

**ASSESSMENT OF THE IMPACT OF ARTISANAL GOLD MINING IN
GIDAN MAI WAYO COMMUNITY, NIGER STATE, NIGERIA**

BY

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA**

OCTOBER, 2021

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**A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL
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OF MASTER OF TECHNOLOGY (MTech) IN URBAN AND REGIONAL
PLANNING (ENVIROMENTAL IMPACT ASSESSMENT)**

OCTOBER, 2021

DECLARATION

This thesis titled: **“Assessment of the Impact of Artisanal Gold Mining in Gidan Mai Wayo community, Niger state, Nigeria”** is a collection of my original research work and it has not been presented for any other qualification anywhere. Information from other sources (published or unpublished) has been duly acknowledged.

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CERTIFICATION

This thesis titled: **“Assessment of the impact of artisanal gold mining in Gidan Mai Wayo Community, Niger State, Nigeria”** by: Yahaya Mohammed Shafii (MTECH/SET/2017/7265) meets the regulations governing the award of degree of the Master of Technology of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This thesis is sincerely dedicated to Almighty Allah. He is the provider of all knowledge and laid the foundation of my education and this has been able to bring me to this level.

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The successful completion of my M.Tech Programme as well as the completion of this thesis work is entirely the work of ALLAH. I remain very grateful to HIM. I am grateful to my Supervisor, DR. E. T. UMARU who is also the Head of the Department (Urban and Regional Planning Department) for taking his time to guide me and also read through my manuscript and corrected me accordingly. I am also grateful to Dr. Mohammed. S. L the PG coordinator for his patience and understanding. Also worthy of mention are the entire Lecturers of the department for their advice and guidance.

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ABSTRACT

There are many challenges facing rural areas in Nigeria which serves as obstacles to the livelihood and wellbeing of the rural dwellers. One of the common challenges is informal Gold mining. Gidan Mai Wayo rural settlement experiences environmental degradation due to the activities of Artisanal Gold miners. The community depends on surface and ground water located around the Gold mining sites, which may have negative effect on their health. Consequently, this study assesses the impact of Gold Mining on Gidan Mai Wayo community and its environs. This study adopted quantitative and qualitative approach in data collection and analysis. Boreholes and wells where the residents access their domestic water from were sampled. A set of questionnaire was administered to the residents on their perception of Gold Mining. Another set of questionnaire was administered to the Miners to assess the techniques used by the Artisanal Gold Miners. Mapping, satellite image classification, checklist, and Chi Square Test were employed to assess the physical and social effect of Gold Mining on the environment. Findings from the research shows that pH (Acid or Alkaline) concentration were higher in wells and boreholes close to the Mining sites, compared to those that are not close the Mining sites. The research also shows that some crimes such as Burglary, Drug Abuse, Banditry, prostitution increased in the study area after the emergence of Artisanal Gold Miners. The research concludes that the activities of Artisanal Gold miners in Gidan Mai Wayo community has negatively affected the environment in many ways, for example loss of vegetation, Decrease in water quality. The study therefore recommends that other sources of Rural Livelihood such as; Farming, Fishing, Hunting should be encouraged in the community, so as to discourage the inhabitants from engaging in illegal mining.

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CHAPTER ONE

1.0

INTRODUCTION

1.1 Background to the Study

Mining that is not officially recognized and structured is seen or described as Artisanal Gold Mining (Gwimbi and Nhamo, 2016). This type of mining is mostly practiced in rural areas of Nigeria and other developing countries of the world, where individuals, families or groups engage in various mining activities (Owusu *et al.*, 2019). These Miners engage in Artisanal Gold mining due to slow economic activities and social hardship in their communities.

The Cameroonian Mining Code of 2001, Article 2, describe Artisanal Gold Mining as all the stages involved in exploitations of resources, with the aim of extracting Gold from the ground, with little or no mechanization. This type of mining is usually carried out in rural or undeveloped areas, and they do not use modern machines in their operations, they are basically done in areas where the total mineable reserve are not of large quantity or ignored by the authorities (Gbireh *et al.*, 2009).

Artisanal Gold Mining definitions comprises of the following attributes; unmechanized tools, informal in nature, labor intensive, and poor economy (Hentschel *et al.*, 2003). Precious metals, stones and valuable mineral are all found in Nigeria (Neingo and Tholana, 2016). This is why Artisanal Gold mining has long been practiced in Nigeria, bolstered by historically high Gold prices, a lack of viable alternative livelihoods, The uncontrolled reoccurrence of Artisanal Gold Mining in Northern Nigeria came at a price namely; degradation of the natural environment, lead poisoning of children in Zamfara, due to high

exposure to elemental mercury pollution of air and water to mention but few (Ralph *et al.*, 2018).

Artisanal Gold Mining has impacted negatively on many communities in Nigeria. It is argued that close to about thirteen million individual including women and children in thirty different countries around the world (including Nigeria) are actively involved in Artisanal Gold Mining (Ali *et al.*, 2018). Artisanal Gold Mining relies on the desire of the miners who are willing to work in risky and hazardous environment with the aim of improving their living standard to propagate the activity (Bryceson and Geenen, 2016). This has led to several environmental and social problems.

Unlicensed and uncoordinated mineral Mining is the source of income for many rural communities in Africa and particularly Nigeria. This came with some negative impacts on the settlement and their occupants. Lack of formal practice and regulations in these activities has reinforced these consequences (Neingo and Tholana, 2016). Local and unregulated Artisanal Gold Mining has generated serious concerns on the environment of Gidan Mai Wayo.

This chapter hopes to introduce the research topic, give general overview of the topic and the structure of the research. The next chapter covers review of relevant literatures associated with this topic while chapter three looks at the methodology employed in this research, it will also state the various processes used to gather information about this research, chapter four is analyses of the data and lastly chapter five gives recommendations and conclusion on the research. It is the hope of this research to present a valid argument on how Artisanal Gold Mining affects Gidan Mai Wayo community.

1.2 Statement of the Research Problem

Mining has become popular in Nigeria and other developing countries because of the recent rise in the prices of Gold and other solid minerals and the difficulty with rural livelihood such as agriculture, fishing hunting and other rural activities (Fritz *et al.*, 2018). However, the wealth comes at high price and it has been realized that mining affects the environment no matter where it occurs (Dery *et al.*, 2019). Artisanal Gold Mining is a source of livelihood to millions of people in developing world (Smith, 2019).

Artisanal Gold Mining in Nigeria is informal, and not guided by the existing laws (McKeown & Bugyi, 2016). It is safe to say the current laws regulating the practice on mining in Nigeria covers Artisanal Gold Mining activities but does not provide the avenue for its formalization or a means of structuring it (Bryceson and Geenen, 2016). This form of Gold mining can expose individuals to mercury vapor if not adequately managed (World Health Organization, 2016). Mercury can also be found in contaminated waste in materials in mining sites (Salati *et al.*, 2016). Acute inhalation of mercury can affect the lungs, which results or lead to respiratory disorder (Ogola *et al.*, 2012).

High inhalational exposures of toxic substances from the mines can also lead to respiratory problems and even death (Mantey *et al.*, 2020). Peripheral nerves and kidney can also be damaged (Ahmed, 2018). Children exposed to elemental and inorganic mercury toxicity can develop edematous, red painful, desquamating fingers and toes as well as hypotension (Ralph *et al.*, 2018).

The Artisanal Gold Mining activities are seasonal in their practice and migratory in search of suspected ore, this frequent movement of the miners makes them vulnerable to sexually

transmitted diseases and other high risky behaviors (Mujere, 2015) Some chemicals such phosgene and others are the harmful gases being released by blasting during Artisanal Gold Mining, which is another consequence caused by Artisanal Gold Mining. The use of diesel and petrol machinery in areas without adequate required ventilation results to the exposure of humans to harmful or toxic chemicals (Esdaile & Chalker, 2018).

Artisanal Gold Mining is associated to traumatic injuries such as fractures, burns, impalement, eye injuries and in some cases physical dismemberment and they are usually caused by rock falls during explosions and unprofessional use of Mining equipment (Smith, 2019). Noise exposure from the mining activities is also attached to some health implications; such as difficulty in hearing, stress and heart disease (Ali, 2006). Noise may also lead to sleep deprivation as well as social and behavioral effects for example, persistent annoyance (Scammacca *et al.*, 2020).

However, some studies by Bansah *et al.* (2016), Bose *et al.* (2016), Bryceson and Geenen (2016), Eludoyin *et al.* (2017), Domínguez *et al.* (2019) Esdaile and Chalker (2018), Farrington (2000), Gwimbi and Nhamo (2016), Haile (2017), Hinton *et al.* (2003), Hoadley & Limpitlaw (2004), Boateng *et al.* (2013), McKeown and Bugyi (2016), Obeng *et al.* (2019), Mkpuma *et al.* (2014), Mujere (2015), reveals how Artisanal Gold mining affects the environment and human beings directly but did not reveal how the Artisanal Gold Mining affects the physical and social development of the areas.

The people of Gidan Mai Wayo community depend on surface water and ground water located around the Gold mining site for their daily water needs. The process of extracting the Gold from gangue materials probably has a negative environmental impacts on the surface

and underground water and the general environment. The Artisanal Gold Miners usually carry out their rocks crushing and washing for gold processing in the nearby surface water within study area. The soluble constituents of the materials usually infiltrate into the surface and ground water. Criminal activities in the study area are high due to the presence of Artisanal Gold Mining. Hence there is the need to assess the environmental and social impact of Artisanal Gold Mining in Gidan Mai Wayo community.

1.3 Research Questions

- i. Where are the Artisanal Gold Mining locations in the study area?
- ii. What are the existing Artisanal Gold Mining practices in the study area?
- iii. What is the relationship between crime rate before and after Artisanal Gold Mining in the study area?
- iv. How does Artisanal Gold Mining affect the physical and social environment of the community?

1.4 Aim and Objectives of the Study

1.4.1 Aim

The aim of this study is to assess the impact of Artisanal Gold Mining in Gidan Mai Wayo community.

1.4.2 Objectives of the study

The objectives of this study are to:

- i. Identify the Artisanal Gold Mining sites in the study area
- ii. Evaluate the existing Artisanal Gold Mining practice in the study area

- iii. Examine the relationship between crime rate before and after Artisanal Gold Mining activities in the study area
- iv. Assess the effects of Artisanal Gold Mining on the physical and social environment of the community

1.5 Hypothesis

Null Hypothesis: There is no statistically significant difference in crime rate before and after Artisanal Gold Mining activities in the study area. Alternative Hypothesis: there is statistically significant difference in crime rate before and after the practice of Artisanal Gold Mining in Gidan Mai Wayo.

1.6 Scope of the Study

The main focus of this research is to assess the physical and social impact of Artisanal Gold Mining in Gidan Mai Wayo community and its environs, for the purpose of creating sustainable rural economy. It shall also assess how Artisanal Gold Mining affects rural development in Gidan Mai Yawo community between the year 2008 to 2019. The study area experienced Artisanal Gold Mining boom in the year 2008, which prompt the choice of the year as a baseline year to conduct this study. The study shall cover the entire Gidan Wayo community as at 2019. This research shall also consider surrounding villages bordering Gidan Mai Wayo community.

1.7 Justification for the Study

Mining has negative impact on the environment and the ecosystem at large, these environmental challenges manifest from excavation stage to the final stage of the mining activities (Omotehinse and Ako, 2019). Artisanal Gold Mining has experience rapid increase

in recent years, the rise in solid minerals prices in Nigeria and the rest of the world and difficulty in other rural livelihood such as farming, hunting and others are the reasons for this explosive growth in Artisanal Gold Mining activities (Fritz *et al.*, 2018). This type of mining is basically proven to be a destructive industry if not properly managed, all the components of the environment such as; air and water are not left by this environmental decay, it is also responsible for destruction of human and animal habitat, resulting to loss of biodiversity (Ali *et al.*, 2018).

Liquid mercury is mixed together with suspected ore (Containing Gold) and washed thoroughly during extraction process, this harmful procedure releases elemental mercury to the environment, which is harmful to human health and the environment at large (Smedley *et al.*, 1996). Occupational exposure to mercury has been investigated in several studies, but effects related to its use in Gold Mining have been less addressed (Álvarez, 2000). Artisanal Gold Mining exposes the Miner and the general population to some risks, such as Ergonomic risks, Psychosocial risks, and others these occupational hazards have serious implications to the environment and can or lead degradation of the environment (Domínguez *et al.*, 2019).

The mining technique used by the Artisanal Gold Miners determines the nature and extent of the environmental damage they cause or create, they also pose some certain risk to environment in general, these risk includes but not limited to cutting of trees and digging or excavation of the land, abuse of natural vegetation and exposure of the top soil, erosion, air and water body pollution resulting from the use of mercury during Gold mining processes. With thousands of illegal miners scattered around the country, environmental degradation cannot be avoided (Omotehinse and Ako, 2019).

Artisanal gold mining is associated with many social problems. Reichel (2020) indicates that local populations are marginalized and oppressed, especially those from lower economic classes, by miners. Communities are exposed to chemical contaminants, heat stress, unsanitary conditions, malaria, prostitution, poor diets, drug-taking and alcoholism (Gwimbi and Nhamo, 2016). This study shall identify the relationship between Artisanal Gold Mining and increase in crime rate in the study area and also shows how the Artisanal Gold Mining affects the physical environment in Gidan Mai Wayo community.

1.8 Limitations

The focus of this research work is to address the effects of Artisanal Gold Mining in Gidan Mai Wayo rural community. However, the data needed for this study are response from the residents and the Artisanal Gold Miners. This research work would have been more accurate if the sample size is sufficient and previous research works are available on how Artisanal Gold Mining affects physical and social development of rural areas. This research therefore generates its data from base map of the study area, police records and satellite image classification.

