollution. Respondents were also asked if they believed the community benefited from the mining activities. Additionally, they were asked if they believed their community was more economically viable or benefited from improved infrastructure (like portable water, health centres and school buildings) due to
the mining activities. Other relevant questions relating to gender, occupation, educational attainment, age, marital status, income, household assets and the type of community were collected. These variables were collected based on relevant theoretical underpinnings. Firstly, demographic, socio-economic and compositional factors have been shown to mediate the health and environmental perceptions in cases of environmental exposures. Secondly, it helps in measuring the relationship between different groupings with health and environment perceptions.

3.6 Self-Rated Health and Mining

Self-rated health (SRH) has been shown to be a consistent predictor of morbidity and mortality across different spectrum of studies (Idler & Benyamini, 1997; Jylha, 2009). After coming into existence in the 1950’s and initially used extensively in sociology (Jylha, 2009), it was adopted by epidemiological and medical research because of the power of its predictability of mortality, morbidity and the general health status of populations with varying socio-cultural backgrounds and environment (Mossey & Shapiro, 1982). This technique enables respondents to assess their own health based on a five point scale, or by simply comparing their health to that of their peers. According to Tissue (1972, pg. 93), SRH is successful in predicting mortality because it provides “..a summary statement about the way in which numerous aspects of health, both subjective and objective are combined within the perceptual framework of the individual respondent”. Thus, what SRH measures, is a cognitive process that is not guided by any formal standard of measurement, which then affords the respondent the opportunity to incorporate personal understanding of health (Jylha, 2009; Mossey & Shapiro, 1982). Respondents are asked the question “In general would you say your health is excellent,
very good, good, fair or poor?” or “compared to others your age, how would you rate your health?” (Cockerham, Sharp, and Wilcox 1983; Idler and Angel 1990). Jylha (2009), posits that, the cognitive process of SRH involves three (3) stages including i) the meaning of health and what components are ascribed to this health ii) how the components in the first process are taken into account and finally iii) the level in the preset scale that best summarizes these components. Although SRH is mostly presented as a cognitive process, it is influenced by socio-cultural, demographic and socio-economic considerations (Idler & Benyamini, 1997; Jylha, 2009; Kelleher, Friel, Gabhainn, & Tay, 2003; Mossey & Shapiro, 1982; Zavras, Tsiantou, Pavi, Mylona, & Kyriopoulos, 2013).

However, SRH has been critiqued for being very subjective with social and cultural conceptualizations of health which makes findings difficult to generalize to other context (see Fillenbaum 1979; Krause and Jay 1994; Wu et al. 2013). Studies by Salomon et al. (2004) discounts this assertion after evaluating a number of studies using self-rated health and conclude that the measure is understood in a similar way regardless of the socio-cultural settings of the study. Lundberg & Manderbacka (1996) on the other hand affirms the internal validity of the instrument and how it accurately measures the health of a population.

In spite of the power of SRH in predicting mortality and the health of populations, its use during environmental exposures has been limited. Considering the limitations of estimating or predicting potential health risk during environmental exposures through technical assessment by the so-called “technical experts” (Anson et al., 1993; Heyworth, Reynolds, & Jones, 2009; Luginaah et al., 2000a; Sen, 2002) the use of SRH in the midst of multiple sources of toxin exposure is useful in examining the impact of exposures in
affected communities holistically (Woolley et al., 2015). Woolley et al. (2015) in a study of residents in a coal mining host community found significant association between different socio-economic and demographic groupings on self-rated health. Specifically, employment in a coal related industry was significantly associated with poor SRH, although the association between SRH and the number of coal mining facilities in close proximity to the respondents’ residence was eventually attenuated. Similarly, Zullig & Hendryx (2011) observed that respondents in Appalachia who were residents of Mountaintop and other areas of coal mining, rated their health as poor and were also associated with poor physical health, poor mental health, and limited physical activity in the most recent days leading up to the interview. Respondents in control communities were however not significantly associated with poor self-rated health, as well as poor physical and mental health. This study therefore uses the concept of SRH to gauge the impact of mining on affected communities in the Upper West of Ghana.

3.7 Data Analysis

After a data entry process using SPSS, I proceeded to clean the data to make sure errors related to wrong entries and coding were corrected. This was to ensure that the final results were not misleading on account of wrong coding or entry. For data analysis, I employed SPSSS to help with the coding and used STATA 12 in the modelling of the data. The detailed description of the method for each paper is fully captured at the methods section. For paper one, the outcome variable was self-rated health. The outcome variable was derived by asking respondents how they rated their health compared with their age cohorts or peers. This construct was in line with other studies (see Giatti, Barreto, & César, 2010; Lindström, Modén, & Rosvall, 2014) that used a similar
technique. The key independent variables include perception or believe about how odours could be impacting health, the frequency at which respondents perceived dust. The selection of the key independent variables was consistent with similar studies that examined environmental pollution and self-rated health (see Luginaah, Martin Taylor, Elliott, & Eyles, 2002; Luginaah et al., 2000). I used negative log-log regression informed by the distribution of the responses to self-rated health which was skewed against the success category “poor health” to produce unbiased estimates. Using binary logistics regression, the second manuscript examines respondents’ satisfaction with their community as a place to live in the midst of mining activities. For this outcome variable, respondents were specifically asked whether they have ever considered moving out of their current community because of perceived negative effects of mining activities. The key independent variables were i) whether respondents were adequately informed about mining activities and ii) if respondents believed the mining company was meeting environmental standards. Another important variable was whether the respondent was suffering from any chronic health problem(s).

The ethics approval for this study was secured in 2014 from the Western University Non-Medical Ethics Board. As part of the ethics requirement, the safety and privacy of respondents were safeguarded during the entire period of the study. Participants were informed prior to each interview their right to discontinue the interview at any point and the privacy of their response.
3.8 Robustness of findings

Motivated by the desire to generalise the findings of this study and minimise bias, robustness was ensured from the study design, implementation, data collection, analysis and writing. The study was highly guided by the ethics requirement. To ensure that the field data collection was of high quality, experienced undergraduate and graduate students were recruited and trained for a two (2) day period to grasp the concept. There was a role play and a mock interview session to address pertinent issues that may arise on the field. R.As were thoroughly briefed on ethics related issues and then deployed to the field. To further ensure quality data collection on the field, all R.As were deployed to one community at a time under my supervision till the quota of questionnaires for the community was exhausted. A probability sampling technique proportional to size was used to make sure each community was adequately represented in the total sample of 801. Data was collected for the impacted and affected communities and analyzed separately. During the data analysis, further internal validity checks ensured the robustness of the findings.

3.9 Conclusion

In this chapter, I explained the limitation of an integrated manuscript style thesis and how the two papers are grounded in the same philosophy and epistemology. I described in detail the research design and methodology, field data collection, data processing and analysis. I justified the use of an extensive methodology and how it is influenced by philosophy and epistemology.
3.10 References


4.1 Introduction

Although the gold mining industry has operated in Ghana for several decades, the activity is increasingly perceived as a health risk by residents in host communities. Residents in communities close to gold mining concessions continuously fault mining firms for health related problems in their community (Balfors et al., 2007; Mensah & Okyere, 2014; Yeboah, 2008). This has resulted in heightened tension between gold mining firms and residents (Akabzaa & Darimani, 2001). In spite of this concern from affected residents, gold mining companies and regulatory agencies continue to deny and understate the environment and health impacts of their activities. Research that assesses how residents perceive mining activities to impact their health is nascent. This study uses self-rated health to examine residents’ perceived health status based on how they gauge the mining activities to be polluting their community, health and physical environment.

Some epidemiological studies however, have established an association between exposures to metal arsenic, mercury, copper, lead, manganese, platinum, zinc, cobalt, cadmium, and dust with adverse human health. Health problems range from kidney damage, upper respiratory infections, cancers of the skin, hyperpigmentation, impaired growth, increased blood pressure, psychological disturbances, headaches to cardiovascular complications (Armah, Luginaah, & Obiri, 2012; Hendryx & Ahern, 2008; Wright, Matooane, Oosthuizen, & Phala, 2014). For instance, a study by Armah et al (2012), in mining communities in the Ashanti and Western Regions of Ghana, found
residents to have unacceptable levels of metal arsenic in their blood samples. Elevated levels of mercury were also found in the urine and hair samples of residents in a mining site in the Talensi-Nabdam District in the Upper East Region of Ghana (Paruchuri et al., 2010). Though the mechanisms through which these heavy metals are ingested by humans is complex, researchers believe when arsenic is leached into soil and water bodies, it is absorbed by plants and fish then later consumed as food (Adimado & Baah, 2002; Akagi et al., 2000; Donkor et al., 2006; Kim & Kim, 1996; Obiri, Dodoo, Okai-Sam, & Essumang, 2006). Instances of contamination of food and water sources of communities due to mining activities have also generated discontent among residents of mining communities.

The strained relationship between some gold mining firms and host communities is partly explained by the difference in “expert” versus “lay” opinions in health risk assessment (Bickerstaff, 2004; Catalán-Vázquez, Riojas-Rodríguez, & Pelcastre-Villafuerte, 2014; Elliott et al., 1999; Luginaah et al., 2000). While governments and mining experts rely heavily on technical assessment to estimate potential health risks, residents in host communities look beyond the technical estimations and base their assessment of potential health risk on a broad range of issues that are frequently overlooked by technical experts (Anson et al., 1993; Heyworth et al., 2009; Luginaah et al., 2000; Sen, 2002). Accordingly, a community’s history and association with the industry, the pattern of exposure and the economic benefits of the industry to the host community substantially influence how residents perceive the impact of mining activities on their health and environment (Beck, 1992; Catalán-Vázquez et al., 2014; Hayes, Stevenson, & Stuetz, 2014; Heyworth et al., 2009). Other factors associated with perceived risk include nature
of exposure (voluntary or otherwise), the anticipated outcome of the exposure (catastrophic or not) and the distribution of benefits among those exposed (Flynn et al., 1994; Garvin et al., 2009; Heyworth et al., 2009). In effect, a community’s assessment of potential health risk to exposure is based on how it impacts the daily lives of residents in the community (Baxter & Greenlaw, 2005; Heyworth et al., 2009) and is therefore socially constructed. The socially constructed nature of health risk perception is responsible for variations in perceived health risks among communities that may be exposed to the same environmental stressors or pollution (Anson et al., 1993; Baxter & Greenlaw, 2005; Heyworth et al., 2009; Sen, 2002).

### 4.2 Social/Cultural Theory of Risk Perceptions

Several theories have been advanced to explain the cognitive or psychological construction of vulnerability to health risk as a result of environmental exposure. They have been grouped into econometric (Paul Slovic et al., 1985), psychometric (Sjöberg, 2000; Trumbo et al., 2016), geographical (Cutter, Mitchell, & Scott, 2000) and social/cultural (Baxter & Greenlaw, 2005; Douglas & Wildavsky, 1983). Some of the theories have been critiqued for overly focusing on the hazard and not the persons perceiving the hazards (Baxter & Greenlaw, 2005). The cultural theory of risk perceptions was developed by Douglas and Wildavsky (1982) due to the limitations of the psychometric theory in accounting for differences in social/cultural variation in risk perceptions. According to the theory, social and cultural inclinations of a given community or group of people influence their health risk perceptions during environmental exposures or hazards (Baxter & Greenlaw, 2005; Douglas & Wildavsky, 1983; Rippl, 2002; Wildavsky & Dake, 1990). Thus, individuals are embedded in the
community’s social structure and this shapes their values, attitudes and worldviews. These values shared with the community becomes the cognitive filter for evaluating or assessing information on potential health risk of an environmental exposure or hazard (Douglas & Wildavsky, 1983; Rippl, 2002; Stern et al., 1995). In effect, the most important factor in health risk perception is not the individual cognitive evaluation of risk, but the shared social worldviews, values and attitudes, described as the cultural biases that predict perceived risk during environmental exposures (Rippl, 2002). Exposures considered substantial health risk to the community are those that disrupt the daily lives of residents, or whose operation and management style conflicts with the community’s world views or culture (Baxter & Greenlaw, 2005; Wildavsky & Dake, 1990).

Expanding on the social/cultural theory of risk perceptions, Baxter and Greenlaw (2005) posit that, the social relational inclinations of a community defined as “hierarchic”, “egalitarian” or “individualistic” in addition to their cultural beliefs that support such social relations play an important role in what the community perceives to constitute substantial health risk. In the social/cultural theory of risk therefore, a community decides on what to fear and even how to fear it based on its cultural biases and their general worldviews reflected in their “ways of life” or “political cultures” (Wildavsky & Dake, 1990). Risks are then either selected for dismissal or amplification based on how it strengthens or weakens the community’s worldviews or “political culture”. For instance, a community predominantly “hierarchical” in nature will dismiss claims of environmental exposures having deleterious effect on the health of residents, once a sanctioned agency and/or technical assessment of health risk by government have assured the community that exposure levels are safe; this will be sharply opposed by a community that is
essentially “egalitarian” and distrusts government (Baxter & Greenlaw, 2005; Wildavsky & Dake, 1990). Though a community’s social inclinational relations may be difficult to measure, they are reflected in how residents relate to each other, view their environment and their trust for the local government and the industry (Baxter & Greenlaw, 2005; McGee, 1999). In the context of this study, considering the fact that the affected communities are mostly agrarian, the compulsory acquisition of lands by the state for mining companies denies farmers access to farmland which affects their livelihoods. Again, the rural landscape is greatly impacted by the introduction of odours, dust and noise disrupting their once pristine environment. Due to the destructive nature of mining activities on the daily lives of residents, their perception of possible health risk emanating from the activities of mining will greatly be influenced by interruption in their way of life.

4.3 Mediators of Perceived Health Risk

When people are exposed to environmental stressors, there are cognitive and behavioural responses to cope with the problem. According to McGee (1999), the cognitive coping response involves an alteration of perceptions and emotions towards the exposure or hazard. In some instances, the affected residents’ cognitive response is to assume the exposure is non-toxic and therefore not harmful to human health. The cognitive coping response is therefore to avoid being bothered by the environmental exposure or hazard (Cohen, Evans, Stokols, & Krantz, 2013 p. 52). With the behavioural response, affected residents may seek more information about the nature and scope of the exposure or hazard and its possible effect on their health. They may complain to the industry or the regulatory agency for a remedy or ultimately relocate from the community. However, the cognitive and behavioural responses are mediated by the nature of the exposure and
individual level factors like age, gender, occupation and length of residency in the community (Anson et al., 1993; Heyworth et al., 2009; Luginaah, Taylor, Elliot, et al., 2002; McGee, 1999; Sen, 2002).

While community health perceptions are greatly influenced by worldviews and “way of life” as posited by the social/cultural theorist of risk perception, the nature of the exposure significantly influences community reactions or response. For instance, the presence of odours and dust as environmental stressors heightens the way(s) residents link the exposure to their health, through symptoms reporting and self-rated health (Luginaah, Martin Taylor, et al., 2002; Steinheider, 1999). While there may not be an agreed definition of odour annoyance and how it impact on psychological constructs, one of the most widely used definitions was provided by Lindvall & Radford (1973) who defined it as a “feeling of displeasure associated with any agent or condition believed to affect adversely an individual or a group”. In cases of gold mining and processing, the use of cyanide in gold extraction gives a “bitter almond” odour that is sometimes perceived by residents as a nauseating smell during spills and through the activities of ASM (Abdalla, Suliman, Al-Ajmi, Al-Hosni, & Rollinson, 2010; Human Rights Clinic, 2010; Logsdon, Hagelstein, & Mudder, 1999). Also, movement of rock material, tailings and tailings dam from mining produces dust that impacts residents (Ogola et al., 2002; Schonfeld et al., 2014; Shi & He, 2012). According to Steinheider (1999) and Luginaah et al (2002) residents reaction to perceived health impacts when exposed to odours occurs in one of four ways, i) directly reporting ill health after perceiving odour, ii) people who may be perceiving ill health may be sensitized on health effects of odourant exposures and may attribute ill-health to the exposure, iii) people experiencing ill health may be sensitized to
become annoyed by an odourant exposure and iv) odour perception and ill health reinforcing each other. In a longitudinal study of a host community of a petrochemical industry, Luginaah et al (2000) observed the mediating effect of odour annoyance on perceived health risk from the industry through symptoms reporting. Residents who complained about odour perception or annoyance were also more likely to report symptoms. In a follow-up to the affected community after the implementation of odour reduction measures, the study reports that the number of residents perceiving odours to be impacting negatively on the community’s health saw a substantial decrease and this correlated with decreased symptoms reporting. Again, there was a decrease in the incidence of odour annoyance in the follow-up year compared to the base year. Similar reaction or responses has been reported for dust pollution. Accordingly, the presence of dust/dirt in the home of residents is seen as an invasion of the personal or safe space by the pollution source (Akabzaa & Darimani, 2001; Bickerstaff & Walker, 2001; Jenkins, 2000; Wakefield, Elliott, Cole, & Eyles, 2001). Though residents may perceive odours and dust in their neighborhood and homes, they are less likely to report symptoms or perceive negative health outcomes if there is a social and cultural attachment to the community. This can be contrasted with residents that report elevated levels of symptoms in the same neighbourhood when there is no connection to the community (Bickerstaff & Walker, 2001; Thrush, Burningham, & Joseph Rowntree Foundation, 2001).

Distance to the source of environmental pollution is well captured in the health risk literature. However, the plethora of research varies on the exact impacts of distance to health risk perceptions. Generally, there is a negative correlation between distance, symptoms reporting, odour annoyance and perceived health risk. Residents who are
farther away from the source of pollution are less likely to report symptoms (Steinheider, 1999; Thouez & Singh, 1984). In contrast, other researchers such as Baxter & Greenlaw (2005) reports of a “donut” effect where residents closest to the pollution source have reduced symptoms reporting and are less likely to perceive the community as unhealthy. Wind direction, risk and benefits, and attachment to the neighbourhood or community have been observed to be responsible for this pattern (Atari et al., 2011; Baxter & Greenlaw, 2005; Baxter & Lee, 2004; Broto et al., 2010; Thouez & Singh, 1984).

Other mediators between environmental exposures and perceived health are occupation, gender, age, presence of children in the household, chronic health problems and ethnicity (Elliott et al., 1999; Flynn et al., 1994; Heyworth et al., 2009; Luginaah et al., 2000; Shi & He, 2012; Vaughan & Nordenstam, 1991). In spite of Ghana’s long association with mining, researchers are yet to fully explore perceived health risk and other theoretically relevant mediators in mining communities. Existing literature has been limited to technical assessment of potential health risk and long term effect of mining on the physical environment. The focus has therefore been reducing environmental stressors within mining host communities to “acceptable standards”. There is dearth of literature on community health risk perceptions and how it contrasts with the technical assessment by the mining industries, the regulating agency and the central government. More importantly, there is limited research on how perceptions of odour and the frequency at which residents perceive dust from mining assess their health. Using a cross-sectional data, this study examines how communities affected by surface mining in the Upper West Region of Ghana perceive their health in relation to mining activities.
4.4 Study Context

The Upper West Region (UWR) of Ghana is located to the north-western part of Ghana — sharing a border with Burkina Faso to the north and west, and with the Upper East and Northern Regions to the east and south respectively. The region occupies about 12.7% of the total land area of Ghana. In terms of climatic conditions, the region is generally dry and semi-arid for most of the year and is covered by the Guinea savannah vegetation. UWR has a total population of 702,110 (Ghana Statistical Service, 2013) with 11 administrative districts. The region suffers from endemic poverty with 7 out of 10 people living on less than $1.25 a day (Ghana Statistical Service, 2014) with limited infrastructural and economic development.

