KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

CHANGES IN LAND USE AND LAND COVER AND COCOA PRODUCTION IN RELATION TO ARTISANAL GOLD MINING IN THE AMANSIE WEST DISTRICT, GHANA

A THESIS SUBMITTED TO THE DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILMENT OF REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN ENVIRONMENTAL SCIENCE

BY

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DECLARATION

I hereby declare that this compilation is my own work toward the award of MPhil. Environmental Science Degree and also, to the best of my knowledge contains no information already published by another individual nor material which had been accepted for the award of any other degree of the university, except where due acknowledgement had been made in the text.

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DEDICATION

I dedicate this work to my husband, Dr. E.S. Blankson and my kids, Aseda and Ama Nyamekye. I also dedicate it to my parents, Mr. and Mrs. Akwetea.

ABSTRACT

Artisanal and small-scale gold mining can greatly impact cocoa production by reducing land cover, labour force and the quantity of cocoa produced, yet these effects have been scarcely studied. This study examined the effects of land use/land cover change as a result of artisanal and small-scale gold mining on cocoa production from 1997 to 2016 in the Amansie West District, Ghana, using both quantitative and qualitative methods. Google Earth, Landsat images and Geographical Information System (GIS) were used to estimate and map land use/land cover changes over the period. Purposive and double-staged cluster sampling methods were used to obtain information on the subject matter from three relevant institutions and 434 cocoa farmers, respectively, in the district. The t-test was used to evaluate the differences in cocoa production between the periods 1997 to 2006 and 2007 to 2016, whereas the Pearson correlation was used to assess the relationship between the farm size and cocoa harvested over the same period. Change matrices for the periods 1986 to 2007 and 2007 to 2016 were used to ascertain the extent to which artisanal gold mining had taken over cocoa land cover. Results indicated a significant decrease in cocoa production over the period 2007 to 2016 compared to the period 1997 to 2006. There was also a statistically significant positive correlation between the extent of farms size and cocoa produced over both. The extent of land cover of cocoa farms accounted for 10 % variance in cocoa production. Subsequently the maps showed that the land cover of cocoa increased by 13% from 1986 to 2007 while in 2016 there was a 1.8 % increase in land cover. Artisanal and small-scale gold mining on the other hand experienced an increase of 124% in land cover from 1986 to 2007, and again, a dramatic increase of 12442% increase in 2016. The change matrices for both 1986 to 2007 and 2007 to 2016 showed that land converted to artisanal mining sites were covered mostly by cocoa farms. These outcomes reflected a direct linkage between the extent of land use and land cover changes due to artisanal and small-scale gold mining and cocoa production which can be effectively addressed if the plight of the cocoa farmer is made the prime focus.

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CHAPTER ONE

INTRODUCTION

1.1 Background

The mining sector is a major contributor to the economic development of many nations throughout the world (Mobtaker & Osanloo, 2014). Ghana, for example, is endowed with many natural resources of which gold is the most important, contributing 44.2 % of Gross Domestic Product (GDP) of $37.1 billion (Danquah *et al*., 2017). Artisanal and small-scale gold mining (ASGM) has been a source of employment to over a million people in the country (Hilson, 2010), with a large number of rural communities depending on it for their livelihood (Boateng *et al.*, 2014). The sector also provides financial support for many Ghanaians including cocoa farmers who are then better poised to improve upon their farming activities and resultantly yield (Okoh & Hilson, 2011).

Despite the high contribution of gold mining to the socio-economic development of Ghana, it has several negative effects on the environment (Hilson, 2001). Whether large-scale or small-scale, gold mining leads to deforestation and degradation of forest in the country; clearing of land for mining renders several lands bare and susceptible to erosion (Mensah *et al.*, 2015). Gold mining also results in pollution of land and water resources through the release of poisonous chemicals such as mercury, arsenic and cyanide into farmlands within the impacted communities. Small-scale surface mining, in particular, causes indiscriminate release of mercury into rivers and streams (Rajaee *et al.*, 2015), compelling the government to spend considerable amount of money to provide water for affected communities (Mensah *et al.*, 2015).

In 1989, the Government of Ghana through the Minerals Commission legalized artisanal and small-scale gold mining (Hilson & Porter, 2005). Over the last decade there has been a dramatic engagement of people in illegal small-scale gold mining which is locally known as "galamsey" in Ghana (Hilson 2001). Apart from the destruction to the environment this form of mining has immensely affected the agricultural sector, especially the cocoa industry, which has been bedeviled with issues such as lack of wholesome water for irrigation, conversion of cocoa lands to mining sites, among others (Snapir *et al*., 2017).

Cocoa (*Theobroma cacao* L.) is a tropical plant that thrives best on fertile and shaded lands (Wessel & Quist-Wessel, 2015). According to the Ministry of Finance (2017), cocoa is second to gold in terms of its contribution to Ghana's GDP (17.3%). About 90% of farmers in Ghana are small-land holders who are only able to acquire land sizes less than 5 ha for farming (Opoku-Ameyaw *et al*., 2010; CRIG, 2017). The cocoa plant is grown in the southern part of the country due to the presence of adequate rainfall and forest cover (Kolavalli & Vigneri, 2011). Coincidentally, high levels of gold deposits are embedded in the earth crust in the southern part of the country where cocoa production thrives (Aborah, 2014). Consequently, artisanal and small-scale gold mining is presumed to play a key underlying role in dwindling cocoa production levels in Ghana by rapidly reducing the land cover and labor force of cocoa.

This practice considered more lucrative than cocoa farming, has allegedly led several farmers to sell out their farms to miners while most young farmers also out-rightly abandon this form of farming for ready cash, specifically acquired through illegal gold mining (Egyir *et al*., 2015, COCOBOD, 2016). This shift from cocoa farming to artisanal gold mining represents a serious land use or land cover change with potentially

devastating effects on environmental resources and cocoa production in Ghana that needs to be evaluated. Careful analysis of this problem is now critical to achieving sustainable cocoa production in Ghana, and the world at large.

1.2 Problem Statement

According to the 2010 Population Census, the Amansie West District in the Ashanti Region is 96.2% rural and 3.8% urban with limited livelihood opportunities (Ghana Statistical Service, 2014). The availability of arable land in the district highly supports production of food crops and cash crops, particularly cocoa. The district is home to many artisanal miners due to its high deposits of gold (GSS, 2014; Danquah *et al*., 2017), and is considered one of the areas in Ghana most impacted by *galamsey* activities. The district has, thus, experienced considerable environmental, economic and social backlash due to the extreme escalation of *galamsey* by both locals and foreigners (Bach, 2014).

Mining activities are steadily taking over arable farmlands (cocoa farms) causing land degradation and thereby rendering these lands unsupportive of any form of agriculture in the district (Hilson, 2001; Danquah *et al*., 2017). Some farmers sell out their cocoa farms for an amount equivalent to 6.5 years of farming period (Bach, 2014), while a large number of them abandon their cocoa farms and embark on artisanal and small-scale gold mining activities (Hilson, 2001; Boateng *et al*., 2014). These farmers eventually lose their arable lands to mining.

Most of the youth in the cocoa industry are reportedly switching to *galamsey* due to the high labor cost and low returns of cocoa production, which is now a threat to the

sustainability of the industry (COCOBOD, 2016). Another negative effect of artisanal and small-scale gold mining activities is the pollution of the Offin and Oda rivers, which are sources of irrigation for most cocoa farms, through indiscriminate use of mercury (ISSER, 2017). Rajaee *et al*. (2015) also pointed out pollution of land and the atmosphere by immeasurable mercury use in this activity. Danquah *et al*. (2017) observed that the main indicators of livelihood such as social, financial, human, natural and physical resources, in mining communities in the district are highly susceptible to the negative effects of mining activities. Amansie West District is struck by other effects of illegal mining such as outbreak of malaria, open pits that serve as death traps, child labor, school dropouts and prostitution (Hentschel *et al*., 2002; Danquah *et al*., 2017). In spite of the numerous reported and perceived effects, the link between changes in land use/land cover as a result of artisanal mining and cocoa production in the Amansie West district is poorly documented and understood.

1.3 Significance of Study

This research seeks to establish the sustainable co-existence of cocoa and gold in the Amansie West District through careful study of both sectors. Furthermore, in line with the Sustainable Development Goals (SDGs) 1, 2 and 6, the study would highlight on the need to reduce poverty among cocoa farmers, enhance production capacity of cocoa and protect water bodies which are sources of irrigation from the negative effects of gold mining. Most importantly, this study would create awareness on the gradual reduction of land cover of cocoa by artisanal and small-scale gold mining in the district and also bring forth pertinent recommendations as solutions to this serious menace. Information gathered in this research would also be a repository of reference for policy makers and academia.

1.4 Objectives of Study

1.4.1 Main objective

This study determined the land use and land cover change as a result of artisanal and small-scale gold mining and its effects on cocoa production in the Amansie West District of Ghana.

1.4.2 Specific objectives

The specific objectives were to:

1. determine the farmers' typology and their perception on cocoa production trends in relation to artisanal and small-scale gold mining in the district.
2. quantify the changes in land use and land cover in the district for the years 1986, 2007 and 2016 using the Geographic Information Systems (GIS).
3. establish the relationship between artisanal and small-scale land use/land cover changes and cocoa production for the period of 1997 to 2016.

1.5 Research Hypotheses

- Artisanal and small-scale gold mining land use and land cover have increased in the Amansie West District since 1997.
- Increased artisanal and small-scale gold mining land use and land cover have led to a reduction in cocoa land cover and production in the district.

1.6 Limitations of Study

Information acquisition from the institutions was the main limitation to the study due to issues in record keeping. The information given by the institutions could not cover the stipulated period of study (i.e., 1997 to 2016). Information on cocoa production from QCC district office of COCOBOD was made available from 2003 to 2016.

Acquisition of information on the district's gold mined over the period 1997 to 2016 from the Minerals Commission was difficult due to the Commission's distrust of the information from the district. Therefore, the national data from 2003 to 2016, which truly reflect the trend in the district was used.

The satellite image for 1997 of the Amansie West District was difficult to be achieved due to the obstruction of clouds in the Ashanti Region during this period. Instead, that of an appropriate period of 1986 was used.

The current fight against galamsey was also another constraint in getting information from cocoa farmers, who might have been involved in illegal mining or sold their farms to these miners. Most of them were of the fear that giving out the right answers will lead to their arrest. This perception was changed through education of these farmers on the purpose of the visits as being only for academic purposes, and also to their benefit in the long run. This and all other information acquired were used while not distorting the basis of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Artisanal and Small-scale Gold Mining

Hentschel *et al*. (2003) defined artisanal and small-scale gold mining as a form of mining embarked upon by companies, kinsmen, persons and groups mostly done in the informal or illegal sector of the market with nominal or no mechanization. These authors also observed that this form of mining is mostly embarked upon in developing countries such as Ghana, Zambia and the Philippines. The International Labour Organization (ILO) of the World Health Organization (WHO) defined artisanal and small-scale gold mining as being of little or basic modernization but rather of high labour demand and mainly conducted in rural communities where there are few avenues of work.

Hilson (2001) also made the distinction that large-scale gold mining compared to artisanal and small-scale gold mining is mostly done by exploring deep in the earth crust and concession cut out is mostly more than 25 acres. These companies are all legally bound and could mine for a period typically five years or more. Artisanal and small-scale gold mining on the other hand is highly characterised by surface exploration. Again this form of mining is done under poor conditions, with rudimentary materials or low mechanization, with or without a license and also with no sense of environmental sustainability (Minerals Commission, 2015). Small-scale mining is also sometimes done in riverbeds, which is termed alluvial mining. According to Hilson (2001), the alluvial type of small-scale mining is easy and so has a lot of people involved in it.

2.2 Gold Mining in Ghana

Ghana, which was called Gold Coast basically due to its land having high deposits of gold, is the world's second largest exporter of gold after South Africa (Debrah *et al*., 2014). The presence of the Birimian group of rocks, consisting mainly of the paleoprotoerozoic rocks and the Tarkwanian group of sedimentary rocks, makes Ghana important in gold deposition in the world (Hilson, 2001). As observed by Hilson (2001), gold mining in Ghana began 2000 years ago when its colonial masters arrived at the shores of the country. Ghana is endowed with several foreign exchange earning resources such as gold, diamond, manganese, timber, cocoa and coffee. The 2017 investor presentation indicated gold as the most important of these resources because it contributes comparably 44.2 % of Gross Domestic Product (GDP) of $ 37.1 billion (Ministry of Finance, 2017). Based on this, the economic development of Ghana is therefore heavily dependent on gold.

Gold mining is done on both large and small scale. Gbireh et al. (2007) stated that large-scale gold mining is legally embarked upon by multinational companies or with the support of some wealthy countries. These authors made it clear that most of these large-scale gold mining companies such as Gold Fields Ghana Limited and Bogoso Gold Mine do their mining with high mechanisation and also contribute immensely to Ghana's economy. On the contrary, the small-scale mining activities are mainly low mechanised and illegal (Hentschel *et al*., 2003).

2.3 Artisanal and Small-Scale Gold Mining in Ghana

Artisanal and small-scale gold mining centuries ago was not regarded as contributing to Ghana's wealth and so was side-lined. The government upheld large-scale mining

since this form of mining was on a large scale and directly enhanced Ghana's economy. According to Appiah (1998), artisanal and small-scale gold mining on the other-hand was engaged in by the local people who mostly mined with rudimentary equipment such as shovels, pick axes and a pan called the 'krowa'. The author again indicated that gold mined on a small scale was directly sold to the Europeans by these local miners thereby causing a loss of revenue by the Government in this sector.

In 1989, the enactment of the PNDC law 218 propelled the legalisation of artisanal and small-scale gold mining to ensure the state's ownership of the gold mined by the indigenes (Boateng *et al*., 2014). According to these authors, the government instituted a law that no mineral specifically gold should be mined without a license. The Economic Recovery Programme (ERP) established in 1983, with much focus on the large-scale mining was an avenue to modify several mining policies to make mining in the country favourable to these miners (Danquah *et al*., 2017). In addition, Boateng *et al*. (2014) also mentioned that the programme created the avenue to ensure recouping of revenue by the government from the mining sector by exploiting the tax payment system. Per the Minerals Commission some mining policies that were reformed through this programme were the Minerals and Mining Law (PNDC Law 153) in 1986 and in 1989 the Mercury Law (PNDC 217), the Small Scale Gold Mining Law (PNDC Law 218) and the Precious Mineral Marketing Corporation Law (PNDC Law 219).

The three forms of small-scale mining according to Aryee *et al*. (2003) differ based on the position or nature of the deposit being mined. These three methods according to them are shallow alluvial mining, deep alluvial mining and hard rock mining. Again the methods according to the authors can be pursued by most of these small-scale

miners due to the little financial commitment needed. Shallow alluvial mining is mostly embarked upon in valleys and areas close to the ground. It is also notably termed ‘dig and wash’. Alluvial deposits mined in this type of small-scale mining are reached not more than three metres below the earth surface. Most unlawful forms of small-scale mining is done using this method. Deep alluvial mining is mostly done when the mineral deposit is 7 to 12 metres below the earth crust. This is for deposits along key river banks and older river ways where deposits are deeply positioned. In the hard rock mining, the ridge of jagged rock or sand containing the gold deposit can be located on the surface of or deep in the earth crust. Explosives are sometimes used to break hard ores. Gold processing in artisanal and small-scale gold mining for all these methods are the same.

