ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF SAND HARVESTING ON THE COMMUNITY IN RIVER KIVOU CATCHMENT, MWINGI SUB COUNTY, KITUI COUNTY, KENYA

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N50/CE/15043/2008

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (ENVIRONMENTAL EDUCATION) IN THE SCHOOL OF ENVIRONMENTAL STUDIES, KENYATTA UNIVERSITY

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Environmental and socio-economic

JUNE, 2015
DECLARATION

This thesis is my original work and has not been presented for a degree in any other university. No part of this thesis may be reproduced without prior permission from the author and/or Kenyatta University.

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DECLARATION BY SUPERVISORS

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DEDICATION

To the Almighty God, for giving me the strength and sufficient grace this far. Blessed be his holy name. To my loving parents, Mzee Wambua Nguta (late) and Mama Ruth Kanindi; I share this work with you all for always encouraging me to achieve my goals, for having unwavering confidence in my abilities, even during challenging times, for providing seemingly infinite compassion and support from which I too often drew, and perhaps most significantly, for instilling in me the values to always work hard, nurture, and have a life-long respect for the local environment and nature.

To my beloved husband Nicholas, our loving children: Moses, David and Amy. I thank you all for your love, support and patience during the entire process of this study.

Finally, I dedicate this thesis to the young people of the world, both male and female in whose hands our future rests.
ACKNOWLEDGEMENT

The completion of this work has been made possible through the assistance and cooperation of several people. I wish to acknowledge Dr. R. K. Kerich and Dr. J. N. Maraga my supervisors for their guidance and moral support throughout my study, whose experiences and insights provided the substance of this research. I salute them for their wealth of knowledge in the field of environmental science, which is exceptional and was invaluable to this study. Secondly, I acknowledge the following persons for advice and assistance in course of my study: Edwin Kiria and Festus Mutiso. I acknowledge and appreciate the staff of Environmental Studies for laying my foundation in my area of study. Finally, I wish to acknowledge the support and responses given by respondents in my area of study, Kivou catchment, Mwingi Sub County, Kitui County, without whom this work would not have been accomplished. I wish to say to all who were involved in this study in one way or another and are not mentioned here, thank you very much.

God bless you all.
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Governance can be defined as the body of rules, enforcement mechanisms and corresponding interactive processes that coordinate the activities of the involved persons with regard to a concerted outcome (Huppert et al., 2001)

Catchment area- refers to an area that is within the 5 km radius from the river.

National sand harvesting guidelines- refers to the guidelines that have been provided by the Kenya government through her environment lead agency, NEMA

Technical sand harvesting committee- Refers to a group technical department mandated to oversee sand harvesting activities in an area as provided by the sand harvesting guidelines.

Natural resource management refers to the management of natural resources such as land, water, soil, plants and animals, with a particular focus on how management affects the quality of life for both present and future generations, (Kellert et al., 2000). Natural resources are not just valuable economic resources; they are also political and social resources. At all levels, local, national and international, actors compete to gain access, control and benefit from natural resources.

Sand is defined as a naturally occurring granular material composed of finely divided rock and mineral particles.

Sustainability refers to simultaneous pursuit of sustained or enhanced environmental quality, economic growth, and social justice.

Sand harvesting is a practice that is used to extract sand mainly through open pits. Sand is also obtained from beaches, inland dunes, ocean beads and river beds. Muhammad et al. (2011), define the practice of sand harvesting as the removal of sand from their natural configuration. The Kenya National Sand Harvesting
Guidelines, (2007) define the practice as the removal, extraction, harvesting or scooping of sand from designated sites.

**Channel** – A natural or artificial waterway that periodically or continuously contains moving water, has a definite bed, and has banks that serve to confine water at low to moderate stream flows.

**Baraza** - an organized public gathering.

**Channel Incision** – A result of down-cutting into the substrate.

**Descriptive research design** – is a type of research method that is used when one wants to get information on the current status of a person or an object. It is used to describe what is in existence in respect to conditions or variables that are found in a given situation.

**Descriptive survey** - The systematic, rigorous investigation of a situation or problem in order to generate new knowledge or validate existing knowledge.

**Stakeholder** - Is anybody who can affect or is affected by a project.

**Sand dam** - is a small dam which is built on and into the riverbed of a seasonal river in order to help in water recharge.

**Participatory** - providing the opportunity for people to be involved in deciding how something is done.

**Community** - a group of people who live in the same area and who have the same interests.

**Biodiversity** - Range of living species, including fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi and even micro-organisms

**Public Involvement** - A variety of interactions between the public sand harvesting groups that range from surveys, focus groups, feedback on discussion documents, public consultation, dialogue, workshops, advisory boards to partnerships.
Surveys - A survey, also called questionnaires, is a method of primary data collection based on communication with a representative sample of individuals. Surveys are usually descriptive in nature, yet can also be used to provide casual explanations or explore ideas.

Sustainable sand harvesting - an integrated system of sand harvesting practices which have a site-specific application that will last over the long term and that does not harm the environment for future generations use.

Training needs - these are skill requirements or needs for all stakeholders involved in any activity.

Social impacts - the social consequences that are likely to follow from specific policy actions or project development.
## ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
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<tr>
<td>DC</td>
<td>District Commissioner</td>
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<td>DEO</td>
<td>District Environment Officer</td>
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<tr>
<td>DMRT</td>
<td>Duncan’s Multiple Range Test</td>
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<td>DSHTC</td>
<td>District Sand Harvesting Technical Committee</td>
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<td>DO</td>
<td>District Officer</td>
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<tr>
<td>FGD</td>
<td>Focused group discussions</td>
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<td>GoK</td>
<td>Government of Kenya</td>
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<td>National Environment Management Authority</td>
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<td>RRO</td>
<td>Riparian Resource Owners</td>
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<td>RSH</td>
<td>River sand harvesting</td>
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<td>KSH</td>
<td>Kenya Shillings</td>
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<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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<td>TSHC</td>
<td>Technical sand harvesting committee</td>
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ABSTRACT

Sand harvesting is a worldwide activity in both developed and developing countries. The leading nations in sand harvesting are United States of America, Australia, Austria, Belgium, Brazil, India, Spain, Nigeria, Kenya and South Africa. In Kenya sand harvesting is practiced in counties proximate to major urban centers such as Machakos, Makueni, Kajiando and Kitui. Sand harvesting is a commercial activity that has continued to be practiced amidst the rapidly growing populations in urban areas and upcoming construction industry. This has largely contributed to an unprecedented demand for sand to meet the ever-rising needs of the building and construction industry. The aim of the study was to identify the environmental impacts of sand harvesting, determine the socio-economic impacts of sand harvesting on local communities and evaluate level of local stakeholders’ participation in the sand harvesting process. Seven sites within River Kivou were selected namely: Mwania, Kwa Nduuthi, Kivou, Ndalani, Mangoloma, Kesu and Kanginga. The sites were purposively selected because sand harvesting was taking place at the time of the study. Three categories of respondents were captured: households within a distance of 5km along the river catchment, sand transporters/loaders and experts in natural resources conservation. Both quantitative and qualitative data were collected using structured questionnaires. Field notes, observation and photography approaches were used to collect additional qualitative data. Data from the field was coded into similar responses and was then keyed into Statistical Package for Social Sciences (SPSS version16). Ms-excel was used to organize the data and to generate descriptive data inform of percentages and frequency and presenting them in form of charts and tables. Pearson Correlation Analysis was done to isolate existence of any correlations among the study parameters such as sand harvesting and environmental degradation and sand harvesting and social-economic impacts. Interview transcripts, field notes and photographs were used to validate the qualitative data. The most critical environmental impact of sand harvesting was on land use with (59%) while the least was loss of properties (2%). A correlation analysis showed a very strong positive relationship (Pearson; n = 159, r = 0.941, p < 0.05) between sand harvesting and community conflicts but a very weak positive relationship (Pearson; n = 159, r = 0.104, p = 0.05) between sand harvesting and family unit breakdown. In conclusion sand harvesting has led to adverse negative environmental degradation in river Kivou catchment, such as river bank degradation, as a result of unregulated sand harvesting, escalation of community conflicts, habitat degradation and water use conflicts between the loaders and the locals. Sand harvesting exercise has resulted to a number of positive socio-economic impacts within the study sites e.g. rural income generation and enhancing infrastructural developments such as road and housing. The study recommended that; the governing structures and policies should be clear on issues of sand harvesting with defined roles of each stakeholder involved in the exercise and guidelines from NEMA on sand harvesting should be adhered to. Further sand dams should be constructed to help in sand storage & water recharging in the catchment, awareness creation on the environmental and socio-economic impacts of sand harvesting should be emphasized, clearly structured benefit-sharing mechanism should be put in place, Intensify stakeholder participation in sand harvesting at all levels so as to improve environmental management as well improve local households’ livelihoods and further reduce potential conflicts. This study will be useful in helping devise a sustainable way of sand harvesting which ensures economic gains and environmental conservation on the other hand, strengthening the existing legislation and may be used as a reference by other researchers.
CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter focuses on background to the Study, problem statement, research questions, objectives of the study which were divided into the main objective and specific objectives. It equally covers the significance of the study and the definition of terms used in the study and the conceptual framework that was applied.

1.1 Background to the Study

Sand means sedimentary material finer than gravel and coarser than silt with grains between 0.06mm and 2mm in diameter (Langer, 2003). The places of sand occurrence are oceans, rivers, streams, flood plains or hills and mountains (Kondolf, et al., 2008). Sand harvesting refers to the actual process of removal of sand from a place of its occurrence (Nema, 2004). Sand harvesting is a worldwide activity in both developed and developing countries (Draggan and Kondolf, 2008). The leading nations in sand harvesting are United States of America, Australia, Austria, Belgium, Brazil, India, Spain, Nigeria, Kenya and South Africa (Draggan, 2008). In Kenya sand harvesting is practiced in counties proximate to major urban centers (Macharia 2004). Previous studies reveal that sand harvesting causes soil degradation and loss of biodiversity. Effects are intense on oceans, rivers, streams, flood plains, hills and mountains. (Byrnes et.al, 2000) Sand harvesting evidently causes community conflicts in absence of a regulatory policy (Ross 2001). The study sought to investigate the environmental and socio-economic impacts of sand harvesting on communities and determine the level of local community’s participation in the sand harvesting process. This study was conducted in river Kivou catchment, Mwingi Central sub county, Kitui County of Kenya.
Sand represents the main source of construction material used throughout the world (Erskine and Green, 2000). According to Makweba and Ndonde (1996), operations of sand harvesting, whether small or large-scale, are inherently disruptive to the environment. Sand harvesting frequently generates land use conflicts in populated areas due to its negative effects including noise, dust, truck traffic, water pollution and visually unpleasant landscapes (Willis and Garrod, 1999). It can also represent a conflict with competing land uses such as farming, especially in areas where high-value farmland is scarce and where post-sand harvesting restoration may not be feasible. As pointed out by social and environmental activists there are potential linkages between resources and conflict and consequential underdevelopment (Ross, 2001). Sand harvesting can cause changes to channel morphology in rivers through the lowering of the riverbed during extraction (Rinaldi et al., 2005).

Further, previous studies (Kondolf, 1998; Langer, 2003; Kondolf et al., 2008) show that sand harvesting can reduce water quality as well as degrade the river channel bed and banks. The harvesting of sand on the floodplain can affect the water table and alter the land-use (Langer, 2003).

Despite widespread occurrence and potential impact on the environment including agricultural lands, sand harvesting has received little attention in terms of research. Even though some studies have informed the local communities on the positive as well as negative impacts of sand harvesting, attention usually seems to be focused on sand harvesting along riverbanks and is seldom considered in the context of farms/cultivated lands. Mutisya (2006) argues that rapidly growing populations in urban areas have contributed to an unprecedented demand for sand to meet the ever-rising needs of the building and construction industry. To meet this demand, sand
harvesters have invaded seasonal rivers in Kenya's arid and semi-arid areas, particularly those neighboring urban centres,

1.2 Problem Statement

Sand harvesting is a worldwide activity in both developed and developing countries. The leading nations in sand harvesting are United States of America, Australia, Austria, Belgium, Brazil, India, Spain, Nigeria, Kenya and South Africa. In Kenya sand harvesting is practiced in counties proximate to major urban centers such as Machakos, Makueni, Kajiado and Kitui among others. Kivou catchment which is the study area is one of the renowned areas in Mwingi Sub County, Kitui County, with extensive commercial sand harvesting. It is a commercial activity that has continued to be practiced amidst the rapidly growing populations in urban areas and upcoming construction industry. This has largely contributed to an unprecedented demand for sand to meet the ever-rising needs of the building and construction industry. Consequently, this has led to land degradation, loss of agricultural lands and biodiversity, destruction of underground aquifers and loss of safe water especially in sites where overharvesting has been done.

