

**THE SOCIO-ECONOMIC EFFECTS OF SAND HARVESTING IN RIVER
THWAKE, KATHIANI DIVISION, MACHAKOS COUNTY, KENYA.**

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DECLARATION

This research project is my original work and has not been presented to any other examination body. No part of this research should be reproduced without my consent or that of University of Nairobi.

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To my family and friends for their encouragement throughout the study

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LIST OF ABBREVIATIONS

| | |
|--------------|---|
| DPSIR | Driving force-Pressure-State-Impact-Response |
| EEA | European Environmental Agency |
| EMCA | Environmental Management and Co-ordination Act (1999) |
| EMP | Environmental Management Plan |
| EPA | Environmental Protection Agency |
| ESI | Environment Sustainability Index |
| GDP | Gross Domestic Product |
| KSH | Kenya Shillings |
| NEMA | National Environmental Management Authority |
| PSR | Pressure-State-Response |
| SD | Sustainable Development |
| SPSS | Statistical Package for Social Sciences |
| SDI | Sustainable Development Initiative |
| SIA | Social Impact Assessment |
| UN | United Nations |
| WEF | World Economic Forum |

ABSTRACT

Sand is a natural resource that exists at valley bottoms of rivers and one of its uses is provision of raw material for construction. The building of homes, institutions and towns require the use of sand at varying quantities. This result in sand harvesting at increasing rates at the seasonal river bottoms which traverse the rural areas. Sand harvesting is one of the serious environmental problems around the globe in the recent years. Sand harvesting activities reduce land socio-economic value by causing land degradation, loss of agricultural lands, low availability of water and of low quality and loss of biodiversity as well as increased poverty among people in the area. To address these problems NEMA has come up with sand harvesting guidelines which need to be enforced.

The main objective of the study was to assess the socio-economic effects of sand harvesting in Kathiani Division. The specific objectives were to determine how sand harvesting activities have contributed to job creation in Kathiani Division; to find out the extent to which sand harvesting activities have improved living conditions among the people living in Kathiani Division; to determine whether sand harvesting activities have affected education among the children; to determine how sand harvesting activities have affected accessibility of better health services among people living in Kathiani Division.

The research study adopted descriptive research design and targeted a population of 236 sand harvesting stakeholders in Kathiani Division. A sample size of 121 stakeholders was used for the study. Secondary data source were basically through desk reviews of existing literature on sand harvesting and scholarly internet sources. Primary data was gathered directly from the stakeholders using structured open-ended questionnaire, observation and photographs. Quantitative data was analyzed using descriptive statistics. Descriptive statistics such as frequency distribution and percentages were used to describe data. The Statistical Package for Social Sciences (SPSS) aided the analysis of the data collected. Inferential statistics, chi-square was used to test the null hypotheses.

From the findings, the study found out that sand harvesting activities have significantly contributed to job creation in Kathiani Division. The study further found out sand harvesting activities have significantly improved living conditions among people living in Kathiani Division; sand harvesting activities have significantly affected education among people living in Kathiani Division. It finally found out that sand harvesting activities have significantly affected accessibility of better health services among the people living in Kathiani Division. The results indicate that sand harvesting earnings are inadequate in the sense that the families cannot afford textbooks and learning materials of their children. Families cannot access better medical services from the income realized from sand harvesting activities. The study recommended that NEMA Social Impact Assessment (SIA) need to be carried out to optimize positive and mitigate negative effects of sand harvesting in Kathiani Division.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Rivers all over the world are under immense pressure due to various kinds of anthropogenic activities, among them indiscriminate extraction of sand and gravel which is disastrous as the activity threatens river ecosystem (Kondolf, 1994). Rivers are equally important in making economic, social, religious and cultural heritage in area through which they flow. Rapid industrialization, urbanization and associated development have resulted in exploitation of the river bed materials like sand and gravel.

Global economic growth in the 21st century entails the need for raw materials to build infrastructure. Sand is one of the raw materials whose excavation is done from river beds. Moreover, it is generally considered that material from alluvial deposits is usually better quality than from other sources, due to sorting processes that separates weak material from strong ones (Kondolf, 1994). Instream sand harvesting has become a widespread phenomenon all over the world.

The demand for sand is growing around the world, particularly in the developing countries such as India, China, and Kenya where the rapid economic development causes strong growth of construction industry. The global sand harvesting concerns about environmental impacts is increasing, report from other countries for example China (Wu *et al.*, 2007), Ghana (Mensah, 2002) and India (Padmalal *et al.*, 2008). Consequently, it has been argued that because of this globalizing extent and the magnitude of its impacts sand harvesting should be considered as an aspect of global environmental change (Sonak *et al.*, 2006). Unscientific and haphazard sand harvesting, in many of the occasion, lead to severe environmental problems to river basin environments that need immediate attention and corrective measures.

United Nation department of social and economic affairs (2003) estimated that in Africa alone, 20 million people depend on sand harvesting activities for subsistence and places the figure at 100 million people worldwide who depend on sand harvesting for survival. The international labor organization (ILO) (1999) estimates that are about 30 countries; depend on the sector for their livelihood (Thomas *et al.*, 2003).

India recognizes that sand harvesting, unless properly regulated, can have adverse environmental and social consequences though economically beneficial to the communities that live around these areas (Davies and Mathus, 1996). There were reports of illegal sand excavation by contractors across major river basins where sand was mined in order to cater for the construction need of the local villages and government offices (Padmalal *et al.*, 2008)

In Kenya sand harvesting has also been reported along major river banks all over in the country and therefore there is need to establish the effects of sand harvesting on the socio-economic lives of the people who live in areas where these activities are carried out. In Machakos County, sand harvesting is causing environmental degradation thus affecting socio-economic development though many agree that it has led to job creation among the youth living in the area (Mutiso, 2012).

1.2 Statement of the Problem

Sand harvesting is a major activity along most river banks in Kenya, due to an increasing demand of housing and development in the construction industry. River Thwake in Kathiani Division, Machakos County, is the source of building sand for Nairobi city, Machakos, Athi River, Thika and other urban areas. Rapid urbanization in Nairobi city and its environs has led to increased demand of this natural resource. Approximately 175,484 tonnes of sand is harvested yearly from Kathiani Division (Poverty Eradication Network, 2009).

According to an Economic Survey (2010), it was observed that although sand harvesting is of great importance to the economy of Kenya, in Kathiani Division those scooping and loading sand are living in poverty. According to Kenya Integrated Household Budget Survey (KIBHS) report (2009) estimates, 77.41 % of individual are below poverty line in Kathiani Division. It is estimated that the sand miners earn between Ksh.2500-3500 and sand loaders are given Ksh.200 to share among themselves per lorry then the lorry fetches almost Ksh.30,000 in the city.

This has left the residents of Kathiani Division poverty stricken even though they have a good and rich natural resource. Sand harvesting activities in Kathiani Division are accompanied by many socio-economic problems which need to be addressed. There

have been many studies on sand harvesting but little has been done to establish its socio-economic effects on the people who live around the river banks.

A study in Lome Togo by Ayenagbo *et al.*, (2011) on the economic value of sand harvesting in Lome, found out that sand harvesting has an important role in the local economy of Togo for many years on a national basis, quarrying has traditionally been probably second after agriculture as a source of rural employment. The study noted that the industry has been particularly important in Lome area since independence.

The harvesting of sand if properly done can bring socio-economic benefits where the activities are done, though these are never obvious that it will benefit the communities. Some communities living in sand harvesting areas continue to live in poverty. A study by Mutiso (2012) on impacts of sand harvesting on education development in public school in Kathiani Division, found out that there is declining education standards in terms of performance, low enrolment and retention rates though sand harvesting should support the education activities. Therefore this study seeks to establish the socio-economic effects of sand harvesting at river Thwake in Kathiani Division, Machakos County, Kenya.

1.3. Research Questions

- (i) Does sand harvesting contribute to job creation in Kathiani Division?
- (ii) Does a sand harvesting improve the living conditions in Kathiani Division?
- (iii) Does sand harvesting affect education among the children living in Kathiani Division?
- (iv) Has sand harvesting activities affected accessibility of better health services among the people living in Kathiani Division?

1.4. Objectives of the Study

1.4.1 General Objective

To establish the socio-economic effects of sand harvesting in river Thwake, Kathiani division, Machakos County, Kenya.

1.4.2. Specific Objectives

- (i) To determine how sand harvesting has contributed to job creation in Kathiani Division, Machakos County.
- (ii) To find out the extent to which sand harvesting has improved the living conditions among the people living in Kathiani Division, Machakos County.
- (iii) To determine whether sand harvesting has affected education among the children living in Kathiani Division, Machakos County.
- (iv) To determine how sand harvesting has affected accessibility of better health services among the people living in Kathiani Division, Machakos County.

1.5. Research Hypothesis

The hypotheses of the study are stated as follows.

1. Ho: There is no significant relationship between sand harvesting activities and job creation in Kathiani Division.
2. Ho: There is no significant relationship between sand harvesting activities and improved living conditions among people living in Kathiani Division.
3. Ho: There is no significant relationship between sand harvesting activities and better education among people living in Kathiani Division.
4. Ho: There is no significant relationship between sand harvesting activities and better health services among people living in Kathiani Division.

1.6 Significance of the Study

Kenya's rapidly growing population in urban areas has contributed to increased demand for sand resource to meet the rising needs of building and construction industry. This increased demand of the resource is making sand harvesting to be widespread, highly unregulated, and uncontrolled and being carried at alarming rate.

