Impacts of Stone Quarrying on Environment and Livelihood of Local Community in Addis Ababa Peri-Urban Areas:

The Case of Hana Mariam Cobble Stone Quarry Site

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DECLARATION

I hereby declare that this submission is my own work towards the MA degree, and that, to the best of my knowledge, it contains neither material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

Declared by

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This thesis is to certify that the thesis carried out by Zelalem Abate entitled 'Impacts of Stone Quarrying on Environment and Livelihood of Local Communities in Addis Ababa peri- Urban Areas: The Case of Hana Mariam Cobble Stone Quarry Site' and Submitted to the fulfillment of Masters Degree of Population, Resource and Development with the regulation of Addis Ababa University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

Although quarrying is economically lucrative business, it is an extractive and exploitive industry which inevitably and irreplaceably depletes natural resources. It is true in the study area in which the destructive nature of quarrying together with poor management of quarry sites, constitute a major threat to the environmental degradation and socio-economic activities of people. Therefore, the study was undertaken to assess environmental and socio-economic impacts of quarrying. It also endeavors to explore the livelihood outcomes realized by the stone workers and local community as a result of stone quarrying activities. The study was a descriptive type of research, which collected the required information through structured and unstructured questionnaires and field observations. In addition, documented data from published and unpublished articles, reports and different map, were used and analyzed. As the research result indicated, quarrying has a significant importance on job creation and better income generation to household's of stone workers to reduce poverty. The findings further showed that the quarrying activities in the study area helps the development of other informal business activities such as petty trading, house renting and small scale transport service provision which support the local community as alternative means of livelihood strategies and to transform from rural to urban activities. Regarding to the environment the bulk excavation pits, overburden wastes together with poor management of quarries resulted inland use- land cover and landscape changes, and caused land degradation and water resource depletion. Furthermore, the respondents explained that un rehabilitated open pits and hip cliff of waste materials causes insecurity which the quarry pits collect water in rainy season and caused to accidents while youths and children swim in the accumulated stagnant water. In view of this, the study recommends effective collaboration among key stakeholders in the sector such as Environmental Protection Agency (EPA), Cobble Stone Project Offices, Local Governments, Quarry Worker Enterprise and local communities is needed to enhance the utilization of resources and minimize the externalities of quarrying on the natural environment through awareness creation, proper management and rehabilitation of abounded quarry pits for other functions and sustainable environment.

*Key words: Q**uarrying, Cobble Stone production, Environmental degradation***

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ABOVE ALL, I GIVE GLORY AND HONOUR TO GOD

TO ALL I SAY; MAY YOU BE BLESSED

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List of Abbreviations

AA	Addis Ababa
AA EPA	Addis Ababa Environmental Protection Authority
AAUDGG	Addis Ababa University Department of Geology & Geophysics
AAWSA	Addis Ababa Water & Sewerage Authority
DETR	Department of Environment, Transport and the Region
DFID	Department Food and International Development
EIA	Environmental Impact Assessment
EPE	Environmental Policy of Ethiopia
EHS	Environment, Health, and Safety
EHSMS	Environment, Health and Safety Management System
EMP	Environmental Management Plan
EMS	Environmental Management System
EROS	Earth Resource Observation and Science
GIS	Geographical Information System
IARC	International Research Agency for Cancer
IEG	the Independent Evaluation Group
IIED	International Institute for Environment and Development
IUCN	International Union for Conservation of Nature
LULCC	Land Use and Land Cover Change
MSEs	Micro and Small-scale Enterprises
NEC	National Environment Commission
NREC	Natural Resources and Environment Committee (National Council)
ORAAMP	Office of the Revision Addis Ababa Master Plan
SD	Sustainable Development
SIA	Social Impact Assessment
SLA	Sustainable Livelihoods Approach
SLF	Sustainable Livelihoods Framework
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty

UN	United Nation
USNAS	United State National Academy of Sciences,
UNCED	United Nations Conference on Environment and Development
UNCED	United Nations Conference on the Environment and Development
UNCCC	United Nations Conference on Climate Change
USGS	United State Geological Survey
UNECA	United Nation Economic Commission for Africa
UTM	Universal Transverse Mercator

Chapter One

Introduction

1.1. Background

Rock quarrying and stone crushing is a global phenomenon, and has been one of the causes of concern everywhere in the world, including the developed countries. (Lammeed and Ayodele, 2010). Quarrying of natural stone, including sand, gravel and crushed rock, represents the main source of construction materials used throughout the world. At the global level, production of natural stone products witnessed a substantial increase over the last decade, with an increasing number of countries involved in the production of natural stone. Worldwide the production of natural stone has increased by 30 percent in the last 10 years (World Bank Stone Report 2002).

However, operations of quarrying whether small- or large-scale, are inherently disruptive to the environment (Makweba & Ndonde, 1996). Mining of stones frequently generates land use conflicts in populated areas due to its negative externalities including loss of vegetation, noise, dust, truck traffic, pollution and visually unpleasant landscapes. It also causes a conflict with competing land uses such as farming, especially in areas where high-value farmland is scarce and where post mining restoration may be infeasible (Willis and Garrod, 1999). According to Ross, (2001), environmental problems are further aggravated by lack of adequate mitigation measures by the respective quarry operators. This in turn affects the ecological sustainability which is a threat to the overall economic sustainability. With regards to the prevailing environmental legislation and its enforcement, there is total lack of efforts in monitoring, rehabilitation, restoration or post-mining programs for minimization of adverse environmental impacts.

Darwish et al. (2010) also stated that, in many of the developing countries, at the time of closure of quarrying activities, most quarries are left without any rehabilitation. As a result abandoned quarries can cause surface run-off and decrease natural recharge.

In Addis Ababa, also a wide range of extracting construction materials with various method of practice is under way both legally and illegally. However, mostly no environmental consideration is incorporated in their plan. Hence different problems have occurred and become a set of environmental issue to which answer must be found in order to make safe operation and environmental sustainability (Enatfenta Melaku, August 2007).

1.2 Statement of the Problem

Following the rapid urban expansion of Addis Ababa, extensive infrastructure and housing development projects are under way and a significant boom in construction material supply, most of which is mainly extracted from the peri-urban areas of the city. According to environmental protection office of Addis Ababa (2011), there were over 400 quarrying projects undertaken in the peri-urban areas of the city and most of them found in Bole, Akaki-Kaliti, Yeka, and Nifassilk-Lafto sub cities. In those areas there have been quarries used to produce cobble stone that contribute to the construction of paved road and provide both economic and social benefits. However, the intensive activities of quarrying disregard to the environment impact leads to a series of socio-economic and environmental problems.

Hence, the study area is one of the most potential quarry sites that create large job opportunity and, supply different construction materials mainly cobble stone for road construction, it is observed that various environmental problems, such as the excavated site is abandoned and left as wasteland,

the overburden materials are improperly dumped for future rehabilitation, soil is eroded and land is degraded, natural river water flow is diverted and impact on groundwater recharge. Besides, the quarry sites in the study area have great problem on the management practice which can be characterized by poor mining plan, lack of ecological considerations, inadequate quarrying process and rehabilitation planning, technical and policy enforcement barriers, which aggravate significantly the degradation on the environment and socio-economic development endeavors in the city, so it needs conducting research on the site to identify the degree of impacts and to take remedy measures. It is difficult to take a sustainable mitigation measure without detail investigation of the impacts. Therefore, this study seeks to investigate the impacts of stone quarrying on the physical as well as socio economic environment at sub city level based on the case study area.

1.3. Objectives of the Study

1.3.1 General Objective

The study aims at assessing the impact of stone quarrying on environmental and livelihoods of the local community in the study area.

1.3.2. Specific Objectives

The specific objectives attempt to:

- Identify and assess the natural environments which are significantly affected by stone quarrying activities.
- Assess the livelihood outcomes of quarrying activities in the study area.
- Investigate land use-land cover changes caused by quarrying in the study area.
- Examine the existing situation and practice of quarrying operation process.

1.4. Research Questions

As stated above the research is aimed at assessing the impact of stone quarrying both on environmental and socio-economic condition of the local communities, it is therefore, focused on to answer the following research questions.

i. How do the process of quarrying and the disposal of effluents and wastes from the quarrying activities affect the surrounding environment in the study area?
ii. What is the impact of quarrying on local livelihoods and natural resource use in the research area?
iii. What livelihood outcomes have the workers attained from engaging in stone quarrying?

1.5. Scope of the study (delimitation)

Although there are many stone quarrying activities in different peri-urban areas of Addis Ababa, the spatial scope of the study is limited on at South West border of Nefas silk Lafto sub city woreda 1 area, locally known as Hanamariam cobble stone project site, where one of massive stone quarrying activities have been undertaken. It starts from the confluence of kersa bela river at north east of Sebeta woreda, Oromia region and from east part of Nefas Silk Lafto Sub City. It covers an area of about 613.2 hectares. The thematic scope with respect to the subject rose on environmental and socio-economic issues that examining the factors, extent and patterns of land use and land cover changes, land and water resource degradation and impacts on other physical environmental elements as well impacts on livelihood strategies, income and economic benefit to the local community and the city.

1.6. Significance of the study

Since the research focuses on the physical and socio-economic impact of stone quarrying, it will contribute to the understanding of quarry operation impact on natural environment. The analysis of the land use land cover also shows the quarry effect on the change in land use and land degradation, and adjacent surface water quality, The study will also help to create awareness on how a quarry can impact the environment, especially when the quarry planted in urban centers. Thus, Planners and decision makers can use the result for proper planning and management of abandoned quarry and to return the quarry site to a safe and secure area. it will also an important document for quarry companies and other stakeholders to have an overview about the strengths, weaknesses, opportunities and threats of the current quarry planning and management with respect to sustainable resource utilization, socio-economic and physical environment protection and development. Generally, the collected data about quarrying activities, its impacts and perception of the respondents on the quarrying activities in the study area can be useful for all those involved in quarry operation and further study.

1.7. Limitations of the study

The limitations of the study include that the respondents may not accurately state and prioritize their problems that affected by quarrying activities. Particularly, most of the resident communities in the study area were not willing to give the relevant data with respect to income, livelihood strategies and impediments in understanding the status of the quarry. There is also a limitation in water resource available data and methods of turbidity test, because it needs laboratory test, the research depend on only questioner and observation. The other limitations include the availability of

limited literatures, developing countries' experience, on the issue under consideration. Furthermore, limited finance and resource might limit the access to get necessary images and data that are used to land use/land cover change detection and quarry rehabilitation analysis.

1.8. Organization of the research

The paper has been organized into five different chapters that include:

Chapter one: explains the introductory section which depicts the background of the research about stone quarrying. Also presents, the statement of the problem under investigation, the objectives and research questions pertinent to the study.

Chapter two: highlights about the theoretical and analytical framework relevant to the study in which the relevant literatures on the topics of stone quarrying, the interaction of quarrying and environment, quarrying and livelihood and sustainability issues are treated.

Chapter three: deals with contexts of the general as well as the case study area. It also concentrates on the methodology of research for both data collection and analysis and, data sources and data types.