Appiah (1998) outlined the various processes that gold goes through to get it ready to be sold to PMMC or other License Gold Buyers (LGBs). These processes begin with excavation of soil from the earth by a group of people. Some of the soil dug out is then fetched back into the pit and water is poured into the pit. The people then stamp on and mix-up the soil to create a mud. The mud is then fetched onto a hopper which is mounted over a sluice. This is then accompanied with pouring of water over the mud to ensure it runs over the board. The make-up of the hopper allows some of the mineral containing material to be trapped. The trapped mineral material on both the hopper and sluice is then inspected to ensure the gold content is assured and separated. A pan or specifically the local ‘krowa’ is used to contain the gold which is then followed by amalgamation of the concentrated gold using mercury. The compound formed after the amalgamation process also called an amalgam is then burnt on charcoal fire resulting in the pure gold.

2.4 Impacts of Artisanal and Small-Scale Gold Mining in Ghana

2.4.1 Economic impact

Small-scale gold mining in Ghana has employed thousands of people (Hilson, 2001). In this type of mining one need not invest so much as it involves the use of simple and basic tools such as pick axe, pans and shovels. This then accounts for the reason why the level of involvement by people in this enterprise keep increasing even though it contributes virtually 10% to Ghana's gold mining production yearly (Wilson *et al*., 2015). Moreover, Gold mined by small-scale miners has shot up from 6% in 2000 to 23% in 2010 (Tetteh, 2011 as cited by Wilson *et al*., 2015). Danquah *et al*. (2017), pointed out the fact that artisanal and small-scale gold mining continues to be an avenue for quick money, in that people get involved in it for betterment of their livelihoods.

Okoh & Hilson (2011) pointed out the fact that artisanal and small-scale gold mining in most countries such as Ghana is a livelihood enhancer either in the short term or the long term. The authors expatiated on the fact that many people specifically in the rural areas, where there are few opportunities, have the tendency of improving on their livelihoods through this form of mining. They specifically mentioned that through the money got from mining farmers are able to easily buy fertilizers and pesticides to improve on their yield. They further said that gains from mining also helps farmers to pay the school fees of their children and feed their households.

Agriculture sustainability is at risk in Ghana due to its high dependence on mining for its economic development (Egyir *et al*., 2015). The agricultural labour force of the country are affected by various forms of health challenges due to the excesses of mining specifically small-scale mining (Rajaee *et al*., 2015). Aborah (2014) also pointed out

the fact that 54% of the people he interviewed had switched from farming to small-scale gold mining which is evident that the work force of the agriculture sector are dwindling. COCOBOD in 2014 launched the 'Youth in cocoa farming initiative' because most of the youthful cocoa farmers were abandoning this work for small-scale mining, which has the tendency of giving them ready cash (COCOBOD, 2016). Wilson *et al*. (2015) hinted that Ghana is currently underdeveloped and facing a lot of challenges in sectors such as health, education and environment, even though it is noted as important in contributing to gold production in the world.

On considering the micro- and macro-economics, Wilson *et al*. (2015) made it evident that people especially in the rural areas embrace mining either by giving out their arable lands to miners or even involving in it to better their livelihoods. They also pointed out that Ghana, being one of the ten most important countries in gold mining in the world, has the small-scale gold mining industry contributing appreciably to its economy. Through trading of gold from this sector, roads are constructed and other amenities provided in the country. This is also evident in the fact that most mining communities have gained benefits such as schools, pipe borne water and dug-out wells through Cooperate Social Responsibilities (CSR) of most miners. Amankwah & Sackey (2004) expounded that migration from the rural communities has considerably minimised due to most people engaging in the small-scale gold mining activities. According to them the mining industry is also the source of raw materials for several industries such as the jewellery and auto-mobile industries. Furthermore, traders in mining communities get their products bought at high prices due to the influx of foreigners (Bach, 2014).

The trap of the poverty cycle is so evident in the lives of people involved in artisanal and small-scale gold mining and their children (Figure 1). Danquah *et al*. (2017), to buttress the point of Wilson *et al*. (2015) indicated that mining communities in Ghana are highly vulnerable to the effects of mining as compared to non-mining communities. For instance, they observed that human capital of agriculture in the mining areas had a high vulnerability index of 0.6 as compared to 0.14 of the non-mining areas. This high vulnerability in these mining areas they explained, is due to the rapid loss of the human resource from the agricultural sector to artisanal and small-scale gold mining. They again added that this is made possible because the latter provides farmers with readily available income than the former.

The income these idle or partly employed farmers get according to Wilson *et al*. (2015) is meagre in relation to the risky activities they engage in whiles mining. This money obtained is so little to be invested, therefore according to the authors the farmers would have to continually depend on this form of mining due to their inability to purchase the required tools for a higher gold output. They subsequently hire tools from others to mine which makes the poverty recurrent.

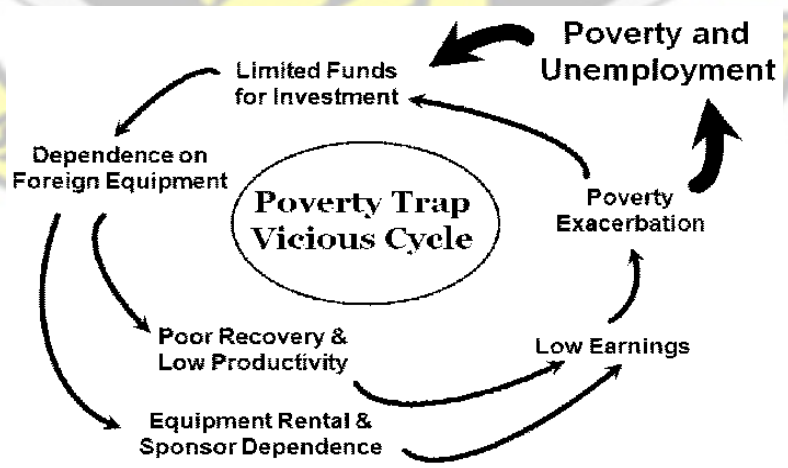

Figure 1. The poverty cycle due to artisanal and small-scale gold mining (Wilson *et al*., 2015, pp. 8140).

2.4.2 Environmental impact

The Minamata Convention on Mercury exposes the effects of mercury which is currently the main compound used in the amalgamation process in small-scale gold mining (UNEP, 2014). Article 7 of the Convention clearly expounds on artisanal and small-scale gold mining activities being devoid of mercury use or being done with reduced levels of mercury. Mercury being a highly persistent chemical is cheap, easily accessible and with a low vapour pressure resulting in its indiscriminate use by small-scale gold miners.

Rajaee *et al*. (2015) with reference to the 2013 Global Mercury Assessment of the United Nation Environmental Programme specified that mercury contributes 37% (727 tonnes) to mercury emission worldwide. These authors again gave the indications of mercury in the elemental (Hg), inorganic salt (HgF_2) and organic (CH_3Hg) forms being injurious to the health of humans and the ecosystem in a whole. They also specifically mentioned that the elemental form of mercury is mainly used by the small-scale gold miners due to its higher tendency of extracting gold from other unwanted materials. Mercury is daily released by small-scale gold miners into streams and land in the liquid form and also the atmosphere in the gaseous form (Bach, 2014). Rajaee *et al*. (2015) further stated that the activities of the artisanal and small-scale miners enhance the mercury cycle (Plate 1).

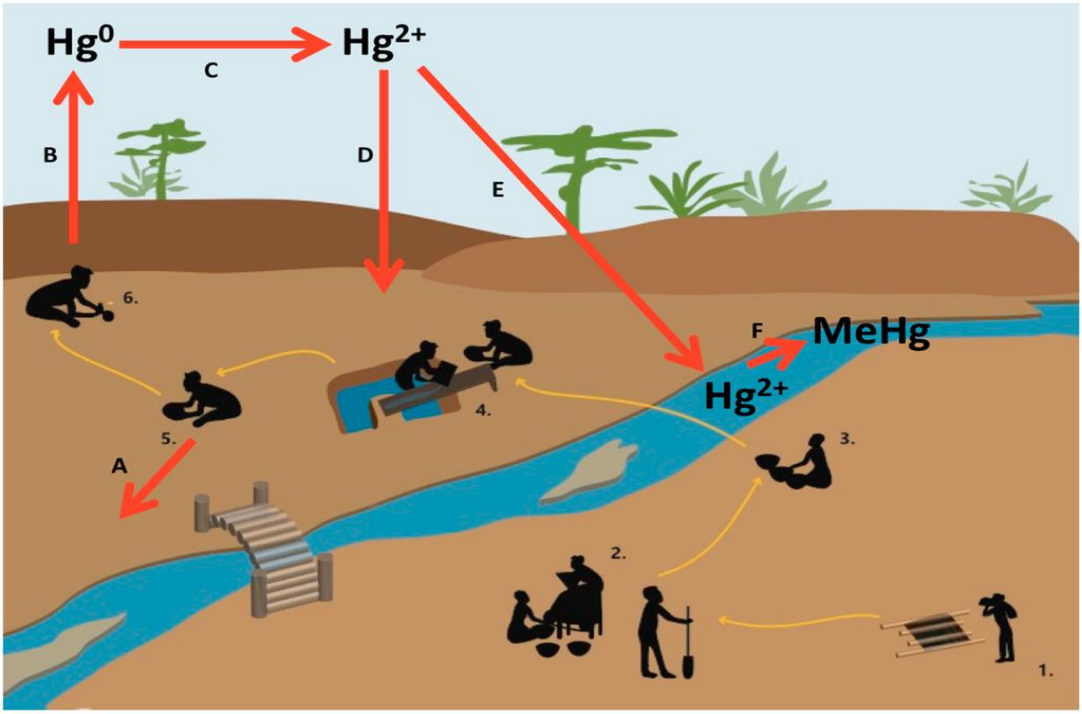

Plate 1. Similarities between artisanal and small-scale gold mining activities and mercury cycle (Rajaee *et al*., 2015). Small-scale mining activities are represented by numbers and the mercury cycle by letters: 1. Digging - a. Amalgamation release Hg to land or streams, 2. Crushing and grinding - b. gaseous Hg to atmosphere, 3. Sieving - c. Metallic mercury oxidized, 4. Sluicing - d. Hydrolysed Hg to the earth, 5. Amalgamation - e. Hydrolysed Hg to water bodies, 6. Burning - f. Hg^{+} converted to CH_3Hg

Aragón & Rud (2012) indicated that many of the woes of the agriculture sector is directly connected to the mining industry specifically the artisanal and small-scale gold mining sector. They observed that the extraction of gold is specifically booming in areas of arable and fertile land. Aborah (2014), in highlighting the thoughts of Aragón & Rud (2012), mentioned the adverse effects of the activities of mining on the health of the farmers. The author also emphasised that issues of air and water pollution by the mines cause farmers involved in these activities or abide in immediate areas close to these mines suffer health problems such as insomnia, skin diseases and fertility issues which makes them unproductive in their work.

Arable land through mining is rendered unsupportive to crop production through clearing of its vegetation, its top soil being dug out and its pollution by heavy metals such as mercury (Aragón & Rud, 2012; Aborah, 2014 & Boateng *et al*., 2014). This eventually results in crops located close to such mining areas having slow or stunted growth (Aragón & Rud, 2012). ISSER in its 2017 post–budget analysis pointed out that most water bodies are destroyed through activities of artisanal and small-scale gold mining thereby reducing the sources of irrigation specifically for cocoa production.

2.4.3 Social impacts

The International Labour Organization (ILO) in its background document on the World Day Against Child Labour (WDACL) described small-scale mining as mainly illegal and labour intensive. This initiative, which is part of its International Programme on the Elimination of Child Labour (IPEC), clearly highlights the fact that illegal small-scale mining is pulling the future leaders of mostly developing countries such as Ghana out of school. This happens because this form of mining employs people with low or no skill and embraces all forms of persons largely children and women. The organization also observed that relatives often forced children into illegal small-scale mining, exposing them to hazards and even death (Plate 2).

Plate 2. Children working at a galamsey site in Ghana (source: Aljazeera America, 2015)

Mining, in general, attracts different people with different ideologies and racial background (Aborah, 2014; Bach, 2014). In general, artisanal and small-scale gold mining is closely related to the art of forceful land acquisition by miners which could be likened to the art of greed (Boateng *et al*., 2014). People will do everything to get a precious stone (gold) due to its relation with wealth which eventually results in several social vices such as armed robbery, prostitution, possession of ammunitions, drug peddling and social unrest (Danyo & Osei-Bonsu, 2016).

Another peculiar issue of societal concern is the conflict between the large-scale miners and small-scale miners (Hilson & Potter, 2005). The authors blamed the Structural Adjustment Programme (SAP), introduced by Government with aid from IMF and World Bank, of favouring the large-scale mining sector against the artisanal and small-scale mining sector. With inference to their study the small-scale miners are of the notion that their lands had being taken over by the large scale miners. This causes them to mine within the concessions of the large scale miners (Hilson, 2001, Plate 3). Which

consequently caused conflicts between the two factions. As a result, Hilson (2001) stated that some large-scale mining companies considering the plight of the small-scale miners allow them to work in a specialized portion of their concessions in a regulated manner. He specified the illegal miners or 'galamseyers' as being the major culprits.

Plate 3: Invasion of Owere mines by illegal miners (ATL FM online news, 2017)

2.5 Legal Framework of Artisanal and Small-Scale Gold Mining

According to Hilson (2001), artisanal and small-scale gold mining before the 1980s was viewed by the government as an unstructured business sector. The author further mentioned that this form of mining was done in an undeveloped and unregulated manner. Government until the 1980s did not give the sector any attention and funding resulting in loss of gold mainly through smuggling and concurrently degradation of the country's environment (Appiah, 1998).

With monetary aid from the World Bank through the Economic Recovery Programme (ERP), Ghana in 1989 formulated the three main policies of artisanal and small-scale gold mining (Minerals Commission, 2013; Danquah *et al*., 2017). The Mercury Law (PNDCL 217) mandates the strict buying of mercury from approved suppliers. The

Small Scale Gold Mining law (PNDCL 218) mandates the Minerals Commission to register artisanal and small-scale mining activities as well as issuing license to such activities. This law ensures issuance of licence to buyers and also mandates the formation of localised support centres in the districts. Lastly the Precious Mineral Marketing Corporation law (PNDCL 219) charges the PMMC to buy and sell gold.

2.6 Artisanal and Small-Scale Gold Mining in the Amansie West District

Amansie West District is one of the 31 administrative districts of the Ashanti Region in Ghana with Manso Nkwanta as its capital (GSS, 2014). The district is endowed with crops such as cocoyam, rice, vegetables and maize (Aborah, 2014). Natural resources of greater economic benefit such as cocoa and gold are also found in the district (GSS, 2014). About 59% of the economic population of district are engaged in agriculture, forestry and fishing while 17 % are miners. The district dwellers mostly engage in these specific occupations among others.

The district is home to most foreign artisanal and small-scale gold miners in Ghana specifically the Chinese (Bach, 2014). Migration to the district from several parts of the country is high, thereby the area has other tribes such as the Ewes, Northerners and other non-native Akans (Aborah, 2014). This is because its land is rich in gold deposits which are mainly in the Tarkwian and Birimian rocks (Hilson, 2001).