1.9 The Study Area

1.9.1 Location

The study area, Gidan Mai Wayo is in Katcha local Government area, in Niger state, North-central Nigeria and has its headquarters in the town of Katcha. The LGA is bordered by the Gbako, Bosso, Mokwa, Agaie, Bida, and Lavun LGAs. A number of towns and villages make up Katcha LGA and these include Badeggi, Katcha, Essa, Bisanti, Kataeregi, Gbakogi, Sidi Saba, Bakeko. The estimated population of Katcha LGA is put at 122,497 inhabitants with the vast majority of the area's populace made up of members of the Nupe ethnic affiliation.

The Nupe Language is predominantly spoken in the area while the religions of Christianity and Islam are commonly practiced in the area (Mohammed *et al.*, 2010).

Katcha is blessed with many valuable minerals including Gold, which is the reason for the presence of mining activities in the area. Trade also flourishes in the LGA with the area hosting a number of markets such as the Ndalada market where a wide variety of commodities are bought and sold. Other important economic activities engaged in by the people of Katcha LGA include woodcarving, animal rearing, and leather works (Ojukwu *et al.*, 2016).

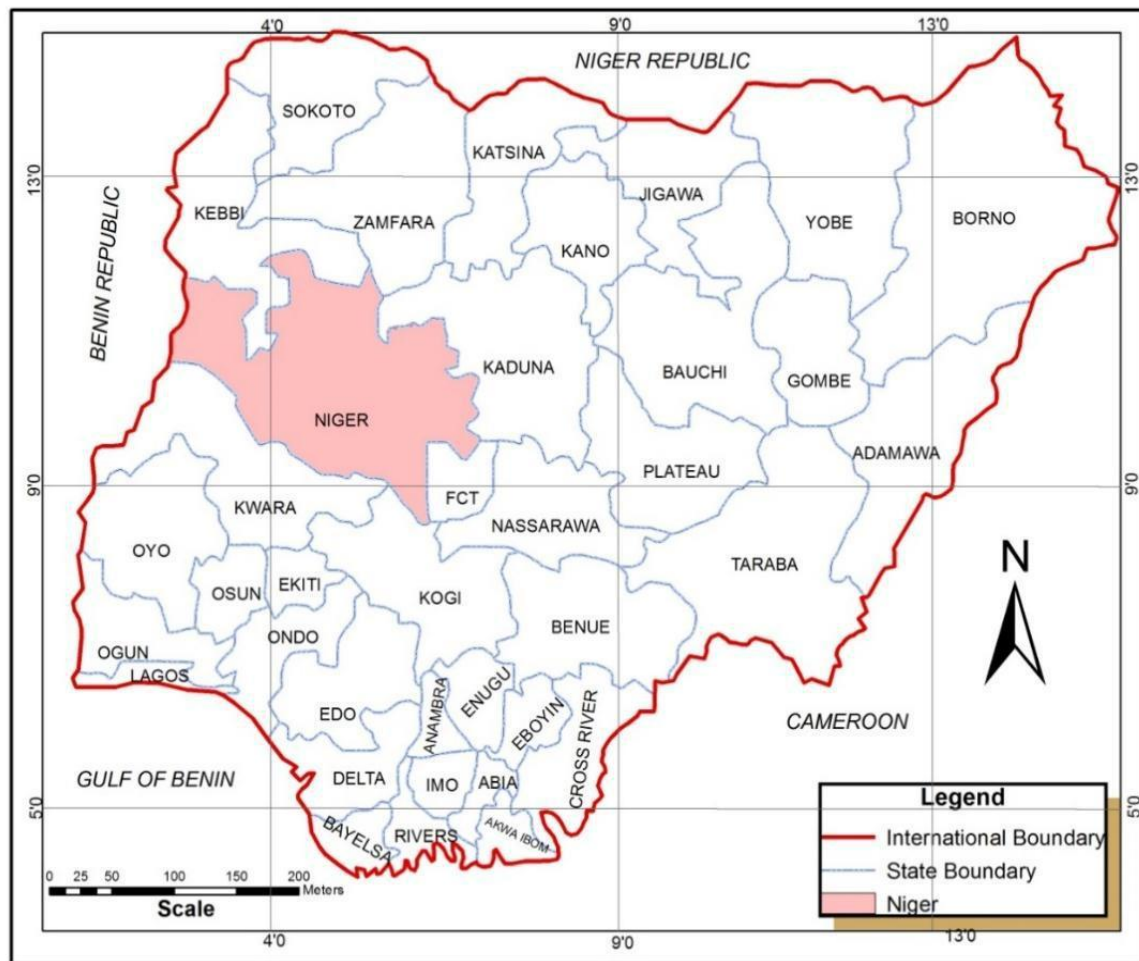


Figure 1.1: Location of Niger State in Nigeria

Source: Abubakar, 2017

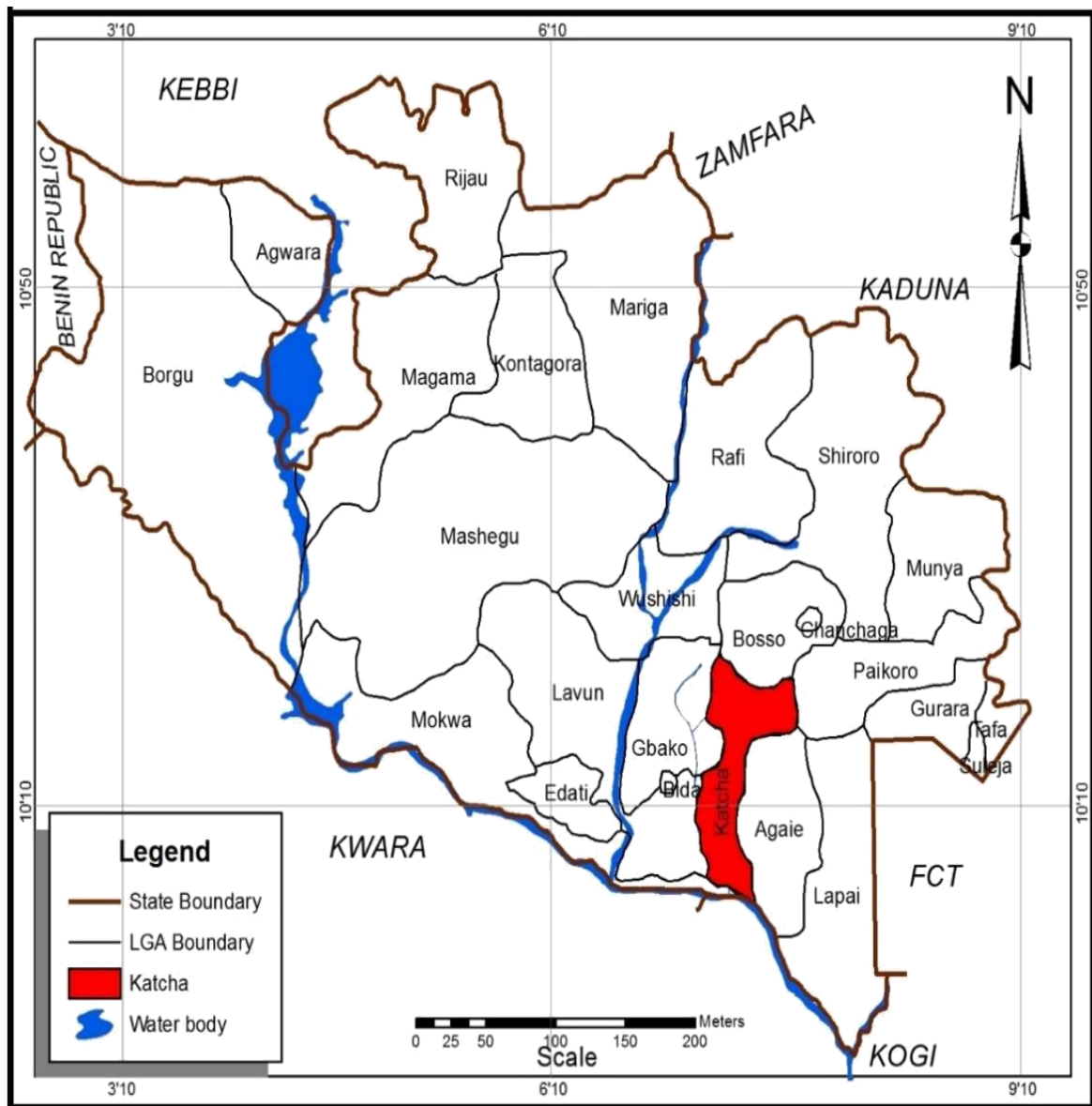


Figure 1.2: Map of Niger State showing Katcha Local Government Area
Source: Abubakar, 2017