Ethnic groups in the region include the Dagaaba, Waala, Sissala and Birifor. Two out of the eleven (11) districts in the region, the Nadowli/Kaleo and Wa East are the site of mining activities which commenced less than a decade ago. The two districts are classified as rural by the Ghana Statistical Service (Ghana Statistical Service, 2013). About 70% and 89% in the Nadowli and Wa East Districts respectively are involved in subsistence agriculture and related activities. Despite the high involvement of residents in agriculture (i.e. over 86%) within the region (Inkoom & Nanguo, 2011; Songsore & Denkabe, 1995), 16% of the population is considered food insecure according to the Word Food Programme Survey (WFP & MoFA, 2012). Farming activities are concentrated between the months of May and August each year when northern Ghana experiences its annual rainfall (Kuuiire et al., 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). The rains are increasingly becoming erratic and unreliable due to the changing climatic conditions (Armah et al., 2011). The rest of the year is generally dry with little or
no farming and other economic activities for residents (Kuure et al., 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). The high incidence of food insecurity in the region may be partly explained by an over-reliance on rain-dependent agriculture and declining farm yields which has been observed in the region in the last three decades. Dwindling harvest and endemic poverty within the region has led to the mass emigration of residents to southern Ghana to engage in farming and other economic activities. The region has an illiteracy rate of 59.5% which is more than twice the national average of 25.9% (Ghana Statistical Service, 2013). The study districts, Nadowli/Kaleo and Wa East, have literacy levels of 41.8% and 24.2% respectively. Wa East is predominantly Muslim (57.9%), while Nadowli is mostly Christian (60.8%). Unlike Southern Ghana which has been a site of mining activities for many years, gold was only recently discovered in commercial quantities in the UWR. Gold mining concessions have been awarded to mining companies by central government to commence mining. The discovery of gold in commercial quantities in the two districts has also resulted in the influx of artisanal gold miners in these locations. In spite of these rapidly evolving dynamics, research that assesses the impact of mining activities on the communities is absent. This study attempts to fill this gap by examining the relationship between odour and dust perceptions on self-rated health among residents in the two mining districts in UWR — Nadowli/Kaleo and Wa East.
4.5 Methods

4.5.1 Data and Analytical Sample

This project is part of a larger health and environment project by the University of Western Ontario and the University for Development Studies, Ghana. The purpose is to examine the health consequences of recent mining activities on host communities using standardized and universally applicable self-rating and perception measurement tools such as the Quick Environment Exposure Sensitivity Inventory (QEESI) (Miller & Prihoda, 1999). Data for this study was collected from household heads (n=801) aged 18 and above from “impacted” and “affected” communities in Nadowli/Kaleo and Wa East districts in the Upper West Region (UWR) of Ghana. Azumah Resources — the company that operates mines in the study area — categorises locations within 5km from mining sites as impacted communities and those between 5km to 10km as affected communities.

The study employed a two-stage stratified sample frame, clustering and systematic simple random sampling with probability proportional to population size to select households. Study communities in Wa East and Nadowli/Kaleo Districts, where mining is taking place, were drawn and clustered into impacted (n=6) and affected (n=8) communities. There is an assumption of a direct effect of mining on the impacted communities, and 70% of the sample was drawn from this group, and subsequently selected the samples per community proportional to the population. The study employed random sampling where every fifth house counted from the entry point to the community was selected to participate in the study. This process was repeated until the sample size was met. Overall, the study identified 820 households and interviewed 801, representing 98% response rate.
This sample formed the analytical basis of the study. Ethical clearance for the study was provided by the Western University and University for Development Studies.

The main research team from Western University, Canada supervised a team of 10 experienced and trained graduates from the University for Development Studies, Ghana to collect the data. Overall, the study provided information on Self Rated Health, mining health perceptions, distance to mining sites, household assets, and biosocial, economic and demographic characteristics of household heads.

4.5.2 Measures

4.5.2.1 Outcome variable: Self-rated Health

Self-Rated Health was derived from the question, “In general, how does your health compare with that of other people of your age group? Would you say your health is Excellent, Very Good, Good, Fair or Poor?”. Fair and poor were combined into “poor” (coded as 1) and excellent, very good and good into “good” (coded as 0). This approach has been used in several empirical studies examining Self Rated Health (see also Giatti et al., 2010; Lindström et al., 2014).

Key independent variables: mining odour and perception of air pollution

Perceptions of environmental exposures such as odours and air pollution from factories have been found to have negative human health consequence (Baxter & Lee, 2004; Luginaah et al., 2000). The proxies for exposure in this study are the two key independent variables (mining odour and perception of air pollution). The study derived mining odour and health variable from the question “Would you say you strongly believe, believe, are...
neutral, disbelieve or strongly disbelieve that odours from surface mining activities are causing health problems (in the communities in the vicinity of the surface mining activities?)” and responses were grouped into ‘believe’ (strongly believe and believe: coded 1), ‘neutral’, coded 2, and ‘disbelieve’ (disbelieve and strongly disbelieve: coded 3). The “perception of air pollution” variable was derived from the question “During this past 4 weeks, how often, if ever, did you notice air pollutants (e.g. dust, exhaust fumes, odours) which you think were from the mining activities when you were at home or in your yard?” Possible responses ‘daily, several times a week, about once a week, several times a month, once a month, and never noticed’ were re-categorized into ‘frequently’ (daily, several times a week, and about once a week: coded 1), ‘less frequently’ (several times a month and once a month: coded 2) and ‘never noticed’ was coded 3. The influence of the two key independent variables on Self-rated health was examined by controlling for the potential effect of other associated variables.

4.5.2.2 Study covariates

Control variables were grouped into biosocial factors (age and gender), sociocultural factors (religion, occupation, education attainment, wealth quintile and child/ren in household), and location factors (distance of household to mine, and District of residence). These groupings were informed by empirical literature on environmental exposure and health (Baxter & Greenlaw, 2005; Luginaah, Martin Taylor, et al., 2002). Occupation and age of respondents were each categorized into four: ‘civil service’, ‘farming’, ‘trading’ and ‘other employment’; and ‘18-29’, ‘30-39’, ‘40-59’, and ‘60 and above’, respectively. Similarly, education attainment and religious persuasion of household heads were put into three categories: ‘no education’, ‘primary’, and ‘secondary
and above’; and ‘Christians’, ‘Muslims’, and ‘Traditionalists’, respectively. Gender, Children in Household, and District of residence variables are dichotomous into ‘male’ and ‘female’; ‘no’ and ‘yes’; and ‘Wa East’ and ‘Nadowli/Kaleo’, respectively. Wealth quintile — an asset based measure — was derived from scores from Principal Component Analysis of household income and other household assets such as livestock, electricity, water and house type and characteristics. This approach is applied universally to estimate the wealth of households, particularly in developing countries where income alone may be an inadequate measure (Ghana Statistical Service, Ghana Health Service, & ICF International, 2015).

4.5.3 Analytic Technique

The association between the key independent variables and self-rated health among household heads in mining impacted and affected communities was examined. The outcome variable is binary, but because the distribution is not asymmetrical, using binary logistic or logit regression analysis would bias the parameter estimates. Instead, negative log-log regression was used given that the distribution of self-rated health was skewed against the success category “poor health” (coded “1”) (see Table 1), to produce unbiased estimates. The log link function of the binominal family addresses the challenge of uneven distribution of the outcome variable (Dobson & Barnett, 2008). Moreover, the ordinary logistics regression is built on the assumption of independence of respondents but given that the study clustered respondents into mining impacted and affected and collected cross-sectional data, responses from the same cluster may be similar, thus the analysis may pose potential bias to the standard errors and parameter estimates. Effect of clustering was controlled for by imposing a unique identification number to each cluster.
of communities on the models using STATA version 12.1 (Stata Corporation, College Station, TX, USA), which is designed to address this kind of problem. Through this technique, standard errors were adjusted to produce robust parameter estimates. A positive coefficient indicates a positive relationship between the independent variable and poor health in this study. Odds Ratios (OR) were estimated using maximum likelihood estimation procedure. Odds ratio greater than ‘one’ is interpreted as a household head being more likely to report poor Self-Rated Health in this study.

The data was first sorted into impacted and affected and fitted three separate nested multivariate models to estimate the net effect of the key independent variables on Self Rated Health in mining impacted and affected communities. Model 1 estimates the effects of the two key independent variables, Model 2 added biosocial variables and Model 3 added sociocultural and location variables (see Table 3). However, the study first estimated the bivariate relationships between each of the independent variables and the outcome variable (See Table 2).

4.6 Results

4.6.1 Sample characteristics

Descriptive statistics are shown on Table 1. More than 75% of the sample population in both impacted and affected communities (with slight difference between the two) generally perceived their health as good compared to their peers. Meanwhile about 25% of respondents from impacted and 22% of those from affected communities believed that odours from mining have a negative impact on their health. In addition, higher proportions of respondents in impacted communities (28%) than affected communities
(13%) reported less frequently witnessing air pollution suspected to be coming from mining activities. In contrast with impacted communities, a higher proportion of the sample from affected communities reported never witnessing (59%) and more frequently witnessing (29%) air pollution from mining.

Moreover, majority of household heads in impacted and affected communities were males (56% and 55%, respectively), between the ages of 18-29 (39% and 43%, respectively), of Christian religious persuasion (77% and 60%, respectively), and engaged in farming as their main livelihood (55% and 35%, respectively). While the majority of study participants had no education in impacted communities (46%), most of their colleagues in the affected communities had attained at least secondary education (34%). Similarly, wealth of households was inversely distributed in impacted and affected communities. While majority (22%) in impacted communities were in the richest wealth category, those in the poorest category in affected communities were the majority (25%). As expected, location variables were also uneven in the two study clusters. Households in affected communities were on an average 7.2km away from mining sites and 2.2km in impacted communities. Moreover, the majority of respondents were resident in affected communities in Nadowli/Kaleo District.
Table 4 - 1 Descriptive Statistics of Dependent and Independent Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impacted (n = 562)</th>
<th>Freq./Mean</th>
<th>%/Std.</th>
<th>Affected (n = 239)</th>
<th>Freq./Mean</th>
<th>%/Std.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRH</td>
<td>Good</td>
<td>426</td>
<td>75.80</td>
<td>183</td>
<td>76.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>136</td>
<td>24.20</td>
<td>56</td>
<td>23.43</td>
<td></td>
</tr>
<tr>
<td>Odours and health</td>
<td>Disbelieve</td>
<td>102</td>
<td>18.15</td>
<td>49</td>
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<tr>
<td></td>
<td>Neutral</td>
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<td>56.76</td>
<td>138</td>
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<tr>
<td></td>
<td>Believe</td>
<td>141</td>
<td>25.09</td>
<td>52</td>
<td>21.76</td>
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<td>Percept. of air pollution</td>
<td>Never witnessed</td>
<td>309</td>
<td>54.98</td>
<td>140</td>
<td>58.58</td>
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<tr>
<td></td>
<td>Less frequent</td>
<td>120</td>
<td>21.35</td>
<td>30</td>
<td>12.55</td>
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<tr>
<td></td>
<td>More frequent</td>
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<td>23.67</td>
<td>69</td>
<td>28.87</td>
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<tr>
<td>Age Groupings</td>
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<td>39.32</td>
<td>103</td>
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<td>40-49</td>
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<td>43</td>
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<tr>
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<td>≥ 60</td>
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<td>22</td>
<td>9.21</td>
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<tr>
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<td>132</td>
<td>55.23</td>
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<td>Religion</td>
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<td></td>
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<td>18</td>
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<td>35</td>
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<td>32.64</td>
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<td>79</td>
<td>33.05</td>
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<td></td>
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<td>21.89</td>
<td>82</td>
<td>34.31</td>
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<td>15.90</td>
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<td>Rich</td>
<td>116</td>
<td>20.64</td>
<td>46</td>
<td>19.25</td>
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<td>Poor</td>
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<td></td>
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<tr>
<td></td>
<td>Poorest</td>
<td>95</td>
<td>16.90</td>
<td>60</td>
<td>25.10</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>No</td>
<td>7</td>
<td>1.25</td>
<td>12</td>
<td>5.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>555</td>
<td>98.75</td>
<td>227</td>
<td>94.98</td>
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<tr>
<td>Distance to mine</td>
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<td>2.2</td>
<td>0.93</td>
<td>7.2</td>
<td>1.61</td>
<td></td>
</tr>
<tr>
<td>District of residence</td>
<td>Wa East</td>
<td>171</td>
<td>30.43</td>
<td>60</td>
<td>25.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nadowli/Kaleo</td>
<td>391</td>
<td>69.57</td>
<td>179</td>
<td>74.90</td>
<td></td>
</tr>
</tbody>
</table>
4.6.2 Bivariate results

Results from the bivariate analysis are presented on Table 2. The study found two statistically significant contrasting associations between the two key independent variables and SRH in impacted and affected communities. Household heads in impacted communities who believed or were neutral on odours from mining activities negatively impacting their health, had higher odds of reporting poor health (OR=1.77, p≤0.001 and OR=1.80, p≤0.001, respectively) compared to those who disbelieved. However, there was no statistically significant association between these groups in reporting SRH in affected communities. Moreover, those who reported witnessing air pollution less frequently in affected communities were 93% more likely to report poor health compared to those who never witnessed air pollution, but this was not significant in affected communities.

In addition, apart from age, religion and wealth, biosocial and sociocultural factors were not significantly associated with SHR in impacted communities. Household heads aged 30-49 years compared with the 18-29 age group, and those with African traditional religious persuasion compared with Christians were more likely to report poor health (OR=1.28, p≤0.1 and OR=2.24, p≤0.001, respectively). Households in poorest wealth category relative to the richest were less likely to report poor health (OR=0.70, p≤0.05). In contrast, biosocial and sociocultural factors were all, apart from age, significant in affected communities. For instance, female household heads had higher odds of reporting poor health than men (OR=1.49, p≤0.05), those with traditional religious affiliation compared with Christians (OR=1.89, p≤0.1), farmers and traders compared with civil servants (OR=1.46, p≤0.1 and OR=1.84, p≤0.05, respectively), and poorest compared with the richest were more likely to report poor health (OR=1.54, p≤0.1). Similarly,
household heads with primary, and secondary or higher education compared with those with no formal education were less likely to report poor health (OR=0.53, p≤0.001 and OR=0.58, p≤0.001). Location factors were not significantly associated with SRH in both impacted and affected communities.

Table 4 - 2: Bivariate Logistic Regression Estimating Poor Health

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impacted (n = 562) OR (Std. Err)</th>
<th>Affected (n = 239) OR (Std. Err)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Odours and health</strong> (ref: disbelieve)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>1.80(0.27)***</td>
<td>1.38(0.29)</td>
</tr>
<tr>
<td>Believe</td>
<td>1.77(0.30)***</td>
<td>1.17(0.29)</td>
</tr>
<tr>
<td><strong>Percept. of air pollution</strong> (ref: never noticed)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less frequent</td>
<td>1.12(0.15)</td>
<td>1.93(0.52)**</td>
</tr>
<tr>
<td>More frequent</td>
<td>1.18(0.15)</td>
<td>1.06(0.19)</td>
</tr>
<tr>
<td><strong>Age Groupings</strong> (ref: 18-29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>1.22(0.16)</td>
<td>1.23(0.24)</td>
</tr>
<tr>
<td>40-49</td>
<td>1.28(0.17)*</td>
<td>1.41(0.33)</td>
</tr>
<tr>
<td>≥ 60</td>
<td>1.34(0.31)</td>
<td>1.30(0.38)</td>
</tr>
<tr>
<td><strong>Gender</strong> (ref: male)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1.07(0.11)</td>
<td>1.49(0.24)**</td>
</tr>
<tr>
<td><strong>Religion</strong> (ref: Christians)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>1.13(0.17)</td>
<td>1.02(0.18)</td>
</tr>
<tr>
<td>Traditional</td>
<td>2.24(0.49)***</td>
<td>1.89(0.65)*</td>
</tr>
<tr>
<td><strong>Occupation</strong> (ref: Civil Service)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming</td>
<td>0.92(0.13)</td>
<td>1.46(0.31)*</td>
</tr>
<tr>
<td>Trading</td>
<td>1.18(0.23)</td>
<td>1.84(0.50)**</td>
</tr>
<tr>
<td>Other employ’t</td>
<td>1.27(0.24)</td>
<td>0.98(0.22)</td>
</tr>
<tr>
<td><strong>Educational attainment</strong> (ref: no education)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.90(0.11)</td>
<td>0.53(0.11)**</td>
</tr>
<tr>
<td>Secondary +</td>
<td>1.12(0.15)</td>
<td>0.58(0.12)**</td>
</tr>
<tr>
<td><strong>Wealth Quintile</strong> (ref: richest)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rich</td>
<td>0.97(0.16)</td>
<td>0.76(0.21)</td>
</tr>
<tr>
<td>Middle</td>
<td>1.01(0.16)</td>
<td>1.20(0.34)</td>
</tr>
<tr>
<td>Poor</td>
<td>1.04(0.17)</td>
<td>1.25(0.33)</td>
</tr>
<tr>
<td>Poorest</td>
<td>0.70(0.12)**</td>
<td>1.54(0.40)*</td>
</tr>
<tr>
<td><strong>Children</strong> (ref: No)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.38(0.66)</td>
<td>1.25(0.46)</td>
</tr>
<tr>
<td><strong>Distance to mine</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00(0.06)</td>
<td>1.02(0.05)</td>
<td></td>
</tr>
<tr>
<td><strong>District of residence</strong> (ref: Wa East)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nadowli/Kaleo</td>
<td>11.09(0.12)</td>
<td>1.23(0.23)</td>
</tr>
</tbody>
</table>

*** p≤0.001, ** p≤0.05, * p≤0.1; Odd Ratios (OR) are adjusted for clustering; Standard errors presented in parenthesis
4.6.3 Multivariate results

After controlling for the effect of the exposure variables in Model 1, odour and health remain robust (only slightly reduced in magnitudes) in both impacted and affected communities. Interestingly, the association between odour and health, and SRH becomes significant in affected communities after controlling for the effect of biosocial factors in Model 2. Household heads who were neutral were more likely to report poor health (OR=1.54, p≤0.05) compared with those who did not believe that odours from mining activities were impacting on their health. In Model 2, there was a significant relationship between age and SRH in both impacted and affected communities. Compared with household heads in ages 18-29, those in 30-39 and 40-49 were more likely to report poor health in impacted (OR=1.30, p≤0.05 and OR=1.32, p≤0.05, respectively) and affected (OR=1.40, p≤0.1 and OR=1.57, p≤0.1, respectively) communities. However, gender differences in SRH remained robust from bivariate results for the affected communities with no significant differences for the impacted communities.

In the final model, which controlled for the effect of sociocultural and location variables, the association between odours and health, and SRH remained robust in both impacted and affected communities while the significant association between perception of air pollution and SRH in affected communities disappeared. Further analysis (results not reported here) indicates that education, religion and wealth were together confounding the significant association in Model 2.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Impacted (n = 562)</th>
<th></th>
<th></th>
<th>Affected (n = 239)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1 OR (Std. Err)</td>
<td>Model 2 OR (Std. Err)</td>
<td>Model 3 OR (Std. Err)</td>
<td>Model 1 OR (Std. Err)</td>
<td>Model 2 OR (Std. Err)</td>
<td>Model 3 OR (Std. Err)</td>
</tr>
<tr>
<td><strong>Odours and health (ref: disbelief)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>1.80(0.27)**</td>
<td>1.87(0.28)**</td>
<td>2.01(0.32)**</td>
<td>1.40(0.30)</td>
<td>1.54(0.34)**</td>
<td>1.53(0.37)*</td>
</tr>
<tr>
<td>Believe</td>
<td>1.77(0.30)**</td>
<td>1.86(0.31)**</td>
<td>1.98(0.36)**</td>
<td>1.15(0.29)</td>
<td>1.25(0.32)</td>
<td>1.18(0.33)</td>
</tr>
<tr>
<td><strong>Percept. of air pollution (ref: never noticed)</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Less frequent</td>
<td>1.12(0.15)</td>
<td>1.13(0.15)</td>
<td>1.16(0.16)</td>
<td>1.90(0.52)**</td>
<td>1.731(0.48)**</td>
<td>1.61(0.51)</td>
</tr>
<tr>
<td>More frequent</td>
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<td>1.19(0.16)</td>
<td>1.227(0.17)</td>
<td>1.00(0.18)</td>
<td>0.96(0.18)</td>
<td>0.92(0.19)</td>
</tr>
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<td><strong>Age Groupings (ref: 18-29)</strong></td>
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<td></td>
</tr>
<tr>
<td>30-39</td>
<td>1.30(0.17)**</td>
<td>1.45(0.21)**</td>
<td>1.44(0.2)</td>
<td>1.40(0.28)*</td>
<td>1.44(0.29)*</td>
<td>1.16(0.35)</td>
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<td>40-49</td>
<td>1.32(0.18)**</td>
<td>1.44(0.22)**</td>
<td>1.57(0.38)*</td>
<td>1.16(0.35)</td>
<td>1.18(0.46)</td>
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<td>≥ 60</td>
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<td>1.43(0.39)</td>
<td>1.57(0.48)</td>
<td>1.78(0.35)**</td>
<td>1.78(0.35)**</td>
<td>1.78(0.35)**</td>
</tr>
<tr>
<td><strong>Gender (ref: male)</strong></td>
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<tr>
<td>Female</td>
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<td>1.59(0.277)**</td>
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<td>1.78(0.35)**</td>
<td>1.78(0.35)**</td>
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<td><strong>Religion (ref: Christians)</strong></td>
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<td>Muslim</td>
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<td>1.21(0.30)</td>
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<tr>
<td>Traditional</td>
<td>2.46(0.57)**</td>
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<td>2.14(0.86)*</td>
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<td><strong>Occupation (ref: Civil Service)</strong></td>
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<tr>
<td>Farming</td>
<td>0.77(0.13)</td>
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<td>1.35(0.38)</td>
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<tr>
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<td>1.51(0.48)</td>
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<tr>
<td>Other employ’t</td>
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<td>0.79(0.21)</td>
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</tr>
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<td><strong>Education attainment (ref: no education)</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.97(0.14)</td>
<td></td>
<td>0.53(0.13)**</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Secondary +</td>
<td>1.22(0.21)</td>
<td></td>
<td>0.57(0.17)*</td>
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<td></td>
</tr>
<tr>
<td><strong>Wealth Quintile (ref: richest)</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rich</td>
<td>1.01(0.18)</td>
<td></td>
<td>0.75(0.22)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Middle</td>
<td>1.04(0.19)</td>
<td></td>
<td>1.26(0.36)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>1.13(0.20)</td>
<td></td>
<td>1.48(0.43)</td>
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</tr>
<tr>
<td>Poorest</td>
<td>0.70(0.13)*</td>
<td></td>
<td>1.75(0.48)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Children (ref: No)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>1.62(0.77)</td>
<td></td>
<td>1.53(0.65)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Distance to mine</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nadowli/Kaleo</td>
<td>1.08(0.15)</td>
<td></td>
<td>2.06(0.53)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>0.40(0.06)**</td>
<td>0.32(0.05)**</td>
<td>0.20(0.12)**</td>
<td>0.51(0.09)**</td>
<td>0.31(0.07)**</td>
<td>0.08(0.07)**</td>
</tr>
<tr>
<td>Log pseudo likelihood</td>
<td>-301.8914466</td>
<td>-298.4944315</td>
<td>-279.4292761</td>
<td>-125.3783676</td>
<td>-120.384064</td>
<td>-103.5819486</td>
</tr>
</tbody>
</table>

***p≤0.001, **p≤0.05, *p≤0.1; Odd Ratios (OR) are adjusted for clustering; Standard errors are presented in parenthesis; Model 1 (Mining Exposures); Model 2 (Biosocial); Model 3 (Sociocultural & Location)
However, age in model 2 for impacted communities significantly changed for those in the 30-39 and 40-49 age cohorts and remained robust in model 3. In contrast, age in affected communities did not see any significant changes from the bivariate results, remaining barely significant (OR=1.44, p≤0.1) for the 30-39 age cohorts in model 3. Meanwhile, female household heads were 78% more likely to report poor health than males. Consistent with the results at the bivariate, those that practiced the African Traditional religion compared to Christians (OR=2.46, p≤0.001) rated their health as poor in impacted and affected communities, though less significant in the latter (OR=2.14, p≤0.1). The impact of other sociocultural factors on SRH in impacted and affected communities was generally varied. For instance, the association between occupation and SRH disappeared while that of education slightly attenuated in affected communities. However, wealth quintiles remain significant from bivariate results. District of residence, which is not significant at bivariate, becomes significant in Model 3 for only affected communities. Compared to household heads resident in Wa East, those in Nadowli/Kaleo had higher odds of reporting poor SRH (OR=2.08, p≤0.001).