Except for Asanko Gold Ghana Limited which is a large - scale mining company, mining sections in this district are mainly the registered small-scale gold miners and the majority being the illegal small-scale gold miners, locally called *galamseyers* (GSS Census, 2010).

2.7 Cocoa Production in Ghana

2.7.1 Ecology of the Cocoa Plant

Cocoa is less resistant to diseases such as the black pod, swollen shoot and capsid infestation (Arę & Gwynne-Jones, 1974). Cocoa is mainly grown by peasant farmers on small holding farms mostly not more than 5 hectares in Ghana and some other West African countries such as Cote D'Ivoire and Nigeria (Essegbey & Gyamfi, 2012). According to Wood (1975), it is mainly grown under slight shade and in soil that is rich in nutrients. Thereby it is grown on the forest floor amidst other plants such as timber and palm oil trees which provide the crop with shade (Plate 4). Its production is affected by bad farming practices, diseases, drought and lack of monetary investment (Schroch *et al*. 2016)

Plate 4. Cocoa plant with pods (Terenzi, 2017)

2.7.2 Ghana's cocoa industry and production trends

In 1870, Tetteh Quarshie travelled to Fernando Po (i.e., present day Bioko in the northern part of Equatorial Guinea) from where he smuggled the Amelonado cocoa seedlings to Ghana in 1879 and began cultivation on a small cocoa farm at Mampong in the Eastern Region of the country (Frankel, 1974). The immense hard work of the Eastern region farmers and the perfect weather condition of the country resulted in the

wide spread of the crop making it a commercial crop (Essegbey & Ofori-Gyamfi, 2012). Consequently, farmers channelled other earnings into the increase production of the crop.

Cocoa currently contributes 17.3% to Ghana's Gross Domestic Product (GDP) of $ 37.1 billion (Ministry of Finance, 2017). It is grown in the southern part of the country, particularly in the semi-deciduous forest areas, where there are high rainfall patterns (Boateng *et al*., 2014). Cocoa production has been the source of income for many farmers in the country especially those in the south (Afari-Sefa *et al*., 2011). According to Frankel (1974), cocoa production in Ghana has been fluctuating over the years. It increased from 80 lbs to 240000 tonnes between 1891 and 1930, making Ghana the highest producer and exporter of cocoa in the world. From the 1930s to the 1960s, the cocoa production rate became constant. Essegbey & Ofori-Gyamfi (2012), revealed that cocoa production levels decreased between the 1980s and the 2000s due to black pod and swollen shoot diseases infestation which resulted in Ghana losing the main authority in cocoa production to Cote D'Ivoire and Malaysia.

In 1983, Ghana incorporated the Economic Recovery Programme aimed at reviving the cocoa industry which resultantly caused an increase in export earnings from 500.0 million US$ in 2001 to 2500 million US$ in 2010 (Essegbey & Ofori-Gyamfi, 2012). The 2016/2017 crop year saw Ghana producing 850,000 metric tonnes of cocoa as compared to the global production level of 4,748,000 metric tonnes (ICCO, 2018). This makes Ghana the second largest producer of cocoa beans in the world market, contributing 20.0% to the world's production levels. In addition, the quality of cocoa beans in Ghana is incomparable in the world (Quarmine *et al*., 2012).

2.8 Cocoa production in Amansie West District of Ghana

The Ashanti region is the third largest region in Ghana, after the Brong Ahafo and Northern regions, with a land cover of 24,389 km^2 in the southern belt of the country (GSS, 2013). The region, characterised by high temperature, rainfall and large forest cover, provides a conducive environment for the production of cocoa and many other crops (Aborah, 2014). It is currently second to the Western region in the quantity of cocoa produced (World Bank, 2011). This is evident as in 2009/2010 cocoa year the Western Region had the highest cocoa production level of 173,110 tonnes followed by the Ashanti Region with 97,310 tonnes. The Ashanti region is made up of 30 administrative districts including the Amansie West, with Kumasi as its capital.

The Amansie West District is also well noted for its good weather conditions that favour cocoa production (GSS, 2014). It is therefore obvious as cocoa plants are seen in all communities in the district.

2.9 Artisanal and Small-Scale Gold Mining and Cocoa Production in Amansie West District

In Ghana today, acres of virgin land (land cover) are being lost to several anthropogenic activities (land use) such as agriculture and mining (Egyir *et al*., 2015). Land use, as defined by Gregorio (2016), is the several processes both biological and physical, found on Earth at a particular time. Gregorio again mentioned that land use also recognizes the various dynamics of processes either natural or man-made that occur on the earth surface and the impact these have on the terrestrial enclave.

Artisanal and small-scale gold mining is a process that to a large extent impacts negatively on cocoa lands in Ghana (Hilson, 2001). This is of great worry because land acquisition is a very important component of cocoa production in the country (Quaye *et al*., 2015). In Ghana, several hectares of cocoa land have been sold to miners whilst some cocoa farmers have been compelled to give out their farms (Bach, 2014; Boateng *et al*., 2014). Subsequently, such cocoa lands are cleared and excavated thereby destroying the natural course of the soil (Aborah, 2014). In the view of Boateng *et al*. (2014), the prior process of clearing land to make way for mining renders most cocoa lands prone to erosion.

Pollution of cocoa lands by mercury used for the amalgamation process is of great worry in cocoa production (Rajaee *et al*., 2015). As noted by these authors, the artisanal and small-scale gold miners use mercury indiscriminately with no regards for its potential to contaminate the soil. As a result, cocoa lands are rendered uncultivable through gold mining processes such as grinding and sluicing of the gold ore (Hilson, 2001; Rajaee *et al*., 2015). The spill over effects of these anthropogenic processes affect to a considerable extent the soil of nearby cocoa farms and eventually causing stunted growth of cocoa on such lands (Aragón & Rud, 2012). Non-reclamation of cocoa lands destroyed by artisanal and small-scale gold miners leaves these lands unsupportive to the cocoa production hence the land cover of cocoa reduced (Boateng *et al*., 2014; Bansah *et al*., 2016). Notwithstanding, water for irrigating cocoa plants are also affected in the process (Snapir *et al*., 2017). Nearby surface water is polluted by mercury and heavy metals such as cadmium and arsenic (Rajaee *et al*., 2015). This type of water would obviously negatively affect the growth of cocoa due to its composition.

Most importantly, labour in cocoa production is dwindling as most of these farmers prefer mining over cocoa farming (Danquah *et al*., 2017). According to these authors, the farmers typically have the notion that artisanal and small-scale mining improves their livelihoods better than farming. Not surprisingly, most youth have shunned cocoa farming and are actively involved in mining for instant cash (COCOBOD, 2016). Other reasons given by these youth for shunning cocoa farming include concerns about diseases, pests, high fertilizer prices, drought, lack of shade, low producer prices and eventually low farmer returns which has made cocoa production unattractive (COCOBOD, 2017).

Cocoa production in the Amansie West District, like other cocoa districts in Ghana, is largely carried out by farmers 50 years and above due to most of the youth having switched to artisanal and small-scale gold mining to better their lot (Dankwa, 2001). Some cocoa farmers in this area sell out their cocoa farms to artisanal and small-scale gold miners at charges which are economically unsustainable (Danquah *et al*., 2017). Another serious issue in this district is the switching of most of the cocoa farmers to artisanal and small-scale mining, thereby the reduction in human capital of the cocoa industry (Boateng *et al*., 2014). Most water bodies in this district according to Aborah (2014) have been rendered unwholesome for irrigation of crops. Most of the lands in the district have been degraded due to artisanal and small- scale gold mining (Bach, 2014) which has reduced their capacity to support crop growth. In general, these illegal artisanal mining processes are severely impacting the cocoa production levels in the district and Ghana as a whole (COCOBOD, 2017).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

This study was conducted in the Amansie West District (longitudes 6.05-6.35^{o} West and latitudes 1.40-2.05^{o} North), one of the 30 districts in the Ashanti Region (Figure 2). With Manso Nkwanta as its capital, the Amansie West district forms ~ 95% of the Antoakrom Official District of the Ghana Cocoa Board (COCOBOD) and also constitutes 5 % of Ashanti Region. Total land area and population of the district is 1230 sq. km and 134,331, respectively (Ghana Statistical Service, 2014).

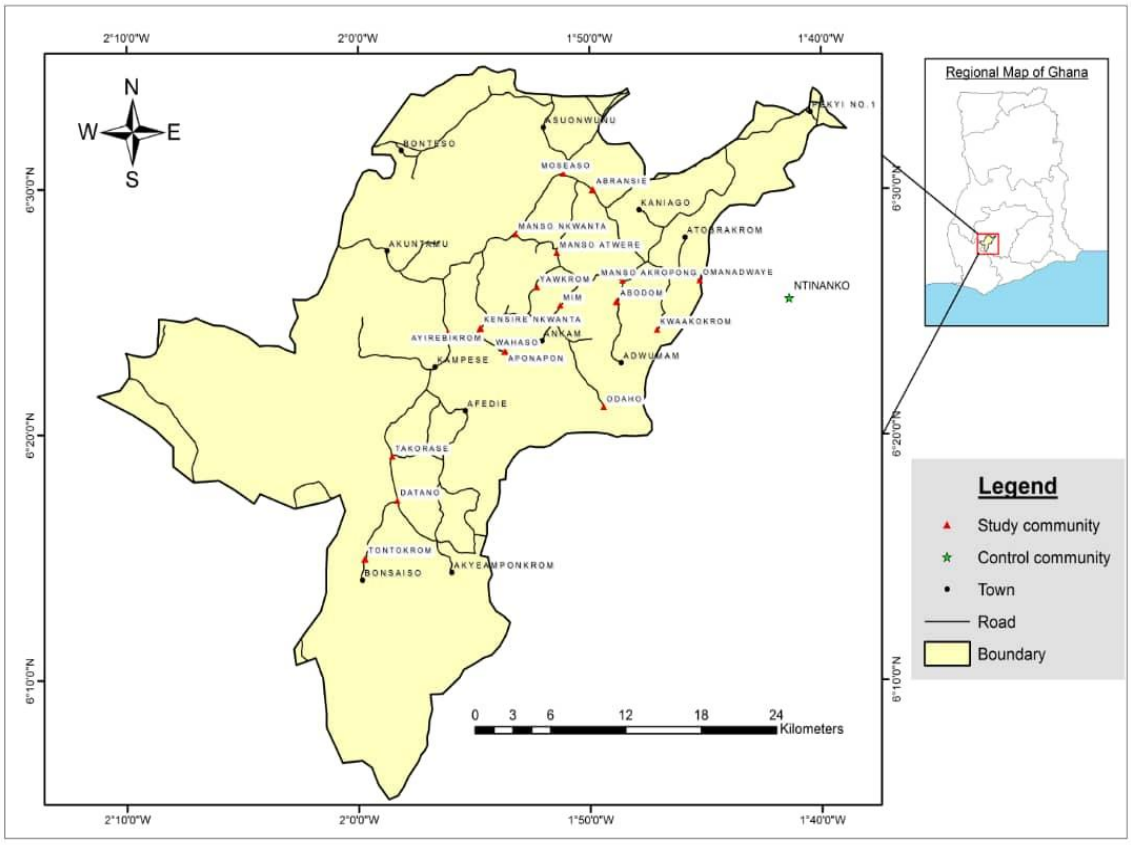

Figure 2: Amansie West District showing the study communities

According to the GSS (2014), average temperature of the area is 27 ^{o}C and major raining season is between March and July while the minor is between September and November. The dry season of the district is from December to March. The district lies within the wet semi-equatorial climate type with a mean yearly precipitation between 855 and 1500 mm. The vegetation is classified as moist semi-deciduous forest, making it a good food and cash crop growing area. More lands are used to grow cocoa than food crops. It is endowed with natural resources such as the Oda River Forest Reserve, Apanprama Forest Reserve, Jimira Forest Reserve, Gyeni River Forest Reserve, Offin River, Oda River and their tributaries (Jeni, Pumpin and Emuna). Inferring from the 2010 Census, it was noted that the primary forest in the area has been degraded through logging, illegal mining practices and bad farming practices.

Mining is the second highest economic activity after agriculture and fishing in the District. Except for Asanko Gold Ghana Limited, mining activities in this district have largely been on small-scale in nature, majority of which are illegal and locally called *galamsey* (GSS, 2014).

3.2 Evaluation of Land Use and Land Cover Changes

Land use and land cover changes were detected and interpreted using remote sensing coupled with Geographic Information System, GIS (Reis, 2008; Mallupattu & Sreenivasula Reddy, 2013). The whole process of data collection in this section was to generate geological maps describing land use and land cover changes in cocoa growing areas in Amansie West District as a result of artisanal and small-scale gold mining. The process begun with the acquisition of the shape file of Amansie West from the Cartography Department of the District Cocoa Health and Extension Division (CHED)

of COCOBOD. This document, which was received in scanned format by experts in the GIS Laboratory of KNUST, was digitized by initial geo-referencing of the scanned image of the shape file. Digitization of the scanned image was necessary to view it naturally (Manjula *et al.*, 2010). The transformed format of geographic features was then made readily available for amendment to ensure effective analysis of the problem statement.

Geo-referencing which precedes the digitization process enabled synchronisation of points in the scanned image with existing geologically referenced data to form a transformed map to change the ambiguous location of the image to the exact topographical locus. Maps formed were then extensively manipulated to visualize accurate land cover and land use changes of the cocoa growing areas as a result of artisanal and small-scale gold mining in the district. The maps were created for the years 1986, 2007 and 2016.

Google Earth was used to verify the topographic attributes of the map. To accomplish this task, 50 points each of the geological features such as forests, settlements, cocoa farms and other vegetation and artisanal and small-scale gold mining sites were picked for verification purposes.

3.3 Determination of the Effect of Mining on Cocoa Production

The effect of artisanal and small-scale gold mining on cocoa production in the Amansie West District was assessed using face-to-face questionnaire interviews. These questionnaires were also used to ascertain the cocoa production levels in the district over the period 1997 to 2016. The structured questionnaires consisting of both opened

and closed-ended questions were developed and administered to relevant institutional institutions in the cocoa sector and cocoa farmers (Appendix 1, 2, 3).

Sampling of the relevant cocoa institutions was done using the purposive sampling approach (Alvi, 2016). Relevant institutions such as the district's Cocoa Health and Extension Division (CHED), Quality Control Company (QCC)) and then Licence Buying Companies (LBCs) specifically Produce Buying Company (PBC) Limited and ECOM Ghana were served with mainly closed-ended questionnaires which were mostly addressed by key informants in the institutions. Both primary and secondary data from these institutions and the Minerals Commission were analyzed to gather enough information on cocoa production and artisanal and small-scale gold mining in Amansie West District from 1997 to 2006 and 2007 to 2016.

As at 2017, the total population of registered cocoa farmers in the Amansie West District was 28,142 (Amansie West District CHED, 2017). These cocoa farmers were found in 250 registered cocoa communities in the district. From this target population, a sample size of 400 cocoa farmers was calculated using the following formula provided by Israel (1992):

$n = N/1 + N(e)^2$,

where: n is sample size; N is total population; and e is the margin of error of 95% confidence interval valued as 0.05

Therefore the sample size of registered farmers

$$N = \frac{28{,}142}{1+28{,}142\ (0.05)^2} = 394 \text{ farmers} \approx 400 \text{ farmers}$$

Based on the calculated sample size, 434 farmers were sampled through the double-staged cluster sampling approach and interviewed through structured closed-ended questions (Alvi, 2016, Appendix 1). The farmers were provided with options to provide other relevant information in the questionnaires. The first stage involved sampling of 20 cocoa communities heavily affected by artisanal and small-scale mining activities in the district (Appendix 4, Figure 2). Subsequently, about 20 cocoa farmers were sampled through the snow-ball approach from each of the initially sampled 20 cocoa communities.