Chapter four: presents the data along with the analysis. It mainly contains the socio-economic characteristics of the respondents and the factors that lead to stone quarrying and the perceptions of respondents towards stone quarrying in relative to livelihood strategies and environment and discuss the results accordingly with the analysis and the literature.

Chapter five: discusses the conclusions and recommendation of the research which are that found to be significant and worth consideration in an effort to enhance the contribution of stone quarrying to people's livelihoods.

Chapter Two

Review of Literature

2.1. Quarrying Operations

Quarrying is an open cast excavations from which fairly massive and deep deposits of hard or soft rocks are extracted, usually for the production of aggregates and stones (Coppin, 1982). It is usually done by open-cast method using rock drills, explosion of dynamite and use of other methods.

Stripping is the initial step in the quarrying operation and involves removal of topsoil and sub soil that covers mineable materials. A variety of equipment is used to strip, transport and redeposit sub-soil (Bauer, 1991).

2.2. Quarrying and Environment

There is a wide range of potential environmental effects caused by quarries and inevitably creates negative externalities. A report by the World Bank working group on environment sustainability reveals that occupations such as lumbering, mining, quarrying, and sandblasting degrade the environmental and worsen the plight of the poor (IEG, World Bank, 2008). Maponga and Munyanduri (1998) also argued that quarrying negatively affects the environment in a variety of ways during exploration and blasting, transportation and disposal of waste rocks. Major environmental effects are destruction of vegetation, disruption of animal habitats, diversion and blockage of natural drainage systems, soil erosion and river siltation, noise and vibration; and dust pollution. Furthermore quarries may also damage or destroy sites of scientific, archaeological, and cultural interest and can negatively affect the local tourism industry. These adverse impacts created by quarrying vary in their frequency and longevity from occasional short-term low-levels of nuisance to daily ever-present disruptions with

cumulative or long-term effects and instances of irreparable damage. The scale of these externalities also varies by aggregate type with dust, blasting and traffic impacts generally being greater at hard rock quarries (DETR, 1998).

2.3. Major Environmental Issues of Quarrying

2.3.1. Land use change and Land degradation

Land use refers to the human uses of land, or immediate actions modifying or converting land cover. On the other hand, land cover refers to the natural cover that characterize a particular area (De Sherbinin , 2002).

In this regard quarrying is one of the land use obtained by extraction of non-fuel and non-metal minerals from rock (Ukpong, 2012). According to Chizoro et al., (1997) quarrying has land use policy implications_ it is either agriculture vs. quarrying or a coexistence of agriculture, often a source of conflict over traditional uses of land. He also added that the clearing of land to develop access roads and to open up mining sites destroys habitats for wild animals, reduces grazing and reduces sources of plant life for human beings and animals (Chizoro et al., 1997). Besides affecting the locals, the noise from blasting and transport activities has caused migration from the surrounding areas, affecting ecological balance by disrupting the food chain (Munyandri, 1998).

Stehouwer et al. (2006) also added quarrying activities exert tremendous pressure on limited soil and water resources, thus increasing the rate of erosion processes and subsequent damage of existing arable lands. Quarrying operations can intensely modify preexisting ecosystems and disturb hydro-geological and hydrological regimes. They can strongly modify the substratum, transform landscape patterns and integrity, destruct

natural habitat and disrupt natural succession, as well as change genetic resources. Castro and Nielsen (2001) explain that, conflicts resulting from natural resource exploitation are typically “severe and debilitating, resulting in violence, resource degradation, and the uprooting of communities”, and if not addressed,” can threaten to unravel the entire fabric of society”. “Each party wants to pursue its own interests to the full, and in doing so ends up contradicting, compromising, or even defeating the interest of the other” (Ochieng-Odhiambo,2000).

2.3.2. Noise and vibration

The primary source of noise during stone quarrying is from earth-moving and, processing equipment, and blasting (Langer, 2001). Blasting which occurs at quarries, can give rise to vibration, audible noise, fly rock and dust. The levels of vibration caused by blasting are well below those which can cause structural damage to properties. Nonetheless, vibration transmitted through the ground and pressure waves through the air (“air overpressure”) can shake buildings and people and may cause nuisance. Audible noise accompanies overpressure. Noise can cause annoyance; nuisance, sleep disturbance and can also affect wildlife. Residential properties, schools, hospitals, nursing homes, churches, etc. are also noise-sensitive receptors.

The impacts of noise are highly dependent on the sound source, the topography, land use, ground cover of the surrounding site, and climatic conditions. The beat, rhythm, pitch of noise, and distance from the noise source affect the impact of the noise on the receiver (Langer, 2001).

2.3.3. Dust Deposition and Air Pollution

Dust is one of the most visible, invasive, and potentially irritating impacts associated with quarrying, and its visibility often raises concerns that are not directly proportional to its impact on human health and the environment (Howard and Cameron, 1998). Dust may occur as fugitive dust from excavation, haul roads, and blasting, or point sources, such as drilling, crushing and screening (Langer, 2001).

Dust pollution from quarrying operations affects local air quality. Quarry dust not only pollutes the air, but may also lead to serious health problems. Quarrying generates dust both on site and on roads. Dust emissions tend to affect animals, vegetation and agriculture, although the precise effects still need to be more extensively researched, (Netherlands Committee for IUCN, 1996). However, incidences of animals inhaling dust containing dangerous (silica) substances have been recorded, as well as oxygen deprivation of plants and trees, which may lead to a plant disease called asphyxia (World Rainforest Movement, 2004).

Dust emissions may be controlled by water sprays and wet processing. However, in quarrying – as opposed to processing – this is rare. Therefore, Residents living in proximity to quarries and quarry workers can potentially be affected by dust. The main potential impacts of dust are visual impacts, coating/soiling of property (including housing, washing, and cars), coating of vegetation, contamination of soils, water pollution, change in plant species composition, loss of sensitive plant species, increased inputs of mineral nutrients and altered pH balances.

2.3.4. Surface and Ground Water Degradation

Quarrying can substantially modify the routing and water quality (Gunn and Hobbs, 1999). Commonly the first impact of quarrying is to remove the overlying vegetation and soil. The removal of topsoil, overburden and aggregates may affect the quality of water recharging of an aquifer, and excavation below the water table may lead to de-watering of adjacent watercourses and wells (Gunn and Hobbs, 1999).

If the protective soil cover or unsaturated rock is removed, the hole created by the mining may focus surface water to the ground-water system. As a result, the quantity, and physical and chemical quality, of surface waters and ground waters may be affected and flows can be increased or decreased and may be contaminated by runoff or dust from the quarry.(Hobbs and Gunn, 1998; Ekmekçi, 1993).

2.4. Socio-Economic Impacts of Stone Quarrying

Even though agriculture remains the key strategy for rural poverty reduction, small scale mineral extraction is as well playing a critical role in rural livelihood improvement there by creating additional job opportunity and helping to generate additional income (Fellmann *et al.*, 2005). According to Wang *et al*, (2010), over 500 million people in developing countries engaged in occupations such as small-scale surface mining and quarrying for survival

In Africa, East Asia, Southeast Asia and Latin America, accessibility to natural resources plays a critical role in the livelihood conditions of people. Since the formal sectors in developing countries have very little potential in terms of job creation (Ibrahim, 2007) the informal sector has become an attractive alternative for achieving livelihood needs.

2.4.1. Quarrying as Livelihood Strategy

A livelihood comprises of capabilities, assets and activities required for living. It is considered sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and contributes net benefits to other livelihoods at the local and global levels and in the short and long duration (Chambers and Conway, 1992).

This approach is relevant to stone quarrying in understanding how individuals meet their needs using minimal financial input, simple technology and indigenous resources amidst a competitive formal market and restrictive government policy. Stone workers use the different assets (human, capital, financial, physical, natural and social capital) they have in order to achieve the different livelihood outcomes. In an effort to ensure sustainable development, laws and policies are often in place to limit over exploitation of these resources (Helmore and Singh, 2001).

2.4.2. Employment and Income

Quarrying activities generate employment and contribute to a country's gross national product, both through production for the local market and for export trade. (National council of Bhutan, 2013).

Kuntala Lahiri-Dutt, (2000) also added that stone quarrying generate considerable employment opportunities as it is a relatively labor intensive, under-mechanized industry. Even if the availability of accurate data on the sector's contribution to overall employment is difficult, for example in India around 2 million people were employed in the sand stone mining

However, population growth and its concomitant high demand for natural resources have put severe stress on the available resources with dire

consequences on their sustainability. Overexploitation of the natural environment has depleted most resources and rendered most productive land beyond repairs (IEG, World Bank, 2008). This development is likely to compound the health and unemployment problems of the poor majority seeking alternative means of livelihoods in rural areas.

2.4.3. Occupational health and safety Impact

The mining and quarrying sector is traditionally a sector that poses large risks to occupational health and safety. Even in modern quarries and mines, fatal injuries occur regularly ("Sustainability of jewelry sold in the Netherlands", CREM, 2005). The most frequent occupational risks related to stone quarrying include:

- Fatal accidents;
- Physical injuries requiring medical treatment;
- Work-related illnesses: respiratory diseases such as silicosis and tuberculosis due to inhalation of dust.

Work-related illnesses endemic to the natural stone industry include the respiratory diseases silicosis and tuberculosis (or silica-tuberculosis). Large numbers of quarry workers suffer from silicosis or tuberculosis due to prolonged inhalation of silica-dust. According to Langer, (2001), it is estimated that some 4 million people die each year from acute respiratory problems in developing countries, for the most part being aggravated by environmental pollution emanating from quarrying, sandblasting and emission of dangerous chemicals.

2.5. Stone quarrying in Addis Ababa

Addis Ababa is endowed with construction minerals such as basalt for the production of crushed aggregates, sub base and base course materials, weathered and fractured basalts used for the production of selected material, ignimbrite for masonry work and cobblestone production, red ash and red clay, (Setegn Berie, 2013), and there are a lot of quarry sites in the city. While, there was lack of research related to when stone quarrying operation was started. But some evidence shows that, for example, Augusta quarry opened before 1960 and active until now, (Enatfenta Melaku , 2007).

In recent Years, with increasing infrastructure development activities the demand of construction material increasing alarmingly due to this the quarrying operation also increased, according to Addis Ababa Environmental Protection Authority there were 400 quarry projects in the city (AA EPA,2011) and most of them especially the cobble stone quarry projects were opened in agricultural area, (Setegn Berie, 2013).

Despite this quarrying become one of the most potential sector to create huge job opportunity, (Setegn Berie, 2013). In this regard UN-habitat together with Ministry of Housing and Urban Development (2013), study asserted that, the cobblestone industry is a local venture that keeps money in the local economy. Moreover, it is labor-intensive and requiring low skills. Through it, especially the urban poor have gained access to employment, creating a major impact on poverty reduction in urban areas. As a result the initiative creates job opportunities for about 489,000 unemployed citizens.

While apart from creating huge job opportunity and satisfying the ever increasing demand of minerals in the construction sector of the city, quarry activities can lead to loss of vegetation cover, soil removal, spring eye spot extinction, scenic quality loss, formation of ugly scenery, susceptible

geomorphology for erosion, land stability problem, destruction of the existing natural landforms & resulting in fast degradation, (Enatfenta Melaku , 2007). Moreover it was aggravated due to lack of the proper technical, financial, law enforcement mechanism with respect to quarry rehabilitation and closure legislation, (Setegn Berie, 2013).