Although sand is a very important socio-economic resource the gravity of the situation is negatively affecting the communities and the region at large. The transporter are making fortune in Nairobi while those scooping and loading living in poverty. Poverty leads to overexploitation of the residents by the sand dealers making the region 'resource curse'. Therefore this research will provide more information to the residents of Kathiani division on the benefits that may come with the harvesting of sand and help them identify ways that they can use sand harvesting to improve their lives.

1.7 Scope of the Study

The study seeks to establish the socio-economic effects of sand harvesting in river Thwake, Kathiani Division, Machakos County, Kenya. The study covered the contribution of sand harvesting industry to job creation, improvement to better living condition among the people, contribution to better education among children living in the area and contribution to accessibility to better health services.

The study focused on the sand harvesters, teachers, the administration staff and the families that live around river Thwake Kathiani division. The study focused on the social environment and did not cover the physical environment and biological environment. The study was carried between January and February 2015 and was based on the sand harvesting activities in the area.

1.8 Limitation of the study

The study faced problems such as lack of co-operation and unwillingness to answer questionnaires by some residents. However, explaining to the potential interviewees that information given was to be treated with utmost confidentiality and research was purely for academic purposes mitigated the problem.

The other limitation was that the time scheduled for data collection was not adequate and the researcher had to allocate more time to ensure that the correct number of responses was achieved. The allocated finances were not adequate given that the researcher had to sometimes move a lot to locate the respondents who were selected by the study and the researcher had to allocate more funds to ensure that the activity went on smoothly to its completion.

1.9 Operational definitions

Designated site: Means any area demarcated and endorsed by the TSHC for the removal, extraction or scooping of sand (NEMA, 2007)

Livelihood –A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for means of living by an individual or community.

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, (Keller *et al.*, 2000).

Poverty: is a state of deprivation associated with lack of incomes and assets, physical weakness, isolation, vulnerability and powerlessness.

Resource curse: Resource curse also known as paradox of plenty refers to the paradox that countries and regions with an abundance of natural resources, specifically point source non-renewable resource like minerals and fuel tend to have less economic growth and worse development outcomes than countries or regions with fewer natural resources (Richard Auty,1993).

Sand dealer: is any person(s) approved to harvest, remove, extract, scoop and transport or sell sand as provided (NEMA, 2007).

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. National Sand Harvesting Guidelines, (2007) define the practice as the removal, extraction, harvesting or scooping of sand from designated sites.

Sand: Means a sedimentary material finer than gravel and coarse than silt with grains between 0.06 mm and 2mm in diameter and include stone, coral and does not include silica sand.

Socio-economic development: is the process of socio-economic development in a society. Socio-economic development is measured with indicators such as Gross domestic product (GDP), life expectancy, literacy and levels of employment. Changes

in less-tangible factors are also considered such as personal safety, freedom from fear of physical harm, the extent of participation of the civil society.

Sustainability: refers to simultaneous pursuit of sustained or enhanced environmental quality, economic growth, and social justice (Eggert, 2006).

Sustainable development: SD is defined as development that meets the needs of the present generation without compromising the ability of future generation to meet their own needs (WECD, 1987). Sustainability emphasis is based upon equality and equity of life. It is founded on socio-economic and environmental bases.

Sustainable livelihood: A livelihood is sustainable when it can cope with and recover from shocks, stresses, be able to maintain and enhance its capabilities and assets in both short and long term period, while not under harvesting the natural resource base.

Technical sand harvesting committee (TSHC): Means a committee composed of persons drawn from the District Environment Committee and co-opted member from local community to oversee sand harvesting activities in the district established under clause 4 of these Guideline.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter contains a review of the past studies. The purpose of the review is to examine the available studies from other scholars and researchers who have done studies on the same subject under investigation. The literature available will provide a guideline to this study and offer a critical analysis of past studies in order to avoid the duplication of previous work.

2.2 Empirical Literature Review

Sand as a resource is of great socio-economic value. It has several varied uses, among them, used as a concrete constituent in the building and construction industry, as an abrasive (sand paper, sand blast), as a source of silica for making sodium silicate, used in foundries for molding and parting. Thus, the importance of the resource cannot be over emphasized, and its uses are inevitable.

River sand is one of the world's most plentiful resource (20 % of the Earth's crust is sand) and has the ability to replenish itself. River sand being a natural resource has utility and it can be extracted by humans to help them in earning a living. Natural resources are out there regardless, of whether or not human beings choose to use them to improve their lives. They are "neutral stuff" that make up the world, but they become resources when we find utility in them (Hunker, 1964). Therefore river sand is vital for human well-being and for sustenance of rivers.

The human species is part of nature and should therefore participate effectively and gain from it. Its existence depends on its ability to draw sustenance from a finite natural world and its continuance depends on the ability to abstain from destroying the natural systems that regenerate the world. Economic activity must account for the environmental costs of production which includes labour. The maintenance of livable global environment depends on the sustainable development of entire human family through the use of natural resource in the improvement of living conditions (Naveen, 2012).

Natural resources are the basic building blocks in the production system, they are raw materials. Keller (1992) observed that little of their value is derived from human input

such as labor; they generally have a lower value per unit than other commodities. In few cases natural resources have high value in the ground, but in this instance it is the consumer that drives the price up, if the demand is greater than the amount of resource available (Cutter, 2004). Therefore natural resources like sand should be used properly to create jobs and improve the people's lives.

Resources when well used can improve the living conditions of the users. Economists view the resources that we extract from nature as form of capital and just as traditional capitalist, systems seek to accumulate and re-invest monetary capital, ecological economist argue that natural capital should be regenerated rather than depleted (Hawken *et al.*, 1999). Environmental protection agency (EPA) call for the development of a "sustainability consciousness" toward a way of living that does not destroy the environment but keep it healthy for future use.

Increased income for people is crucial for the sustainability of the family and improvement of their living conditions. Social scientists believe that real development lies in the economic empowerment of people and especially at family level. It is believed that unemployment for people implies not only deterioration in their living standards but also an increase in their dependence on other people and loss of autonomy as well as security (Sen, 1989).

Globally, sand harvesting is in great demand due to increased demand in the construction industry and should be of great economic benefit to the people who live in the area through accessing better education for their children. Globally, sand deposits are actively harvested on every continent except Antarctica (Naveen, 2012). In the United States sand harvesting has been carried out in California, Monterey bay area, Georgia, Florida, Virginia and New Jersey. In Australia sand harvesting is carried out in kurnell peninsula where the harvesters use the money to invest in business activities and take their children to school while contributing to the construction of buildings. Though as much as it has contributed to the improvement of the people's lives it has also led to the development of negative effect of sand including the permanent loss of sand in areas as well as habitat destruction (Naveen, 2012).

A study by Borges *et al.*, (1992) in Acero archipelago Portugal found out that sand harvesting impact social and economic growth of archipelago in 20th century particularly in last quarter of the century resulted to accelerated coastal development which included the construction of communication infrastructure and buildings all of which required large volume of sand .Given the local geological constrains, natural and suitable for aggregate in construction is a scarce natural resource. Construction therefore used beach and dunes as principle aggregate source, exploiting the weakness of legal constraints to these types of harvesting activity as well as the in existence of proper coastal management plans.

Sand harvesting like any other economic activity is able to help the people in a given area in affording their basic needs given that it raises their purchasing power. A study by Deller and Schreiber (2012) on Franc Sand harvesting and Community Economic Development found that communities that are more heavily dependent on harvesting for employment tend to experience greater negative impacts after the mines close than positive impacts while the mines are in operation including the inability to afford basic health requirements.

The study also revealed that in many ways sand harvesting can provide well-paying jobs leading to lower levels of poverty. But on the other hand, sand harvesting activity appears to be associated with poorer overall health levels within the community. The study concluded that for remote rural counties there is weak evidence that counties more heavily dependent on harvesting for employment will tend to have a slower population growth rate and that there is more consistent evidence that harvesting has a positive impact on employment, health and income growth rates (Deller and Schreiber, 2012).

A study by Binoy *et al.*, (2002) in river pariyar Karela India found out that annual demand for sand for construction purpose in Karela is estimated at more than 3 million tonnes. Collecting sand from river and its distribution has become an industry giving job opportunities for thousands. According to estimates, sand mining provides direct employment opportunities to over 60,000 registered laborers in the state.

On an average, each laborers earn an amount of Rs. 150-200/- per day or even more from sand harvesting.60 % of the labors engaged in the activity and solely dependent on sand mining and are more than 35 years.

According to Welmer and Becker-Platen (2002) Africa has significant sand harvesting, in Sierra Leone, the activity is destroying the natural of the area, driving away tourists, business owners and residents and contributing to coastal erosion.

Ayenagbo *et al.*, (2011) did a study on socio-economic effects of sand and gravel mining in Lome Togo found out that quarrying industry and associated other transport and related services industries have had an important role in the local economy of Togo for many years. On national basis quarrying has traditionally been probably second only to agriculture as a source of rural employment. The industry is one large employer identified a lot of jobs associated with quarry ranging from manager laborers and truck drivers. The harvesting of sand and gravel in Togo has created job for youth. The revenue gained is used in most part to meet basic needs of the family including food, to pay tuition for children. The laborers work in primitive conditions with the use of archaic tools (Shovels, hoes, buckets) and no guarantee of support in case of accident. They earn average 3,000 CFA francs per day and the revenues are used to meet basic needs food, rent, medical care and children schooling. On health diseases such as malaria, stomach disorder, hernias as well as sexual and physical weakness due to difficult working condition were common. The study found out that of 68 respondent, 60% attested to having consulted a doctor but the purchase of the prescribed drugs was almost impossible because of the poverty level.