The above mentioned unsustainable human activities usually have a negative effect on the environment and the socio-economic aspects. The environmental impacts are long lasting and are at most of the time irreversible or may take a long time to reverse them. The purpose of this study is therefore to study the impacts of unsustainable sand harvesting to the environment and the community and come up with recommendations to ensure sustainable harvesting of the resource ensuring socio-economic development and environmental conservation. This study seeks to assess the impacts of sand harvesting in River Kivou catchment and the associated socio-
economic challenges in order to come up with ways of striking an efficient balance
between sand harvesting for development and environmental conservation.

1.3 Research Questions
The researcher was guided by the following questions while conducting the study.

i) What are the environmental impacts of sand harvesting in River Kivou and its
catchment?

ii) What are the socio-economic impacts of sand harvesting on local
communities?

iii) What is the level of stakeholders' involvement in the sand harvesting process?

1.4 Research Objectives
The main objective of the study was to investigate the environmental and socio-
economic impacts of sand harvesting on communities in River Kivou catchment,
Mwingi central sub county, Kitui County.

1.4.1 Specific objectives
The study was guided by the following specific objectives

i) Identify the environmental impacts of sand harvesting in River Kivou and its
catchment.

ii) Determine the socio-economic impacts of sand harvesting on local
communities of River Kivou catchment.

iii) Evaluate level of local stakeholders' involvement in the sand harvesting
process in River Kivou catchment.
1.5 Justification and Significance of the Study

There is limited research undertaken in the sector of sand harvesting in Kenya, thus the rationalization of this study. River Kivou catchment is in Kivou ward, Mwingi sub county, Kitui County. The catchment area further constituted of seven active sites where sand harvesting was taking place at the time of the study. The sites were: Mwania, Kwa Nduuthi, Kivou, Ndalani, Mangoloma, Kesu and Kanginga sites. The sites were selected because sand harvesting is rampant in the sites and a lot of complains are received regarding the impacts of the activities (Nema, 2009). This study therefore came up with adequate recommendations on sustainable sand harvesting, considered appropriate for the study area, and the process is expected to be replicated in other areas that practices sand harvesting. The policy and regulatory framework, proposed in this study should guide in sustainable exploitation of sand; which will hopefully increase employment opportunities for the locals, reduce crime rates, increase revenue collections for the local county councils, increase funding for community-based projects and reduce conflicts within the various actors in this industry. It would also form a good basis for future research in this field. This study is significant in that the society and the academia world are bound to gain in the following ways:-

Knowledge gap - There is limited research undertaken in the sector of sand harvesting in Kenya, thus rationalization of this study.

Policy makers - Provides guidelines on mainstreaming sustainable sand harvesting in rural development, enhancing environmental conservation and maximizing on the economic gains.

Students of natural resources - It broadens their knowledge in sand harvesting and forms a baseline for further research.
University Lecturers - Provides University Lecturers with information

Society - it provides information on how to sustainably harness resources within their locality

Sociologists - It points out the social challenges that would be witnessed with the start of sand harvesting in their in the rural areas.

Environmentalist - it Provides knowledge in management of environmental challenges posed by sand harvesting in river Kivou catchment.

1.6 Scope and Limitations of the Study

The project was undertaken for a period of eight months (8) and proposed a sustainable governance structure, for sand harvesting in the study area. Among other issues that were studied, include impacts of sand harvesting on the environment, level of stakeholder involvement and the socio-economic impacts of the sand harvesting exercise as well as socio-economic profiles of the people in the study area, physical and environmental structures.

The major limitations encountered during the study included limited past data in which to compare the present status of sand harvesting, there was limited research done on this area in Kenya and also the study was made difficult by the geographical hardships of study area and the scattered settlements/research units and this had impact on the sampling design. Nevertheless, the research was successful and very reliable despite the prevailing conditions.
1.7 Theoretical Resource Conservation Model.

Figure 1.1: Modified conceptual model for sand harvesting planning

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter covers a review of various issues, texts and other publications considered to be relevant to this study. Topics reviewed included: economic impacts of sand harvesting, environmental impacts of sand harvesting, social impacts of sand harvesting and stakeholder involvement and participation in sand harvesting in River Kivou catchment, Mwingi central sub county, Kitui County.

2.2 Sand harvesting in the world

Sand harvesting is a worldwide activity in both developed and developing countries as was realized by Draggan (2008). Industrial sand is produced, processed and used in construction industry all over the world. The leading nations in harvesting and processing of sand are United States of America, Australia, Austria, Belgium, Brazil, India, Spain, Nigeria, Kenya and South Africa. As a cheap and readily accessible resource many companies are involved in its harvesting both legally and illegally without considering the damage they are causing to the environment (Draggan, 2008). A publication by Schaetzl (1990) showed that historically, from 1920s many states in USA relied on harvesting of sand for road and cement aggregate. The uses had doubled by 2008 to date. Sand is harvested more than all other minerals in most States in America. According to Draggan (2008), USA is the largest producer and consumer of sand in the world as well as the leading exporter of silica sand to every region of the world. This is because it has extensive high quality deposits of the resource combined with technology to process it into any product. Construction sand is produced in all fifty states. The highest producers are California, Texas, Michigan, Minnesota, Ohio, Arizona, Utah, Colorado and Washington. They all produce about
52% of total amount of construction sand. More than a billion tonnes of sand and gravel are produced and used annually. Due to high demand in these States, some sand is still imported from Canada, Mexico, Bahamas, and Australia (Draggan, 2008).

2.3 Sand harvesting in Africa

There is a great concern on the way the environment is disturbed by excessive removal of sand for construction industry especially in urban development in Africa. Mwangi (2008) noted that for thousands of years, sand has been used to construct strong houses, roads and dams in Africa since they are cheap and readily accessible resources. Today demand has increased as socio-economic life of Africans has improved generally. Sand harvesting is common in most African states but done both legally and illegally.

Lawal (2011) examined sand harvesting activities both on land and in rivers as a business venture in Minna Emirate Council of Niger State. Stakeholders from the harvesting activities were listed as landowners of quarry sites who sold the sand to private and government contractors. Local government authorities and Niger State where quarries are located were also listed as beneficiaries. The activities also involve farmers, whose cultivating and grazing lands are destroyed, wildlife community whose habitats are harvesting areas, aquatic community members as well as harvesters themselves. Aromolaran (2012) carried out a study to examine effects of sand harvesting activities on rural people living on agricultural land in Ogun State, Nigeria. Many people supported the good uses of sand but the negative impacts on their land were more than the benefits. Lawal (2011) highlighted that sand mining is rapidly becoming an ecological problem as demand increases in many states of
Nigeria's industry and construction sectors. The harvesting is done both legally and illegally leading to environmental devaluation.

A study by the Times of India (2012) found that Sand harvesting in India is adversely affecting the Rivers, sea, forests & environment. Illegal harvesting of Sand and the lack of governance, in a big way is causing land degradation and threatened its rivers with extinction. Harvesting of sand, for instance, is depleting the waters of the rivers. Weak governance and rampant corruption are facilitating uncontrolled and illegal harvesting of sand and gravel in the rivers, threatening their very existence. This unrestrained and unregulated activity is posing threats of widespread depletion of water resources which may lead to avoidable food shortages and hardships for the people. Despite numerous prohibitions and regulations, sand harvesting continues rapidly on the riverbed of the Bharathapuzha.

2.4 Sand harvesting in Kenya

Mwangi (2007) discussed sand harvesting as a threat to the environment in Kenya though with both positive and negative impacts. The sand harvesting is done legally and illegally on rivers, beaches and plain fields. Wachira (2009) supported Mwangi by reporting on a case study survey on sand harvesting in Machakos District of Kenya which is increasing due to the need for sand in construction industry. The survey showed that approximately two hundred thousand tonnes of sand are harvested for construction every year. Streams around Machakos, Makueni and Mwingi and counties are seriously damaged as trucks transporting sand pass along Mombasa and Thika highways. The trucks pass at intervals of five every half an hour. The government had to task the National Environment Management Authority (NEMA) Watchdog of Kenya, to come up with guidelines to sand harvesters and traders in the
then Eastern Province, Mwangi (2007). These Guidelines here in referred to National sand harvesting guidelines, 2007; are to apply to all sand harvesting activities in Kenya. This will ensure sustainable utilization of the sand resource and proper management of the environment. The guidelines recommend further the formation of a Technical Sand Harvesting Committee (TSHC) which has various responsibilities, e.g., be responsible for the proper and sustainable management of sand harvesting within the area in respect of which it is appointed, be responsible for the designation of authorized sand harvesting sites on riverbeds, lakeshores, seashores, farms, Government or Trust land, subject to the provisions of the Constitution of Kenya, Government Land Act, Trust land Act and Mining Act, Forest Act and any other relevant legislations, and define the extent of each Riparian Resource Management Association’s (RRMA) area of operation and perform any functions as may be prescribed by the District Environment Committee (DEC) and the Technical Sand Harvesting Committee and whose operations will be guided by the following environmental and social considerations:

2.4.1 Environmental Considerations;

The Technical Sand Harvesting Committee will ensure that:

a. Sand dam(s)/ gabion(s) are constructed in designated sand harvesting sites;

b. Where more than one sand dam/ gabion is to be constructed, they shall be at most 200 metres apart;

c. Lorries will use designated access roads only to sand harvesting sites;

d. Designated sand harvesting sites are rehabilitated appropriately by the Riparian Resource Management Association, county council and approved...
dealer under close monitoring and supervision by the Technical Sand 
Harvesting Committee in compliance with EMCA, 1999;

e. Sand harvesting or scooping is restricted to the riverbeds with no harvesting 
allowed on riverbanks to avoid widening of rivers;

f. It specifies the area of sand harvesting and the depth to which the harvesting 
will be done.

g. The requirements of an environmental impact assessment/environmental audit 
pursuant to the Environmental Management and Co-ordination Act No. 8 of 
1999 have been fulfilled.

2.4.2 Social Considerations

The Technical Sand Harvesting Committee will ensure that:

a. Sand loaders are over 18 years of age residing within the local community.

b. Approved sand dealers will pay a negotiated and agreed wage to sand loaders.

c. The loaders will organize themselves into recognized groups with clear 
operational structures for their self-regulation. The Riparian Resource 
Management Association will oversee the operations of the loaders.

d. Approved sand dealers are encouraged to support local community projects in 
consultation with the Riparian Resource Management Association.

e. Subject to the Local Government Act, local authorities are encouraged to 
invest proceeds of sand cess in environmental conservation activities and local 
community projects in the District (National sand harvesting guidelines, 
2007). Further in Kenya sand harvesting, is a sub-sector that is labor intensive 
and therefore has great potential to generate employment at local levels 
(K'Akumu, 2009). The Ministry of Environment and Mineral Resources
(2010), through National Minerals and Mining policy, stipulates that artisanal and small-scale harvesters (ASH) contribute significantly to the creation of mineral wealth, but there is however, need to mainstream the operations of ASH in order to address the challenges they face.

According to PEN, 2009, approximately 175,484 tonnes of sand are harvested yearly in the greater Machakos district with very little income earned being ploughed back to the local area for development. Further, they insinuate that the practice of irresponsible and unsustainable sand harvesting has caused environmental destruction and devastated scenery.

Further a baseline study carried out by PEN in 2009, showed that sand harvesting is a major concern in the greater lower eastern region of former eastern province. Most of the sand used for construction, especially in Nairobi and the surrounding satellite towns is harvested from Ukambani, mainly in the Mwingi, Makueni, Makindu, Kilome, Machakos, Mwala, Yatta, Kangundo and Masinga. The sand harvesting business is booming due to the growing demand in the construction industry. As a result, streams around Mwingi, Machakos, Kangundo, Kathiani, and Mwala are badly affected. Even though, the demand for this raw material in the building and construction industries is bound to increase with the proposal to upgrade Nairobi into a metropolis.

NEMA, 2013, advocates for sustainable sand harvesting. Unsustainable scooping of sand causes soil erosion, negatively impacts biodiversity, changes river courses making the flow of rivers a problem. Sand harvesting also leads to loss of water for livestock and domestic use.
2.4.3 Economic impacts of sand harvesting

Sand had been a useful natural resource for thousands of years worldwide and is fundamental to human existence. Today, demand for sand has increased. Harvesting operators in conjunction with resource agencies need to work hard and make sure the extraction is done responsibly. Schaetzl (1990) discussed sand as crucial resources to economic development activities when making aggregate in United 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. Pit sand is mixed with cement to form concrete, mortar and plaster for construction of strong structures. Aggregate is used to make road bases and coverings, concrete products and shoreline protection.