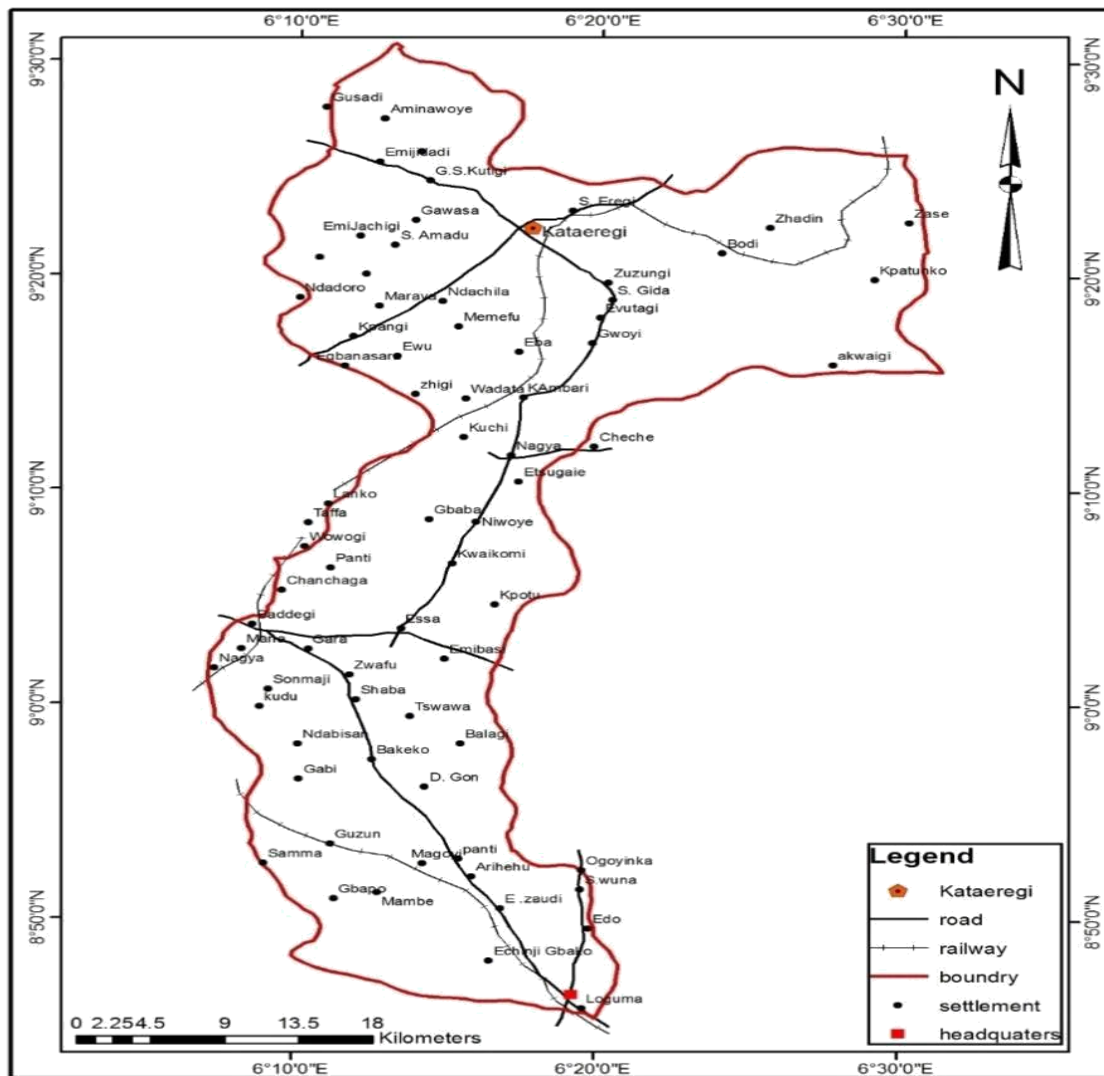


Figure 1.3: Map of Katcha showing the Study Area
Source: Abubakar, 2017

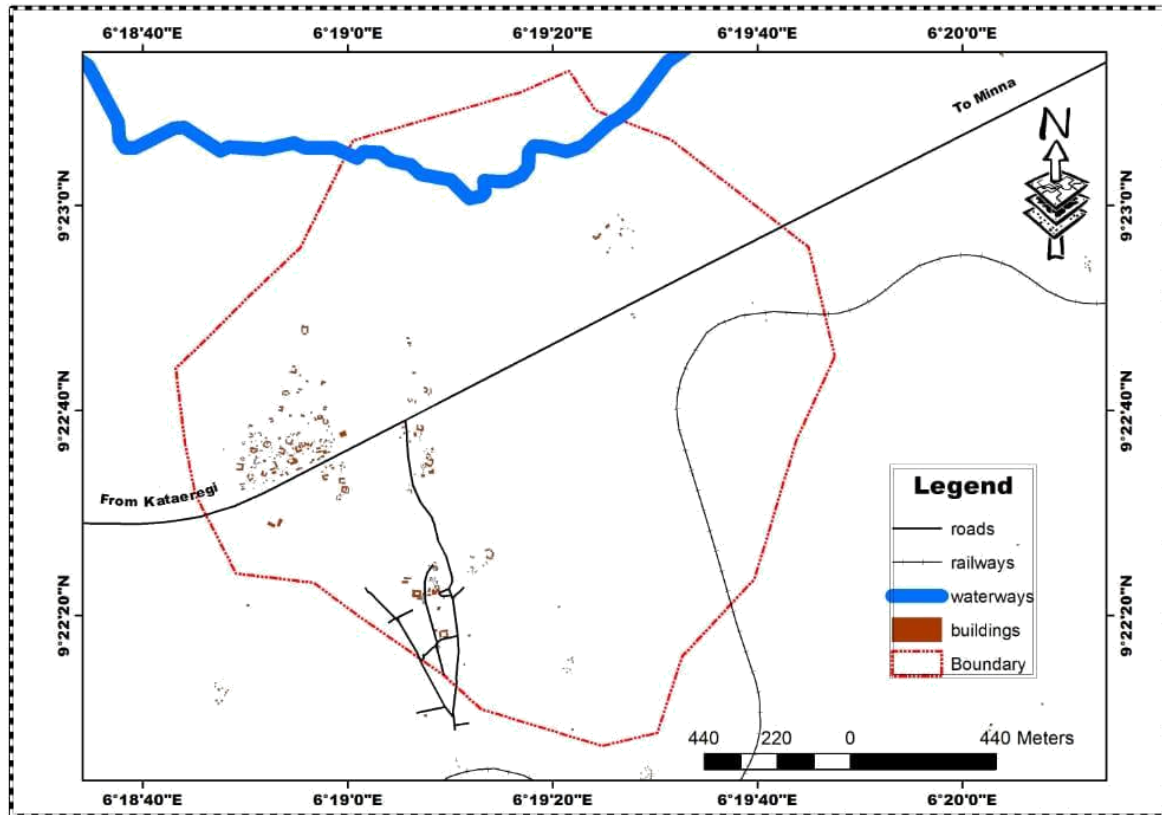


Figure 1.4: Map of the Study Area
Source: Author's Fieldwork, 2019

1.9.2 Population

The population of Gidan Mai Wayo is heterogeneous in nature, consisting of different tribes from all over the nation. Based on 2016 national population commission data, the population of Gidan Mai Wayo is 610. (National Population Commission)

1.9.3 Geology and topography

The structure and shape of Gidan Mai Wayo rural settlement is the same with most parts of Northern Nigeria, which belongs to the Basement complex. The study area consists of various hard Rocks, that is metamorphic granite rock. The area has deposits of gravels and stones scattered around (Abubakar, 2017).

1.9.4 Climate

As a typical middle belt community, Gidan Mai Wayo community experience a definite wet and dry season. The duration of wet season last for about 200 days, starting mid-April to the end October. (Onyekuru and Marchant, 2012). The harmattan (cold) wind ushers in the dry season, March and April is the hottest in preparation of another season. March records the highest temperature of about 37.1⁰c. Gidan Mai Wayo though hot, is blessed with moderate climatic conditions almost throughout the year. As a result of the climate being the tropical in nature, the sunshine duration ranges between eight – ten hours a day and ranging from about 30°C - 37.0°C annually with the highest temperature recorded in the month of march. However, the marked increase in cloud cover during the months of July, august and September makes the hours of sunshine per day, drop sharply to an average of about four hours (Pius, 2017).

The middle of March is the normal onset of rain. The middle of October to early November is the end of the raining season. Consequently, the duration of the rainy season varies from about 190 days to 240 days amounting to annual mean rainfall approximately 1,650mm per annum. The month of July to September records about 60 percent of the annual rainfall. The beginning and the end of the season is known for frequent occurrences of squall lines. This is a weather condition that is heralded by the occurrence of Cumulus-nimbus cloud. It is accompanied with high lightning and thunder, followed by strong wind and high rainfall (Alabi, 2012).

The humidity of the town rises everywhere during the rainy season and falls inseparably during the dry season within the town. In the afternoon relative humidity of the town cloud

rise above 60 percent during the rainy season and fall to as 30 percent during the dry season (Idris *et al.*, 2015).

1.9.5 Vegetation and soil

Gidan Mai Wayo lies in vegetational zone of Guinea savannah. The zone is mostly covered by grassland and trees (Agada *et al.*, 2016) Urbanization in the area has seriously changed the natural local vegetation in some parts of the community. The most common plants in the community include; Filhu, neem trees and shear butter tree (Alabi, 2012).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical/Conceptual Framework

2.1.1 Growth pole theory

Francois Perroux in the 1950s authored this theory. He built the theory on the basis of economic growth in different regions, his argument was that development or growth is not uniform in different places but has different degrees of intensity in different points or poles, and they move via different means and its final outcome for the state of economy is different in different regions (Komarovskiy and Bondaruk, 2013). Komarovskiy and Bondaruk (2013) sees growth pole theory as a business entity (company or Industry) or a set of different units and these units are the forces that drive economic development, and the input-output linkages are responsible for these growth.

However in relation with the theory of growth poles, there have been cases of economic growth which happens in the region without growth pole, which translate that the presence of growth is not essential to economic growth (Gavrilă *et al.*, 2017). Development of regions that depends on growth pole strategy in developing countries came to light in the 1960s especially in the Latin American regions (Speakman & Koivisto, 2013). After the failed application of the growth pole theory the concept dwindled by the 1970s (Gavrilă *et al.*, 2017).

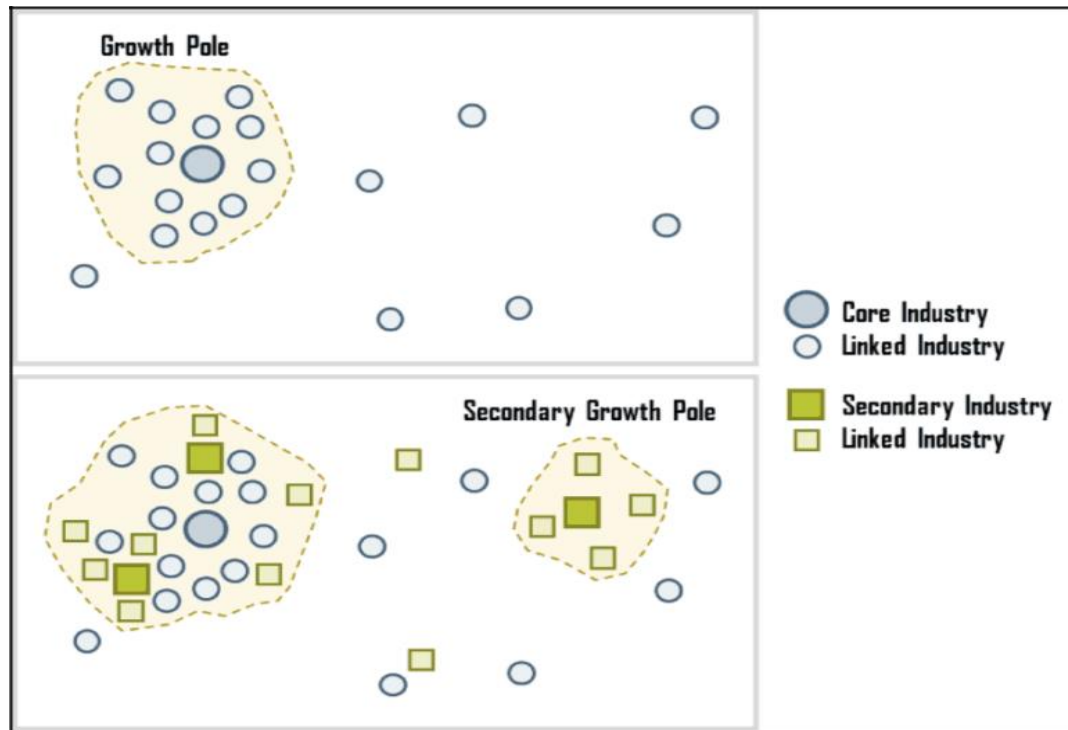


Figure 2.1. Representation of growth pole

Source: Celikyay, (2007)

2.1.2 Relevance of growth pole theory to this study

The argument of Francois Perroux (1903–1987) which states that development is not the same in various places but the development has different levels of severity at different poles or point, and the spread through various channels and its end outcome for the condition of the economy is different in different places cannot be over emphasized, because regional development is uneven in Nigeria and other developing countries of Africa, Gidan Mai Wayo is lagging behind in terms of infrastructural facilities and the available ones are deteriorating as a result of environmental degradation caused by the Artisanal gold miners (Farrington, 2000). The theory attempt to explain why some regions do not develop at the same rate with other regions.

2.2 Concept of the Environment

The environment consist of many variables, which surrounds man as well as other organism (Celikyay and Uzun, 2007). The environment also includes water, air and land and the interrelationships which exist among and between water, air and land and human beings and other living creatures such as plants, animals and microorganisms (Patten, 1997). The natural environment consists of four interlinking systems, namely; the atmosphere, the hydrosphere, the lithosphere and the biosphere. These systems are always in constant change and such changes are affected by human activities and vice versa (Celikyay and Uzun, 2007).

2.2.1 Environmental degradation

Environmental degradation can be traced back to human civilization, little attention has been given to the environment until 1972 United Nations Conference on the environment that held in Stockholm (Thakur, 2010). Environmental degradation can be described in various ways, as given below by different authors: Environmental degradation is the reduction in quality and value of the natural environment through human interactions with the environment and natural disasters. Agyemang (2013) sees environmental degradation as a condition which reduces the value of the natural environment to meet with the ecological and socio-economic needs. Any change to the physical and natural Environment that reduces the air, water, and soil quality or affects the ecosystem in a way that it reduces its value is seen as environmental degradation (Choudhary, 2015).

The scope of environmental degradation covers issues such as land degradation, loss of forest, desertification, biodiversity threatened, pollution, climatic change, rise of sea level and others (Agyemang, 2013). On this note, environmental degradation can be seen as a hub

which covers different issues including global warming, deforestation and desertification, population biodiversity loss, animal extinction.

2.2.2 Causes of environmental degradation

Varieties of factors can be responsible for environmental changes, these factors include: Increase in energy use, Urban growth, increase in population, Agriculture and others. Environmental degradation includes but not limited to; Land degradation, Degradation of water resources, Degradation of fisheries, Loss of biodiversity, climatic change (Singh, 2009). These main causes of Environmental degradation results to loss of rain forest, it also leads to air and water pollution, depletion in the ozone layer and general destruction of the environment (Choudhary, 2015).

2.3 Rural Livelihood

There are many definitions to livelihoods, some notable once are “ways in which people access and mobilize resources that enable them to pursue goals necessary for their survival and longer term well-being, and thereby reduce the vulnerability created and exacerbated by conflict” (Malleon, 2008). Livelihood can also be seen or described as an agreed set of activities carried out in certain time for given line span, with aim of proving necessities of life such as food, water, shelter and clothing, this can be done by one person or group of persons with common interest of proving for self or household, livelihood usually requires performing certain task with dignity (Van *et al.*, 2017).

A livelihood is considered to be means of living only if it is sustainable. However, a sustainable livelihood is when withstand shock and also has the ability and capacity to recover from the shock, maintaining itself over a given period of time and has opportunities

for everyone at the present and future (Wondim, 2019). Livelihood should have the needed capacity, assets that is material and social that is required before it can be seen an acceptable mean of earning (Ellis, 1998). The ability to recover from stress, draught, flood, war and other natural and manmade challenges are strong attributes of Livelihood (Van *et al.*, 2017). On this note the focus here is Rural livelihood, which can be seen as the capabilities, assets, and activities the rural people require for a means of living (Malleeson, 2008). It also involves diversification of livelihoods, ‘is a strategy to cope with economic, environment shock, and an instrument to ease poverty’ (Wondim, 2019).

2.4 Concept of Rural Development

To some, rural development is synonymous with agricultural development; others view it from a much more comprehensive stand point which includes; the creation of opportunities and incentives for savings, credits and investment at the local level for the provision of rural facilities, roads, agro-industries and agro-services (Alderman *et al.*, 2004). Rural development can therefore be seen as large re-organization and mobilization of the rural dwellers so as to cope effectively with the daily challenges of their lives and with changes consequent upon this (Abdullateef, 2009).

The major objective of rural development is to increase farm productivity, for achieving rapid economic transformation, increasing profits to farmers and to increase the household outputs of selected agricultural products The objectives of the Rural Development Strategies are to improve farm productivity, for achieving rapid economic growth, to increase household outputs of some agricultural products, and to promote value addition and ensure a stable and reliable market for these agricultural products (Arumalla, 2011). The lack of understanding

of the actual meaning of the concept of rural development has led to the proliferation of approaches, strategies and principles aimed at achieving rural development especially among the developing countries (Abdullateef *et al.*, 2017).

2.4.1 Rural development strategies in Nigeria

2.4.1.1 Pre-independence experience in rural development

Township ordinance of 1917 was the first Government's participation in the provision of infrastructures in Nigeria, this Township ordinance recognizes the first, second and the third Township ordinance in its classification which was an attempt for the development of rural areas in Nigeria (Raheem and Bako, 2014).

2.4.1.2 Post-independence experience in rural development

Even though, the political drivers of the post independent Nigeria were indigenous, majority of them are from rural areas, the period experienced bulk concentration of infrastructural transformation on the modern sector of the economy at the expense of capital investment in economy of rural dwellers. Government effort to develop rural areas in Nigeria that has been neglected was seen as a priority through rural development or transformation (Ugboh and Tibi, 2008).