A study by John victor Mensah (2002) in coastal sand harvesting in Ghana found out that the process of sand harvesting had accelerated coastal environmental degradation at an alarming rate in many areas.Mensah(2002) in his study found out that the main effects of uncontrolled sand harvesting included loss of land (19.2 per cent),destruction of beach(18.2 percent),destruction of road 16.5 percent and conflict (13.5 percent),loss of vegetation (12.2 percent),Destruction of property 11.8 percent and use of child labour 8.4 per cent in Ghana .The loss of land and destruction of property is due to soil erosion that leads to loss of coastal land.

While it is true that the sand users may be seen to be the main beneficiaries, there have been no studies that show that the process affect positively on the health and lives of the communities involved in harvesting of sand in Machakos County and therefore need to look into strategies that the local authorities can ensure that the communities benefit from the activities (Mwaura,2013).

Sand harvesters are economically impoverished with some not able to afford medical services when they fall sick due to prolonged exposure to water born diseases while contractors and transporters are getting richer.

Mensah (2002) in his study in Ghana noted that sand harvesting is causing child labour of children aged 14 yrs assist their mothers in sand harvesting. For Mensah to some extent sand harvesting is increasing employment opportunities, Mensah also noted social economic factors are the main reasons why people undertake sand harvesting. In the coastal area people are unemployed and underemployed which compels them become sand carriers, sand loaders, and tally clerks in order to make ends meet. The uncontrolled sand harvesting, the sand contractor fetch minimal daily wages rate of US \$ 55.47 per day, while sand carriers, sand loader make daily net income of US \$ 1.54 and US \$ 2.16 respectively. This is high profit margin showing the contractors earn more than the loaders. Mensah also found out that the demand of sand and stones are caused by high housing and construction works in nearly all urban centers.

With Kenya experiencing huge growth in real estate development which contributes to overall economic growth, effective policies are required to manage sand harvesting which is an important component in the construction process. Currently Kenya does not have a national policy or law that regulates sand harvesting. The major concern is that sand is resource that contributes to economic growth of the rural areas contributing to environmental degradation of river drainage basin (Arwa, 2012).

According to EMCA (1999) in Kenya it is stipulated that sand harvesting project should undergo an Environmental Impact Assessment (EIA) to determine its impacts on the environment. Sand is not classified as a mineral under harvesting act cap 306 or subsidiary legislation. This means the commissioner of mines through the act does not regulate sand extraction. This has made the National Environmental Management

Authority (NEMA) to develop a draft guideline for extraction of sand resource as a temporary solution.

NEMA (2007) developed guidelines to provide procedure to streamline sand harvesting in the country with the view of making it sustainable industry that supports economic development for enhanced livelihood while safeguarding the environment. The guidelines were launched on 26th October 2007 by the Minister for Environment and Natural Resources at Mlolongo Township during stakeholder forum that comprised owners of Lorries, transporters, loaders and land owners. The guidelines have been accepted as applicable, inclusive and friendly to the environment by the stakeholder. It is therefore incumbent upon to the players to comply with guidelines to ensure sustainable environment management.

Sand harvesting guidelines ensures sustainable utilization of the sand resource and proper management of the environment NEMA (2007).According to NEMA the Technical Sand Harvesting Committee (TSHC) has been given mandate to ensure that: Sand dams gabions are constructed in designated sand harvesting site, lorries are supposed to use designated access roads only to sand harvesting sites, designated sand harvesting site are rehabilitated appropriately by Riparian Resource Management Association (RRMA), County council and approved dealer under close monitoring and supervision by the Technical Sand Harvesting Committee in compliance with EMCA, 1999. Sand harvesting is restricted to riverbeds with no harvesting allowed on river banks in order to prevent widening of river.

As far as social justice is concerned, NEMA TSHC is supposed to ensure that sand loaders are over 18 years, approve sand dealers will pay a negotiated and agreed wage to sand loaders. The committee is also supposed to approve sand dealers are encouraged to support local community project in the consultation with the RRMA. According to NEMA (2007) no person is allowed to harvest sand from any area not designated as sand harvesting site by TSHC and the site must have an Environmental Management Plan (EMP) to guide in the rehabilitation of the sites (EMCA, 1999).

In addition, harvesting of sand should not exceed six (6) feet in depth; designated sand collection sites should be at least 50 meters from the riverbanks or dyke for on farm harvesting (NEMA, 2007) and harvesting should be done concurrently with restoration

of areas previously harvested. Sand harvesting in the area should be strictly open-cast harvesting. In case of underground tunneling or extraction of sand appropriate technology should be done to safeguard human safety.

According to National Environmental Management Authority (NEMA, 2007) river sand harvesting should be taken in way that ensures adequate reserve of the sand is retained to ensure water retention. Sand harvesting should not be allowed in river banks, harvesting should take place within 100 meters of either side of physical infrastructure including bridges, roads, railway line and dyke (NEMA, 2007). The guidelines state that harvesting to be done between 6 p.m. to 6 a.m. and the transportation hours of 8 P.m. to 6 a.m.

In the guidelines it is also stipulated that any person who sell sand will require issuing a receipt to the purchaser and keeping records of such for periodic inspection by relevant authorities. In addition, sand harvesting should be restricted to river beds with no harvesting allowed in banks to avoid widening of river (NEMA, 2007). The National sand harvesting guideline cannot be enforced because they have not been gazette to become law under Environmental Management and Co-ordination act (EMCA). As a result of lack of statutory provision, massive sand harvesting has led to drying of many rivers because sand is the natural tank for storing water.

Although sand harvesting has a positive impact on socio-economic conditions on the local population, it is causing massive environmental degradation as a result of haphazard scooping in Kathiani Division (Mutiso, 2012). This resulted to banning of sand harvesting and transportation in Kathiani on Friday, February 10:2012. (NEMA, 2007).

Muchena (2008) in his study on the indicators for Sustainable Land Management in Kenya's Context admitted that sand harvesting as much as it was economically beneficial and improved the living conditions of the people living around the river banks, it would not be sustainable in the long run if proper measures are not taken to control environmental degradation that was threatening agricultural activities. Agriculture was necessary for the improvement of the people's livelihood and better health through the growing and availability of enough food.

Sand harvesting is of great socio-economic importance to Kenyans and can improve the overall life quality of the people in the areas that harvesting is done. It should however, be recognized that the processes involved in prospecting, extracting, refining and transporting involves a variety of stakeholders from the point of harvesting through transportation to the middle men and finally to the users though it affects the economic lives of the people who deal in such activities (Macharia, 2004).

Sand harvesting can have huge positive economic impact on the people involved in the business but Musyimi (1993) feared that sand transporters are making a fortune in Nairobi while those scooping and loading it into Lorries are living in poverty with fears that sand scoopers are paid Shs.200 each for loading a lorry which fetches between Kshs 20,000-30,000 in the city. While transporters continue to make huge amounts of profits, sand scoopers are not able to take their children to good schools. The local authority is planning to initiate the creation of industries to pack the sand which will then be sold in hardware stores like cement. This will ensure that the sand harvesters who are the locals benefit a lot from the activity and are able to afford better education for their children.