Harvesting of sand had been done for road and cement aggregate for centuries worldwide. According to Draggan (2008), 50% of sand harvested in USA is used in construction to make concrete for roads, durable bricks, blocks, pipes construction fill and sometimes mixed with asphalt. In industry, 39% sand is used to make glass, 22% as foundry sand, and 5% as abrasive sand while 34% is for other uses.

Sand harvesting represents the main source of construction material used throughout the world, with examples from Australia (Erskine & Green, 2000), France (Petit, Poinsart & Bravard, 1996), Italy (Surian & Rinaldi, 2003), the USA (Kondolf, 1994), Belgium (Gob, Houbrechts, Hiver & Petir, 2005) and Britain (Sear & Archer, 1998). Sand is indispensable for many economic development activities such as road building and concrete production. It also has other uses such as in glass making for window panes, glassware, glazing for pottery, lenses, television tubes, mirrors, fibre glass reinforcement, lamps, stained glass art, lasers, insulators, telescopes, bottles and containers for alcohol, soft drinks, and food items like jams, pickles (USGS, 2011). It
is also used in several concealed ways such as hydraulic fracturing applications (Scienceviews.com, 2003-2010), in the making of semi-conductors that are used in almost every electronic device today ranging from notebooks to mobile phones and even in cars.

Sand is also a source for strategic minerals such as Silica, Garnets, Thorium and ores such as Titanium, Uranium, Zirconium and Ilmenite. Nonetheless, two examples can be given to illustrate the breadth of use:

a) Titanium is used in 'Production of lightweight alloys, aircraft components (jet engines, aircraft frames), automotive components, joint replacement (hips ball and sockets), paints, watches, chemical processing equipment, marine equipment rigging and other parts exposed to sea water), pulp and paper processing equipment, pipes and jewellery (IIED and WBCSD, 2002).

b) Heavy Minerals such as Rutile, Sillimanite and Monazite are also sourced from sand.

Sand harvesting has also led to improved economic gains in all areas where it's done. In the case of Togo for instance, the sand harvesting industry, and associated other transport and related service industries have had an important role in the local economy for many years. On Togo's national basis, sand harvesting has traditionally been probably second only to agriculture as a source of rural employment. The harvesting of sand in Togo has created jobs for youths. Social and economic parameters that can improve social conditions (such as income and local revenue generation), this revenue is used in most part to meet the basic needs of the family including food, to pay tuition for children and even for entertainment (Ayenagbo et al., 2011).
Sand harvesting sites employ a large number of the youths and other casual people who sell food stuffs to the harvesters. Sand harvesting has contributed significantly to the economic development in areas where it’s done through the creation of employment opportunities, creation of local supply of raw materials for industry, generation of export revenues and alleviation of poverty (Ayenagbo et al., 2011). There is creation of employment for families at harvesting sites in Indian regions (Saviour, 2012). Lawal (2011) noted that by year 2001 alone, a total of seven thousand, one hundred and thirty one sand harvesters had been employed in Nigeria’s Niger State alone, according to statistics provided by Mine Safety and Health Administration. Mwangi (2007) supported this positive impact of sand harvesting in Kenya when he highlighted that there is creation of employment to locals above eighteen years as manual loaders at harvesting sites. In Botswana, Mbaiwa (2008) realized the same impact of employment creation to youth, both citizens and non-citizens seasonally at harvesting and construction sites to load tipper trucks. While in Zimbabwe, Lupande (2012) noted creation of employment for youth who are licensed to harvest sand and some to load the trucks as a positive impact of harvesting. Harvesting activities brought wealth to Indian communities (Saviour, 2012). Sand harvesting activities generate revenue and income to local governments and land owners in Africa’s developing nations which reduce poverty. This was noted by Lawal (2011) in Niger State of Nigeria where financial benefits from sand harvesting work shows that local government earn about eight percent of total profits from business while the harvesters gets about ninety two percent of Accrued revenue. Kenyan local government also benefits from sand harvesting as highlighted by Mwangi (2007), when legal harvesters are to pay for the licenses.
2.5 Environmental Impacts of Sand Harvesting

Bagchi (2010) discussed environmental land and surface degradation as a serious impact of sand harvesting 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 harvesting causes destruction of aquatic and riparian habitat through large changes in channel morphology, lowered water table, instability and sedimentation at harvesting sites due to stock piling and dumping of excess harvesting materials. Sand harvesting also poses a threat to critical infrastructure such as bridges, roads, railway tracks (Kondolf et al., 2001). Environmental problems due to sand harvesting occur when the rate of extraction of sand exceeds the rate at which natural processes generate and replenish it. Sand harvesting has several negative impacts. It poses a threat to water security in several ways. Dredging results in lowering of the alluvial water table which, in turn, directly affects groundwater storage capacity (Kondolf et al., 2001). Excessive dredging allows for saline intrusion into groundwater (Viswanathan, 2002). The lowered water table implies a rise in water costs, thus restricting access to only those who can afford it (Hoering, 2008). It results in habitat loss including destruction and fragmentation of fragile, endangered ecosystems and reduced species richness (Myers, 1999, Global Witness, 2010).

Sand harvesting also causes increased shoreline erosion rates, especially when harvested unscientifically (Byrnes et al., 2000) and decreases protection from sea
water especially during ocean disasters (Myers, 1999). It also poses a threat to critical infrastructure such as bridges, roads and railway tracks (Kondolf et al., 2001). Sand harvesting has also been known to cause loss of livelihoods in several instances (Hoering, 2008, Young and Griffith, 2009 and Viswanathan, 2002). Other macroeconomic impacts have also been observed such as changes in land use patterns (Myers, 1999) and increased public health costs (Myers and Muhajir 1997, Mensah, 1997). The morphologies of the harvesting areas have demonstrated the impact of sand harvesting with the prowess to destroy the cycle of ecosystems. Numerous publications have been written with respect to these effects, and the next step is what to do to minimize, prevent or correct these environmental effects; the so called mitigating measures (Pielou, 1966).

In 1991, Ghana, for instance, adopted a National Environmental Policy for “ensuring a sound management of sand resources and the environment, and to avoid any exploitation of these resource in a manner that might cause irreparable damage to the environment” (Ebenezer, 1991). Harvesting of sand represents the main source of construction material used throughout the world (Erskine and Green, 2000). According to Makweba and Ndomde (1996), operations of sand harvesting, whether small or large-scale, are inherently disruptive to the environment. Prospecting, extracting, and transporting sand have great potential for disrupting the natural environment (Rabie et al., 1994).

Although sand harvesting provides a variety of socio-economic benefits, its environmental and social costs, if not well handled, can be massive in terms of land conversion and degradation, habitat alteration and water and air pollution. Sand harvesting carries the potential of destroying habitats and the species they support. It
causes such damage to the biodiversity as well as catastrophically resulting into pollution, introduction of alien species, over-harvesting of natural resources and destruction of habitats (Roda, 2008). For example, human activities that accelerate stream bank erosion such as riparian forest clearing or in stream sand harvesting, cause stream banks to become net sources of sediment that often have severe consequences for aquatic species (Newell et al., 1999).

Channel instability and sedimentation from in-stream harvesting can also damage public infrastructure (bridges, pipelines, and utility lines). Impacts to the biological resources include removal of infauna, epifauna, and some benthic fishes and alteration of the available substrate. This process can also destroy riverine vegetation, cause erosion, pollute water sources and reduce the diversity of animals supported by these woodlands habitats (Byrnes and Hiland, 1995).

Even if the habitats are not directly removed by harvesting, changes to ground water or surface water has caused some habitats to dry out and others have become flooded (Dubois and Towle, 1985). Environmental impacts to river systems where in stream sand harvesting has been improperly managed have been described by Collins and Dunne (1990); Kanehl and Lyons (1998); Kondolf (1997); Florsheim (1998) and Naiman et al., (1998) as a major source of environmental impacts which are and not limited to: channel modifications such as widening or deepening the channel, creation of deep pools, loss of ruffles, alteration of bed load, alteration of channel flow, and degraded aesthetics, upstream and downstream erosion and related impacts.

Other impacts include: modification of aquatic habitats including spawning beds nursery habitat, shell fish habitat and riparian habitat, degradation of water quality including increased turbidity, reduced light penetration, increased temperature and re-
suspension of organic or toxic materials; bridge scour and other impacts to infrastructure. The bridge scours (erosion of river beds at bridge foundations) is due in part to in-stream sand harvesting and in part to channelization of the river (Langer, 2003) in that the foundations that are supposed to remain under the riverbed are now exposed. The principal cause of environmental impacts from in stream harvesting is the modification of channel characteristics especially the removal of more material than the system can naturally replenish or the combined result of many small but intensive operations (Rowan and Kitetu 1998).

The removal of sand from a stream creates a change in the cross section of the stream. Removing sand may causes an increased gradient at the site of extraction. Increasing the gradient of the stream may cause upstream incision. Removing sand from streams, particularly reaches of streams that are eroding or down cutting may cause a decrease in bed load. For example, human activities that accelerate stream bank erosion, such as riparian forest clearing or in-stream harvesting, cause stream banks to become net sources of sediment that often have severe consequences for aquatic species (Newell et al., 1999). Meador and Layher (1998) have summarized the impacts of improper in-stream sand harvesting on aquatic habitat as erosion leading to bank failure, which can cause loss of riparian habitat and loss of shade along the stream banks. It can also result in channel bed hardening destabilization of spawning gravel and nursery habitat, degradation of stream fisheries, increases in suspended sediment load lowering of alluvial water tables and stagnant low flows. (Waters, 1995).

An extensive further review of literature reveals that indiscriminate extraction of river sand can result in serious offsite and onsite impacts, leading to changes in channel form, drying of river banks and disruptions of food webs (Rivier and Sequier 1985).
Removal of sand results in destruction of underground aquifers and loss of safe water. Sand scooping adversely affects surface water quality and quantity and damages the aquatic ecosystem. Transportation of sand by heavy trucks causes environmental degradation by accelerating soil erosion and affecting soil stability. Storage of sand causes destruction of surface areas through clearing of vegetation and uses land that could be used for agriculture. A significant decrease in bed load can cause downstream incision, Suspension of organic or toxic materials; bridge scour and other impacts to infrastructure. Noise generated from traffic movements to and from the sand harvesting sites is a great nuisance to the riparian communities (Andoh, 2002). Apart from threatening bridges, sand harvesting transforms the riverbeds into large and deep pits; as a result, the groundwater table drops leaving the drinking water wells on the embankments of these rivers dry. Bed degradation from in-stream harvesting lowers the elevation of stream flow and the floodplain water table which in turn can eliminate flow depth and a bar skimming operation increases flow width. Both conditions produce slower stream flow velocities and lower flow energies, causing sediments (Ashraf et al., 1992).

2.5.1 Aquatic and riparian habitats

Sand harvesting causes habitat loss including destruction and fragmentation of fragile, endangered ecosystems and reduces species richness (See Myers, 1999, Global Witness, 2010). Effects directly related to sand harvesting and to changes in geomorphology include increased sedimentation, turbidity, and bank full widths (Rosgen, 1996), higher stream temperatures, reduced dissolved oxygen, lowered water table, decreased wetted periods in riparian wetlands, and degraded riparian habitat (Nelson, 1993;
1996; Meador and Layher, 1998; Bork, 1999; Roell, 1999;) and original research by Kanehl and Lyons, 1992; Brown et al., 1998;). Channel geomorphology changes, such as a wider and shallower streambed (Kanehl and Lyons, 1992; Brown et al., 1998) may consequently result in increased stream temperature (Kondolf, 1997). Although studies have shown differing results, chemical changes such as reduced dissolved oxygen and changes in pH levels have been reported downstream of in-stream harvesting areas (Nelson, 1993; Meador and Layher, 1998).

Loss of riparian habitat may result from direct removal of vegetation along the stream bank to facilitate the use of a dragline or through the process of lowering the water table, bank undercutting, and channel incision (Kondolf, 1997; Brown et al., 1998). Sand harvesting imposes pressure on the biological communities thriving in the river environments. The riparian zone acts as resting and nesting ground for many migratory birds and the destruction of this valuable area affects those migratory birds (Sreebha, 2010). Local channel changes propagate upstream or downstream and can trigger lateral changes of the stream as well as the riparian zone. Alteration of the riparian zone affects the physical and biological functioning of the stream (Packer et al, 2005).