With the assistance of the CHED office, one of the non-mining communities in Amansie West District was identified and purposively investigated as a control site for the study (Appendix 4, Figure 2). The reference community was sampled from 3 non-mining communities in the Antoakrom Official District of the COCOBOD. From this reference community, 21 cocoa farmers were similarly sampled and interviewed with the same structured closed-ended questions used in the mining-affected communities. This helped better envisage the extent of impact caused by artisanal and small-scale gold mining on the land use and land cover of cocoa production in the mining-affected cocoa communities in the district.

The questionnaires administration process to the farmers and institutions took place from 30th January through to 20th February 2018. The mode of transport to these farmers were mostly by motor cycles, taxis and mini buses. In the case of the farmers this process mainly took place in their homes and few times chipped into their meeting agenda. The Akan language was the main mode of communication during meetings with the farmers. Information obtained from the farmers was hand written.

Questionnaires to the farmers and institutions were prepared to provide data on personal information or demographics, cocoa production trends and the relationship between artisanal mining and cocoa production.

3.4 Data Analysis

The data obtained from the study were entered using Epi Data and analysed with Stata Version 12, Microsoft Excel and the R software. Through these soft wares, descriptive statistics were computed. The student t-test was used to ascertain the statistical difference between the means of cocoa produced by the farmers in the district over the two periods 1997 to 2006 and 2007 to 2016. Scatter plots were also used to visualize the relationship between the farm size and cocoa produced by the farmers over the same periods of study. Graphs were generated from data of cocoa produced and gold mined from 2003 to 2016, obtained from COCOBOD and Minerals Commission respectively. This data helped to better appreciate the relationship between artisanal and small-scale mining and cocoa production.

Maps obtained through remote sensing and GIS were visually analyzed and presented, to convey the land use and land cover changes evident in the cocoa communities heavily impacted by artisanal and small-scale gold mining. Fifty (50) geographical points each of forest, settlements, cocoa farms, artisanal mining sites and other vegetation types were picked and superimposed on the GIS maps for accuracy purposes. The pixel by pixel method was used to generate change matrices, for the periods 1986 to 2007 and 2007 to 2016, to help quantify the extent to which artisanal mining had taken over the land cover of cocoa.

CHAPTER FOUR

RESULTS

4.1 Demographic Characteristics of the Respondents

The demographic characteristics of the 434 farmers who were surveyed in the study are presented in Table 1. Majority of the farmers in both mining and reference communities were elderly (i.e., aged 50 years and above). About 66.7% of the respondents in the mining communities belonged to this age group, with 24.9%, 8.1%, 1.2% and 0.2% falling within the age groups of 40-49, 30-39, 20-29 and less than 20 years, respectively. Similarly, a higher percentage (76.2%) of the respondents from the reference community were aged 50 years and above whilst 23.8 % of them were aged 40 to 49 years.

The farmers in the mining communities were mostly males (60.1 %) and married (74.4 %). Again, most of the farmers (43.6 %) had dependents numbering more than nine (9). Those with 4-6 dependents followed at 27.7 % and then those with 7-9 dependents at 20.1 %. Farmers with 1-3 dependents formed the smallest proportion (8.8 %) of those interviewed. Similarly, the reference community was also dominated by males (90.5 %), who also had many dependents to fend for. Majority of these farmers in this community had dependents of 4 to 6 (33.3 %) and 7 to 9 (33.3 %). Those farmers with dependents more than 9 constituted 19.1 % of the sampled population.

Farmers interviewed generally had low level of education, with 18.0 % of those from the mining communities having no formal education while 17.3 % and 55.8 % were primary school and middle school or Junior High School (JHS) leavers, respectively. A small proportion of the farmers were Senior High School graduates (6.7 %) while only

1.8% had obtained tertiary level of education. The level of education of respondents in the reference community followed a similar pattern as in the mining communities.

Clearly, most of the respondents had been involved in cocoa farming for a long time. For the mining communities, 52.1 % had practiced cocoa farming for 20-29 years, 30.0 %, 7.6 % and 2.1 % had been into it for 30-39 years, 40 to 49 years and 50 years or more respectively. However, a small percentage of the respondents (8.3 %) had been cocoa farmers for less than 20 years. Similarly, the reference community had 95.2 % of the respondents who had worked as cocoa farmers for a period not less than 20 years.

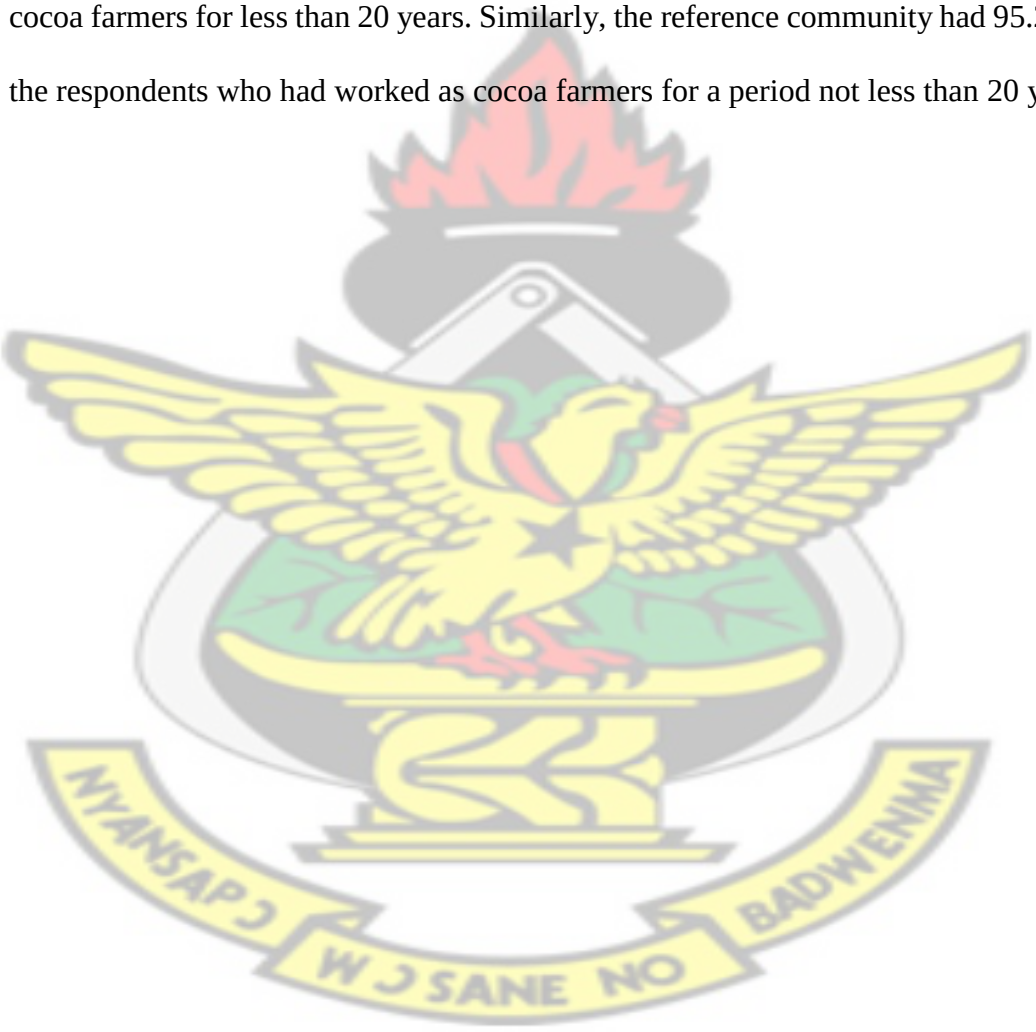

Table 1: Socio-demographics of farmers interviewed in the study.

Variable	Frequency (%)	
	Mining Communities (n=434)	**Reference Community (n=21)**
Age		
Less than 20 years	1 (0.23)	-
20-29 years	5 (1.15)	-
30-39 years	35 (8.06)	-
40-49 years	108 (24.88)	5 (23.81)
50 years and above	285 (65.67)	16 (76.19)
Sex		
Male	261 (60.14)	19 (90.48)
Female	173 (39.86)	2 (9.52)
Marital status		
Single	16 (3.69)	-
Married	323 (74.42)	19 (90.48)
Divorced	43 (9.91)	2 (9.52)
Co-habitant	2 (0.46)	-
Widowed	50 (11.52)	-
Number of dependents		
1-3	38 (8.76)	3 (14.29)
4-6	120 (27.65)	7 (33.33)
7-9	87 (20.05)	7 (33.33)
More than 9	189 (43.55)	4 (19.05)
Education		
No formal education	78 (17.97)	3 (14.29)
Primary	75 (17.28)	1 (4.76)
Middle/JSS	242 (55.76)	15 (71.43)
Vocational/technical	2 (0.46)	-
SHS	29 (6.68)	2 (9.52)
Tertiary	8 (1.84)	-
Number of years as farmer		
Less than 20 years	36 (8.29)	1 (4.76)
20-29 years	226 (52.07)	14 (66.67)
30-39 years	130 (29.95)	6 (28.57)
40-49 years	33 (7.60)	-
50 years and above	9 (2.07)	-

Source: Field survey, February 2018

4.2 Cocoa Farming Practices by Farmers in the Amansie West District

Approximately 43.6 % of the farmers had inherited their lands from their relatives whilst 19.6 % of them bought the lands for cocoa farming (Table 2). Also, 18.2 % of the farmers acquired their lands as gifts, with 17.7 % engaged in share cropping with other persons. Only a small percentage of the farmers interviewed had obtained their lands through renting. In comparison, 38.1 % of farmers from the reference community had acquired their lands by inheritance, 33.3 % had purchased them, whereas 19.0 % had obtained them as gifts. The remaining 10.0 % of the farmers acquired theirs through share cropping. In descending order, 31.6 % of the farmers owned two cocoa farms, 24.7 % four or more farms, 22.8% three farms and then 21.0 % had one farm of their own. Slightly contrasting to the main sample, the reference community had 38.1 % each of farmers who had two and three cocoa farms respectively. Also, 14.3 % of farmers had only one cocoa farm whilst only 9.5 % owned four or more farms.

The size of cocoa farms owned by farmers varied somewhat across the mined-impacted communities and reference community, although most of the people were smallholder cocoa farmers (Table 2). About 59.0 % of the farmers in the mining communities had cocoa farm size ranging between 1-6 hectares compared to 90.0 % from the reference community.

The data showed that majority of the farmers from both the mining communities (74.9 %) and the reference community (90.5 %) sprayed their cocoa farms at least three times a year (Table 2). However, some farmers from the mining communities either sprayed their farms irregularly (41.9 %) or did not sprayed them at all (41.9 %). For the

reference community, many farmers regularly sprayed their cocoa farms (42.9 %) whilst others did it occasionally (47.6 %).

Table 2. Cocoa production practices by farmers in the Amansie West District

Variable	Frequency (%)	
	Mining Communities (n=434)	Reference Community (n=21)
Land tenure system		
Inheritance	189 (43.55)	8 (38.10)
Share cropping	77 (17.74)	2 (9.52)
Outright purchase	85 (19.59)	7 (33.33)
Gift	79 (18.20)	4 (19.05)
Rental	4 (0.92)	-
Number of cocoa farms owned		
One	91 (20.97)	3 (14.29)
Two	137 (31.57)	8 (38.10)
Three	99 (22.81)	8 (38.10)
Four or more	107 (24.65)	2 (9.52)
Size of Cocoa Farm (ha)		
1-3	156 (35.94)	12 (57.14)
4-6	101 (23.27)	7 (33.33)
More than 6	177 (40.78)	2 (9.52)
Often Spray Cocoa Farm/yr		
Once	23 (5.30)	-
Twice	76 (17.51)	2 (9.52)
Thrice	162 (37.33)	7 (33.33)
More than thrice	163 (37.56)	12 (57.14)
None	10 (2.30)	-
Received support from AEO		
Yes and regular	70 (16.13)	9 (42.86)
Yes but not regular	182 (41.94)	10 (47.62)
No	182 (41.94)	2 (9.52)

Source: Field study, February 2018. Numbers in parenthesis are percentage values

Farmers perceived the absence of Agricultural Extension Officers (AEOs) as a huge problem. AEOs visit, according to majority of the farmers (41.9 %) from the mining

communities, was not regular or lacking altogether (41.9 %). Only 16.1 % confidently mentioned that AEOs visited them regularly. Similar patterns of AEOs visitation were observed in the reference community. A small percentage of the farmers interviewed had never seen an extension officer before.

4.3 Farmers' Perception of Effects of Artisanal Gold Mining on Cocoa Production in the District

On the trend of cocoa production in the district, an overwhelming majority (83.6 %) of the farmers from the mining communities perceived a decreasing trend from 2007 to 2016 (Figure 3). For the same period, 13.8 % of the farmers claimed to have observed an increase in production whereas 1.2 % did not see any significant change. Similarly, 85.7 % of the farmers in the reference community observed a decreasing trend in cocoa production over the past decade. Nevertheless, the subsidiaries of COCOBOD ranked cocoa in the district as of very good quality. The district therefore always maintained the position of 1st to 5th in cocoa production level performance in Ashanti Region over the period of study.

Farmers from both the mining-impacted communities and the reference community largely attributed the observed decreasing trend in cocoa production levels in the district to several factors, the most important of which were lack of financial support, pests and diseases, lack of fertilizers and bad climate, in that order (Table 3). Interestingly, the cocoa farmers from the two surveyed areas ranked artisanal and small-scale mining lower among these factors; it was ranked 6th with mean score of 3.80 in the mining communities and 7th with a mean score of 2.04 in the reference community. Obviously,

the farmers' rankings of these factors were generally similar between the two studied areas.