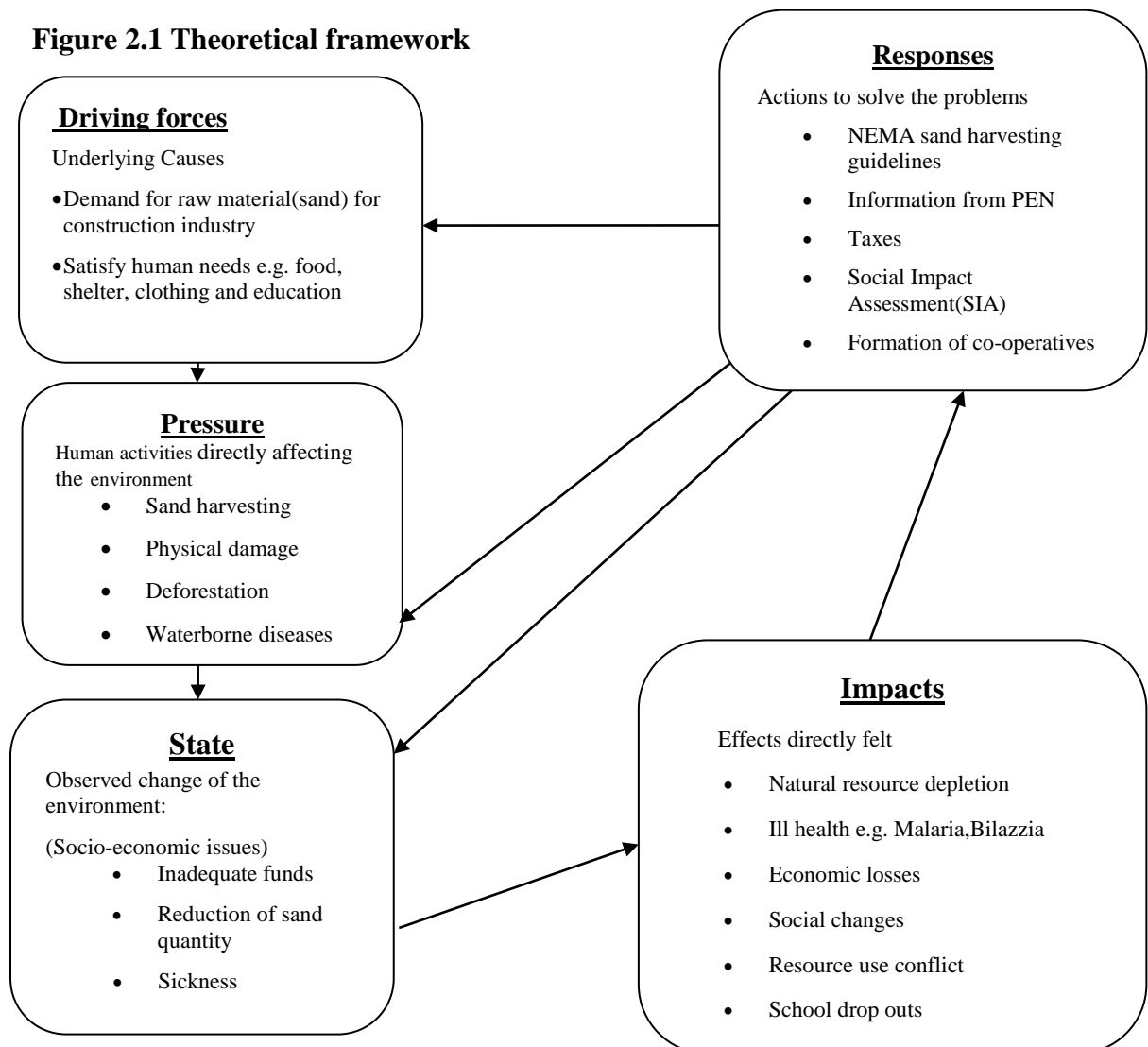
Mwaura (2013) carrying out a study on the effects of sand harvesting on economic growth in Kenya with case study of Machakos County established that in many areas along the river banks harvesting of sand and gravel on agricultural land is one of the alternative livelihood activities of the rural people and has now become a source of livelihood for many rural communities in Machakos County. All what needs to be done is to improve the activities so that they can be as beneficial to them as possible.

A study by Mutiso (2012) on the impact of sand harvesting on education of pupil in primary school in Kathiani district found out that sand harvesting negatively influence the education of pupil in terms of school attendance this because most of them are involved in sand harvesting activities during school hours. The study also found out that pupils tend to dropout starting at standard six and reach a peak at standard seven just before getting to their final year of the primary school cycle at standard eight levels the teacher said dropout had increased by 66.25%. The dropout cases were as result of pupils being involved in sand harvesting activities. The socio-economic effects of sand harvesting activities are not well known. The study was carried out to fill this gap.

2.3 Theoretical Framework for Socio-economic Development

Development of the social system is considered a process of interactions between the economic subsystem and the cultural-institutional subsystem. The former consists of activities combining economic resources (labor, capital, and natural resources) through technology to produce goods and services useful for human living. These economic activities are coordinated and controlled by the latter, which consists of institutions (the rules of society) and culture (people's value system). A model is developed to conceptualize how technological and institutional changes interact with each other, how they respond to changes in resource endowments, and how such responses are governed by cultural traditions. Harvesting of sand is a socio-economic activity that is almost identified with the people who live along the river.

Figure 2.1 Theoretical framework



Source: Modified from European Environmental Agency (EEA ,2007)

The theoretical framework Driving force Pressure State Impact Response (DPSIR) shows the linkage of sand harvesting activities and its socio-economic effects. The driving forces are the changes in social, economic and institutional system that directly and indirectly trigger pressure on the environmental state. The driving forces towards sand harvesting is to engage in socio-economic activity to satisfy human needs that include food, health, shelter, clothing and education.

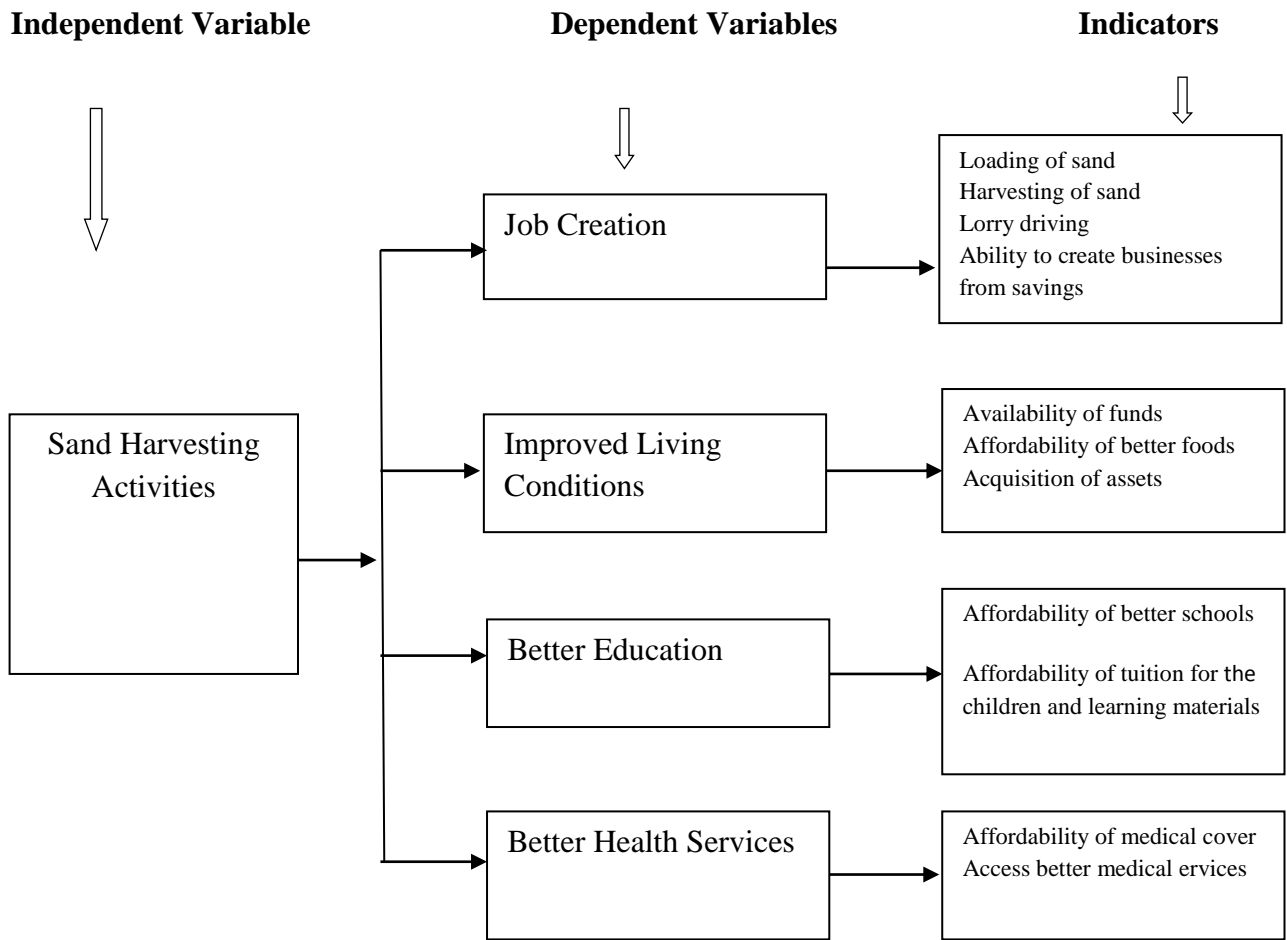
In addition, the driving force is to get raw material (sand) for construction industry to build roads, utility poles and buildings. The drivers put a lot of pressure on the environment that is physical environment, biological environment and human environment. The pressures include uncontrolled sand harvesting, physical damage, deforestation, waterborne diseases, vehicular emissions.

The pressure exerted by society may lead to unintentional or intentional change in the state of the human environment that is the living conditions for humans are affected leading to socio-economic issues e.g inadequate funds, reduction of sand quantity, sickness, unemployment and illiteracy.

The impacts are changes of environmental functions affecting socio-economic dimensions, which are caused by change in state of system. (Change in environmental function such as sand resources assess, water, and health). The socio-economic effects of sand harvesting include: natural resource depletion, ill health, economic losses, social changes, resource use conflict and school drop outs.

The impacts trigger responses. Responses are the policy actions which are directly or indirectly triggered by perception of impacts and which attempt to prevent, eliminate, compensate and reduce their consequences. Responses can be at society level, group, government or non-governmental sectors. The actions to solve the identified problems include NEMA sand harvesting guidelines, information from Poverty Eradication Network (PEN), taxes, Social Impact Assessment (SIA) and formation of co-operatives to increase the benefits of sand harvesting. The responses affect the socio-economic drivers on how sand harvesting is carried out.