2.5.2 Drying of river banks and water aquifers.

Sand harvesting has several negative impacts. It poses a threat to water security in several ways. Dredging results in lowering of the alluvial water table which, in turn, directly affects groundwater storage capacity (See Kondolf et al., 2001). Excessive dredging allows for saline intrusion into groundwater (Viswanathan, 2002). The lowered water table implies a rise in water costs, thus restricting access to only those who can afford it (Hoering, 2008). Further Pereira (2012) revealed that sand
harvesting is a threat to water security resulting from loss of groundwater storage due to lowering of alluvial water table. For example, major rivers in India’s Kerala district such as Pampa and Manimala have been lowered with four to six metres. If sand harvesting continues in India uncontrollably up to 2050, water table will drop to approximately 2537 square metres. A lowered water table due to sand harvesting causes water wells to dry, and people starving. Suspended solids affect domestic water users downstream which increase treatment costs. Saviour (2012) also noted the deterioration of water quality due to dissolved suspended materials and solids from harvesting activities. Water quality can also be compromised by oil spills and leakages from excavation machinery and transportation vehicles which may poison aquatic life (Stebbins, 2006).

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 sand extraction, ponds forms an environment conducive to mosquito breeding. Lawal (2011) agreed with Bagchi on creation of pools as a result of harvesting which are breeding sites for pests in Nigeria.

Destruction of land as a result of sand harvesting changes the land surface and this affects the quantity and quality of water in aquifers (Welhan, 2001). Another effect of sand harvesting on water is modification of the recharge area for groundwater by changing the land surface, such as forming depressions so that water no longer flows along original pathways. Such changes may increase or decrease rainwater recharge to groundwater. Shorter flow paths may increase susceptibility to contamination while
re-directed flow paths may deplete total recharge of the aquifer (Peckenhams, Thornton and Whalen, 2009).

Where a riverbed overlies deep alluvium or other erodible materials, and there is a significant interruption in downstream supply of bed load, bed lowering can be substantial and this can in turn lower the groundwater table, which can variously affect flood plain hydrology and habitat (Goodwin and others 1992; Evoy and Holland 1989). A lowered groundwater table can kill riparian vegetation (Kondolf and Curry 1986).

In many cases where bed lowering occurs, depending on vegetation and site conditions, it may be slow enough for some riparian plants to colonize newly exposed stream banks, this could change the age and species structure of riparian communities. Groundwater lowering can also kill vegetation in floodplain wetlands and along sloughs, where trees might play important roles in providing cover, shade, and a supply of large wood for salmonid habitat (Kondolf and Curry 1986). Groundwater table lowering can eliminate recharge to a stratigraphically higher aquifer or breach and contaminate a lower aquifer. This could in turn affect a river's low-flow regime. Examples of the interplay of bed lowering and groundwater flow changes are Cache Creek, California (Wahler 1981; Woodward-Clyde Consultants 1976; Collins and Dunne 1990) and Russian River (Goodwin and others 1992). Evoy and Holland (1989) includes a discussion of the interplay between groundwater change and bed lowering. Where bed lowering is large, (meters to tens of meters), overbank flooding can be virtually eliminated. This reduction in overbank flooding can reduce the supply of organic-rich fine sediments to the floodplain, and could reduce the replenishment of water to floodplain wetlands and sloughs and to aquifers. Reduction of overbank flooding can also aggravate downstream flooding because of the loss of floodplain...
water storage. Large amounts of lowering can also increase bank heights and induce bank erosion and can cause tributary streambeds to erode.

Sand acts as a safe aquifer for water flowing below and through it. Removal of sand results in destruction of underground aquifers and loss of safe water. Sand scooping adversely affects surface water quality and quantity and damages the aquatic ecosystem. Haulage of sand by heavy trucks causes environmental degradation by accelerating soil erosion and affecting soil stability. Storage of sand causes destruction of surface areas through clearing of vegetation and uses land that could be used for agriculture (Mutisya, 2006).

2.5.3 Air pollution

Besides compacting land, heavy vehicles are a source of pollution to the villages near harvesting sites. According to Lawal (2011), noise and air pollution occur as dust accumulates from designated roads which are a reality to villages near harvesting 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 can cause ground tremors. Pereira (2012) realized that sand is dredged illegally twenty four hours a day, all year round even during monsoons using mechanical dredgers in India. These produce a lot of noise which hampers sleep and normal school operation hours. Vibration noise generated from overburden excavation and transport is severe at night and is an annoyance to people.

According to Matt (2008), outdoor air pollution alone causes an estimated 800,000 deaths each year especially in developing world. Dust from sand harvesting sites is a
major source of air pollution. Further Schaetz (1990) realized that sand harvesting 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 harvesting sites as the continuous movement of heavy vehicles cause problems to cattle posts, agricultural land, borehole and well users. Noise pollution from the moving trucks ferrying sand is a nuisance and should be controlled (Hans, 2006). Noise is a disturbance to the human environment that is escalating at such a high rate that it will become a major threat to the quality of human lives (Daniel, 2002). Although noise is a significant environmental problem, it is often difficult to quantify associated costs. According to Tsidzi and Adofo (1993) noise in sand harvesting areas interfere with human activities such as sleep, speech and hearing as well as stress-related diseases like hypertension.

2.5.4 Land Degradation and Vegetation Effects

Sand harvesting has been known to cause loss of livelihoods in several instances (See Hoering, 2008, Young and Griffith, 2009 and Viswanathan, 2002). Other macroeconomic impacts have also been observed such as changes in land use patterns (Myers 1999) and increased public health costs (Myers & Muhajir 1997, Mensah, 1997).

In terms of land degradation, surface sand harvesting, widely practiced today, disfigures the topography and surface drainage leading to deforestation and soil erosion, dust generation, long-term compaction, subsidence and reduced agricultural
productivity (Tuffour, 1997). The principal cause of environmental impacts from in-stream sand harvesting is the modification of channel characteristics especially the removal of more material than the system can naturally replenish. Taking into consideration the places of occurrences of the adverse environmental impacts of river sand harvesting, Kitetu and Rowan (1997) classified the impacts broadly into two categories namely off-site impacts and On-site impacts. The off-site impacts are, primarily, transport related, whereas, the on-site impacts are generally channel related. The on-site impacts are classified into excavation impacts and water supply impacts. The impacts associated with excavation are channel bed lowering, migration of excavated pits and undermining of structures, bank collapse, caving, bank erosion and valley widening and channel instability. The impacts on water supply are reduced ground water recharge to local aquifers, reduction in storage of water for people and livestock especially during drought periods, contamination of water by oil, gasoline and conflicts between harvesters and local communities. The reports show that depletion of sand in the streambed and along coastal areas causes the deepening of rivers and estuaries, and the enlargement of river mouths and coastal inlets. It may also lead to saline-water intrusion from the nearby sea.

Further in-stream sand harvesting results in the destruction of aquatic and riparian habitat through large changes in the channel morphology. Impacts include bed degradation, bed coarsening, lowered water tables near the streambed, and channel instability. In a recent study, it is reported that sand harvesting from the Achankovil river in Kerala state in India; over the past few decades has caused notable changes in the eco-biology of benthic communities (Sunil Kumar, 2002). It is well understood that sand harvesting changes the physical characteristics of the river basin, disturbs the closely linked flora and fauna, and alters the local hydrology, soil structure as well

Removing sand may cause an increased gradient at the site of extraction increase the gradient of the stream may cause upstream incision. Erosion caused by in-stream harvesting can cause bank failure, which can cause loss of riparian habitat and loss of shade along the stream banks (Meador and Layher, 1998).

Sand harvesting removes vegetation from the bar and adjacent bank, which can increase water temperature (Beschta et al, 1987; Sullivan et al, 1990), although this effect may be unimportant in most harvested rivers which are relatively wide. Removing standing and downed trees on bars reduces the river’s load of large woody debris, which is important in creating habitat and supplying nutrients (Bisson et al, 1987, and Murphy and Meehan 1991), and in promoting vegetative colonization of bars following the disruption of bars by floods (Abbe et al, 1993) which can create and stabilize off-channel habitats. In-stream sand harvesting can result in channel bed hardening, destabilization of spawning gravel and nursery habitat, increases in suspended sediment load lowering of alluvial water tables ad stagnant low flows. All these impacts can result in major changes to aquatic and riparian habitat. Fine sediments sand harvesting is one of the major environmental factors in the degradation of stream fisheries (Waters, 1995).

As indicated by Sandeccki (1989), such direct in-stream harvesting can alter the channel geometry and bed elevation and may involve extensive clearing, diversion of flow, stock piling of sediment, and excavation of deep pits. This can also result in
significant distortion of the channel morphology (Rinaldi et al., 2005), which often causes silting as a result of erosion of the banks and consequent flooding, which may worsen especially during high precipitation. Lorries which are used to transport the sand disturb the vegetation and further exposes the area to erosion and harsh weather conditions (Mossa & McLean, 1997). This can as well cause loss of the protection provided by soil as it filters out pollutants (Kalbitz, Solinger, Park, Michalzik and Matzner, 2000; Rutherford, Chiou & Kile, 1992) and can further affect aquatic life in such riverine areas.

2.6 Social impacts of sand harvesting

Social impact can be defined as the process of assessing or estimating, in advance, the social consequences that are likely to follow from specific policy actions or project development, particularly in the context of appropriate national, state, or provincial environmental policy legislation. Social impacts include all social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society. Cultural impacts involve changes to the norms, values, and beliefs of individuals that guide and rationalize their cognition of themselves and their society (Burdge and Frank Vanclay, 2004).

Sand harvesting has potentially adverse impacts on the natural environment, society and cultural heritage, the health and safety of sand harvesters, and communities based in close proximity to operations (Moody and & Panos, 1997) and dislocation (Akabzaa, 2000).

According to Tsidzi and Adofo (1993), noise in sand harvesting areas interferes with human activities such as sleep and stress-related diseases like hypertension. Noise
disturbance is attributed to movement of Lorries in and out of the sand harvesting sites (Andoh, 2002).

Sand harvesting and extraction does not only directly affect the biophysical environment of rural communities but also indirectly affects the socio-economic and socio-cultural environment of communities as well. Such social impacts range from health, conflicts, and problems related to drug use and alcoholism and other social vices like robbery and divorce (Mutisya, 2006). Further, Mutisya (2006) asserts that influx of both locals and expatriates into sand harvesting areas without their spouses has fostered prostitution in such areas.

2.6.1 Health impacts of sand harvesting

Most of the sand harvesting activities take place very close to communities and are often abandoned after completion. During rainy seasons, the abandoned pits collect water and as a result attract malaria parasites resulting in infection of community people.

Other diseases such as cholera, dysentery and diarrhea, among others, are associated with the sand harvesting activities, since harvesting sites are often used as rubbish dumping sites (Moody and Panos, 1997). Inhaling large amounts of dust from the sand and sharing poor quality air in the sand harvesting sites are some of the major causes of health hazards among harvesters. Spillage and leakage of fuels, oils from lorries when harvesting sand in the rivers pollutes the water and these has a negative health impact to the people who consume the water and even the livestock.

Ten people interviewed in harvesting area of East Konga of Iceland indicated loss or reduction of farmlands as a major impact of sand harvesting. Other significant impacts of sand harvesting in the area obtained as views include pits serving as
breeding grounds for mosquitoes and spread of other diseases, erosion and loss of vegetation, loss of economically important trees, as well as roots of conflicts (Musah and Kjorn, 2007).

2.6.2 Conflict due to sand harvesting

A study in New England (Socolow, 1995) found that, the failure to plan for the protection and extraction of sand resources often results in increased consumer costs, environmental damage and an adversarial relation between the aggregate industry and the community.

Again sand harvesting frequently generates land use conflicts in populated areas due to its negative externalities including noise, dust, truck traffic, pollution and visually unpleasant landscapes (Willis and Garrod, 1999). It also can represent a conflict with competing land uses such as farming, especially in areas where high-value farmland is scarce and where post-harvesting restoration may not be feasible. As pointed out by social and environmental activists there are potential linkages between sand resources and conflict and consequential underdevelopment (Ross, 2001).

The rampant social conflict that exists in sand harvesting communities, the widespread discontent in those communities is the result of their total or partial alienation from actively taking part in decisions affecting them believing falsely that planners or policy makers know best. Many sand harvesting communities feel cheated by not taking part in decisions affecting their livelihood or not benefiting adequately from their “God given” natural resource on which their livelihoods depend. As a result, some sand harvesting communities resort to legal and non-legal actions in their bid for self-determination and the control of their own resources. These conflicts have resulted in the destruction of property and in death and have seriously affected

### 2.6.3 Drug and substance abuses

Drug use among workers, especially those in small-scale sand harvesting is on the increase as many of them believe that drugs such as bhang stimulate and help them to do the daunting and difficult jobs they found themselves in. Unfortunately, it is common to see some of them overusing drugs and causing problems in the community and in their families (Gichuki, *et al*, 2000). Long hours of shift work in the harvesting areas have resulted in family dislocation and disintegration as well as musculo-skeletal disorders and alcoholism (Forson, 2002).