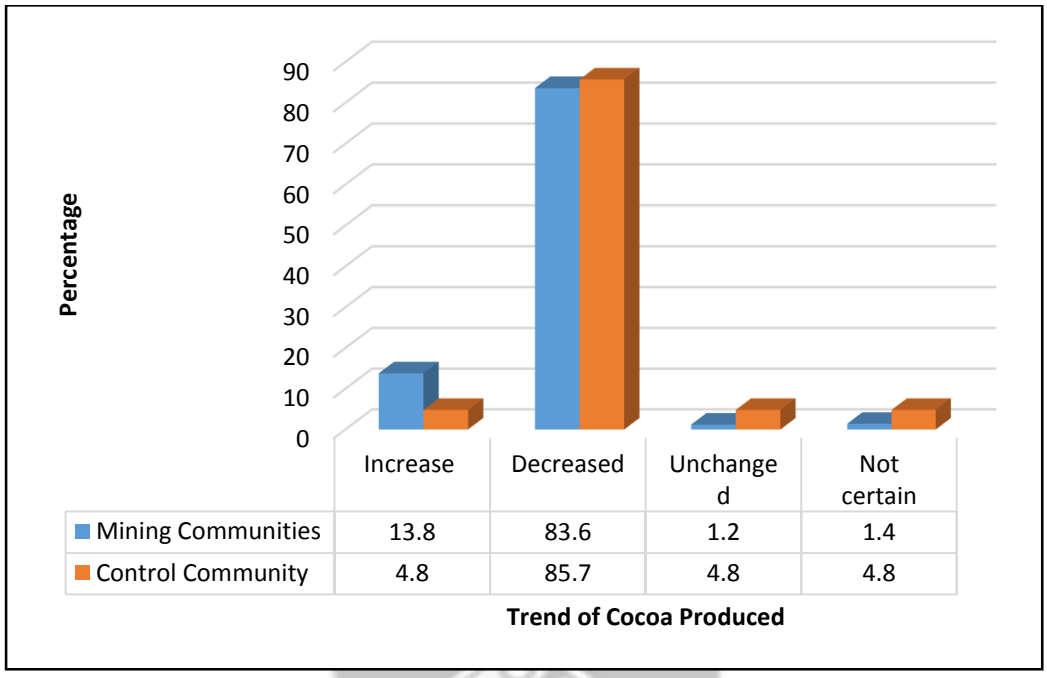

Figure 3: Perception of farmers on cocoa production trends in the Amansie West District, Ashanti (2007-2016)

Table 3: Farmers' perception on factors that negatively affect cocoa production in the Amansie West District

Factor	Mining Communities		Reference Community	
	Mean Score	Rank	Mean Score	Rank
Lack of financial support	4.72	1st	5.0	1st
Lack of fertilizers	4.28	3rd	4.66	3rd
Lack of extension support	3.89	5th	3.95	5th
Inaccessible or inconsistent mass spraying	3.58	7th	3.90	6th
Bad weather/climate	3.96	4th	4.42	4th
Pest and diseases	4.47	2nd	4.85	2nd
Artisanal and small-scale mining	3.80	6th	2.04	7th

Source: *Field study, February 2018*

Only a small percentage of the farmers (9%) had given out their cocoa lands to artisanal and small-scale gold miners in the district (Table 4). The majority of those who gave out their lands cited financial constraints (46.0 %) and compulsion (40.5%) as the main

reasons for their actions, with a small percentage of 13.5% doing so because of inconsistencies in cocoa production. The cocoa farms given out typically ranged between 1 and 5 hectares in size (86.5 %). Most of the farmers received cash amount of more than GH¢9000.00 as compensation for giving out their lands, although a slight majority (54.1 %) of them were not satisfied. Over the period of the study, 11.0 % had freely opted to personally engage in illegal gold mining whilst still engaged in cocoa farming (Figure 4). Most of these farmers (62.5 %) switched from cocoa farming to mining because they were hard pressed with finances and needed to get quick money to support their farms (Figure 5). Also 35.4 % were moved by the inconsistency in cocoa production to put a hold on their cocoa farms and to indulge in artisanal and small-scale mining.

Table 4. Information on cocoa farms given out by farmers to miners.

Variable	Frequency (N=434)	Percentage (%)
Gave out Farm to miners		
Yes	37	9.0
No	397	91.0
Reason for given out farm		
Financial constraints	17	45.95
Compulsion	15	40.54
Inconsistency in cocoa production	5	13.51
Size of cocoa farm given out		
1-5 hectares	32	86.49
6 hectares and above	5	13.51
Amount received for given out farm		
2000-5000	5	13.51
5000-7000	2	5.41
7000-9000	8	21.62
Above 9000	22	59.46
Mode of compensation		
Cash	12	80.00
Given another land	2	13.33
Nothing	1	6.67
If compensated was it satisfying		
Yes	17	45.94
No	20	54.05

Source: Field study, February 2018

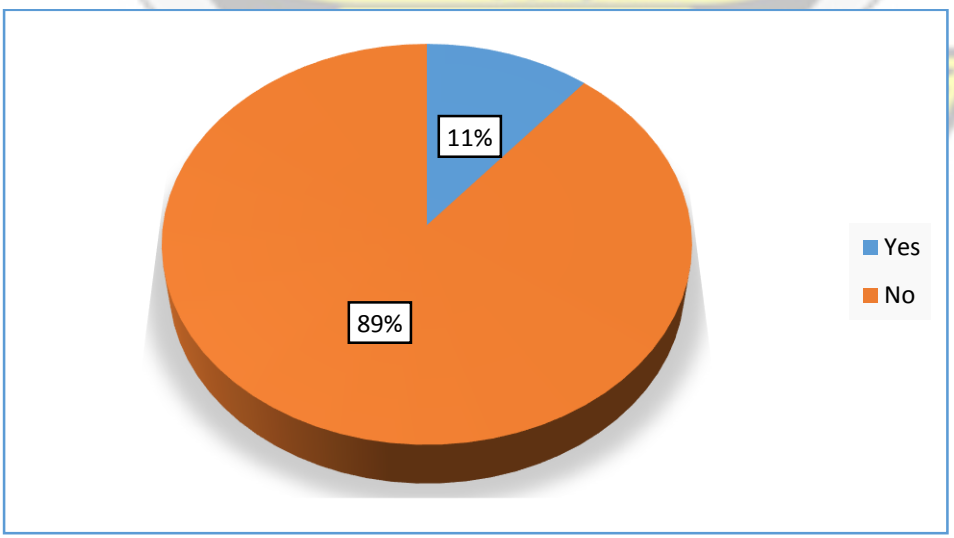

Figure 4: Proportion of farmers switching to mining.

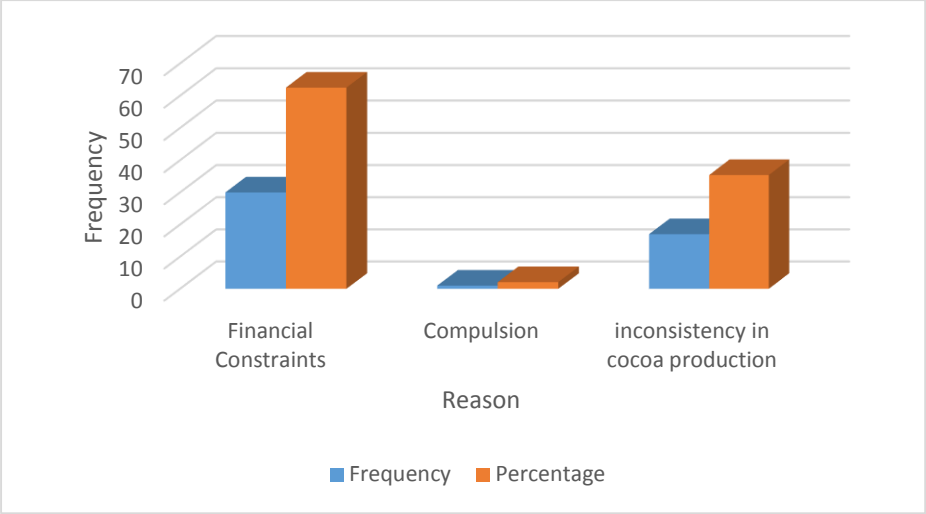

Figure 5. Reasons for switching from cocoa farming to mining

Table 5. Difficulties in land acquisition in the study communities in relation to artisanal mining.

Difficulty	Mining Communities	Control Community
Most lands degraded or rendered infertile	28	14
Lands sold to small-scale miners	6	-
Others	66	-
No difficulty	-	86

Source: Field study, February 2018. Values are percentages

In the mining communities, the cocoa farmers reported degradation of forestland or loss of soil fertility through erosion (28 %) and sale of land for mining (6 %) as two of the most serious difficulties that confront them in respect of land acquisition for farming (Table 5). In addition, a number of farmers (66 %) had other issues such as land disputes and lack of financial capabilities for acquisition of lands, which were expensive due to mining. In the reference community, most farmers (86%) faced no difficulty in land acquisition. The only problem mentioned by 14 % of these farmers was that lands close to some active mining communities were degraded and rendered infertile.

Table 6: Challenges faced by cocoa farmers due to 'galamsey'

Challenges	Mining Communities	Reference Community
Cocoa lands rendered degraded and polluted	22	5
Water for irrigation polluted	30	-
Compulsion in acquisition of cocoa farms by miners	5	-
Poverty	8	-
Poor growth/yield of cocoa plants	12	14
Others	23	-
No challenges	-	81

Source: Field study, February 2018. Values are in percentages

The intensity of the effect of 'galamsey' on cocoa production in the mining communities differed from that of the reference community (Table 6). Majority (30%) of the farmers in the mining communities viewed 'galamsey' as a source of water pollution. Others (23 %) mentioned diversion of paths to their cocoa farms through the creation of deep trenches by these miners as a major challenge that pose a threat to their safety. Some of the farmers (22 %) had their cocoa lands being degraded and polluted by excesses from nearby mining sites. Additionally, 12%, 8% and 5% of the farmers respectively encountered challenges such as poor growth of cocoa plants, poverty and compulsion in acquisition of cocoa farms by miners. Most of the farmers (81%) in the reference community were of the view that 'galamsey' had no effect on their cocoa farms. Others (5 %), nonetheless, claimed that their farms had been degraded or rendered less productive due to the spillover effects of 'galamsey' from the neighboring mining communities.

4.4 Land Use and Land Cover Changes in the Amansie West District

Changes in land use or land cover in the Amansie West District for the past four decades (1986-2016) are presented graphically in Figure 6, with the quantitative estimate of cover provided in Table 7. In 1986, artisanal and small-scale mining was barely

noticeable, covering only 22.95 ha (0.02%) of the land area of the district. The cocoa farms were also sparsely but evenly distributed in the district, covering an area of 55925.4 ha (46.6%). A greater part of the land then was covered by forest, other vegetation and human settlements (spanning 40257.2 ha, 19550.3 ha and 4354 ha, respectively).

By 2007, artisanal mining sites had started glaringly in the northern part of the district, increasing in extent to 51.4 ha at 124 % (Table 8). The area covered by cocoa farms in the district had also increased to 63177.3 ha at 13%, with the other vegetation types increasing slightly to 27927 ha whilst the forest area decreased to 18806.7 ha. The built up areas also increased extensively this year with a land cover of 10,147.4 ha.

Noticeably, in 2016, the total area of land covered by artisanal and small-scale mining in the Amansie West District had increased substantially to 6446.8 ha (5.4%). This change represents an increase of 12442 % (Table 9) relative to the 2007 value of 51.4 ha. On the other hand, cocoa land cover increased only marginally to 64307.9 ha, representing an increase of 1.8 % compared to the 2007 value. The CHED office confirmed this change, by observing that land area of artisanal mining had increased dramatically over the last decade. The land cover of other vegetation also decreased to 10998.4 ha from 27927 ha. The forest slightly increased in land cover from 18806.7 ha to 27125.2 ha. Meanwhile land cover of settlements had also slightly widened from 10147.4 ha to 11231.5 ha.

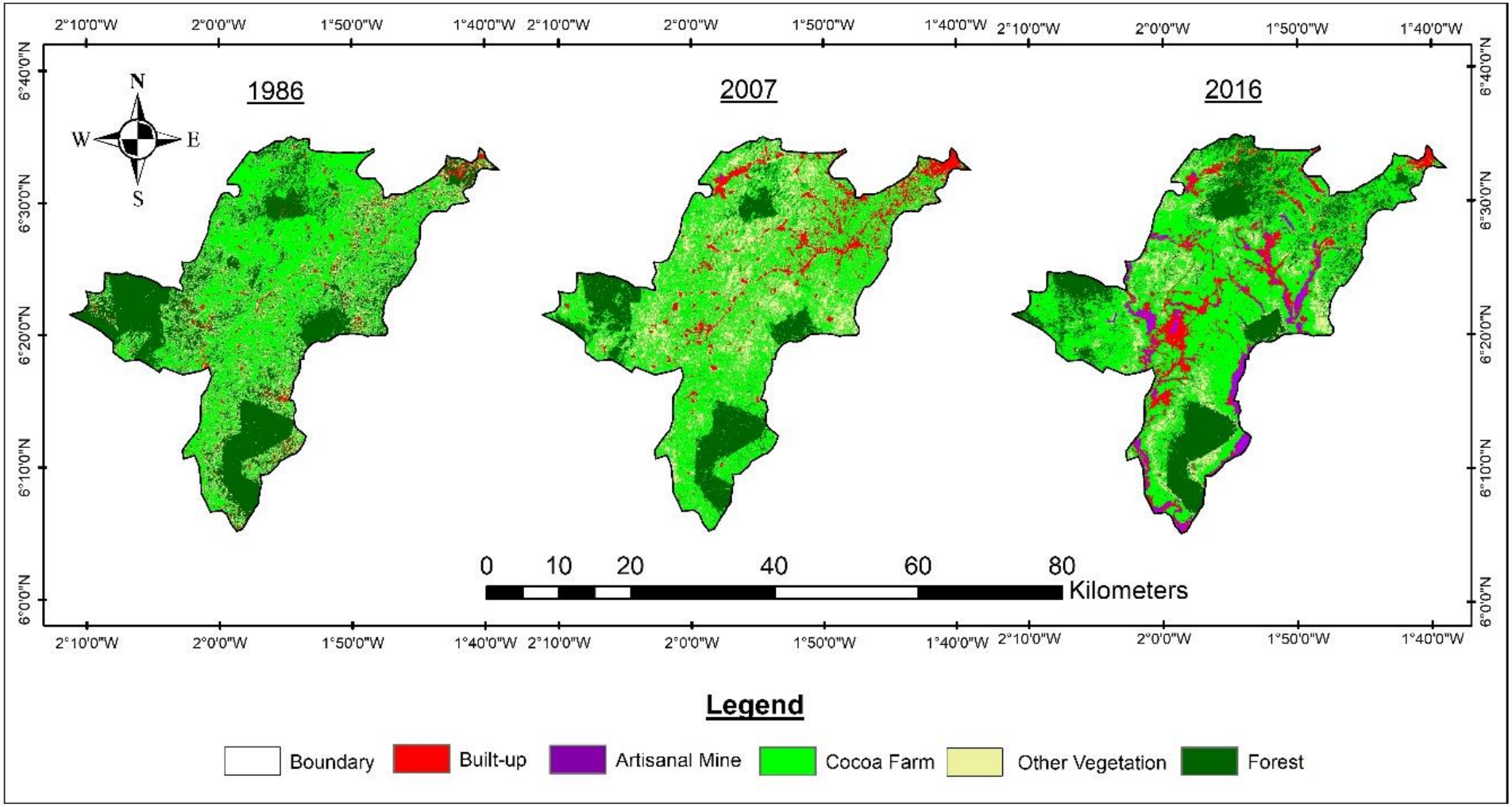

Figure 6: Land use and land cover changes in the Amansie West District of Ghana for the periods 1986, 2007 and 2016.

Table 7: Estimated land cover (in hectares) and land use changes in the Amansie West District of Ghana

Land cover class	1986		2007		2016	
	ha	%	ha	%	ha	%
Settlement	4353.9	3.6	10147.4	8.4	11231.5	9.4
Artisanal mine	23.0	0.02	51.4	0.04	6446.8	5.4
Cocoa farm	55925.4	46.6	63177.3	52.6	64307.9	53.5
Other vegetation	19550.3	16.3	27927.0	23.3	10998.4	9.2
Forest	40257.2	33.5	18806.7	15.7	27125.2	22.6

Change matrices for land use and land cover for the periods 1986 to 2007 and 2007 to 2016 are presented in Tables 8 and 9. Inferring from Table 8, land converted to settlements in 2007 was largely covered with cocoa farms (5416.92 ha), followed by other vegetation (1697.13 ha) and forest (1122.65 ha) in 1986. Artisanal mining covered 51.4 ha of the land area of the district, much of which was had been converted from cocoa farms (41.94 ha). Forest (16574.1 ha) and other vegetation (12660.8 ha) were the top most land cover in 1986 converted to cocoa farms in 2007. Again land converted to other vegetation was mainly covered by cocoa (17640.7 ha) and also forest (4977.68 ha). Finally, reduction (-53.3%) in the forest land cover in 2007 was mainly caused by the further increase in the land cover of cocoa farms (644.76 ha) over the period. Increase in the land cover of vegetation was a factor but with a relatively reduced effect.