However, still there are no environmental interventions incorporated in the operation of most quarry projects. As a result different problems have occurred and become a set of environmental issue that need to be considered in order to reduce the problems of these activities and ensure that the quarrying operation could be carried out in an environmental friendly manner by designing quarry rehabilitation program (Setegn Berie, 2013).

2.6. Stone quarrying and Sustainable Development

Sustainable development in a minerals context including quarrying can be seen to play-out at three levels:

- Theoretical considerations of non-renewable _ natural resource management (Selman, 2000);
- A strategic scale of efficient supply (Kelvi.B and Adriad.P 1996); and
- The local site-specific level in terms of the environmental impacts of working a particular deposit (Owens & Cowell, 1996).

The theoretical level essentially takes an ethical perspective that questions the very principle of extraction, the right to readily remove common mineral resources and the pursuit of progress or personal wealth for grounding issues of generational equity and responsible environmental stewardship

through policies and guidelines, gradual adoption of resource conservation, principles and encouraging progressive improvements in the efficiency of extraction, utilization of quarry fines and appropriate end-use controls for primary mineral assets so as to moderate demand Bloodworth*et al*, (2009).

At the strategic scale supply and demand mechanics tend to dominate debates on sustainable minerals development (Cowell and Owens, 1996). At the heart of this, the question is the pattern of the quarry network in relation to market hubs and growth-areas, and their connectivity to transport infrastructures in reducing the carbon footprint of mineral extraction and transportation.

The site specific level of environmental impact hinges on regulatory measures and the limits of project design within site specific contexts (Tiess, 2007). In this respect Environmental Impact Assessment [EIA] can be seen as a vital instrument of SD, raising awareness of key environmental issues (Glasson, 1999), scrutinizing the duration and cumulative effects of externalities and ensuring the most sustainable outcomes practicable are implemented.

Chapter Three

Research Methods and Methodology

3.1. Context of Addis Ababa and the Study Area

3.1.1 General Over view

Addis Ababa is the capital, political and cultural center of Ethiopia. It is an official diplomatic center of Africa Union since 1963 and United Nation Economic Commission for Africa (UNECA), (ORAAMP, 2000). According to the 2007 Ethiopian census, the population in Addis Ababa was 2.8 million, growing with an annual rate of 2.1 % (CSA Summary Report, 2008). Even though there are more than 900 urban centers in Ethiopia, Addis Ababa, its capital city, consisted of about 23% of the total urban population in the country, is a primate city (PCC, 2008).

To accommodate the ever-increasing population, industry concentration, and commercial expansion, Addis Ababa city has been expanding horizontally towards its peri-urban areas. According to Lulseged, (2011), between 1986 and 2010 the built up area increase 3 times which is from 67.08km²in 1986 to 188.01 km².

It also documented that the effect of urbanization in terms of forest and soil degradation, water pollution, and overall decline in agricultural production, agricultural community displacement, and squatter settlement proliferation Abdissa (2005), Melesse (2005), and Gete (2007). It is generally acknowledged that uncontrolled urban expansion can undermine social and environmental sustainability.

3.1.2 **Location**

Addis Ababa is located between 8° 49' 55" & 9° 5′ 53″ latitude and 38° 44′ 24″ and 38°54'19" longitude on the shoulder of the Western Main Ethiopian Rift Escarpment and the southern flank of Entoto ridge (3199m a.s.l.) and expanded in all directions. This ridge marks the northern boundary of the city following the east-west trending major fault (Ambo-Kassam). Other prominent volcanic features surrounding the city are Mt. Wochacha in the west (3385m a.s.l.), Mt. Furi (2839m a.s.l.) in the southwest and Mt. Yerer (3100m a.s.l.) in the south east and covers 54,000 hectare of land. (AAU Department of Geology & Geophysics, 2003).

3.1.3 **Climate and Rain fall**

Addis Ababa has a subtropical highland climate. The city has a complex mix of highland climate zones, with temperature differences of up to 10 °C (18 °F), depending on elevation and prevailing wind patterns. The high elevation moderates temperatures year-round, and the city's position near the equator means that temperatures are very constant from month to month. According to National Metrology Agency 2006, report the annual maximum, minimum and average rainfall is 1,250mm, 700mm and 1180.4 mm respectively. While the maximum rainy season is during summer which is from June to September and the lowest or dry season is in winter.

3.1.4 **Geological Formation and Structure**

The geology of Addis Ababa is mainly characterized by Nazreth group and Akakie basalt rock types where basalt extractions are inter spread with large accumulations of basalt flow, ignimbrites and related volcanic rocks (AAEPA, 2012). It is sub grouped as Lower Welded Tuff, Aphanitic basalt and Upper Welded Tuff. The group is underlain by Addis Ababa basalt and

overlain by Bofa basalts. (Morton et al., 1979).Under this cathagorized the Aphanitic Basalt covers the southern part of the town, especially the areas of Bole International Airport and Lideta Airfield. The Upper Welded Tuff outcrops all over the southern part of the town including Bole, Nefas Silk and Railway station; besides, it is also present in the central and northern parts of the city, (Getaneh Assefa et al., 1989).

The Young Trachyitic Flow is predominating in the southwest part of the town, from Dama hotel towards Furi and Repi along the hills and foothills of HanaMariama and TuluIyou where the study area is found. It is porphyritic with phenocrysts of plagioclase (albiteoligoclase) sandine, biotite within a groundmass of micro lities of feldspar. Moreover, it is underlain by the tuff that covers the young ignimbrite and overlaying by alternating flows of plagioclase porphyritic basalt and rhyolite especially in the Repi hill.

In general, due to its basaltic as well as ignimbrite nature and mass existence of those rock types are found in most part of quarry sites.

3.2 **Case Study Area**

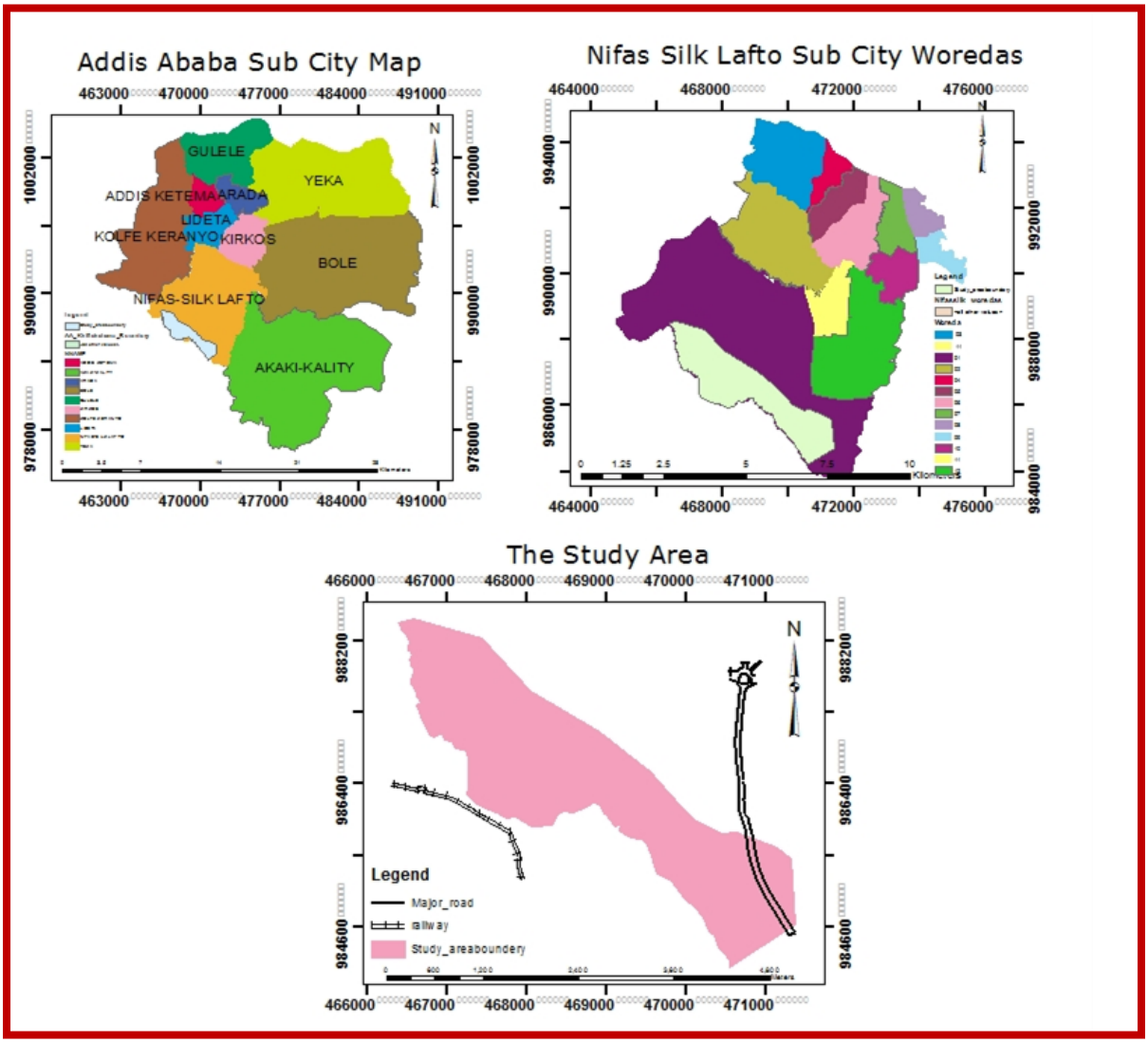
To understand the socio-economic and environmental impact of stone quarrying, as well as ease of data collection a case study area is selected purposefully from the existing quarry areas of Addis Ababa based on easy accessibility and availability of information. The study area is found in Nefas Silk Lafto Sub city under woreda 01 jurisdiction and locally named as “Hana Mariam” cobble stone project site. It is found near to the newly constructed ring road that comes from the Toll road to the previous ring road junction at Haile Garment and the new railway that comes from Dire Dawa to Sebeta. It covers nearly700 hectares of land of the quarry and the surrounding neighbors, which have specific influences from the quarry, had been taken for survey. Environmental aspects like air, sound, etc. are considered to

understand the impact on socio-economic status. The location and position the neighbors were also considered in this study since there is great variation in the mode of impacts.

3.2.1. Location of Case Study Area

The study area is located at the foot of Furigarabolo Mountain from south and, Dertu Mojo to HanaMariam ridges from north along river bank of" kersabela. It is just at the boarder of Addis Ababa and Sebetaworeda in Oromia Region.

