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SCHOOL OF GRADUATE STUDIES

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

ENVIRONMENTAL ENGINEERING CHAIR

EVALUATION OF ENVIRONMENTAL IMPACTS OF MINING TECHNOLOGY: A CASE OF SAND, SOIL AND GRAVEL MINING IN GAMBELLA TOWN, SOUTH WEST OF ETHIOPIA:

BY:

NHIAL DUOTH KHON

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN JIMMA UNIVERSITY, JIMMA INSTITUTE OF TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR MASTER DEGREE OF SCIENCE IN ENVIRONMENTAL ENGINEERING

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DECLARATION

I declare that this thesis work entitled "evaluation of environmental impacts of mining technology in Gambella town, south west of Ethiopia: A case of sand, soil and gravel mining." is my original work, and it has not been presented as a prerequisite for any master degree at Jimma university or elsewhere, and that all sources of materials utilized in this thesis have been properly acknowledged.

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With our consent as university supervisors, this research has been submitted for examination.

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ABSTRACT

Mining is the extraction of valuable minerals or others geological materials from the earth,usually from an ore body or placer deposit. Mining is often asources of local employment/income and may contribute to local and regional economies .mining are very important resource for the development of the country.This research gave an insight for local studies and investigations to understand how environmental impacts of mining technology of sand,soil and have influenced both environment and peoples of the town.Therefore,The main objective of the study was to investigates the environmental impacts of mining activities on environment in Gambella town , south west of Ethiopia. Both quantitative and qualitative data gathering methods were carried out. Primary data were collected directly through questionnaires, observation and structured interviews like Focus group discussion (FGD) and Key informant interview (KII). When selecting the respondents from Gambella town's kebels, Purpose sampling technique was used. Data were coded and entered before to analysis then for analysis of data that were gathered, descriptive data analysis had been used. Field measurements and observation data had been analyzed using the selected sampled points that had been analyzed using Statistical Package for Social Science (SPSS) and Microsoft excel, while secondary data were collected through reviewing the literatures and Gambella mining and energy manual reports. Sample size for this study had been two hundred respondents which include keys informants and focus group discussion. The result of both qualitative and quantitative data that were gathered has been presented by tables, pie charts, graphs and which was generated through household questionnaires had been analyzed using descriptive statistical tools such as frequency, percentage. The finding indicates that Majority, 66% of the respondents reported to benefit from the sand mining activity and soil components by getting cheap sand for construction of theirs house. However, Finding had shown 92.5% of the respondents strongly agreed that they were negatively affected by the activity. The finding revealed that most peoples by 76.5% in the town are living near the mining areas, especially peoples inhabiting the Jibjiba River, pamur river and echucy baro river sites. Majority of the respondents, (94.5%) who had been participated in the study are aware of accidents. However, Results of the study noted that rivers those removals of rivers sand have led to widening and deepening of the rivers as negative impact by 48%. Soil components and gravel are excavated from open area that created uncovered pits that cause accidents to children and livestock 20% living near the mined areas. The dust and noise pollution from Sino-truck transporting sand and soil are pollution effects concerns of the villagers as Sino-truck are passing through the town. The study concluded that. The environmental change such as population, standard of living, and technology which affected the sustainability of mining on the environment is greatly happened in this particular town. At every season being summer or winter, mining activities have been done negatively rather than considering the negative environmental impacts they had brought to the environments, therefore environmental impacts that it left is a great damages to both communities of the town and the environments.

Keywords: *Environmental impacts, Extraction, Gambella Town, Grave, Mining, Sand and Spss.*

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LIST OF ACRONYMS AND ABBREVIATIONS

CSA	Central Statistical Authority
DOE	Department of Environment
EIA	Environmental Impact Assessment
EMA	Environmental Management Authority
EPA	Environmental Protection Agency
EMP	Environmental Management Plan
FGD	Focus Group Discussion
GDP	Gross Domestic Product
KII	Key Informant Interveiws
NEMA	National Environment Management Authority
ME	Microsoft Excel
SPSS	Statistical Package for Social Sciences
UNCED	United Nations Conference on Environment and Development
VDC	Village Development Commit
VH	Village Head

CHPATER ONE

1. INTRODUCTION

1.1.Background

Mining is the extraction of valuable minerals or others geological materials from the earth,usually from an ore body or placer deposit. Mining is often asources of local employment/income and may contribute to local and regional economies (Fleming Da and Mesaham Ta, 2014) and (Knobblock Ea and Pettersson O``,2010). mining are very important resourceforthedevelopmentofthecountry.

Sands are now being extracted at a much faster pace than their renewal rate. For example, building and land-reclamation projects exhausted marine sand resources in Dubai, and the country now imports its sand. This extraction is having a major impact on rivers, deltas and coastal areas, and has affected the provision, protection and regulation of ecosystem services. Dredging and extraction of aggregates destroys organisms, habitats and ecosystems, and deeply affects the composition of biodiversity.

The extraction of aggregates in rivers has led to severe damage to river basins, in particular lowering of the river bed and therefore water tables. This has increased the incidence and severity of droughts, as tributaries of major rivers dry up when sand extraction reaches certain thresholds. Sand extraction has also increased river pollution(Christiansen *et al.*, 2020). Marine mining has resulted in beach erosion. This is despite the fact that beaches are crucial in protecting land, especially given rising sea levels. The environmental impacts of sand extraction have economic consequences. Tourism may be affected through beach erosion, while fishing is impacted through destruction of benthic fauna. Agriculture could be affected through loss of agricultural land from river erosion and, as mentioned above, the lowering of the water table. A two-pronged approach has been proposed to reduce sand extraction (UNEP, 2014): Large-scale mining, quarrying and reclamation activities should only be authorized once sound scientific assessment shows there would be limited impact on the environment. Extraction should reflect the true cost of mining. Sand extraction should be properly taxed, so that other options become economically viable. Mining can result in land use change and may have associated with negative impacts on the environment including deforestation

erosion,contamination and alteration of the soils components,contamination of local streams,wet lands and an increase in noise level,dust and emission(Warhate *et al*., 2006). mining abandonment,decommissioning and repurposing can also resulte in significant environmental impacts like soil and water contamination. Mchaina D,(2001) and Veiga MM and Hinton JJ, (2002). Mining can also have positive and negative impacts on humans and societies.those negative impacts may includes human healths and living standards.(Stephen and Ahern ,2001) and (Loayza and Rigolini, 2016).

Mineral resources are a potentially great source of wealth for poor countries. Minerals resources, such as copper, diamonds, gold and tin, can provide with large revenues that can be used to alleviate poverty (for example, economic growth can contributes to poverty reduction via creating jobs, therefore, generate income for workers and their families). According to World Bank, small scale mining can provide employment for about 13 million workers across the world whereas large-scale mining provides direct employment for about 203 million worker. Artisanal and small-scale mining (ASM) in Africa have been identified as an important economic opportunity for people in rural areas . In fact, artisanal mining is largely driven by poverty; and may complement more traditional forms of rural subsistence earning.

Mining is a significant primary industry and contribute to the nation's economy. The minerals extracted (metallic, non-metallic or industrial minerals) are used for a wide a range of purposes including electrical generation, production of cement, steel, agricultural lime, commercial and residential building materials, asphalt (bitumen), and medicines, jewellery, as well as countless household, electronic, and other manufactured products.

Mining is required to obtain any material that cannot be grown through agricultural processes, or feasibly created artificially in a laboratory or factory. Mining in a wider sense includes extraction of any non-renewable resource such as petroleum, natural gas, or even water. Modern mining processes involve prospecting for ore bodies, analysis of the profit potential of a proposed mine, extraction of the desired materials, and final reclamation of the land after the mine is closed. mining is known to affect traditional practices of indigenious peoples living in near by communitie and conflicte is often present (GibsonG, and Klinck J,2005).

Though mining is a major economic activity in many developing and developed countries, however mining operations, whether small- or large-scale, are inherently disruptive to the environment, producing enormous quantities of waste that can have deleterious impacts for the environments. Mining operations usually create a negative environmental impact, both during the mining activity and after the mine has closed. The mining industry is the most significant industrial producer of solid, liquid and gaseous wastes. Mining wastes can be categorised into mining, processing and metallurgical wastes. For example, mining wastes (e.g. open pit and underground mining) can contain waste rocks, overburden, spoils, mining water, atmospheric emissions.

Mining and mineral exploration can impact on the environment (air and water pollution) via generation of wastes (hazardous substances such as heavy metals, metalloids, sulfate, radioactive substances (uranium), fly ash (residues generated in combustion of coal), acids (sulfate), and processed chemicals (cyanides). In addition, mining may produce noise pollution, dust pollution and visual pollution and may cause destruction and disturbance of ecosystems and habitats, erosion, formation of sinkholes, loss of biodiversity and contamination of soil, groundwater and surface water(Case *et al*. 2010). Acid mining drainage (AMD) from waste rocks, tailings, and other mine components, is the single most important environmental concern in the mining industry. Thus, most of the world's nations have passed regulations to decrease the impact. Work safety has long been a concern as well, and modern practices have significantly improved safety in mine.

The UN Millennium Ecosystem Assessment determined that environmental degradation is more prominent with in wetland systems than any other ecosystem on earth. The international conservation efforts are being used in conjunction with the development of rapid assessment tools to inform people about wetland issues (Amponsah-dacosta 2009). Rivers in the southwest cost of India are under immense pressure due to various kinds of human activities among which indiscriminate extraction of construction grade sand is the most disastrous one (Padmalal *et al*., 2008). Sand mining is the extraction of sand mainly through an open pit but sometimes mined from beaches and inland dunes or dredged from ocean and River beds. Sand is often mined and used in manufacturing for example as an abrasive or in concrete. Sand mining presents opportunity to extract rutile, limonite and ziron, which contains the

industrially useful elements like titanium and zirconium in the world today (Padmalal *et al*., 2008).

Sand and gravel are crucial resources to economic development activities in developed and developing nations. Recovery from river channels, flood plains and glacial deposits as well as processing of these resources is costly but valuable in construction and industry (Atejioye and Odeyemi 2018). Also, Bagchi, (2010) supported Kuttipuran, (2006) on that construction boom fueled the demand for sand and gravel facilitating uncontrolled extraction which threatens existence of river systems. Illegal mining of mineral resources in India such that the country's natural resources are destroyed as forests are clean felled. Sand mining in Africa is highlighted that the activity is rapidly becoming an ecological problem as demand for gravel and sand increases. The resources are used in the construction of strong structures which improves the social economic lives of most Africa though with noticeable negative environmental impacts (Atejioye and Odeyemi 2018) and Lawal, (2011).

Ethiopia located in the Horn of Africa between latitudes and longitudes which covers a land area of about 1.14 million km with a population of over 73 million. Kenya, Djibouti, Somalia, Sudan and Eritrea are the neighboring countries. Ethiopia has adopted federal administrative system comprising of 9 regional states and two City Administrative Councils. The geology of Ethiopia ranges from oldest (Precambrian) to recent volcanic and sedimentary formation. The oldest (Precambrian) rocks host most of the economic metallic mineral deposits that include primary and secondary enriched (placer) gold, platinum, platinum group elements (PGE), nickel, tantalum, base metals (like copper, lead and Zinc), industrial minerals (like phosphate, iron ore), gemstones (like ruby, emerald, sapphire, garnet, etc) and also decorative and dimension stones such as marble, granite and other coloured stones.

Ethiopia has a huge potential of various mineral resources, but not yet well explored and exploited, and hence its contribution to the overall economy or GDP is low. However, as reported by the World Bank Group (2014), its contribution to the foreign exchange earnings reached about 10% of which the artisan mining takes the lion's share of over 65%. Ethiopian economy is dominantly based on the primary economic activities, which have left impacts on the society, traditions, working style, resource utilization and trade since millennia (Asiedu

2013). Ethiopia has favorable geological environment hosting varieties of mineral resources. Gold potentials sites are confined to Precambrian basement rocks known as Northern, Western and Southern greenstone belts. The Greenstone belts have large potential for any scale of gold mining. Small scale gold mining has been basic mineral and rocks production throughout the older civilianization of the country. The placer gold deposit has been mined traditionally for several thousand years back to biblical times (Young 1999).

Gambella region is located in south west of the country (Ethiopia). It is766 km from Addis Ababa and is between Latitude in the North and Longitude in the east. It shares borders in the West with Republic of South Sudan, in the East with Oromia and SNNP regional states, in the North with Benshangul Gumuz and Oromia regional states and in the South with SNNP regional state. Based on the projection from 2011 CSA census, it has a population of 465,401 (48% female and 52% male) in 2011 EFY. Most part of the region is considered as extended low land with highland in the eastern part, surrounded by chain of mountain in the north and north east descending down to the wide flat land to the west.

Gambella has a huge potential of various mineral resources, but not yet well explored and exploited, and hence its contribution to the overall economy is important. Its contribution to the developmental activities of the region show the significantly of mineral resources in the region.The royalties which are collected every month through the mineral and energy developmental agency has contributed to the economical values of the country as whole. Though mining activities of this sand, gravel and quarry sites of granite contribute to economy development of the region, though it disrupted the environment.

1.2. Statement of problem

In some parts of the world through the study of environmental impacts of mining, factors affecting environmental changes are population, standard of living and technology (mining methods used) were identified (Rubin & Leiby, 2001). Challenges were identified in the selected villages included the environmental protection absence, administrative challenges, issues which relate to policy and political interference. These mined resources are cheap, accessible and lead to environmental impacts which many associations involve in its mining both legally and illegally without considering the harms they are causing to the environment

Draggan, (2008). The majority of rural areas in Africa like in South Africa, Ghana, Uganda and Kenya are experiencing the challenges of environmental impacts of mining activities because they cannot apply appropriate management and environmental policy. In Ethiopia, the mining legislation of Ethiopia, which came in to effects in 1993 has provision that requires as a compulsory criteria to study ,submit and get approval of environmental impacts assessment from respective Authority in order to develop large scale mining projects. In Southern Ethiopia, About 75 percent of mines are leaving legacies environmental impacts and large costs for public UNDP, (2018) and Arsema Girma, (2009). There are some studies that have been done in other areas of Africa; like South Africa and others Regions of Ethiopia about evaluation of environmental impacts of sand, soil and gravel mining. In the same way Gambella town has the same problem as other districts of Ethiopia and other parts of Africa in general that needed to be study. In the above findings, it shown that there are problems that let environmental impacts managements not to be sustainable. Therefore, the researcher had assessed the environmental impacts of sand, soil and gravel mining in Gambella town. The mining activities and expansion of the town development have become environmental impacts of the inhabitants of the town in particular, due to this expansion the demand of sand and soil components for town developmental activities has become the main environmental impacts to the community. However, The miners or mines associations have develop interest in mine and increase the production rate of mining activities (sand, gravel and soil components) with in the town which lead to negative impacts on environment. Therefore, this supply of construction materials to the community in the town has negative environmental impacts on the environments. Thus, the researcher wants to investigate both the positive and negative environmental impacts of mining activities in the town with particular mineral mined most and make the recommendation and mitigate the sustainable use of mining activities and appropriate managements policy.

Again there is no research that has been attempted in this topic in this area that is the goal of the researcher to focus on this topic.

1.3.Objectives of the study area

1.3.1. General objectives

- To investigate environmental impact of Sand, Soil and Gravel Mining on environment in Gambella Town, south west of Ethiopia.