2.4.2 Approaches to rural development in Nigeria

River Basin Development Authority; this Approach was created in the early 1976 by decrees 24 and 28 respectively, and the scope was later expanded in (Egbe, 2014). Its main aim was to improve the water bodies of the river basins in the entire country in order to better the lives of the citizens (Egbe, 2014).

Operation Feed the Nation (OFN): was an agricultural extension and mobilization program for the nation and It was launched by Gen. Olusegun Obasanjo in 1976. It was an attempt to achieve self-sufficiency in food crop production and to attract the younger generation to see the need to engage in or return to farming. (Kamar, 2014).

Green Revolution: Alhaji Shehu Shagari introduced this Rural Development Approach in 1980 with the aim of making the country self-sufficient in food production just like the Operation Feed the Nation (OFN), this program attempted to mechanized agriculture in the country. However, the program did not achieve it mandate because the same government embarked on large scale importation of grains from other foreign countries (Ugboh and Tibi, 2008).

The Agricultural Credit Guarantee Scheme (ACGS): This scheme was established to ease farmers and rural dwellers access needed for credit facilities. The government did so by establishing various financial institutions around the country, these institutions grant farmers and rural dwellers loan facilities without collateral and interest to boost the economy of the rural population (Egbe, 2014).

Directorate for Food, Roads and Rural Infrastructure (DIFRRI): This was to improve the overall quality of life of the rural areas and also their standard of living. This program was one of the Gen. Ibrahim Badamasi Babangida's attempt to better the lives of the rural dwellers in Nigeria (Egbe, 2014).

The Better Life for rural women Programme: The then first lady of Nigeria Hajia Maryam Babangida in 1987 established this program (Hodge & Midmore, 2008). One of the objectives of the program was to encourage women in rural areas to engage in practices that

would make their lives better and also to improve their living standards (Ugboh and Tibi, 2008).

. National Directorate of Employment (NDE): This is another betterment program established by Gen. Ibrahim Badamasi Babangida in the 1980s to bridge the gap in employment of Nigerians and also to encourage entrepreneurial skills among the youths. This program improve the skills of representatives of various industries (Kamar, 2014).

Mass Mobilization for Social Justice and Economic Recovery (MAMSER): was also created by Gen. Ibrahim Badamasi Babangida which advocated loudly on people's right, this program task was to engage in mass consultations around the country and make recommendations on the challenges recorded during the consultations (Hodge and Midmore, 2008).

2.5 Concept of Artisanal Gold Mining

Various authors attempted to describe the concept of Artisanal Gold Mining which usually has the following key words in common: illegal, unmechanized, nomadic, individual, poverty driven, however some notable description are considered bellow.

Artisanal Gold Mining is an ancient practice that remains used in present times (Álvarez, 2000). Artisanal Gold Mining (ASGM) or Small Scale Gold Mining as widely used interchangeably, constitutes illegitimate activities of extracting gold ore from the earth without valid documents of operation, rights, licenses, permits that allows land use for mineral mining other exploration legitimately (Ahmed, 2018).

Considering Local and National backgrounds, various factors covering economic, social, environment, health, and technology comes to play in Artisan Gold Mining. This complex interplay of factors may vary greatly in degree and manner (World Health Organization, 2016). The Minamata Convention on Mercury defined the act as ‘gold mining carried out by individual miners or group of professional miners with little or no investment in capital and production.

The International Labour Organization termed illegal mining as ‘mining with low level mechanization that incurs intensive labour (WHO, 2016). Centering on the above definition, and highlighting on the economic and social effects of Artisan mining, it was elaborated by the World Bank’s Communities, Artisanal and Small-Scale Mining (CASM) initiative that the activity is largely driven by poverty, and by people with poor education, living in the undeveloped areas of a country or state, mostly with very minute alternatives of employment (WHO, 2016).

It is worth noting at this point that Artisanal Gold mining anywhere have similar factors and attributes: non formal work environment, no use of mechanized tools causing intensive use of labour, lack of investment capital and low productivity, limited land for mining, limited access to target markets and general business exploitation due to limited education (Hentschel *et al.*, 2003). The characteristics noted above further iterate the ring of poverty that coexist in an Artisanal or small scale mining environment, most notable in situations where the actual mining and other processing techniques are inefficient, resulting substandard product and little profit gain (Ahmed, 2018).

Coupling with this submission, hazardous tendencies are associated with this activity. Over 70 countries are involved in Artisanal and small-scale mining covering approximately 10-15 miners, where 4-5 million in approximate includes women and children (Farrington, 2000). Increasing difficulty in earning a living from other activities such as agriculture and increasing mineral prices have double the amount of people directly engaged in ASM, sighting the number at 30 million people I 2014. (Fritz *et al.*, 2018).

2.6 Concept of Poverty

There are many definitions of poverty, depending on how it is viewed. Encyclopaedia Encarta, defines poverty as the condition of having insufficient resources or income. Generally, poverty can be viewed as the lack of basic human needs for sustainable living and useful working efficiency such as adequate and nutritious food, clothing, housing, clean water and health services (Dercon, 2009). When a society hardly survive on a level of subsistence, such society is seen or describe as being poor, together with the inability to meet up with certain necessities of life, such as shelter, clothing and needed nutrients (Dapel, 2018). According to The World Bank in collaboration with World Development Report (WDR) highlighted that the condition of a person could be seen as poor if one lives below US \$370 at any given time and it can be called extremely poor if the person live bellow US\$ 1 per day, and moderately poor if the person is on less than US\$2 daily (Dapel, 2018).

It has been estimated that about 63 percent of world poverty are in rural areas, Sub Sahara Africa accounts for 65 to 90 percent of the Worlds poverty (Alderman *et al.*, 2004). Poverty is mostly a rural affairs and rurally oriented, there is high probability that if you pick a poor person randomly, such person would be from a rural area or has rural origin (Dercon, 2009).

2.7 Characteristics of Artisanal Gold Mining

Diversity is one of the major characteristics of Artisanal Gold mining, thereby performing illegal and informal activities that are not tolerated by the authorities. These activities can be season-based or can run through the year, comes as a result of a boom-and-bust cycle or a long-term period (Klubi *et al.*, 2020). In a family-based survival practice of Artisanal and Small Scale Gold Mining (ASGM), the complete family consisting of People of different ages work in the mines and sees it as a source of livelihood, most practitioners of small scale Gold Mining are nomadic in nature and are usually poor, they engage in these practice because of the difficulty in earning a living through other rural livelihood (World Health Organization, 2016).

In a typical Artisanal Gold Mining environment, the primary work of the men is excavation of the area suspected of Gold, while the women and sometimes the children support in the mine and also combining it with domestic (Hinton *et al.*, 2003). However, this balance sought by blending household activities and mining often comes with consequences of various health challenges to the entire family member, especially the women. Absence of regulation in the sector of artisanal and gold mining contributes in worsening these health problems; no awareness and education about health hazards associated with mining; unavailability of protective equipment, lack of training, and high illiteracy rates resulting to zero or little technical knowledge (Gbireh *et al.*, 2009). The unavailability of expertise and financial strength necessary to migrate to more organized mining practices have also worsen health problems even in situations where Artisanal and Small Gold Mining is formally operated. (Haile, 2017).

Access to safe drinking water, sanitation and health facilities prove almost impossible to mining communities that practice mining in remote regions, or when the local health care facility is pressured by patients due to massive immigration. (Gbireh *et al.*, 2009).

2.8 Impacts of Artisanal Gold mining on Human Health

Artisanal gold mining activities have negative consequences on human health as shown on some studies as highlighted bellow:

Artisanal gold mining can expose individuals to mercury substances when they are not properly contained by the Artisanal Gold Miners during the process of mining gold, these released mercury gets into the stomach and intestine of the miners and can cause serious consequences to their health (Appel *et al.*, 2012). Serious exposure of mercury may affect the respiratory system of man and in some cases it may also lead to sudden death, It can also have serious consequence on the kidney of the Artisanal Gold Miners (Gyamfi *et al.*, 2020). Artisanal Gold Mining activities involves the use of children in the mines, and these children are at the risk of contracting oedematous (Lanzano, 2018). Most Artisanal Gold Mining are seasonal and migratory in nature, these two characteristics makes the miners to be vulnerable to sexually transmitted infections (STIs), especially HIV and AIDS (Salati *et al.*, 2016).

The ages of Artisanal Gold Miners ranges between 11 to 50 years and most miners claim to add mercury in the process of amalgamation, they experienced many health challenges such as., cough, chest pain, weakness of the body, stress, insomnia, excessive salivation and so on. after coming in contact with mercury (Haile, 2017). Noise exposure from the mining activities is also related to the following outcomes; hearing impairment, hypertension, heart disease, and serious stress (Klubi *et al.*, 2020).

Continuous exposure to harmful substances generated by small scale miners may likely cause asthma, tuberculosis, loss of hearing, vibration syndrome, radiation, and other injuries to the body (Gwimbi and Nhamo, 2016). The health implications of Mining on the miners are challenging, with inhaled mercury leading to neurological damage and other health issues.(Esdaile & Chalker, 2018). Kidney problems, respiratory problems, dizziness, and miscarriages in women may occur when the tool and material used for Mining are poisoned with toxic substances in and around the Mines, and increase in death rate in the community where Illegal Mining takes place (Eludoyin *et al.*, 2017).

Mothers living in the vicinity where Artisanal Gold Mining occur are not left out in the menace, the experiencing a reduction of 0.51 percentage points in the chances of having a child with low APGAR (Appearance, Pulse, Grimace, Activity and Respiration) when given birth to (Maponga and Ngorima, 2003),

2.9 Impact of Artisanal Gold on the Environment

The environment is seriously affected with the activities of Artisanal Gold Miners, these consequence on the environment occurs from the starting stage to the end of the mining practice (Omotehinse and Ako, 2019). In Nigeria, mercury pollution to the natural environment is the main environmental problem caused by the illegal or small scale miners, due to the fact that these miners prefer to use mercury as a means of extracting Gold from the suspected ore, they see it as cheap and easy Gold Mining Technique (Xiao *et al.*, 2017).

Among human activities that affects the environment negatively, history has shown that mining is major player in the destruction of the environment, it destroys the ecosystem through removal of soil and natural vegetation (Abdulwahab *et al.*, 2012).

The organized and unorganized sectors of mining has caused various environmental problems such as: destruction of vegetation, resources being wasted, rise in water siltation and turbidity, the severity of these damages are determined by some factors such as; the technique being used to extract Gold, the exposure of the ore to the surface, and the tools used by the miners (Maponga and Ngorima, 2003). Deforestation due to the practice if illegal mining is another major impact on the environment, for example in Bolivia it was reported that between the year 2006 to 2009 about 20km² of forest was lost, if these practice is left unchecked the biodiverse ecosystem would be at risk (Esdaile and Chalker, 2018). Waste is another environmental challenge caused by ASGM, in areas where, uncontrolled mining occurs it is likely to generate tons of waste, particularly mercury waste (Haile, 2017). Artisanal Gold Mining activities generates traces of metallic elements in the environment and had adverse effect on human health (Tankari *et al.*, 2019).

Artisanal Gold Mining contaminates the soil of areas where it occurs as indicated by the work of Niane *et al.* 2019 for example a study in china concludes that villages in China with the history of Artisanal Gold Mining have their soils contaminated compared villages without Artisanal Gold Mining history Xiao *et al.* 2017.

2.10 Review of Related Literatures

There are lots of literatures on Artisanal Gold Mining, For instance; Bansah *et al.* (2016) conducted a study on the Hazardous Nature of Small Scale Underground Mining in Ghana,

where it was revealed that because of Gold Mining activities in the area, the general environment and human health are in serious danger. In the same study they also reported that miners in the mines experience serious injuries and fatalities in recent times from poorly supported stopes. The practice exposes Artisanal Gold Miners to all sort of risk.

Another study by Eludoyin *et al.* (2017) concluded that places of Artisanal Gold Mining activities has higher concentration of harmful chemicals compared to non-mining areas. They also implied that areas where mining took place consist more of sandy particles and has less nutrients compared to farmlands, forest and undisturbed land. Esdaile and Chalker (2018) investigated the mercury problems in Artisanal Gold mining and asserted that mining has serious consequence on the health of the miners when they inhale mercury, it leads to brain damage and other health complications. The water and soil in the community and nearby communities are affected with mercury contamination and repeated accumulation of places of food supply, for example; fish, a common source of protein of Artisanal Gold mining areas.

However Farrington (2000) in his study on Environmental Problems of Placer Gold Mining in Mongolia and established that with proper reclamation plan, the problems caused by Artisanal Gold could be avoided. Obeng *et al.* (2019), studied the Local Effects of Artisanal Gold Mining observed that Artisanal Gold mining may be highly labour intensive compared to organized mining sectors, but it is unmechanized and informal nature comes at a price to environment and human health, however it increases the income of household engaging in it by 0.2 percent and it is driven by non-agricultural income sources. Subsequently, Gwimbi and Nhamo (2016) studied how of Artisanal small scale Mining have impacted the environment and human health in the Batouri Gold District, East Cameroon, and has stressed

that bodily injuries, abnormal respiratory conditions, diarrheal conditions, psychotic imbalance, infection of the skin, intestinal worms infections, malaria and muscle and skeleton problems. Haile (2017) in Garasi, Eritrea stressed that miners especially, Artisanal Gold Miners agreed that they use mercury during amalgamation and that cough, chest pain, weakness, insomnia, excessive salivation and other are the common health complications miners experience after exposure to mercury.