Figure 1 Location map of the study area

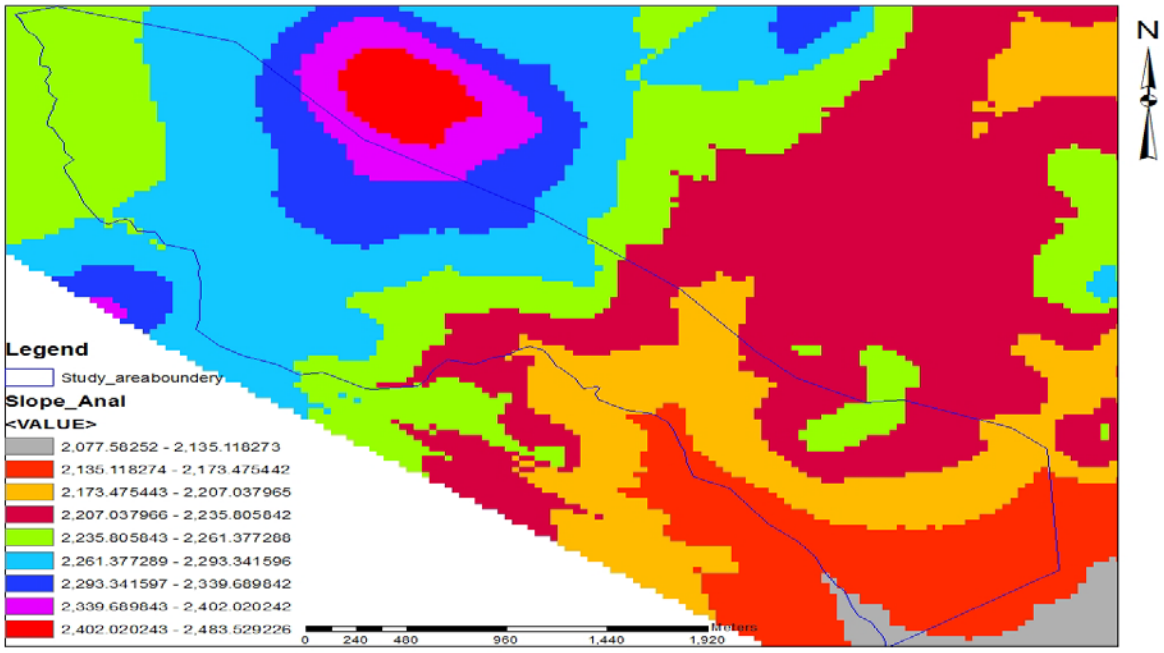


3.2.2. Topography and Drainage Pattern of Case Study Area

As explain above the study area is located at the foot of mountain Furi in the south and south west and mountain Dertu Mojo and Hana Mariam in the North and North west and which elongates the kersabela river bank towards little Akaki river. Although there is significant difference in the degree of weathering on the slopes, mostly soils are highly eroded and result in thin soil cover.

As we have seen from the slop analysis of the study and surrounding area the slope is almost constantly decreasing from top to bottom and have an elevation difference about 326.35 meter in which the lower elevation is the study area, so that it serve as a catchment area to the surrounding hill sides and exposed to erosion.

Figure 2 Slop analysis of the study area



3.3 **Research Methodology**

Qualitative and quantitative methodologies have been used by social scientists to generate knowledge. In quantitative questionnaires are suitable when a researcher seeks short and precise answer from the respondents and can easily be compared, aggregated; statically analyzed, tabulated and displayed diagrammatically. The closed-ended questions exposed researcher to variety of opinions from different respondents within a short period. To note, however, responses from close ended questionnaires lack depth. While, with the development and perceived legitimacy of both qualitative and quantitative research in the social and human sciences, mixed methods research, employing the data collection associated with both forms of data, is expand ling (john w. Creswell, 2002,).

The study was a descriptive type of research which investigate and analyzed the realities and facts what is happening in the ground or the study area and, it was done based on a mixed approach when the qualitative methodology aims at describing phenomena to rich contextual data by unearthing information that could not be easily quantified and; could be gathered through interview, focus group discussion and observation, whereas, the quantitative method was used to support the qualitative method and assessed and analyzed the perception as well as both the negative and positive contributions of stone quarrying to people's livelihood, using open-ended questioners; in relation to the socio-demographic characteristics of the quarry workers and the local communities.

3.3.1 **Research Design**

Research design is needed because it facilitates the smooth sailing of the various research operations, thereby making research as efficient as possible yielding maximal information with minimal expenditure of effort, time and money (Kothari, 1985). Yin (1994) supplements that; research design is the logic that links the data to be collected and the conclusions to be drawn to the initial questions of a study.

Literature review

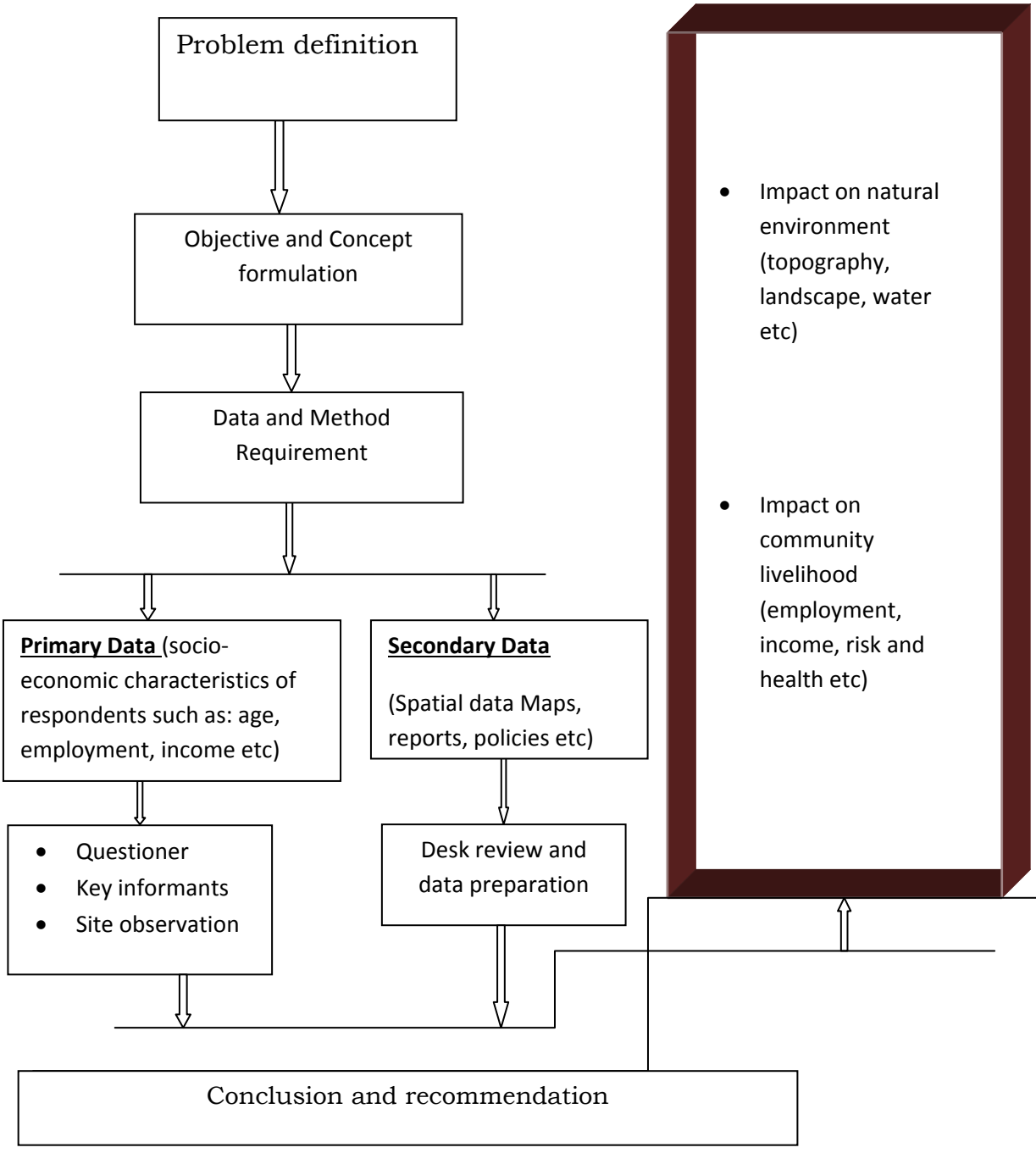


Figure 3 Research design diagram

3.3.2. Sampling Technique and Sample Size

*3.3.*2.1. Selection of Case Study Area

Purposive sampling technique was used to select the study area. Because Hana Mariam project site is one of the major quarry sites for the production of cobble stones and have large size of employee. Besides this, it is government project site which mostly conducted without EIA, while found on environmentally sensitive areas, without leaving appropriate space to the river banks.

3.3.2.2. Population Sample Frame

Due to the characteristics of the population in the study area the population was categorized in to two sample frames, i.e. the quarry employees, most of them are migrant people and the local residence community that they reside for long period in the study area.

Regarding population size, during the reconnaissance survey and the data obtained from Hana Mariam cobble stone project office there are about 9600 employee in the quarrying and cobble stone chiseling works with 132 quarry workers small scale enterprises having a minimum of 5 members of each and, 536 cobble stone chiseling enterprises with a minimum 15 members of each.

Concerning the local community the woreda administration told me there were around 150 households living there. But during the reconnaissance survey and Google earth map there are around 250 households were enumerated. Therefore I took the maximum size that I have got. Hence in the study area the size of the population were 9600 quarry workers employee and 250 resident communities respectively.

3.2.3.3 Household Sampling and Sample Size Determination

i. Sample Size Determination

There are several methods to determine the sample size of respondents from finite population. Hence in this study to draw representative sample households (n) from the population (N) of each sample frame, I used the formula, which was proofed by Israel (1992).

$n = \frac{N}{1+N(e)^2}$ Where, n is required sample size

N is total population in the sampling frame

e is the precision level with 95% of confidence level i.e. 0.1

Therefore, based on the formula given the sample size in each frame is determined as follows:

a. For quarry employees N= 9600

$$n = \frac{9600}{1+9600(0.1)^2} \quad =98.96 \sim 99$$

b. For local residence community N=250

$$n = \frac{250}{1+250(0.1)^2} \quad = 71.42 \sim 71$$

ii. Household Sampling

To select the sample household from each sample frame, the methods applied vary according to the nature of structure of data source that available. Therefore, for the local community population sample frame first select the first hose from one edge and then select systematically after every three houses.

In case of quarry employee, there is a project management office on the site and under the project office there are 10 coordination offices and 668

enterprises. Hence to select the sample household, snowball sampling was applied to identify 5 from coordination office and 33 enterprises from selected coordination offices, which (Berg, 1988) adopted to select respondents in chain which it is used in the assumption that a "band" or "link" exists between the initial sample and others in the same population allows a series of referrals to be made. While after selecting the enterprises there is a registration book that contained names of stone workers, so, select randomly from lists.

3.3.3. Data Sources and Methods of Data Collection

For the purpose of this research both primary and secondary sources of data were utilized.