Unfortunately, although medical tests are conducted before employment is offered in many sand harvesting companies, many of them do not conduct periodic or exit medical examinations to ascertain the health status of their workers. Migration into sand harvesting communities and reduction in agricultural activities, largely attributable to large-scale sand harvesting has resulted in high food prices and rent for local inhabitants, especially those not working with the sand harvesting sites.

### 2.7 Stakeholder involvement and community participation in sand harvesting.

Local groups of people have managed the land on which they live and the natural resources with which they are surrounded for millennia. Indigenous African communities often developed elaborate resource management systems (Fabricius, 2004), as have local communities throughout the world (Ostrom, 1990; Borrini-Feyerabend *et al.*, 2004). Today, local groups of pastoralists, farmers, sand harvesters
and hunter-gatherers throughout Africa maintain many traditional systems of collective natural resource management which help to sustain the livelihoods and cultures of millions of people.

Over the past 30 years, public participation not only has produced decisions that are responsive to community interests and values, but also has helped resolve user conflicts. In sustainable sand harvesting, natural resource management involves not only agronomy but also spatial and temporal scales and interdependences, on site and off site effects, tradeoffs of different management options, the need to involve a wide range of stakeholders — often with conflicting interests — in collective action can’t be over emphasized (Cruz, 1996).

All stakeholders should be involved in sand harvesting process because while the principles of participation are universal, the practice of participatory planning and management must take into account the values, communication patterns, knowledge and skills of all stakeholders. Stakeholders must also be defined broadly, in order to capture a wide range of groups and individuals to manage the sand and reduce conflicts in all sand harvesting sites (Nema, 2004). If participants feel the process was fair and their inputs were used, it will ultimately enhance their compliance. In fact, it has been demonstrated that the perception of legitimacy is linked to the participants’ views of them and fairness of the process (Sutinen and Kuperan, 1999). Literature reveals that participation enhances compliance because stakeholders are more knowledgeable about; committed to and supportive of regulations if they had a say in the process. Participation also leads to increased legitimacy, build trust, and educate the public about the environment (Beierle and Cayford, 2002).
Stakeholder participation has been based on the premise that participation is desirable in all aspects and phases of development planning, including natural resource management. The case for participation is multi-faceted and compelling, with the justification including such issues as: efficiency and effectiveness of management; responsiveness to community needs; the integration of environmental concerns into a wider development context; the incorporation of popular knowledge and wisdom into formal management systems; and community empowerment (Brown, 1995).

Furthermore, participants who view the process as legitimate generally feel a strong obligation to comply with the results, even if the mandates contradict their self-interests (Sutinen and Kuperan, 1999). Clearly, an essential aspect of the participation process is that stakeholders view their involvement as meaningful and as making a difference (Pirk, 2002).

Community participation and stakeholder involvement in sand harvesting can’t be overemphasized. Brody et al (2003) suggest that information empowers the public to become involved in and make an impact on the planning process. Pomeroy (1995) maintains that only an empowered community can address both the need for economic development and the conservation of natural resources. In the end, resource conflicts may be diminished, access rights distributed more effectively, management initiatives better implemented, and resources better managed when stakeholders are more involved in management initiatives (Pomeroy, 1995).
2.8 Summary of Literature

In conclusion the reviewed literature has been able to inform the researcher on the issues of sand harvesting in various aspects. It has collectively informed these study on the environmental impacts of sand harvesting such as, Drying of river banks and collapsing of the bank due to over harvesting, Land degradation, Loss of agricultural land, soil erosion, landscape destruction, biodiversity loss, and destruction of water aquifers leading to Loss of water and water scarcity and socially it causes community conflicts, Leads to dust pollution and water pollution and Loss of property. It has also revealed that sand is a resource that if used sustainably can enhance the people’s economic gains and also improve the environment.

This review has also highlighted the existence of sand harvesting guidelines aimed at regulating the exercise of sand harvesting in the county as a whole.

However, reviewed literature could not answer the objectives informing the study and hence this study aimed at: identifying environmental impacts of sand harvesting in River Kivou catchment; determining the socio-economic impacts of sand harvesting on local communities and evaluating level of local households’ participation in sand harvesting in the study area.
CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research design, the study area, sample and sampling procedure, data collection instruments and data analysis. The study was specifically aimed at investigating the impact of sand harvesting from river Kivou on the environment and socio-economic life of the local community, level of stakeholder involvement and recommend ways and means of making the sand harvesting an economically viable venture and socially and environmentally sustainable. Data for this project were collected via a number of data collection tools between January 2012 to January 2013.

3.2 Study Area

3.2.1 Location

River Kivou catchment is in Kivou ward, Mwingi Central, Kitui County (figure 1). Kivou has a total population of 24,886 and an area of 242.90 Km². The ward has the following sub-locations: Ithumbi, Kyanika, Kivou, Enziu and Kanzui. The area of study was Kivou and Enziu which make the catchment area. The catchment area further constituted of seven active sites where sand harvesting was taking place at the time of the study. The sites were: Mwania, Kwa Nduuthi, Kivou, Ndalani, Mangoloma, Kesu and Kanginga sites. The sites were selected because sand harvesting is rampant in the sites and a lot of complains are received regarding the impacts of the activities (Nema, 2009). The people around these sites are mainly subsistence farmers and pastoralists. A small percentage (10%) of the population have permanent jobs while another 10% engage in sand harvesting usually during the off-
season when there is drought and people do sand harvesting as a coping mechanism towards drought mitigation (GoK, 2010).

Figure 3.1: The study area, Kivou Catchment in Mwingi, Kitui County
Source: Author, 2015

3.2.2 Climate and agro-ecological zones

The area falls within agro-climatic zones V and VI (Sombroek et al., 1982). The climate of the area is hot and dry for the greater part of the year with temperature ranging from 12°C to 36°C, with a mean of 24°C. The rainfall pattern is bi-modal with the long rains occurring between March to May while the short rains are experienced
between October and December. The annual rainfall ranges between 400 and 800 millimeters and is usually characterized by poor distribution especially the long rains. Due to the frequent droughts in the district, people do sand harvesting as a coping mechanism towards drought mitigation (GoK, 2010).

3.2.3 Physiographic and Natural Conditions

The landscape is generally flat, with a plain that gently rolls down towards the east and northeast where altitudes are as low as 400m. The drier areas experience severe droughts, which have led to livestock deaths and food shortages leading to a number of people losing their livelihoods hence getting into the business of sand harvesting in order to earn a living (GoK, 2010).

3.2.4 Soils

The location has red sandy soils, loamy sand soils and patches of black cotton soils (Jaetzold et al. 2006). River valleys have saline alluvial soils of moderate to high fertility. Otherwise, soils are of low fertility and prone to erosion. Most of the land surface are covered by shallow and stony soils unsuitable for crop farming and the people rely on relief food and do charcoal and sand harvesting as a coping mechanism.

3.2.5 Settlement Patterns

Kivou location is a homogeneous location inhabited mainly by Kamba people. The location has a population of 24, 886 and covers an area of 242.90km². The main limiting factors for settlement and agriculture are the lack of rainfall and unreliable sources of surface water (Owako, 1971). The latter has been further exacerbated by
disruption of stream flow due to sand harvesting. Most streams are intermittent and deeply incised (Moore, 1979).

3.2.6 Vegetation

The vegetation of the study site is highly heterogeneous probably due to variation in both soil type and history of land use (Belkhodja et al. 2003; Jaetzold et al. 2006; Omondi, 2007). Large areas of the study site are occupied by bushlands, grasslands and shrub-lands, comprising various combinations of dry land vegetation. The predominant plant association is a mixture of Acacia-Commiphora bushlands. Perennial grasses such as *Eragrostis superba* Peyr., *Cenchrus ciliaris* L., *Enteropogon macrostachyus* and some *Pennisetum* species provide forage to grazing animals.

3.2.7 Livestock Production

Livestock production is the principal economic activity in the area, although crop production is limited to isolated pockets of cultivable land. Livestock kept are mainly: sheep, goats, cattle, camels and donkeys.

3.2.8 Poverty Index

The location has a poverty level estimated at 61.56 percent (GoK, 2010), predisposing the population to food security-related shocks and hazards. The location has three main livelihood zones namely; mixed farming, marginal mixed farming and formal employment/casual waged labor/business. Due to frequent droughts, people normally engage in various drought coping mechanisms which include: sand harvesting, charcoal production among others; activities that impact to the environment. These calls for the need to find ways and means of making sand harvesting economically viable and environmentally sustainable in Kivou-Mwingi Central District (Gok, 2007)
3.3 Research Design

Research design refers to the method used to carry out a research. Descriptive research design was chosen because it enables the researcher to generalize the findings to a larger population. According to Cooper and Schindler (2003), a descriptive study is concerned with finding out the what, where and how of a phenomenon. A descriptive Research design was therefore adopted to enable an in-depth investigation into the matter under study, this method was preferred because it provokes the ‘what’ questions this study was aimed at answering namely: what are the environmental and socio economic impacts of sand harvesting in River Kivou catchment? What is the level of the stakeholders’ participation? The study aimed at collecting information from the sand harvesters and the non-sand harvesters through questionnaires, interview schedules and focused group discussions aimed at ascertaining the extent of environmental degradation caused by the sand harvesting and the social economic impacts of sand harvesting and the level of community involvement in the exercise. Both primary and secondary sources of data were used. The primary sources of data included: quantitative data collected using questionnaires, interview schedules, focused group discussions and qualitative data collected through observation and photography. While secondary sources included: data from sand harvesting cooperative society in Mwingi, records from NEMA offices in Mwingi and Kitui County and journals.

3.3.1 Unit of Analysis

A unit of analysis is the entity about whom or which the researcher gathers information. A unit of analysis can also be said to be the element or aggregation of elements (for example individuals, groups, nations, regions) from which information
is analyzed. The units of analysis in this study were: Households, transporters, and experts in natural resource management.

3.3.2 Units of Observation

Units of observation refer to the sources of primary data about the issue under investigation which are the study respondents. The study respondents were the sand harvesting communities around the River catchment that is the individuals from the households where sand harvesting was taking place.

3.4 Sample Size and Sampling procedure

3.4.1 Study Population

Target population in statistics is the specific population about which information is desired. According to Ngechu (2004), a population is a well defined or set of elements, events, group of things that are being investigated. This definition ensures that population of interest is homogeneous. The target population was 5100 households. However, the sample was taken from the accessible households within 5km along the river and had stayed for over 10 years. Seven sites Kanginga, Mwania, Kivou, Ndalani, Kesu, & Mangoloma were purposively selected because they lie along the river where rampant sand harvesting takes place.

Simple Random Sampling and Purposive sampling were used to select the category of respondents. The local administrators provided a list of all the households within the 5km distance along Kivou river catchment and close to the sand harvesting sites, (land owners, small scales business people), The researcher compiled a local list of the transporters & loaders as well as experts in natural resources conservation and management in the area who made the key informant group. A list of 42 transporters
was taken from Nema office, a criteria was drawn to select the sample of transporters purposefully: ones licensed by NEMA to take sand from the study sites, those who had been doing the business for more than five years, hence a total of 20 transporters, a list of 38 loaders was also developed, 20 loaders were purposively selected. The area District commissioner, area DO, 8 relevant government departments, 2 chiefs, 3 officials of sand harvesting cooperative society, 5 officials of NGOS working on Natural resource management formed the 20 experts purposively sampled to be involved in the study. Random numbers were used to select 100 households from the list. Therefore, the researcher had a total of 160 respondents. Mugenda and Mugenda (2003), Kothari C.R. (2004) explains that, the target population should have some observable characteristics, to which the researcher intends to generalize the results of the study. Therefore, the researcher had a total of 160 respondents as outlined below (table 1).

Table 3.1: Study sample size

<table>
<thead>
<tr>
<th>No.</th>
<th>category</th>
<th>No of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Households</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Transporters and loaders</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Experts in natural resource management</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>160</td>
</tr>
</tbody>
</table>

The respondents were all from Kivou catchment area and direct and indirect participants in sand harvesting process.
3.5. Data collection

3.5.1 Pre-testing the Research Instruments.

A pilot study was conducted to test the suitability and reliability of interview schedule and the questionnaire. The pilot study allowed for pre-testing of the questionnaire. The clarity of the questionnaire to the respondents was necessary so as to enhance its validity and reliability. The aim was to correct inconsistencies arising from the questions, which ensured that the questionnaire measured what it was intended. The pilot data was not included in the results of this study.