4.7 Discussion

The paper examines community perception on health risk in the midst of environmental stressors (odours and dust) caused by surface mining in the Upper West Region of Ghana. The UWR has a prolonged dry season spanning from September to April (Kuuire et al., 2013). Together with the harmattan winds, the effects of dust and odours from mining concessions can have a serious health effect on surrounding communities. The finding shows that, residents who perceive odours to have a deleterious effect on the health of the community rated their health as poor compared to those that believed otherwise. Odour
annoyance in particular has been found to be a major influence on health risk perception during environmental exposures (see also Elliott et al., 1999; Luginaah, Taylor, Elliot, et al., 2002; Luginaah et al., 2000). This is especially the case where in this study context there are multiple sources of odour emission through ASM activities. Displaced from their ancestral lands and livelihoods, some residents in impacted communities are directly engaged in the illegal artisanal gold mining which directly contributes to odours and dust (Veiga et al., 2014). Based on odour mediated mechanisms, artisanal gold mining conducted in close proximity to residential communities may intensify the odour perception and annoyance leading residents to report poor self-rated health. Considering the general level of pollution and environmental degradation within the study context, it is not surprising residents that are neutral on the perceived health effects of odours within the study communities are still more likely to rate their health as poor compared to those that disbelieved. However, the lack of association between those that believed odours are causing health problems and self-rated health in the affected communities may be due to the greater sense of awareness of environmental pollution and also distance from the mining activities. However, residents in affected communities who are neutral on the health effects of odours, though indecisive on the medium through which odours impact their health, may still perceive adverse health impacts of mild odours on their health. It is therefore not surprising that, those that are neutral in the affected communities are still more likely to rate their health as poor compared to those that disbelieved. The difference in association between odour perception in impacted versus affected communities make the findings consistent with the literature on the negative gradient between perceived health risk and distance to exposures or hazards (Luginaah, Taylor, Elliot, et al., 2002; Steinheider, 1999).
Although previous studies have reported an association between frequent sighting of dust especially at home and perceived health risk (see Bickerstaff, 2004), the findings did not show any association between dust and perceived health risk. This may be due to a number of factors. First, the study context is in a dry savanna environment (Breuning-Madsen & Awadzi, 2005; Tiessen, Hauffe, & Mermut, 1991) where the harmattan winds and climate change have subjected residents to persistent dust exposure. This may have desensitised the residents on the perceived health effects of dust (see also Atari et al., 2011; Atari, Luginaah, & Fung, 2009; Atari, Luginaah, Gorey, Xu, & Fung, 2013). The notion of desensitisation likely explains why residents in the affected communities who witnessed dust less frequently were initially more likely to rate their health as poor compared to those who never noticed, while those that witnessed it more frequently were not significantly different from those that never witnessed air pollution. However in the final model, after taking into account socio-cultural factors, there was no difference in perceived health risk between those that never noticed dust, those that perceived it less frequently and those that perceived it frequently. Second, according to Cavalini et al (1991), when residents are exposed to environmental hazards, the coping measures may be problem-oriented, where residents get annoyed by the exposure and report symptoms, or emotion-oriented where residents regulate their emotions to accept or adjust to the hazard, therefore becoming less annoyed by it. Similar observations were made by Lazarus and Folkman (1984) in hazard coping measures. Affected residents may have developed an emotion-oriented approach in dealing with dust pollution that leaves them less bothered about the potential health impact of dust pollution on their health, especially as they are seasonally (November to March) faced with the dry harmattan winds from the nearby Sahara desert (Breuning-Madsen & Awadzi, 2005; Tiessen et al., 1991). What is
more worrying is the potential effects of particulate matter that has been linked to respiratory and cardiovascular health effects. Given the lack of environmental monitoring of pollution from dust and odours in this study context, it not possible to make a link, but the long term monitoring of the effects of mining in this dry environment will warrant such environmental monitoring.

Consistent with other studies, there was no difference between type of occupation and perceived health risk in the context of environmental exposures (see Claeson, Lidén, Nordin, & Nordin, 2013) in both impacted and affected communities. Since all communities in the study context are rural, those who identify with other professions may also be farmers (70% and 89% in the Nadowli/Kaleo and Wa East districts respectively). However, other studies that classified employment based on respondents direct engagement by the firm or otherwise, found significant differences in perceived health risk among those employed in the firm (less symptoms reporting and annoyance) and those that are not (Woolley et al., 2015). With regards to gender, some authors (see Elliott et al., 1999; Flynn et al., 1994; Oiamo & Luginaah, 2013) have observed gender variations in health risk perception in relation to environmental exposures. Women have a heightened perception of health risk during environmental exposures and are more likely to report symptoms or rate their health as poor compared to men (Oiamo & Luginaah, 2013). While this observation was consistent with the findings in the affected communities, gender variation in the impacted communities is not significant. Greenberg and Schneider (1995) argues that, in environments stressed by a range of hazards or pollution, gender variation in perceived health risk may seem to disappear. Yet, given the potential physiological differences between men and women (Oiamo & Luginaah, 2013),
such lack of evidence may not necessarily be telling the entire story of the effects of exposure. Considering the multiple sources of pollution (odours and dust from mining sites and artisanal miners) in the impacted communities, high economic deprivation and lack of social infrastructure, it is expected there will be little or no gender differences in perceived health risk as suggested by Greenberg and Schneider (1995). However, the impact of educational attainment on perceived health risk in communities exposed to environmental hazards has been mixed. Some scholars argue that, formal education equip individuals with health knowledge thereby heightening their assertiveness for perceived health risk. According to this group of researchers, persons with some level of educational attainment tend to rate their health poorer or report symptoms when their community is exposed to environmental hazards compared to those with little or no formal education (see Egondi et al., 2013; Elliott et al., 1999). Other empirical studies however found no association between level of educational attainment and perceived health risk (see Claeson et al., 2013; Omanga, Ulmer, Berhane, & Gatari, 2014). The findings in the impacted communities are consistent with the latter group of researchers. Considering the magnitude of environmental pollution in the impacted communities, formal education may not be useful in assessing the possible impact of environmental stressors on community health. However, the findings in the affected communities are consistent with the former group of researchers who report that, formal education makes people assertive in perceived health risk during environmental exposures. Although exposure (odour and dust) levels are very low in affected communities compared with impacted communities, residents with formal education are more likely to associate mild odours and dust with adverse health compared to those with no education.
Poverty has been strongly linked to adverse health effects in exposure situations (see O’Neill et al., 2003). In the current study context, the Ghana Statistical Service estimates that seven (7) out of every ten (10) residents lives on less than $1.25 a day. The chronic and pervasive nature of poverty may explain why wealth did not make a strong contribution in the models. Nevertheless, the poor in the impacted communities were more likely to report poor health. Similar results have been reported by Howel et al (2003). However, the inverse relationship between the poorest wealth quintile and reported health in the impacted communities call for an in-depth study to further explore the relationship between the two. These findings also points to the difference between districts in perceived health risk in impacted and affected communities. Due to the promise of social infrastructure like schools and portable water to the impacted communities by the mining company, perception of potential health risk may be influenced by the direct benefits communities stand to derive from the mining activities. Furthermore, residents in impacted communities are directly benefiting from mining activities as some community members are engaged by the mining company with a promise of recruiting more residents as mining activities expand. Again, a significant number of residents in the impacted communities may also be benefiting through the activities of ASM. In the affected communities however, there are limited potential community benefits from the mining company. In addition, there are lots of advocacy and sensitization on health impacts of mining within the Nadowli district due to its administrative role for the mining company. With limited economic/community benefits and increased awareness of possible health impacts, residents in the affected communities who belong to the Nadowli/Kaleo district are likely to perceive adverse health and rate
their health as poor compared to affected residents in the Wa East district that may lack awareness.

It is well documented in the literature that older age cohorts are more likely to rate their health as poor compared with younger cohorts (Giatti et al., 2010; Lagarde & Palmer, 2008; Woolley et al., 2015). It is possible the difference in cohort health interpretation, expectations and needs make older cohorts to perceive and rate their health as poor (Chen, Cohen, & Kasen, 2007). In the affected communities however, the oldest cohort were not different from the youngest cohort in reporting poor self-rated health. Considering that older cohorts have been associated with olfactory decline (Murphy et al., 2002; Venstrom & Amoore, 1968), it is possible increased olfactory impairment (low sensory detection of odours) may be influencing their perceived health risk in the impacted communities, especially as old age has also been observed to be associated with better coping mechanisms to odours (Cavalini et al., 1991).

The findings also show a strong association between religious affiliation and perceived health risk. Traditionalists compared to Christians perceived their health as poor in relation to environmental pollution. The African Traditional Religion holds nature sacred (Rusinga & Maposa, 2010) and believes the health of the environment is intrinsically linked to the health of humans. In their perspective, when nature is abused, the ancestral spirits inflict the custodians with deteriorating health and even death (Taringa, 2006). Given that this study context is experiencing a lot of pollution and environmental degradation, adherents of the African Traditional Religion may directly link environmental degradation to a deleterious effect on their own health based on their belief of a synergy between nature and human health.
4.8 Study Limitations

This study has some noteworthy limitations. First, this data was collected as cross sectional, and it is therefore difficult to assume causal relationships between dependent and independent variables. These findings are therefore limited to associations. Again, because the data is self-reported, the findings could be biased due to over reporting of issues as it relates to mining which is a sensitive area of concern for respondents in the study communities. In spite of these limitations, these findings are consistent with the literature and important for policy in Ghana and elsewhere.

4.9 Conclusion

Regulatory agencies and government have relied on technical estimations in assessing potential health impacts on residents in close proximity to environmental exposures. As part of the technical appraisals, level of exposure in the affected community is compared with an acceptable standard of toxin exposure considered safe for humans (Elliott et al., 1999; Paul Slovic, 1987; Slovic, 1993). Among other things, the technical assessment may include the type and nature of the exposure/toxins, medium of exposure (land, air water), and the characteristics of vulnerable or susceptible groups within the population (e.g. children and pregnant women). Though there are frequently no conclusive evidence in levels of exposure to be considered “safe” due to the confounding effects of the latency of certain ailments, multiple sources of toxin exposures among others (Frank, Gibson, & Macpherson, 1988; Hill, 1965; Ozonoff, 1994; Smith & Phillips, 1992), governments, regulatory agencies and mining firms still rely on technical expert reports in estimating possible health and environmental impacts in host communities. These findings show
that, differences in gender, age, educational attainment and religion are important in evaluating potential health risk of mining by residents in this dry savanna region. As suggested by Elliot et al (1999), a broader definition of health encompassing physiological and psychosocial components that targets the peculiar context of the affected communities must be defined in health risk assessment prior to the commencement of mining activities. This will make it relatively easier to communicate health risk in a language that will be easily understood by the local populace. These findings also call for a broader consultation with affected communities to incorporate their concerns in managing environmental pollution when mining activities become fully operational. It is further suggested that, instead of mining companies and the central government relying solely on technical experts and estimations to declare environmental exposures as safe, community perceptions and input must be made in order to avert possible future confrontations between firms and their host communities which in the past has led to loss of lives, damage to property and sometimes complete shutdown of mining operations.
4.10 References


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Chapter 5: To move or not to move: community reaction to surface mining in the Upper West Region of Ghana

5.1 Introduction

Northern Ghana has been described as a natural resource “drought zone” because of the absence of extractive industries in this part of the country (Plange, 1979). Due to a colonial legacy of under-developing Northern Ghana and making it a manual labour reserve for the mining industry and plantation farms in Southern Ghana (Songsore & Denkabe, 1995), the colonial government was disinterested in prospecting for mineral deposits which would have led to the development of mines in this part of the colony. However, in the post-independence period and more recently, there is a heightened interest in prospecting for new gold deposits in Northern Ghana particularly in the Upper West Region of Ghana (Hilson, 2010; Moomen & Dewan, 2016). By 2010, there were 12 mining concessions in the Northern Zone of the country out of a total of 233 concessions nationwide (Minreals Commission of Ghana, 2010). Prospective gold deposits have also led to the influx of artisanal small scale mining activities in these areas. Given the environmental condition in this dry savanna area, the potential impact of mining activities on health, local small scale holder farmers and the general social organization is worrying as the area is rural and agrarian. As surface mining activities require large tracts of land and is also associated with environmental pollution, it is likely to affect residents’ relation to and utilization of their ancestral lands and environment. Together with the limited economic opportunities and high rates of out-migration, residents’ detachment from their land due to pollution, land seizures and other mining related activities will have a
devastating effect on the existence and longevity of affected communities during and after mining activities have come to a close. The study therefore aims to examine residents’ perception of their environment and community wellbeing due to the emerging gold mining activities in affected communities in the Upper West Region of Ghana.

5.2 Mining in Ghana

Mining has been a major backbone to Ghana’s economy spanning from pre-colonial to post-colonial times (Hilson, 2002b; Yelpaala & Ali, 2005). In post-independent Ghana, the sector has been an important source of livelihood for several communities (Yelpaala & Ali, 2005). Prior to the colonial era, minerals were extracted on a small scale with rudimentary traditional techniques and tools that had minimal environmental impacts (Dumett, 1998; Hilson, 2002b). Although alluvial mining was widespread along the banks of major rivers in the country, shallow pit and deep shaft mining were all practiced. Most of the gold extracted in the pre-colonial era was used locally. However, contact with the Arab world through the Trans-Saharan trade led to an increase in gold production to meet the demand (Reader, 1998). The Arab world remained the largest influence on mining in West Africa for about seven-hundred (700) years before European Navigators reached the coast of West Africa (Hilson, 2002b). The dawn of colonization driven by a desire to exploit minerals and other resources, witnessed the introduction of large scale commercial mining in the country. Between 1881/2 to 1894 a total of seventy (70) colonial mining concessions were secured although only five (5) of these concessions were in full scale commercial mining. These concessions were located around the Tarkwa-Prestea area in the Western region and Obuasi in the Ashanti region where an estimated two thousand four hundred (2,400) indigenes were employed (Silver, 1981).
From the period of the contact with the Europeans, the local mining industry which hitherto had been operating with minimal environmental disruption entered a new phase where its impact on the physical environment began to affect host communities. The enactment of the “Concessions Ordinance” by the British Colonial Government in 1900 legitimised large scale land acquisition from communities for mining (Hilson, 2002b), taking over community lands and displacing the local population from their traditional livelihoods of subsistence agriculture. Furthermore, mining activities introduced environmental toxins and pollutants into the host communities in addition to the competition with local livelihoods for land use (Amonoo-Neizer et al., 1996). More recently, the emergence of small scale artisanal miners in Ghana’s mining industry has worsened the environmental concerns of residents in host communities.
Unlicensed, illegal and unmonitored, artisanal miners use unapproved techniques and chemicals in gold extraction leaving behind eyesores, tailings, ponds and traces of chemical toxins in the ecosystem (Armah, Luginaah, Taabazuing, & Odoi, 2013; Gavin, 2002).
Currently, mining industries are increasingly attracted to rural environments for mineral prospecting and exploration in developing countries (Madeley, 1999; Veiga, Scoble, & McAllister, 2001). While several reasons have been adduced for this development (see Madeley, 1999), rural communities in Ghana are now being overwhelmed with high levels of mining related environmental degradation. Especially in surface gold mining, the breaking and transportation of rock materials introduce environmental stressors such as dust into the physical environment. The removal of the top soil to reach gold bearing rocks leads to the destruction of the natural landscape, vegetation and fragile ecosystems. The effects of surface gold mining further compound environmental degradation of host communities. According to Kitula, (2006, p. 1), environmental degradation associated with mining occurs due to “inappropriate and wasteful working practices and rehabilitation measures”. The long term ability of the physical environment to support the ecosystem and humans tend to be precarious in such polluted environments. Mine tailings, dams, ponds and eyesores left behind after mining activities takes several decades for the land to regenerate and support ecosystems (Tetteh et al., 2015). The practice of irreparable damage to the environment after mining activities is more severe in developing countries including Ghana. This situation persists because of the dysfunctional policy and laws on environmental pollution and land reclamation (Taabazuing et al., 2012). Poor and corrupt governments in need of revenue from mining to meet immediate socio-economic needs believe enacting strict laws on best environmental practices is a disincentive to potential investors (Garvin et al., 2009; Westin, 1992). Westin (1992) reports that, while rich nations regard eyesores from mining as part of the associated environmental cost, poor nations in the Global South dismiss them. Yet, within the dysfunctional nature of the mining policy subsystem, what
is found is poor coordination of regulatory agencies. In Ghana, this challenge is further compounded by limited resources to effectively monitor mining activities, leading to a worsening environmental impact of the mining sector (Akabzaa & Darimani, 2001). Aryee et al (2001) further contends that the mining regulatory framework in Ghana does not address negative social and environmental impacts which is due to a weak capacity of agencies in charge of its enforcement. For instance, mining affected residents in the Wassa West District of the Western Region perceived the Environmental Protection Agency (EPA), Mines Department and Mining Inspectorate in charge of monitoring and ensuring mining environmental best practices as ineffective in protecting them against environmental pollution and associated ailments from mining operations (Taabazuing et al. 2012). In his assessment of the activities of the Environmental Protection Agency (EPA) in developing countries with particular focus on Ghana, Appiah-Opoku (2001) bemoaned the adoption of Western models of Environmental Impact Assessment (EIA) in Ghana, which are not well suited for the country’s socio-economic and institutional conditions. Moreover, these models are strictly scientific/technical and do not integrate local knowledge in assessing potential risk and managing the possible impacts of mining activities. See also Armah et al. (2011).

Mining activities impact greatly on agricultural activities. For instance, Adomako et al. (2014) assessed the impact of mining on rice farming and reported a reduced yield from polluted rice fields compared to control areas without mining activities. Particularly, in open cast mining, the removal of the nutrient-rich top-soil, necessary to support plant growth greatly impact agrarian livelihoods. In cases where the mining company is mandated by law to reclaim mined lands, the top-soil is stockpiled, becoming biologically
unproductive for agricultural purposes, because of the duration and process of storage (Ghose, 2004). Wong (2003) indicates that, the original top-soil in mine degraded areas is mostly missing or contains skeletal amounts of organic matter and nutrients like nitrogen essential for plant growth. Where the top-soil exists, it is heavily polluted by toxic metals like copper, lead, nickel, zinc and manganese which affects the abundance, diversity and interaction of soil organisms that enhance plant growth (Ghose, 2004; Levy & Cumming, 2014; Wong, 2003). Mining is also associated with severe soil erosion, reduction in water content and soil porosity (Chen et al., 2014; Lin et al., 2005; Schueler et al., 2011a). As mining practices continue to degrade agricultural land, food security concerns are increasing for residents in affected communities (Garvin et al., 2009).