An investigation by Hinton *et al.* (2003) during the study of Clean Artisanal Gold Mining shows that misuse of mercury can lead severe health hazard for miners that are involved in Gold mining, including the neighbouring communities and their inhabitants that may likely be exposed to mercury either directly or indirectly. They also indicate that the nature of Artisanal Gold Mining can or may lead to occupational hazard, but majority of the risk are linked to machinery accidents and ground collapsing due to landslide and shaft collapses. Furthermore an observation by (Hoadley and Limpitlaw, 2004) in their study on The Artisanal and Small Scale Mining Sector & Sustainable Livelihoods observed that the poverty is one of the major drivers when it comes Artisanal Gold Mining and by this Artisanal Gold Mining will continue to grow in rural and poverty driven.

Boateng *et al.* (2013) revealed that the farmers in the community experience variety of challenges posed by activities related to mining, such as water pollution, due to excessive use or uncontrolled use of harmful chemicals, pollution of the air and degradation of the land as a result of the use. The farmers also witnessed premature dropping of pods, leaves becoming yellow and little yield on cocoa farms that are close to the mining sites. Another study by Ahmed, (2018) in his Smart Artisanal Gold mining from Sudanese Perspective revealed that the natural landscape of an environment is altered and irregular change in the natural

hydrology of the environment, pollution to the desert areas that occurs as result of gold exploration by the means of harmful and hazardous substances such as mercury, arsenic, and cyanide, acid drainage, which poses serious threat to the surrounding rivers and underground water. Additional revelation by the same author states that illegal mining has resulted in polluting the soil of surrounding Agricultural land which makes farming less productive to the farmers in the area and also neighboring areas. Another study by McKeown and Bugyi (2016) in their study on how water pollution affects Human Health and Environmental Sustainability found out that site that experience the operations of Artisanal Gold Mining records water quality that are below the standard of Ghanaian national standard for drinking water, with high concentration of manganese. They also state that the relationship between unstable Artisanal Gold Mining activities and the natural seasonal hydrology of the tropical river, resulted to impermanent variability in water quality parameters.

Furthermore, another study by Mkpuma *et al.* (2014) in the study of Environmental Problems of Surface and Underground Mining argued that Artisanal Gold Mining comes at a price on the environment with environmental problems such as pollution, erosion, destruction of natural ecosystem and others. all the components of the environment are affected by Artisanal Gold Mining and the impacts are permanent/temporary, beneficial/harmful, redeemable/unredeemable but irreversible.

Another study by Mujere (2015) implied that Artisanal Gold Mining causes imbalance to aquatic life, land disturbance, deforestation and depletion of water resources, biodiversity threatened, increase in siltation level, turbidity and metal content in sand. Human and animal health also suffer negatively on account of the operations of the Artisanal Gold Miners. Based on the findings from their study, they suggested that small scale mining should be formalized

and supported by the government of Mozambique and Zimbabwe so that the mining activities can be environmentally friendly and sustainable. A study on how Gold mining affects Newborns' by Tankari *et al.* 2019. on the other hand, highlighted that mothers residing close to the mine are affected by the harmful chemicals used by the miners and that results to reduction in APGAR that is Appearance, Pulse, Grimace, Activity and Respiration score in new born babies to 0.5% point in the chance of having an infant with low APGAR score after birth. (From a basis of 4.5%). However, they found a negative impact in mothers living far from the mine, chances of giving birth to a child with low APGAR score at birth rose by 0.45% point.

Bryceson and Geenen (2016) argued that because Artisanal Gold Mining provides livelihood in Sub Sahara Africa we should not forget that mining comes at a price to the environment and the sectors internal dynamics should also be considered, hence they recommended labour transformation. However Hinton *et al.* (2003) sees Artisanal Gold Mining as a business enterprise in Nigeria and other developing countries. Furthermore a study on the Health hazards of artisanal and small-scale gold mining by Bose *et al.* (2016) shows that chronic mercury intoxication is one of the top 20 health hazards recorded in Zimbabwe due to Artisanal Gold Mining, other health hazards recorded include but not limited to accidents in the tunnels, shaft and open pit, noise, dust, and exposure to lead.

Domínguez *et al.* (2019) in their study on the Analysis of risks in underground mining, in Guanajuato, Mexico and propagates that accidents in mining site are high because of the inappropriate nature of the working place, they also suggested the use of modern tools and machine by the miners to reduce these avoidable accidents, Subsequently Obeng *et al.* (2019) indicated that Illegal mining activities were identified as the cause of environmental problems

such as water pollution, deforestation, poor soil fertility and limited access to land for agriculture productivity.

But Artisanal Gold Mining according to Owusu *et al.* (2019) in their study shows that exploitation of Gold is the most important factor that influences revenue growth from Artisanal Gold Mining,. This can be seen as the positive effect of Artisanal Gold Mining. Ako *et al.* (2014) in their own study in Minna Niger state, did an evaluation on the Environmental Hazard associated with artisanal Gold Mining and reveal that Artisanal Mining activities have impact on physical environment such as Land devaluation, loss of vegetation, erosion and reduction in the quality of water. plants and animals gets contaminated from the toxic elements in the soil and passes it on to humans via food chain, they can also find their way to the surface and ground water around the mining sites, making the water to be unsafe for human consumption. These adverse effect can cause slow growth in plants and health complications in humans.

This portrays the argument that Artisanal Gold Miners in Gidan Mai Wayo community are exposed to various health issues such as respiratory problems, noise pollution, liver problems and others. Another relevant study stressing the effects of Artisanal Gold Mining on humans by Gantumur *et al.* (2017) states that the elementary mercury used by Artisanal Gold miners is organic and toxic in nature and has negative influence on central and peripheral nervous system, according to them, when humans inhale this mercury vapors, it can damage the digestive and immune system, lungs, and kidneys leading to severe dysfunctions and even death.

Obase *et al.* (2018) in their study on the Impact of Artisanal Gold Mining in Batouri Gold district East Cameroon reported that after carrying out blood analysis of the miners in the area the following results were recorded. Most Artisanal or Small Scale Gold Miners experience the following health challenges; 35.6% of the miner's experience musculoskeletal disorder, 26.4% experience malaria and hernias, the average mercury and lead presence in the blood of the miners is $2.27 \pm 8.85 \mu\text{g/L}$ and $12.73 \pm 32.73 \mu\text{g/L}$ respectively and 9.2% of them are highly intoxicated with mercury.

The activities of these Artisanal Gold Miner is similar to that of Gidan Mai Wayo settlement and as such the health and environmental challenges would not be different. Mining activities are partially seasonal, this is in line with a study by Ibrahim *et al.* (2020) studied images from 2016 to 2019 using Sentinel 2 data to identify mining areas and the dynamics in land cover changes in El barge, Colombia and concludes that there is annual changes in mining activities in the area and argued that more mining activities are recorded in dry season compared to wet seasons, the result also shows a slight reduction in detected mining areas in from 2016 to 2019. Artisanal Gold Mining sites contain some hazardous chemical that are harmful to plants and animals for examples, a study by Razanamahandry *et al.* (2016) conducted a research in Burkina Faso on soil and water in study area to know if there is presence of cyanide degrading bacteria in the soil and water of all the samples taken, it was revealed in the study that free cyanide was present in all the samples, with the amount of concentration ranging from 0.023 to 0.9 mg kg₋₁, and 0.7e23 mg L₋₁ in the soil and water samples, respectively.

The stages such as: Amalgamation, Separation, Removal of excess mercury, Burning of the amalgamation to find Gold releases mercury waste to the environment, which is harmful to

the ecosystem (Vieira, 2006). It is estimated that mercury that is released to the environment range from 800 to 1000 tone/annum. Of this total, approximately 200e250 tone of Hg are released in China, 100e150 tone in Indonesia, and 10e30 tone each in Bolivia, Brazil, Colombia, Peru, Philippines, Venezuela and Zimbabwe (Veiga *et al.*, 2006). Gidan Mai wayo doesn't escape the effects of mercury as their Artisanal Gold Mining practice doesn't differ from the above. It has been observed in areas where Artisanal Gold Mining takes place, the air contains amalgam (mercury and silver metal) which is harmful to human and animal health (Gyamfi *et al.*, 2020).

Artisanal Gold Mining are basically illegal mining activity (Chipangura, 2019), the practice involves the use of women and children as indicated in some studies, for instance Zolnikov (2020) in his study Effects of Government Ban on Artisanal Gold Mining in Ghana states that that approximately 1 million women lost their jobs in in Akwatia, Ghana. Mambrey *et al.* (2020) in their analysis took the sample of 207 (blood and Urine) to find out the presence of mercury, and revealed that 4.75 µg/L was the median mercury value, 612 µg/L as the maximum. 3.98 µg/g as the medium mercury concentration, with a maximum value of 478 µg/g. The median blood mercury value was 2.70 µg/L with a maximum of 167 µg/L.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the modalities that the researcher put in place to carry out this study, which are the various methods and techniques that the researcher would input in the course of this research work to acquire the required data needed for this study. This chapter has therefore been designed to clarify and reduce to the barest minimum any form of ambiguity in the use of methods during the course of this research work.

3.2 Research Population

The population of the study area was identified, from which the sample population was derived, using the Taro Yamani formula. According to the Authors' fieldwork, 2019, Gidan Mai Wayo community has the population of 610, with 240 males and 370 females, respectively.

3.3 Sampling Size

The projected population of the study area is calculated as:
$$= (+)$$

Where;

$$P=610$$

$$r = 2.26 (0.026)$$

$$n = 14$$

$$= 610(1+r)$$

$$= (1+0.026)^{14}$$

$$= 610 (1.026)^{14}$$

$$= 610 \times 1.432$$

$$= 874$$

Taro Yamani demographic formulae was used to determine the sample size from which sample frame was gotten, the formulae are given below;

$$n = \frac{N^2}{N + (Z^2 \cdot e^2 \cdot \frac{N}{2})} \quad 1$$

Where;

n = sample size

N = Population of the study area

e^2 = degree of confidence

The population (N) = 874

Level of significant (e) = 0.05

$$n = \frac{874^2}{1 + 874(0.05)^2}$$

$$n = \frac{874^2}{1 + 874(0.0025)}$$

$$n=874/1+2.185$$

$$n=874/3.525$$

$$n=248$$

The sample size is 248

3.4 Sampling Technique

Systematic Random sampling was employed in selection of households across the entire sample frame in the administration of questionnaire. This involves the selection of every n th item in the population after the random selection of the first item.

3.5 Method of Data Collection

Questionnaire, personal interviews, and physical observation was used to collect data from the study area because of how accurate they have proven to be. The questionnaires were administered to residents and the workers in the mining sites to collect information on how Artisanal Gold mining affects their lives and the general environment.

3.6 Nature of Data Required

The nature of data required for this Research is presented according to objectives as follows;

To identify the Artisanal Gold Mining sites in the study area

The data required or needed for this objective are; Base map of the study area, Coordinates of the mining sites, Population of the study area, Size of the mining sites

To evaluate the existing Artisanal Gold Mining practice in the study area

Data required or needed for this objective are; Gold mining practices, Standards on mining

To examine the relationship between crime rate before and after Artisanal Gold Mining activities in the study

Data required or needed for this study are: Police records and interviews

To assess the effects of Artisanal Gold Mining on the physical environment of the community

Data required or needed for this study are: Base map of the study area, Satellite image of the study area, Farmland lost to due to mining activities, Economic trees lost due to the mining activities, Purity of the water around the mining sites, land reclamation approach if available.

3.7 Sources of Data

The main sources of data for this research work are primary and secondary sources of data

3.7.1 Primary Sources of Data

The researcher's physical observations and measurements, questionnaire administration, data generation on population characteristics, environmental conditions and water analysis are the main sources of primary data.

3.7.2 Secondary sources of data

Required information needed for this work was sourced from relevant journals, textbooks, maps. Satellite images were collected from Landsat 7 from United States Geological Survey Department (USGS). Others include materials from the online sources, National Population Commission, Nigeria Bureau of Statistics, and past research reports. Base map and street maps, were collected from Niger State Ministry of Land and Housing, Minna, which also form part of the secondary data used for this research.

3.8 Data Analysis Techniques

Mapping of the Artisanal Gold Mining sites was carried out, to show the spatial distribution of the Artisanal Gold Mining sites in respect of objective one. Checklist was used to assess the existing Artisanal Gold Mining practice in the study area in respect of objective two. Chi-square was used to examine the relationship between crime rate before and after Artisanal Gold Mining activities in the study area regarding objective three. Satellite image classification was carried out to analyse the Landuse landcover changes in order to examine the effects of Artisanal Gold mining on the physical environment in the community.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Artisanal Gold Mining Sites in the Study Area

4.1.1 Locations of artisanal gold mining sites

This Figure shows where the Artisanal Gold Mining sites are located within the study area. The Mining sites were formally used for crop production before the emergence of the Artisanal Gold Miners who excavates the land in search of Gold.