Figure 2.2 - Conceptual Frame work



Source: Researcher (2015)

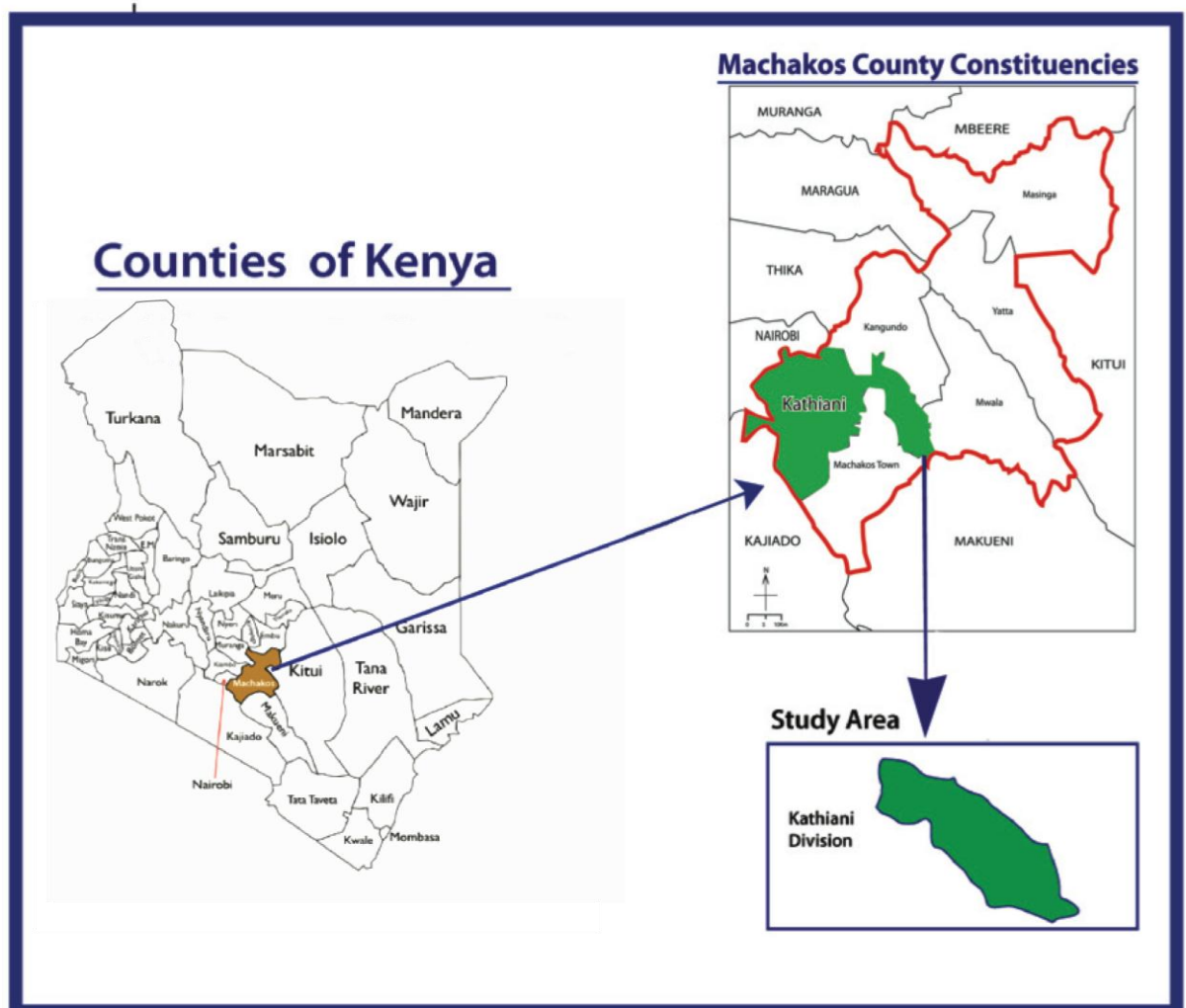
CHAPTER THREE

THE STUDY AREA

3.1 Position and size

The study was conducted at river Thwake, Kathiani division in Machakos County. The County has 6 constituencies which are: Kathiani, Machakos town, Masinga, Yatta, Kangundo, Mwala (figure 3.1). Kathiani Constituency consists of Athiriver and Kathiani division. Kathiani division which is the study area covers an area of 207.0 Km² and is located a longitude 37⁰20' E – 37⁰30' E and latitude 1⁰30'S -1⁰20' S.

Figure 3.1 Location map of the study area

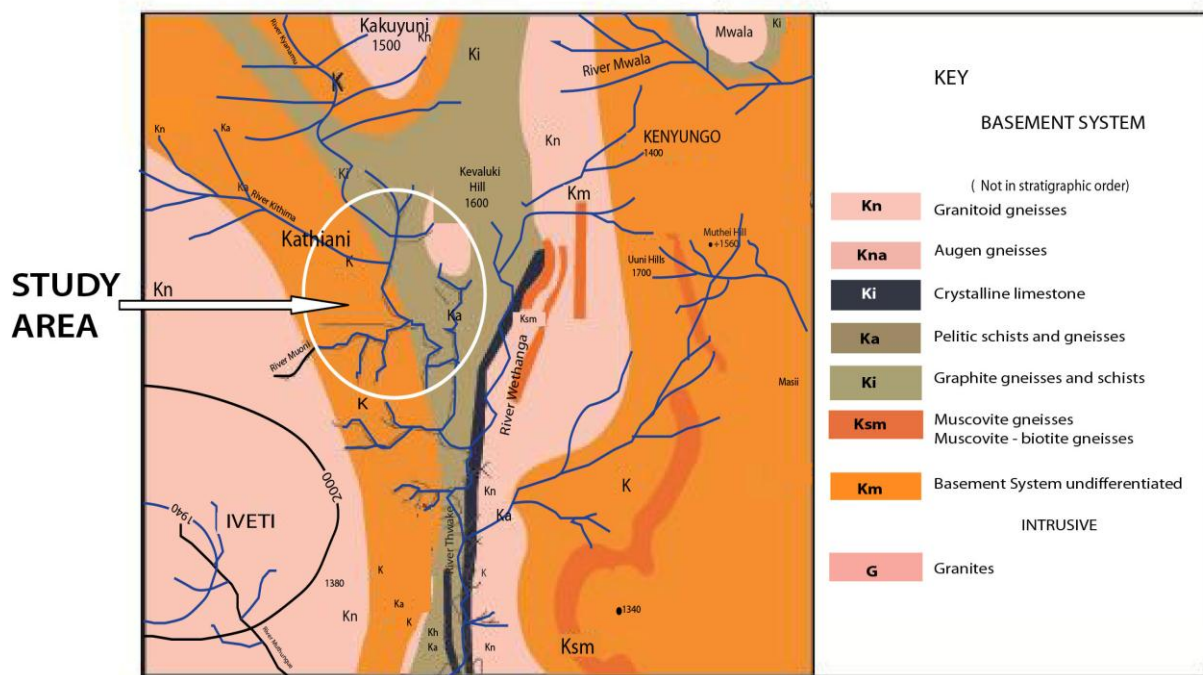


Source KNBS Census 2009, Survey of Kenya, ILRI

3.2 Geology.

The geology of the study area consists of the basement system consisting of the following parent rock material, Granitoid Gneisses, Pelitic schist and gneisses, This were formed in the Achaean period (Baker B.H,1954).After weathering of this basement rocks by physical, chemical and biological process sediments are formed that make sandy soils (figure 3.2)

Figure: 3.2 Geological map of Kathiani division




Source: Baker B.H, 1954(Mines and Geology)

3.3 Drainage system

Most of the rivers in the study area are seasonal, they include river Thwake, river Mwala, river Wethanga, river kithima, river Kyanamu and river Muthungue as shown in figure 3.2. These Rivers erode the sediments formed during weathering where they sorted and deposited on the river beds where sand harvesting takes place (Figure 3.3) The rivers are major source of water in the study area and have been affected by sand harvesting. As a result there is high water scarcity which affects women and girls since they are charged with responsibility of ensuring the household needs for water are met. In the process, they are denied the opportunity to engage in other economic activities and schooling.

Soil information

| | | | |
|------------|--|---|--|
| M11 | Somewhat excessively drained, shallow to moderately deep, reddish brown, friable, rocky and stony, sandy clay loam eutric CAMBISOLS, partly Lithic phase; with LITHOSOLS, eutric REGOSOLS and Rock Outcrops) | L26 | Association of imperfectly drained, moderately deep, dark grayish brown to black, very firm sandy clay, with a topsoil of friable, humic, sandy clay loam to clay loam (eutric GREYZEMS). |
| H13 | Somewhat excessively drained shallow, reddish brown, friable, rocky or stony. Sandy clay loam (eutric REGOSOLS, lithic phase; with Rock Outcrops and Calcic CAMBISOLS) | Pdo | Imperfectly drained, deep, dark grayish brown, firm clay (hardpan) abruptly underlying a topsoil of sandy clay loam. (Eutric PANOSOLS). |
| L1 | Well drained, very deep, dark red, very friable clay (nito – rhodic FERRAL SOLS) | F13 | Well drained, very deep, yellowish red to dark reddish brown, loose, loamy coarse sand to friable sandy clay loam (ARENOSOLS). |
| L7 | Well drained, shallow, brown, firm, gravelly clay, with a stony to boulder surface (chromic CAMBISOLS, lithin and boulder -mantle phase) | F15 | Complex of somewhat excessively drained to well drained, deep to very deep, dark red to brown, loose sandy loam to friable to firm clay (undifferentiated ACRISOLS; with ARENOSOLS) |
| L9 | Moderately well drained, very deep, dark grayish brown, firm clay (verto-luvic PHAEZOZEMS; with eutric PLANOSOLS) | Uu3 | Well drained, moderately deep, dark brown, friable clay loam, with a very thick acid humic topsoil (humic CAMBISOLS) |
| L11 | Imperfectly drained, very deep, dark grey to black, firm to very firm, boulder and stony, cracking clay, in places with a calcareous, slightly saline deeper subsoil (pellic VERTISOLS.) | Uh15 | Well drained, moderately deep to very deep, dark red to reddish yellow, friable to firm, rocky, sandy clay loam to clay (chromic* ACRISOLS and FERRALSOLS). |
| L15 | Imperfectly drained, moderately deep to deep, very dark grey to black, firm to very firm, slightly calcareous, cracking clay, in many places with a gravelly, calcareous deeper subsoil (VERTISOLS) | Um19 | Well drained, moderately deep to very deep, dark reddish brown to dark yellowish brown, friable to firm, sandy clay to clay; in many places with a top soil of loamy sand to sandy loam (ferrals – chromic*/orthic/ferric ACRISOLS; with LUVISOLS and FERRALSOLS). |
| L17 | Moderately well drained, shallow, yellowish red to dark yellowish brown, friable, gravelly clay over petroplinthite or rock (50-70%) IRON STONE SOILS; with Lithosols) | Topographic Information  | |