Further the researcher carried out a pilot study to pretest the validity and reliability of data collected using the questionnaire. According to Berg and Gall (1989) validity is the degree by which the sample of test items represents the content the test is designed to measure. Content validity was employed in this study as a measure of the degree to which data collected represented a specific domain or content of a particular concept. Mugenda and Mugenda (1999) contend that the usual procedure in assessing the content validity of a measure is to use a professional or expert in a particular field. Reliability is increased by including many similar items on a measure, by testing a diverse sample of individuals and by using uniform testing procedures.

Ten respondents were selected to participate in the pre-testing exercise. 5 were selected from the 100 households in table 3.1 above, 3 from transporters and loaders and 2 from experts. Quantitative and qualitative data were collected.

3.5.2 Interview schedule

The respondents in table 3.1 above were interviewed through administration of questionnaire. For household’s surveys, only the household heads were interviewed while for transporters and loaders, only participants who were 18 years and above
were interviewed. For experts in natural resources management, all the sand harvesting cooperative officials and other experts identified by the researcher were interviewed. The aim of the selection was particularly to give broad views on the subject.

For household surveys, open ended questions were used since this approach allows a more in-depth investigation into the unique experience of each interviewee (Huntington, 2000). It also allows people to speak for themselves without their answers being biased by predetermined hypothesis-based questions (Huntington, 2000; Rubin J. & Rubin S., 2005). Most of the questions raised during the interview were to elaborate and/or clarify the interviewee's understanding of a point or to direct the interviewee to a new topic relevant to the aim of the study.

3.5.3 Questionnaire

The questionnaire had three sections namely: section one which was concerned with the environmental issues of sand harvesting, section two focused on socio-economic impacts and section three dealt with the stakeholder involvement. The aim of the questionnaire was focused on gathering views from the study areas on the environmental, socio-economic impacts of sand harvesting on the local communities and levels of stakeholder involvement in sand harvesting activities. A sample of the questionnaire is therefore presented in appendix.

3.5.4 Observations

Generally observations involved the use of all senses to perceive and understand the experiences (Sarantakos, 2005). Pons (1992) specified that use of observation in social research usually involves listening as well as watching. The researcher
specifically employed observation, where the researcher joined the group of study and made observations as any other member of the group. This type of observation was ideal in understanding deep information which could otherwise not have been accessed by the researcher. Issues of sustainable sand harvesting, general observable environmental effects of sand harvesting, ways of harvesting the sand and the community involvement were very important in order to come up with valid conclusions of these study hence observation was regarded as the best method to collect valid data. Various Photo graphs were taken in this study. Observed information was recorded in terms of descriptive notes.

3.5.5 Focus Group Discussion
The study also engaged focus group discussions for the purpose of getting the participants' views Greenbaum, T. L (1998). The Focus Group Discussion consisted of 8-10 people and each had a leader, each group discussion took one hour. These groups included relevant government departments, local area leaders, officials of sand harvesting cooperative society, officials of NGOS working on Natural resource management, experts involved in natural resource management in the area, loaders, transporters, land owners and business people; these groups had vast knowledge on sand harvesting activities around the River Kivou catchment. Key among the issue of interest discussed in the focused groups were and not limited to: environmental impacts of sand harvesting, level of communities involvement, financial gains from sand harvesting, regulation of sand harvesting as per Nema 2009 sand harvesting guidelines, community conflicts if any, social trends in sand harvesting areas, governments role in sand management and environmental restoration in all sand harvesting sites. The group met at Nema Office. The researcher chaired the meeting.
as well as moderated the discussions as per the guiding questions Krueger, R. A. and Casey, M. A. (2009). This is shown in Appendix III.

3.6 Data Analysis and Presentation

Data from the field was coded into similar responses and was then keyed into Statistical Package for Social Sciences (SPSS version16). Ms-excel was used to organize the data and to generate descriptive data inform of percentages and frequency and presenting them in form of charts and tables. Pearson Correlation Analysis was done to isolate existence of any correlations among the study parameters such as sand harvesting and environmental degradation and sand harvesting and social-economic impacts. Interview transcripts, field notes and photographs were used to validate the qualitative data. The analyzed data was presented inform of narratives, tables and charts.
CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

This chapter presents the results and discussions of the study findings. The study was specifically aimed at investigating the impact of sand harvesting from river Kivou on the environment and socio-economic life of the local households, level of stakeholder involvement and recommend ways and means of making the sand harvesting an economically viable venture and socially and environmentally sustainable.

4.2. Respondents demographic characteristics

4.2.1 Age of the respondents.

From the study, the minimum age was 18 years. The limit of 18 years was adopted to avoid interviewing underage persons especially among the sand loaders and again such young persons may not have adequate knowledge on the study subject. There was no upper limit on age but the oldest respondent was 83 years. The average age of respondent was 49 years.

4.2.2 Gender of the Respondents

Majority of the respondents were males (72%) (Figure 2). This was attributed to the fact that most of the participants in sand harvesting were males. Though women (28%) featured in the sand harvesting exercise in the entire catchment, their roles remained peripheral selling snacks to the sand loaders and drivers.

The study found a strong positive correlation between sand harvesting activities and the involvement of men in the sector (Pearson; n = 159, r = 0.819, p < 0.05).
Further the study noted that majority of the respondents were males 72% for the reason that culturally they are deemed automatically the head of the family. Moreover, the high number of males in the sector was also attributed to the fact that sand harvesting is traditionally believed to be a masculine job hence the high number of men involved in the exercise.

**4.2.3 Marital status of the Respondents**

Further, among the respondents interviewed, 73% were married, 19% single and 8% divorced (Figure 3). Out of the 19% singles, majority were loaders and in the age bracket (19-26 years). From these findings, it was deduced that the engagement of these youths in sand harvesting has promoted reduction of crime in the area and also minimized over reliance on forest for charcoal burning.
Figure 4.2: Marital status of the respondents in the study sites

4.2.3 Level of Education

Respondents who had attained college and other higher level of education were 17%. This comprised mostly of the experts in natural resource management interviewed in this study. Majority of the respondents (47%) had acquired a form four certificate while 23% had a standard eight certificate and below, and the remaining 13% ascertained that they had not attended any formal education. Most of the loaders were usually primary school drop outs that opted to engage in sand harvesting for survival hence contributing to the number of respondents without class eight certificates.
4.2.4 Occupation and Employment Status

Majority of the respondents were farmers while others engaged in various forms of businesses in the town of Mwingi. Of all the sand loaders interviewed, 80% reported that they did not have any other form of employment. The reason some of the young people gave for engaging in sand harvesting was that they lack the necessary qualifications to enter into any other kind of training or formal work. The other categories of respondents were doing professional jobs in government offices especially the experts interviewed in this study. Majority of the drivers (87%) did not have alternative source of income and wholly depended on sand harvesting while only 13% of the drivers had alternative sources of income. Interview on employment status showed that 62% were farmers, 12% loaders, 7% drivers, 10% professionals in government offices, and 9% others.

Figure 4.3: Level of Education of the Respondents
4.2.5 Daily Earnings

The average revenue for sand loaders was Kenya shillings 540 per person per day (Table 1). The maximum revenue per day was 780 and minimum revenue Ksh. 310. The daily revenues were mostly dictated by the frequency of the Lorries in sand harvesting sites and the season. Earnings were highest during the dry season and lowest during the rainy season. Other than the earnings of the loaders there were also small businesses that were organized around the sand harvesting sites mostly being done by women. They included sales of food and beverages ("chapatti" and "beans) teas, sodas and cigarettes (Table 2).
### Table 4.1: Daily earnings of laborers in various sites

<table>
<thead>
<tr>
<th>Sites</th>
<th>Maximum revenue (Ksh/Day)</th>
<th>Minimum revenue (Ksh/Day)</th>
<th>Average (Ksh/Day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mwania</td>
<td>1000</td>
<td>300</td>
<td>650</td>
</tr>
<tr>
<td>Kwa nduuthi</td>
<td>750</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Kivou</td>
<td>650</td>
<td>350</td>
<td>500</td>
</tr>
<tr>
<td>Ndalani</td>
<td>750</td>
<td>350</td>
<td>550</td>
</tr>
<tr>
<td>Mangoloma</td>
<td>500</td>
<td>250</td>
<td>375</td>
</tr>
<tr>
<td>Kanginga</td>
<td>1000</td>
<td>350</td>
<td>675</td>
</tr>
<tr>
<td>Kesu</td>
<td>750</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>770</strong></td>
<td><strong>300</strong></td>
<td><strong>500</strong></td>
</tr>
</tbody>
</table>

Source: (Mwingi sand harvesting cooperative society, 2009)

Such differences in earnings were attributed to location of the sand harvesting site. Daily earnings in more interior sites were found to be lower compared to those sites neighbouring shopping centres or near towns.

### 4.3 Environmental Impacts of Sand Harvesting

During field observation various environmental impacts such as river banks degradation, collapsing riverbanks, habitat destruction, riparian zone damage, dust, noise, water pollution due to oil spills and sedimentation were observed (figure 4.5)
Figure 4.5: Degraded river banks and collapsing river banks due to sand harvesting along river Kivou

From the results of the study, it was observed that the most critical environmental impact of sand harvesting was on land use with (59%), followed by drying of river banks and collapsing of the river banks (21%), dust and water pollution (9%), community conflicts (5%) and the destruction of roads (4%). The least environmental impacts were identified as loss of properties (2%). However, all respondents from each of the study areas indicated positive impacts of sand harvesting as enhancing infrastructural developments such as road and housing and providing employment to sand harvesters, as well as providing income for landowners (Table 3).
Table 4.2: Environmental impacts of sand harvesting

<table>
<thead>
<tr>
<th>Environmental impacts of sand harvesting</th>
<th>%</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying of river banks and collapsing of the bank due to over harvesting</td>
<td>21</td>
<td>2</td>
</tr>
<tr>
<td>Negative impacts on land use (Land degradation, Loss of agricultural land, soil erosion, landscape destruction, biodiversity loss, and destruction of water aquifers leading to Loss of water and water scarcity respectively)</td>
<td>59</td>
<td>1</td>
</tr>
<tr>
<td>Community conflict</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Leads to dust pollution and water pollution</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Destruction of roads</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Loss of property</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

These results agreed with another study done by Sandecki (1989) who found out that sand harvesting activities along the rivers can retard free flow of the water course, alter the channel geometry and bed elevation and may involve extensive clearing, diversion of flow, stockpiling of sediment, and excavation of deep pits. This can also result in significant distortion of the channel morphology (Rinaldi et al., 2005), which often causes silting as a result of erosion of the banks and consequent flooding, which may worsen especially during high precipitation. Sand stockpiles were observed on the riverbanks and these overburden the banks and alter the channel hydraulics during high flows (figure 4.6)
This study confirmed that sand harvesting disturbs the vegetation and further exposes the area to erosion and harsh weather conditions and this agrees with studies done by (Mossa and McLean, 1997). This can as well cause loss of the protection provided by soil as it filters out pollutants (Kalbitz et al., 2000; Rutherford et al., 1992) and can further affect aquatic life in such riverine areas. Other negative impacts indicated were: noise, water and dust pollution and conflict generation. Oil spills leading soil and water contamination were evident in the study site (figure 4.7)
Moreover, out of all respondents interviewed 40% knew of the existence of state regulation thus, National Environment Management Authority (NEMA) which is involved in stream lining sand harvesting in the area. Also, 60% indicated the existence of the regulation on sand harvesting. However, 25% of the respondents indicated non-compliance with the regulations and 15% was not sure whether there was any regulatory framework that provided a strong foundation for sustainable sand harvesting in order to enhance the environment and that no closure standards or specification guidelines for reclamation were available. This agreed with Mwangi (2007) who discussed sand harvesting as a threat to the environment in Kenya though with both positive and negative impacts. He further confirmed that sand harvesting is done legally and illegally on rivers, beaches and plain fields. Wachira (2009) supported Mwangi by reporting on a case study survey on sand harvesting in Machakos District of Kenya which was increasing due to the need for sand in construction industry and competition was ripe between the locals need for water for their domestic use and also for livestock. This photo validation further agreed other scholars in that; Effects directly related to sand harvesting and to changes in geomorphology include increased sedimentation, turbidity, and bank full widths (Rosgen, 1996), higher stream temperatures, reduced dissolved oxygen, lowered water table, decreased wetted periods in riparian wetlands, and degraded riparian habitat (Nelson, 1993; 1996; Meador and Layher, 1998; Bork, 1999; Roell, 1999;) and original research by Kanehl and Lyons, 1992; Brown et al., 1998;).
All the respondents agreed to the fact that enforcement level to compliance to all laws governing sand harvesting was weak and there was a need of constituting a strong committee to monitor implementation of Sand harvesting, marketing and transportation for its sustainability. Despite the low compliance, the local
administration was found useful in the enforcement and monitoring of sand harvesting activities (figure 4.9).