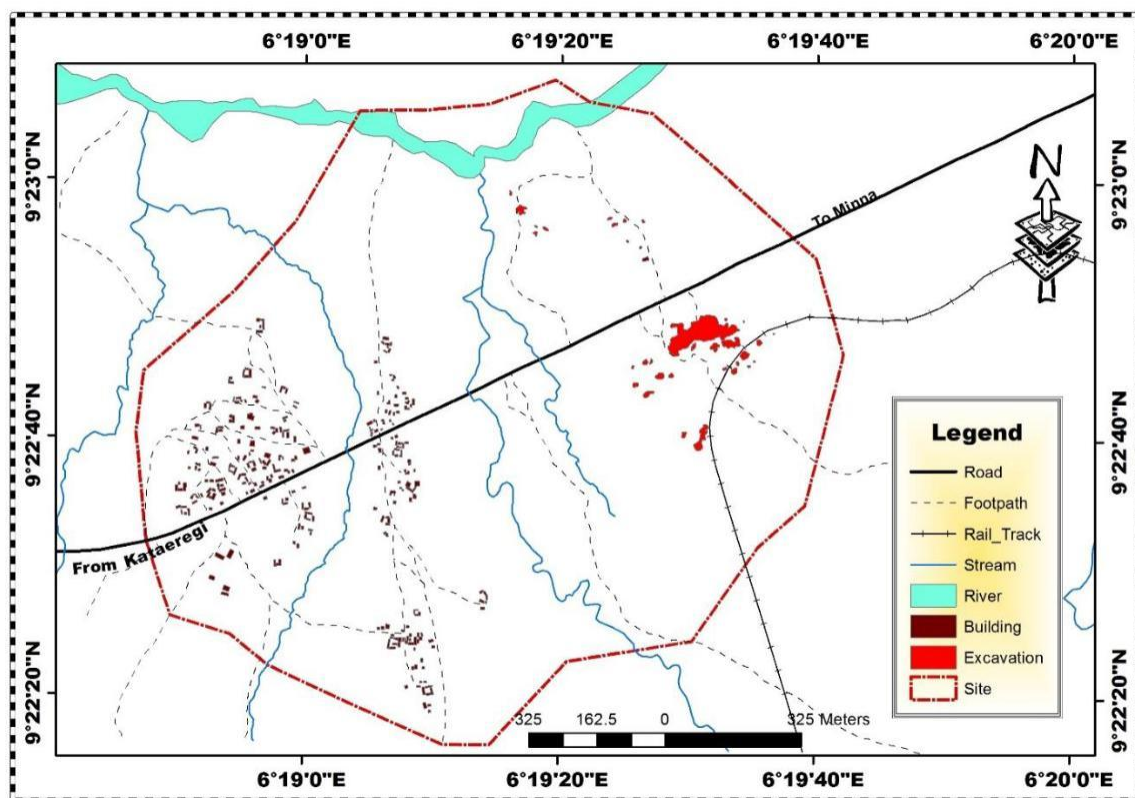


Figure 4.1: The Study Area Showing Locations of Mining Sites
Source: Author's Fieldwork, 2019

The Gold Mining sites are scattered within the study area as indicated in Figure 4.1. The Artisanal Gold Miners did not carry out their excavations (Gold mining activities) in a

particular manner, they excavate any area they suspect its ore can contain Gold. These careless excavations by the Miners without a proper reclamation plan, degrades the environment and also have negative impact on the economy of Gidan May Wayo community, because the land where used for agricultural before the emergence of these Miners. Excavation for mining purposes are also done close to and under the Rail line that passed through the study area as shown in the above map, this hazardous practice not only put the Rail transportation at risk but the community at large. The implication of this unsafe practice by the Artisanal Gold miners makes the environment unattractive for other uses such as farming, physical development, game reserve.



Plate I: Degraded land as a result of Artisanal Gold Mining in the study area
Source: Author's Field Survey, 2019

Plate I shows how Artisanal Gold Mining activities in Gidan Mai Wayo community has affected the value of the land in the community due to the unguided mining practices. These illegal miners do not see the need to engage in Land reclamation after degrading the land to their Mining activities. The implication of this man made hazard include Soil erosion, Loss of fertility, Destruction of species habitat and biodiversity, Excessive nutrients run off into lakes and so on, this is in agreement with some studies by (Omotehinse & Ako, 2019) and (Niane *et al.* 2019) which has serious consequences on the environment.

4.1.2 Satellite image of the site before and after the activities of gold miners

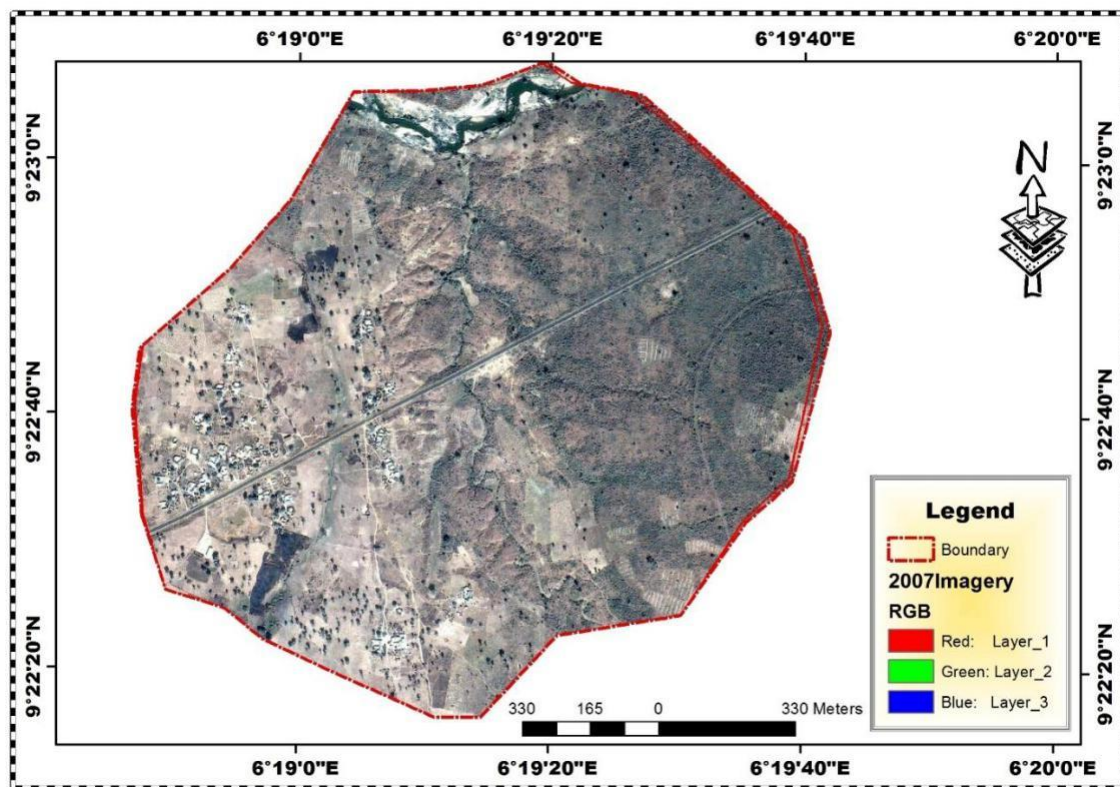


Figure 4.2: 2007 Satellite image of the site (before the activities of Gold Mining)
Source: Author's Fieldwork, 2019

Figure 4.2 is a typical satellite image of the study area in 2007 of Gidan Mai Wayo settlement before the emergence of Artisanal Gold Miners, the area was a rural community with natural

vegetation suitable for Agricultural activities, the settlers of this community were known for crop production as a means of livelihood, crops such as maize, millet, groundnuts, Yam e.t.c were cultivated by these farmers and sold at the nearby markets, (Gadan Eregi market and Kata Eregi market respectively).

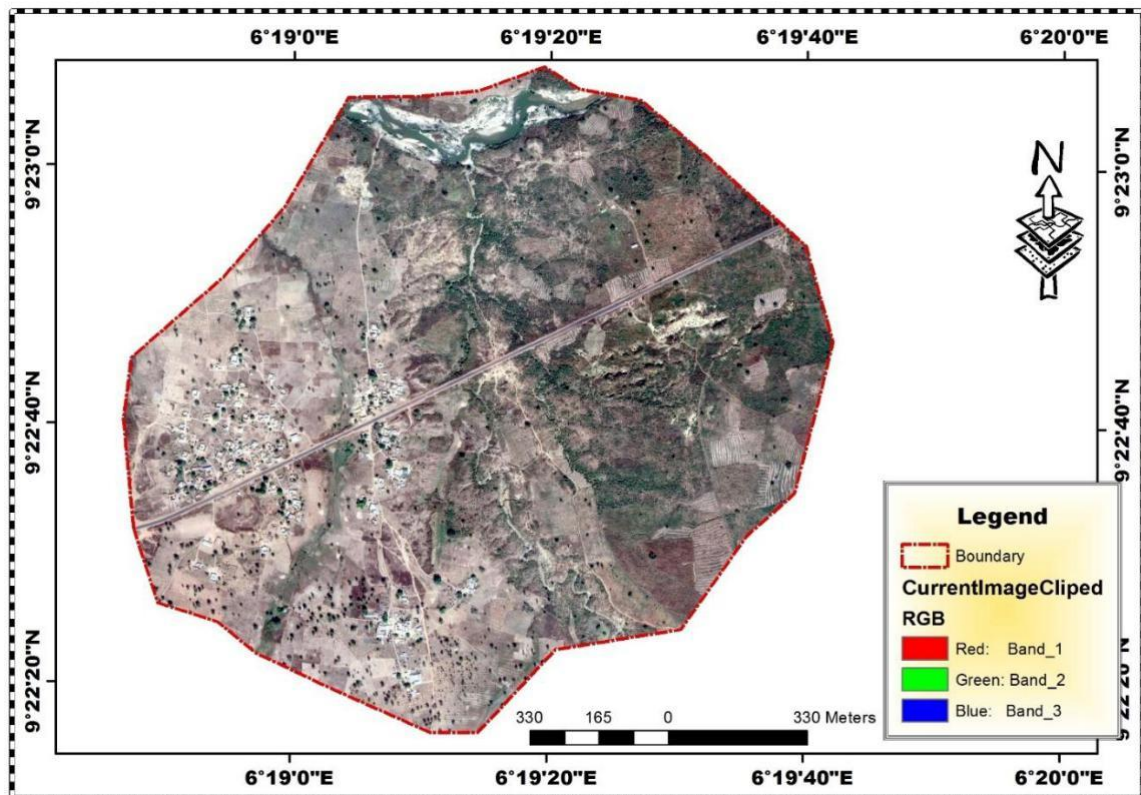


Figure 4.3: 2019 Satellite image of the study area
Source: Author's Fieldwork, 2019

When the present satellite image (Figure 4.3) of the study area was compared with the image (Figure 4.2) before the activities of Artisanal Gold Miners, it was observed that the area has lost most of its vegetation to the mining activities by these illegal miners, this loss of farmland to mining has reduced farming activities in Gidan Mai Wayo community drastically. Most farmers in Gidan Mai wayo rural community are now engaged in Artisanal Gold Mining directly or indirectly, disregarding the hazard involved. Artisanal Gold Mining practice has

negative effects on human health, water, physical environment to mention but few, this is in line with the findings of Esdaile & Chaker (2018) concludes that Artisanal Gold Mining has serious consequences on human health and the environment at large

4.1.3 Size and number of artisanal gold mining sites

Table 4.1: Size and Number of the Artisanal Gold Mining Sites in the study area

Items	Number	Area (ha)	Percentage
Excavations	34	1.20	0.64
Buildings	291	1.55	0.83
Others		183.5	98.52
Total land area		186.25	100

Table 4.1 shows that the number of excavations in the study area are 34, covering 1.20 hectares of land (0.64%), the total number of buildings in study are 291, covering 1.55 hectares (0.83%) and others covers 183.5 (98.52).

4.2 Existing Artisanal Gold Mining Practice in the Study Area

4.2.1 Gold extraction techniques

There are two existing techniques for Gold extraction in the study area. These are; panning and table shaking techniques.

4.2.1.1 Panning



Plate II: Panning Technique
Source: Author's Field Survey, 2019

Plate II shows Panning technique, which is the use of iron pan with flat bottom to wash ore with the aim of separating Gold from other particles, the panning method is easier to use by the Artisanal Gold Miners compared to other Mining Technics, because the material needed for it are available and cheap, this Technique is used in the study area as a means of separation of Gold. Mercury is being use in this method and it contaminates the surrounding surface and underground water and it result to reduction in water quality in the area.

4.2.1.2 Table shaking



Plate III: Table Shaking Technique

Source: Author's Field Survey, 2019

Plate III shows Table Shaking technique where one side of a table is being elevated to create a slope that will allow free flow of water and grinded soil, ore, rocks particles to wash into a pit, during the process of the washing of the Gold and other particles, the gravity separates the Gold from other unwanted particles. This technique also contaminates the environment as the water being used contains iron and other toxic substances.

4.2.2 Gold mining instruments

There are a lot of Gold mining instruments available but Artisanal Gold Miners uses unsophisticated instruments as indicated in the Checklist below;

Table 4.2: Checklist of the Instruments used by the Artisanal Gold Miners

S/N	Instrument	Available	Not Available
1.	Gold Testing Kits	X	
2.	Gold fever Links		X
3.	GPS and Navigation Devices		X
4.	Magnifiers, Loupes		X
5.	Nugget Display Cases		X
6.	Shovels	X	
7.	Rakes	X	
8.	Picks	X	
9.	Beach and Sand Scoops		X
10.	Power Sluices and Hibankers		X
11.	Rock Tumblers		X
12.	Gold Concentrators		X
13.	Rock Crusher	X	
14.	Knives	X	
15.	Sluice Boxes	X	
16.	Face Mask	X	
17.	Water Pumps	X	
18.	Rakes	X	
19.	Picks	X	
20	Torch Lights	X	

There are various Gold Mining Instruments available, such as Gold Fever Links, GPS and Navigation Devices, Magnifiers, Loupes, Nugget Display Cases, Power Sluices and Hibankers, Rock Tumblers & Gem Polishers, Gold Concentrators and so on, but Artisanal Gold Miners use unsophisticated tool such as Gold Testing Kits, Shovels, Rakes, Picks, Knives, Sluice Boxes, Face Mask, Water Pumps, Rakes, Picks, Torch Lights and so on as indicated in Table 4.2.