Source: Ralph J. (1978). Farm Management Hand Book of Kenya: Ministry of Agriculture. Vol. II/A

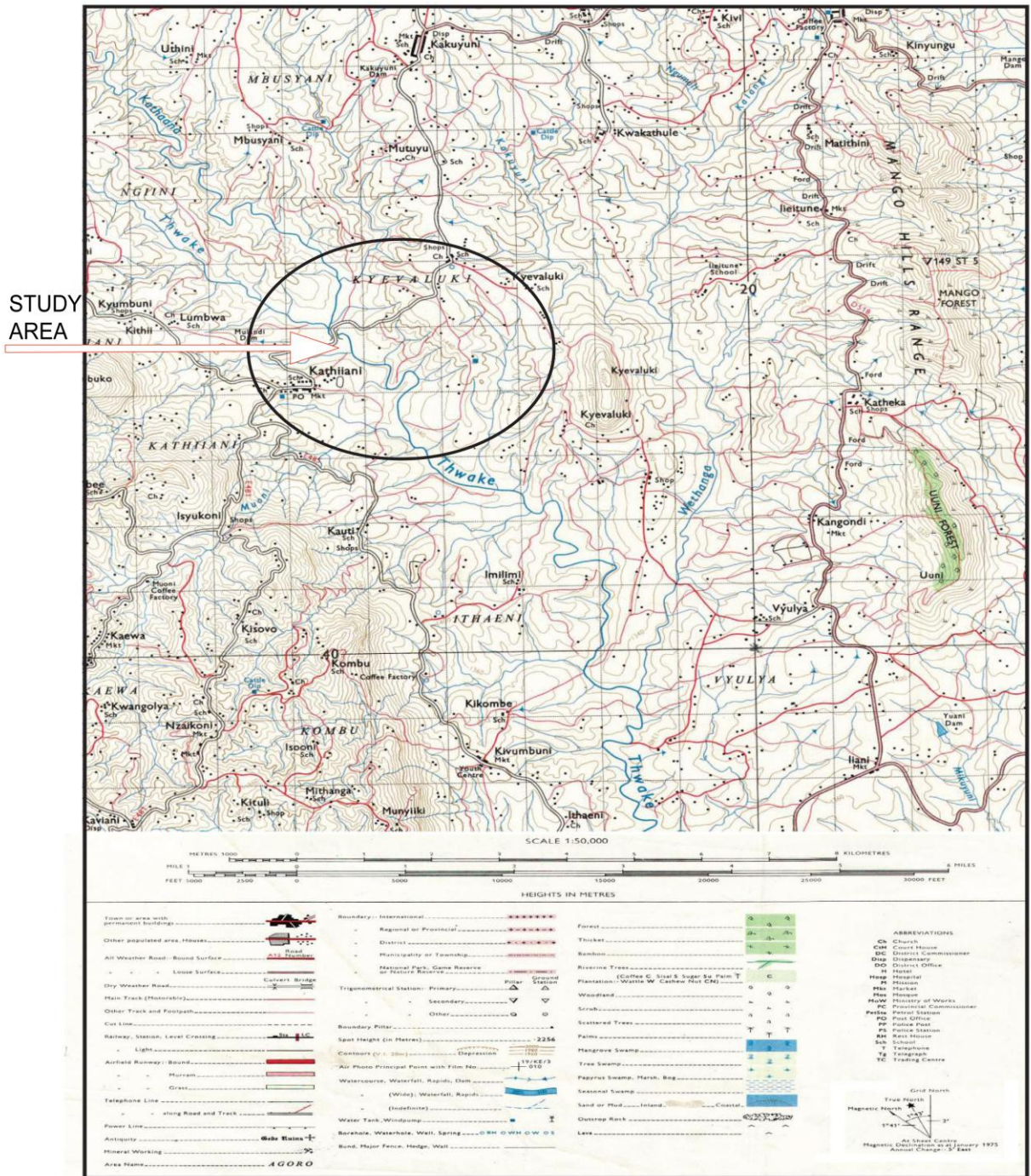
3.5 Topography

Kathiani division has a variety of topographical features. The landscape is largely a plateau that rises from 700m to 1700 m above sea level and is interrupted by an escarpment and a series of hill masses, the highest of which is Kilimambogo or Ol Donyo Sabuk, which rises to 2,144m above sea level. The Division is bound in the western part by the Kapiti and Athi Plains, in the north by the Athi River which curves round the solitary hill of Ol Donyo Sabuk to flow to the south east (figure 3.4).

Rising steeply to the north east of Athi River is the Yatta Plateau, which is broken by occasional hills. In the central part of the division is a striking series of hill masses that stretch in a roughly north-south axis. This series includes the Ol Donyo Sabuk, Kanzalu ranges, and Mango hills ranges, Kangundo, Mua, Mitaboni, Iveti and Kiima Kimwe (figure 3.4)

Figure 3.4 Topographical map of Kathiani Division.

TOPOGRAPHICAL MAP OF KATHIANI



Source: survey of Kenya (1975)

3.6 Climate

The study area is generally hot and dry; it has two rainy seasons, the long and the short rain seasons. The long rains seasons starts at the end of March and continues up to May, while the short rains season starts at the end of October and lasts till December. The annual average rainfall ranges between 500mm to 1300mm. There are significant regional and seasonal variations within the district and rainfall reliability is quite low. Kathiani division is a high altitude area receives slightly higher rainfall than the low land areas.

Mean monthly temperatures vary between 18⁰C and 25⁰C. The coldest month is July while October and March are the hottest. The highland areas which receive higher rainfall are more suitable for rain-fed agriculture than the lowland areas; while the plains support ranching. The varied climate conditions facilitate weathering process leading to formation of sediments that are carried to river beds and deposited.

3.7 Vegetation

Vegetation in the study area is more than 10 m tall and has interlocking cover of between 80-100 %.Forests occurs in hilltops above 500m above sea level in kathiani division. The other vegetation includes woodland that is usually 10-20m tall herbaceous cover. We have combretum species common wetter area of commiphora species, found in drier areas. Other species include *Enchea* spp, *Croton macrostachus*,*Raveta teifana*,*Vanguewa* spp,*Terminalia* spp. When vegetation is cut the soil is exposed thus leading to soil erosion and mass wasting, the sediments are then transported to river beds and deposited (figure 3.5).

Figure 3.5 Vegetation of the study area.



Source: Field data (Jan 2015)

3.8 Wildlife

Wildlife in the study area includes terrestrial animals, aquatic animals and birds. The terrestrial mammals include Grant gazelle, waterbuck, warthogs, dikdik, hyena, Reedbuck, squirrels and variety of snakes. Wildlife has effect on rocks; animals like squirrels burrow or create tunnels underground this allows water and air to reach rocks beginning weathering process (Machakos County Strategic plan, 2013)

3.9 Population

Table 3.1 Population Distribution in Kathiani Division, Machakos County

| Constituency | Divisions covered | Area km ² | Population (1999) | Population (2009) |
|-----------------|--------------------------|----------------------|----------------------|----------------------|
| Machakos town | Central & Kalama | 669.00 | 184,274 | 199,211 |
| Kathiani | Athiriver | 843.20 | 48,936 | 139,502 |
| | Kathiani division | 207.00 | 95,096 | 104,217 |
| Yatta | Yatta & Katanga | 1,057.30 | 125,755 | 147,579 |
| Mwala | Mwala & Yathui | 1,018.00 | 154,778 | 163,032 |
| Masinga | Ndithini & Masinga | 1,402.90 | 106,836 | 125,940 |
| Kangundo | Matungulu & Kangundo | 854.80 | 190,969 | 219,103 |

Source: District planning unit Machakos 2006 and Independent Electoral and Boundaries Commission (IEBC) 2013.

Increased population in the county has led to increased demand of sand for construction purposes leading to overexploitation of the resource. In addition, natural environment is highly degraded because of need of the land for settlement and agricultural activities, as a result there is increased soil erosion whereby the sediments are taken to river beds and deposited.

3.10 Economic activities

In the study area the main economic activity is sand harvesting and quarrying. In addition, agriculture is also being practiced, the crops that are grown are maize, cassava, onion, pawpaw, mangoes, potatoes, spinach, bananas, cabbage, kales, valore, tindooni, avocados, citrus, potato, cowpeas, chick pea and passion fruits.

In addition, in the study area we also have animal rearing the animals include: dairy animals, beef animals, Goats, Sheep, poultry, Donkeys and Bee keeping.