1.3.2. Specific objectives

- To analyse the size of pits where river sand, grave and soil components sites are excavated for obtaining Sand, Soil and Gravel Mining in the area .
- To evaluate the positive and negative environmental impacts of Sand, Soil and Gravel Mining on environments in the area.
- To give appropriate recommendation and mitigation approaches of Sand, Soil and Gravel Mining that can reduce negative and enhance positvie impacts?

1.4. Research Question

- What are the Soil components or Minerals mined most?
- What are the positive and negative environmental impacts of Sand, Soil and Gravel Mining?
- Which appropriate recommendations and mitigations measures that can be given to reduce the negative and enhance positive impacts of Sand, Soil and Gravel Mining?

1.5. Significant of study

Data from this study were contributed to improve the understanding of the environmental impacts of mining activities that affects the safety of the environments. The data that had been also assessed in the study area, hence contributed to the sustainable management of mineral resources used in the area. This helped to understand and implement environmental impacts of mining activities management strategies. The information assessed have been represented an important preliminary tool in decision making pertaining to the management of environmental impacts of mining technology.

The finding of this study had been shown that the primary beneficiary of this research output will be the community in the study area in general, non-governmental organizations and

government sectors in particular. Finally it would help as a reference or literature for practitioners who are interested to investigate on the related issues. Furthermore it could serve as a source for future researcher in this particular area.

1.6 Scope of the study area

The study area is very vast, consist of the three zonal administration ,with one special woreda, thirteen woreda and many kebels under each zone and woredas, but the researcher had been concentrated on environmental impacts of mining technology with in the Gambella town in specific areas as 01, 02, 03 and 05 kebeles (villages) in particular where huge mining activities occur on Jib jibe river, Pameri river, Baro river (echuey site) and open pit areas of Yahweh site, Kermet site and Welonga site. The researcher had studied the environmental impacts of mining technology specifically in Gambella town with specific minerals which are mined most in the study area. As sand pit mining, river sand mining, gravel aggregate, soil mining and the quarry sites are mined most in the town, the researcher had done his research with in those sites of minerals.

The researcher selected Gambella town purposively because of the massive construction activities going on there as the regional town expand that is first priority .the extraction of sand, gravel, soil components and quarry sites of aggregate demand increase in the region with the increase of those developmental activities the accessibility of the study area is the second priority of researcher. There were positive potentials environmental impacts on others side of the region of mining activities as described above, but the insecurity and accessibility problems have made the researcher to focus with in the main town. .

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Theoretical reviews

2.1.1 Concept and term definition

Soil is an important resource covering the land surface. Human community depends on soil for agriculture, construction and even as a habitat for various organisms (Mwangi, 2007).People benefit from soil particularly sand but interface and disturb the resource through excessive exploitation to fulfill their needs. There is worldwide concern about the environment which prompted this study.It provides information about sand mining impacts on environment and peoples who are hoped to guide the policy makers most especially in the conservation sector to come up with better regulations aimed at conserving wetlands and making sand mining sustainable to promote a natural sustainable ecosystem to biodiversity. The following key concept definition is definite for the purposes of the study.

Environmental impacts: these are effects (positive and negative) on the natural surrounding as a result of an activity for the purpose of the thesis. Some indicators are air, dust, noise, water pollution, land degradation. Mining: is the extraction of valuable minerals or others geological materials from the earth, usually from ore body. Mining can also be required to obtain any materials that cannot be grown through agriculturally processes, or feasibly created artificially in laboratory. Impacts: is the action of one object coming from other things in to contact with another.

2.1.2 Theories of mining impacts on environment

The frequently severe and enduring impacts of mining activities on the natural environment are widely reported. For instance, surface mining often cuts back forest and other vegetation cover, removes topsoil and introduces heavy machinery (which can be particularly damaging in fragile environments). Chemicals and other harmful substances used to process ores can enter waterways and the natural environment when not managed appropriately. There is often an extensive amount of mine waste that can be toxic in nature, posing a significant risk

through failures of storage facilities to contain the waste. There have been a number of catastrophic events linked to failures of large facilities, such as the Samarco tailings dam disaster in Brazil in November 2015 (Hatje *et al.*, 2017). In addition, mining does not happen in isolation. There is arranging of ancillary activities to support operations, including roads, railways, energy generation facilities and so on. Where mines are located in remote areas, the need for new infrastructure and energy generation can be particularly important to consider. The extent and severity of mining impacts on the environment depend on the type of operation and the sensitivity of the environment (and these vary throughout the life cycle of the project). The impacts of mining can extend beyond the operations of the mine. Closed mines have the potential to cause environmental damage as well as posing a risk to safety. Therefore, the potential impacts throughout the whole life cycle of a project, and for years beyond closure of the mine itself, need to be considered. The environmental impacts of extractive activities are summarized below, with a view to outlining key parameter. For a more detailed discussion, see (Dolega *et al.* 2016).

The three prominent factors affecting environmental changes are population, standard of living and technology (Rubin & Leiby, 2001). Standard of living or the level of affluence of the population is usually measured in terms of economics such as Gross Domestic Product (GDP) per capita. The more affluent the population, the more goods and services demanded, and the greater the resulting environmental impacts. Third critical factor is technology- the vehicles for delivering the goods and services that people demand. These three factors are closely interrelated with each other. They are the principle drivers determining future land use pattern, natural resource requirements and pollutant emissions to air, water and land. However the environmental impacts of human activities like sand mining depend directly on the number of people inhabiting in the area(Rubin & Leiby,2001). Sand extraction from river channels and overbank areas causes local disruptions which can be anticipated and prevent through appropriate EIA's (Chamley, 2003).After recording various environmental problems of river sand mining in various physiographic zones, an EIA was carried out to suggest appropriate Environmental Management Plan (EMP) for regulating the mining on a sustainable basis.

A study by Mutiso (2012) on the impact of sand mining on education of pupil in primary school in Kathiani district found out that sand harvesting negatively influence the education of pupil in terms of school attendance this because most of them are involved In sand harvesting activities during school hours and days. The study also found out that pupils tend to drop out starting at standard six and reach a peak at standard seven just before getting to the final year of primary school cycle at standard eight levels the teacher's aid dropout had increased by 66.25%. The dropout cases were as a result of pupils being involved in sand harvesting activities. The socio economic effects of sand harvesting are not well known and the study was carried out to fill this gap (Mensah, 2002). In his study in Ghana noted that sand harvesting is causing child labor of children aged 14 years assist their mothers in sand harvesting. For Mensah to some extent sand harvesting is increasing employment opportunities, Mensah also noted social economic factors are the main reasons why people undertake sand harvesting.

The uncontrolled sand mining, the sand contractor fetch minimal daily wages rate of US $ 55.47 per day, while sand carriers and loader make daily net income of US $ 1.54 and US $ 2.16 respectively. This is high margin showing the contractors earn more than the loaders. A study on the Franc Sand harvesting and Community Economic Development found that communities that are more heavily dependent on harvesting for employment tend to experience greater negative impacts after the mines closed then positive impacts while the mines are in operation including the inability to afford basic healthy requirements. But on the other hand, sand mining appears to be associated with poorer overall health levels within the community.

Though as much as it has contributed to the improvement of the people's lives it has also led to the development of negative effects of sand including permanent loss of sand in areas as well as habitat destruction (Naveen, 2012).Various animals depend on sand beaches for nesting clutches, and mining has led to the near extinction of gharials species of crocodile in India. Disturbance of underwater and coastal sand causes turbidity in the water, which is harmful for organisms like coral that need sunlight. It can also destroy fisheries, financially harming their operators. Removal of coastal barriers, such as dunes, sometimes leads to flooding of beachside communities, and the destruction of picturesque beaches causes tourism

to dissipate. Sand mining is regulated by law in many places, but is often done illegally. (Land and Environment: sand mining). Globally, it is a $70 billion industry, with sand selling at up to $90 per cubic yard (Mills & Staats, 2016).

Excessive sand mining affects the wetland ecosystem were by it negatively impacts the adjoining ground water system and the uses that local people make of the wetland, destruction of aquatic and riparian habitat through large changes in the channel morphology, cause the entire stream bed to degrade to the depth of excavation, it changes the sediment budget and cause bed degradation which results into changes in channel hydraulic.

2.2. Empirical review

2.2.1 .The Environmental Impacts of Mining

Mining is an activity that needs to be very properly planned with all likely, probable and possible impacts anticipated, identified, evaluated and mitigation, measures planned because it is a short-term activities with long-term effects (Abdus –Saleque, 2008). The issue is that mining involves a lot of stages which usually begins from deposit prospecting and exploration stage, mine development and preparation stage, mine exploration stage and treatment of the mineral itself with each of these stages involving specific environmental impacts (Gualnam, 2008). It is also noted that the preparation of access routes, topographic and geological mapping, geophysical work, hydro-geological research, deforestation of the land and elimination of vegetation affecting the habitats of hundreds of endemic species, consequent erosion and silting of the land, reduction of water table, contamination of the air, water and the land by chemicals such as cyanides, concentrated acids and alkaline compounds and air pollution caused by dust, gases and toxic vapour can have diverse affect on the environment and health and social life of the local communities (Abdus-Saleque, 2008). Hence, it is not wrong to assume that the impacts of mining are related to mining itself, which frequently involves or produces hazardous substances and causes destruction in the natural environment in one way or the other.

In fact, environmental impacts of mining are well documented and the literature abound with environmental impacts in the form of waste management, impacts to biodiversity and habitat, deforestation of land with the consequent elimination of the vegetation, pollution (water, air,

land and even noise pollution) etc. In Ghana and many other tropical areas of mining, it is noted that mining is a major cause of deforestation and forest degradation, generating a large number environmental impacts (World Rainforest Movement, 2004). Surface mining alone is on record to represents a serious threat to the last vestiges of Ghana‟s forest resources and threatens the rich biodiversity of the country's tropical rainforest, which has raised concern about the question of sustainable forest management and mining activities (World Rainforest Movement, 2004). In addition to the threat posed by mining to biodiversity, the removal of the forest cover is swiftly drying up rivers and streams, resulting in the extinction of river hosted animal and plant species associated with tropical rainforest. Even, many communities complain that snails, mushrooms, medicinal plants, etc. are no longer available in the areas of mining due partly to mining activities (World Rainforest Movement, 2004) in addition to the numerous health problems such as malaria, tuberculosis, conjunctivitis and other skin diseases posed by mining activities (World Rainforest Movement, 2004).

It has been found out that due to the negative environmental impacts of mining activities in Obuasi by the Ash Gold Mining Company, the health of most of the people in that community is very poor with a high prevalence of upper respiratory tract infection (URTI) in the area which medical experts attributed to the mining activities and its associated pollution, arsenic poisoning (Awudi, 2002). In addition, mining impact related diseases such malaria, diarrhoea, upper respiratory tract infections, skin disease, acute conjunctivitis and accidents is noted to be high in Tarkwa, another mining community in Ghana (Awudi, 2002).

It is noted that large-scale mining activities generally continue to reduce the vegetation of most of the mining communities to levels that are destructive to biological diversity (Akabzaa & Darimani, 2001). In Mongolia, it is stated that deterioration in water quality resulting from water pollution, mercury pollution, waste rock piles and tailings repositories as well as air pollution has been a major characteristic of mining induced impacts in communities where mining operations are undertaken (The World Bank, 2006). Again, a major environmental problem have resulted in most mining communities in Ghana and is largely brought about by the mining boom which requires massive vegetation clearance and land excavation, waste disposal, mineral processing and misuse of mining. Four statement Nil, Minimum (min), Medium (med) and Maximum (max) on each environmental components

2.2.2. Environmental impacts of mining technology in the world

Mining activities that comprise the sand mining, the gravel extraction and the mineral processing are the worldwide activities in the developing and the developed countries that was realized by Draggan(2008).the lead in mining activities and processing of sand, gold and gravel aggregate mineral resources are America ,Australia ,Austria ,South Africa, Spain and Kenya. These resources are cheap and accessible which many associations involve in its mining both legally and illegally without considering the harms they are causing to the environment Draggan (2008).

2.2.3. Environmental impacts of mining technology in Africa

The excessive removal of soil for construction industry in urban development especially in Africa has great concern on ways the environment is disturbed. Sand and gravel aggregates have been used as construction materials to construct strong houses, roads and dams for many years in Africa since they are accessible and cheap resources Mwangi(2008). Africans have improved socio-economic life generally as the demand of sand and gravel extraction has increased. The positive and negative impacts of mining technology of soil mining was discussed as a threat to the environment by Mwangi(2007). Sand mining case study survey in Machakos District of Kenya which have increases mining activities due to the for soil in construction industry reported by Wachira(2009) to supported Mwangi explaination.

2.2.4. Positive environmental impacts of mining technology in the worldwide

Sand and gravel have been fundamental to human existence and a useful natural resource for many years in worldwide. Today, demand for sand and gravel has increased. Mining operators in conjunction with resource agencies need to work hard and make sure the extraction is done responsibly Sand and gravel as crucial resources to economic development activities was discussed by Schaetzl(1990) when making aggregate in Unites states of America. Development is a process of adding improvements to a piece of land such as grading, drainage and access roads. Schaetzl defined aggregate as a substance made from several materials such as river sand and gravel.

2.2.5. Negative environmental impacts of mining technology in the world

Sand and gravel are important natural resources in economic development worldwide but the continuous removal have adverse effects on the environment. Negative environmental impacts seem to outweigh positive effects in mining worldwide. Different negative impacts had been noted in United States of America due to in stream mining occurring in rivers and streams. Kondolf (2007) defined in stream mining as the mechanical removal of gravel and sand directly from an active channel. Forms of in stream mining such as pit excavation and bar skimming, causes bed degradation of rivers known as channel incision. The process occurs as head cutting or hungry water. When head cutting extraction is done on active channel, it lowers stream bed to create a nick point which steepens channel slope and increases flow energy.

Mining is an activity that needs to be very properly planned with all likely, probable and possible impacts anticipated, identified, evaluated and mitigation, measures planned because it is a short-term activities with long-term effects (Abdus –Saleque, 2008). The issue is that mining involves a lot of stages which usually begins from deposit prospecting and exploration stage, mine development and preparation stage, mine exploration stage and treatment of the mineral itself with each of these stages involving specific environmental impacts (Gualnam, 2008). It is also noted that the preparation of access routes, topographic and geological mapping, geophysical work, hydro-geological research, deforestation of the land and elimination of vegetation affecting the habitats of hundreds of endemic species, consequent erosion and silting of the land, reduction of water table, contamination of the air, water and the land by chemicals such as cyanides, concentrated acids and alkaline compounds and air pollution caused by dust, gases and toxic vapour can have diverse effect on the environment and health and social life of the local communities (Abdus-Saleque, 2008). Hence, it is not wrong to assume that the impacts of mining are related to mining itself, which frequently involves or produces hazardous substances and causes destruction in the natural environment in one way or the other.

In fact, environmental impacts of mining are well documented and the literature abound with environmental impacts in the form of waste management, impacts to biodiversity and habitat, deforestation of land with the consequent elimination of the vegetation, pollution (water, air,

land and even noise pollution) etc. In Ghana and many other tropical areas of mining, it is noted that mining is a major cause of deforestation and forest degradation, generating a large number environmental impacts (World Rainforest Movement, 2004). Surface mining alone is on record to represents a serious threat to the last vestiges of Ghana's forest resources and threatens the rich biodiversity of the country's tropical rainforest, which has raised concern about the question of sustainable forest management and mining activities (World Rainforest Movement, 2004). In addition to the threat posed by mining to biodiversity, the removal of the forest cover is swiftly drying up rivers and streams, resulting in the extinction of river hosted animal and plant species associated with tropical rainforest. Even, many communities complain that snails, mushrooms, medicinal plants, etc. are no longer available in the areas of mining due partly to mining activities (World Rainforest Movement, 2004) in addition to the numerous health problems such as malaria, tuberculosis, conjunctivitis and other skin diseases posed by mining activities (World Rainforest Movement, 2004).