3.3.3.1. Primary Data

The primary data were gathered from the cross-sectional survey through questionnaire, interviews and observation.

i. Questionnaires

Data were collected from the local residence community and quarry employees using open and close-ended questions. Open-ended question enable respondents to freely express their options and view without prejudices, and hence obtain adequate information in relation to the objectives set for this study. However, the close-ended questions, apart from reducing time consumption, made it easier for data analysis and processing of factual information. Questionnaire were administered to these groups of respondents to get their views and perception on the impact of stone quarrying on individual employment status, income as well as health issues and on the physical environmental condition of the locality. (See the questioner in the annex part)

ii. Key informants Interview

It was conducted with people from different offices with different responsibility, and expertise knowledge as well as experience to collect data related to quarry impact and livelihood of the community, management problems, land vulnerabilities occurred, major challenges to quarry program, the deriving factors to the change of natural environment and possible suggestions in the view of communities and quarry owners to handle the challenges of sustainable development using checklists.

Table 1 Key informants working organization and expertise composition

Organization	No of key informants	Expertise Knowledge
AA EPA	2	Geographer, environmental planning and landscape design
AA cobble stone project office	1	Management
AA Land bank and lease office	1	Urban planner
AA City Plan Institute	2	Urban planner and geographer
Hana Mariam cobble stone project office	2	Management and Economics
Nifas silk Lafto EPA	1	Geographer
Woreda administration head	1	Biology
Quarry employee enterprise leaders	3	-

Source: compiled by researcher

iii. Observation

Observation was important because it provided background information about the environment where the study was taken. Therefore, an extensive personal observation was undertaken in order to support the primary data that gathered and be able to gain richer understanding about the phenomena in natural setting and qualify the nature of the problem. In addition to interviews I accessed non-verbal information through observation. The observation was made with the help of base map and checklist as per the objective of the study. The checklist includes issues like the status of quarrying operation, rehabilitation condition, and effects of quarry problem on the existing ecosystem, the drainage pattern of the site, highly affected/problematic areas, and condition of river bank, condition of natural water ways, vegetation cover as well as the working environment of workers and other related issues in the study area. The observable data were captured as photos, sketches and notes.

3.3.3.2. Secondary data

i. Non -Spatial Data Source

Relevant non-spatial secondary data were collected from different sources, particularly, from government organization such as Federal Ministry of Mining, Addis Ababa City EPA, and Addis Ababa Cobble Stone Project Office, City Planning institute and land management offices. The main data gathered from such institutions were different year existing spatial data of the study area, plan report documents, mining operation legal frameworks (policy, proclamation and regulations of mining activity), yearly reports, and cobble stone project work legal frame works. Moreover extensively used Internet browsing for academia and literature reviewing of best practices

from selected countries in the areas of sustainable quarry management and livelihood were discussed.

ii. Spatial Data source

Satellite image **:**three cloud-free Land sat TM scenes, acquired on December 23, 1995, December 10, 2005 and December 22,2015 with Row/Path: 54/168, were obtained to quantitatively measure and observe the trends & patterns of land use and land cover of the study area. The three images were taken at a similar time of respective year to minimize phonological effects. All images bands 1–5 and 7 have a spatial resolution of 30 m, and the thermal infrared band has a spatial resolution of 120 m. The image was acquired through the USGS Earth Resource Observation and Science (EROS) through http://glovis.usgs.gov/ free of charge, which had been geo-referenced by supplier to the Universal Transverse Mercator (UTM) map projection (Zone 37), WGS 84 datum and ellipsoid. In order to see the clear change in land use and land cover both satellite images were clipped by the same current boundary shape file.

Additionally in order to verify the spatial data analysis,2016 Google earth Image was extracted from Google earth and spatial data such as 1995 base maps, 2005 thematic maps, land use and contour line/topographic maps were collected from Addis Ababa City plan Institute.

3.3.4. Method of Data Analysis and Interpretation

3.3.4.1. Non-spatial Data Analysis

For the purpose of accomplishing the objectives of the study and to answer the research questions, the researcher edited, coded, classified and tabulated the non-spatial collected raw data in order to make it ready for analyzing using SPSS software. Then statistical tools used in the analysis were SPSS and Excel. Whiles descriptive analysis was used to describe the socio-demographic characteristics (mainly in the form of tables, bar charts and pie charts for the purpose of visual expression).

3.3.4.2. Spatial Data Analysis

In this stage, digital image processing of the satellite data carried out for extraction of pertinent information using Arc GIS 10.1 and ERDAS IMAGINE 2013. The generated, collected and digitized data was organized into logical groups of entities such as slope and Land use/Land cover maps. In order to verify the existing situation of the ground truth, satellite image processing were supported by secondary spatial data from the 1995, 2005 and 2011 thematic maps of the city as well as the photos captured during site observation. Finally the acquired information from the analysis was presented in the form of standard thematic maps and tables.

In addition to this for slope and topographical issues analysis contour lines were made from the 2005 base map and the map prepared using Digital Elevation Model (DEM).

Chapter Four

Data Presentation, Analysis and Discussion

4.1 Socio-Demographic Characteristics of the Respondents

4.1.1 Sex and Age Distribution and Characteristics of Respondents

Like any other informal sector activities all working age groups and both sexes were engaged in stone quarrying. While due to the nature of the work that needs energetic working people mostly youths and men's are involved in the stone quarrying and coble production activities. From the data analysis only 23% of the quarry workers were females and the rest 77% were males.

Similarly as shown in the Table 2 below 52.5% and 34.3%of the workers were between the age group 18 to 25 and 26 to 33 respectively, whereas the age beyond 42 were only 2% which was under age category of 42 to 50. This implies that youths were the dominant employee of quarry works and cobble production.

Table 2: Age distribution of Quarry worker respondents

Age Group	Frequency	Percent
18-25	52	52.5
26-33	34	34.3
34-41	11	11.1
42-50	2	2.0
>50	0	0.0
Total	99	100.0

Source: compiled from field survey (2016)

4.1.2 Principal Occupation of Respondents

In the study area, respondents reported that they involved in diverse economic activities, including quarrying, government and non-government employment, subsistence business activities, and mixed labor, while the dominant activity in the area was quarrying and cobble production, which accounts 89% of the quarry workers and 52.35% from the total respondents of the sample survey were engaged in quarrying and cobble stone chiseling works as a primary occupation. In contrast there were no people fully engaged in agricultural activities.

The mixed labor in quarrying with small business and agriculture shared 12.74% and 2.94% respectively.

Table3: Socio-economic activities of respondents in the study area

Occupation	Quarry Workers		None Quarry workers		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Government employee			5	7.0	5	2.94
Owen business/Petty			23	32.4	23	13.52
Private employee			14	19.7	14	8.23
quarry worker	89	89.9			89	52.35
Mixed labor in agriculture and quarry labor			5	7.0	5	2.94
Mixed labor in agriculture and small business			13	18.3	13	7.64
Mixed labor in quarrying and small business	10	10.1	11	15.5	21	12.74
Total	99	100	71	100	170	100

Source: compiled from field survey (2016)

In general, as shown in table 3 agriculture is not serving as a primary economic base in the study area, rather as a complimentary income source

to their livelihood. Hence it indicated that agriculture has no significance in the livelihood strategies of the community.

4.1.3. Place of Origin of the Quarry Workers

Although most of the quarry workers reside in the neighboring villages of the study area as a shelter, interviews revealed that 96 % of the quarry employees were migrants from different regions of the country. As they explain they were landless youths, and came from regions and rural communities. Therefore, due to the opportunity they have got a long term employment in quarrying and related works they settled permanently in the area.

Though, the influx of this migrant labor may understandably have a significant positive and negative impact on local social structures as well as economy. From the open ended questionnaire, the local residence respondent said that, the existence of the quarry site close to the communities' village created market opportunity for house renting, transport services, tools and food items selling positively and them able to transform them to urban economic activities. While, they also strongly argued that: increased in alcoholism, prostitution, and other crime which adversely affected the community.

4.2. Socioeconomic Outcomes of Stone Quarrying in the Study Area

4.2.1. Quarrying as a Source of Employment and Livelihood Strategies

As stated in the literature, quarrying as labor intensive work it creates substantial job opportunities in many countries. Similarly, the Government of Ethiopia identified it as one of livelihood strategies and facilitates the availing resources of land, credit, tools, trainings and information to those who wants to engaged in the sector.

Hence, in the study area many people were engaged and employed in quarrying and related activities to full fill their livelihood need. From the data analysis, it revealed that 89.5% of the quarry workers respondents and/or 52.35% of the total sample population considered the sector as a primary livelihood strategy and 12.74% of the respondents use as a supplementary strategy to their livelihood.

Additionally, from the response to the question why they engaged in stone quarrying activities they asserted that poverty as a major causative factor and most of them prefer engaging in it due to getting privacy and better income rather than private sector employment and daily works.

Table 4: Quarry workers perception against factors of engagement in quarrying

Responses	Rank				Total
	1	2	3	4	
Poverty	**55**	24	15	5	99
Better Income	44	**33**	22	0	99
Job Opportunity	11	11	**66**	11	99
Saving	0	0	11	**88**	99

Source: Field survey (2016)

Moreover, according to Addis Ababa Project Office five years report there were 2,240 micro and small enterprises established and 111,965 people directly employed in quarrying and cobble stone production in Addis Ababa and from this 31.11 percent or 34,830 people were employed in the study area project.

Table 5: Summery of Job opportunity created in stone quarrying and cobble stone production in Addis Ababa the past five years

Site Name	2003 E.C	2004 E.C	2005 E.C	2006 E.C	2007 E.C	Five Years Total	Average
*Hana Mariam	3,424	8,310	14,416	5,775	2,905	34,830	6,966
**Others	7,078	8,934	29,744	26,333	5,046	77,135	15,427
Total	10,502	17,244	44,160	32,108	7,951	111,965	22,393
Percentage of Hana From Total	32.6	48.19	32.64	17.98	36.536	31.11	

***Hana Mariam the study area**
**** Others include Gelan Gura, Bole lemi, Gewasa, Katila, ChefeAyat and YekaTafo**
Source: compiled by the researcher from secondary data (2016)

In conclusion, the stone quarrying industry as a whole has been generating considerable employment opportunities and served as a livelihood strategy to many people in the study area as well as at the city level. While, there was a difference in choice of livelihood strategy between the local community and the migrant people. As revealed in the study the local communities were almost none that engaged in the quarrying activities, however most of them involved in other activities which benefited indirectly. From their response, the quarrying activity in the locality creates indirect job opportunity and income source such as house renting, mini cafes and restaurants and corner shops to the local community. As revealed from the data 32.4% of the local community engaged in petty trading considered it as a livelihood strategy.

4.2.2. Quarrying for Better Income

As presented in the table 6 below, the house hold income analysis showed that 34.1% of the quarry workers earned more than 3001 birr per month while for the none-quarry workers only 18.3% got above 3001 birr. On the contrary 32.39% of the none-quarry workers have got below 2000 birr per month but for quarry workers only 8.1% earned below 2000 birr.