Perhaps the greatest challenge to land based activities especially agriculture in host communities in Ghana is the appropriation of lands originally used for agriculture. For instance, over 70% of agricultural lands in Tarkwa have been taken over by mining activities alone which denies the indigenes access to agricultural activities (Akabzaa & Darimani, 2001). The construction of mining sites, tailing dams, mine camps, roads and resettlement of affected communities permanently takes between 40%-60% of the total land area originally allocated to mining companies by the close of operations (Akabzaa & Darimani, 2001). The permanent loss of lands has implications for access to arable land for agriculture and other livelihoods in host communities (Lawson & Bentil, 2014). Although the mining rhetoric utilises a narrative which suggest the industry creates employment for the working age population in affected communities, evidence shows that only 0.7% of the total adult working population are employed by mining firms compared to over 55% employed by agriculture (Akabzaa, 2009). During the explorative stages of
mining, communities are promised jobs and general improvement in the community’s socio-economic conditions. Consequently, there are high community expectations from mining companies during full scale mining operations. However, the limited number of indigenes employed by mining companies from host communities and destruction of livelihoods leads to a hostile relationship between the community and the mining industry (Armah et al., 2011; Lawson & Bentil, 2014).

Several studies have reported severe pollution of sources of drinking water; mostly streams and rivers. For instance, Asante et al. (2007) reports that, Obuasi a mining community in the Ashanti Region of Ghana, has high concentration of arsenic metals and magnesium in drinking water. Prior studies in the same host community reported similar findings (see Akabzaa, Banoeng-Yakubo, & Seyire, 2009; Amonoo-Neizer, Nyamah, & Bakiamoh, 1996; Smedley, Edmunds, & Pelig-Ba, 1996) which suggest the practice has persisted for decades. For instance, the World Health Organization (W.H.O) recommends that the level of arsenic in water should not exceed 0.01 ppm, yet sources of drinking water in Prestea and Tarkwa in the Western Region of Ghana had arsenic concentration which ranged from 0.90–8.25ppm (Serfor-Armah, Nyarko, Adotey, Dampare, & Adomako, 2006). Arsenic, mercury and other heavy metals found in drinking water in host communities have been traced to mine tailings, tailing dams and ponds. After the gold extraction process, tailings which contain high amounts of arsenic and other metals are dumped and over time the chemicals are leached contaminating sources of drinking water for the host community (Akabzaa et al., 2009; Kuma & Younger, 2004; Serfor-Armah, Nyarko, Adotey, Dampare, & Adomako, 2006). Though mining companies continue to understate the impacts of their operation on water pollution and associated ill-
health, there is mounting evidence which suggests exposure to arsenic, mercury and other metals have long-term health impacts on residents in host communities (Armah, Luginaah, et al., 2012). Since most host communities are agrarian, consuming fish from polluted rivers and streams or eating crops cultivated in the environs of mining activities or through dermal contact are alternate sources of arsenic and mercury ingestion into the human body (Mensah & Okyere, 2014). Hyperpigmentation, growth deficiencies, psychological disturbances, upper respiratory infections, cardiovascular complications, increased blood pressure, kidney damage and cancers of the skin are some of the common diseases associated with mining pollutants (Armah et al., 2012; Hendryx, 2009; Wright, Matooane, Oosthuizen, & Phala, 2014). In most cases, children within these communities are most vulnerable to the absorption of arsenic (Armah et al., 2012; Carrizales et al., 2006). Though government and regulatory agencies have relied on “expert technical assessment” to declare as safe environments in close proximity to mining activities, affected communities continue to fault mining companies for the elevated levels of ailments (Balfors et al., 2007; Mensah & Okyere, 2014; Yeboah, 2008). According to Elliot at al. (1999), while the mining industries are solely dependent on “expert” advice or reports on potential health risk of exposures in many communities, residents base their assessment of potential health risk on a range of factors that are mostly overlooked by the so-called “experts”. With frequent exposures and ingestion of mercury, arsenic and other heavy metals, residents in host communities especially those that are further invaded by artisanal gold miners, have recorded unacceptable levels of heavy metals and other pollutants in their blood and body tissue (Adimado & Baah, 2002; Armah, Luginaah, & Obiri, 2012; Obiri, Dodoo, Okai–Sam, Essumang, & Adjourlo-Gasokpoh, 2006; Obiri, Dodoo, Okai-Sam, & Essumang, 2006). Exposed residents are sometimes (forty) 40 times
more likely to be infected with diabetes mellitus, hyperkeratosis or pigmentation among others (Armah, Luginaah, et al., 2012). These problems affect residents satisfaction with their community as mining impacts their health and economic activities and the serenity of their community with some members seeking to relocate (Carrington et al., 2011).

Host communities are equally inundated with a number of social problems which affects their wellbeing and satisfaction with their community. Host communities are mostly marginalized through the compulsory acquisition and forceful evictions from their ancestral lands, disrespect for their customs, beliefs and practices, arbitrary arrest and inadequate compensation (Jul-Larsen et al., 2006; Kitula, 2006; Lawson & Bentil, 2014; Taabazuing et al., 2012). Social tension which is common in host communities has been associated with loss of livelihoods, poverty, marginalisation, environmental degradation and conflict with mining companies over ownership and use of land (Abuya, 2013; Hilson, 2002b; Lawson & Bentil, 2014). Increased crime rates have also been identified as a social impact on host communities (Carrington et al., 2011). The influx of mine workers, greatly impacts the demographic structure and dynamics of host communities (Carrington et al., 2011; Hilson, 2002a; Sweeting & Clark, 2000) with implications for the cost of living, community acquaintance and cohesion, gender dynamics and survival of the community beyond the lifespan of the mine (Carrington et al., 2011; Hilson, 2002a; Sweeting & Clark, 2000). In addition, the influx of mine workers lead to rapid population growth in host communities, which may not be accompanied by commensurate increase in the community’s physical infrastructure. Akabzaa & Darimani (2001) observes that, Tarkwa faced a number of social issues which include unemployment, family disorganization, increased school drop-outs, prostitution, drug abuse and inadequate
housing. Increasingly, school children below the legal working age, drop out of school to work in artisanal gold mining concessions (Arthur, Agyemang-duah, Gyasi, Yeboah, & Otieku, 2016; Hilson, 2010) which leads to truancy, petty theft and increased crime that disrupts the social organization of the affected community (Akabzaa & Darimani, 2001; Kitula, 2006)

Most work has focused on the old mining communities in Southern Ghana. However, underground mining has historically been practiced in the South. The sudden influx of surface mining in a dry environment that sometimes experiences dust storms from the Sahara desert calls for an understanding of how these surface gold mining activities are impacting the environment and the health of the people. Research on possible health impacts in Ghana is limited in scope, as residents are only sampled for their blood and body tissues for laboratory analysis without examining ways they perceive mining activities to be impacting their environment and health. This has resulted in a research gap between residents’ perception of their health and satisfaction with their community in relation to environmental pollution and disruption of their way of life. This paper contributes to the literature by assessing residents’ perception and satisfaction with their community due to mining activities

5.3 A Political Ecology of Mining

Political ecology theory on environmental change, resource utilization and power relations among actors in the use of natural resources has been used in the mining literature (see Hitch, 2006; Kronenberg, 2013). According to Bryant & Bailey (1997), political ecology is primarily focused on stakeholders with different paradigms and value
perspectives in the use and exploitation of the ecosystem. The exercise of unequal power between stakeholders is critical in shaping the process and outcome of resource extraction. Some authors have argued that, because stakeholders have varying values attached to the ecosystem, those that exercise the greatest power are able to influence the discourse on the ecosystem and determine the environmental outcomes (Kronenberg, 2013; Martínez-Alier, 2009). For instance, in issuing a license to a mining company to commence operations in Ghana, the central government is driven by prospective tax revenues, the mining company on the other hand is motivated by profit maximisation, while the affected communities although interested in new economic opportunities, are concerned about possible environmental and health impacts (Lawson & Bentil, 2014). However, even though residents in host communities suffer the long term effects of environmental pollution from mining, the influence of the state and mining corporations subdue community interest and values in how their environment is exploited and managed. Consequently, powerful multinational businesses and the state solely determines which population is exposed to environmental hazards (Bryant & Bailey, 1997; Hitch, 2006; Taabazing et al., 2012). According to Blaikie (1985), “place based” actors are residents in communities directly affected (environment, health, social, economic) by the exploitation of the ecosystem. “Non-place-based” actors on the other hand, are the externals (business corporations and the central government) to the local environment that are not directly affected by its exploitation, yet yield the power to decide on how it is exploited. Little attention is therefore paid to the environmental and economic concerns of residents as corporations seek to maximise profit.
Historically, natural resource exploitation and associated environmental problems have been linked to the spread of capitalism by Western powers in the nineteenth century, when resources from colonies were exploited without due regard to the interest of affected communities (Bryant & Bailey, 1997; Dumett, 1998). Currently in the post-independent era, governments in former colonies still exercise total state control over resources therefore reinforcing the unequal power relations with local communities. The fusion of the economy of former colonies into the Capitalist West dominated economic order, through the export of raw materials for European and American markets, makes third world countries more vulnerable to resource exploitation and environmental degradation. Specifically, Bryant and Bailey (1997, p. 8) states that, “A colonial legacy of integration in a global capitalist economy, natural resource dependency, environmental degradation and centralized political control have conditioned environmental use and conflict in the postcolonial control times”. Thus, poor countries especially in the Global South continue to be treated as a raw material reserve for Western markets (Martínez-Alier, 2003 p. 10). With limited capital, poor states are unable to invest in the extraction of their own natural resources, leaving multinational businesses to dominate and control natural resource extraction.

In Ghana, due to the inherited colonial module of state resource control, and the influence of a hegemonic capitalist market, the state enact policies which specifically favours multinational mining businesses by compulsorily acquiring lands from locals who are helpless against the coercive force of the state (Owusu-Koranteng, 2008). For instance, Ghana’s Mineral and Mining Act 2006, empowers the President and the sector Minister to compulsorily acquire lands for mining purposes without any formal in-depth consultation.
with affected communities. Mining affected communities go through land seizures, disregard for customs, increased cost of living, environmental pollution and diseases (see Taabazuing et al., 2012). Impacted communities increasingly are unable to mobilise against the state and mining companies considering the unequal power exercised by the state against them. In the study context, residents report of constant harassment from the state security. Specifically there is police and military presence on mining concessions, preventing host communities from assessing their farms, gathering fruits and hunting (Moomen & Dewan, 2016). Under Ghana’s Minerals and Mining Act 2006 “Every mineral in its natural state in, under or upon land in Ghana, rivers, streams, water sources throughout the country, the exclusive economic zone and an area covered by the territorial sea or continental shelf is the property of the Republic and is vested in the President in trust for the people of Ghana” (Act 703, Clause 1). Thus, minerals rich lands automatically reverses to the state. Although the mining sector in Ghana and elsewhere has been projected as an avenue for job creation and improvement in the socio-economic status of affected communities (place based actors), there is ample evidence to suggest communities derive limited benefits, yet they are afflicted with multiple environmental, social and health related problems while the state and foreign mining companies (non-placed based actors) maximises revenue and profit from the exploitation (Bryant & Bailey, 1997). In place of the current arrangement by the state and multinationals in resource identification, exploitation and development, some political ecologist (Robbins, 2011, p. 13) have suggested a social justice approach where the place based actors who are directly affected by the resource exploitation are empowered to determine the use and exploitation of the environment in a way that is aligned to their own values and attachment to the ecosystem.
The limited participation of indigenous populations in the use of their environment due to unequal power relations with the state has resulted in community dissatisfaction with their environment and a sense of alienation from their ancestral lands (Akabzaa & Darimani, 2001; Aubynn, 1997). Most residents in affected communities are indigenous to the land and have been living on it for several decades before the arrival of mining companies (Hilson, 2002a, 2002b). Their exclusion from decisions to award concessions that eventually affects their way of life and sustenance affects their sense of wellbeing and satisfaction with their ancestral land. Mining activities may be at variance with cultural and religious practices that rests on a physical environment devoid of pollution and noise. In the current study context, affected residents are rural and agrarian, and have been depending on the land for several decades. The compulsory acquisition of their lands for mining firms has led to displaced livelihoods, insecurity and adverse health concerns in a once serene rural environment. The preceding theoretical discussion is used to explain the study of environmental and health perceptions in the Upper West Region of Ghana.

5.4 Study Context

The Upper West Region (UWR) of Ghana is located to the north-western part of the country — sharing a border with Burkina Faso to the north and west, and with the Upper East and Northern Regions to the east and south respectively. It is specifically located between latitudes 9° 30’ and 11° 00’ N and longitudes 1° 25’ and 2° 45’ With a total land area of 18,476 square kilometers which represents roughly 12.7% of the total land area of Ghana (Ghana Statistical Service, 2013). It has dry climatic condition which is semi-arid for most of the year and is covered by the Guinea savannah vegetation. According to the Ghana Statistical Service (2013), the region is the least populated with a total of 702,110
people which represents only 2.8% of the national population. It has eleven (11) administrative districts with Wa as the regional capital. The region suffers from endemic poverty with seven (7) out of every ten (10) residents classified as poor (Ghana Statistical Service, 2014).

Ethnic groups in the region include the Dagaaba, Waala, Sissala and Birifor. Two out of the eleven (11) districts in the region, the Nadowli/Kaleo and Wa East are the site of mining activities which commenced less than a decade ago.

The two districts have been classified as rural by the Ghana Statistical Service (Ghana Statistical Service, 2013). Roughly 70% and 89% of the residents in the Nadowli and Wa East Districts respectively are involved in subsistence agriculture. Despite the high involvement of residents in agriculture within the region (Inkoom & Nanguo, 2011; Songsore & Denkabe, 1995), 16% of the population is considered food insecure (WFP et al., 2012). Farming activities are concentrated between the months of May and August each year when northern Ghana experiences its annual rainfall (Kuuiire et al., 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). Yet rains are increasingly becoming erratic and unreliable (Armah et al., 2011). After the rain season, the rest of the year is generally dry with little or no farming and other economic activities for residents (Kuuiire et al., 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). The high incidence of food insecurity in the region may be partly explained by an over-reliance on rain-dependent agriculture and declining farm yields which has been observed in the region in the last three decades (Kuuiire et al., 2013; Nyantakyi-Frimpong & Bezner-Kerr, 2015). The region has an illiteracy rate of 59.5% which is more than twice the national average of 25.9% (Ghana Statistical Service, 2013). The study districts, Nadowli/Kaleo and Wa East, have literacy
levels of 41.8% and 24.2% respectively. Wa East is predominantly Muslim (57.9%), while Nadowli is mostly Christian (60.8%). Unlike Southern Ghana which has been a site of mining activities for many years, gold was only recently discovered in commercial quantities in the UWR. Gold mining concessions have been awarded to mining companies by the central government to commence mining. In September 2014, the Upper West Regional House of Chiefs, a constitutionally recognised body which represents the Traditional Authority in the region in a press conference/statement registered their dissatisfaction with the central government and the mining company by reporting that their communities were neither consulted nor adequately informed on the leasing of community lands for mining activities. Among other things, they complained about economic hardships due to land seizure, desecration of religious sites, increased school drop-outs, increase in crime, disrespect for their customs, depletion of biodiversity in the fragile ecosystem, diseases and general decline in wellbeing of residents in affected communities. The discovery of gold in the two districts has also resulted in the influx of artisanal gold. In spite of these rapidly evolving dynamics, research that assesses the impact of surface mining activities on residents’ perception with their communities is absent. This study makes a contribution to the mining literature by examining residents’ satisfaction with their community as a place to live amidst the economic, social, environmental and health effects of surface mining activities.
5.5 Methods

5.5.1 Data and Analytical Sample

Data for this study was from a community health impact study of mining affected communities in the Upper West region of Ghana. The study examined the influence of perceptions of surface mining activities on residents’ decision to relocate from their community. In this study context, people mostly have strong attachment to their ancestral community and relocating because of mining activities means they consider their community a risky place and a continuous stay would harm their health. This quantitative study employed standardized and universally applicable self-rating and perception measurement tools such as the Quick Environment Exposure Sensitivity Inventory (QEESI) (Miller & Prihoda, 1999) to collect data on perception of environmental exposures, self-rated health and attitudes towards community among household heads aged 18 and above residing in mining communities in the Nadowli/Kaleo and Wa East districts in the Upper West Region (UWR) of Ghana.

Using Slovan’s sampling formula given as: \( n = \frac{N}{1 + (N \cdot e^2)} \), where: \( n \) = number of samples; \( N \) = total population; and \( e \) = margin of error, a minimum sample size of 394 was determined at a 5% margin of error from a sample population of 25,978, the total population of the two study districts according to the 2010 Population and Housing Census (Ghana Statistical Service, 2013). The study sampled 820 to enhance the statistical power of the analysis. A two-staged stratified sampling with probability proportional to population size was used in sampling study participants. In sampled communities, every fifth house counting from the entry to the community was selected.
and the household head was interviewed. The study had a response rate of 98% (801 participants), which formed the analytical sample in this study.

5.5.2 Measures

“Considered relocating”, the dependent variable in this study was derived from the question “have you felt dissatisfied about your community because of surface mining activities and considered moving?” with four response options, “yes”, “no”, “don’t know”, and “refused”. Responses were categorised into yes (coded 1) and others that responded “no” “don’t know” and “refused” (coded 0). To address the study objective of examining the influence of perception of adverse health and environment effects of mining activities on residents decision to relocate, two independent variables were derived; informed about mining activities, and perception that mining activities were meeting environmental standards from two Likert scale questions ranged from “strongly agreed” to “strongly disagreed”, which was re-categorised into “disagree”, “neutral” and “agree” (coded: 1, 2, and 3, respectively).

The literature indicates that, disparities in perception of the impacts of environmental exposure on community health and wellbeing could be mediated by perception of one’s health status, socio-economic factors such as wealth, education and occupation; biological, cultural and place-based characteristics (Baxter & Greenlaw, 2005; Elliott et al., 1999; Luginaah, Taylor, Elliott, & Eyles, 2002; Luginaah et al., 2000). The study adjusted for the impact of health attributes (self-rated health and chronic health condition). Self-rated health was derived from the question “In general, how does your health compare with that of other people of your age group, would you say your health is
“Excellent, Very Good, Good, Fair or Poor?” which was categorised into poor health (coded 1) and good health (coded 2). The chronic health variable was constructed from 12 questions on reported diagnosed chronic conditions. A “yes” response to at least one of the questions was categorised as “yes” (coded 1) and no to all the 12 questions was categorised as “no” (coded 2). Socio-economic [wealth of household (richest=1, rich=2, middle=3, poor=4 poorest=5), occupation (civil servants=1, farmers=2, traders=3, others=4), and education (no education=1, primary=2, secondary and above=3)]; biological [age, and gender (male=1, Female=2)]; socio-cultural [ethnicity (Dagaaba=1, Sissala=2, Waala=3, Brifo=4, others=5), religion (Christians=1, Muslims=2, Traditionalist=3), marital status (married=1, not married=2) and children in family (no=1, yes=1)]; and place-based factors [mining community type (impacted=1, affected=2), distance to mine and District of residence (Wa East=1, Nadowli/Kaleo=2)] were adjusted in our models.

5.5.3 Analytic Technique

The study examined the impact of residents’ perception about mining activities meeting environmental standards and being adequately informed about mining activities on their decision to relocate from mining the community. A multivariate binary logistic regression Model was used because the outcome variable was binary and fairly symmetrical with “0/1” outcomes. Other binary outcome statistical methods such the Probit, Ordinal, complementary and negative log-log regressions of the GLM binomial family link functions were not appropriate for this analysis because of the nature of the outcome variable (Deddens & Petersen, 2008). Logistics regression are built on the assumption of independence of responses but given the cross-sectional nature of our data, especially as
respondents were selected in cluster of impacted and affected communities, there is the tendency to have similar responses from similar communities and clusters. Unique identifier numbers were imposed to each respondent on our model using the “vce” option in STATA 12 to correct this problem, and produce robust standard errors. Additionally, regression co-efficients were exponentiated into Odds ratios for easy interpretation. Odds ratio greater than “1” is interpreted in this study as having higher odds or more likelihood of considering relocating compared to a reference category and Odds less than 1 is interpreted as having lower odds or less likelihood to report consideration of relocation. Finally, it adjusted for the effect of other relevant empirical and theoretical factors with the use of four multivariate regressions. The first introduced health attributes, the second added socio-economic, biological and socio-cultural, and the last added place-based factors (see Table 3).