Sand is one of most important resource in the Kathiani division; the availability of sand in the area is associated with geological conditions prevalent in the area which is dominated by basement rock overlain by volcanic rock.

Sand comes into the river through the process of erosion and even though the division has undertaken soil conservation measures seriously, some amount of sand has always found its way into the rivers. Sand harvesting in the area is concentrated along the river Thwake catchment area.

Along the river basin sand harvesting is the principal livelihood for locals in the study area because sand is used for building and construction industry. Sand as a natural resource is the backbone of Masaku county council. The council levies fees on the Lorries as the issue permits to the lorry drivers to transport sand the area offers employment opportunities to resident's. In addition, it offers new employment opportunities to sand harvesting related jobs. The river is the source of large quantities of building sand in fact over 70 % of sand consumed in Nairobi comes from Kathiani division. Sand harvesting is generally transforming the living standard of people. However, in the study area there is serious environmental degradation due to sand harvesting that has resulted to destroying the water sources. This is so as the sand is scooped and the riverbed has been left bare resulting to lack of retention of water resources. This has led problem of water scarcity for domestic and livestock use which affects the social economic development of the area (Machakos County Strategic plan, 2013).

The damages the sand transport Lorries have done to the roads and to the terrain in some parts of the division itself testifies to how little revenue is being ploughed back into protecting the interests of the local people. Sand harvesting activities in the study area is making the area to be vulnerable to landslides.

Sand harvesting activities has been uncoordinated making some of the river bare and causing a lot of soil erosion during the rainy seasons. In the study area, where the activities have been carried out in underground caves, some have collapsed occasionaly leading to loss of life (Machakos County Strategic plan, 2013).

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This chapter presents the methodology of the study; it comprises research design, target population, sampling technique, data collection methods and data analysis methods. The chapter addresses the actual methodologies used in the research process from inception to the end.

4.2 Study Design

The study employed descriptive research design for it to portray an accurate profile of situations (Cooper, 1998). This was designed to describe the characteristics of a particular phenomenon in a situation. It was used to obtain information concerning the current status of the sector, to survey what exists with respect to the conditions in a situation. The design helped the researcher obtain information concerning the socio-economic effects of sand harvesting in river Thwake, Kathiani Division.

4.3 Target population

The study focused on 236 stakeholders in sand harvesting industry who includes relevant local authority, construction industry, sand miner who includes sand loader, truck drivers, teachers, community members, local administration staff and chief, NGO's e.g. the Poverty Eradication Network (PEN). The 56 sand loaders and 30 lorry drivers stakeholders were recorded in Masaku County Council, 60 teachers were recorded in education office at Kathiani, 10 Administration staff/chief at Administration office at Kathiani and 80 community members were obtained from census report (Population census, 2009).

4.4 Sampling Method

Due to the nature of the study, the researcher used stratified random sampling. The target population was first separated into mutually exclusive, homogenous segments (strata), and then simple random samples were then selected from each segment (stratum). The strata used in the study were population subgroups which include drivers, sand loaders, Administration officers, and teacher and community members.

4.5 Sample size

In selecting the sample size, various factors were considered including available time and financial resources, variability of the population (which was considered relatively homogenous based on the study topic), Confidence level, precision level and the population size. At precision levels (sampling error) of + or -5 % (based on balancing of expected accuracy level and available time and financial resources), confidence level of 95 % at 30% degree of variability level of 3 adopted from Watson (2001). Watson table on how to determine a sample size as shown in appendix 1, suggests a sample size of 121 units for a population of 236 elements. Thus a sample size of 121 units (stakeholders) was considered optimal and reliable based on the expected data requirement for this study. The 121 units were shared proportionally amongst the 5 strata, based on the ratio of total number of stakeholders in Kathiani Division and level of variability as follows.

Table 4.1 Sampling Matrix

| | Population subgroups (strata) | Target Population | Sample size |
|---|--|--------------------------|--------------------|
| 1 | Lorry drivers | 30 | 15 |
| 2 | Loaders | 56 | 28 |
| 3 | Administration staff/Chief | 10 | 8 |
| 4 | Teachers | 60 | 30 |
| 5 | Community members | 80 | 40 |
| | Total | 236 | 121 |

4.6 Data Collection Procedures

Both primary and secondary data were used in this study.

4.6.1 Primary data

Primary data was collected from the respondents by closed and open-ended questionnaires, direct observation and photographs. Primary data was the main data that was gathered for the purpose of the research and provided much of the actual facts from the field. The data collected was called the raw data since it had not been interfered with in any way and was only made available by the research study.

Questionnaires consist of questions which were sent to the respondent to seek information from them and later be tabulated and subjected to a statistical analysis under the study. Semi-structured questions were used since the method was easy to compute and permits respondents to give their opinions freely. A questionnaire is a set of few questions asked in a logic sequence but put in a writing form (Cooper, 1988). They required brief and direct answers. The questionnaire had both closed and open questions. Questionnaire was used since the study was concerned with variables which cannot be directly observed such as views, opinions, perceptions and feeling of the respondents. Questionnaires encouraged each participant to provide accurate information. The whole of the target population was expected to be literate and unlikely to have difficulties responding to the questions posed to them.

4.6.2 Secondary data

This data is normally stored in archival records, publications, books, journals, articles and scholarly internet sources. Data was obtained from libraries, Government Ministries, department and organization. Literature published by United Nations environmental programmes, other organization of environmental programmes and other affiliated organization especially on environmental impact assessment methods were reviewed.

4.7 Data Analysis

The questionnaires were collected and checked for completeness. Quantitative data was coded by assigning a code to every response. Quantitative data was analyzed using descriptive statistics. Descriptive statistics such as frequency distribution and percentages were used to describe data. The Statistical Package for Social Sciences (SPSS) aided the analysis of the data collected. The analysis was necessary to draw inferences and make conclusions about the variables under investigations.

The data collected was used to test the null hypotheses. The data collected prompted the use of chi-square which is inferential statistics. This was because it provided a relationship between the two variables. It measured the discrepancy between the observed and expected frequencies. So the test was easy to use (Mugenda, 1999) .This also matched because a chi-square is non-parametric test.

4.8 Data presentation

Finally, the analyzed data was presented through graphical illustrations. These were in the form of tables, graphs, pie charts depending on how easily any of them could be employed and understood.

CHAPTER FIVE
RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents results and discussions of the study from the data collected from the questionnaires through frequency tables, percentages and graphs with clear interpretation of each research findings on the socio-economic effects of sand harvesting in river Thwake, Kathiani division, Machakos County, Kenya.

5.2 Presentation of the research findings

The researcher prepared and issued out 121 questionnaires to the respondents.

5.2.1 Response Rate

In the study out of 121 respondents who were interviewed 73.5% responded to the study while 26.5 % did not respond at all. This findings of the study shows that the study was well responded to with a good number of the sampled respondents participating in the study helped in collecting enough data on the socio-economic effects of sand harvesting in river Thwake ,Kathiani division.

5.2.2 Gender of the respondents

The study sought to establish the gender of the respondents as this was important in establishing whether the study was representative as possible as socio-economic activities affects both male and female.

Table 5.1 Gender of the respondents

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-----------|---------|---------------|--------------------|
| Valid | Female | 7 | 7.9 | 12.1 |
| | Male | 51 | 57.3 | 87.9 |
| Total | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.1 shows that 57.3% of the respondents who participated in the study were male, while 7.9% of the total respondents who participated in the study were female. The findings of the study show that the study was inclusive of the gender given that women affected most when their the negative effect on the economy and therefore their views were also incorporated in the study to establish the socio-economic effects that sand harvesting would have to the residents of Kathiani Division.

5.2.3 Number of children by the respondents

The study had also sought to establish the number of children that the sand harvesting families had for socio-economic analysis of the effects of sand harvesting would have on the quality of life on the family and the results are presented below.

Table 5.2 Number of children by the Respondents

| Number of children | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| 0-3 | 20 | 22.5 | 35.1 | 35.1 |
| 4-6 | 23 | 25.8 | 40.4 | 75.4 |
| Valid 7 and above | 14 | 15.7 | 24.6 | 100.0 |
| Total | 57 | 64.0 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.2 shows that 22.5% of the respondents families that participated in the study had between 0-3 children , 25.8 % of the families practicing sand harvesting around the area of the study had from between 4-6 children while 15.7% of the respondents families had from 7 and above children. It can be drawn from the study shows that the total number of children in a family would also highly affect the socio-economic effects that sand harvesting would have on the lives of these families.

5.2.4 Education level of the respondents

The study sought to establish the education level of the respondents and the results are presented below.