Figure 4.9: Local leaders assessing the environmental damage brought about by sand harvesting in the area.

This agreed with Mwangi (2007) who suggested the implementation of the sand harvesting guidelines in order to safeguard the environment. Sand dams and gabions as illustrated below should be done in order to harvest sand sustainably. Further sand should be harvested only on the designated sites only.

Figure 4.10: Riverbank degradation due to sand harvesting

Out of all of the respondents, 97% agreed that various stakeholders should be involved in sand harvesting, transportation and marketing systems for its
The respondents indicated that sand harvesting in all the sites was left to the loaders, transporters and some brokers and a further 65% confirmed that the exercise was not participatory. However, there were some respondents who remained indifferent to each of the variables under consideration and these amounted to 2% of the respondents.

About 97% of the respondents had the view that, with good technology and managerial skills, there should be no reason for preventing the opening of any sand harvesting sites and that the resource should be harnessed maximally to benefit all the stakeholders involved. Daly (1991) points out that getting macroeconomic policies right may ensure resource allocation, and sustainable development and this agree with 90% of the respondents who stated that with good policies, sand harvesting can improve their livelihoods.

4.4 Social impacts of Sand harvesting

The table below presents statements that give the picture of the social impacts of sand harvesting, marketing and transportation as gathered from the respondents (Table 4).

A correlation analysis showed a very strong positive relationship (Pearson; n = 159, r = 0.941, p < 0.05) between sand harvesting and community conflicts but a very weak positive relationship (Pearson; n = 159, r = 0.104, p = 0.05) between sand harvesting and family unit breakdown. ANOVA showed significant statistical differences (p = 0.035 at p<0.05) in the occurrence of these social impacts between individual sites.
Table 4.3: Social impacts of sand harvesting

<table>
<thead>
<tr>
<th>Statements</th>
<th>Positive</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community conflicts</td>
<td>128</td>
<td>1</td>
</tr>
<tr>
<td>School drop-outs</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>Prostitution and increased HIV prevalence</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Drug and substance abuse</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Insecurity</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Family unit breakdown</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

Majority of the respondents (80 %) strongly agreed that community conflicts were mainly due to sand harvesting and it was mainly between the community (farmers) fighting over water alongside the loaders and transporters doing sand business. Similar sediments were expressed by Ross (2001). When such conflict arose, the local administrators were found useful in conflict resolution (figure 8).

Figure 4.11: A District Commissioner (DC) addressing a public meeting aimed at resolving conflicts arising from sand harvesting in the study sites
This study revealed that majority of the people in these areas engage themselves in farming as a way of life and so sand harvesting is left to the young men, who have little regard to the environmental impacts of sand harvesting. This encourages loss of valuable agricultural land, harvesting of sand near bridges leads to loss of good roads and this does not only deny them their livelihood but also infringes upon their cultural heritage. Tyaa bridge (figure 9) was found to be impacted negatively by sand harvesting activities. The bridge is important in the social and economic life styles of the local community since it provides safe passage to and from Mwingi town.

Figure 4.12: Tyaa Bridge which has its foundation exposed due to sand harvesting in Kanginga study site.

Half of the respondents were in agreement that school dropout was partly due to sand harvesting and the other half blamed the dropout on the ability of the parents to sustain their children in school due to poverty levels among them.

On drug and substance abuse, 70% confirmed that it was common in the sand harvesting sites than anywhere else. 85% confirmed that even a new non drug abuser member joining the sand harvesting business stood a 100% chance of starting to abuse the drugs with time. Majority (80%) agreed that insecurity is higher in sand harvesting area than in non harvesting area. The implication of this is that with the
majority of the respondents agreeing to the fact that sand harvesting has such negative impacts there is need to improve on ways and means of making sand harvesting an activity which is environmentally and socially sustainable in order to achieve the perceived maximum economic benefits from the sand in the study area. More stakeholder involvement needs to be done, awareness done on the environmental and socio-economic impacts of sand harvesting and means and ways of maximizing the benefits while minimizing the negatives adopted. During the study, NEMA and the local administration were found to undertake community awareness and outreach program on sand harvesting within the study sites (figure 10). The aim of the sensitization exercises was to ensure sustainable extraction of the resource as well as adherence to the regulations governing the sector and also to get a general view of the sector from the public.

Figure 4.13: NEMA and local administration awareness exercise in the study site
4.5 Economic impacts of Sand Harvesting on Local Households

Majority of the respondents (87%) indicated positive impacts of sand harvesting as enhancing infrastructural developments such as road and housing and providing employment to sand harvesters, as well as providing income for landowners, the loaders and drivers. The respondents felt that there should be full stakeholder involvement for maximum gains and sustainability of the sand harvesting. The respondents were in agreement that life was better with sand harvesting by 50% while the other 50% felt that the sand harvesting has not improved their livelihood (Table 5). However, Test of Homogeneity of Variance isolated significant statistical differences ($p=0.02$ at $p<0.05$) in economic impacts of sand harvesting within and between sites.

Majority of the respondents (65%) conceded that much of the proceedings from the sand harvesting business went only to a few pockets and hence there was an
insignificant development due to the business in terms of infrastructure, health and other social amenities, and electricity provision. The study further revealed that although much of the profits go to a few people if the sand harvesting sites where to be closed these will have a magnitude impact on the community. Majority of the respondents (80%) felt that the industry employs a lot of youths as loaders and adults who are engaged in various activities in the sites and with a ban on the sand harvesting all these beneficiaries' stands to lose their source of income. This can lead to serious impacts on the community at large (Table 5).

Majority of the respondents (70%) strongly agreed that their living standards had improved significantly; they could afford three meals per day, take their sick to the hospital and afford drugs and their school going children were not frequently sent home due to fee balances and the school dropout rate had reduced significantly (Table 4.4).

### Table 4.4: Economic impacts of sand harvesting

<table>
<thead>
<tr>
<th>Statements</th>
<th>%Positive response</th>
<th>%Negative response</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved living standards and livelihoods</td>
<td>87</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Availability of electricity, healthcare and transport</td>
<td>70</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>General development in the area</td>
<td>75</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Improved taxes received from sand.</td>
<td>80</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Extend of loss on closure of sites.</td>
<td>65</td>
<td>35</td>
<td>6</td>
</tr>
<tr>
<td>Improved medical care.</td>
<td>79</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>Reduced school dropouts.</td>
<td>45</td>
<td>55</td>
<td>7</td>
</tr>
<tr>
<td>Satisfactory stake holder involvement.</td>
<td>25</td>
<td>75</td>
<td>8</td>
</tr>
</tbody>
</table>
Sand harvesting also contributes to government revenue where every lorry that ferries sand pays a levy of KSh 3,000 per trip to the local authority. Employment is another economic benefit of sand harvesting. There are a number of people who are employed as loaders, drivers, tea sellers and other staffs in the sand harvesting cooperative. For example in the year 2009, the Mwingi sand harvesting cooperative society had a total of 105 employees ranging from office to field staff (Mwingi sand harvesting cooperative society records 2009). Majority of the youths in Kivou catchment were employed in sand harvesting sites, about 75 per cent were in sand loading, about 10% in tea selling and the other 15% were in sand transportation.

In Mwingi, for example, the sand harvesting cooperative society built the chief’s office and two schools as a social corporate responsibility. The cooperatives also engaged themselves in paying the salaries of three primary school teachers within Kivou catchment (Mwingi sand harvesting cooperative society 2009). The community also used the proceedings from the sand and upgraded their feeder roads. Other stakeholders have, as part of their corporate social responsibility, provided infrastructure to support community development and, in some cases, have negotiated with communities on benefits. Indeed, road links must often be established, water and power provided, and the ‘human’ infrastructure improved through the provision of medical and education facilities for efficient sand harvesting operations to take place.

4.6 Participatory and stakeholders’ involvement

Various stakeholders were identified during the study which included: local communities, transporters, sub-county administration, provincial administration, and sand harvesting cooperatives, NEMA, other government agencies, CBOs, NGOs and learning institutions.
In reference to sand harvesting guidelines and regulations of 2007, it was observed that all these stakeholders had differentiated roles in sand harvesting. For instance, the community’s role were; responsible for sustainable management of sand harvesting activities in its area of operation, Sub-county administrators were to collect cess revenue and re-invest the same on rehabilitation of environment and infrastructural development.

The sand harvesting cooperatives role was to engage the loaders and ensure they are paid and also ensure environmental protection and conservation through planting of trees and construction of sand dams and gabions and infrastructural development as a way of giving back to the community.

The other stakeholders formed the technical sand harvesting committee whose mandate was; Be responsible for the proper and sustainable management of sand harvesting within the District in respect of which it is appointed, be responsible for the designation of authorized sand harvesting sites on riverbeds, lakeshores, seashores, farms, Government or Trust land, subject to the provisions of the Constitution of Kenya, Government Land Act, Trust land Act and Mining Act, Forest Act and any other relevant legislations, and define the extent of each Riparian Resource Management Association’s area of operation and perform any functions as may be prescribed by the District Environment Committee. Its operations will be guided by the following environmental and social considerations. The social considerations were as enumerated here in:

a. Sand loaders are over 18 years of age residing within the local community.

b. Approved sand dealers will pay a negotiated and agreed wage to sand loaders.
c. The loaders will organize themselves into recognized groups with clear operational Structures for their self-regulation. The Riparian Resource Management Association will oversee the operations of the loaders.

d. Approved sand dealers are encouraged to support local community projects in consultation with the Riparian Resource Management Association.

e. Subject to the Local Government Act, local authorities are encouraged to invest proceeds of sand cess in environmental conservation activities and local community projects in the District.

Further the environmental considerations were:

a. Scooping/harvesting of sand should not exceed six (6) feet in depth.

b. Designated sand collection sites should be at least 50 metres from the riverbanks or dykes for on-farm sand harvesting.

c. Scooping/harvesting should be done concurrently with restoration of areas previously harvested. Such restoration will be undertaken with guidance from the Technical Sand harvesting Committee.

d. The scooping/harvesting should be strictly open-cast harvesting.

e. Where underground tunneling or extraction of sand is to be undertaken, appropriate extraction technology should be applied to safeguard human safety.

Provincial administration role was to enforce the sand harvesting guidelines to ensure that sand is ferried within the stipulated time, only permitted routes are followed to the sand harvesting sites, while the chiefs and elders were to ensure that only adult loaders above eighteen years are allowed in the sand harvesting business and under age people are strictly not allowed.
Mwania study site had the highest level of stakeholder involvement, while the least was Kesu site (figure 11). Most of the sites recorded low stakeholders involvement. The implication of this is that there is need to improve on stakeholder’s involvement through awareness creation and trainings in order to achieve the perceived maximum benefits from sand harvesting and marketing. There is a high need of stakeholder involvement because the results of this study revealed that lack of community and stakeholder involvement in the management of the sand has led to poor management of the resource as reported by over 90% of the respondents. Out of all of the respondents, 97% agreed that various stakeholders should be involved in sand harvesting, transportation and marketing systems for its sustainability.

![Participatory and Stakeholders' involvement in sand harvesting](image)

**Figure 4.15: Participatory and Stakeholders’ involvement in sand harvesting**

These findings agreed with Kaza (1988) who eloquently portrayed the need for stakeholder involvement: “With involvement comes understanding, with understanding comes public support and commitment.” Participation by parties with a stake in the resource not only increases the level of understanding and support for a natural resource use and protection but also reduces potential conflicts and the need for heavy enforcement. The results further agree with the argument that compliance and involvement are interrelated phenomena, and that involvement contributes to compliance through the participation process (Hall, 1972) and also with Cruz (1996)
who asserts that the need to involve a wide range of stakeholders — often with conflicting interests — in collective action of resource management can’t be over emphasized.
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The first objective was to identify the environmental impacts of sand harvesting in River Kivou catchment. The findings from this study have shown that there is significant environmental degradation in river Kivou catchment as a result of unregulated sand harvesting. The balance of nature is disturbed and this has a multiplier effect on the ecosystem. This degradation has resulted to river banks degradation, collapsing riverbanks, habitat destruction, riparian zone damage, dust, noise, water pollution due to oil spills and sedimentation. This degradation can be minimized to acceptable level if guidelines and regulations on sand harvesting are taken into account. Adherence to these will ensure that the environmental and economic systems of sand harvesting are at equilibrium hence sustainability of the sector.