5.6 Results

5.6.1 Sample characteristics

Descriptive statistics shown on Table 1 indicate majority of respondents (61%) disagreed that they were well informed of mining activities and 72% disagreed mining activities were meeting environmental standards. However, 37% of respondents reported they had considered relocating. This finding is astonishing given the strong sense of place attachment that rural people tend to exhibit. Twenty four percent of the respondents reported poor health and 66% reported living with at least one chronic health condition. Household wealth was almost evenly distributed. About forty percent of the respondents are in the poor or poorest wealth category. In terms of the occupation as expected, most of
the residents were small holder farmers, with 42% having no formal education. The average age was 36 years and 68% of respondents reported having at least a child in their household. The average site was four kilometres.
Table 5 - 1: Descriptive Statistics of Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Categories</th>
<th>%/Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Considered relocating</td>
<td>No</td>
<td>63%</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>37%</td>
</tr>
<tr>
<td>Informed of mining operations</td>
<td>Neutral</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>61%</td>
</tr>
<tr>
<td>Meeting Environmental Standards</td>
<td>Neutral</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>72%</td>
</tr>
<tr>
<td>Self-Rated Health</td>
<td>Poor</td>
<td>76.0%</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>24.0%</td>
</tr>
<tr>
<td>Chronic Health condition</td>
<td></td>
<td>1.52 (1.61)</td>
</tr>
<tr>
<td>Wealth Quintile</td>
<td>Poorest</td>
<td>19.4%</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>20.5%</td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>19.8%</td>
</tr>
<tr>
<td></td>
<td>Richer</td>
<td>20.2%</td>
</tr>
<tr>
<td></td>
<td>Richest</td>
<td>20.1%</td>
</tr>
<tr>
<td>Occupation</td>
<td>Other</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>Trading</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>Farming</td>
<td>49%</td>
</tr>
<tr>
<td></td>
<td>Civil Servants</td>
<td>22%</td>
</tr>
<tr>
<td>Educational attainment</td>
<td>No education</td>
<td>42%</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>Secondary +</td>
<td>26%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>35.71 (13.17)</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>56%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>44%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Dagaaba</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Sissala</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Waala</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>Brifo</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>1%</td>
</tr>
<tr>
<td>Religion</td>
<td>Christians</td>
<td>72%</td>
</tr>
<tr>
<td></td>
<td>Moslem</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Traditionalists</td>
<td>8%</td>
</tr>
<tr>
<td>Marital Status</td>
<td>married</td>
<td>68%</td>
</tr>
<tr>
<td></td>
<td>Currently not married</td>
<td>32%</td>
</tr>
<tr>
<td>Children</td>
<td>Yes</td>
<td>98%</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2%</td>
</tr>
<tr>
<td>Mining Community type</td>
<td>Affected</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Impacted</td>
<td>30%</td>
</tr>
<tr>
<td>Distance to mine (km)</td>
<td></td>
<td>3.70 (2.57)</td>
</tr>
<tr>
<td>District of residence</td>
<td>Wa East</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Nadowli/Kaleo</td>
<td>70%</td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td>801</td>
</tr>
</tbody>
</table>
5.6.2 Bivariate results

Table 2 provides the results of the bivariate analysis. Those reported not being well informed were more likely to consider relocating. Similarly, those who think that the mining companies are not meeting environmental standards also considered relocating (OR=2.58, p≤0.001 and OR=1.98, p≤0.001, respectively). The study also found that disparities in health attributes were significantly associated with the decision to relocate from the community. Respondents who reported good self-rated health compared to those who reported poor self-rated health, and those who reported having a diagnosed chronic condition had higher odds of considering relocation (OR=1.54, p≤0.05; and OR=1.12, p≤0.05, respectively).

Consistent with the literature, those in the richest households were significantly more likely to have considered relocation compared to the poorest. In addition, respondents with Islam religious affiliation compared to Christians, those with no child in the household, those residing in affected mining communities, and residents in Wa East were more likely to have considered relocating. Finally, the aged and those residing farther away from a mining site had lower odds to have considered relocating.
Table 5 - 2: Bivariate logistic Regression Estimating Considered Relocating from Mining Community in the Upper West Region of Ghana

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (Robust Std. Err)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informed of mining operations (ref: neutral)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>1.34(0.36)</td>
</tr>
<tr>
<td>Disagree</td>
<td>2.58(0.60)***</td>
</tr>
<tr>
<td>Meeting Environmental Standards (ref: neutral)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>1.57(0.46)</td>
</tr>
<tr>
<td>Disagree</td>
<td>1.98(0.45)***</td>
</tr>
<tr>
<td>Self-Rated Health (ref: Poor)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>1.54(0.28)**</td>
</tr>
<tr>
<td>Chronic Health condition</td>
<td></td>
</tr>
<tr>
<td>Wealth Quintile (ref: Poorest)</td>
<td>1.12(0.05)**</td>
</tr>
<tr>
<td>Poorer</td>
<td>0.98(0.24)</td>
</tr>
<tr>
<td>Middle</td>
<td>1.56(0.38)*</td>
</tr>
<tr>
<td>Richer</td>
<td>1.77(0.42)**</td>
</tr>
<tr>
<td>Richest</td>
<td>2.13(0.51)***</td>
</tr>
<tr>
<td>Occupation (ref: Other)</td>
<td></td>
</tr>
<tr>
<td>Trading</td>
<td>1.09(0.30)</td>
</tr>
<tr>
<td>Farming</td>
<td>1.09(0.23)</td>
</tr>
<tr>
<td>Civil Servants</td>
<td>0.92(0.22)</td>
</tr>
<tr>
<td>Educational attainment (ref: no education)</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>1.04(0.18)</td>
</tr>
<tr>
<td>Secondary +</td>
<td>1.14(0.21)</td>
</tr>
<tr>
<td>Age</td>
<td>0.99(0.01)**</td>
</tr>
<tr>
<td>Gender (ref: male)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.91(0.35)</td>
</tr>
<tr>
<td>Ethnicity (ref: Dagaaba)</td>
<td></td>
</tr>
<tr>
<td>Sissala</td>
<td>0.91(0.35)</td>
</tr>
<tr>
<td>Waala</td>
<td>1.25(0.27)</td>
</tr>
<tr>
<td>Brifo</td>
<td>0.69(0.41)</td>
</tr>
<tr>
<td>Others</td>
<td>0.86(0.75)</td>
</tr>
<tr>
<td>Religion (ref: Christians)</td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>1.41(0.26)*</td>
</tr>
<tr>
<td>Traditional</td>
<td>1.04(0.28)</td>
</tr>
<tr>
<td>Marital Status (ref: married)</td>
<td></td>
</tr>
<tr>
<td>Currently not married</td>
<td>0.10(0.15)</td>
</tr>
<tr>
<td>Children (ref: Yes)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.73(0.32)***</td>
</tr>
<tr>
<td>Mining Community type (ref: Impacted)</td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td>2.99(1.44)**</td>
</tr>
<tr>
<td>Distance to mine</td>
<td>0.97(0.02)*</td>
</tr>
<tr>
<td>District of residence (ref: Nadowli/Kaleo)</td>
<td></td>
</tr>
<tr>
<td>Wa East</td>
<td>2.01(0.32)***</td>
</tr>
<tr>
<td>Observations</td>
<td>801</td>
</tr>
</tbody>
</table>

*** p≤0.001, ** p≤0.05, * p≤0.1; Odd Ratios (OR) are adjusted for clustering; Standard errors are presented in parenthesis
5.6.3 Multivariate results

Results of multivariate analysis are presented in Table 3. After adjusting for the impact of the two key independent variables together in Model 1, being informed of mining activities, and perception that mining activities were not meeting environmental standards remained statistically significant but their significance and magnitude attenuated slightly (OR=2.22, p≤0.001 and OR=1.53, p≤0.1, respectively). With the introduction of health attributes and socio-economic characteristics into Model 2, the disparities in the decision to relocate between those who reported not adequately informed of mining activities and those who reported being neutral reduced by 13%, while disparity between those who perceived mining activities as not meeting environmental standards and those who reported neutral increased to 1%. In addition, self-rated health and diagnosed chronic health condition remained significantly associated with considered relocating with improved magnitudes from bivariate results (OR=1.66, p≤0.001 and OR=1.14, p≤0.001, respectively). Household wealth remained significantly associated with relocation consideration in Model 2. All statistically significant associations in Model 2 remained robust in Model 3. Consistent with bivariate results, Muslim household heads (OR=1.81, p≤ 0.05) compared to their Christian colleagues, and respondents without a child (OR=3.39, p≤ 0.05) were more likely to report relocating. As expected, older respondents were less likely to have considered relocating.
Table 5 - 3 Multivariate Logistic Regression Estimating Considered Relocating from Mining Community in the Upper West Region of Ghana

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 OR (R. Std. Err)</th>
<th>Model 2 OR (R. Std. Err)</th>
<th>Model 3 OR (R. Std. Err)</th>
<th>Model 4 OR (R. Std. Err)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Informed of mining operations (ref: neutral)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>1.19(0.34)</td>
<td>1.08(0.32)</td>
<td>1.02(0.31)</td>
<td>1.07(0.33)</td>
</tr>
<tr>
<td>Disagree</td>
<td>2.23(0.55)***</td>
<td>2.10(0.53)***</td>
<td>1.98(0.51)***</td>
<td>2.10(0.55)***</td>
</tr>
<tr>
<td><strong>Meeting Environmental Standards (ref: neutral)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>1.32(0.42)</td>
<td>1.26(0.42)</td>
<td>1.30(0.45)</td>
<td>1.23(0.43)</td>
</tr>
<tr>
<td>Disagree</td>
<td>1.53(0.37)*</td>
<td>1.62(0.41)*</td>
<td>1.64(0.44)*</td>
<td>1.61(0.45)*</td>
</tr>
<tr>
<td><strong>Self-Rated Health (ref: Poor)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>1.661(0.32)***</td>
<td>1.656(0.33)**</td>
<td>1.652(0.33)**</td>
<td>1.652(0.33)**</td>
</tr>
<tr>
<td><strong>Chronic Health condition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wealth Quintile (ref: Poorest)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poorer</td>
<td>1.17(0.30)</td>
<td>1.12(0.30)</td>
<td>1.15(0.31)</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>1.70(0.43)**</td>
<td>1.61(0.42)*</td>
<td>1.64(0.43)*</td>
<td></td>
</tr>
<tr>
<td>Richer</td>
<td>1.86(0.46)**</td>
<td>1.84(0.48)**</td>
<td>1.85(0.48)**</td>
<td></td>
</tr>
<tr>
<td>Richest</td>
<td>2.40(0.61)***</td>
<td>2.37(0.63)***</td>
<td>2.25(0.60)***</td>
<td></td>
</tr>
<tr>
<td><strong>Occupation (ref: Other)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trading</td>
<td>1.15(0.34)</td>
<td>1.15(0.35)</td>
<td>1.05(0.33)</td>
<td></td>
</tr>
<tr>
<td>Farming</td>
<td>0.96(0.22)</td>
<td>1.02(0.25)</td>
<td>0.85(0.21)</td>
<td></td>
</tr>
<tr>
<td>Civil Servants</td>
<td>0.82(0.22)</td>
<td>0.86(0.24)</td>
<td>0.77(0.22)</td>
<td></td>
</tr>
<tr>
<td><strong>Educational attainment (ref: no education)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>1.07(0.20)</td>
<td>0.98(0.20)</td>
<td>0.98(0.20)</td>
<td></td>
</tr>
<tr>
<td>Secondary +</td>
<td>1.40(0.30)</td>
<td>1.28(0.30)</td>
<td>1.40(0.33)</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (ref: male)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ethnicity (ref: Dagaaba)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sissala</td>
<td>0.60(0.25)</td>
<td>0.33(0.15)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waala</td>
<td>0.76(0.22)</td>
<td>0.44(0.14)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brifo</td>
<td>0.58(0.39)</td>
<td>0.52(0.40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>0.40(0.31)</td>
<td>0.39(0.34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Religion (ref: Christians)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>1.81(0.48)**</td>
<td>1.55(0.42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional</td>
<td>1.32(0.42)</td>
<td>1.49(0.49)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marital Status (ref: married)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently not married</td>
<td>0.89(0.17)</td>
<td>0.99(0.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Children (ref: yes)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3.39(1.73)**</td>
<td>3.90(2.15)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mining Community (ref: Impacted)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td></td>
<td></td>
<td>0.68(0.27)</td>
<td></td>
</tr>
<tr>
<td><strong>Distance to mine</strong></td>
<td></td>
<td></td>
<td>0.91(0.06)</td>
<td></td>
</tr>
<tr>
<td><strong>District of residence (ref: Nadowli/Kaleo)</strong></td>
<td></td>
<td></td>
<td>2.87(0.64)***</td>
<td></td>
</tr>
<tr>
<td>Wa East</td>
<td></td>
<td></td>
<td>0.91(0.06)</td>
<td></td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>0.241(0.06)***</td>
<td>0.079(0.03)***</td>
<td>0.132(0.07)***</td>
<td>0.219(0.16)***</td>
</tr>
<tr>
<td><strong>Log Pseudo likelihood</strong></td>
<td>-513.5499</td>
<td>-496.3622</td>
<td>-487.68428</td>
<td>-475.10014</td>
</tr>
</tbody>
</table>

***p≤0.001, **p≤0.05, *p≤0.1; Odd Ratios (OR) are adjusted for clustering; Standard errors are presented in parenthesis; Model 1 (Perception of Mining); Model 2 (Health & Socioeconomic); Model 3 (Demographic); Model 4 (Location).
In our final Model (Model 4) which introduced place-based factors, those who reported being informed of mining activities compared to those who reported neutral were 101% more likely to have considered relocating, and those who reported a perception that mining activities were not meeting environmental standards compared to those who reported neutral were also 61% more likely to report leaving the community. Similarly, those who reported good self-rated health relative to those who reported poor self-rated health, and those who reported living with diagnosed chronic health condition were more likely to report they have considered leaving their community due to the mining activities (OR=1.65, $p \leq 0.05$ and OR=1.20, $p \leq 0.001$, respectively). Furthermore, richer households compared to the poorest, those without children compared to those with children, and resident in Wa East compared to Nadowli/Kaleo District, had higher odds of relocation consideration. Meanwhile, older age, and household heads of Sissala and Waala ethnic affiliation compared to Dagaaba were less likely to consider relocating (OR=0.98, $p \leq 0.05$; OR=0.33, $p \leq 0.05$ and OR=0.44, $p \leq 0.05$, respectively).

**5.7 Discussion**

When mining becomes a push factor, where affected residents are moving out of their community, suggests their health and community wellbeing has been compromised and their daily way of life is greatly impacted. Despite the assumption that mining serves as a pull factor to local communities, this does not seem to be the case in a region where young people are already pushed to migrate to Southern Ghana in search of farmlands and jobs (Kuure et al., 2013; Van der Geest, 2011). The surface mining in the Upper West Region is not only dispossessing farmers of their farmlands but also acting to exacerbate the plethora of socio-economic problems as many considered moving from the local
communities due to its impact on their environment, health, livelihoods, customs, religious practices and general social organization (Akabzaa & Darimani, 2001; Mensah & Okyere, 2014).

The findings of the study are consistent with the literature and suggest that an active interaction between the mining company and affected communities eases suspicion, tension and mistrust for mining operations in the community. This is particularly evident in our study, where those that disagreed they were adequately informed about the mining activities were more likely to have ever considered relocating from the community due to mining activities compared to those who were neutral. Community and mining company interaction offers both sides the opportunity to engage in dialogue on mutual concerns and work towards addressing such issues (Tuokuu, Amponsah-Tawiah, Jones, & Jones, 2016; Veiga et al., 2001). Generally, communities that are hostile to mining operations are those for which mining activities are new to the community as pertains in our study context, and where perceptions are rife about the intrusion of mining activities on the community’s environment, culture and history (Veiga et al., 2001). Engagement with host communities is therefore important for addressing the concerns of communities in mineral extraction activities. Peters et al. (1997) reports that, residents’ perception about the company’s concern, openness and honesty towards the community is essential in building community trust for the company and alleviating their fear about adverse health effects. Considering that the major mining company in our study context has a Community Relations Officer who may occasionally engage residents, opinion leaders and chiefs in affected communities in dialogue as required by sections of Ghana’s mining act, it is not surprising respondents that have previously participated in such dialogues
perceive less risk from mining activities and are therefore more likely to see the community as safe — discarding any ideas of relocating from the community. Accordingly, one approach that has been adopted by multinational mining companies is Corporate Social Responsibility (CSR) which addresses some of the socio-economic needs of communities (Garvin et al., 2009). CSR is one of the means through which mining companies does outreach to their host communities, providing some of their infrastructural and social needs while building a stronger company-community relationship (Garriga & Melé, 2004; Tuokuu et al., 2016). Particularly in our study area which is beset with endemic poverty, social deprivation and years of government neglect, promise of the provision of social amenities through CSR may likely lead to a cordial relationship between the two as observed by Garvin et al. (2008). Currently Azumah Resources has partnered with the Australian Volunteer Program (AYAD) and Concern Universal (CU) an NGO to empower women through the provision of small scale shea butter processing plants for women in the affected communities at Gabilee (http://www.azumahresources.com.au/community-shea.php). They have also partnered GEODRILL to provide assistance to some schools in impacted communities providing study materials which is hoped to boost school attendance and improve academic work (http://www.geodrill-gh.com/about-us/social-responsibility/in-collaboration-with-azumah-resources). Such community engagement has also been seen by some researchers as a tool for minimizing anti-mining sentiments within populations in host societies. For example a study by Moffat & Zhang (2014) where community engagement with mining companies alleviated the community’s fears about environmental and health effects, was essential in securing a “social license” to ensure smooth mining operations in host communities.
Environmental pollution and the ability of the ecosystem to support livelihoods during and after mining operations are core concerns of affected communities. Given that residents in our study area are largely agrarian and have livelihoods that directly depend on the land (Kuure et al., 2013; Moomen & Dewan, 2016), doubts about the commitment of the mining company in protecting the physical environment, will make residents perceive mining activities as an intrusion into their environment and culture, especially when mining activities are recent in the host community (see also Veiga et al., 2001). This may explain why residents who disagreed the mining company was meeting environmental standards were more likely to consider relocating.

The fact that those reporting good health were more likely to consider leaving the community reinforces the lingering concerns about all the younger people migrating to southern Ghana. Furthermore, Self-Rated Health (SRH) captures the psychosocial state of respondents in addition to the biomedical (Idler & Benyamini, 1997). In this study context, SRH could be multi-dimensional (Idler & Benyamini, 1997; Jylha, 2009) and may capture respondent’s general wellbeing, deprivation and other forms of vulnerability such as food insecurity, material deprivation and social exclusion. Thus, those that rate their health as poor may be incapacitated in relocating from their present community even though they may be dissatisfied with mining-related impact in the community. Furthermore younger cohorts who have traditionally been associated with migration from this study area (Abdul-korah, 2008) are also associated with good self-rated health (Kawachi, Kennedy, & Glass, 1999; Zavras et al., 2013). However, there may be a need for further qualitative study to explore this nuanced relationship between SRH and the desire to relocate from the communities. However, residents reporting chronic health
conditions were more likely to have considered moving out of the community. This situation is explained by the fact that, residents diagnosed with chronic health conditions may perceive environmental pollution in their community to aggravate their health problems. Additionally, it is possible that people who may have been recently diagnosed with chronic health problems may perceive their exposure to environmental toxins from mining activities as the cause of their health condition which then informs their desire to relocate from the community. For instance, Hunter et al. (2004) reports that, residents who were suffering from respiratory related health conditions were more likely to attribute their exposure to air pollution for their health condition. Similarly, Luginaah, et al. (2000) and Claeson et al. (2013) report similar findings.

While some residents in our study may be concerned about the suitability of their community as a place to live, due to mining activities, only those with the requisite economic means to relocate from the community have considered doing so. Thus economic status or wealth acts as a barrier to residents who would have otherwise relocated out of the community. According to Carrington et al. (2011), out migration of residents from host communities may not only be as result of environmental pollution, but the increased cost of living, declining community acquaintanceship due to the influx of mine workers and the increased crime rates. Given that the study context is marked by general deprivation and economic poverty, the ability to relocate from the community due to mining related impacts is financially demanding as migrating households are compelled to find an alternate form of livelihood for sustenance in a new community with little or no social support. It is therefore not surprising that those that belong to the higher wealth quintiles were more likely to relocate from the community. Furthermore, Akabzaa
& Darimani (2001) observed in the Tarkwa mining district of Ghana, where families were unable to relocate from the community on their own budget, they opted for either a resettlement or a relocation package from the mining company. This implies that in settings like the study area where such resettlement/relocation scheme currently is non-existent, although families may desire to relocate from the community, limited financial resources will act as a barrier.