Table 4.3: Artisanal Gold Mining Instruments and their Uses

S/N	INSTRUMENTS	USES
1.	Pan	To extract Gold from a placer deposit
2.	Sluice Boxes	To recover and separate Gold from placer
3.	Rock Crusher	To crush hard rocks
4.	Face mask	To reduce inhalation of dust
5.	Knives	To cut ore
6.	Water pump	To pump water
7.	Picks	To dig hole
8.	Rakes	To separate different sizes of particles
9.	Shovels	To carry particles in large quantity
10.	Torch light	For lightening
11.	Books	To keep records
12.	Gold Testing Kit	To test the purity of the Gold and the “Karat”.

The unmechanized nature of Artisanal Gold Mining activities attracts the use of unsophisticated tools for its operations as shown in Table 4.3, such light tools include Pan, which is used to extract Gold from placer deposit, Sluice Boxes, used to recover and separate

Gold from placer, Rock Crusher, used to crush rocks, Face Mask, which is used to reduce the inhalation of harmful substances, Knives, used to cut ore, Water Pump, which used to pump water, Picks, used to dig holes, Rakes, used to separate different sizes of particles, Shovels, used to carry particles in large quantity, Torch Lights, used for Lightening, Books, used to keep records, Gold Testing kit, used to test the purity of Gold.

4.3 Relationship between Crime Rate Before and After Artisanal Gold Mining Activities

4.3.1 Annual average crime recorded before and after artisanal gold mining activities

Table 4.4 show the relationship in crimes recorded in the study area, before the emergence of the Artisanal Gold Miners and after the activities of Gold Mining, it shows that some crimes such as Burglary, Assault, Rape, Murder, Kidnaping, Banditry, Police Brutality, Drug Peddling, Drug Abuse, Prostitution, Teenage Pregnancy, Cattle Rustling increased in Gidan Mai Wayo community after the emergence of Artisanal Gold Miners.

Table 4.4: Annual Average Crime Recorded Before and After Artisanal Gold Mining activities

S/N	Crime	Before Artisanal Gold Mining (Annual Average)	After Artisanal Gold Mining (Annual Average)
1	Burglary	9.3	21.4
2	Assault	8	31.5
3	Rape	0	8
4	Murder	0	5
5	Kidnapping	0	0
6	Banditry	1	3
7	Police Brutality	0	0
8	Terrorism	0	1
9	Drug Peddling	0	7.2
10	Drug Abuse	4	78.3
11	Prostitution	0	89.4
12	Teenage Pregnancy	4	16
13	Cattle Rustling	2	8.5
14	Consensual Same Sex	0	6
15	Human Trafficking	0	0

4.3.2 Chi-squared

Table 4.5: Chi-Squared Tests

	Value	<i>Df</i>	<i>P</i>
X ²	75.00	60	0.092
N	15		

The recorded crimes before and after the activities of the Artisanal Gold mining in the community were tested and ascertain the validity of the Nigerian police claims through the chi-square test and the results shown in Table 4.5, The chi-square calculated value of 75.00 and *p* value of 0.092 were obtained. Considering 95% confidence interval and 5% significance, the chi-square *p* value is greater than 5% and hypothesizes that the null hypothesis is rejected while the alternative hypothesis is accepted and therefore indicates that there is statistically significant difference in Crime Rate Before and After Artisanal Gold Mining Activities. This therefore can be inferred that there is a strong relationship between crime rates and Artisanal Gold mining activities in Gidan Mai Wayo.

4.4 Effects of Artisanal Gold Mining on the Physical Environment

4.4.1 Effects on land use

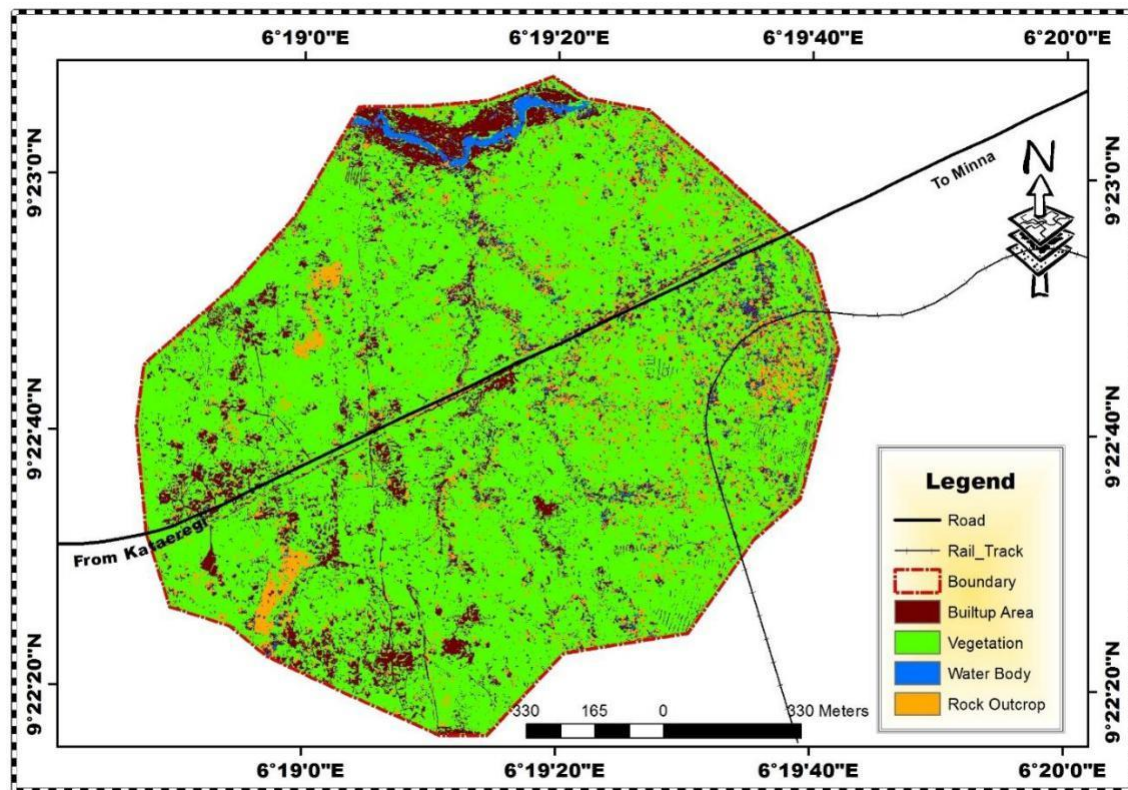


Figure 4.4: The Study Area Before the Activities of Artisanal Gold Mining (2007 Classified Image)

Source: Author's Fieldwork, 2019

Figure 4.4 shows that as at 2007, before the emergence of Artisanal Gold Mining in Gidan Mai Mai Wayo community, the area had undisturbed vegetation as shown in Figure 3. Just like any other rural area, the residents of this community engaged in farming as their means of livelihood and they use this area for their farming activities.

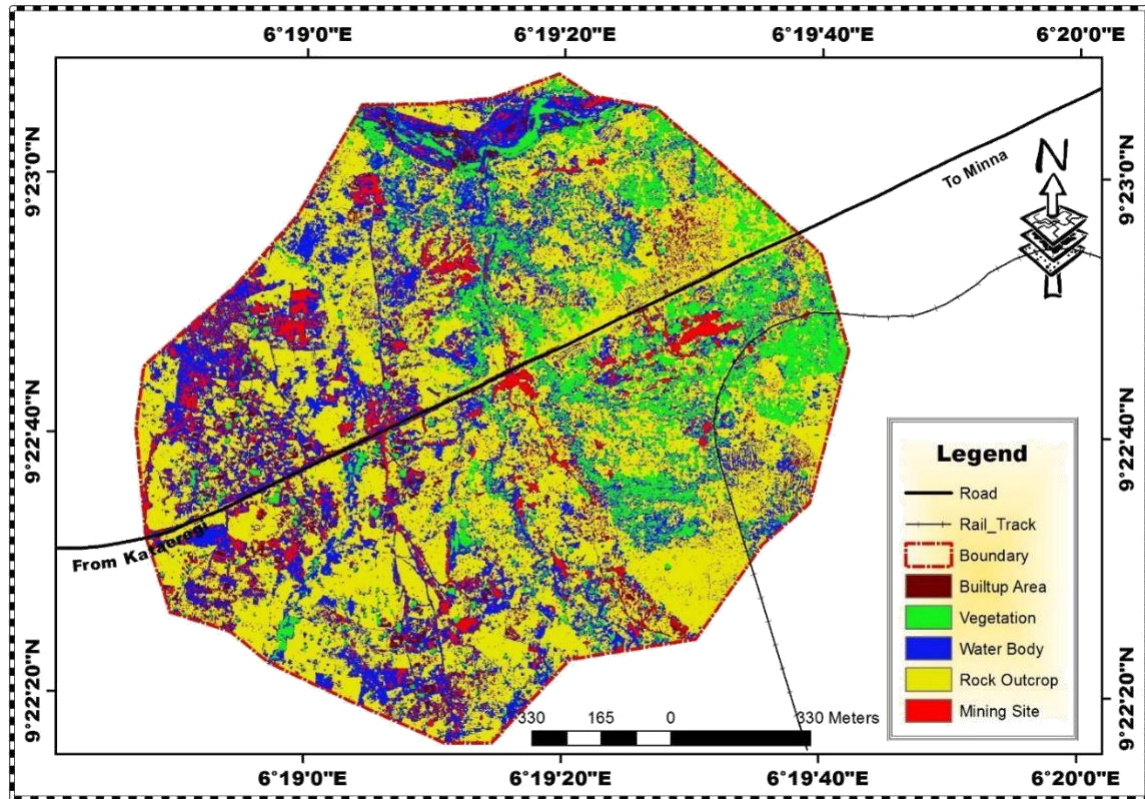


Figure 4.5: The Study Area in 2019
Source: Author's Fieldwork, 2019

Figure 4.5 shows how vegetation were lost to Artisanal Gold Mining activities, excavations done because of mining activities (Environmental Degradation), excavations done under rail lines (which is hazardous to the rail and passengers). The activities of the Miners also make the environment vulnerable to erosion due to the loss of vegetation in the area. The farmland lost to Artisanal Gold Mining makes the residents to change their livelihood from farming to other rural alternatives (Artisanal Gold Mining), this sudden change of livelihood makes the residents to engage in crime because they cannot adapt easily to their new livelihood.

Table 4.6: Changes in Land Uses Between 2007 and 2019

Land Use	2007		2019	
	Area (Km)	%	Area (Km)	%
Built Up Area	28.14	13.59	53.6	26.18
Vegetation	26.39	12.75	8.19	4.00
Water Body	135.29	65.35	54.3	26.52
Rock Outcrop	17.19	8.30	77.1	37.65
Mining	0	0.00	11.57	5.65
Total	207.01	100.00	204.76	100.00

Table 4.6 indicate changes in land Use between the year 2007 and 2019 respectively. 2007 being a year before emergence of Artisanal Gold Miners in Gidan Mai Wayo community recorded the following land use changes: Built up Areas 28.14 Area(km), Vegetation 26.39 Area (km), Water Body 135.29 Area (km), Rock Outcrop 17.19 Area(km), Mining 0 (km). while 2019 satellite image classification recorded 53.6 Area (km) Built up Area, Vegetation 8.19 Area (km), Water Body 54.3 Area (km), Rock Outcrop 77.1 Area (km), Mining 11.57 Area (km).

With these recordings it is safe to say Gidan Mai Wayo community experiences significant land use changes from the year 2008 to 2019, considering the scope of this study, there is loss of Vegetation from 12.74% in 2007 to 4% in 2019, decrease in Water Body from 65.35% in 2007 to 26.56% in 2019, Built up Area increased from 13.59% in 2007 to 26.185% in 2019, Rock Outcrop increased from 8.3% in 2007 to 37.65% in 2019, Mining was 0% in 2007 and in 2019 it recorded 5.65% of the total area as indicated in Figure 4.6.

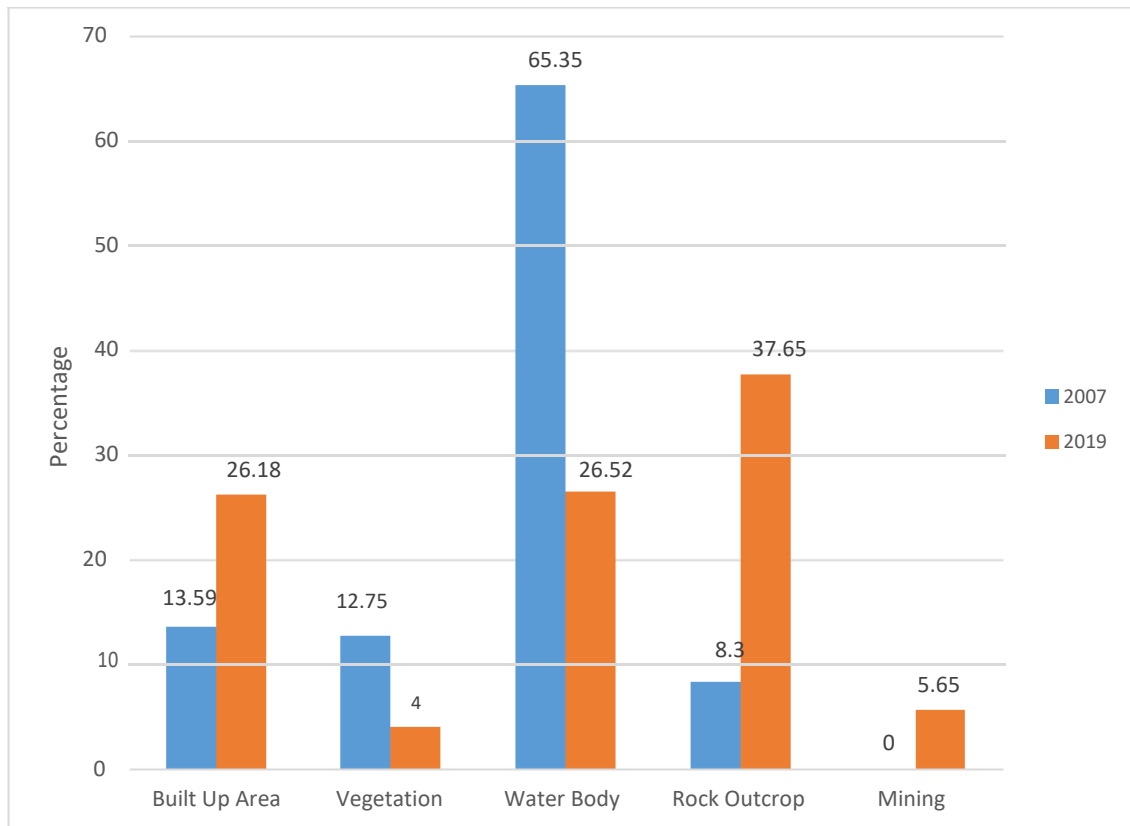


Figure 4.6: Changes in Percentage Between 2007 and 2019
Source: Author's Fieldwork, 2019

Figure 4.6 shows in percentages how land uses change in the study area due to the activities of Artisanal Gold Miners, these physical changes signify the effects of Artisanal Gold Mining on the environment.