Table 8: Change matrix of land use and land cover (ha) from 1986 to 2007

		2007					
Year	**Land cover classes**	**Settlement**	**Artisanal mine**	**Cocoa farm**	**Other Vegetation**	**Forest**	**Total**
1986	**Settlement**	**1904.13**	4.59	1747.8	568.98	128.4	4353.93
	Artisanal mine	6.57	**0.45**	13.5	2.07	0.36	22.95
	Cocoa farm	5416.92	41.94	**32181.1**	17640.7	644.8	55925.42
	Other Vegetation	1697.13	2.34	12660.8	**4737.57**	452.4	19550.27
	Forest	1122.65	2.08	16574.1	4977.68	**17581**	40257.21
	Total	10147.4	51.4	63177.3	27927	18807	120109.8
	Change rate (%)	133.1	124	13	42.8	-53.3	

Table 9: Change matrix of land use and land cover (ha) from 2007 to 2016

Year		2016					
	Land cover classes	**Settlement**	**Artisanal mine**	**Cocoa farm**	**Other Vegetation**	**Forest**	**Total**
2007	**Settlement**	**4162.69**	616.77	4193.46	450.72	723.8	10147.42
	Artisanal mine	14.88	**32.95**	3	0.4	0.17	51.4
	Cocoa farm	5030.82	4043.43	**38417.9**	6751.71	8933	63177.26
	Other Vegetation	1911.6	1644.3	18783.5	**3201.84**	2386	27927.04
	Forest	111.51	109.35	2910.06	593.73	**15082**	18806.65
	Total	11231.5	6446.8	64307.92	10998.4	27125	120109.8
	Change rate (%)	10.7	12442.4	1.8	-60.6	44.23	

Considering the data in Table 9, it is realized that land converted to settlements in 2016 was generally covered by cocoa farms (5030.82 ha) and other vegetation (1911.6 ha) in 2007. Obviously cocoa farms were the majority. On the other hand, land converted to artisanal mining sites in 2016 were mainly covered with cocoa farms (4043.43 ha) and comparatively low with other vegetation (1644.3 ha) in 2007. Similar to the previous period, land cover of other vegetation (18,783.5 ha) was predominant in land converted to cocoa farms in 2016. The reduction in the land cover of other vegetation in 2016 was primarily as a result of increase in land cover of cocoa farms (6751.71 ha). The 44.43% increase in forest cover in 2016 after the decrease in 2007 was possible by forest rejuvenating mostly in areas previously covered by cocoa farms (8933.4 ha) and relatively low by other vegetation (2385.8 ha) in 2007.

4.5 Relationship between Artisanal and Small-Scale Land Use/Land Cover Change and Cocoa Production

The cocoa production and artisanal gold production trends in the Amansie West District for the period 2003 to 2016 appeared to be correlated somewhat (Figure 7). Despite the undulating pattern, cocoa production increased steadily from 10856 tonnes in 2003 to 17528 tonnes in 2010. This pattern was confirmed by the district CHED and QCC offices, who noted that the district had experienced an increase in production over these years. From this peak, however, the cocoa production level in the district drastically reduced within the last decade to 13026 tonnes in 2015 and rose again in 2016 (16175 tonnes) below the highest level attained in 2010. Like cocoa, gold production from the artisanal and small-scale mining sector exhibited an increasing pattern from 221000 oz in 2003, peaked at 1572328 oz in 2013, and decreased to 1031178 oz in 2015 before rising again in 2016.

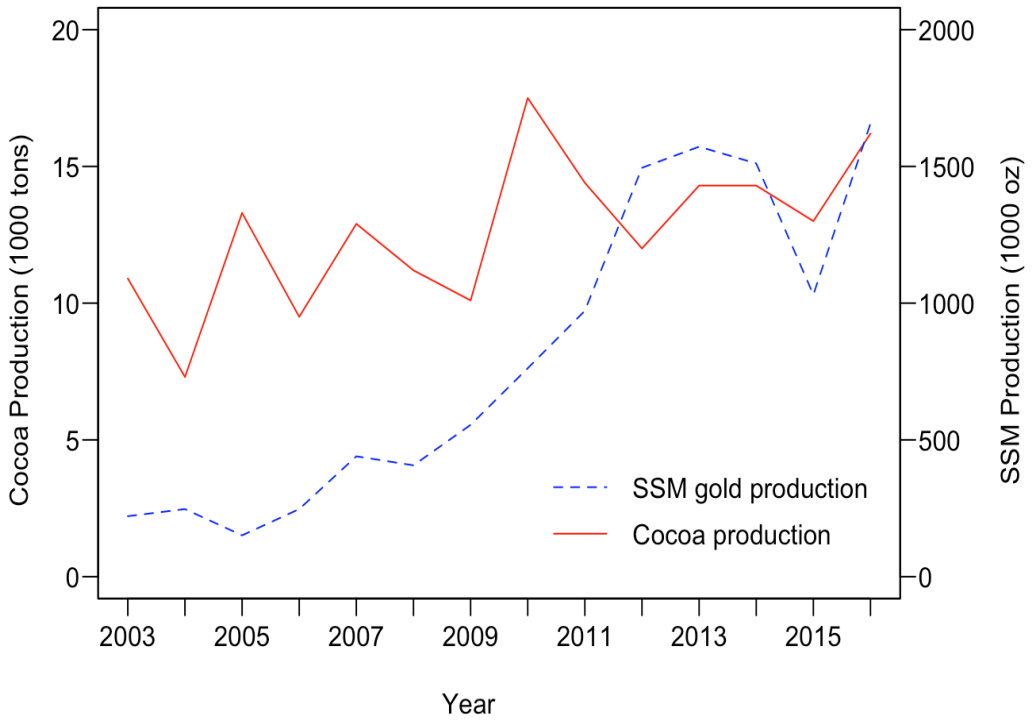

Figure 7: Artisanal and small-scale gold and cocoa production in Ghana (2003-2016)

Data obtained from the farmers confirmed the reduction in the amount of cocoa harvested by the farmers over the last decade described above; significantly lower yields were recorded over the period 2007-2016 (0.80 tons) compared to 1997 to 2006 (1.14 tons; Figure 8). A strong positive relationship was also observed between farm size and quantity of cocoa harvested over the period of analysis (Figure 9).

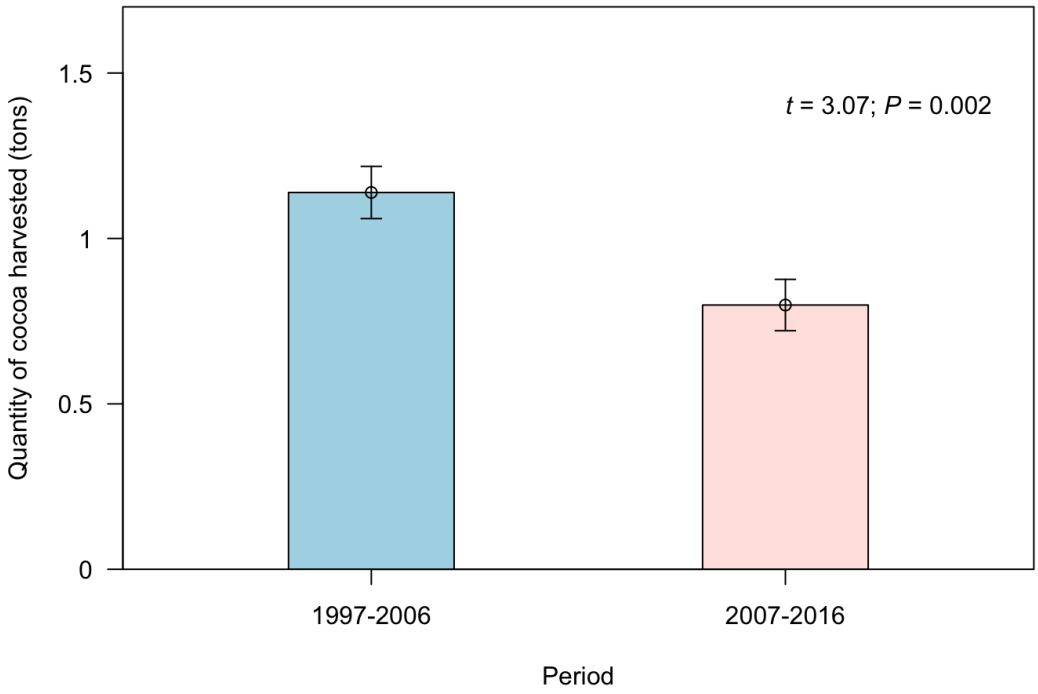

Figure 8: Quantity of cocoa produced by farmers in the Amansie West District compared for the last two decades.

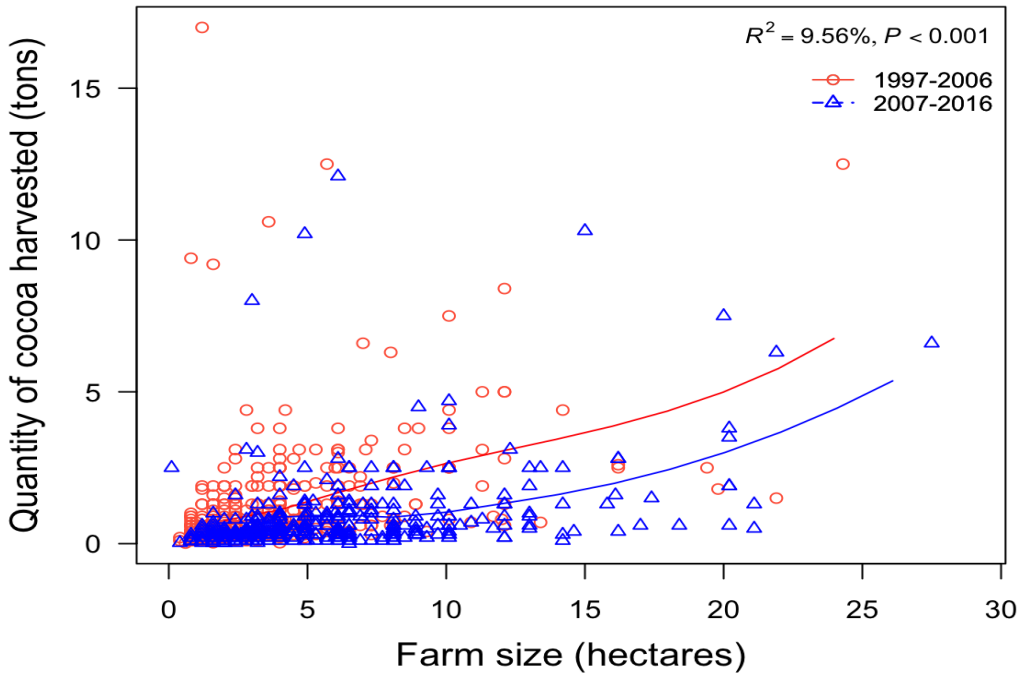

Figure 9: Relationship between farm size and quantity of cocoa harvested by farmers for the two decades

CHAPTER FIVE

DISCUSSION

5.1 Farmer Typology and Perception on Effects of Artisanal and Small-scale Gold Mining on Cocoa Production

The ages of majority of the farmers being 50 years and above revealed the unsustainable nature of cocoa production in the Amansie West District (Table 1). Inferring from Dankwa (2001), cocoa farming could be described as predominately occupied by the elderly with most of them having less strength to forge ahead. Comparatively, younger cocoa farmers (i.e., those aged 15 to 35 years) constituted the minority in cocoa production in the district (Table 1) as they see it to be less lucrative. Most of the youth in the district who are the future of this industry are also not encouraged by the living standards of the elderly cocoa farmers hence their decision to shun cocoa farming and rather indulge mainly in mining.

Gender inequality in cocoa farming is also an important factor that has encouraged most females to enter into gold mining in the district. The males proved to thrive better compared to the females due to the highly tedious and manual nature of the cocoa farming process (Boateng *et al*., 2014; Table 1). Men also get easier access to many benefits such as extension services making the females unsecured in cocoa farming. Thus, most women would rather hire young men to maintain their cocoa farms while they engaged in mining in which they are mainly involved in less strenuous activities such as carrying of ore, sluicing and separation of ore from gold (UNDP, 2016). Despite the unsafe nature of artisanal and small-scale gold mining, these women tend to engage in it to better their livelihoods and to help fend for their dependents.

The cocoa sector can be highly innovative and technologically-dynamic if much emphasis is placed on investment in higher levels of formal education specifically in the rural enclave (Weir, 1999). This was clearly evident in the Amansie West District where most farmers due to low or no formal education (Table 1) appeared to be comfortable with the low-yielding, primitive forms of farming which involves cutlasses and hoes. Encouraging higher formal education for farmers is important because it has the tendency to make them learn and adopt better technologies that could boost the level of cocoa production in the district (Amoah, 2013). Artisanal and small-scale mining is fast attracting these "frustrated" farmers because most activities of this form of mining can be appreciated with low or no education (Hentschel *et al*., 2002). This is the case because mining improves living standards better than engagement in the age-old cocoa production.

Most of these farmers rather personally indulge in mining while still holding on to their farms mostly with the quest to gain some money to provide for their farming needs (Figure 6; Okoh & Hilson, 2011) and that of their families. Cocoa needs a lot of tendering in the form of provision of shade, weeding, pruning, application of fertilizer and insecticides, which needs the outright focus of the farmers to help attain the targeted amount of production in the district. Artisanal and small-scale mining, according to COCOBOD (2017), tends to shift the focus of these farmers from the laid down principles in cocoa farming hence contributing to the decreased yield observed in the district over the period 2007 to 2016 (Figure 3; Figure 8).

Even though land acquisition is not the only important factor in cocoa production, it is pivotal in expanding the cocoa coverage, which invariably influences the production

levels (Quaye *et al*., 2015). As further noted by Quaye *et al*. (2015), better regulation of the land tenure system in Ghana would also increase cocoa production in the country. Consistent with these observations, the current study revealed that a higher percentage of the farmers acquired their cocoa lands by inheritance, which gives them easy access to land. Outright purchase of land also portrayed how these farmers were poised on improving the production level of cocoa in the district.

5.2 Relationship between Artisanal and Small-Scale Gold Mining and Cocoa Production

Cocoa production under normal circumstances is to increase with land cover. This norm is evident from the results of this study, which indicated statistically significant positive correlation between extent of land cover and cocoa produced by the farmers over the periods 1997 to 2006 and 2007 to 2016. Results of the study also indicated that the extent of farm cover accounted for approximately 10 % of the variance in cocoa production. Although not the only factor that affect cocoa yield, changes in land cover (i.e., cocoa farm size) can lead to considerable changes in cocoa production levels (Boateng et al., 2014). Thus, it can be inferred that the decreasing trend in cocoa production observed since 2007 is related to the extent of land cover of cocoa.