Table 6: Income category and amounts of income of respondents

Income Category	None Quarry Workers		Quarry Workers		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
500 to 1000	4	5.6			4	2.35
1000 to 1500	7	9.9	1	1.0	8	4.71
1501 to 2000	12	16.9	7	7.1	19	11.18
2001 to 2500	19	26.8	28	28.3	47	27.65
2501 to 3000	16	22.5	29	29.3	45	26.47
3001 to 3500	10	14.1	18	18.2	28	16.47
3501 to 4000	3	4.2	12	12.1	15	8.82
4001 to 5000			4	4.0	4	2.35
Total	71	100.0	99	100.0	170	100.00

Moreover, the average household income in quarrying and non- quarrying communities varies from 2805 and 2300 Birr per month respectively. Therefore, it could be conclude that there is a significance income difference between quarrying and non quarrying workers that is quarry workers have got better income than non quarry workers in the study area.

Besides from the saving perception and characteristics analysis of respondents 100% of the quarry workers have been able to save monthly where as only 46.5% of the none-quarry workers able to save from their monthly income. Therefore, the result shows that there is a significant income difference between the quarrying and none quarrying households and most of the quarry household respondents confessed the saving capacity favored them to invest in other assets.

4.2.3. Contribution of Quarrying to Local Economy

The aim of organizing, facilitating and take over the initiative of the quarry sector to the employee by the government was to create job opportunity, improve the culture of saving of the workers and enables them to transform to the other productive sectors of the economy such as manufacturing, construction, textile and others. According to the MSE development strategy document the employee is expected to save a minimum of 10% -20% of their income while, from the respondents response it revealed that most of the quarry workers saving able to save 40 percent of their monthly income.

According to the respondents, one of the reason that enforce them to engaged in quarry works were the saving strategy which the government facilitate the service on site, hence, the employee have saved millions of birr and were enabled to establish medium level enterprises.

From the data collected and compiled yearly project office report (see table 7 below) revealed that, the employee in the sector could be able to save beyond 1 Billion birr in the past five years and the study area contributes 33.45 percent of the total saving.

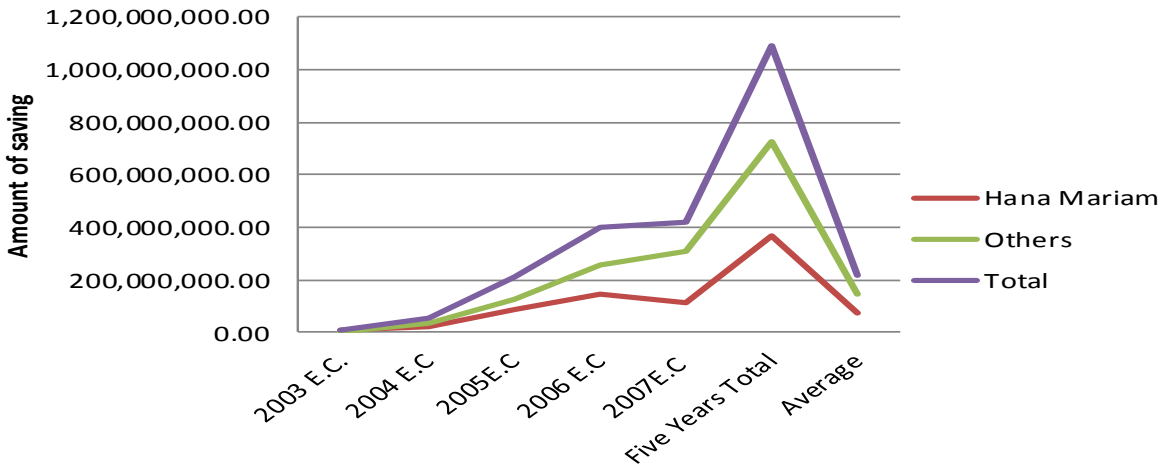
Table 7: Summery of saving amount in stone quarrying and cobble stone production in the study area and Addis Ababa the past five years

Site Name	2003 E.C.	2004 E.C	2005E.C	2006 E.C	2007E.C	Five Years Total	Average
Hana Mariam	5,965,669.43	18,282,477.79	86,592,316.69	143,406,158.77	110,894,050.97	365,140,673.65	73,028,134.73
Others	3,234,250.00	33,053,328.81	125,207,691.84	253,986,731.10	311,075,227.60	726,557,229.35	145,311,445.87
Total	9,199,919.43	51,335,806.60	211,800,008.53	397,392,889.87	421,969,278.57	1,091,697,903.00	218,339,580.60

Source: Computed from secondary data (2016)

Besides, as presented in figure below the trend analysis shows that saving of the quarry workers in general as well as the study area increased yearly.

Figure 4 Saving Trends of quarry workers in the past five years



Source: compiled and analyzed from secondary data by the researcher

Therefore, saving can be vital to increase the amount of fixed capital available, which contributes to economic growth. Thus the saving practice in the sector has been contributing to personal finance; money used to purchase stocks, put in an investment fund or used to buy any asset. Moreover the saving practice that done by quarry workers contributes to a national saving growth rate broadly.

4.2.4. Other Social Impacts of Quarrying

4.2.4.1. Accidents and Fatal Death

Hazardous working conditions in both quarrying and cobble chiseling works are exposed to a high incidence of fatal occupational diseases silicosis and tuberculosis. Workers are also required to carry very heavy weights, mainly in shallow quarries and non-mechanized plants.

As I have observed stone quarrying activities create steep rock cliffs and deep gaping pits on the surface. These features characterized the working

environment of the stone workers difficult and made them prone to accidents and fatality.

According to the respondents accidents were caused by collapse of walls on the stone workers affect their lives and reduced their capability to engage in income generating quarrying activities hence affecting their livelihood outcomes as well.

Another impact of stone quarrying in the area is the impact on the surrounding residence. As described on Fig.5 most quarrying activities take place very close to residences and are often abandoned after completion. Therefore, during rainy seasons, the abandoned pits collect water causes breeding mosquitoes and spread of malaria and other related diseases.

Figure 5 Risks of quarrying to the local community due to collected water and settlement at the edge of the pit

a) Built houses at the edge of excavated hoses

b) Collected water which causes mosquito breeding and accidents

In addition to these, youth's death was reported by media while swimming in the collected water. These who died in such accident were as much of 38 people in the area. Besides due to house at the edge of the abundant pits the residence psychologically fills insecure especially for their children.

4.3. Physical Environment and Quarrying in the Study Area

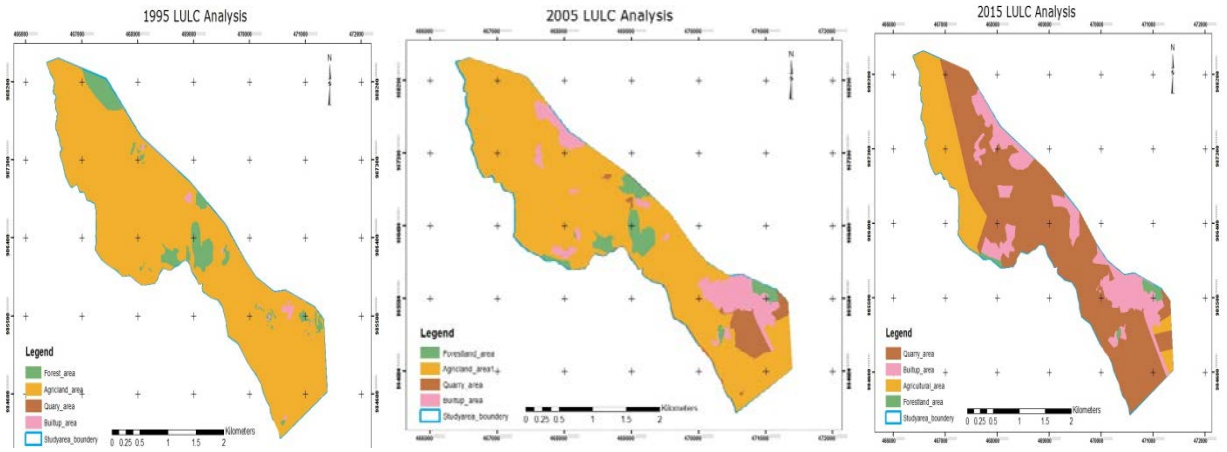
4.3.1 Existing land use land cover of the study area

For land use pattern analysis of the study area, I used Land Sat images of 1995, 2005 and 2015. Despite this, it was supported by various secondary spatial data set sources from the city administration base maps such as the 1995, 2005 and 2011 organized different thematic maps. For the purpose of ease assessment the land use/ land cover classes' categorized in to four groups that includes, built up area, quarry areas, forest and green areas, and agriculture lands as described in details in the table below.

Table 8 Land covers Classification Scheme

Land cover class	Description
Built-up	Developed - Areas covered by considerably constructed materials (e.g. asphalt, concrete, buildings, etc) that can be for residential, commercial services, transportation, communication and industrial purposes.
Agriculture and grass land	Includes cultivated and grass land that used to grow field crop and grazing areas dominantly covered with grasses.
Quarry Areas	Areas characterized by bare and outcropping rock. Quarries/Strip Mines/Gravel Pits - Areas of extractive mining activities with significant surface and abandoned quarry site. cobble stone production sites and dumping sites which the resource is already exploited),
Forest	Areas characterized by vegetation cover (It can be natural and plantation; tree canopy have considerable percent of the cover).

Figure 6: LULC change analysis map of (1995, 2005 and 2015)



Source: analyzed from land sat image

Based on the land use land cover analysis result of the respective year presented in table below, in 1995 agriculture was the dominated land use function in the area and accounts 87.07% from the total and the rest land use functions were insignificant and quarries were none at a time. Whereas in 2015 land use and land cover result the agricultural land use functions decline and, quarry and built up land use functions expanded and accounts 55.18% and 20.68% respectively.

Table 9: Land use and land cover proportion of the study area (1995, 2005 and 2015)

LULC Type	1995		2005		2015	
	Area in Ha	**%**	**Area in Ha**	**%**	**Area in Ha**	**%**
Built-up areas	20.43	3.12	73.64	11.23	135.61	20.68
Quarry areas	0.00	0.00	31.01	4.73	361.77	55.18
Agriculture and Grass land	570.88	87.07	517.60	78.95	144.25	22.00
Forest cover	64.31	9.81	33.40	5.09	13.99	2.13
Total	655.62	100.00	**655.62**	**100.00**	**655.62**	**100.00**

Source: Extracted from analysis of Land sat images of 1995, 2005, and 2015 and AAC base maps

4.3.2. Trend and rate of change of land use and land cover

As described above over the study period, quarry areas were increased highly and become the dominant land use especially within the past ten years. As presented the land use dynamics analysis of the study area in table 10 shown below the rate of change quarry land use functions increased in 18.09 percent annually. Whereas the agricultural and forest land use function decreased by 21.33 and 2.51 percent in the given year.