It has been found out that due to the negative environmental impacts of mining activities in Obuasi by the AshGold Mining Company, the health of most of the people in that community is very poor with a high prevalence of upper respiratory tract infection (URTI) in the area which medical experts attributed to the mining activities and its associated pollution, arsenic poisoning (Awudi, 2002). In addition, mining impact related diseases such malaria, diarrhoea, upper respiratory tract infections, skin disease, acute conjunctivitis and accidents is noted to be high in Tarkwa, another mining community in Ghana (Awudi, 2002).

Bagchi (2010) discussed environmental land and surface degradation as a serious impact of in stream mining on Indian rivers. There is damage to river banks and general ecosystems due to access ramps to riverbed. Soil erosion occurs as there is disturbance of groundwater and changes in river courses. Continuous removal of sand from river bed increases velocity of flowing water which erodes beds and banks. Kondolf (2007) noted that as the velocity increases, the river bed can propagate both upstream and downstream for many kilometers. This can lower alluvial water tables. Stebbins (2006) added that in stream sand mining causes destruction of aquatic and riparian habitat through large changes in channel morphology,

According to Bagchi (2010), there is contamination of sand aquifer water due to formation of ponds as harvesters tend to dig on areas with thick sand bed creating water ponds. Water

accumulates in ponds combined with biodegradable materials from flora and fauna wastes causing contamination. Besides, stagnant water on gravel extraction ponds form an environment conducive to mosquito breeding. Lawal (2011) agreed with Bagchi on creation of pools as a result of mining which are breeding sites for pests in Nigeria.

Several negative impacts were noted on habitats. Stebbins (2006) realized that valuable timber resources and wildlife habitats are destroyed as all species require specific conditions to ensure long term survival. Native species in stream and rivers are uniquely adapted to conditions that existed before human began large scale alterations which favors some species over others. This leads to loss of fisheries productivity, biodiversity and recreational potential. As deep pools are filled with gravel and sediments, there is a reduction in habitat complexity and large predatory fish. Channel widening causes streambed to be shallow, producing braided flow or subsurface inter gravel flow in riffle areas hindering movement of fish between pools (Stebbins, 2006). Mining operations involve deforestation, habitat destruction and biodiversity erosion (Saviour, 2012).

Schaetzl (1990) realized that sand and gravel mining generate extra heavy vehicles and traffic, impairing negatively on the environment. Heavy vehicles cause access roads on riparian zone and compact the ground. Kuttipuran (2006) supported Schaetzl (1990) on formation of access roads on river beds as heavy machinery and tipper trucks move to collection points. Some tracks are caused by pedestrians. There is general destruction to roads and bridges. This effect is felt more by villagers near mining sites as the continuous movement of heavy vehicles cause problems to cattle posts, agricultural land, borehole and well users.

Besides compacting land, heavy vehicles are a source of pollution to the villages near mining sites. According to Lawal (2011), noise and air pollution occur as dust accumulates from gravel roads which are a reality to villages near mining areas. There is general degrading of ecosystem in Nigeria. Air pollution caused by dust particles can be a health hazard causing respiratory disorders such as asthma and irritation of lungs (Saviour, 2012). The sand is also extracted from rock blasting which generate noise pollution. The ground vibrations produced

destruction of existing vegetation and soil profile significantly in topsoil affecting flora and fauna in Indian regions as mining continues. Kuttipuran (2006) supported this impact by noting that loss of vegetation and ecosystems is common around and next to Indian rivers, an eyesore which gives an offensive look to the natural beauty of the environment. Still in India, Pereira (2012) recognized that there is destruction of mangrove forests due to illegal.

Construction of storage docks, roads, infrastructure for easy mining, storage and transportation of sand from the rivers. This has increased vulnerability of land to floods in Mumbai. Aromolaran (2012) noted land degradation in agrarian community by destroying the soil surface and structure as well as declining the nutrient status of agricultural land. Lawal (2011) discussed environmental devaluation as a result of man's activities such as sand and gravel mining in Nigeria. There is loss of valuable fertile land and timber as well as habitat alterations which disrupt ecosystems and destroy native species. Increase in turbidity affect aquatic species, a major impact to fauna. Therefore, there is need for a preliminary investigation into the type of vegetation occurring there and possible impacts before mining.

Gravel extraction and pit sand mining on open areas had left open pits around expanding urban areas in United States of America (Draggan, 2008). Scenes of accidents involving children and grazing animals are common due to the open pits left on bare ground in Nigeria (Lawal, 2011). Water accumulates in the open pits during the rainy season and domestic animals drown in the pits. Livelihoods of fishermen in India are threatened by sand barges which often destroy their nets (Pereira, 2012). Loss of lives had also been recorded in India which impacted tourism, agriculture and fishing potential. Bagchi (2010) reported on accidents as common in Palakkad District of India as children drown in water filled open pits when they try to swim, thus there is loss of recreational potential for the land. Massive construction has led to excess mining which create pits and holes in farms surrounding Harare (Lupande, 2012). Pits created by miners in Botswana pose a danger to wildlife and livestock. Disturbance of land surface areas leave huge open pits difficult physically and economically to rehabilitate after mining takes place (Wokorach, 2002).

Bagchi (2010) gave other general impacts of general impacts of sand mining as a drop in water table in Godavari River in the west of India which is leading to dry wells perennially and drought. Villagers obtain the resource through tankers and pipes over long distances.

There is environmental degradation on open land and rivers as domestic purposes and animals. Mining operations deforestation erosion.(2004) a environmental impacts of mining in general to soils around mining areas in Botswana. The research concentrated on areas around Kgwakgwe Manganese Mine. Chemical

2.2.6. Environmental impacts mitigation and solution of mining technology worldwide.

The United Nations Conference on Environment and Development Report (2002), Agenda 21 advocates sustainable use of natural resources. Sustainable means ability to continue and be used for a long time. Goddard (2007) highlighted that man benefit from sand and gravel, as cheap and readily accessible resources for development, so there should be conservation and rehabilitation of these resources for future use. All governments worldwide should advocate for environmentally sustainable development.

Kondolf (2007) discussed the importance of an environmental assessment management and monitoring program as part of extraction license in America. This is necessary to minimize negative impacts as mitigation and restoration strategy will be included. Monitoring regularly is important to ensure proper mining. Mitigation processes include minimizing extent of mining, repairing and rehabilitation of mines as well as replacement of resources. There is need for re1toration and compensation of biotic integrity of ecosystems. Most soil mining affect environment and India is inclusive as Saviour (2012) noted that the country is working hard to tackle negative impacts. The miners are supposed to draft an Environmental Management Plan (EMP) which ensures that potential impacts of projects are assessed and incorporated into early stages of development planning. The preparation of EMP had become a statutory requirement for granting permits in India.

Clearance should be obtained from Department of Environment (DOE) and Ministry of Environment and Forests before permits are issued (Saviour, 2012). Kuttipuran (2006) suggested watershed restoration through replanting of riparian vegetation to replace large woody debris while conserving spawning gravel. This will re-establish ecological carrying capacity of the habitats, ecosystems and increase fish production. Aromolaran (2012) recommended the planting of trees and shrubs that could help to regenerate degraded land and

Channels with heavy tipper trucks and front end loaders. Crossing active channels with trucks may lead to contamination of water with oil spills and leakages. Wachira (2009) recommended strict laws to be imposed on license holders as a prerequisite to miners in Kenya. Mwangi (2007) recommended restriction of heavy front end loader equipment on mining areas and instead encouraged use of shovels which have less impact on the ground. Kuttipuran (2006) suggested that mining of river sand should strictly be done on larger rivers such as Bharathapuzha and Pamba in India containing a lot of sand avoiding smaller rivers and streams which may easily be destroyed. Braided river systems are recommended instead of straight, meandering and split rivers. Strictly, operators should never be allowed to divert streams and rivers creating inactive channels. Lawal (2011) recommended the use of abandoned stream channels on terraces, inactive floodplains and deltas as the best sources of gravel and sand. He noted that gravel pits on floodplain should not go deeper than water table. He recommended that pit excavations on adjacent floodplain or terraces should be separated from active channel for two to three decades by constructing buffers or levees to reduce long term flooding.

Stebbins (2006) researched on co-existence of gravel sand mines and water supply wells and revealed that continuous removal of the resources harm ground water quality. He suggested regulators to assess changes in ground water and develop a methodology on management of both resources effectively. Hill and Kleynhans (1999)'s research included recommendations to decision makers who are involved in reviewing sand mining and gravel extraction to make informed decisions when issuing licenses. Lawal (2011) encouraged Nigerian authorities to discourage indiscriminate opening up of plots for sand and gravel mining. The government should evolve a policy compelling miners to reinvest and repair old disused mine sites so as to reduce occurrences of landslides or earth tremors in the locality. Government should consider changes in market prices of sand and gravel so as to charge according to economic value of environment. Ekosse (2004) recommended remedial measures for reclamation of the contaminated soil to appropriate land use.

After reviewing the National Marine Fisheries Service (NMFS), Kondolf (2007) suggested that the government of USA should use modern technology and field sampling prior to extraction to establish and document baseline data and evaluate ways of minimizing negative

impacts. This can be done through calculating sediment and hydraulic flow budgets, then find possible changes in water quality and channel morphology. There is need to address cumulative impacts and propose possible mitigation and restoration strategies. Close monitoring permitted operations and verifying environmental safeguards by regulating extraction rates and volume is important.

2.2.7. Summary

Safe environment is a precondition for the health, developmental and a basic human right, yet it is denied to hundreds of millions of peoples throughout the developing countries (UNICEF, 2008). The study area is predominantly an agricultural zone, with dense agricultural activities. Majority of the people in this region depend on agricultural products.

The problem with sand mining or mining activities at this areas is that most people who mine it do not look at the negative side impacts of this activity on the environment but only do to maximize their personal benefits economically. In this study (paper) an attempt will be made to assess environmental impacts analysis of mining technology. The researcher have design the opportunity for the resident of the region to get involved in the study through respondents, key informant interviews and focus group discussion. This is one important goal of researcher to analysis environmental impacts of mining technology in the study. Again there is no research that has been attempted in this topic in this area that is the goal of the researcher to focus on this topic. Since the respondents or investigators are parts of this society and become one of the disadvantages group researcher prefer this opportunity (there had been no hidden issues) to deal with and the problem have been seen from its grass root level. Therefore the study had helped to identify the impacts and have created the possible knowledge that is important to promote sustainable measures of sand mining in Gambella town to save the Environment.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the study area

This study had been conducted in Gambella town, south west of Ethiopia. Gambella region is located in south west of the country (Ethiopia). It is766 km from Addis Ababa and is between 70 51 & 045' Latitude in the North and 33000 – 350 151 Longitude in the east. It shares borders in the West with Republic of South Sudan, in the East with Oromia and SNNP regional states, in the North with Benshangul Gumuz and Oromia regional states and in the South with SNNP regional state. Based on the projection from 2011 Central Statistical Authority, It has a population of 465,401 in 2011. Most part of the region is considered as extended low land with highland in the eastern part, surrounded by chain of mountain in the north and north east descending down to the wide flat land to the west.

The following is map of study area

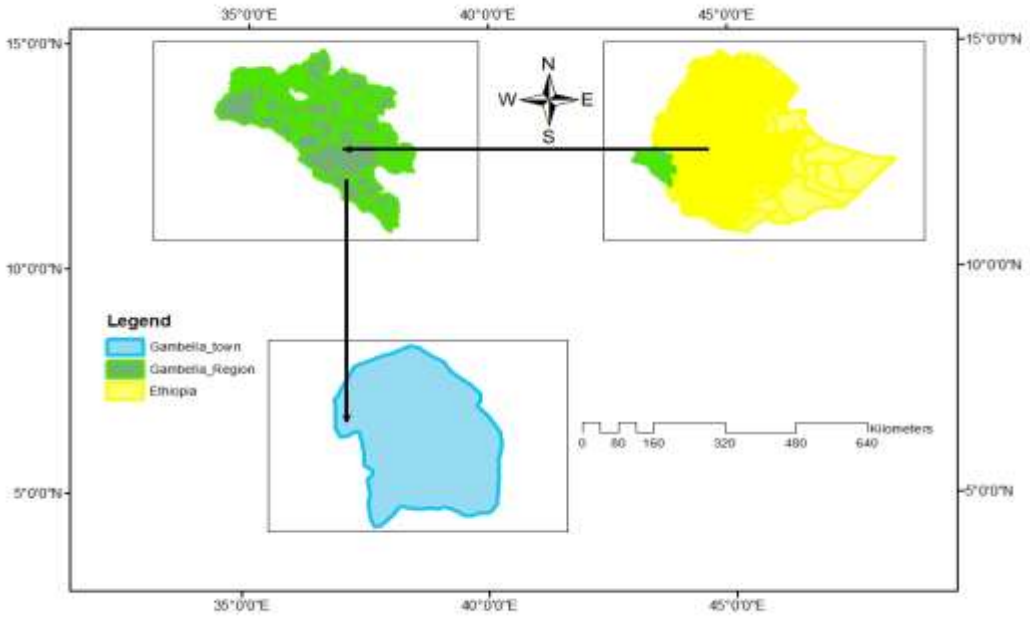

Figure.3. 1: Map of study area

3.2. Study period

The study was carried out from the beginning of February to the end of July 2021 in Gambella town, south west of Ethiopia.

3.3. Study design

To collect and analyze relevant data on factors affecting the environment for environmental impacts of mining technology in Gambella town, Observation and Exploratory survey design were used.

Both Qualitative and Quantitative research design have been used in combination in this study. A qualitative research is a descriptive approach when there is documentation of what is exactly said, observing behavior or even studying written documents. A qualitative researcher gets ideas from people being studied.

A qualitative research design is a study design that uses questionnaires and interviews to collect primary data. Qualitative research take places in the fields because it aims at finding out the documentation of what is exactly said by the peoples that have been studied. Uses questionnaires survey, focus group discussion and key informants techniques to gathers the real information need it for furthers analysis of the impacts of mining activities on the environment in the study areas. A qualitative design presents the data which had been studied in the form of figures, tables, photos and graphs. Data that was collected had been presented in form of figures, photos, graphs and tables. A quantitative research design is an explorative non-experimental, descriptive structure which involves quantifying relationships between variables. The design deals with figures and quantities. The design involves precise measurements and statistical analysis of data using computer packages.

3.4. Population

The total number of population in Gambella regional state is 465,401 (48% female and 52% male) in 2011 EFY, Based on the projection from 2011 CSA census.

3.5. Sample size and sampling procedures

Samplings have been necessary to choose respondents before distributing the questionnaires. These selection elements are basic unit category in which data and information was gathered

to represent the entire population of the study areas was the process defined by Beck and Polit (2008). Population is defined as a collection of all individual items or point under investigation by Chimedaz (2003). Sample sizes for this study have been two hundred (200) respondents which include keys informants and focus group discussion. The minimum sample size formula is given below:

$nr = \frac{N}{1-N(\alpha^2)}$, Where *N* is the population size and α is the error level which is set at 0.05 and 0.95 confidence interval. This equation is called Yamane equation and used when the sample size is known. The sampling technique considered in this study was the purposive sampling because it meets researcher's study objectives.