The period of 2007 to 2016 had been widely recognized for the escalation in artisanal and small-scale gold mining activities in the country (Boateng *et al*., 2014). The results of this study indicating over 12440 % increase in artisanal land use and cover compared to the previous decade provide strong support for this view. Interestingly, results of this study showed that land converted to artisanal mines were mostly covered with cocoa farms for the two periods. On critical analysis it is realised that the period 2007 to 2016

had a larger proportion of the land covered by cocoa (4043.43 ha) converted into artisanal mining sites as compared to that (41.94 ha) of the previous period. This further means that artisanal mining had to a large extent taken over the land cover of cocoa over the last decade. The results generally suggest a strong negative relation between artisanal land use changes and cocoa production in the district. Mining activities had rendered most arable cocoa farms uncultivable hence farmers were not able to effectively expand their farms and increase their cocoa production level. Most of the forestlands had also been degraded by these miners, rendering them prone to erosion. These mined lands lacked the rich topsoil, were polluted and converted into several patches of pits (Hilson, 2001). These changes remain a threat to cocoa production in the district, despite current interventions to arrest the situation. According to Quaye *et al*. (2015), CHED and other relevant institutions of agricultural land management, on effective management of these lands would, to an extent, secure the future of cocoa. The mining activities also reduce soil moisture levels and pollute water bodies, which serve as sources of irrigation in the dry season.

The land cover of cocoa farms increased appreciably from 1986 to 2007 at 13 %, after which the rate weakened. This probably explains the 21.7 % reduction in cocoa production from 2007 to 2009. The decreasing trend in cocoa production would have been expected to continue in the following years, but for the several interventions including the full enforcement of Hi-Tech, mass spraying programme and construction of good road network in the cocoa communities (Ashitey, 2012). These interventions apparently resulted in the 73.9 % and 19.3 % increments in cocoa production in 2010 and 2012 to 2013, respectively.

Gold production in the country, which is reflective of that of the Amansie West District, sharply increased by 286.3 % from 2008 to 2013. Subsequently there was a slight decrease by 3.9 % in 2014 and further decreased by 31.8 % in 2015 before increasing again in 2016 by 60.7 %. This trend could be attributed to the fight against mining by the inter-ministerial task force in 2013. This task force while decreasing the activities of illegal miners might have also been associated with the increase in cocoa production in 2013, after the drop in 2012, by arable lands being made available to cocoa farmers for expansion of cocoa land cover. The massive drop of cocoa in 2012 after the success attained in 2010 was possible, even with the enforcement of the initiatives mentioned by Ashitey (2012), because the mining factor was present. The production levels of cocoa remained virtually constant from 2013 to 2014 possibly due to the ongoing fight against galamsey, which made it difficult for miners to acquire more cocoa lands. The surge in cocoa production in 2016 likely resulted from the rejuvenation of CODAPEC and Hi-Tech programmes as well as more miners switching back to cocoa farming in light of the existing ban on artisanal and small-scale mining. On the other hand gold production also increased in 2016 due to the laxation of the fight against 'galamsey' in 2015, which allowed the miners to get back into their clandestine and destructive activities.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Majority of farmers in the district experienced a drastic decrease in cocoa produced over the period 2007 to 2016 (0.80 tonnes) as compared to 1997 to 2006 (1.14 tonnes). This was evident as artisanal and small scale mining had claimed a significant percentage of the labour force and land cover of cocoa production over the last decade.

Land cover of cocoa increased from 1986 (55,925.4 ha) to 2007 (63, 177.3 ha) by 13% and slightly increased from 2007 (63,177.3 ha) to 2016 (64307.9 ha) by 1.8%. Concurrently, land cover of artisanal mining increased from 1986 (22.95 ha) to 2007 (51.4 ha) by 124 % and dramatically increased from 2007 (51.4 ha) to 2016 (6446.8 ha) by 12442.4 %. From 1986 (4353.93 ha) to 2016 (11231.5 ha), the settlements, on the other hand, increased by 158 % while other vegetation decreased by 43.7% from 1986 (19550.3 ha) to 2016 (10998.4 ha). Forest cover also decreased by 32.6 % from 1986 (40257.2 ha) to 2016 (27125.2 ha).

There was a statistically significant positive correlation between land use/land cover changes in relation to artisanal and small-scale gold mining and cocoa production in the district for the periods 1997 to 2006 and 2007 to 2016. Also 10% of variance in cocoa production was accounted for by land use and land cover changes over the specified periods.

6.2 Recommendations

With emphasis on the results and findings of the research, the following recommendations are made to help make the cocoa industry more sustainable in spite of the threat from artisanal and small-scale gold mining:

1. Policies and laws on the small-scale mining industry should be amended and enforced to ensure effective regulation of the sector and thereby gradually fade out illegal mining. Concurrently, policies and programmes such as Hi-Tech and mass spraying of the cocoa industry should be effectively enforced to boost the cocoa industry so that farmers, especially the youth, would remain in or be attracted to the industry.
2. Farmers should be actively involved in policy formulation and implementation so that they can feel part of the cocoa industry. This will ensure their loyalty to the sustainability of the cocoa industry.
3. The Government of Ghana (GoG) through COCOBOD should ensure cocoa production inputs such as fertilizers and pesticides are highly subsidized for farmers to enhance effective control of pest and diseases and growth of cocoa for higher yield in the district. This would prevent farmer frustrations and enhance farmer security in the cocoa industry. Farmers would invariably desist from selling out their farms or involving in illegal mining so that they can help sustain cocoa production.
4. Farmers should be taken through effective and continuous education on artisanal and small-scale gold mining and its effects on cocoa production. Education should also place much emphasis on the dangers farmers are likely to encounter as a result of their involvement in this form of mining. This information flow can be through extension visits, social media and workshops.

5. The on-going fight against illegal small-scale mining or ‘galamsey’ in the district should be intensified while reclamation of cocoa farms and other arable lands degraded by small-scale miners should be enforced and regulated by GoG and other relevant stakeholders through public-private partnership.

REFERENCES

Aborah, E. O. (2014). *Effects of small-scale mining on food production in the Amansie West District of the Ashanti Region.* Master's thesis, Department of Development Planning and Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. https://www.knust.edu.gh.

Alvi, M. H. (2016). A Manual for Selection Sampling Techniques in Research. Research Manual. Iqra University, Karachi

Amankwah, R. K & Anim-Sackey, C. (2004). Strategies for Sustainable Development of the Small-scale gold and Diamond Mining Industry of Ghana. *Resources Policy*, Vol. 29. pp. 131-138.Doi: 10.1016/j.resourpol.2004.07.002

Amansie West District Assembly (2012). District Composite Budget for the 2012 Fiscal Year. Ministry of Finance and Economic Planning, Ghana. https://www.mofep.gov.gh.

Amoah, S. K. (2013). *Factors Affecting Cocoa Production in Upper Denkyira West District.* Master's Thesis, Department of Mathematics. Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. https://www.knust.edu.gh.

Appiah, H. (1998). Organization of Small-scale Mining activities in Ghana. The Journal of the South Africa Institute of Mining and Metallurgy, Vol. 98(7). pp. 307-310.

Araǵon, F. M., & Rud, J. P. (2012). Mining, Pollution and Agriculture Productivity: Evidence from Ghana. Discussion Paper, Department of Economics, Simon Fraser University, Burnaby

Arę, L. A. & Gwyne-Jones, D. R. G. (1974). Cocoa in West Africa. Ibadan. Oxford University Press.

Aryee, B. N. A., Ntibery, B. K., & Atorkui, E. (2003). Trends in the Small-scale Mining of precious minerals in Ghana: a perspective on its Environmental impact. *Journal of Cleaner Production*. Vol. (11).pp.131-140

Ashitey, E. (2012). Cocoa Report Annual. Global Agricultural Information Network. Gain Report Number GH 1202, USDA.

Bach, J. S. (2014). *Illegal Chinese gold mining in Amansie West, Ghana: An Assessment of its impact and implications*. Master's thesis, Department of Development Studies, University of Agder. https://brage.bibsys.no/xmlui/handle/11250/222376.

Bansah, K. J., Sakyi-Addo, G. B, & Dumakor-Dupey, N. K. (2016). Post-mining Reclamation in Artisanal and Small-scale mining. International Conference and Exhibition on Advanced and Nano Materials proceedings. pp. 172-179 DOI: 10.13140/RG.2.1. 2559. 7685.

Boateng, D. O., Cudjoe, F. N. Y, & Ofori, J. (2014). Impact of Illegal Small-scale mining (Galamsey) on Cocoa production in Atiwa District of Ghana. *International Journal of Advance Agriculture Research*. Vol. 2. pp. 89-99. https://www. bluepenjournals.org/ijaar.

Cocoa Research Institute of Ghana. (2017). Report on Land Tenure and Cocoa Production in Ghana. CRIG/WCF Collaborative Survey.

Dankwa, J. B. (2001). *Factors affecting adaptation levels of cocoa technologies in the Ashanti Region of Ghana*. Master's Thesis, Department of Agricultural Economics and Extension, University of Cape coast, Cape coast, Ghana. https://www.ucc.edu.gh.

Danquah, J. B., Fialor, S. C., & Aidoo, R. (2017). Vulnerability of Rural Livelihoods to the Effects of Mining: A Case study of Amansie West District of Ghana. International *Journal of Economics, Commerce and Management*. Vol. V (3). pp. 29-55. http://ijecm.co.uk/.

Danyo, G., & Osei-Bonsu, A. (2016). Illegal Small-scale Gold Mining in Ghana: A Threat to Food Security. *Journal of Food Security*. Vol. 4 (5).pp. 112-119. DOI: 101269/jfs-4-5-2.

Debrah, A. A., Watson, I. & Quansah, D. P. O. (2014). Comparison between Artisanal and Small-scale mining in Ghana and South Africa: Lessons learnt and ways forward. *Journal of the Southern Africa of Mining and Metallurgy*, Vol. 114 (11). pp. 913-921

Egyir, I. S., Baffoe-Bonnie, E., Otchere, G. O., Asante, S. A., & Oku-Afari, K. B. (2015). Conference on International Research on Food Security, Natural Resource Management, Rural Development. Humboldt-Universität zu Berlin & Leibniz Center for Agricultural Landscape Research (ZALF).

Essegbey, G. O., & Ofori-Gyamfi, E. (2012). Ghana Cocoa Industry-An Analysis from the Innovation System Perspective. *Scientific Research Journal*. Vol. 3. pp. 276-286.doi:10.4236/ti.2012.34038 or http://www.SciRP.org/journal/ti.

Frankel, J. A. (1974). Cocoa in Ghana: The Cocoa Farmers, the Cocoa Marketing Board and the Elasticity of Supply, MIT. http://www.hks.harvard.ed u/fs/ jfran kel/ cocoa_in_ghana.pdf.

Gbireh, A. B., Cobblah, A. & Suglo, R. S. (2007). "Analysis of the Trends of Gold Mining in Ghana". *Ghana Mining Journal*, Vol. 9. pp. 38-49

Ghana Cocoa Board. (2017). Galamsey Killing Cocoa Industry. https:// www. Ghana web.com/GhanaHomePage/business/Galamsey-killing-cocoa-industry-COCOBOD-CEO-597586.

Ghana Cocoa Board (2016). Ghana Government Policies towards Accelerated Growth in Cocoa Production. Ghana Cocoa Board, Cocoa Market Outlook Conference, London.

Ghana Statistical Service. (2014). 2010 Population and Housing Census: Amansie West District Analytical Report.

Ghana Statistical Service. (2013). 2010 Population and Housing Census: Ashanti Regional Analytical Report.

Gockowski, J., Afari-Sefa, V., Sarpong, D. B, Osei-Asare, Y. B. & Dziwornu, A. K. (2011). Increasing Income of Ghanaian Cocoa Farmers: Is Introduction of Fine flavor Cocoa a Viable Alternative. *Quarterly Journal of International Agricultural*, Vol. 50 (2). pp. 175-200

Gregorio, A. D. (2016). Land Cover Classification System: Classification concepts. Food and Agricultural Organization. Software version 3. www.fao.org/ publications.

Hentschel, T., Hruschka, F., & Priester, M. (2003). Artisanal and Small-scale Mining: Challenges and Opportunities. International Institute for Environment and Development, London. https://www.iied.org.

Hilson, G. (2010). 'Once a miner always a miner': Poverty and Livelihood diversification in Akwatia, *Ghana. Journal of Rural Studies*, Vol. 26 (3). pp. 296-307. https://doi.org/10.1016/j.jrurstud.2010.01.002

Hilson, G. (2001). A Contextual Review of the Ghanaian Small-scale Mining Industry. International Institute for Environment and Development, London. No.76. https://www.iied.org.

Hilson, G. & Potter, C. (2005). Structural Adjustment and Subsistence Industry: Artisanal Gold Mining in Ghana. Development and Change, Vol. 36 (1). pp. 103-131

Institute of Statistical, Social and Economic Research. (2017). 2017 Post-Budget Analysis: Sowing the Seeds for Growth and Jobs Budget, College of Humanities, University of Ghana, Accra, Ghana. Vol. 5.

Israel, G.D. (1992). Determining Sample Size. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Fact sheet PEOD-6.

Kolavalli, S. & Vigneri, M. (2011). Cocoa in Ghana: Shaping the success of an economy. in: P. Chuhan-Pole, M. Angwafo (Eds.), Yes Africa can, World Bank, Washington, pp. 201–217.

Mallapattu, P. K., & Sreenivasula Reddy, J. R. (2013) Analysis of Land Use/ Land Changes Using Remote Sensing Data and GIS at an Urban Area, Tirupati India. *The Scientific World Journal*, Vol. 2013, pp. 1-6. http://dx.doi.org/ 10. 1155/2013/268623.

Mensah, A. K., Maahiri, I. O., Owusu, O., Mireku, O. D.,Wireko, I., & Kissi, E. A. (2015). Environmental Impacts of Mining: A Study of Mining Communities in Ghana. *Applied Ecology and Environmental Sciences*, Vol. 3 (3), pp. 81-94. doi: 10.12691/aees-3-3-3.

Minerals Commission. (2015). Artisanal and Small Scale Mining (ASM) Framework. Annual Report.

Ministry of Finance. (2017). Revitalizing the Economy for Growth and Jobs. Investor Presentation

Mobtaker MM, Osanloo M (2014). Positive Impacts of Mining activities on Environment, In: Legislation, Technology and Practice of Mine Land Reclamation: Proceedings of the Beijing International Symposium on Land Reclamation and Ecological Restoration (LRER 2014), Beijing, China, 16-19 October 2014, CRC Press, pp 3-7.

Okoh, G. & Hilson, G. (2011). Poverty and Livelihood diversification: Exploring the Linkages between Smallholder farming and Artisanal Mining in Rural Ghana. *Journal of International Development*, Vol.23, pp. 1100-1114. DOI: 10.1002/jid.1834

Opoku-Ameyaw, K., Baah, F., Gyedu Akoto, E., Anchirinah, V., Dzahini Obiatey, H. K., Cudjoe, A. R., Acquay, S. and Opoku, S.Y. (2010). Cocoa Manual A Source Book for Sustainable Cocoa Production. Cocoa Research Institute of Ghana, Tafo, Akim.