The finding that there is no significant difference between the types of occupation and the desire to relocate due to mining activities is contrary to the literature. Several studies have linked the undesirability of host communities by residents not only to the environmental pollution, but the scarcity of lands for agriculture and other land based economic activities. This problem is even more pronounced where the host community is agrarian and is largely dependent on the land for livelihood and sustenance (see Akabzaa & Darimani, 2001; Garvin et al., 2009; Hilson & Yakovleva, 2007). This lack of difference could be explained by the fact that although residents may identify with other occupations, they may still be involved in farming (70% and 89% in the Nadowli/Kaleo and Wa East districts respectively). However, considering the fact that, young people from the UWR have traditionally migrated to Southern Ghana, especially to the Brong Ahafo Region to escape the stressed environment and to engage in economic activities (Van der Geest, 2011), a deterioration of the environment through mining activities will further push residents with the capacity to relocate to do so, leaving behind the poor, vulnerable and deprived population like the aged. Thus, the type of occupation in this context does not influence the decision to relocate from the community.
While researchers have observed that educational attainment makes individuals more assertive to health risk in their immediate environment (see Egondi et al., 2013; Elliott et al., 1999), the overall impact of mining including increased cost of living, diminishing community acquaintance, increased crime rates, social disorganization and general environmental degradation affects all residents in the community regardless of educational attainment. This may explain why educational attainment does not predict households that desire to relocate from the community. On the other hand, the findings show that the older the age of residents, the lesser the likelihood to move out of the community due to mining activities. Researchers have argued that, the longer people stay in a community, the greater the bond, social capital and ties they build with other community members (Goudy, 1990; Mesch & Manor, 1998; Trentelman, 2009). Considering that most residents in these communities are indigenous to the land and have been living on it for centuries, they have developed an attachment to the community. As people age, this sense of attachment becomes stronger which makes it difficult relocating from the community although they may be greatly impacted by mining activities. Again, when people age they become more vulnerable and may not have the requisite economic means to relocate from their current community of residence. Bickerstaff & Walker (2001) suggest that, where people have a social and cultural attachment to a place, even in the event of environmental pollution, they still disassociate the negative effects of the pollution from the community. Similar findings were made by Wakefield et al. (2001) and Bickerstaff (2004).
5.8 Study limitations

This study has some noteworthy limitations. First, the data was collected as cross-sectional, and it is therefore difficult to assume causal relationships between dependent and independent variables. These findings are therefore limited to associations. Again, because the data is self-reported, the findings could be biased due to over reporting of issues as it relates to mining which is a sensitive area of concern for respondents in the study communities. In spite of these limitations, the findings are consistent with the literature and important for policy in Ghana and elsewhere.

5.9 Conclusion and Policy Implications

Contrary to the mining narrative which suggests mining activities serves as a pull factor to host communities because of the associated economic benefits, the findings in this study suggests that in the UWR of Ghana, mining may rather act as push agent. Given that the region has been experiencing an exodus of people to the Southern part of the country, especially among the youth for some decades due to the stressed environment and limited economic opportunities (Abdul-korah, 2008; Kuuire et al., 2013; Van der Geest, 2011), the introduction of environmental toxins in the dry savanna environment will worsen the out-migration pattern given that residents have considered doing so. The peculiar situation of the UWR in general and the mining affected communities in particular, calls for an increased efforts to reducing environmental pollution in affected communities through intensified monitoring of mining activities. Currently, the legal framework for mining in Ghana is very exclusionary, with limited participation of residents in affected communities (see Ghana’s Mineral and Mining Act of 2006) in the
process of award mining rights. In spite of this, the study suggests a continuous dialogue with residents where the mining company give updates on their operations to affected communities while taking onboard their concerns. This will reduce tension, suspicion and mistrust for mining operations. An active engagement with the community allays their fears about health, environment and economic impacts of mining activities which ensures a good working relationship. Furthermore, it is suggested that the EPA is strengthened to compel mining companies to meet environmental protection standards which assures residents of a sustainable livelihood when mining operations in the community comes to an end. Also, affected communities should be involved in the issuance and renewal of mining licensing to ensure their concerns are incorporated by the mining companies. With help from civil society and NGO’s residents can be more assertive in exercising their rights through advocacy and the legal regime to have their concerns addressed by government and the mining company. Although some authors have critiqued CSR as substituting government commitment to infrastructural and social development by affected residents, it still plays an influential role of building a good relationship between the mining company and the host community, especially as most host communities are rural and are materially deprived. Finally, there is a need for a reassessment of Ghana’s Minerals and Mining Act 2006, as the State through the Executive wing of government are given the most power in licensing and monitoring mining activities. There is a need to empower local residents who will be directly impacted by mining operations to be directly involved in the licensing process and given more voice in negotiating how their ecosystem is used.
5.10 References


Chapter 6: Summary and Conclusion

This chapter gives a summary of the major findings of this dissertation. It highlights the contributions of the research within the mining discourse in Ghana and elsewhere. The chapter makes important suggestions for mining policy in Ghana and countries with a similar context. The chapter concludes with suggestions for possible directions for future research in mining.

6.1 Introduction

The aim of this research is to examine residents’ environment and health perceptions in communities affected by surface gold mining activities in the Upper West Region of Ghana. Although mining has been a major part of Ghana’s history (Hilson, 2002b), there has been limited scholarship on how residents affected by mining activities perceive mining operations to impact their environment and health. Earlier studies have assessed the impact of mining on the physical environment (i.e. water, land and air) (Hilson, 2002c), the health of affected residents (Yeboah, 2008), livelihoods and social organization of affected communities (Akabzaa & Darimani, 2001). For instance, Amonoo-Neizer et al. (1995), reports that in Obuasi, a gold mining community in the Ashanti Region of Ghana, mining pollutants were highly concentrated in soil, fish and food crop samples. The study further observed a distance gradient in levels of contamination from areas closer to mining sites. Akabzaa et al. (2009), corroborates the high concentration of pollutants in water sources in Obuasi, which the authors argue, was compounded by the activities of Artisanal Small Scale Miners (ASM). Similar findings are reported for Tarkwa a gold mining community in the Western Region of Ghana,
where Armah et al. (2012) found mercury and arsenic in the blood and body tissue of residents to be in excess of eighteen (18) times the World Health Organization’s (WHO) recommendation.

These findings highlight the susceptibility of residents in mining communities to diseases along with the long term implications of pollution on the physical environment (Armah et al., 2016; Samuel Obiri, Yeboah, et al., 2016). While research has established the predisposition of affected residents to short and long term health implications, residents’ self-assessment of their health and environment is nascent. Yet the importance of residents’ perceptions of their environment and health has a significant role in what actions residents can or cannot take. An examination of residents perception is therefore necessary as it is influenced by a number of factors that are either directly or indirectly related to the exposure (Baxter & Greenlaw, 2005; Elliott et al., 1999). Public perception of health and environment also defines the nature of the relationship that exists between mining companies and affected communities. For instance, the benefits from the mining activities, the type and nature of risk, the distribution of risk and benefits among residents, duration of community’s association with the risk, attachment to the community and other socio-cultural variables define pathways through which affected residents perceive environment and health impacts from exposures (Baxter & Lee, 2004; Flynn et al., 1994; Garvin et al., 2009; Heyworth et al., 2009). Thus, a biomedical assessment of environment and health challenges posed by mining operations may not capture the full impact, as the concept of “place” and attachment to the community influences how residents perceive adverse effects (Eyles, 1985; Luginaah, 2009), which
traditionally has been ignored by “experts” when estimating the potential health risk to environmental exposures.

Informed by the challenges of the biomedical approach in measuring health and wellbeing as merely the absence of ailments, infections and diseases (Dixon, 2014; Luginaah, 2009), this thesis uses the concept of self-rated health to gauge the influence of environmental exposures in residents’ perceived health status. Due to the rural and agrarian nature of affected communities that have lived on the land for several generations, the study also examined how the recent mining activities impact residents’ sense of community attachment and wellbeing. The main research questions sort to enquire the effect of mining activities on residents self-rated health and whether residents were being pushed out of their ancestral lands and communities by seeking to relocate to new communities to safeguard their health and wellbeing. The study has the following research objectives;

1- To examine how mining impacted and affected communities in the Upper West Region rate their health based on their perception of the noxious effects of mining.

2- To assess how the effects of surface mining activities is affecting residents’ community attachment.

3- To examine how social status (measured by education and wealth), influence how affected residents rate their health and perceive the suitability of their communities as a place for habitation.
6.2 How the findings from the two articles are integrated

The two manuscripts in the thesis examine how mining activities are perceived to be impacting the environment and health of residents in affected communities. The first manuscript examines ways mining activities are perceived to impact residents’ health through their self-reported health status using SRH. The second manuscript assesses residents’ perception of the environment as constituting substantial health risk, and how this may form the bases for their decision to relocate from the community. The second manuscript also examines community wellbeing in relation to the mining activities. Both manuscripts reveal that, mining activities are negatively impacting the community which is reflected in residents reporting poor self-rated health and the desire of some residents to relocate from their ancestral communities due to pollution and the destruction of their physical environment.

6.3 Summary of findings

6.3.1 Objective One:

*How mining communities in the Upper West Region rate their health based on their perception of the noxious effects of mining.*

Using quantitative methods, this objective is examined by making self-rated health the outcome variable with key independent variables as, the belief that odours from mining activities are causing health problems in the community and, the number of times residents witness dust pollution in their community (see Chapter 4). The findings reveal that, residents’ self-rated health differed by their perception of odours from mining activities causing health hazards in their community, but this varied between impacted and affected communities. Consequently, in affected communities, those that believe
odours from mining communities are causing health problems were more likely to rate their health as “poor” compared to those that disbelieved. In impacted communities however, there is no difference amongst residents in their SRH based on beliefs about odours from mining. Possibly, due to the distance to mining activities, there is minimal odour perception in affected communities and thus, residents did not conceive a direct path between odours and their health. This finding is corroborated by several researchers like Steinheider (1999) and Thouez & Singh (1984) who found a gradient between exposures and perceived health risk. From this research objective, it is further observed that, residents who may not be certain about the role of odours on community health are more likely to rate their health as poor. As this finding persists in both affected and impacted communities, it seems to suggest that where residents are not well informed about the ways in which exposures affect their health, they are likely to perceive high risk with the exposure. The findings also show that, the frequency at which residents witness dust pollution from mining activities in their respective communities is not significantly associated with their self-rated health in both impacted and affected communities. Since communities in this study are generally dry and experience the seasonal dry harmattan winds from the Sahara desert (Tiessen et al., 1991), residents in both impacted and affected communities may be desensitized to dust pollution and as a result, do not associate it with their health. Desensitization has been found in several studies that examine communities exposed to environmental toxins (see also Atari, Luginaah, & Baxter, 2011; Atari, Luginaah, & Fung, 2009; Atari, Luginaah, Gorey, Xu, & Fung, 2013).
The findings for this research objective also suggest that age, gender, education, wealth, religion and district of residence also affects how residents rate their health, which tends to vary between impacted and affected communities.

6.3.2 Objective Two:

*In what ways are mining activities affecting residents’ community attachment.*

With the second research objective, residents’ attachment to their communities is assessed by examining the decision to relocate from their communities due to the effect of surface mining (see Chapter 5). The results indicate that, residents are likely to consider moving out of the community when they are not adequately informed of mining activities. This may signal an “expert” versus “lay” understanding of the impact of mining activities whereby those with adequate information likely from “experts” and regulatory agencies are less likely to consider relocating. Thus, a lack of understanding translates into perceived negative health effects and the desire to relocate. Consequently, residents reporting a limited understanding or knowledge of mining activities desire to relocate because of their “lay” understanding of possible health outcomes from the mining activities. Given that there is a great cultural attachment to the land in the study context, the decision to relocate from one’s ancestral community emphasize how residents are impacted by mining activities.

Not surprisingly, residents who report having one or more chronic health condition are more likely to consider relocating from the community compared to those who do not report any chronic illness. Residents with chronic health problems may perceive the effect of mining in their communities in two ways: i) mining activities are responsible for their chronic health condition which informs the need to relocate to safeguard their health
and/or ii) mining activities are worsening the chronic health condition, therefore the need to relocate. Other researchers (see also Claeson, Lidén, Nordin, & Nordin, 2013; Hunter, Bickerstaff, & Davies, 2004; Luginaah, Taylor, Elliott, & Eyles, 2000) have reported similar findings. Moreover, the findings in this study demonstrate the effects of wealth on residents’ potential decision making in the context of exposure. Given that the relatively wealthy individuals were also more likely to report considering moving from mining affected communities, with the reverse for those in the poorest wealth quintile, means those in this poor category had no choice but to stay put. Thus, while residents may be fully aware of the environmental and health consequences of mining activities, the decision to stay or relocate from the community is influenced by other factors that are readily overlooked during Environmental Impact Assessment (EIA) by mining exposure “experts”. While the finding that residents that rate their health as poor are less likely to consider relocating from the study communities may be counter intuitive, especially as those with one or more chronic health conditions are more likely to consider relocating, Jylha (2009) and Idler & Benyamini (1997) posit that, SRH measures the context specific concept of health. Thus, respondents may incorporate other subjective meanings of health which combines the biomedical understanding of health with the subjective meanings of health. Given that the study context is generally deprived, the concept of SRH likely incorporates deprivation, social exclusion, poverty and food insecurity. This finding further reinforces the subjective and contextual meanings of health measured as SRH and biomedical health among residents.

6.3.3 Objective Three:

*How relative social status (measured by education and income) influence residents self-rated health and how they perceive the suitability of their communities as a place to live.*
This study objective is assessed in both manuscripts by measuring the influence of wealth and education, on residents’ self-rated health and their decision to relocate from their community (see Chapters 4 and 5). Severally, researchers have studied residents perception of environmental exposures without recourse to the proximity to the centre of the exposure, the findings in this study reveals that, the role of wealth and education on self-rated health varies relative to the proximity to the mining activities. While education does not play a significant role in SRH in impacted communities possibly due to the intensity of the exposures, the educated in the affected communities contrary to the literature, are more likely to rate their health as poor compared to residents with no education (see also Kelleher, Friel, Gabhainn, & Tay, 2003; Woolley et al., 2015). Therefore, the educated in this study context may perceive mining activities to be adversely impacting their health and thus rating their health as poor. Similarly, while studies (see also Bobak, Pikhart, Rose, Hertzman, & Marmot, 2000; Kawachi, Kennedy, & Glass, 1999) confirm our findings that those in the poorest wealth quintile are more likely to rate their health as poor, the reverse is observed for the impacted communities. These findings also call into question previous research and “techniques” used in measuring exposures by “experts” which have treated affected residents and communities as one homogenous group. This implies in designing mining mitigation policies, mining companies and regulatory agencies need to employ multiple approaches that best suits impacted and affected communities. Furthermore, there may be a need for future research to further explore the role of relative social status in self-rated health between impacted and affected communities.
Moreover, given that relocating from the community involves committing economic resources to resettle in a new community, those with limited resources will be debarred from doing so as residents in the poorest wealth quintile compared to the rest are less likely to consider relocating. Meanwhile the level of education seems to not influence the decision to relocate. As the region has been associated with out-migration to southern Ghana for several decades (see Abdul-korah, 2008; Kuuire, Mkandawire, Arku, & Luginaah, 2013; Songsore & Denkabe, 1995), it is ironic that mining activities seem to be a push rather than a pull factor further compounding the problem of the mass exodus of the youth.

6.4 Contributions of the Study

6.4.1 Contributions to the literature

This study makes a noteworthy contribution to the literature on mining. Various studies in Ghana over the years have focused on assessing the impact of mining activities on the physical environment (rivers, land and air) and on the biomedical health of residents. This has resulted in a plethora of literature on residents’ predisposition to diseases due to the ingestion of mercury, arsenic and heavy metals associated with mining activities (see Armah et al., 2011). While studies that analyze the impacts of mining activities on affected communities in Ghana has continued for years, such studies have been limited to Southern Ghana with little attention paid to the emerging mining sector in Northern Ghana. This study therefore adds to the literature on mining in Ghana by examining impacts of gold mining in Northern Ghana, a different geographical context. The findings suggest that, while the presence of dust and soot in the homes of affected communities in
Southern Ghana is a major influence on how residents perceive adverse effect on their health (see Akabzaa & Darimani, 2001), the peculiar climate and ecological characteristics of Northern Ghana does not seem to significantly influence residents perceptions of adverse health effects. This finding may be due to the fact that populations in this dry savanna environment are desensitized to the effects of dust in particular, given that this is always the occurrence in the dry seasons. Moreover, although SRH has been used to study the health of populations in various contexts, it is rarely used in examining the health of residents in a surface mining community like the study context. To the best of my knowledge, this is the first time this tool is being used in the context of Ghana. Considering the difficulties in determining the exact ways through which pollutants may be affecting the health of residents in mining communities, using SRH to understand the effects of mining on residents’ health is important as it captures both the biomedical and psychosocial dimensions (Idler & Angel, 1990; Idler & Benyamini, 1997). The study findings are consistent with the literature which suggests that where residents perceive negatively the quality of their physical environment or their neighbourhoods they tend to rate their health as poor (see also Collins, Hayes, & Oliver, 2009). The desire to relocate from mining communities by some residents as a result of exposure is also consistent with existing literature (see Carrington, Hogg, & McIntosh, 2011; McGee, 1999). Yet, the desire to move tends to be influenced by available resources of the individual or the household (see chapter 5). These findings are generalizable to other communities in northern Ghana and elsewhere with similar socioeconomic, historical and ecological characteristics that are being inundated with mining activities.
6.4.2 Methodological contributions

This study also makes some important methodological contributions. Using the concept of SRH, the study affirmed previous studies which concluded that, exposed residents in mining affected communities are at a potential health risk from mining activities (see Smedley, Edmunds, & Pelig-Ba, 1996). So far, only few studies have used a quantitative/extensive methodology to study the environment and health perceptions of residents in mining affected communities.

6.5 Policy Implications

This research has some policy implications for mining in Ghana and elsewhere. The findings from this study are consistent with previous studies in Ghana where mining activities are reported to be negatively affecting the environment and the health of residents (see Amponsah-Tawiah & Dartey-Baah, 2011; Armah et al., 2016; Erdiaw-Kwasie & Mabunyewah, 2012; Hilson & Yakovleva, 2007). Given that residents’ who believe mining activities cause health problems in their community rate their health as poor, reinforces the dichotomy between “expert” versus “lay” assessment of health risk during environmental exposures. Consequently, despite the assurance that activities may not be harmful, residents may still perceive it as health hazards as demonstrated by the findings. As suggested in the conclusion paragraph of Chapter 4, a broader consultation with affected communities when estimating potential health risk posed by mining pollution is essential. This will make “experts” understand the pathways through which affected communities assess potential health risk and perceive mining activities to be impacting their health and the environment. It will also be necessary to equip the
regulatory agencies, to make frequent field visits to be able to enforce strict adherence to environmental best practices and halt activities that may exacerbate the associated environment and health impacts of mining on the local population.

It is also evident from this study that prior consultation and continuous dialogue with affected residents influence how they perceive mining activities to be impacting their environment and health. The findings reinforce the need to engage host communities to allay their fears of adverse health effects. Results from this further suggest that perception of residents about the suitability of their communities as a place to live is influenced by perceptions of mining activities meeting environmental standards. As residents will continue to live in the community after the close of mining operations, dissatisfaction with their community due to the mining activities may compel them to relocate. As suggested in Chapters 4 and 5, there is a need to enforce stringent adherence to environmental best practices to safeguard the environment and health of residents.

Moreover, considering that the Upper West region is already inundated with high levels of migration to southern Ghana (Songsore & Denkabe, 1995) unlikely serving as a typical pull factor, the recent mining activities in these communities are pushing residents out and will continue to worsen the trend. Consequently, in addition to government and non-governmental interventions to address the challenge of the mass exodus of especially the youth, the peculiar situation of the affected communities will need a specialized strategy that addresses the traditional causes of out-migration and the emerging problems associated with the mining activities. Furthermore, since ASM further compounds the problem of environmental pollution, government needs to regulate their activities to ensure best practices by reducing bureaucracies associated with registration and licensing.
There is a need for a governmental review of the mining and minerals act to empower affected communities to have a greater say in the licensing and process leading up to mining operations in their vicinity. This will reduce the mistrust and tension between the mining firms and their host communities.

6.6 Limitations of the study

Notwithstanding the contributions of this research to the literature, theory and policy on mining, the thesis has some noteworthy limitations. First, the data for this study is cross-sectional, which limits the interpretation of the results to association but not causation. Also, given that the affected communities are very deprived, it is difficult to tease out the exact underlying factors influencing SRH. Therefore any attribution to mining activities has to be done with caution. Other factors that could influence SRH include malnutrition, limited access to healthcare and alcohol abuse which seems rampant in the region (Luginaah & Dakubo, 2003).