3.6. Study variables

3.6.1. Independent variables:

- Excavation:

3.6.2. Dependents variables:

- Water:
- Air:
- Vibration:
- Noise and dust

3.7. Data collection Instruments

Primary data were collected directly through questionnaires, observation and structured interviews like Focus group discussion (FGD) and Key informant interview (KII). When selecting the respondents from Gambella town's kebels, Purpose sampling technique was used. Data were coded and entered before analysis then for analysis of data that were gathered, descriptive data analysis had been used. The secondary data was collected from government manual report, journals and internet were utilized by employing quantitative and qualitative methods .The instruments like digital camera had been used to capture/take photographs from affected areas or sites. Field measurement has been done by using 100m measuring tape with the help of field assistant. Household questionnaire surveys were conducted together with research assistants from March to April 2021. Prior to the administration of the household questionnaire, five field

assistants had been recruit and trained on the study objectives and the administration of the questionnaire for a whole day.

Key Informant interviews structured interviews were organized and administered to the key informants who would have experience about the title as the land and forest officers, minerals and energy development officers, village's heads and village development committee. Checklist guide which consist of structured interview questions have been used to guide the interviews.

Focus Group discussion had been held based on the fact that the method reveals in-depth information on issues, perception, and ideas of various community groups. For a proper data relevance management, two to three groups (minimum and maximum) of six to 12 peoples were formed for the discussion to have significant information. Purposive selection had been used to select the various categories of the respondents in terms of age to include youths and elders; sex to include males and females, and working experience in mining to include people who worked in mines and those who are not working. These groups was included because to diversify information on the subject matter and field observation with selected community members and mineral miners. Field site observations has been made to authenticate different activities which are practiced by the mining companies or associations in extracting sands, soil components and gravel quarry sites and the way they affect vegetation and land within the study areas. Field site visits have been organized in collaboration with the local leaders and the mining officers in the study areas.

3.8. Data processing and analysis

Quantitative and qualitative have been used as data analysis methods. Data was collected through field observations of affected sites, taking photographs, measurements of length, depths and width of the pits, rivers and trenches. Descriptive statistics had been used to compare and contrast data that was gathered on extraction of minerals in the study areas. Field measurements and data from both quantitative and qualitative had been analyzed using the selected sampled points that had been analyzed using Statistical Package for Social Science (SPSS) and Microsoft excel. The data results which had been collected as demographic data of mean age distance of home from extraction site and the mean of involvement in extraction activities was calculated. Further analysis have been done to find approximate volume of sand and soil

component extracted considering sizes of pits, trenches and widening of the river. Qualitative data that which had been gathered had presented by tables, pie charts and graphs, Quantitative data which was generated through household survey and minerals development agency manual was analyzed using descriptive statistical tools such as frequency, percentage.

Generally, method for propensity scores and logistic model in matching is the most commonly used estimation and is relatively easy to interpret given that the predicted probabilities. Before propensity score, the functional form of the logistic model was presented according to (Gujarati 1995).

3.9. Ethical consideration

The study had been conducted after getting permission from ethical committee of Jimma Institute of Technology, school of civil and environmental engineering. In order to ensure the confidentiality of data collection and to keep the right of the respondents the following ethical protocols were carefully applied:

- The respondents were asked for their willingness.
- Based up on their permission they were oriented or informed with the objectives and aim of the study.
- Letter of confirmation for conducting the study was presented for respondents.
- The investigator had been used a pseudo name instead of their real name for respondents whom do not permit their name to be mentioned.

3.10. Limitation of the study

- The study had been limited by depends on the variables which are used
- The study had been limited on the area
- The study had been limited on the method that used
- The study had been limited depend on the sample size
- The study had been limited depend on Energy**,** Time, and Money

3.11. Operational Definition

Constraints: For the researcher and in the context of this research constraints are; Parameter that affect environments quality. For this topic one of the constraints are mining activities, extraction of minerals, and excavation of soil, environmental impacts, and technology. depth,width ,length and distance of pit ,river sand and sand quarry sites.

CHAPTER FOUR

RESULTS AND DISUSSIONS

4.1. Field Measurements and Observations

The researcher visited the most mining areas of river sands and soil components extraction areas to observe and take measurements with in six visits in order to know the progress of mining activity within the mined areas. However, the visits to mining sites were not consistent with in the first days of the month-April due to lack of transportation, insecurity and because it was the hottest season of the year. There after visits were done for each soil components and river sand, four sites were sampled that are A, B ,C where mining is going on and D as undistributed area (a control) (Christiansen, B., *el ta*, 2020).

4.1.1. Soil components extraction sites A

Table 4.1 below shown the field measurements of six visits collected from sampled soil components extraction sites A. Depth of pit were shown slightly increase on each visits to give a difference of 2.5 m when the initial depth was 5 m and final depth was 7.5 m. The width was shown an increase of 27.5 m, while the length of the pit showed an increase from 120 m to 198.8 m from all the six visits. This mean the general increase of the size of pit was due to continue operation of mining activities going on in the sites (Mensah, A. K. *et al.*, 2015).

Table 4. 1: Field measurement from soil components extraction site A

Visiting round	1	2	3	4	5	6
Date	12/04/2021	13/04/2021	14/04/2021	15/04/2021	16/04/2021	17/04/2021
Pit Length(m)	120	176	176.5	187.5	187.6	198.8
Pit Width(m)	25	37	37.5	38.5	45.5	52.5
Pit Depth(m)	5	5.5	6.5	6.5	7.5	7.5
water present	no	yes	yes	yes	yes	yes
trucks/miners present	yes	yes	yes	yes	yes	yes
dumped waste present	no	no	no	no	no	no
mining in progress	yes	yes	yes	yes	yes	yes

4.1.2 Soil components extraction site B

Table 4.2.show that the finding of measured depth of the sampled pit was increasing on every visits. During the first day, 6 m was recorded as the initial depth of the pit and this increased up to 13.5 m as a final depth in all sixth visits, while the width of pit increased from 37 m to 68.5 m and the length from 198 m to 216.5 m. The approximate volume of soil components extracted considering the measurements of obtained in the first visits was 43,956 cubic meters. This increased to 200,208.375 cubic meters by sixth visits, showing that an approximate volume 156,252.37 cubic meters had been removed from the soil components extraction sites (Madyise, Tariro, 2013). The interviews collected data from respondents and the researcher showed the exactly the results that mining is active till the days that the researcher visited the mining sites. The researcher had seen the SINO-TRUCK and loader machine on the mining sites.

Table 4. 2: Field measurement from soil components extraction site B

Visiting round	1	2	3	4	5	6
Date	12/04/2021	13/04/2021	14/04/2021	15/04/2021	16/04/2021	17/04/2021
Pit Length(m)	198	200	211	216.5	216.5	216.5
Pit Width(m)	37	47.5	55.2	68.5	68.5	68.5
Pit depth(m)	6	11	12.5	13.5	13.5	13.5
water present	no	no	no	no	yes	yes
trucks/miners present	yes	yes	yes	yes	no	no
dumped waste present	no	no	no	no	no	no
mining in progress	yes	yes	yes	yes	no	no

4.1.3. Soil components extraction site C

Table 4.3 field measurements from soil components extraction site c

The finding of measurement depth of the pit increased from 5 m to 15.5 m in sixth visits. Width increased from 25 m to52.5 m, while length increased from 120 m to 198.8 m. approximate volume extracted in the first visit had been 15000 cubic meters which increased to 16177.5 cubic meters by sixth visits, obtained an approximate volume of 146773.5 cubic meters that was removed from soil components extraction site. On the continue measurements the size of pit was changed at every visits which revealed the

progress of mining activities

Table 4. 3: Field measurements on width, depth and the length of pit on the sampled site C.

Visiting round	1	2	3	4	5	6
Date	13/04/2021	14/04/2021	15/04/2021	16/04/2021	17/04/2021	18/04/2021
Pit Length(m	120	176	176.5	187.5	187.8	198.8
Pit Width	25	37	37.5	36.5	45.5	52.5
Pit Depth(m	5	6.5	8.4	11	11.5	15.5
water present	no	yes	yes	yes	yes	yes
trucks/miners present	yes	yes	yes	yes	yes	yes
dumped waste present	no	no	no	no	no	no
mining in progress	yes	yes	yes	yes	yes	yes

4.1.5. River sand extraction site A

Table 4.4 showed that river depth increased from 11 m to 12.5 m at sampled point site A in the sixth visits of the researcher. River width increased from 60 m to 78.5 m, while the length of river where sand had been mined was increased from 120 m to 125 m. Data that were collected revealed that the river was widening and deepening in the sampled site. The interviews indicated that the miners extracted river sand on the walls of the river for they needed high quality river sand from the inner layer or at the bed of the river as to be seen on figure 4.10.extraction of river sand from the inner layer

Table 4. 4: Field Measurement from River Sand Extraction site A

Visiting round	1	2	3	4	5	6
Date	**13/04/2021**	**14/04/2021**	**15/04/2021**	**16/04/2021**	**17/04/2021**	**18/04/2021**
Pit Length(m	120	124	124	125	125	125
Pit Width	60	30.5	32.5	42	44	78.5
Pit Depth(m	11	11.5	11.5	12.5	12.5	12.5
Water Present	yes	yes	yes	yes	yes	yes
trucks/miners present	yes	yes	yes	yes	yes	yes
dumped waste present	no	no	no	no	no	no
mining in progress	yes	yes	yes	yes	yes	yes

4.1. 6.River sand extraction site B

Table 4.5 revealed that river depth from the sampled point increased from 9.5 m to 13.5 m with in sixth visits, which an increase difference of 1.5 m. Width of river increased from 51 m to 79.8 m with an increased difference of 22 m and The length of the river pit where sand had been collected had increased from 98 m to 120 m with an increase difference of 22 m.

Table 4. 5: Field Measurements from River Sand Extraction site B

Visiting round	1	2	3	4	5	6
Date	13/04/2021	14/04/2021	15/04/2021	16/04/2021	17/04/2021	18/04/2021
Pit Length(m)	98	124	124	125	125	120
Pit Width (m)	51	30.5	32.5	42	44	79.8
Pit Depth(m)	9.5	11.5	11.5	12.5	12.5	13.5
water present	yes	yes	yes	yes	yes	yes
trucks/miners present	yes	yes	yes	yes	yes	yes
dumped waste present	no	no	no	no	no	no
mining in progress	yes	yes	yes	yes	yes	yes

4.1.7 River sand extraction site C

Table 4.6 show that the initial depth of sampled point which had measured increased from the 10 m to 15.5 m in sixth visits with increase differences of 2.5 m. The width was increased from 46 m to 52.5 m, with an increase of 22 m and length of river sand pit of the sampled point was from 86 m to 125 m extension and increase gradual from 86 m to 125 m as the production of river sand quality and quantity continue along river Extension.

Table 4. 6: River sand extraction site C

Visiting round	1	2	3	4	5	6
Date	13/04/2021	14/04/2021	15/04/2021	16/04/2021	17/04/2021	18/04/2021
pit length(m	86	124	124	125	125	125
pit width	46	30.5	32.5	42	44	52.5
pit depth(m	10	11.5	11.5	12.5	12.5	15.5
water present	yes	yes	yes	yes	yes	yes
trucks/miners present	yes	yes	yes	yes	yes	yes
dumped waste present	no	no	no	no	no	no
mining in progress	yes	yes	yes	yes	yes	yes

4.2 .Positive and negative environmental impacts of sand, soil and gravel mining

4.2.1. Distribution of respondents by homestead distance from mining areas

The represented and collected data in this bar graph on the figure 4.1 below reveal most peoples area living near the mining areas, especially peoples inhabiting the Jibjiba River, pimur river and echucy baro river sites in Gambella town by 76.5%. Fewer peoples by 3% are living far away from the operational sites of the mining. Respondents reported that soil components mined mostly on open bushy field which could be grazed land and crop fields where huge clearance of land and vegetation can be done and observed, while river sand is mined from streams and rivers (Namin, F. S. and Bascetin, A,2011).

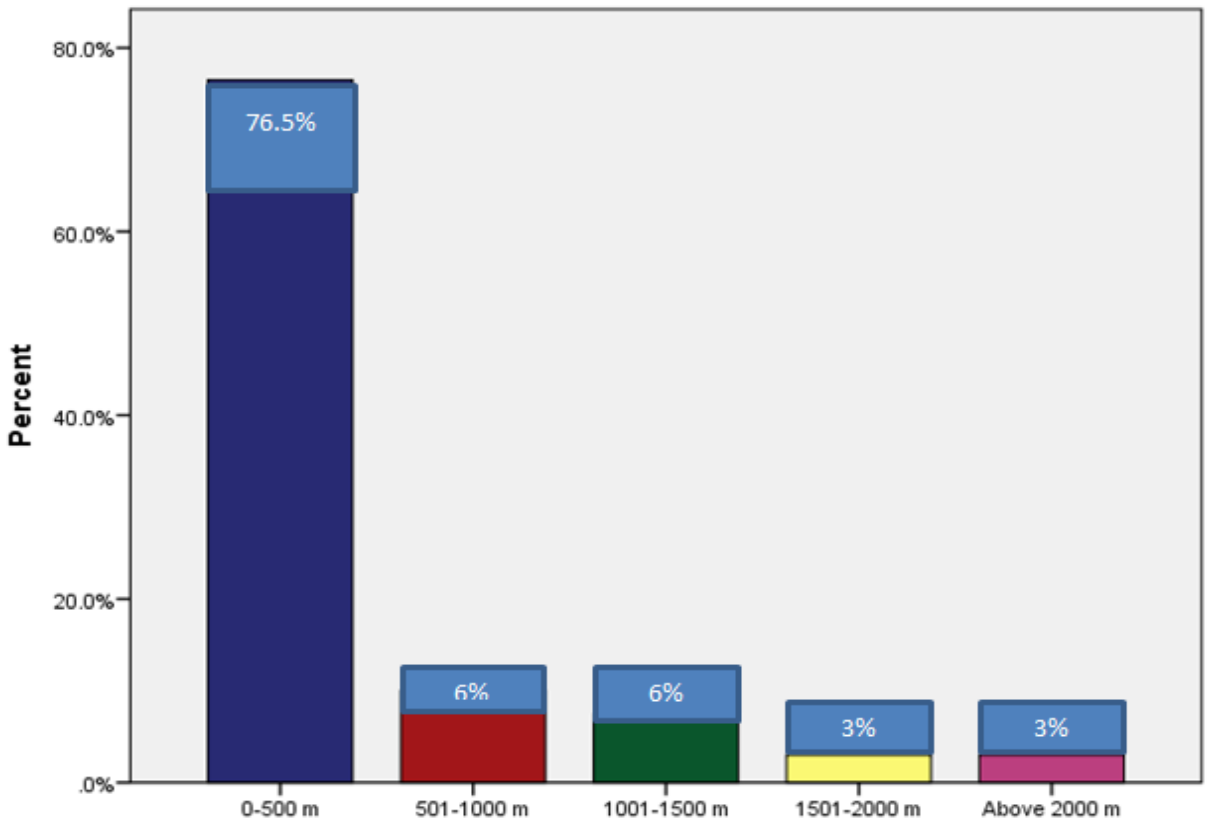

Figure 4. 1: Distribution of respondents by homestead distance from mining areas

4.2.2. Distribution of respondent's home at distance from roads used by SINO-TRUCH transporting river sand and soil components.