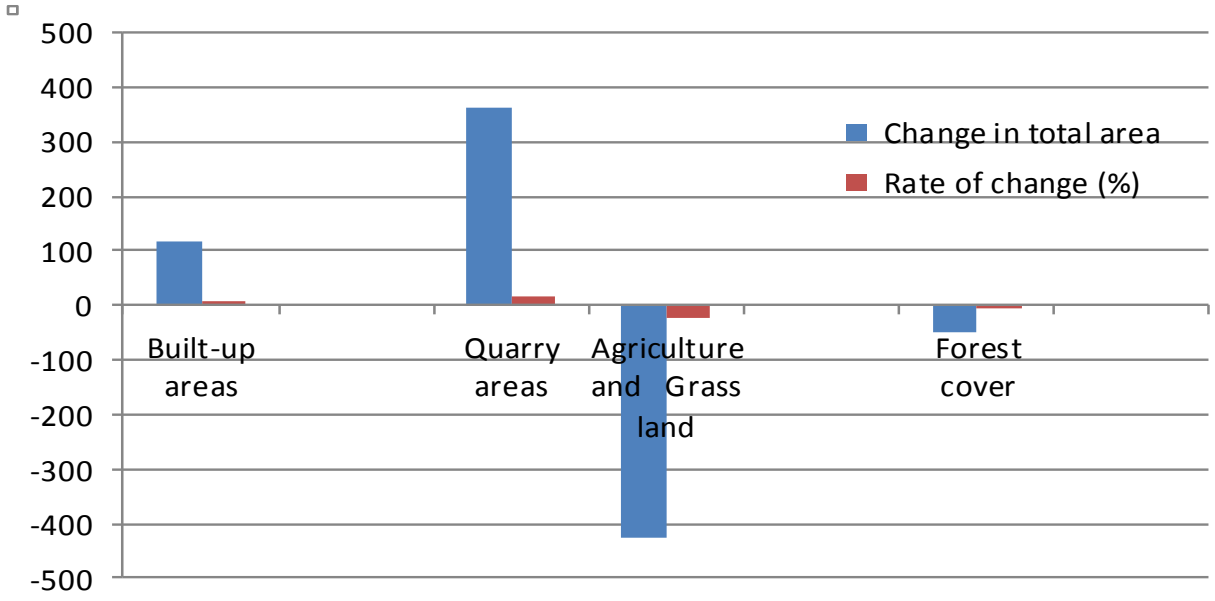
Table 10: Rate of change (%) of land use and land cover in the study area (1995 to 2015)

LULC Type	Base year (1995)		Final Year(2015)		Change Between 1995 to 2015	
	Total Area	Percentage	Total Area	Percentage	Change in area	Rate of change (%)
Built-up areas	20.43	3.12	135.61	20.68	115.18	5.76
Quarry areas	0	0	361.77	55.18	361.77	18.09
Agriculture and Grass land	570.88	87.07	144.25	22	-426.63	-21.33
Forest cover	64.31	9.81	13.99	2.13	-50.32	-2.52

Source: Computed based on statistical data extracted from own image analysis, (2016)

In general, the analysis result showed that the land use land cover change is the major environmental problems that led to land degradation in the study area.

Figure 7: Rate of change of LULC between 1995 and 2015



Source: compute from the statistical data of the LULC change analysis

Generally the trend and rate of land use and land cover between the 1995 and 2015 revealed that a reduction in agriculture and forest, whereas quarry areas are expanding at the expense of agriculture and forestlands. This in turn forced the local community residence to transform and shift their livelihood strategies from agriculture to urban activities such as: petty trading, house ranting and small scale transport sector.

4.3.3. Land Conversion and Degradation

Land use conversion and degradation is one of the significant impacts arising out of mining and quarrying activities, which is mainly in the form of alteration of landscape due to excavation, stacking of top soil and loss of land due to dumping of waste and over burden soil. As described above the first and for most impact in the study area was the land use land cover change where in the last 20 years especially within the past 10 years 55.18% of agricultural land was changed to quarry areas as a result due to quarrying activities the landscape is changed and degraded.

From Social Impact Assessment (SIA) survey of the impact of stone quarrying on local environment information, it revealed that the quarrying activity in the study area has very high impact on the physical environment. Furthermore, as shown in the table 11 below, the respondents identified loss of agricultural land, land degradation and depletion of water resource as a major physical environmental impact of quarrying in order.

Table 11: Respondent's Order of perception on major environmental impact

Responses	Rank					Total
	1	2	3	4	5	
Loss of Agricultural Land	**60**	34	47	29	0	170
Land Degradation	**58**	**89**	**13**	**10**	**0**	170
Ground and Surface Water Depletion	**0**	**12**	**96**	**60**	**2**	170
Dust and Air Pollution	**52**	**35**	**10**	**39**	**34**	170
Deforestation	**0**	**0**	**1**	**34**	**135**	170
Total	170	170	170	170	170	

Source: compiled from field survey (2016)

To conclude, as I observed and most key informants asserted poor management and lack of rehabilitation of the quarry pits, in the area, resulted highly degraded land and has become non utilizable and abandoned area.

4.3.4. Waste Accumulation and Inappropriate Disposal

Solid waste may be generated at any stage of the quarry cycle. Large quantities of soil, overburden of waste rock may need to be removed to expose the target mineral. As we have seen from the figure below the over burden of waste material over the surface accumulated without proper

management. It was estimated that the overburden waste materials has a depth of 2 meters and total areas of the abandoned quarry site is estimated to be 361 hectares (3.61km^2). Therefore, the volume (V) overburden material is calculated as:

Volume = Total area of the abandoned quarry sites in the study area X average depth of the top soil with volcanic tuff materials

$$V=3.61km^2 * 2m=7,220,000m^3$$

Besides, from the cobble stone production experts, from one meter cube of raw stone it could be usable with a maximum of 75to 80 percent while the rest 20 to 25 percent withdrawal, as left west. Hence, the available data about the amount of extracted raw stone that got from the project office in the past four years were around 320,505.67m^3; therefore, about 25% (80,126.42m^3) was dumped as west material. Despite this, house hold solid waste material was disposed and aggravated the land degradation and contamination of the area. Totally it is estimated that over 7,300,126m^3 wastes were dispose over there without proper land filling and management.

Figure 8 Waste accumulation and impact on Physical environment because of degradation

a) Over burden waste rock from chiseling of cobble stone in the site

b) Dumped soil and wastes on abandoned quarry pits

In general, as shown in figure 8 the over burden material was too much and it creates a cliff and resulted agley and degraded land. So that the study area needs attention in order to restore and sustain the physical environment.

4.3.5. Ground Water Table Alteration and Contamination

The impact of the mining and quarrying activities on water can be determined by physical observation and turbidity tests. The test revealed an increased turbidity in downstream areas as compared to the upstream results. In this research the impacts of quarry on the surface as well as ground water is analyzed based on physical observation and interviews of the respondents.

As explained in the literature, the removal of topsoil, overburden and aggregates may affect the quality of water recharging capacity of an aquifer, and excavation below the water table may lead to de-watering of adjacent water courses and wells. Therefore, as shown in the figure the excavation of the quarry below the water table in the area causes de-watering and depletion of rechargeable of the aquifer and results local changes to the groundwater flow regime. Due to in depth bulk excavation of quarries the water table levels of groundwater altered and it flows into the quarry pit as a result the water table rebounds to a new state of hydrological equilibrium and may increase susceptibility to contamination.

Figure 9: Ground water table alteration and source pollution

a) Dewatering and depletion of quarry pits on ground water

b) Communities use the contaminated water for domestic purpose

Moreover in most periphery areas, there was lack of access of potable water so; rivers and spring are important source of domestic water use to the residing communities. Therefore, as shown in the picture in the study area, the communities were watering from contaminated and bulk excavation pits of the quarries.

4.3.6. Diversion of flow direction and pollution of surface water

Altering the landscape over which water flows can change the pattern of surface water flow. Quarrying and gravel extraction involve processes which generate suspended sediment. In the study area, it was observed that river bed extraction include: exacerbation of river bed and diversion activity by pits and access roads, over material deposited waste on river banks within the site and down the river basin affects the changing in the surface water resources quantity and quality.

In addition due to poor management of the site the abounded quarry pits served as dumping sites for waste materials; when there is heavy rainfall sediment-laden storm water may be discharged into the local surface water

networks. Soil and sediment loading of rivers and other water bodies may cause disturbance to aquatic flora and fauna and alter flow regimes.

Despite this as described in the slope analysis, the study area is located at the escarpment of Furi Mountain it is vulnerable to erosion during rainy season, so it is unavoidable that dumped soil and wastes will be washed away during rainy season and causes the increased turbidity of rivers.

Figure 10 Surface water diversion and contamination

a) Impact of diverging of river basin on surface water

b) Disposed waste on river basin

Generally as we have seen in the figure - the excavated top soil and other wastes in the study area were dumped over the river bank and eroded by the surface water to down the stream and contaminate the river.

Chapter Five

Summery, Conclusion and Recommendations

5.1. Summery

The overall purpose of this study was to assess the impacts of stone quarrying on environment and livelihood of local community in Nefas silk Lafto sub city Hanamariam cobble stone quarry area. Specifically, it aimed at; assessing and identifying significantly affected elements of the natural environment and socio-economic activities associated with livelihood of the community. The study also explored perceptions of respondents in line with the impact of quarrying activities on the environment, household income and local community health and safety.

As findings revealed that_ the quarrying activity in the area affect the natural environment through changing the land use, land cover and the landscape. Quarry extraction in the area involves bulk excavation of rocks and disposing of overburden rock wastes, which caused loose of agricultural land. Negative landscape effects due to presence of abandoned quarry pits and heaps of quarry wastes together with lack of quarry pit restoration plan and/or after-use plans degraded the land. Besides altering the landscape and river bed extraction include: exacerbation of river bed degradation, diversion of right of way of streams, partial blockage of rivers due to roads or quarry pits and suspended sediment generation led to a significant depletion of both surface and ground water resources.

The study also fined out quarrying serve as an alternative job opportunity and created large amount of employment at the study area and city level. It also asserted that the engagement in stone quarrying at the study area was

both poverty and income driven that the limited access to productive assets, such as land and capital lead them to migrate from their origin and engaging in stone quarrying. The stone workers in this study had free access to utilize resources where quarrying is carried out since quarrying became a primary economic occupation for the majority of the communities.

Findings also showed that, stone workers through their activities were able to support their households without any external intervention. This displayed an aspect of self-sufficiency, or self-reliance which is also a salient feature in relation to sustainability. Because the stone workers able to save to accumulate financial capital and involve in other sector.

The health and safety of miners and the nearby communities are at risk from a variety of factors, ranging from the inhalation of dust, poor safety procedures and water contamination to unprotected pits and cliffs. For instance, during the rainy seasons, form breeding grounds for disease vectors such as mosquitoes and housefly the agents that spread malaria and water borne diseases. The risks due to open pits and heap waste cliffs resulted in accidents in the surveyed area range from minor to major injuries, to fatal deaths and are severest during the rainy seasons. Based on district statistics, on average, 38 people die from mine-related accidents each year.

5.2. Conclusions

In assessing the impact of stone quarrying on environment and livelihood of local community with reference to the study area can be conclude as follows:

- Quarrying has led to a significant change in landscape and land degradation. Negative landscape effects due to presence of abandoned quarry pits and heaps of quarry wastes together with lack of quarry pit restoration plan and/or after-use plans degraded the land and depleted both surface and ground water resources.
- Quarrying largely serve as source of employment and livelihood strategies to the rural poor and it enhance other livelihood coping strategies such as petty trading, small scale transport services and house renting in the locality.
- Although, most experience showed that quarries are mostly owned by private companies and that the employees were vulnerable to work insecurity and better wages, while, it is better experience that quarrying in the study area was community based and managed by the government and enterprises together. As a result many land less and vulnerable people to have resources were engaged in the quarrying activities directly and employee themselves to secure their livelihood as well as income generation means.
- There is safety problem which perception shared among local communities in the study area reveled that quarrying has exposed to fatal accidents and contributed to the prevalence of some diseases, loss and/or reduction of farmlands, these effects have therefore been found to have significant impacts on the residents of the communities.