Second, the data is self-reported which makes it susceptible to biased responses. Mining in the affected communities is a sensitive issue considering complaints about the seizure of lands and degradation of the environment from community leaders and the residents alike; it is possible responses to some questions were overstated. Moreover, considering the fact that some residents are either employed by mining firms or actively engaged in ASM, their responses may be biased due to the direct benefits which accrue to them. Furthermore, asking residents to recall noticing pollution within the last four weeks also makes responses to the questions prone to recall bias as some respondents may not be able to accurately do so.
Third, the decision to relocate from the study area may not only be influenced by mining activities as residents for decades have been migrating to Southern Ghana to work in the mines, and more recently migrating to the Brong Ahafo Region due to environmental change. Thus, mining activities in communities could only be facilitating this problem especially as farmlands have been compulsorily acquired for mining purposes. Considering the worsening climatic conditions within the area, the desire to relocate cannot entirely be dependent on the environmental toxins associated with the gold mining activities.

Fourth, the study is only reported from the perspective of affected residents without any input from the perspective of the other stakeholders including the mining company, the Environmental Protection Agency (EPA) and the Minerals Commission of Ghana. Furthermore, the study survey instrument was silent on residents that were directly employed by the mining company and residents who have relocated mainly due to the mining activities.

Finally, concepts such as SRH have traditionally used a qualitative approach as it is designed to capture the subjective meaning of health and wellbeing in the context of respondents. Therefore, using an extensive/quantitative approach may ignore some of the subjective understanding of health in this study context. Despite this, other studies have also used quantitative methodology to study SRH (see Chen, Cohen, & Kasen, 2007; Woolley et al., 2015). In spite of these challenges, this study makes an important contribution to the mining literature and can inform mining policy in Ghana and elsewhere.
6.7 Directions for future research

Based on the limitations of this study there are prospects for future research on environment and health in the context of mining in Ghana. Given that this research lacks a base study to compare SRH and perceptions of the affected communities prior to mining activities, future research can make use of longitudinal study designs involving control communities where residents in a prospective gold mining community are followed over time to assess the changing impacts of mining on their SRH. The use of “control communities” with similar historical, cultural, socio-economic and ecological characteristics will help gauge the full impact of mining activities on affected communities.

While this study employs a quantitative methodology, its structured approach likely ignores some of the meaning and core issues that affect residents in relation to the mining activities. A qualitative approach can be used to understand the meaning residents attach to the effects of mining especially why this influences people desire to relocate from their communities. This will also make it possible to better understand the subjective ways through which residents perceive the health effects of mining activities. Finally, there is a need for future research to combine community environment and health perceptions with actual pollution measurements in affected communities to be able to understand the direct impacts of mining activities. Level of dust pollution, land degradation and water pollution could also be assessed or measured. Similarly, level of arsenic in the blood and body tissue of residents needs to be examined. Future research can also aim at documenting if there are new health problems in these mining areas by liaising with the local healthcare
providers. The identification of new health problems will provide further understanding of the effects of surface mining and possible policy options.
6.8 References


Appendix A. Research Ethics Approval

Western University Health Science Research Ethics Board
NMREB Delegated Initial Approval Notice

Principal Investigator: Dr. Isaac Lagmah
Department & Institution: Social Science/Geography, Western University

NMREB File Number: 30578
Study Title: Environmental and Health Perceptions in the Vicinity of Surface Mining Concessions in the Upper West Region of Ghana.
Sponsor:

NMREB Initial Approval Date: August 22, 2014
NMREB Expiry Date: December 31, 2015

Documents Approved and/or Received for Information:

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<th>Document Name</th>
<th>Comments</th>
<th>Version Date</th>
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<tr>
<td>Other</td>
<td>RA Confidentiality Agreement</td>
<td>2014/07/20</td>
</tr>
<tr>
<td>Letter of Information &amp; Consent</td>
<td>LOI - cleaned</td>
<td>2014/06/13</td>
</tr>
<tr>
<td>Instruments</td>
<td>Study Questionnaire - Cleaned</td>
<td>2014/06/13</td>
</tr>
<tr>
<td>Western University Protocol</td>
<td>REB Protocol - Cleaned</td>
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The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the above named study, as of the NMREB Initial Approval Date noted above.

NMREB approval for this study remains valid until the NMREB Expiry Date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario.

Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 0003041.

Ethics Officer to Contact for Further Information

This is an official document. Please retain the original in your files.
### General Information

<table>
<thead>
<tr>
<th>NAME OF LOCALITY</th>
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<tr>
<td>NAME OF DISTRICT</td>
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</table>

**LOCATION:** (1 = RURAL 2 = URBAN) 

**LOCALITY CHARACTERISTICS:** (1 = LARGE TOWN, 2 = SMALL TOWN, 3 = VILLAGE) 

**COMMUNITY STATUS IN REFERENCE TO MINING** (1 = AFFECTED, 2 = IMPACTED) 

**WHAT IS THE DISTANCE FROM YOUR COMMUNITY TO MINING ACTIVITIES** 

<table>
<thead>
<tr>
<th>RECORD</th>
<th>DON'T KNOW</th>
<th>REFUSED</th>
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</table>

### Attitudes Towards Community

1. I'd like to ask you some questions about your community. Can you please tell me in general, how satisfied are you with this community as a place to live? Would you say VERY SATISFIED, SOMewhat SATISFIED, NOT TOO SATISFIED, or NOT AT ALL SATISFIED? 

   - VERY SATISFIED ………………….1
   - SOMEWHAT SATISFIED ………2
   - NOT TOO SATISFIED ……………3
   - NOT AT ALL SATISFIED ………..4
   - DON’T KNOW ……………………..8
   - REFUSED …………………………9

2. Does the surface mining activities affect your satisfaction with this area as a place to live? 

   - YES ……………………………………..1
   - NO ………………………………………2
   - DON’T KNOW …………………………8
   - REFUSED …………………………….9

3. Have you ever considered moving because of the surface mining activities? 

   - YES ……………………………………..1
   - NO ………………………………………2
   - DON’T KNOW …………………………8
   - REFUSED …………………………….9
<table>
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<tr>
<th>Question</th>
<th>Options</th>
<th>Code</th>
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</table>
| 4. Do you have any other concerns about the MINING ACTIVITIES that we haven't mentioned? | YES ..................................................1  
NO ..................................................2  
DON'T KNOW ..........................................8  
REFUSED .............................................9 | ... | ... |... |
| 5. What is your NUMBER ONE concern about the surface mining activities? | ---------------------------------- | ... | ... |... |
| 6. How would you rate your overall level of concern about that issue? Would you say you are SLIGHTLY concerned, MODERATELY concerned, or EXTREMEY concerned? | SLIGHTLY CONCERNED ..........1  
MODERATELY CONCERNED ....2  
EXTREMELY CONCERNED ..........3  
DON'T KNOW ...............8  
REFUSED .................9 | ... | ... |... |
| 7. Would you say there are BENEFITS to having the surface mining activities in this area? | YES ..................................................1  
NO ..................................................2  
DON'T KNOW ..........................................8  
REFUSED .............................................9 | ... | ... |... |
| 8. What is the most important benefit of having the surface mining activities in this area? | NO BENEFITS ..................................1  
EMPLOYMENT ..................................2  
WATER ..........................................3  
SCHOOL BUILDING ....................4  
OTHER (SPECIFY) ..........................5  
DON'T KNOW ..............................8  
REFUSED .........................9 | ... | ... |... |
| 9. What is the second most benefits to having the surface mining activities in this area? | NO MORE BENEFITS ..................1  
DON'T KNOW .........................8  
REFUSED .........................9 | ... | ... |... |
| 10. Aside from the surface mining activities, do you have any concerns about other environmental problems in your area? | YES ..................................................1  
NO ..................................................2  
DON'T KNOW ..........................................8  
REFUSED .............................................9 | ... | ... |... |
| 11. What is the most important concern you have? | NO CONCERNS ..........................1  
HEALTH ........................................2  
LAND AVAILABILITY ......................3  
OTHER (SPECIFY) .........................4  
DON'T KNOW ..............................8  
REFUSED .................................9 | ... | ... |... |
| 12. What other environmental concerns do you have? | NO MORE CONCERNS ..................1  
DON'T KNOW .........................8  
REFUSED .........................9 | ... | ... |... |
<table>
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<th>Question</th>
<th>Options</th>
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</table>
| 13.| How would you rate your OVERALL level of concern? Would you say you are SLIGHTLY concerned, MODERATELY concerned or EXTREMELY concerned? | SLIGHTLY CONCERNED .......1  
    |                                           | MODERATELY CONCERNED ...2  
    |                                           | EXTREMELY CONCERNED .....3  
    |                                           | DON'T KNOW .................8  
    |                                           | REFUSED ....................9  |   |
| 14.| Do you believe that odours from the mining areas are causing health problems in the communities in the vicinity of the mining activities? | YES ........................................1  
    |                                           | NO .....................................2  
    |                                           | DON'T KNOW .......................8  
    |                                           | REFUSED ..........................9  |   |
| 15.| Would you say you strongly believe, believe, are neutral, disbelieve or strongly disbelieve that odours from surface mining activities are causing health problems (in the communities in the vicinity of the surface mining activities?) | STRONGLY BELIEVE ............1  
    |                                           | BELIEVE ................................2  
    |                                           | NEUTRAL ................................3  
    |                                           | DISBELIEVE ..........................4  
    |                                           | STRONGLY DISBELIEVE ..............5  
    |                                           | DON'T KNOW ...........................8  
    |                                           | REFUSED ................................9  |   |
| 16.| Would you say you strongly believe, believe, are neutral, disbelieve or strongly disbelieve that surface mines are impacting farmland in your area? | STRONGLY BELIEVE ............1  
    |                                           | BELIEVE ................................2  
    |                                           | NEUTRAL ................................3  
    |                                           | DISBELIEVE ..........................4  
    |                                           | STRONGLY DISBELIEVE ..............5  
    |                                           | DON'T KNOW ...........................8  
    |                                           | REFUSED ................................9  |   |
|   | **General Health Status**                                               |                                                                         |   |
| 17.| I would like to ask you about your health. In general, how does your health compare with that of other people of your age group? Would you say your health is Excellent, Very Good, Good, Fair or Poor? | EXCELLENT ........................1  
    |                                           | VERY GOOD ........................2  
    |                                           | GOOD ...................................3  
    |                                           | FAIR ...................................4  
    |                                           | POOR ...................................5  
    |                                           | DK/NOT SURE ..........................8  |   |
| 18.| (*Adapted from the Duke Health Survey*)  
    | Here are a number of questions about your health and feelings. I will read you a statement. Please answer which of the three options is most closely suited to you. | YES, DESCRIBES ME EXACTLY...............................1  
    |                                           |  
    |                                           | YES, DESCRIBES ME SOMEWHAT ..............2  
    |                                           |  
    |                                           | NO, DOESN'T DESCRIBE ME AT ALL ..........................3 |   |
| 19.| I am not an easy person to get along with                                | YES, DESCRIBES ME EXACTLY...............................1  
    |                                           | YES, DESCRIBES ME SOMEWHAT ..............2  
<pre><code>|                                           | NO, DOESN'T DESCRIBE ME AT ALL ..........................3 |
</code></pre>
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| **20.** | I am basically a healthy person | YES, DESCRIBES ME EXACTLY…………………………………...1
|   |   | SOMEWHAT DESCRIBES ME......2
|   |   | NO, DOESN’T DESCRIBE ME AT ALL ……………………………………………………3
|   |   |   |
| **21.** | I give up too easily | YES, DESCRIBES ME EXACTLY…………………………………...1
|   |   | SOMEWHAT DESCRIBES ME......2
|   |   | NO, DOESN’T DESCRIBE ME AT ALL ……………………………………………………3
|   |   |   |
| **22.** | I have difficulty concentrating | YES, DESCRIBES ME EXACTLY…………………………………...1
|   |   | SOMEWHAT DESCRIBES ME......2
|   |   | NO, DOESN’T DESCRIBE ME AT ALL ……………………………………………………3
|   |   |   |
| **23.** | I am happy with my family relationships | YES, DESCRIBES ME EXACTLY…………………………………...1
|   |   | SOMEWHAT DESCRIBES ME......2
|   |   | NO, DOESN’T DESCRIBE ME AT ALL ……………………………………………………3
|   |   |   |
| **24.** | I am comfortable being around people | YES, DESCRIBES ME EXACTLY…………………………………...1
|   |   | SOMEWHAT DESCRIBES ME......2
|   |   | NO, DOESN’T DESCRIBE ME AT ALL ……………………………………………………3
|   |   |   |
| **25.** | Today, would you have physical trouble or difficulty walking? | NONE………………………..…….1
|   |   | SOME ……………………………..2
|   |   | A LOT ………………………….….3
|   |   |   |
| **26.** | Today, would you have physical trouble or difficulty doing physical work? | NONE………………………..…….1
|   |   | SOME ……………………………..2
|   |   | A LOT ………………………….….3
|   |   |   |
| **27.** | During the PAST 4 WEEKS how much trouble have you had with: Sleeping? | NONE………………………..…….1
|   |   | SOME ……………………………..2
|   |   | A LOT ………………………….….3
|   |   |   |
| **28.** | Hurting or aching in any part of your body? | NONE………………………..…….1
|   |   | SOME ……………………………..2
|   |   | A LOT ………………………….….3
|   |   |   |
| **29.** | Getting tired easily? | NONE………………………..…….1
|   |   | SOME ……………………………..2
|   |   | A LOT ………………………….….3
|   |   |   |
| **30.** | Feeling depressed or sad? | NONE………………………..…….1
|   |   | SOME ……………………………..2
|   |   | A LOT ………………………….….3
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|   |   |   |</p>
<table>
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<tr>
<th>NO</th>
<th>QUESTION</th>
<th>RESPONSE OPTIONS</th>
<th>CODE</th>
</tr>
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</table>
| 31 | Nervousness?                                                             | NONE………………………..…….1  
SOME ……………………………..2  
A LOT ………………………….….3 |      |
| 32 | During the PAST 8 WEEKS how often did you: Socialize with other people (talk or visit with relatives) | NONE………………………..…….1  
SOME ……………………………..2  
A LOT ………………………….….3 |      |
| 33 | Take part in social, religious, or recreation activities (community, church, political party meetings) | NONE………………………..…….1  
SOME ……………………………..2  
A LOT ………………………….….3 |      |
| 34 | Stay in your home or hospital because of sickness, injury, or other health problem | NONE………………………..…….1  
SOME ……………………………..2  
A LOT ………………………….….3 |      |

**Symptoms**

<table>
<thead>
<tr>
<th>NO</th>
<th>QUESTION</th>
<th>RESPONSE OPTIONS</th>
<th>CODE</th>
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</table>
| 35 | Now I'd like to ask you a series of questions about POSSIBLE health problems you MAY be experiencing. DURING THE PAST 4 WEEKS. How often have you had problems with HEADACHES over the PAST 4 WEEKS? | DAILY .................................1  
ALMOST EVERY DAY ...............2  
ONCE A WEEK ........................3  
ONCE A MONTH .......................4  
LESS OFTEN THAN ONCE A MONTH.................................................................5  
NOT AT ALL.............................6  
DON'T KNOW ............................8  
REFUSED ...............................9 |      |
| 36 | How often have you had TROUBLE SLEEPING over the PAST 4 WEEKS? | DAILY .................................1  
ALMOST EVERY DAY ...............2  
ONCE A WEEK ........................3  
ONCE A MONTH .......................4  
LESS OFTEN THAN ONCE A MONTH.................................................................5  
NOT AT ALL.............................6  
DON'T KNOW ............................8  
REFUSED ...............................9 |      |
| 37 | How often have you had DIZZY SPELLS? | DAILY .................................1  
ALMOST EVERY DAY ...............2  
ONCE A WEEK ........................3  
ONCE A MONTH .......................4  
LESS OFTEN THAN ONCE A MONTH.................................................................5  
NOT AT ALL.............................6  
DON'T KNOW ............................8  
REFUSED ...............................9 |      |
| 38. | How often have you had SINUS CONGESTION THAT IS NOT RELATED TO A COLD? ...over the PAST 4 WEEKS? | DAILY ........................................1
ALMOST EVERY DAY .................2
ONCE A WEEK .............................3
ONCE A MONTH.........................4
LESS OFTEN THAN ONCE A MONTH........................................5
NOT AT ALL...............................6
DON'T KNOW .........................8
REFUSED .................................9 |
|---|---|---|
| 39. | How often have you had IRRITATED, SORE OR RED EYES? ...over the PAST 4 WEEKS? | DAILY ........................................1
ALMOST EVERY DAY .................2
ONCE A WEEK .............................3
ONCE A MONTH.........................4
LESS OFTEN THAN ONCE A MONTH........................................5
NOT AT ALL...............................6
DON'T KNOW .........................8
REFUSED .................................9 |
|---|---|---|
| 40. | How often have you had COLDs ...over the PAST 4 WEEKS? | DAILY ........................................1
ALMOST EVERY DAY .................2
ONCE A WEEK .............................3
ONCE A MONTH.........................4
LESS OFTEN THAN ONCE A MONTH........................................5
NOT AT ALL...............................6
DON'T KNOW .........................8
REFUSED .................................9 |
|---|---|---|
| 41. | How often have you had a RUNNY OR STUFFY NOSE THAT IS NOT RELATED TO A COLD?...over the PAST 4 WEEKS? | DAILY ........................................1
ALMOST EVERY DAY .................2
ONCE A WEEK .............................3
ONCE A MONTH.........................4
LESS OFTEN THAN ONCE A MONTH........................................5
NOT AT ALL...............................6
DON'T KNOW .........................8
REFUSED .................................9 |
|---|---|---|
| 42. | How often have you had a SORE THROAT THAT IS NOT RELATED TO A COLD? ...over the PAST 4 WEEKS? | DAILY ........................................1
ALMOST EVERY DAY .................2
ONCE A WEEK .............................3
ONCE A MONTH.........................4
LESS OFTEN THAN ONCE A MONTH........................................5
NOT AT ALL...............................6
DON'T KNOW .........................8
REFUSED .................................9 |
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<th></th>
<th>Question</th>
<th>Options</th>
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</table>
| 43.| How often have you had EARACHES? ...over the PAST 4 WEEKS?               | DAILY .................................1  
ALMOST EVERY DAY ............2  
ONCE A WEEK .....................3  
ONCE A MONTH ....................4  
LESS OFTEN THAN ONCE A MONTH..............................................5  
NOT AT ALL.........................6  
DON'T KNOW ........................8  
REFUSED ...........................9 |   |
| 44.| How often have you had CHEST PAINS...over the PAST 4 WEEKS?              | DAILY .................................1  
ALMOST EVERY DAY ............2  
ONCE A WEEK .....................3  
ONCE A MONTH ....................4  
LESS OFTEN THAN ONCE A MONTH..............................................5  
NOT AT ALL.........................6  
DON'T KNOW ........................8  
REFUSED ...........................9 |   |
| 45.| How often have you had COUGHING THAT IS NOT RELATED TO A COLD?...over the PAST 4 WEEKS? | DAILY .................................1  
ALMOST EVERY DAY ............2  
ONCE A WEEK .....................3  
ONCE A MONTH ....................4  
LESS OFTEN THAN ONCE A MONTH..............................................5  
NOT AT ALL.........................6  
DON'T KNOW ........................8  
REFUSED ...........................9 |   |
| 46.| How often have you had WHEEZING OR OTHER TROUBLE BREATHING? ...over the PAST 4 WEEKS? | DAILY .................................1  
ALMOST EVERY DAY ............2  
ONCE A WEEK .....................3  
ONCE A MONTH ....................4  
LESS OFTEN THAN ONCE A MONTH..............................................5  
NOT AT ALL.........................6  
DON'T KNOW ........................8  
REFUSED ...........................9 |   |
| 47.| How often have you had HIVES OR SKIN RASHES?...over the PAST 4 WEEKS?    | DAILY .................................1  
ALMOST EVERY DAY ............2  
ONCE A WEEK .....................3  
ONCE A MONTH ....................4  
LESS OFTEN THAN ONCE A MONTH..............................................5  
NOT AT ALL.........................6  
DON'T KNOW ........................8  
REFUSED ...........................9 |   |
<table>
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<tr>
<th>Question</th>
<th>Options</th>
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<th>...</th>
</tr>
</thead>
</table>
| 48. How often have you had NOSEBLEEDS? ...over the PAST 4 WEEKS?         | DAILY ........................................1  
ALMOST EVERY DAY ..................2  
ONCE A WEEK .........................3  
ONCE A MONTH.........................4  
LESS OFTEN THAN ONCE A MONTH........................................5  
NOT AT ALL..........................6  
DON'T KNOW .........................8  
REFUSED ..............................9 |     |     |
| 49. Have you had any other health problems over the PAST 4 WEEKS that I have not asked you about? | YES........................................1  
NO .....................................2  
DON'T KNOW .........................8  
REFUSED ..............................9 |     |     |
| 50. How often have you had a problem with [q49 ABOVE]? ...over the PAST 4 WEEKS? | DAILY ........................................1  
ALMOST EVERY DAY ..................2  
ONCE A WEEK .........................3  
ONCE A MONTH.........................4  
LESS OFTEN THAN ONCE A MONTH........................................5  
NOT AT ALL..........................6  
DON'T KNOW .........................8  
REFUSED ..............................9 |     |     |