Quarmine, W., Haagsma, R., Sakyi-Dwason, O., Asante, F. Van Huis, A., & Obeng-Ofori, D. (2012). Incentives for Cocoa bean production in Ghana: Does quality matter? *NJAS-Wageningen Journal of Life Sciences*. Vol. 60-63.pp. 7-14.http://dx.doi.org/10.1016/j.njas.2012.06.009

Quaye, W., Ampadu, R., Onumah, J. & Titiah, A. 2015. Does the Current Land Tenurial arrangement in Ghana incentivize adoption of environmentally sustainable cocoa production practices? A case study of four selected cocoa growing districts in Ghana. *African Journal of Science, Technology, Innovation and Development*, Vol. 7 (4). pp. 265-275. Doi: 10.1080/20421338.2015.1082366

Rajaee, M., Obiri, S., Green, A., Long, R., Cobbina, S. J., Nartey, V., Buck, D., Antwi, E., & Basu, N. (2015). Integrated Assessment of Artisanal and Small-scale Gold Mining in Ghana – Part 2: Natural Sciences Review. *International Journal of Environmental Research and Public Health*. Vol. 12, pp. 8971-9011. doi:10.3390/ijerph120808971

Reis, S. (2008). Analyzing Land use /Land cover changes Using Remote Sensing and GIS in Rize, North-East Turkey. *Sensors*. Vol. 8. pp. 6188-6202.DOI: 10.3390/s8106188

Schroth, G., Läderach, P., Martinez-Valle, A. I., Bunn, C., & Jassogne, L. (2016). Vulnerability to Climate Change of Cocoa in West Africa: Patterns, Opportunities and Limits to Adaptation. *Science of Total Environment*. Vol. 556. pp. 231-241

Snapir, B., Simms, D.M & Waine, T. W. (2017). Mapping the Expansion of galamsey Gold mines in the Cocoa growing area of Ghana using Optical remote sensing. *International Journal of Applied Earth Observation and Geo information*. Vol. 58. pp. 225-233. DOI: 10.1016/j.jag.2017.02.009

Tetteh, K. (2011). An Overview of Ghana's Artisanal and Small-scale Mining (ASM) Sector, Ghana Minerals Commission: Accra, Ghana.

United Nations Development Programme. (2016). Social Analysis of Ghana's Artisanal and Small-scale Mining Sector. Final Report.

United Nations Environment Programme (UNEP). (2014). Minamata Convention on Mercury and its implementation in the Region of Latin America and the Caribbean. Basel Convention Coordinating & Stockholm Convention Regional Centers. http://www.mercuryconvention.org.

Weir, S. (1999). The Effects of Education on Farmer Productivity in Rural Ethiopia. Oxford: Centre for the Study of African Economies, Department of Economics, University of Oxford.

Wessel, M., & Quist-Wessel. (2015). Cocoa production in West Africa, a Review and Analysis of recent Developments. *NJAS-Wageningen Journal of Life Sciences*, Vol. 74-75. pp. 1-7. www.elsevier.com/locate/njas

Wilson, M. L., Renne, E., Roncoli, C., Agyei-Baffour, P. & Tenkorang, E. Y. (2015). Integrated Assessment of Artisanal and Small-Scale Gold Mining in Ghana-Part 3: Social Science and Economics. *International Journal of Environmental Research and Public Health*, Vol. 12. pp. 8133-8156. Doi: 10.3390/ijerph120708133

Wood, G.A.R. (1975). Cocoa. 3rd edition, Longman Scientific and Technical Tropical Agricultural Series. New York.

World Bank (2011). Supply Chain Risk Assessment: Cocoa in Ghana. Ghana Cocoa SCRA Report.

APPENDICES

APPENDIX 1: QUESTIONNAIRE TO THE COCOBOD

A QUESTIONNAIRE ON "CHANGES IN LAND USE AND LAND COVER AND COCOA PRODUCTION IN RELATION TO ARTISANAL GOLD MINING IN THE AMANSIE WEST DISTRICT, GHANA"

Dear Respondent,

The purpose of this questionnaire is to gather information regarding the effect of artisanal gold mining on land use/land cover and cocoa production in the Amansie West District. This particular questionnaire is focused on seeking the views of your prestigious institution on the effect of the artisanal mining on cocoa production.

Information provided in this questionnaire is needed purposely for this academic research. Any data provided will be confidentially guarded.

Thank you. .

Anastasia Comfort Blankson

(MPhil. Environmental Science Student)

Department of Theoretical and Applied Biology, KNUST

Date of Interview……..

Section A: Company/Institutional Information

1. Name of Company (Optional)……
2. Nature of business ……
3. Rank/Position of Respondent……
4. Period of operation in the district <5yrs [ ] 5-9 yrs. [ ] 10-19yrs. [ ] 20-29yrs [ ] 30 and above [ ]

Section B: Cocoa production and Artisanal and Small scale Mining in Amansie West District

5. What is the role of your company in cocoa production in the district?

Export of cocoa beans [ ] Extension services [ ] Seed production [ ] Cocoa Research [ ] Quality Control [ ] Determine producer price [ ] Purchase of cocoa [ ] Any other……

6. What is the trend of cocoa production in the district, (if available)?

Year of production	Qty. Produced
1997-2006	
2007-2016	

7. How do you perceive the cocoa production trend in the district?

Increasing [ ] decreasing [ ] static [ ] Any other……

8. How has the district fared compared to other districts of the Ashanti Region in the quantity of cocoa produced over the period 1996 to 2016, (if available)?

1st -5th [ ] 6th -10th [ ] 11th-15th [ ] 16th -20th [ ] 21stand above [ ]

9. How are farmers in the district equipped to maintain quality of cocoa beans from production to purchase?

Education of farmers [ ] financial support [ ] technological assistance [ ] Any other ……

10. What is the nature of cocoa beans purchase from the district?

Good quality [ ] moderate quality [ ] poor quality [ ] any other ……

11. Please rank the impact of the following factors on cocoa production in the district on a scale of 1-5?

SN	Factor	Rank				
		1 (no impact)	2	3	4	5 (Strong negative impact)
1	Lack of financial support					
2	Lack of fertilizers					
3	Lack of extension support					
4	Inaccessible or inconsistent mass spraying					
5	Bad weather/climate					
6	Pest and diseases					
7	Artisanal and small-scale mining					

12. Please rank the following initiatives according to how they will be more effective in mitigating the effect of artisanal and small scale gold mining on cocoa production in the district on a scale of 1-5?

SN	Initiative	Measure				
		1 (low effectiveness)	2	3	4	5 (high effectiveness)
1	Hi Tech					
2	Mass Spraying					
3	Youth in cocoa programme					
4	Farmer incentives					
5	Stabilization of producer prices					
6	Providing financial support					

13. What has being the extent of land cover of cocoa in the district, if applicable?

Year of production	Land cover for cocoa	Land cover for mining
1997-2006		
2007-2016		

14. How has artisanal and small scale mining contributed to the extent of land cover of cocoa over the period 1996 to 2016?

Highly [ ] moderately [ ] minimal [ ] Any other……

Thank you.

APPENDIX 2: QUESTIONNAIRE TO PRODUCE BUYING COMPANIES

A QUESTIONNAIRE ON "CHANGES IN LAND USE AND LAND COVER AND COCOA PRODUCTION IN RELATION TO ARTISANAL GOLD MINING IN THE AMANSIE WEST DISTRICT, GHANA"

Dear Respondent,

The purpose of this questionnaire is to gather information regarding the effect of artisanal gold mining on land use/land cover and cocoa production in the Amansie West District. This particular questionnaire is focused on seeking the views of your prestigious institution on the effect of the artisanal mining on cocoa production.

Information provided in this questionnaire is needed purposely for this academic research. Any data provided will be confidentially guarded.
Thank you. .

Anastasia Comfort Blankson
(MPhil. Environmental Science Student)
Department of Theoretical and Applied Biology, KNUST

Date of Interview……..

Section A: Company/Institutional Information

1. Name of Company (Optional)……
2. Nature of business……
3. Rank/Position of Respondent……
4. Period of operation in the district <5yrs [ ] 5-9 yrs. [ ] 10-19yrs. [ ] 20-29yrs [ ] 30 and above [ ]

Section B: Cocoa production and Artisanal and Small scale Mining in Amansie West District

5. What is the role of your company in cocoa production in the district?

Export of cocoa beans [ ] Extension services [ ] Seed production [ ] Cocoa Research [ ] Quality Control [ ] Determine producer price [ ] Purchase of cocoa [ ] Any other……

6. As a cocoa buying company, how many communities in the district do you buy cocoa beans from?

> 10 [ ] 11-20 [ ] 21-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ] 61-70 [ ] 70& above [ ]

7. What is the trend of cocoa purchase in the district, (if available)?

Year of purchase	Qty. purchased
1997-2006	
2007-2016	

8. How has the district fared in the produce of quality cocoa for purchase between the periods 1996 to 2016?

Excellent [ ] very good [ ] moderate [ ] poorly [ ] any other ……

9. Please rank the impact of the following factors on quantity of cocoa purchased at farm gate in the district over the period of 1996 to 2016 on a scale of 1-5?

SN	**Factor**	**Rank**				
		1 (no impact)	**2**	**3**	**4**	**5 (Strong negative impact)**
1	Lack of financial support					
2	Lack of fertilizers					
3	Lack of extension support					
4	Inaccessible or inconsistent mass spraying					
5	Bad weather/climate					
6	Pest and diseases					
7	Artisanal and small-scale mining					

10. How has artisanal and small scale gold mining in the district distinctively affected your operations as an License Buying Company (LBC) in the cocoa industry?

Reduced cocoa quality [ ] dwindled quantity of cocoa [ ] reduced land cover of cocoa [ ] reduce number of farmers [ ] any other……

Thank You

APPENDIX 3: QUESTIONNAIRE TO COCOA FARMERS

A QUESTIONNAIRE ON "CHANGES IN LAND USE AND LAND COVER AND COCOA PRODUCTION IN RELATION TO ARTISANAL GOLD MINING IN THE AMANSIE WEST DISTRICT, GHANA"

Dear Respondent,

The purpose of this questionnaire is to gather information regarding the effect of artisanal gold mining on land use/land cover and cocoa production in the Amansie West District. This particular questionnaire is targeted at farmers to seek their views on the effect of the artisanal mining on cocoa production.

Information provided in this questionnaire is needed purposely for this academic research. Any data provided will be confidentially guarded.

Thank you. .

Anastasia Comfort Blankson

(MPhil. Environmental Science Student)

Department of Theoretical and Applied Biology, KNUST

SECTION A: PERSONAL INFORMATION

1. Age:<20 [ ] 20-29 [ ] 30-39 [ ] 40-49 [ ] 50 or above [ ]

2. Community name: …….....

3. Sex: Male [ ] Female [ ]

4. Marital status: Single [ ] Married [ ] Divorced [ ] Co-habitant [ ] Other [ ]

5. Number of dependents: 1-3 [ ] 4-6 [ ] 7-9 [ ] More than 9 [ ]

6. Educational background: Never [ ] Primary [ ] Middle/JHS [ ]

Vocational/Technical [ ] SHS/GCE/A-Level [ ] Tertiary [ ] Other …….

SECTION B: COCOA PRODUCTION TRENDS

7. How long have you been a cocoa farmer? 1-5yrs [ ] 6-10yrs [ ] 11-15yrs [ ] >15yrs [ ]

8. What kind of land tenure system are you involved in?

Share cropping [ ]Outright purchase [ ] Inheritance [ ] Gift [ ] Rental [ ]Any other (Please specify)……

9. How many cocoa farms do you have? One [ ] Two [ ]Three [ ]

Four or more [ ]

10. How large is/are your cocoa farm/farms? 1-3 ha [ ] 4-6ha [ ] >6ha [ ]

11. How has your trend of production been over the past 10 years?

Increased [ ] Decreased [ ] Unchanged [ ] Not certain [ ]

12. Please provide more information on the trend of your cocoa production.

Period	Farm size	Quantity harvested	Farmer returns (Amount accrued)
1997-2006			
2007-2016			

13. How often do you spray your cocoa farm in a year?

Once [ ]Twice [ ] Thrice [ ] More than thrice [ ] None [ ]

14. Do you regularly receive support from Agriculture Extension Officers? Yes and regular [ ] Yes but not regular [ ]No [ ]

SECTION C: ARTISANAL GOLD MINING AND COCOA PRODUCTION

15. Rank the impact of the following factors on cocoa production in your community on a scale of 1-5 (1 no negative impact ….5 strong negative impact).

SN	Factor	Rank				
		1 (no impact)	**2**	**3**	**4**	**5 (Strong negative impact)**
1	Lack of financial support					
2	Lack of fertilizers					
3	Lack of extension support					
4	Inaccessible or inconsistent mass spraying					
5	Bad weather/climate					
6	Pest and diseases					
7	Artisanal and small-scale mining					

16. Have you ever given out your cocoa farm to a small-scale gold miner? Yes [ ] No [ ]

17. If yes, what was your reason for giving it out?

Financial constraints [ ]Compulsion [ ]Inconsistency in cocoa production [ ] Any other [ ] ……

18. What was the size of your cocoa farm when you gave it out for small-scale gold mining? 1-5ha [ ]6-10ha [ ]11-15ha [ ] 16-20ha [ ]20 & above ha [ ]

19. If you personally sold the land, how much were you paid for it?

< GhC2000 -5000 [ ]> GhC5000-7000 [ ] > GhC7000-9000 [ ] > GhC 9000 [ ] Any other [ ] ……

20. If you were compelled to give out your land for small scale gold mining, what happened after that?

Given cash [ ] Compensated with another land [ ] Provided with shelter [ ] Given nothing [ ] Any other (please specify) ……

21. If compensated, was it enough to sustain you and your family? Yes [ ] No [ ]

22. Have you ever abandoned cocoa farming for mining? Yes [ ] No [ ]

23. If yes, what was the reason for the switch?

Financial constraints [ ]Compulsion [ ] Lack of financial support [ ]

Inconsistency in cocoa production [ ]Any other (please specify) ……

24. Which of the following difficulties applies to you with regards to acquiring land for cocoa farming in your community?

Most forest lands degraded by galamsey [ ] Lands mostly sold to small-scale miners [ ] Most lands rendered infertile due to erosion [ ] Any other (please specify) …….....……

25. What are the major challenges you face in cocoa farming due to small scale gold mining in the district?

Cocoa lands rendered degraded and polluted [ ]Water for irrigation polluted [ ] Compulsion in acquisition of cocoa farms by miners [ ] Poverty [ ] Poor growth/yield of cocoa plants [ ] Any other (please specify) ……

26. How long have you encountered these challenges?

10 years now [ ] 20 years now [ ]30 years now [ ] not sure [ ] not applicable Any other (please specify) ……

Thank you.

APPENDIX 4: LIST OF SAMPLE COMMUNITIES

Heavily Mined Cocoa Communities

Manso Abodom	Manso Abransie
Manso Adubia	Manso Agroyesum
Manso Akropong	Manso Aponapon
Manso Atwere	Manso Ayirebikrom
Manso Datano	Manso Kansirinkwanta
Manso Kwaakokrom	Manso Mim
Manso Moseaso	Manso Nkwanta
Manso Odaho	Manso Omanadwaye
Manso Takorase	Manso Tontokrom
Manso Wahaso	Manso Yawkrom

Reference cocoa community

Manso Ntinanko