5.3. Recommendations

To address the impacts of gravel mining activities the following under-listed recommendations are suggested:

i. The main barriers that hinder and aggravate the environmental impact of quarrying in the study area were lack of awareness and enforcement. Therefore, meaningful awareness creation program should be made by the concerned body to quarry developers, quarry operators and the community at large. All relevant stakeholders in the quarrying sector including Environmental Protection Agency (EPA), Cobble Stone Project Office, Enterprises, Local administrations and communities should strengthen collaboration among themselves for effective awareness creation on environmental impact mitigation and enforcement of mining regulation.

ii. Restoration and rehabilitation program should be planed and implemented from the scratch. Agro forestry practices and tree planting in degraded quarry mining sites should be encouraged. In the same way, environmental sustainability should be given a high priority in an effort to preserve finite resources for the future generations. There is need to ensure that mining operations are conducted in such a way that the broader scale benefits to society are openly acknowledged and that concerted efforts are made to ensure that these benefits can be sustained even when mining activities have stopped.

iii. Opening of pits should be done at distances from communities and closure and restoration ensured on timely basis as this can help reduce the prevalence rate of quarrying related accidents and diseases in the communities.

iv. Local communities should be benefited directly from quarrying opened in their areas through participation of the quarrying activities, selection of sites for the quarrying and restoration programs. This could improve their economic livelihoods and also enhance their commitments towards reclamation of abandoned quarry.

v. Due to its nature stone quarrying activities were exposed to accidents and deaths. Lack of awareness about safety measures against these accidents and preventable diseases coupled with poor tools jeopardize the workers' lives and likewise their livelihood. Therefore, through different stakeholders and the local communities, awareness campaigns and sensitization meetings may be organized periodically at the quarry. Quarries' need to be alerted about the effects of their activities and encouraged to take measures to mitigate or reduce the negative impacts.

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Annex

Questionnaire for local community and quarry workers

Dear Sir/ Madam

This questioner is prepared to assess the impacts of stone quarrying on environment and livelihood of local community in Addis Ababa the case of NifasSilcLafto Sub city. The information is specifically for study purpose and is highly confidential. Your positive response is highly appreciated.

a) Date of Interview……

b) Respondents number……

A. Demographic Information

1. Age:

a) Less than 18 years b) 18-25 years c) 26-33 years d) 34-41 years e) 42-49 years f) 50+ years

2. Sex:

a) Male b) Female

3. Level of Education:

a) Illiterate b) Read and writec) Primary d) Secondary

e) Tertiary/university

4. Marital Status:

a) Single b) Married c) Widow

5. House Hold Size:

a) 1 b) 2-3 c) 4-5 d) 6-8 e) 8+

6. Occupation

a) Agriculture b) government employs c) Private Sector employs d) Own business e) quarry labor f) Mixed labor in agriculture and quarry g) Mixed labor in agriculture and small business e) none

7. HH Income / month

a) < 1000 b) 1000 to 2000 c) 2001 to 3500 d) 3501 to 5000 e) > 5000

8. Migration Status: a) Indigenous b) Migrant

B). Environmental and Socio-Economic impacts of stone quarrying and perception of communities

8. What are the major economic activities/income generating means in the district in order of importance?

a) Cultivation of food crops b) livestock production c) petty trading d) Stone quarrying e) others specify

9. Why are you engaged in stone quarrying?

a) Job opportunity b) additional income generation

10. For how long have you been engaged in stone quarrying?

a) Less than 6 months b) Less than a year c) 1-2 yrs. d) 2- 3years
e) Greater than 3 Years

11. Are there any members of your family engaged in stone quarrying?

a) Yes b) No

12. If yes how many? Specify:

a) Child b) Spouse c) Relative

13. How much do you earn per day or week or month? Specify it.

14. How has stone quarrying changed your status?

a) Income b) Marital c) Children's education

15. Do you consider stone quarrying a widespread economic activity in the locality/district?

a) Yes b) No

16. Do you believe quarrying create reliable and alternative job opportunity for inhabitants in the district?

a) Yes b) No

17)If yes how?

……

……

……

……

18) If no, why?

……

……

……

……

19. Have you ever seen the site of stone quarrying in the locality?

a) Yes b) No

20. If yes, how can you describe the methods used in the quarrying activity in terms of impacts on the physical environment?

a) Doesn't have any impact b) little impact

c) distractive d) Very distractive e) No certain

21. Do you agree methods of stone quarrying are responsible to habitat and land degradation in the area?

a) Strongly agree b) agree

c) strongly disagree

d) Disagree

22. Do you believe the activities of stone quarrying contribute to scarcity of agricultural land?

a) Strongly agree b) agree

c) strongly disagree

d) Disagree e) no certain

23. What is the relationship between quarries and local residents in the area?

a) Very good b) good

c) bad

d) Very bad e) No certain

24. Give reason to support your answer in (23) above?

……

……

……

……

25. Have there been any conflicts between quarries and local community members in the past?

a) Yes b) no

26. If yes, what was the cause of the conflict?

……

……
……
…….

27. Due to pits of quarrying what occupational health and safety risks observed in the area? List according to severity of the problem

a) Fatal accident b) physical injury

c) respiratory disease

28. Is there any rehabilitation program to quarry sites after closing?

a) Yes b) No

29. If your answer is yes for

(28) Who are responsible?

a) Local community b) quarries

c) Governmental organization

Check list For Focal Group Discussion and Key Informants

TO: Addis Ababa environmental protection office experts, "Quable" stone/dressed stone project office experts, quarry project site coordinators, local administration head

1. How do the quarry sites selected?
2. Is there under take EIA before the quarry sites selected?
3. How do the local communities participate in the site selection?
4. Why do people join stone quarrying in spite of other economic activities?
5. Who are mainly involved in the stone quarrying industry and where do they come from?
6. How does stone quarrying enhanced the lively hood of local community and the quarry workers?
7. What are the effects of stone quarrying on the environment?
8. What problems are faced the local community and the quarry workers respectively?
9. Are there any mitigation measures put in place to reduce these problems?
10. Are there any government/NGO initiatives to improve the industry in terms of:
    a) Awareness
    b) Funds
    c) Any other
11. Who are responsible to rehabilitate quarry sites after closing?
12. What police and organizational structural measures are available to control quarrying activities in order to reduce environmental impacts?

Annex 2

Table: Income

	None Quarry Workers		Quarry Workers		Total	
	Frequency	Percent	Frequency	Percent	Frequancy	Percent
<1000	4	5.6			4	2.35
1000 to 1500	7	9.9	1	1.0	8	4.71
1501 to 2000	12	16.9	7	7.1	19	11.18
2001 to 2500	19	26.8	28	28.3	47	27.65
2501 to 3000	16	22.5	29	29.3	45	26.47
3001 to 3500	10	14.1	18	18.2	28	16.47
3501 to 4000	3	4.2	12	12.1	15	8.82
4001 to 5000			4	4.0	4	2.35
Total	71	100.0	99	100.0	170	100.00

Migration Status	None Quarry workers House Hold		Quarry workers House Hold	
	Frequancy	Percent	Frequancy	Percent
Native/Indiginious	37	86.0	4	3.5
Migrant	6	14.0	110	96.5
Total	43	100.0	114	100.0

Table Migration status of quarry workers

Table : Job opportunities of stone quarrying and coble stone production in Addis Ababa

No	Site Name	Sub city	Fiscal /Budget Year																			
			2003 E.C				2004 E.C				2005 E.C				2006 E.C			2007E.C				
			No of enterprize	No of memebers			No of enterprize	No of memebers			No of enterprize	No of memebers			No of enterprize	No of memebers		No of enterprize	No of members			
				Male	Female	Total		Male	Female	Total		Male	Female	Total		Male	Female	Total		Male	Female	Total
1	YekaTafo	Yeka	74	472	177	649	438	2,925	812	3,737	158	2,438	123	2,561								
2	***Hana Mariam	Nifas silk Lafto	130	2275	1149	3424	443	5,925	2,385	8,310	854	10,152	4,264	14,416	434	3,999	1,776	5,775	475	10,144	3,047	13,1
3	ChefeAyat	Bole	51	654	173	827	422	3,005	604	3,609	243	2,668	470	3,138	359	3,524	785	4,309	185	2,742	692	3,4
4	GelanGura	AkakiKality	304	3,984	1,618	5,602	161	1,335	253	1,588	616	4,292	842	5,134	1,131	8,926	2,441	11,367	202	2,328	855	3,1
5	Bole Lemi	Bole									1,081	14,424	1,872	16,296	284	2,636	588	3,224	50	424	103	5
6	Gewasa										105	537	81	618		0			107	1,975	565	2,5
7	Katila										215	1,736	261	1,997	652	5,950	1483	7,433	198	1,697	444	2,1
	Total		**559**	**7385**	**3117**	**10502**	**1464**	**13190**	**4054**	**17244**	**3272**	**36247**	**7913**	**44160**	**2860**	**25035**	**7073**	**32108**	**1217**	**19310**	**5706**	**250**

No	Site Name	2003 E.C			2004 E.C			2005 E.C			2006 E.C			2007 E.C				
		Saved by enterprize	Saved by individuals	Total	Saved by enterprize	Saved by individuals	Total	Saved by enterprize	Saved by individuals	Total	Saved by enterprize	Saved by individuals	Total	Saved by enterprize	Saved by individuals	TotTablal	Saved by enterprize	
1	Hana Mariam	1,498,269.48	4,467,400.00	5,965,669.43	581,143.00	17,701,064.79	18,282,477.79	12,468,524.92	74,123,791.77	86,592,316.69	142,742,272.77	663,886.00	143,406,158.77	1,718,485.60	109,175,565.37	110,894,050.97	159,008,695.77	2
2	Others	816,729.00	2,417,521.00	3,234,250.00	94,252.30	32,115,106.14	33,053,328.81	1,924,730.94	123,282,960.90	125,207,691.84	220,331,632.76	33,655,098.34	253,986,731.10	2,056,431.32	309,018,796.28	311,075,227.60	225,223,776.32	5
3	Total	2,314,998.48	6,884,921.00	9,199,919.43	675,395.30	49,816,170.93	51,335,806.60	14,393,255.86	197,406,752.67	211,800,008.53	363,073,905.53	34,318,984.34	397,392,889.87	3,774,916.92	418,194,361.65	421,969,278.57	384,232,472.09	7
4	Percentage	64.72	64.89	64.84	86.04	35.53	35.61	86.63	37.55	40.88	39.31	1.93	36.09	45.52	26.11	26.28	41.38	

Table Amount of saving in the past five years by individuals and interprises