**Chronic Health Problems**

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<th>Question</th>
<th>Options</th>
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</table>
| 51. Now I'd like to ask about certain chronic health conditions you may have. We are interested in “long term conditions” that have been diagnosed by a health professional. Do you have skin conditions? | YES........................................1  
NO .....................................2  
DON'T KNOW .........................8  
REFUSED ..............................9 |     |     |
| 52. Do you have hay fever or other allergies?                           | YES........................................1  
NO .....................................2  
DON'T KNOW .........................8  
REFUSED ..............................9 |     |     |
| 53. Do you have arthritis or rheumatism?                               | YES........................................1  
NO .....................................2  
DON'T KNOW .........................8  
REFUSED ..............................9 |     |     |
<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Don't Know</th>
<th>Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you been woken by an attack of shortness of breath at any time in the last 12 months?</td>
<td>Yes………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>Have you had an asthmatic attack in the last 12 months?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>Are you currently taking any medication for asthma, including inhalers, aerosols or tablets?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>Do you have any other respiratory problems?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>If yes, please specify.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have high blood pressure or hypertension?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>Do you have heart disease?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>Do you have diabetes?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>Do you have urinary problems or kidney disease?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
</tr>
<tr>
<td>Do you have a stomach ulcer or ulcers?</td>
<td>Yes…………..</td>
<td>No …………</td>
<td>Don’t Know</td>
<td>Refused</td>
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**Environmental Exposure Proxies**
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<th>Choices</th>
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<tbody>
<tr>
<td>During this past 4 WEEKS, how often, if ever, did you notice air pollutants (e.g. dust, exhaust fumes, odours) WHICH YOU THINK WERE FROM THE MINING ACTIVITIES when you were at home or in your yard?</td>
<td>DAILY ..................................1  SEVERAL TIMES A WEEK ....................2  ABOUT ONCE A WEEK ............3  SEVERAL TIMES A MONTH ......4  ONCE A MONTH .....................5  NEVER NOTICE .....................6  DON'T KNOW ......................8  REFUSED ..........................9</td>
</tr>
<tr>
<td>When you noticed the air pollutants (e.g. dust, exhaust fumes, odours) during past 4 WEEKS HOW OFTEN did it bother you?</td>
<td>EVERY TIME ...............................1  ALMOST EVERY TIME ..........................2  MORE THAN HALF THE TIME ..........3  ABOUT HALF THE TIME ............4  LESS THAN HALF THE TIME ..........5  NEVER BOtherED .................6  DON'T KNOW ......................8  REFUSED ..........................9</td>
</tr>
<tr>
<td>When you noticed the air pollutants (e.g. dust, exhaust fumes, odours), HOW MUCH did it bother you?</td>
<td>Great deal .............................1  Somewhat .................................2  Only a little .......................3  Not bothered .....................4  Don't Know ......................8  Refused ..........................9</td>
</tr>
<tr>
<td>On a scale of 0-10 (no disturbance at all) to 10 (intolerable disturbance), how much are you annoyed by air pollution (from mining activities) at your actual home, if you keep the windows open?</td>
<td>Enter number ___________  Don't Know ..........................88  Refused ..........................99</td>
</tr>
<tr>
<td>Did air pollution cause disruption in your family or social activities during July and/or August?</td>
<td>Yes .....................................1  No .......................................2  Don't Know ......................8  Refused ..........................9</td>
</tr>
<tr>
<td>I'm going to ask you a number of questions about HOW air pollution disrupted your family and/or social activities during past 4 WEEKS. (Only if they answer yes in 34) First, did you have to keep the windows closed?</td>
<td>Yes .....................................1  No .......................................2  Don't Know ......................8  Refused ..........................9</td>
</tr>
<tr>
<td>How often did you have to keep the windows closed because of air pollution in the past 4 WEEKS?</td>
<td>Often ..................................1  Occasionally .........................2  Only Once .......................3  Don't Know ......................8  Refused ..........................9</td>
</tr>
<tr>
<td></td>
<td>Question</td>
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<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>70.</td>
<td>Was your or a family member’s sleep affected by air pollution in the past 4 WEEKS?</td>
</tr>
<tr>
<td>71.</td>
<td>How often was your or a family member’s sleep affected by air pollution in the past 4 WEEKS?</td>
</tr>
<tr>
<td>72.</td>
<td>Were you unable to entertain friends outside because of air pollution in the past 4 WEEKS?</td>
</tr>
<tr>
<td>73.</td>
<td>How often were you unable to entertain friends outside because of air pollution in the past 4 WEEKS?</td>
</tr>
<tr>
<td>74.</td>
<td>If you noticed air pollution during the past 4 WEEKS of this year, how would you compare them with what you remember from the same period of the previous year?</td>
</tr>
<tr>
<td>75.</td>
<td>In the past twelve months have you been exposed to pesticides (bug or weed killers) around the home or yard?</td>
</tr>
<tr>
<td>76.</td>
<td>Do you have a gas powered stove?</td>
</tr>
<tr>
<td>77.</td>
<td>In the past twelve months have you used a fireplace in your home?</td>
</tr>
<tr>
<td>78.</td>
<td>What types of flooring or carpets does your house have? Does it have:</td>
</tr>
</tbody>
</table>

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## Attitudes towards mining

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Response Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>79.</td>
<td>I think the surface mining company has made a positive contribution to the community</td>
<td>STRONGLY AGREE ……………1&lt;br&gt;AGREE …………………………….2&lt;br&gt;NEUTRAL …………………3&lt;br&gt;DISAGREE …………………4&lt;br&gt;STRONGLY DISAGREE ……..5</td>
</tr>
<tr>
<td>80.</td>
<td>I am satisfied with the surface mining company’s level of support for the community</td>
<td>STRONGLY AGREE ……………1&lt;br&gt;AGREE …………………………….2&lt;br&gt;NEUTRAL …………………3&lt;br&gt;DISAGREE …………………4&lt;br&gt;STRONGLY DISAGREE ……..5</td>
</tr>
<tr>
<td>81.</td>
<td>I think residents should have more say about issues that affect the community</td>
<td>STRONGLY AGREE ……………1&lt;br&gt;AGREE …………………………….2&lt;br&gt;NEUTRAL …………………3&lt;br&gt;DISAGREE …………………4&lt;br&gt;STRONGLY DISAGREE ……..5</td>
</tr>
<tr>
<td>82.</td>
<td>I think the surface mining company is meeting its environmental commitments</td>
<td>STRONGLY AGREE ……………1&lt;br&gt;AGREE …………………………….2&lt;br&gt;NEUTRAL …………………3&lt;br&gt;DISAGREE …………………4&lt;br&gt;STRONGLY DISAGREE ……..5</td>
</tr>
<tr>
<td>83.</td>
<td>I am adequately informed about the surface mining company’s operations</td>
<td>STRONGLY AGREE ……………1&lt;br&gt;AGREE …………………………….2&lt;br&gt;NEUTRAL …………………3&lt;br&gt;DISAGREE …………………4&lt;br&gt;STRONGLY DISAGREE ……..5</td>
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## Access to Healthcare

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<tr>
<th></th>
<th>Question</th>
<th>Response Options</th>
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<tbody>
<tr>
<td>84.</td>
<td>Have you ever been enrolled in the NHIS?</td>
<td>YES ……………………………………..…1&lt;br&gt;NO …………………………………………2&lt;br&gt;REFUSED ……………………………….9</td>
</tr>
<tr>
<td>85.</td>
<td>IF NO TO Q84 ASK In your opinion how will you assess the nature of services you get at health facilities compared to those who have the NHIS card?</td>
<td>BETTER…………………………1&lt;br&gt;SAME ……………………………….2&lt;br&gt;WORSE ………………………………3&lt;br&gt;REFUSED ……………………………….9</td>
</tr>
<tr>
<td>86.</td>
<td>IF YES TO Q84 ASK In your opinion how will you assess the nature of services NHIS cardholders get at health facilities compared to those who have no NHIS?</td>
<td>BETTER ……………………………1&lt;br&gt;SAME ……………………………….2&lt;br&gt;WORSE ………………………………3&lt;br&gt;REFUSED ……………………………….9</td>
</tr>
<tr>
<td>Question</td>
<td>Instructions</td>
<td>Options</td>
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<tr>
<td>87.</td>
<td>When did you <strong>FIRST</strong> enroll in the NHIS?</td>
<td>NEVER ENROLLED ............0&lt;br&gt;YEAR.............MONTH.........</td>
</tr>
<tr>
<td>88.</td>
<td>Are you <strong>CURRENTLY</strong> enrolled in the NHIS?</td>
<td>YES ....................................1&lt;br&gt;NO ....................................2&lt;br&gt;REFUSED ....................................9</td>
</tr>
<tr>
<td>89.</td>
<td><strong>IF NO TO Q88 ASK</strong>&lt;br&gt;Why are you not currently enrolled?</td>
<td>LACK OF MONEY ....................................1&lt;br&gt;NOT INTERESTED IN NHIS ....................2&lt;br&gt;NO REGISTRATION DESK HERE .................3&lt;br&gt;OTHER .........................................4&lt;br&gt;DON'T KNOW ....................................8</td>
</tr>
<tr>
<td>90.</td>
<td>Have you ever visited a health facility to seek treatment for your illness since 2005?</td>
<td>YES ....................................1&lt;br&gt;NO ....................................2&lt;br&gt;NEVER BEEN ILL .........................3&lt;br&gt;REFUSED ....................................9</td>
</tr>
<tr>
<td>91.</td>
<td><strong>IF YES TO Q90 ASK</strong>&lt;br&gt;When did you last visit a health facility to seek treatment for your illness?</td>
<td>WITHIN LAST 4 WEEKS ............1&lt;br&gt;ONE MONTH TO SIX MONTHS ..........2&lt;br&gt;7 MONTHS TO 1 YEAR .................3&lt;br&gt;MORE THAN 1 YEAR ....................4&lt;br&gt;DON'T KNOW ....................................8&lt;br&gt;REFUSED ....................................9</td>
</tr>
<tr>
<td>92.</td>
<td>Since the introduction of the NHIS how would you rate its impact on how frequently people use health facilities?</td>
<td>LESS USE OF HEALTH FACILITIES .........1&lt;br&gt;NO CHANGE IN USE .......................2&lt;br&gt;MORE USE OF HEALTH FACILITY .........3&lt;br&gt;DON'T KNOW ....................................8&lt;br&gt;REFUSED ....................................9</td>
</tr>
<tr>
<td>93.</td>
<td>How far is it from where you live to the nearest health facility?</td>
<td>LESS THAN 1KM .....................1&lt;br&gt;BETWEEN 1 AND 5KM .....................2&lt;br&gt;MORE THAN 5 KM .......................3&lt;br&gt;DON'T KNOW ....................................8&lt;br&gt;REFUSED ....................................9</td>
</tr>
<tr>
<td>94.</td>
<td>Have you ever been diagnosed with any illness in the last 4 weeks?</td>
<td>YES ....................................1&lt;br&gt;NO ....................................2&lt;br&gt;DON'T KNOW ....................................8&lt;br&gt;REFUSED ....................................9</td>
</tr>
<tr>
<td>95.</td>
<td>During your last illness where did you seek treatment?</td>
<td>DID NOT SEEK TREATMENT ............1&lt;br&gt;HEALTH CENTRE ......................2&lt;br&gt;HOSPITAL .................................3&lt;br&gt;COMMUNITY HEALTH WORKER .........4&lt;br&gt;TRADITIONAL HEALER ..................5&lt;br&gt;DRUG KIOSK/STORE .....................6&lt;br&gt;DON'T KNOW ....................................8&lt;br&gt;REFUSED ....................................9</td>
</tr>
<tr>
<td>Q.</td>
<td>Description</td>
<td>Options</td>
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<tr>
<td>96.</td>
<td>IF RESPONDENT DID NOT SEEK TREATMENT ASK</td>
<td>DO NOT HAVE INSURANCE...1&lt;br&gt;DISTANCE TOO FAR ...2&lt;br&gt;OTHER (SPECIFY) ...3&lt;br&gt;DON’T KNOW ...8&lt;br&gt;REFUSED ...9&lt;br&gt;</td>
</tr>
<tr>
<td>97.</td>
<td>Are there any community health workers in this village/town?</td>
<td>YES ...1&lt;br&gt;NO ...2&lt;br&gt;DON’T KNOW ...8&lt;br&gt;REFUSED ...9&lt;br&gt;</td>
</tr>
<tr>
<td>98.</td>
<td>Do you have a drug dispensing kiosk/outlet (mini-pharmacy) in this community?</td>
<td>YES ...1&lt;br&gt;NO ...2&lt;br&gt;DON’T KNOW ...8&lt;br&gt;REFUSED ...9&lt;br&gt;</td>
</tr>
<tr>
<td>99.</td>
<td>Are there any non-governmental organizations working in this area?</td>
<td>YES ...1&lt;br&gt;NO ...2&lt;br&gt;DON’T KNOW ...8&lt;br&gt;REFUSED ...9&lt;br&gt;</td>
</tr>
<tr>
<td>100.</td>
<td>What is your most important source of information about health matters in this community?</td>
<td>COMMUNITY HEALTH WORKER ...1&lt;br&gt;GOVERNMENT HEALTH CENTRE/HOSPITAL ...2&lt;br&gt;FAITH-BASED HEALTH CENTRE/HOSPITAL ...3&lt;br&gt;NGO ...4&lt;br&gt;DON’T KNOW ...8&lt;br&gt;REFUSED ...9&lt;br&gt;</td>
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</table>

**Socio-Demographic Information**

<table>
<thead>
<tr>
<th>Q.</th>
<th>Description</th>
<th>Options</th>
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</thead>
<tbody>
<tr>
<td>101.</td>
<td>Gender</td>
<td>MALE ...1&lt;br&gt;FEMALE ...2&lt;br&gt;</td>
</tr>
<tr>
<td>102.</td>
<td>What is your age?</td>
<td></td>
</tr>
<tr>
<td>103.</td>
<td>Marital status</td>
<td>NEVER MARRIED ...1&lt;br&gt;CURRENTLY MARRIED ...2&lt;br&gt;DIVORCED ...3&lt;br&gt;WIDOWED ...4&lt;br&gt;REFUSED ...9&lt;br&gt;</td>
</tr>
<tr>
<td>104.</td>
<td>What is your occupation?</td>
<td>AGRICULTURE/FARMER ...1&lt;br&gt;TRADING ...2&lt;br&gt;CIVIL SERVANT ...3&lt;br&gt;OTHER SELF-EMPLOYED ...4&lt;br&gt;UNEMPLOYED ...5&lt;br&gt;</td>
</tr>
<tr>
<td>Question</td>
<td>Options</td>
<td></td>
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<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
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</tbody>
</table>
| What is your highest level of education?                                | NO EDUCATION ................................ 1  
                                PRIMARY EDUCATION .......................... 2  
                                SECONDARY EDUCATION ...................... 3  
                                TERTIARY EDUCATION ........................ 4  
                                VOCATIONAL ................................. 5  
                                REFUSED .................................. 9  |
| How many people in total live in your household?                       |                                                                                             |
| How many of the people in your household are children?                 |                                                                                             |
| What is your religion?                                                 | CHRISTIAN ..................................... 1  
                                MUSLIM ....................................... 2  
                                TRADITIONALIST ............................. 3  
                                NO RELIGION .................................. 4  
                                OTHER ....................................... 5  
                                REFUSED .................................. 9  |
| Ethnicity                                                               | SISSALA ........................................ 1  
                                WAALA .......................................... 2  
                                BRIFOR ......................................... 3  
                                DAGAABA ....................................... 4  
                                OTHER (NORTHERN) ......................... 5  
                                OTHER (SOUTHERN) ........................... 6  |
| What is your annual household income?                                  | RECORD ......................................... 1  
                                DON'T KNOW .................................. 8  
                                REFUSED .................................. 9  |
| Which one of the following housing type best describes the type of dwelling this household occupies? | HOUSE ........................................... 1  
                                                                 TRADITIONAL DWELLING/HOMESTEAD .................. 2  
                                                                 COMPOUND HOUSE ................................ 3  
                                                                 ROOM IN HOUSE .................................. 4  
                                                                 HUT/SHACK ..................................... 5  
                                                                 OTHER (SPECIFY): ............................. 6  |
| Does your house have electricity?                                      | YES ............................................. 1  
                                NO ............................................. 2  
                                DON'T KNOW .................................. 8  
                                REFUSED .................................. 9  |
| Does your house have running water?                                    | YES ............................................. 1  
                                NO ............................................. 2  
                                DON'T KNOW .................................. 8  
                                REFUSED .................................. 9  |
| Does this household own any livestock?                                 | YES ............................................. 1  
                                NO ............................................. 2  
                                DON'T KNOW .................................. 8  
                                REFUSED .................................. 9  |
| How many of the following types of animals does your household own?     | Goats .......................................... |

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<table>
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<tr>
<th>your household have?</th>
<th>Pigs</th>
<th>Cattle</th>
<th>Donkey</th>
<th>Sheep</th>
<th>Chicken</th>
</tr>
</thead>
</table>

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<tr>
<th>116. Which of the following best describes the household structure?</th>
<th>Female Centered (No husband/ male partner in household, may include relatives, children, friends)</th>
<th>Male Centered (No wife/ female partner in household, may include relatives, children, friends)</th>
<th>Nuclear (Husband/ male partner and wife/ female partner with or without children)</th>
<th>Extended (Husband/ male partner and wife/ female partner and children and relatives)</th>
<th>Polygamous (husband with more than one wife)</th>
<th>Other (specify):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Appendix C: Curriculum Vitae

Roger Antabe

EDUCATION

Sept 2014 to Aug 2016: Masters Candidate, University of Western Ontario, Canada
Thesis Title: Environment and Health Perceptions in the Vicinity of Surface Mining Concessions in the Upper West Region of Ghana.

May 2007 Bachelor of Arts, Geography and Resource Development
University of Ghana

May 2005 Certificate, International Water Management
University of Ghana/Norwegian University of Science and Technology.

TEACHING EXPERIENCE

Sept 2014 to Apr 2016 Teaching Assistant, University of Western Ontario
Course Title: 1- Geography of Western Europe (Geog 2050B)
2- Geography of Tourism (Geog 2144A)
3- Fundamentals of Geography (Geog 1100)


RESEARCH EXPERIENCE

June-Aug 2014 Masters Thesis Research

Nov 2007-June 2008 Field Research Officer, Centre for Remote Sensing and Geographic Information Services, Department of Geography, University of Ghana

Jan-May 2006 Undergraduate Thesis Research

Publications:

Peer Reviewed Articles


Atuoye, K. N., Kuuire, V. Z., Kangmennaang, J., Antabe, R., & Luginaah, I. Residential remittance and food security in the Upper West Region of Ghana. *International Migration* (revised and resubmitted)


**Conference presentations:**

**Oct 2015**
Canadian Association of Geographers, Ontario Division (CAGONT) Conference at Carleton University, Ottawa (23-24 October)
- Antabe, R., Sano, Y., Atuoye, K. N., Luginaah, I “Women’s household decision making autonomy and the use of postpartum family planning in the Democratic Republic of Congo: Evidence from the Demographic and Health Survey”

**Sep 2015**
Science in the Developing World: Enhancing Research Capacity. Conference at Balsillie School of International Affairs, University of Waterloo (17-18 September)
- Antabe, R., Atuoye, N. K., Kuuire, V. Z., Sano, Y., Vercillo, S., Luginaah, I “Understanding the paradox of high health insurance enrolment in a hungry region: Food insecurity and health insurance in the Upper West Region of Ghana (Poster Presentation)

   ○ Antabe, R., Atuoye, K. N., Sano, Y. Vercillo, S., Kuuire, V. Z., Luginaah, I “Impact of household food insecurity on health insurance enrolment in Ghana”

Oct 2014  Canadian Association of Geographers, Ontario Division (CAGONT) Conference at York University
   ○ Antabe, R., Atuoye, K. N., Kuuire, V. Z., Luginaah, I “Health insurance enrollment and food insecurity in the Upper West Region of Ghana”

AWARDS

2014-2016  Western Graduate Research Scholarship (WGRS)
            CAD$ 54000

April 2015  Society of Graduate Students (SOGS) Conference Travel Grant
            CAD$ 500

VOLUNTARY EXPERIENCE AND COMMUNITY INVOLVEMENT.

2015-2016  Ghana Association of London and Middlesex (GALM)
            Deputy Secretary
            Food Drive for London Food Bank Volunteer

2015-2016  Geographers Graduate Society at Western (GEOGRAD)
            Elected member of the Speaker Series Committee
            Representative to the Society of Graduate Students (SOGS)