The second objective was to determine the socio-economic impacts of sand harvesting on local communities of River Kivou catchment. The sand harvesting exercise result to a number of positive and negative socio-economic impacts within the study sites. Key among the negative impacts was community conflicts due to the impact of sand harvesting on water resources. However, this can be mitigated appropriately if harvesting of sand is only done up to a specific limit that does not impact on water resource. The limits are clearly specified in NEMA guidelines on sand harvesting. Among the positive impacts was the role of the sector in rural income generation and infrastructural development. Revenues from the sector were found to benefit the participants and multiplier effects trickled down to the larger community. Feeder roads were improved, a school constructed and three teachers employed by the sector.
All these contributed significant and positive socio-economic impacts of sand harvesting to the local community.

The third objective was to evaluate level of local stakeholders’ participation in the sand harvesting process in River Kivou catchment. Despite that fact that there was clearly defined roles of various stakeholders, the study observed that there was a gap in implementation of the NEMA sand harvesting guidelines hence unsustainable practices resulting to conflicts and environmental degradation. The study further found that some of the stakeholders are critical in enforcement of the guidelines such as the local administration whose failure has led to unregulated sector whose sustainability is questionable. Further, this has resulted to unbalanced environmental-economic system resulting to environmental degradation.

5.2 Recommendations

In order to promote environmental sustainability, enhance socio-economic benefits of sand harvesting, the practicability of this study was that recommendations made will be used to guide the policy makers in planning and facilitating the adoption of sound sand harvesting methods in order to protect the environment and enhance the socio-economic benefits of sand for sustainable development. The recommendations outlined below are envisaged to lead to reduction of extreme poverty and improved environment:

- There is need to intensify the stakeholder involvement and participation in sand harvesting in order to increase the level of understanding and support for sand use and protection and also reduce potential conflicts and the need for heavy enforcement.
• Guidelines from NEMA on sand harvesting should be adhered to. Enforcement of the guidelines is critical to sustainability of the sector. To achieve this, the study recommends involvement of all stakeholders and that the management of sand should not be left to a few people as indicated in this study.

• The governing structures and policies should be clear on issues of sand harvesting. A task force should also be formed to supplement and reinforce the existing mechanisms for planning, administration and management of river sand harvesting (RSH) activities in Kivou catchment, Policy formulation, coordination, monitoring and advisory tasks will constitutes the main functions of the task force.

• Further, on the mitigation of the environmental impacts, it is recommended that in all the sites within a distance of 100 meters, a sand dam should be constructed to help in sand storage and water recharging in the area.

• A clearly structured benefit-sharing mechanism should be put in place. Such a mechanism should take into account all the stakeholders involved. Putting up a conflict resolution strategy will go further in solving conflicts over the resource. These mechanisms will ensure sustainable resource use with the environmental domain focusing on protection of the integrity and resilience of ecological systems.

• The study recommends that Environmental Impact Assessment on sand harvesting in river Kivou catchment should be done in all seven designated sand harvesting sites as required by law in order to promote optimal development planning and provide a follow up.
5.3 Further Research

Further study is recommended to evaluate the impact of sand harvesting on the water resource in Kivou catchment.
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APPENDICES

Appendix 1: Questionnaires for the Households.

Introduction
I am a student at Kenyatta University undertaking a Master’s Degree course in Environmental Studies. I am carrying out a research on the Socioeconomic and Environmental Impacts of sand harvesting in Kivou catchment Mwingi Central. I humbly request you to assist me in filling in this questionnaire on your opinion on this issue. Please take some time to complete this questionnaire. Provide precise and honest answers. All the information you give will be treated with utmost confidence and will be used purely for purposes of this research.
Your cooperation will be highly appreciated.
Thank you in advance.

Part I. Background Data
Tick (✓) the option applicable for each of the questions listed below.

I. Gender: Male [ ] Female [ ]

II. What is your age bracket in years----------------- 

III. How long have you lived in Kivou?
   Below 5 years [ ]
   5-10 years [ ]
   11-16 years [ ]
   17-22 years [ ]
   Above 23 years [ ]

IV. For how many years have you been involved in sand harvesting issues directly or indirectly?
   Less than 5 years [ ]
   6-11 years [ ]
   12-17 years [ ]
   18 years and above [ ]
V. What is your highest level of academic qualification?

Degree [ ]
Diploma [ ]
Secondary Level [ ]
Primary Level [ ]

Any other, please clarify .................................................................

VI. What is your current designation?

Farmer [ ]
Professional [ ]
Business [ ]

Any other, please clarify.................................................................

........................................................................................................

Part II. ENVIRONMENTAL CONCERNS

1. In your honest opinion, do you think there are negative impacts brought about by sand harvesting?

Yes [ ] No [ ]

2. The table below presents statements that could influence the environmental negative impacts of sand harvesting in Kivou area. Indicate the extent to which you agree or disagree with each statement by ticking in the appropriate column below.


<table>
<thead>
<tr>
<th>S/NO</th>
<th>STATEMENTS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Sand harvesting has negative impacts on:</td>
<td></td>
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</tr>
<tr>
<td>a.</td>
<td>Land use?</td>
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<tr>
<td>b.</td>
<td>Water catchment?</td>
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<td>c.</td>
<td>In your opinion do you agree to the</td>
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<tr>
<td></td>
<td>statement that dying of river banks is</td>
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<td>due to</td>
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<td>Question</td>
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<td>Leads to dust pollution and water pollution</td>
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<td>d. Community conflicts in this area are due to Sand harvesting?</td>
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<tr>
<td>e. Sand harvesting has led to increased Soil erosion?</td>
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<td>f. Infrastructure services. (road, waterpipe, electricity)</td>
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<tr>
<td>II Are the present methods and implements used in sand harvesting the best environmentally?</td>
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</tr>
<tr>
<td>iii Do you think sand harvesting should be managed in order to enhance the environment as well as achieve the social economic benefits?</td>
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<tr>
<td>IV Is the exercise participatory? Are all the community members fully involved in sand harvesting?</td>
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<tr>
<td>V Is there a committee that monitors implementation of Sand harvesting?</td>
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</tr>
</tbody>
</table>

3. How else in your opinion does sand harvesting impact on the environment and has not been captured?
   i) ........................................................................................................................................
   ii) ........................................................................................................................................
   iii) ........................................................................................................................................

Section II: SOCIAL CONCERNS
1. In your opinion do you think sand harvesting has social impacts on the people of Kivou, whether negative or positive?
   Yes [ ] No [ ]
2. The table below presents statements that give the true picture of the social impacts of sand harvesting. Indicate the extent to which you agree or disagree with the statement by ticking in the appropriate column below.

1. **Strongly agree**  2. **Agree**  3. **Not sure**  4. **Disagree**  5. **Strongly disagree**

<table>
<thead>
<tr>
<th>S/N</th>
<th>STATEMENTS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Sand harvesting has led to:</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>a. Community conflicts?</td>
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<tr>
<td></td>
<td>b. School drop-outs?</td>
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<td></td>
<td>c. Family break ups;</td>
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<td></td>
<td>d. Prostitution?</td>
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<td></td>
<td>e. Drug and substance abuse?</td>
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</tr>
<tr>
<td>ii</td>
<td>Are there cases of insecurity due to sand harvesting?</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>iii</td>
<td>Are there negative impacts of sand harvesting on the family unit?</td>
<td></td>
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</tr>
</tbody>
</table>

3. What do you think is the solution to all the above negative social impacts mentioned?

4. Suggest ways and means of reinforcing the positive social impacts?

**Section III.: ECONOMIC IMPACTS**

1. In your own opinion, do you think Sand harvesting has improved you economically?
   - Yes [ ]
   - No [ ]

2. The table below presents factors that could indicate economic empowerment. Indicate the extent to which you agree or disagree with the statements by ticking in the appropriate column below.

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Statements</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Life is better now with sand harvesting or was it better before.</td>
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</tr>
<tr>
<td>II</td>
<td>Local livelihoods are positively affected by sand harvesting</td>
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<td></td>
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</tr>
<tr>
<td>III</td>
<td>The extent of general development in the area as a result of infrastructure and services provided by the sand harvesting operations, e.g. electricity, healthcare and transport are satisfactory.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>The economic changes that may occur or have occurred as a direct result of the opening of the mine, e.g. economic returns to local settlements through royalties and mine taxes, and mine development initiatives are satisfactory?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>The likely direct economic changes that may occur as a direct result of the mine closure, e.g. loss of jobs at the mine (permanent employees and contractors) and the impact of such changes on the local settlements, community organization and lifestyles is highly significant and will impact the community negatively.</td>
<td></td>
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<tr>
<td>VI</td>
<td>The living standards of the people in river Kivou catchment has improved?</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>A. People able to take three meals a day?</td>
<td></td>
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<tr>
<td></td>
<td>B. The local households able to take their sick to the hospital and afford drugs?</td>
<td></td>
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<tr>
<td></td>
<td>C. The number of school dropouts due to lack of school fees decreased.</td>
<td></td>
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</tr>
</tbody>
</table>

3. In your opinion what do you think is the best strategy in sustainable sand harvesting in order to enhance economic benefits?

........................................................................................................................................
........................................................................................................................................

4. Is the exercise participatory? Are all the community members fully involved in sand harvesting? (Tick the applicable answer)

1. Least involved
2. Fairly involved
3. Moderately involved
4. Most involved
Appendix 2: Questionnaire II for Focus Group Discussion

Investigating the impact of sand harvesting from river Kivou on the environment and socio-economic life of the community and level of stakeholder involvement

**Background information**

<table>
<thead>
<tr>
<th>Information about the interviewee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: ...........................................</td>
</tr>
<tr>
<td>Questionnaire No: ..........................</td>
</tr>
<tr>
<td>Date: .........................................</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location and Name of Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village ......................................</td>
</tr>
<tr>
<td>Sand harvesting site</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interviewee work profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer: ......................................</td>
</tr>
<tr>
<td>Business man ................................</td>
</tr>
<tr>
<td>Government: ................................</td>
</tr>
<tr>
<td>Others (specify): ........................</td>
</tr>
</tbody>
</table>

1. Do you think sand harvesting has positive or negative impact on local or neighboring Communities?
2. What is the main positive impact?
3. What is the main negative impact?
4. Do you think mitigation measures should be applied to limit negative impact (in 3 above)?
5. If yes, which measures?
6. Do you think sand harvesting causing depletion of vegetation around the sand harvesting sites?
7. In your opinion, is sand harvesting negative or positive for agriculture? Why?
8. In your opinion, do you have a comprehensive state permits on sand harvesting?
9. Is it clear in your opinion, who is responsible for applying rules regarding sand harvesting?
10. Is monitoring often done to ensure compliance?
11. Are rules regarding sand harvesting enforced properly?
12. If no, do you have any opinion why it is not properly enforced?
13. In your opinion, are sites being restored soon enough after use or are they left open?
14. Is it clear who is responsible for restoring and closing the already harvested sites?
15. Who are the usual owners of sand harvesting areas (landowners) in the area (a) Government (b) Individuals (c) others (specify).
Appendix 3: Interview schedule for professional

1. Do we have sand harvesting activities in your region?
   Yes [ ]    No [ ]

2. Are you involved in sand harvesting activities?
   Yes [ ]    No [ ]

3. What is your level of involvement?
   ..............................................................................................................................
   ..............................................................................................................................
   ..............................................................................................................................

4. a) Any environmental issue related to sand harvesting
   Yes [ ]    No [ ]
   b) If yes state them
   ..............................................................................................................................
   ..............................................................................................................................
   ..............................................................................................................................
   c) How can we mitigate the negative environmental issues of sand harvesting

5. a) Any social issues related to sand harvesting
   Yes [ ]    No [ ]
   b) What are the social issue related to sand harvesting
   ..............................................................................................................................
   ..............................................................................................................................
   ..............................................................................................................................
   c) How can we mitigate the negative social issues related to sand harvesting?

6. a) Any economic impact of sand harvesting
   Yes [ ]    No [ ]
   b) If yes state them
   ..............................................................................................................................
c) How can the negative impacts be mitigated?

.................................................................................................................................
.................................................................................................................................

d) How can the positive impacts be reinforced?

.................................................................................................................................
.................................................................................................................................

7. A) Do we have any policy issues related to sand harvesting?

   Yes [ ]  No [ ]

If yes state some of the policies related to sand harvesting

.................................................................................................................................
.................................................................................................................................

b) In your opinion, what is the level of compliance to the policies

.................................................................................................................................
.................................................................................................................................

c) In your own opinion, what is the level of stakeholder involvement in policy implementation?

.................................................................................................................................
.................................................................................................................................

d) What are the policy gaps in the sector

.................................................................................................................................
.................................................................................................................................

e) What are your recommendation on sand harvesting policies and stakeholder involvement?

.................................................................................................................................
.................................................................................................................................