4.4.2 Effects artisanal gold mining on drinking water

Table 4.7: Some chemical parameters from the sampling sites

Parameter	Well 1	Well 2	WHO Standards
Ph	2.3	3.0	6.5-7.5
Iron (mg/l)	0.9	0.10	≤ 1.0
Mercury (mg/l)	0.01	0.33	$\leq 0.0.1$
Sulphates mg/l	0.01	14.59	≤ 250
Arsenic mg/l	0.01	0.9	≤ 0.05
Turbidity (NTU)	3.55	180	1-5

Table 4.7 shows that pH (acid or Alkaline) concentration were lower in Well 1 because it is not close to the panning area while Well 2 recorded higher pH level due to the closeness to the panning area. Well 1 also recorded lower mercury concentration compared to Well 2 that recorded higher mercury concentration. Turbidity were lower in well 1 than Well 2, the reading from Well 2 is above the WHO standards. Sulphates concentration increased in Well 2 which is close to panning area, this is because ore contains Sulphides and minerals which are released to the streams during panning. The water analyses are a clear indication that Artisanal Gold Mining have serious impact on ground water wherever it occurs, which makes the water in the study area substandard as it contradicts World Health Organization standards. This is in agreement with a study by (Suleiman, 2016) which highlighted that Lead,

Manganese, Zinc, and Iron were higher than the recommended WHO standards in water around Gold Mining sites.

Table 4.8: Some chemical parameters from the sampling sites

Parameter	Borehole 1	Borehole 2	WHO Standards
Ph	2.1	2.8	6.5-7.5
Iron (mg/l)	0.7	0.9	≤ 1.0
Mercury (mg/l)	0.8	0.21	≤ 0.01
Sulphates mg/l	0.01	13.34	≤ 250
Arsenic mg/l	0.9	0.7	≤ 0.05
Turbidity (NTU)	2.56	167	1-5

Two Boreholes were sampled in the study area to know the level of certain chemicals present, the results reveals in Table 4.8 that Borehole 1 contains 2.1 pH and Borehole 2 recorded 2.8 pH respectively against WHO standard. Iron (mg/l) recorded 0.7 in Borehole 1 that is closer to the mining area compared to Borehole 2 that recorded 0.9, the result showed iron concentration increased in Borehole 2 because of the activities of the Artisanal Gold Miners. The mercury concentration in Borehole 2 is higher than that Borehole 1 which is more than the acceptable level recommended by the World Health Organization as indicated in Table 3, reason being that Artisanal Gold miners mostly use mercury in Gold dressing. Borehole 2 that is close to Gold washing sites in the study area recorded 13.34 level of sulphates against

the recommended level of ≤ 250 as given by WHO. The Arsenic present in Borehole 2 is lower than Borehole 1 that is not close to mining area. Turbidity (NTU) recorded 167 in Borehole 1 and 2.56 in Borehole 1 respectively. Some studies, such as (Macdonald et al., 2015) are in line with this analysis by stating that high qualities of sediments and other harmful contaminants are present in water bodies along mining sites in their study area. These harmful contaminants are harmful to human's health and the environment at large.

4.5 Summary of Findings

It was found out that Artisanal Gold Miners in Gidan Mai Wayo community carried out their excavations in search of Gold haphazardly, without following any particular manner. It also revealed that there are 34 Gold Mining excavated sites in the study area, covering 1.20 hectares of land. Panning and Table shaking are the Gold extraction techniques used by the Artisanal Gold Miners in Gidan Mai Wayo Rural community.

The study also revealed that Pan, Sluice Boxes, Rock Crusher, Face Mask, Knives, Water Pumps, Picks, Rakes, Touch Lights, Record Books; Gold Testing kits are the common instruments used by the Artisanal Gold Miners in the study area. The study found out that some crimes such as Burglary, Assaults, Rape, Murder, drug Peddling, Drug Abuse, Prostitution, Teenage pregnancy, Cattle Rustling, Consensual same sex increased in the study area after the emergence of Artisanal Gold Miners in Gidan Mai Wayo community. In the same study it also shows that there is strong relationship between crime rate and Artisanal Gold Mining in the study area.

Vegetation and water bodies were lost in the study area due to the activities of the Artisanal Gold Miners in Gidan Mai Wayo community. Some chemicals such as ph, Iron (mg/l),

Mercury (mg/l), Sulphates mg/l, Arsenic mg/l, Turbidity (NTU) recorded in Wells and Boreholes closer to Artisanal Gold Mining sites are higher compared to Wells and Boreholes that are not close to the Mining sites. It is also observed that Artisanal Gold Mining affects the physical and social development of Gidan Mai Wayo Rural Settlement.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The activities of Artisanal Gold miners in Gidan Mai Wayo rural community have negatively affected the environment in many ways and also neglected environmental laws and auditing, for example; lack of land reclamation after excavations in search for Gold, Deforestation, Biodiversity Threatened, Loss of farmland and Economic trees, Pollution of the environment, Noise, Decrease in water quality, increase in crime rate to mention but few. These environmental challenges have affected the physical and social development of Gidan Mai Wayo community and it has portrayed the augment that the Artisanal Gold Mining in the community has affected the rural development, sustainability and the livelihood of the dwellers.

5.2 Recommendations

- i. Other sources of Rural Livelihood such as; Farming, Fishing, Hunting should be encouraged so as to discourage people from engaging in illegal mining.
- ii. The Government should proscribe Artisanal Gold Mining as illegal activity and lay down strict penalty for its practice.
- iii. The residents should report to the relevant authorities any suspicious act by the miners to avoid breakdown of law and order.
- iv. There should be awareness to the residents and the miners on the hazard of exposure to mercury and other toxic substances generated from Artisanal Gold Mining activities.

- v. Where Artisanal Gold Mining can't be banned completely, the practice should be environmentally friendly.
- vi. The residents of the community should treat the water from the wells borehole or look for alternative source of water
- vii. Reclamation of degraded lands should be enforced on the Artisanal Gold miners.
- viii. The Artisanal Gold Miners should engage in Mining techniques that are environmentally friendly and safe to human health.

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APPENDICES

APPENDIX A

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

SCHOOL OF POSTGRADUATE,

DEPARTMENT OF URBAN AND REGIONAL PLANNING

Questionnaire on: Assessment of the Impact of Artisanal Gold Mining in Gidan Mai wayo community, Niger state, Nigeria. (For Miners)

Please kindly supply the information bellow, it is strictly for academic purpose and would be treated confidentially.

1. Gender

2. (a) male [] (b) Female []

3. Age

(a) Less than 20yrs (b) 21-30 yrs [] (c) 31-40 yrs [] (d) 41- 50 []
51- 60 yrs [] (e) Above 60 []

4. Marital status

(a) Single [] (b) Married [] (c) separated [] (d) divorced

5. Occupational Structure

(a) Civil Servant [] (b) Business [] (c) Private [] (d) Trader []
(e) Artisan [] (e) Others specify_____

6. Monthly Income

(a) Less than 7,500 [] (b) 7,501 – 15000 [] (c) 15,001 – 25000 []
(d) 25,001 – 35000 [] (e) Above 35,000 []

7. Highest Qualification

(a) Primary [] (b) O' Level [] (c) ND/NCE[] (d) 1st Degree/HND []

(e) M.Sc/M.Tech & Above

8. Duration of stay in the Area

(a) Below 1 yr [] (b) 1- 5 yrs [] (c) 5 – 6 yrs [] (d) 6 – 10 yrs []
(e) Above 10 yrs []

9. Source of water for Domestic Use? (a) Well [] (b) Borehole [] (c)
Water vendors [] (d) Pond/stream [] (e) pipe born water []

10. What Technique do you use to extract the gold? (a) Placer mining method []
(b) Panning method [] (c) Sluicing method [] (d) Rocket Box method []
(e) Hard Rock mining method [] (f) By product gold mining method []

11. What Gold Dressing method do you use? (a) Mercury amalgamation method []
(b) Gravity separation (Amalgamation) cyanide process [] (c) Flotation process []
(d) Gravity separation (Amalgamation) flotation process [] (e) Cyanidation (Full
mud cyanidation) process []

APPENDIX B
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF POSTGRADUATE,
DEPARTMENT OF URBAN AND REGIONAL PLANNING

Questionnaire on: Assessment of the impact of artisanal gold mining in Gidan Mai wayo community, Niger state, Nigeria. (For the Residents)

Please kindly supply the information bellow, it is strictly for academic purpose and would be treated confidentially.

12. Gender

13. (a) male [] (b) Female []

14. Age

(a) Less than 20yrs (b) 21-30 yrs [] (c) 31-40 yrs [] (d) 41- 50 []

51- 60 yrs [] (e) Above 60 []

15. Marital status

(b) Single [] (b) Married [] (c) separated [] (d) divorced

16. Occupational Structure

(b) Civil Servant [] (b) Business [] (c) Private [] (d) Trader []

(e) Artisan [] (e) Others specify_____

17. Monthly Income

(b) Less than 7,500 [] (b) 7,501 – 15000 [] (c) 15,001 – 25000 []

(d) 25,001 – 35000 [] (e) Above 35,000 []

18. Highest Qualification

(b) Primary [] (b) O' Level [] (c) ND/NCE[] (d) 1st Degree/HND []

(e) M.Sc/M.Tech & Above

19. Duration of stay in the Area

(b) Below 1 yr [] (b) 1- 5 yrs [] (c) 5 – 6 yrs [] (d) 6 – 10 yrs []

(e) Above 10 yrs []

20. Source of water for Domestic Use? (a) Well [] (b) Borehole [] (c)

Water vendors [] (d) Pond/stream [] (e) pipe born water []

21. Do you engage in any business with the Miners? Yes [] No []

22. Do the Mining activities affect your Livelihood? Yes [] No []

23. Have you lost farmland to the Mining? Yes [] No []

24. How can you describe the Mining in the area? Possitive [] Negative []

25. Do you want the government to regulate or stop the Mining in the community? Yes
[] No []

APPENDIX C

Plate of grinding machine and sacked ore



GRANDING MACHINE



SUSPECTED ORE

APPENDIX D

Contingency table of the relationship between Crime Rate Before and After Artisanal Gold Mining Activities

Contingency Tables

Before Artisanal Gold Mining (Annual Average)	After Artisanal Gold Mining (Annual Average)													Total
	0	1	16	21.4	3	31.5	5	6	7.2	78.3	8	8.5	89.4	
0	3	1	0	0	0	0	1	1	1	0	1	0	1	9
1	0	0	0	0	1	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	0	0	0	0	1	0	1
4	0	0	1	0	0	0	0	0	0	1	0	0	0	2
8	0	0	0	0	0	1	0	0	0	0	0	0	0	1
9.3	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Total	3	1	1	1	1	1	1	1	1	1	1	1	1	15

APPENDIX E

The summary of the research methodology is presented in the table below

Objectives, Data Needed and Analysis Techniques

Objectives	Data Needed	Sources of Data	Analysis Techniques
i. To Identify the Artisanal Gold Mining sites in the study area	Base map of the study area, Coordinates of the mining sites, Population of the study area, Size of the mining sites	Primary sources (observation) and Secondary sources (NPC, Niger State Ministry of Lands and Housing and National Bureau of Statistics)	Mapping and satellite image classification
ii. Evaluate the existing Artisanal Gold Mining practice in the study area.	Reconnaissance Survey of the site, Satellite image of the mining site, Questionnaire Administration on some of the Artisanal Gold Mining practices, Standards on mining	Primary sources (Questionnaire, interview and observation) and secondary sources (United State Geological Survey Department, Reports)	Checklist
iii. Examine the relationship between crime rate before and after Artisanal Gold Mining activities in the study area	Police records	Primary sources Test (Questionnaire, interview and observation) and secondary sources (Police records)	Chi-square

Iv. Assess the effects of Artisanal Gold mining on the physical environment of the community	Base map of the study area, Satellite image of the study area, Farmland lost to due to mining activities, Economic trees lost due the mining activities, Purity of the water around the mining sites, land reclamation approach if available	Secondary sources (Niger State Ministry of Lands and Housing and National Bureau of Statistics)	Satellite image classification
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