Figure 4.2 Data collected that are represented here by respondents on bar graph show that the modal range class is 0-500m that mean numerous of peoples are living near the transporting roads of river sand and soil components used by SINO-TRUCK. Some sands and soil components are extracted from lands field of hayawu area which mean more respondents are in the range of 501-1000 and 1001-1500 meters range that pass through that village. This means hayawu villages are affected more by air pollution in the form of noise, vibration and dust pollutions as negatives environmental impacts soil components mining from SINO-TRUCKS passed every day through the town.

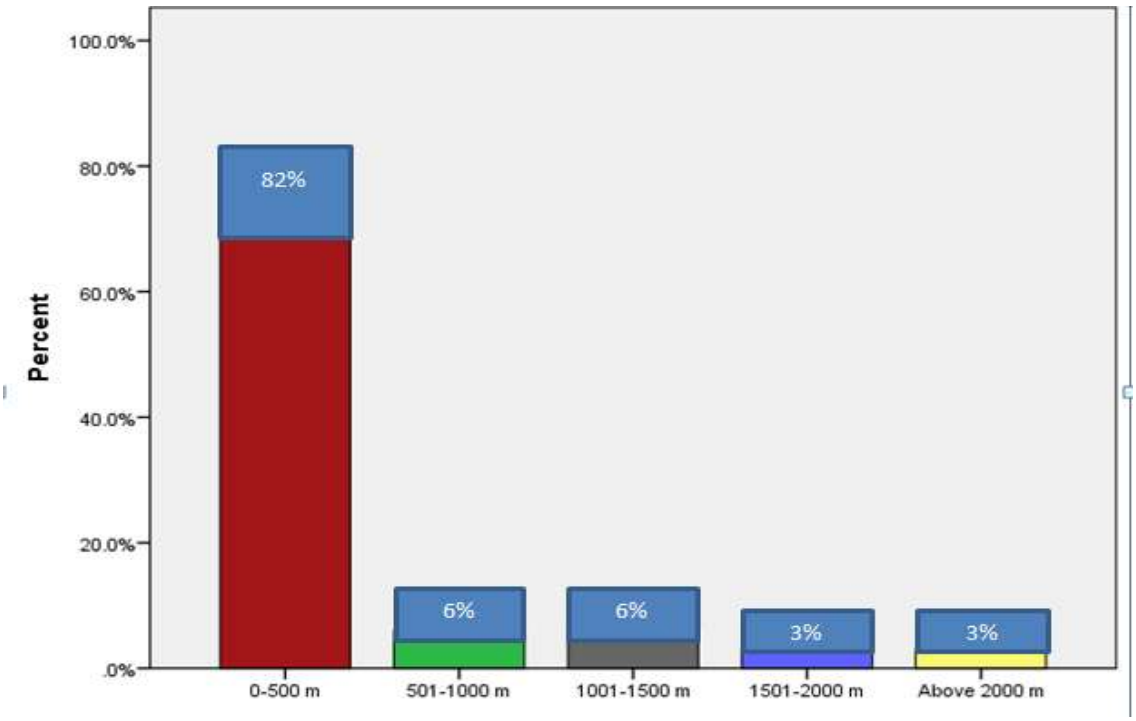

Figure 4. 2: Distribution of respondent's home at distance from roads used by SINO-TRUCH transporting river sand and soil components

4.2.3. Activities of the respondents at and around mining sites

Data collected and displayed in Figure 4.3 show that resident of Gambella Town visit soil components extraction and sand mining areas regularly for various purposes. The main activities are Get domestic's water, herding livestock and farming by mostly male mature respondents with 29%, 25% and 14% respectively. Soil mining is done by few villagers (12.5%) as private businesses and for domestic purposes. Respondents gave other activities as fishing, recreational (8.5%) as they visit mining areas for leisure purposes and on their way to the fields. sand mining is done by fewer miners who were participated in mining manually with 12%. Eight (8) respondents from the 20-25 age group and sixth (6) respondents from 26-30 age group said that they visit mining areas when they are on part time jobs to load trucks manually.

Respondents who indicated that they do soil mining, had explained what they use soil for and Twenty five (25) respondents who indicated that they are involved in sand and soil mining, 50% use it for domestic purposes which include building houses and brick moulding, When asked about how often they collect soil and what they use for its transportation, some

respondents informed the researcher that they buy from the SINO-TRUCKS passing through the Town 16 cubic meters per TRUCK only when they need it.

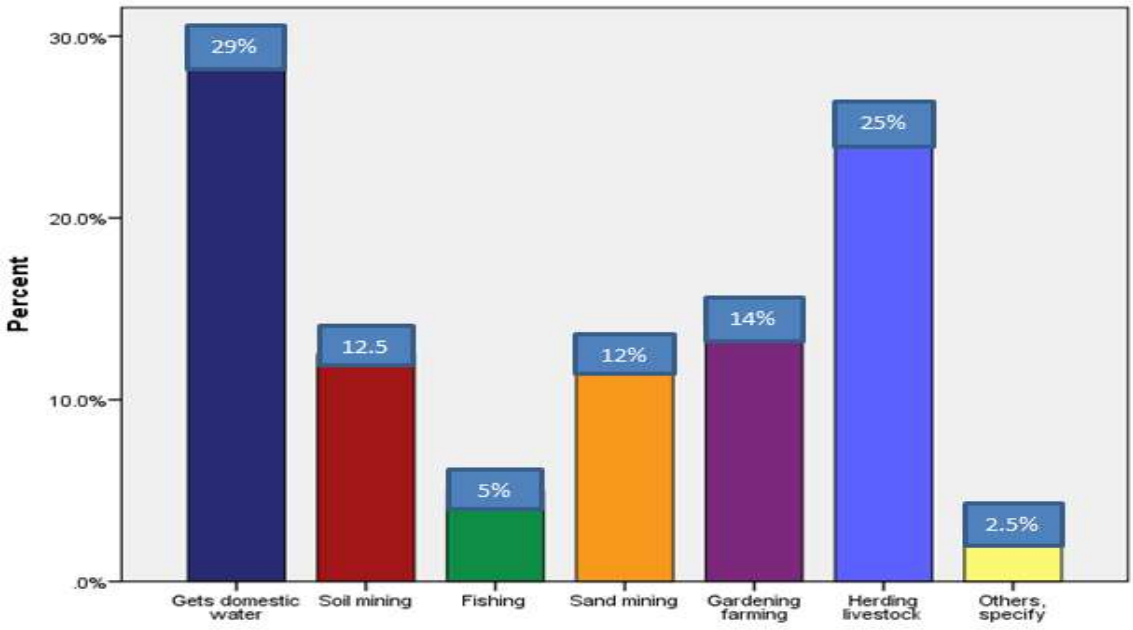

Figure 4. 3: Activities of the respondents

4.2.4. Respondents visits to sand mining and soil extraction sites

Figure 4.4 shows that many inhabitants of the Town (72%) visit sand and soil components mining areas regularly for various reasons. Most respondents who indicated that they visit extraction sites were men, fifty years and above who go to the farming lands as well as herding livestock. There were many respondents below 30 years who indicated that they never visit extraction sites. This is because it is most likely some are schooling and have little interest in mining as an activity. Women dominated the sometimes and rarely options probably because they are ever occupied by other duties in homes and are not involved much in sand mining activities since they are crossing the mining field to collect fire wood (Dolega *et al.* 2016).

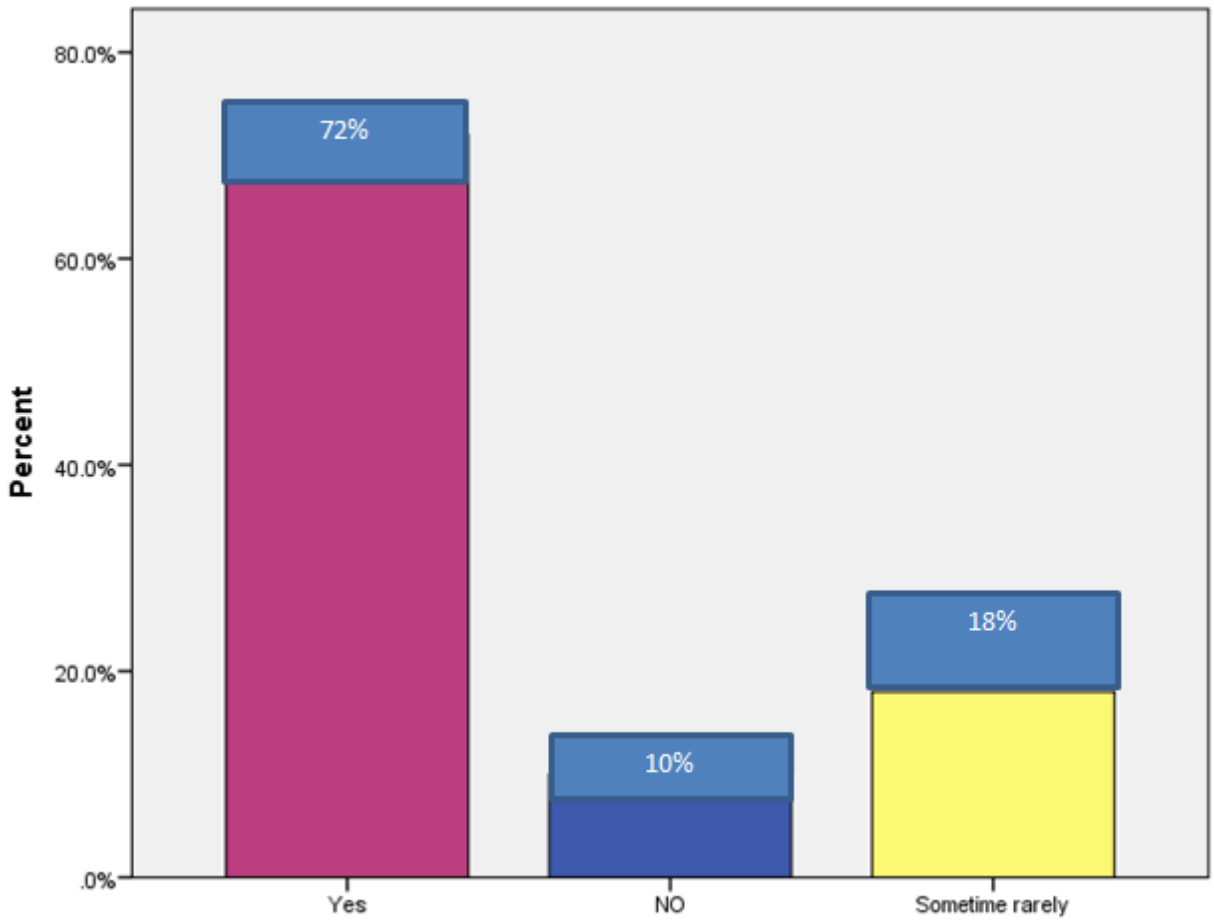

Figure 4. 4: Respondents visits to sand mining and soil extraction sites

4.2.5. Distribution of Benefit services respondents get from miner through sand mining and soil components extraction

Figure 4.5 Distribution of Benefit services respondents get from miner through sand mining and soil components extraction.

The finding indicates that Majority, 66% of the respondents reported to benefit from the sand mining activity and soil components by getting cheap sand for construction of theirs house, 15 % of the respondents reported that they have benefited from mining activities around them received income for farm field crossed when mining operate every they came through, while 9.5% respondents who reported few benefits cheap labor for using and 9.5% also got employment as a reward for theirs field that had been damaged by passing of Sino-truck transported the sand and soil. Respondents derived various direct benefits from sand mining and soil components extraction.

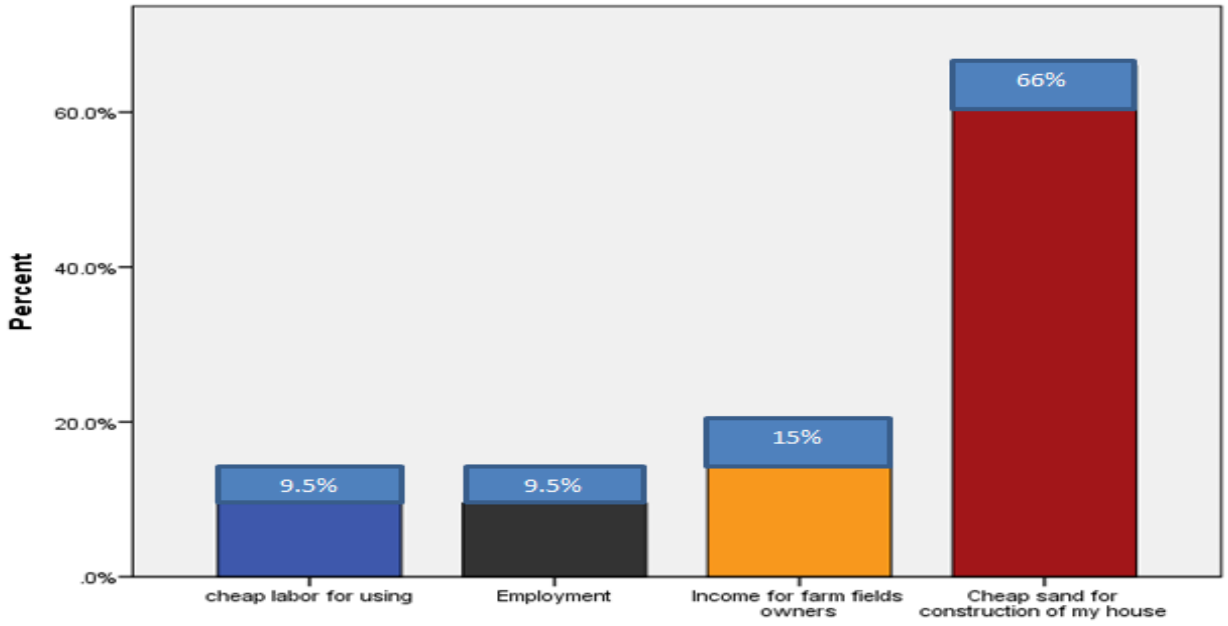

Figure 4. 5: Distribution of Benefit services respondents get from miner through sand mining and soil components extraction

4.2.6. Proportion of negative environmental impacts do peoples face at echucy baro site due to sand mining extraction.

Figure 4.6.shows that widening and deepening of the baro river (48%) was a major negative impact faced in the in mining operation, accidents (20%) in the community at both the mining and around mining site, unsafe water obtained from baro river for home use (20.5%) used by people for domestic use, dust and noise pollution (6.5%) and lately agricultural decline with (5%).

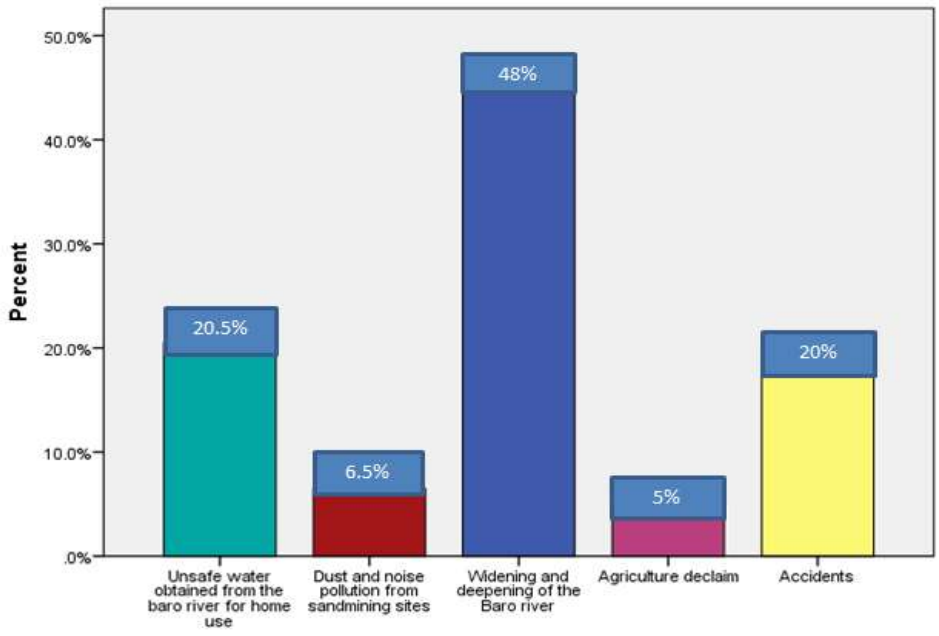

Figure 4. 6: Proportion of negative environmental impacts do peoples face at echucy baro site due to sand mining extraction

4.2.7. Proportion of negative environmental impacts observed by respondents at soil components mining.

Figure 4.7 this are the Pollution type which affects respondents in mining operation in Gambella town. The respondents were mostly affected by Deep pits with/without water (29%), land degradation and disturbance with dust and noise pollution (20.5%%) , deepening of river bank (12.5%) , loss of vegetation (7.5%) also affects the villagers, soil erosion (6%) due to poorly excavated land and lastly land alteration with (4%) (Figure 4.19) (Roos, N. *et al* , 2020).

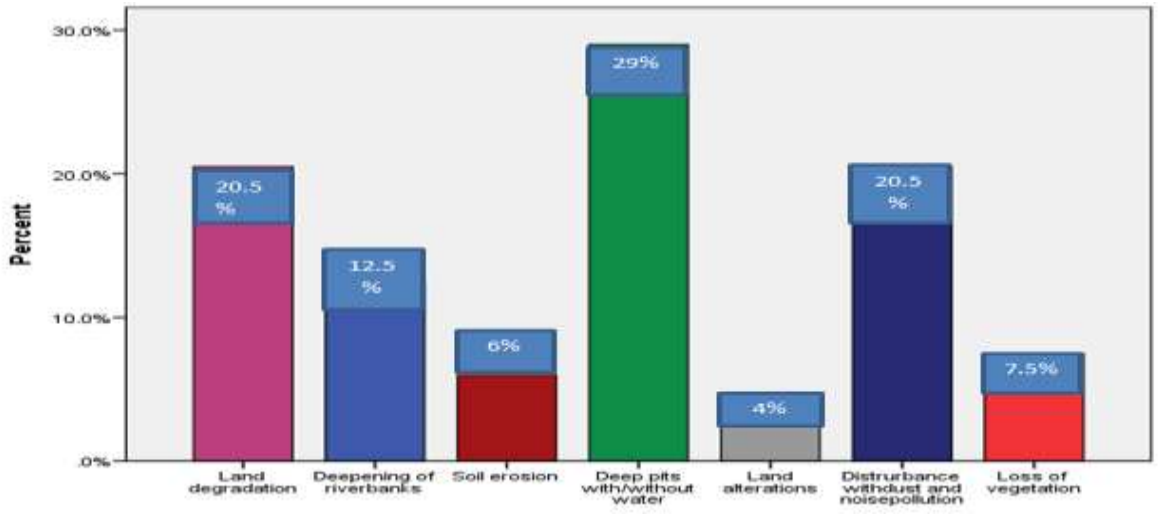

Figure 4. 7: Proportion of negative environmental impacts observed by respondents at soil components and river sand mining.

4.2.8. Distribution level of agreements on negative environmental impacts of sand extraction at echuey baro river sites

Figure 4.8 Respondents level of agreements on negative environmental impacts of sand extraction at echuey baro river sites on the figure 4.20 the study sought to establish whether sand mining negatively affects the people of Gambella town and 92.5% of the respondents strongly agreed that they were negatively affected. However, 4.5 % of the respondents said this activity did not cause pollution to the community, while 3% of the respondents never knew whether river sand mining affects their community and were even not aware of the effects of sand extraction problems in the area. Suspended solids affect domestic water users downstream which increases treatment costs.

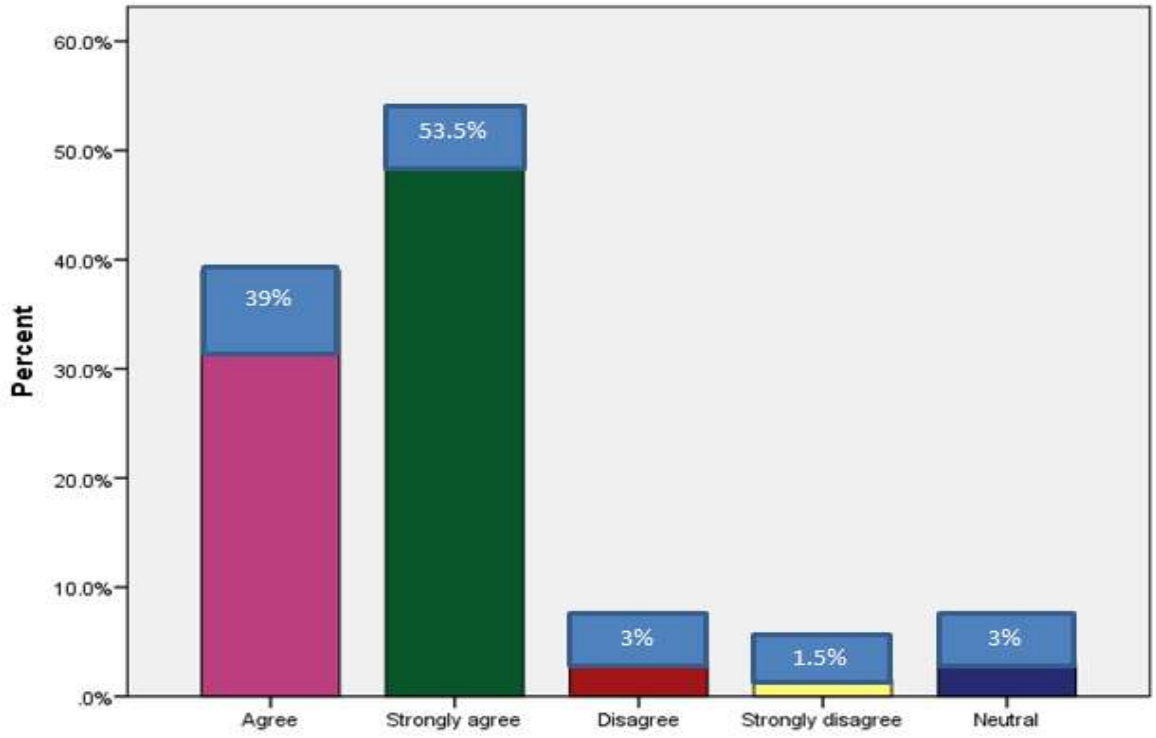

Figure 4. 8: Respondents level of agreements on negative environmental impacts of sand extraction at echuey baro river sites

4.2.9. Distribution of the accidents reported by respondents during and after sand ,gravel and soil components mining

Figure 4.9 shown respondents' responses on accidents which had been reported due to mining activities. Majority of the respondents, (94.5%) who had been participated in the study are aware of accidents in both deep pits where soil is extracted and on roads caused by trucks transporting it and in the river where sand is extracted. Some of the respondents (5.5%) argued that there are no accidents caused by these trucks and mining activities in the town. Respondents discussed the type of accidents in their respective village included:

- ✓ Some children and people fall in the excavated pit left behind uncovered broken theirs legs or hands.
- ✓ Some peoples died of crocodile attack due to deepening and widening of the river banks and beds.
- ✓ Some children died in the river as they drown when they tried to fetched water for drinking

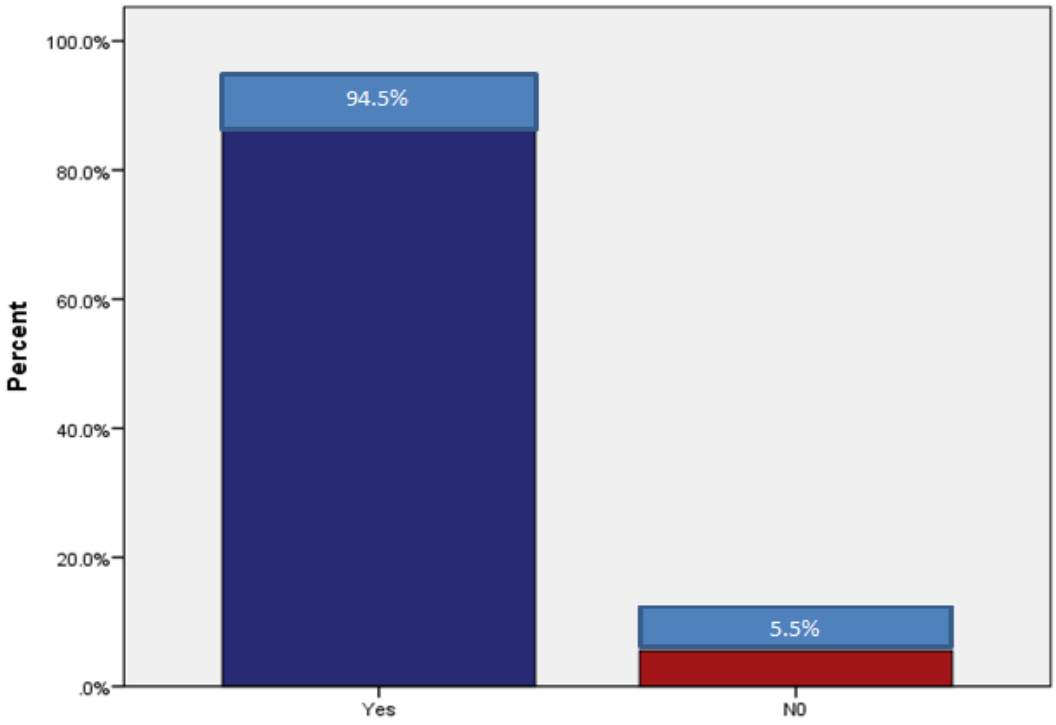

Figure 4. 9: Distribution of the accidents reported by respondents during sand and soil components extract Children tried to swim in pit leaved by miner and drowned there.

4.2. 10.Environmental impacts of sand mining, soil and gravel extraction

Sand is a natural economic resource for the development of one's nations and that must benefit all citizen of a country as whole. In recent years the sand and gravel mining activity had increased worldwide fuelled by construction boom in both developed and developing world (Case, T H E, , and Jones Opoku-ware,2010.). Gambella is not an exception with expansion of its capital city, Gambella Town. Impressive development of the new Gambella university, bureau of education, bureau of agriculture , bureau of civil service and many more residential areas has increased the demand for river sand, pit sand ,soil components and gravel extraction as miners are eager on those resources as they though it's the initial income (Mbaiwa, 2008). There is continuous mining of the resource by either licensed and unlicensed associations or mining companies. The activity had been revealed both positive and negative impacts to the environment.

4.2.11. Positive impacts of river sand, soil and gravel extraction

This study has shown positive impacts of sand mining, gravel production and soil components extraction for Gambella Town expansion through interviews, focus group discussion, questionnaire survey and observations. Infrastructure Development of this town is one of the important benefits of mining using cheap and readily accessible resources. The use of high quality river sand, soil components and gravel in combination in building durable structures and attractive building in the town. Interviews that had been conducted with builders and residents of the town revealed that the resources strengthen buildings when mixed with cement and concrete. They buy sand and gravel from Sino- trucks at 3500-4000 and 6000-1000 per Sino-truck respectively (16 meters cubic), though the prices is negotiable and attract the miner which lead to large destruction of the environments. River sand, gravel and cement are mixed together when making strong foundations, durable structures and molding bricks. The VDC members that were interviewed highlighted the same positive impact as they use sand and gravel from nearby jibjib river, pameri river and baro river for building residential and rental houses which brings income to the village. Villagers have built modern and durable houses with cheap cost. Interviews with officials from Bureau of Mines and Energy also supported sand mining and soil components extraction as an important activity for development. Majority of residents benefit from sand mining, gravel extraction and soil components as highlighted by interview results as the resources are cheap, accessible and used in construction of durable structures in both urban and rural areas.

Majority of the respondents in Gambella town have pointed out employment opportunities as a great positive benefit they get since they earn money daily from the sand mining and soil components and through open interviews, many of the respondents had been managed to buy some home equipment like radios and televisions, phones, bicycles and motorcycles and better economic status then before when they are not participated in the activity. The people that had been engaged in sand harvesting have been able to improve their social income levels and are now able to purchase basic electronic goods that are required and to some extend reflect the social economic status of an individual all over the world as related to Mensah (2002) that the harvesting of sand in Ghana has created job for youths.

Questionnaire survey and interview results had revealed that sand mining and gravel extraction activities create employment. These activities employed residential youth, Sino-truck drivers, front end loader drivers, excavator drivers as permanent job for them and there are some mostly mature adults also. Unemployed youth are earning a living through sand mining and gravel extraction.

Sand mining and soil component activities are a source of revenue for the country and income to some companies and individuals. Interviews with officials from Bureau of mines and Energy has revealed that the Gambella government through the Director of Mines, obtain revenue from small minerals that included sand soil component and gravel as royalties of 5% of the gross market value per month from licensed companies. Figure below 4:21 shows a front end loader ready to load soil component. Interviews with truck drivers shown that they are either employed or own trucks which they use to buy, transport and soled sand and gravel to individuals building or construction companies from licensed individuals.

4.2.12. Negative impacts of river sand mining, soil and gravel extraction

Sand Soil components and gravel, like others precious minerals are natural resources which are highly demanded in construction industries of Gambella. All citizens of this region must to benefit from this resource but this is not the case with residents and farmers of jibjibe residents and baba john residents easter Districts, that is 01, 02, 03 and 05 farms who live in fear of sever environmental impacts of mining due to continuous mining activities in the town. Interviews that were conducted with residents show that the miners have become great problem that they prevent as to fetch water in the river and wells digs around the beach, depriving us from benefitting from rivers and open areas where they used to dig wells for domestic purposes and watering livestock. The miners said they are legal licensed that the government had gave them the right to exploited the sand through the whole rivers and open areas forcing them out of the rivers and grazing lands .They are chasing us not to have clean water from the digged wells even after the mining have been operated we fetch dirty water with suspended solids practices said by woman near the mined river. Some licensed and Illegal miners attack and overpower residents with sharp objects. The activity has many negative environmental impacts to both residents and the environment (Madyise, Tariro, 2013). The respondents had been noted deepening and widening of rivers as a negative

impact. The Continuous mining of river sand alters river courses and increases the general width of the river as seen on figure 4.10. Respondents (48%) realized that this widening of rivers.

Due to the fact that sand mining in Gambella town is not sustainably carried out and the activity is strongly and highly engaged in by the local people and the others, this has caused social economic and environmental impacts and these are expected to increase in time even when the mining site is closed as according to Deller and Schreiber (2012) who found out that communities that are more heavily dependent on sand production for employment tend to experience greater negative impacts even after the mine have been closed than positive impacts while the mines are in operation including the inability to afford basic healthy equipment. Environmental degradation like through wetland destruction was another great problem reported which had caused soil erosion, vegetation loss, pollution of water. This is in line with Mensah (2002) in his study in Ghana found out that the main effects of uncontrolled sand harvesting include loss of land, destruction of beach, destruction roads and loss of vegetation as the researcher agree that produce the same results with. Agricultural decline also was another challenge faced and respondents had reported that this challenge was increasing always since energetic youths were all running to sand mining activity leaving crop farming to less energetic and old people in the families. Another cause was due to the fact that the town is surrounded by farm land and the land is plate that is suitable for the farming activity, everyone have tried to have a small pieces of farming land, However, transportation of sand and soil become difficult, if they are not to cross the farm land. This is in line with Mwaura (2012) that has carried out a study on the effects of sand harvesting on economic growth in Kenya with the case of Machakos County established that in many areas along the river banks harvesting of sand and gravel on agriculture land is one of the alternative livelihood activities of the rural people and has now become a source of livelihood for many of rural communities in Machakos County. The respondents further reported that their crops were destroyed by Lorries and land were degraded.

Water problems were reported as a great concern in Gambella town, therefore available water was not ready for domestic use because it was unsafe and little in the wells due to pollution and decline in water table yet most of the water was obtained from wells around and within

that mined rivers. This was in line with Pereira (2012) reveled that sand mining is a problem to water security that results from the loss of groundwater storage as a result of lowering alluvial water table. Suspended solids have affected domestic water users downstream which increases treatment costs. Water quality can also be compromised by oil spills and leakages from excavation machinery and transportation vehicles which also poison aquatic life. Bagchi (2010) also discussed that environmental land and surface degradation is a serious impact of in stream mining on Indian rivers. There is a damage to river bank. The access roads that are made into mining areas along the rivers banks destroyed Vegetation and ecosystems revealed as environmental impacts. The clearing of large open lands before mining is required during Pit sand, Soil components and gravel extraction that cause huge impacts to environments. The continuous removal of vegetation exposes the land to erosion. Residents who took part in the study (6%) identified erosion as a serious effect of mining to rivers, crop fields and grazing lands. Interview results with truck loaders and environmental officers revealed the same impact.

Field measurements from sampled river sand mining Sites A-C showed that at A, river deepened from 11m to 12.5 m and widened from 6om to 78.5m. Site B, river deepened from 9.5m to 13.5m and widened from 51m to 79.8m. Site C, river deepened from 10m to 15.6m and widened from 46m to 52.5m. The measurements meant that there is a general alteration on river channels due to continuous mining (see Figure 4.22). Figure 4.9: Widening of river bed due to mining .There is also general depletion of riverbeds as continuous removal of sand exposes underlying impermeable clay layers, increasing occurrences of floods in rainy season. Riverbed widens (48%) Interviews with environmental officers revealed that there is general damage to rivers and environment as mining is done uncontrollably. Widening of river increases possibility of flooding as there is no smooth flow of water. This leads to collapsing of riverbeds. As streams and rivers widen and deepen, there is contamination and shortage of sand aquifer water due to formation of ponds. Sand bed thicknesses vary due to uneven rocky bed of rivers (Case, T H E, and Jones Opoku-ware,2010). Miners tend to dig more sand from a pocket where there is wide thickness of sand which leads to formation of ponds and water accumulates as seen on Figure 4.11. measurements from sampled Soil components Sites A-C showed that at A, Soil components deepened from 5m to 7.5 m and widened from 25m to

52.5 m. Site B, Soli components deepened from 6 m to 13.5 m and widened from 37 m to 68.5 m. Site C, deepened from 5 m to 15.5 and widening 25 to 52.5 m.

Figure 4. 10: Widening of river bed due to mining

The finding had revealed that the miners has continuously dig soil from open area where there is wide thickness of soil component deep in to ground that led to the formation of ponds and had hold water as seen on figure 4.11 below. The respondents indicated that children are visiting the pond to play and swim there that lead them to drown in and many children had been broken their legs as they played with throw in the pond as cultural playground activity. Deep open burrow pits also are a source of pest breeding. As was noted by 5% of the respondents, stagnant water accumulates in open pools left by miners (Saini, V., *et al* ,2016).

Figure 4. 11: accumulation of water in an open pit

Figure 4.12 below shows accumulation of stagnant water and the growth of grass conducive to mosquito breeding place, the accumulate water was surface water sources below shows accumulation of surface water in open burrow pits and Pool of water growth of grass on surroundings creating an environment suitable for mosquito breeding which spread malaria to villagers nearby (Saini, V., *et al,* 2016). The respondents had reported more accidents in and around mining areas as a negative impact of this soil component extraction and gravel mining. Snake bit is mostly happed when children had been played around the pools of water. Livestock died always at summer due to the accumulation of snail in the pools, that snail had been consumed together with grass and when animals drink water too as negative impacts to us .said one of the resident in the town.

Figure 4. 12: Stagnant water and growth of grass conducive to mosquitos breeding place

Figure 4.13.extraction of river sand from the inner layer

The continuous removal of sand on the river bank in intent of search of quality sand at the inner layer. The river extension was increased as the Mining was in progress that fresh Sino-tracks wheel and roots of trees seen exposed at riparian zone. The interviews indicated that miners preferred the inner layer for high quality sand and that led to negative environmental effects both on environment and peoples.

Figure 4. 13: Extraction of river sand from the inner layer

Formation of access roads on riverbed and open lands as seen in Figure 4.14 compact the ground, destroy soil structure; then, water cannot infiltrate but flows along the surface. Figure 4.14: Access roads and stock piling on river bed On the contrary Sino-trucks wheels of front end loaders extracting river sand have been seen. This increases wind erosion. Interview results from Sino-truck drivers and loaders confirmed that many machines move on river bed, pit and gravel areas several times on daily basis which loosen the soil and increase wind erosion (Roos, N. *et al.* 2020).

Figure 4. 14: Access routes and stockpiling on river bed

4.3. Solutions and rehabilitation to sand and soil components to concerned bodies

The study allowed the villagers to give suggestions on solutions to sand and soil components activities in their areas. When asked about what they can recommend as the immediate solutions to the negative impacts of sand mining and soil extraction, respondents had been given suggestions at community, district and national levels (Ethiopia as a whole).

4.3.1. Solutions at community level

Mitigation measure that had been given at this level suggested by the respondents to be done at community level to reduce negative impacts of sand mining and soil extraction in the Town are the following:

- Respondents volunteered to form committees, clusters and watch groups to monitor, supervise and guard mining areas with help of VDC
- Only miners with licenses should be allowed into mining areas and stop illegal miners through tight security.
- Reuse and recycling of building material to reduce demand for river sand, pit sand and soil components.
- Sino-trucks could not be allowed to use soil components routs passing through villages but routs outside residential areas to reduce dust causing air pollution.
- Construction of soil conservation structures to reduce soil erosion.
- Sand and soils miners should pay royalties to the village leaders so that the community benefit directly.
- Consultations to be done by Land ,forest and environmental protection agency ,mining agency with village leaders before permits are issued so that they may be involved in surveying land and recommend on where to mine .
- All community members must cooperate and report illegal miners to responsible authorities instead of harboring them.
- All Sino-trucks transporting sand and soil mining should pass through village leaders for inspection and verifying licenses since some miners use fake documents .
- Village leaders including chiefs must be involved in imposing punishments to illegal miners and confiscate sand then sell it to benefit the whole community.

- There must be regular formal meetings between miners and all stakeholders affected by the activity to discuss the impacts and come up with a way forward to the issue.

4.3.2. Solutions at district level

Mitigation measure that had been at this level suggested by the Respondents to be done at District level to prevent or reduce the negative impacts of sand mining and soil extraction are the following:

- Issuance of permits and licenses to be strictly done on condition that miners will be monitored by Land, forest and environmental protection agency, mining agency and ensure that created pits are reclaimed as rehabilitation.
- Allow sand mining to be done only during certain seasons of the year but not in rainy season.
- Number of permits and licenses issued must be very minimal.
- The committees formed to guard and monitor mining should control and restrict number of truck loads per day.
- Restrict time of harvesting which should only be done during the day.
- Sand and gravel mining must not be done on one area but alternating sites to reduce over extraction which destroy the environment beyond rehabilitation.
- Regular patrols must be done by Land ,forest and environmental protection agency, Department of Mines and police to restrict some areas for example riverbanks, near schools, clinics or residential.
- Land, forest and environmental protection agency should compensate affected citizens

4.3.3. Solutions at national level

Mitigation measure that had been at this level suggested by the Respondents to be done at national level to prevent or reduce the negative impacts of sand mining and soil extraction are the following:

- ✓ Strict laws and legislature to prohibit and control mining production and selling of sand and soil components which could include severe punishments like arresting illegal and legal miners who refuse to reclaimed the mined sites, heavy fines and penalties of up to 20000 thousand Ethiopian birr, long imprisonment sentences such as up to 12 year jail term must to be apply.
- ✓ Controlling number of permits and licenses issued.
- ✓ Close monitoring and evaluation of the activity, restrict mining in summer and during rainy season.
- ✓ Construction of separate sand and soil transport routs for Sino- trucks to reduce traffic congestion, accidents as well as noise and air pollution.
- ✓ Mining should use dry pit method of mining.
- ✓ Prohibit sand and soil components mining at summer time and rainy season.
- ✓ Regular meetings between Land, forest and environmental protection agency, Department of Mines and village leadership to discuss the soil mining activity and possible impacts.
- ❖ Educate and inform public about the impacts and accidents caused by sand and soil mining through media for example television, radio and newspapers. Discussion with all concerned villagers as 01villagers, 02 villagers, 03 villagers and 05 villagers had gave many suggestions as solutions to sand mining and soil extraction. Strict laws, regular meetings and consultations, restriction of mining time, recycling of resources and issuance of licenses were some of the solutions noted. All these means as the residents are aware of the environmental impacts and are willing to be involved in reducing the negative effects

4.3.4. Rehabilitation programs to sand mining and soil components extraction

The study required villagers to suggest rehabilitation programs which could be implemented in their communities and on sand and soil mining sites. Respondents suggested several rehabilitation programs which could be implemented in their areas such as:

- Reclamation of pits created by all miners as a way of rehabilitation.
- Replanting vegetation on mined areas to prevent further damage.
- Construction of special roads for tipper trucks to reduce accidents and pollution.
- Perpetrators must be stopped from mining in residents' fields without permission.
- Miners should be educated on short and long term negative impacts of continuous mining from same areas through regular meetings.
- Close monitoring and evaluation of mined areas.
- Use of alternative resources to river sand and soil components such as crushed stone.
- Prohibit dumping of waste by placing signs on all open areas.
- Open a dumping site or landfill next to sand and soil mining areas to reclaim land since village are near.
- Fence abandoned pits and use them as water source for livestock.
- Use of open pits as dumping sites and landfills.

❖ Discussion several rehabilitation programs had been also given by the villagers that could be implemented in their communities. Replacing the opened pits created by mining with mine gauge has been the general consensus of villagers because of the problem of waste dumped in these pits. Respondents were very cooperative and willing to suggest on what can be done to curb environmental damage caused by sand and soil mining. 4.4 Interview respondents' general comments on sand and soil mining interviewing key people directly or indirectly involved in sand and soil mining was one of the methods used to compile data in the research. The researcher interviewed Gambella town chief and 01 village chief on background to mining and said that this activity started around 1974 in Ethiopian calendar and up to new when Gambella town started to expand at a faster rate. Miners were extracting mainly river sand from JibJib River, Pameri River and Baro echuey river site for construction of Regional building such as civil services bureau, agricultural bureau and educational

bureau. When mining operate at the beginning, there were no consultations done with village leaders. Negative impacts highlighted that mining were done everywhere in the town except one side 04 village. In a separate interview with Department of Mines' Licensing officer, the researcher discovered that the department is responsible for issuing all mining licenses with validity of 1 year to 5 years with possibility of extension each year to most mining activities including sand and soil components. The conditions for getting a license include the company or individual obtaining a letter of surface rights from place where the mine will be done as kebele then mining offices of woreda to Regional mining bureau where mining license is issued with surveyed coordinates, sketch map plan and total area to be mined from land board, and get clearance on the quality and quantity of the resources.

CHAPTER: 5

CONCLUSION AND RECOMMENDATION

5.1. Conclusions

This research educed the environmental factors that change the environments and the peoples inhabiting the area. The environmental change such as population, standard of living, and technology which affected the sustainability of mining on the environment is greatly happened in this particular town. At every season being summer or winter, mining activities have been done negatively rather then considering the negative environmental impacts they had brought to the environments, therefore environmental impacts that it left is a great damages to both communities of the town and the environments. The results of the finding indicated that respondents by (48%) had been noted deepening and widening of rivers had been negative environmental impacts affected the community. The results shown 92.5% of the respondents reported that mining activities which operated in the town had negative environmental impacts on the community. The finding shown (94.5%) of the accident had been happened due to mining activities in the town respondents were negatively affected. The continuous mining of river sand and open field around the town have widened and deepened river courses and affected the general width of the rivers and open field mined areas negatively was realized by (48%). Many of the respondents were not happy with the environmental degradation, agricultural declaim, soil erosion, unplanned topographic alteration of the land, high rates of demand for the sands, gravel and soil components with in the Town, caused accidents, threats from both licensed and unlicensed illegal miners and damage of wetland ecosystem. Generally mining disturb land surface areas having huge open pits which are difficult physically and economically to rehabilitate at the time mining cease. Excessive mining leads to depletion of resources on both river beds and open lands. Then, the study concluded that sand mining, gravel and soil components extraction in Gambella town generally contributes negative impacts on socio-economic, agricultural and environmental aspects of the people since is not sustainably used. There is need for laws across the globe by high level decision makers to enforce solutions to environmental problems and implement all the stated recommendations

5.2. Recommendations

Mining operations must be conducted in a manner that minimizes or eliminates adverse impacts on both in stream and soil components of ecosystems comprising of biota and habitats. The Gambella government through the mining bureau should call for a high level decision making forum involving all stake holders to discuss the problem of both licensed and unlicensed sand and soil mining companies and come up with immediate solutions which limit environmental damage. The mining bureau should evolve a policy compelling miners to reinvest and repair old disused mine sites to reduce occurrence of landslides, creation of pond and streams. Effective legal framework, strict laws and legislature are important as mining bureau with coordinated help of police force and village leadership must impose heavy fines including long jail terms to miners who extract without mining rights and licenses. Surface rights rent should be affordable to all miners to allow them to spend part of the money on repairing environmental damage due to mining operation. Environmental Assessment Management and Monitoring Programs to have are very important. Environmental impact assessment and Environmental management planning have to be done before any mining operations. There must be mining closure plane before the mining activities and must to be show up during the issues of the licenses. Authorities are to strengthen laws on not allowing people to enter vulnerable areas through close monitoring of the mining activities in all areas Close monitoring ensures that there is proper mining and no gravel recruitment downstream Mining bureau, District Authorities and Land, forest, environmental protection bureau Boards should ensure that farmers whose land is mined, livestock drowning in open pits and cattle dying from measles after eating dumped waste are compensated directly or indirectly by legal miners. The authorities must encourage the Reuse and recycling of old building material as a way of reducing over extraction and dumping of waste on the environment. Land, forest and environmental protection agency with collaboration with mining bureau and energy boards should prohibited illegal mining and promote the sustainable use of mining areas under extraction. Only licensed miners should be allowed into extraction site with sustained use of environments and illegal miners will not have access. The local mining committee board should be form to register all new incoming sand miners in to the mining areas and continuously monitor their methods of sand mining to control poor methods of mining and control unplanned population increase in the mines demand. The mining methods that could

be used in this should be manual methods operation. Use of machine should be prohibited as it damaged the bed and rim of rivers and excavated huge amount of land with in short period, remove large vegetation as great impact to both environments and human inhabiting that cleared areas .The mining bureau officers should educate the public in Gambella town including the miners which are causing the negative impacts of continuous mining through meetings and media such as national televisions, radio and face book media.

5.2.1. Recommendation to decision makers

- The Gambella government through the mining bureau should call for a high level decision making forum involving all stake holders to discuss the problem of both licensed and unlicensed sand and soil mining companies and come up with immediate solutions which limit environmental damage.
- Effective legal framework, strict laws and legislature are important as mining bureau with coordinated help of police force and village leadership must impose heavy fines including long jail terms to miners who extract without mining rights and licenses.
- Land, forest and environmental protection agency
- Environmental impact assessment and Environmental management planning have to be done before any mining operations.

5.2.2. Recommendation to miners

- Mining operations must be conducted in a manner that minimizes or eliminates adverse impacts on both in stream and riparian components of ecosystems comprising of biota and habitats.
- Mining sites should be located far a ways from residential areas.
- Mining should not be done at summer seasons.
- Miners could not to mine inner layers of the rivers.
- Miners should prohibit the huge clearance of both vegetation and land.
- Miners could do reclamation and rehabilitate the mine sites after they exploited.

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ANNEXES

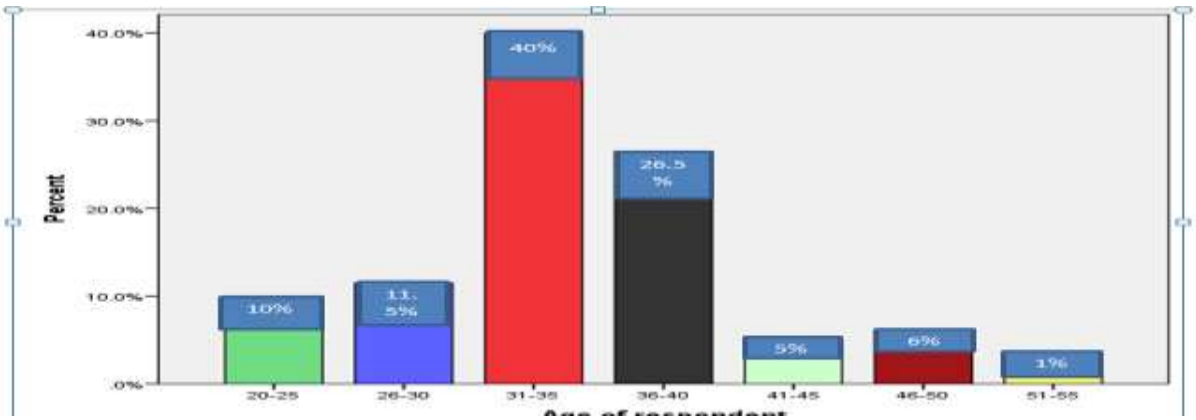
ANNEXES 1.DEMOGRAPHIC DATA OF THE RESPONDENTS

Annexes Table 1: Distribution of the Respondents by Gender

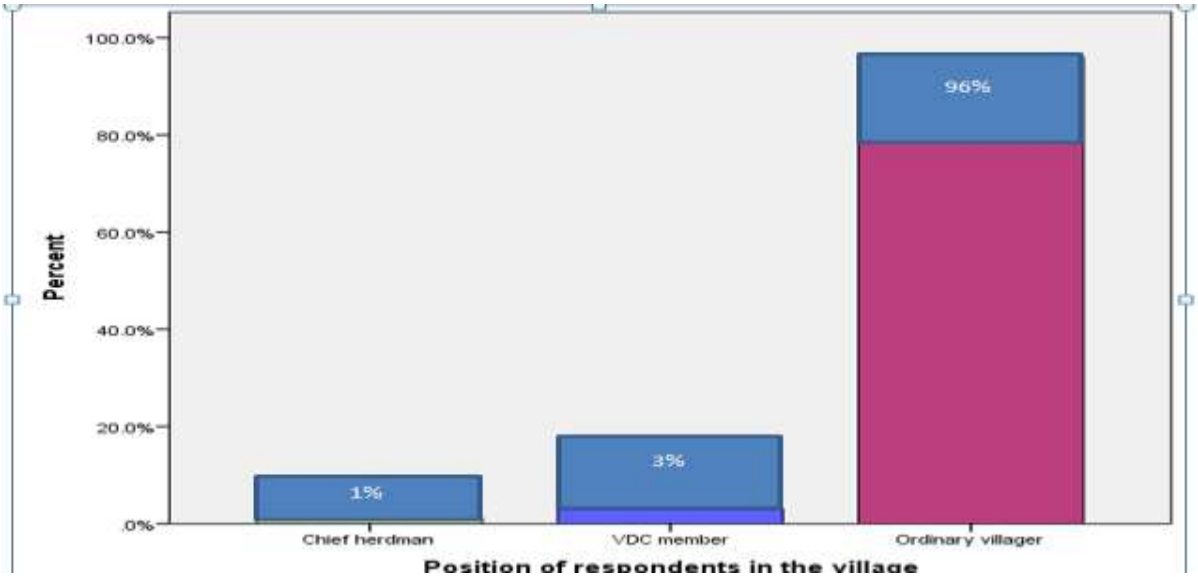
Gender	Frequency	Percentage
Male	161	80.5
Female	39	19.5
Total	200	100

Annexes Table 2: Distribution of educational background of the respondents

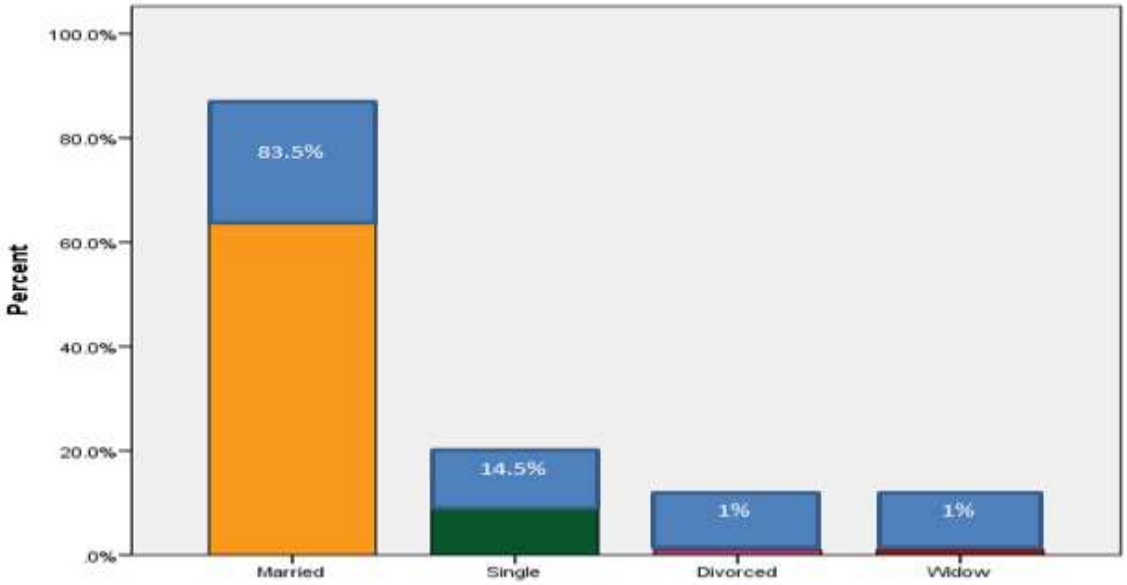
Educational background of the respondents	Frequency	Percentage
Primary	0	0
Secondary	3	1.5
Tertiary	97	48.5
Not read and write	50	25
Degree and above	50	25
Total	200	100.0



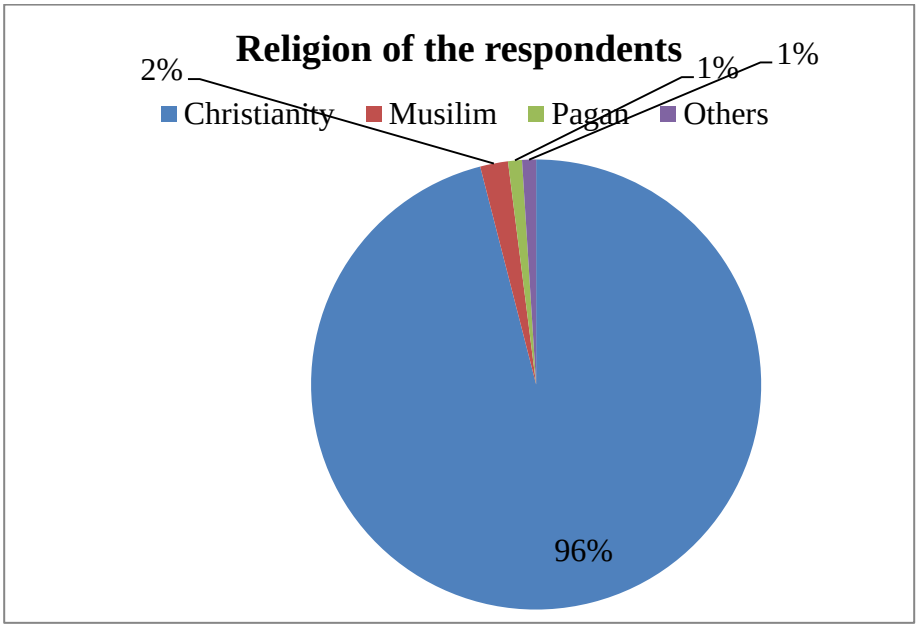
Annexes Figure 1 : Distribution of respondents by Age



Annexes Figure 2: Distribution of respondents by position in the village



Annexes Figure 3: Distribution of marital status of the respondents



Annexes Figure 4: Distribution of Religion of the respondents

Annexes 2 some sampled photos

Annexes Figure 5: Mining progress on pit sampled site A an initial formation of stream

Annexes Figure 6: Front end loader loading Sino-trucks from sampled point site B

Annexes Figure 7: Tree-roots exposed due to pit soil extraction at sampled point site C

Annexes Figure 8: Undistributed lands (control)

Annexes Figure 9: Extraction of river sand from the inner layer

Annexes Figure 10: Show active river sand bed continuously mined.

Annexes Figure 11: Show the active mine along river bed extension

Annexes Figure 12: Undistributed River land (river control)

A**nnexes Figure 13:** Extracted gravel quarry site

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Annexes Figure 14: grinded gravel site machine

Annexes Figure 15: Extraction soil component site

Annexes Figure 16: Front loader extracting river sand

Annexes 3. DATA COLLECTION INSTRUMENTS QUESTIONNAIRE OF THE STUDY

JIMMA UNIVERSITY

INSTITUTE OF TECHNOLOGY

SCHOOL OF POST GRADUATE STUDIES

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

MASTER OF SCIENCE PROGRAM IN ENVIRONMENTAL ENGINEERING

DEPARTMENT OF WATER SUPPLY AND ENVIRONMENTAL ENGINEERING

JIMMA UNIVERSITY, INSTITUTE OF TECHNOLOGY

MY NAME IS NHIAL DUOTH A STUDENT OF JIMMA UNIVERSITY, INSTITUTE OF TECHNOLOGY.

I AM CARRYING OUT A RESEARCH ENTITLED AN EVALUATION OF ENVIRONMENTAL IMPACTS OF SAND, SOIL AND GRAVEL MINING IN GAMBELLA TOWN, SOUTH WEST OF ETHIOPIA FOR MASTER OF SCIENCE DEGREE IN ENVIROMENTAL ENGINEERING.

The information you will give is purely academic and will be treated with confidentiality and you do not have to write your name on the questionnaire to remain anonymous. Am kindly requesting your participation in this study by answering the following questions. Please read all questions and answer them carefully.

The Questionnaire has four parts.

PART A

PERSONAL DETAILS

Tick the correct option(status).

1. GENDER: Male Female

2. AGE GROUP 21-25 26-30 31-35 36-40

41-45 46-50 51-55 56+

3. POSITION IN VILLAGE: CHIEF HERDMAN

VDC MEMBER ORDINARY VILLAGER

4. WHAT IS YOUR LEVEL OF EDUCATION?

a) Primary

b) Secondary

c) Tertiary

d) Not studied

PART B

GENERAL QUESTIONS AND POSITIVE ENVIRONMENTAL IMPACTS ON SAND MINING AND SOIL EXTRACTION

For questions 4-8, tick the appropriate answer.

5. How far do you live from sand extraction and soil mining areas approximately? 0-500m 501-1000m 1001-1500m 1501-2000m

above 2000m

6. How far do you live from the main sand and soil road used by SINO- TRUCKS transporting sand and soil ? 0-500m 501-1000 1001-1500 1501-2000m above 2000m -1160m

7. Do you often visit the sand mining area? YES NO

Sometimes Rarely

8. If yes, choose and tick activities you normally do at the sand mining areas.

Gets domestic water soil mining fishing sand mining

gardening farming herding livestock others, specify----------

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9. If one of the activities you chose in question 7 is sand mining,

a) What do you use the sand for?

_____

b) How often do you collect the soil, sand and what do you benefited from sand extraction and soil mining?----------

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10. What services are you getting from sand and soil mining activity?

(a) Cheap labor for using

(b) Employment

(c) Income for farm fields owners

(d) Cheap Sand for construction of my house

THIS IS IMPORTANT FOR PART C AND D

Fill in your opinions in the spaces provided.

All answers are considered correct, important and will be treated with confidentiality

PART C

RESIDENTS' VIEWS ON NEGATIVE ENVIRONMENTAL IMPACTS OF SAND MINING AND SOIL EXTRACTION

1. How do you feel about sand mining and soil extraction, Is there is negative impacts, what are they? Descript!

---

2. Do you think sand mining and soil extraction have negative impacts on residents of town, you?

(a) Yes

(b) No

(C) I don't know

3. If yes what are some of the negative impacts do you face due to the sand mining

Activity on Ichuey beach site?

(a) Unsafe water obtained from the Baro River for home use.

(b) Dust and noise pollution from sand mining sites

(c) Widening and deepening of the Baro River.

(d)Agriculture declaim

(e) Wetland destruction

(f) Accidents

4. The soil mining and sand extraction might be affecting you as a resident in a nearby village. If yes, state, the effects of the activity has on your life.----------

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5. Have you observed any negative impacts?

Yes

No

If yes, select the impacts you have observed

Land degradation, deepening of riverbanks, Soil erosion, Deep pits with/without water, Land alterations, Loss of vegetation, disturbance with dust .

Others, specify----------

6. (a) Had you ever heard of accidents reported during sand extraction and soil mining?

(b)How does the community react to such accidents?

PART D

SOLUTIONS TO SAND MINING AND SOIL EXTRACTION

7. What can you recommend as the immediate solutions to the negative impacts of sand mining and soil extraction:

(a) at 01 Kebel community level----------

(b) At Gambella Town level----------

(c) At national level----------

8. What rehabilitation programme can be implemented in your area----------

9. Do you thing the regulation and policies of the region should be applied to make sand mining activity sustainable. If yes which regulation and policies measure? ----------

------Thank you for answering this questionnaire truthfully. You are assured that all information will be treated with confidentiality.