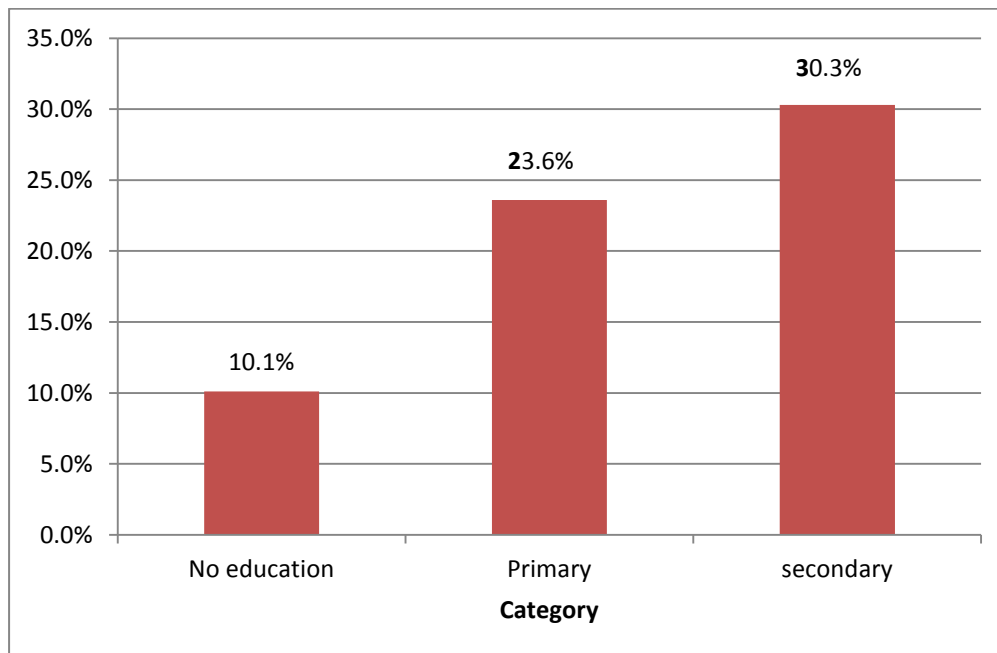


Figure 5.1 Education level of the respondents

Source: Field data, Jan (2015)

Figure 5.1 shows that 23.6 % of the respondents who participated in the study had gone up to primary level of education, 30.3% had gone up to secondary level while about 10.1% of the respondents who participated in the study had no education at all. The findings of the study shows that most of the people who engaged in sand harvesting had no proper education though they were in a position to respond to the question posed by the study and understood what was required of them.

5.2.5 Respondents who worked in the sand industry

The study sought to establish whether the respondents worked in the sand industry and the results are presented below.

Table 5.3 Respondents who worked in the sand industry

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|-----------|---------|---------------|--------------------|
| No | 1 | 1.1 | 1.7 | 1.7 |
| Valid Yes | 57 | 64.0 | 98.3 | 100.0 |
| Total | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.3 shows that 64 % of the respondents who worked in the sand industry while 1.1% of the respondents said that they did not work in the industry. The findings of the study show that most of the respondents worked in the industry and therefore were aware of what was happening in the sand harvesting industry.

5.2.6 Occupation in the sand harvesting industry

The study sought to establish the occupation of the respondents in the sand harvesting industry and the results are presented below.

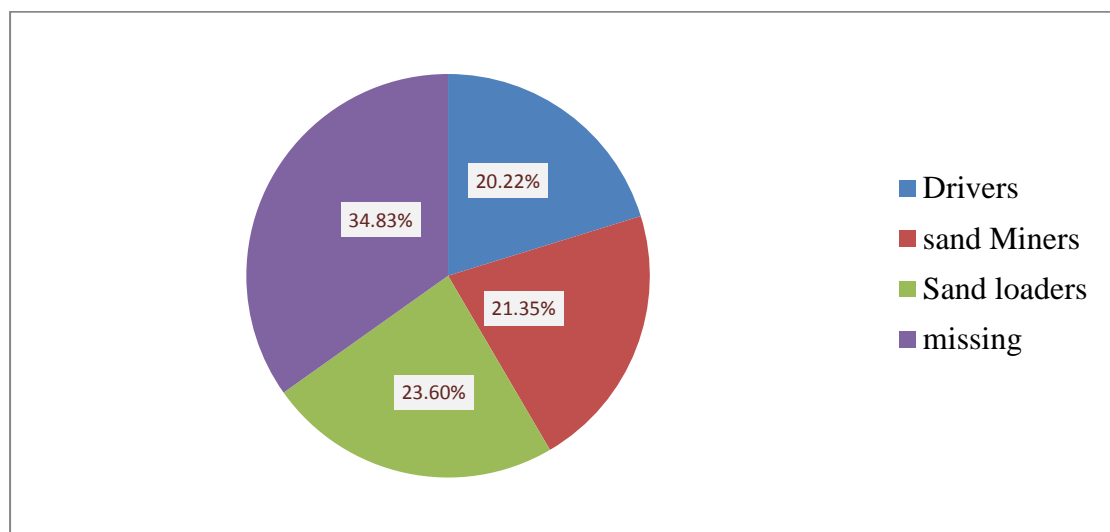


Figure 5.2 Occupation in the sand harvesting industry

Source: Field data, Jan (2015)

Figure 5.2 shows that 20.2 % of the respondents worked as drivers, 21.3 % of the respondents who participated in the study were sand miners 23.6 % were sand loaders working in the industry. The study shows that all the categories in the sand industry were well represented in the study and therefore the findings were as representative as possible. Sand harvesting as an activity involves many stakeholders from harvesting to the users and includes prospecting, extracting, refining and transporting involves a variety of stakeholders from the point of harvesting through transportation to the middle men and finally to the users though it affects the socio-economic lives of the people who deal in such activities (Macharia, 2004).

5.2.7 Living conditions of the respondents

The study sought to establish number of animals the respondents had and the results are presented below.

Table 5.4 Number of animals per household

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------------------|-----------|---------|---------------|--------------------|
| Valid Goats/sheep | 4 | 4.5 | 6.9 | 6.9 |
| Bulls | 44 | 49.4 | 75.9 | 82.8 |
| Cows | 10 | 11.2 | 17.2 | 100.0 |
| Total | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.4 shows that 4.5% of the respondents had goats and sheep, 49.4% of the respondents had bulls.11.2% of the respondents had cows that would give milk. The findings of the study show that some of the respondents who had participated in the study and were occupied with sand harvesting had gained from the activity from the time they started. Many of the respondents attested that they had more animals than before family joined the sand harvesting activity.

The study found out that sand harvesting has created employment and offered income to most of the residents in the area. Sand being a natural resource is able to bring economic benefits to the people who reside in places where these natural resources are found. It is the way they are used that they are able to benefit people who reside where they come from as observed by Hunker (1964) that natural resources are out there regardless, of whether or not human beings choose to use them to improve their lives. They are “neutral stuff” that makes up the world, but they become resources when we find utility in them. People living in a particular area should be able to benefit from the natural resources that are found in a particular area as agreed by Naveen (2012) that the human species is part of nature and should therefore participate effectively and gain from it.

The study also sought to establish the assets that the respondents had bought since joining the sand harvesting and the results are presented below.

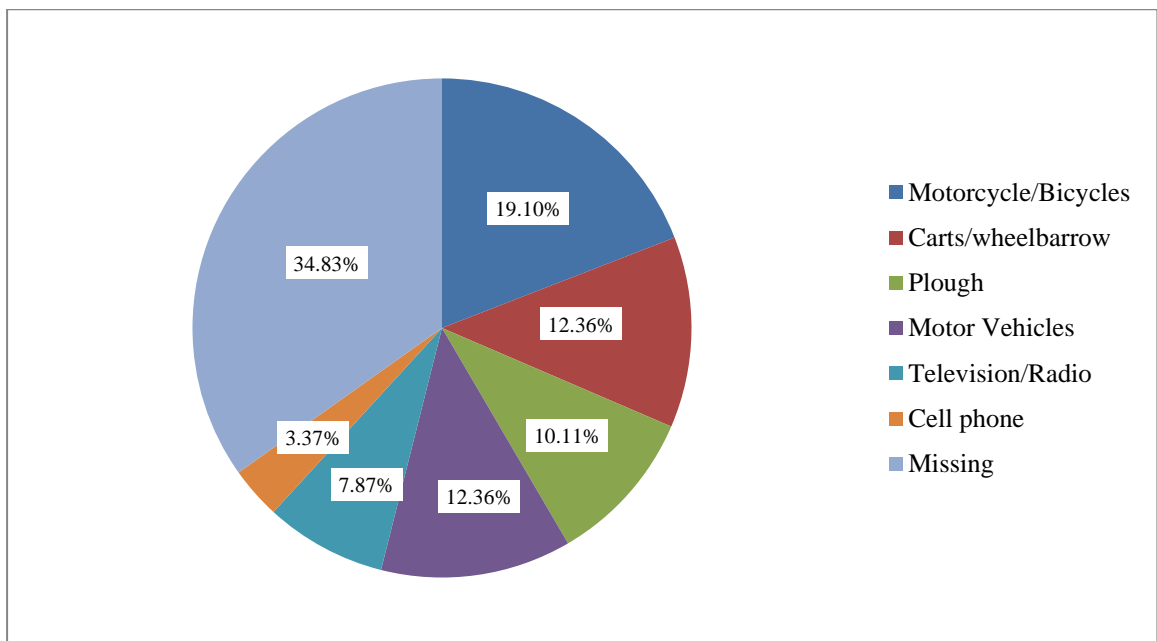


Figure 5.3 Assets that the respondents had bought since joining the sand harvesting
Source: Field data, Jan (2015)

Figure 5.3 shows that 19.1 % of the respondents had bought Motorcycles, 12.4% of the respondents had bought Bicycles, Carts, wheelbarrow to help them in the farm and to travel from one place to another with some of them using the bicycles as boda boda to make more money, 10.1% of the respondents had bought Plough to use in their farms and improve crop production. The findings of the study shows that 3.4% of the

respondents had bought Motor vehicles while 7.9% having bought Television and Radios to watch and listen at home. Finally in this part the findings of the study that 12.4% of the respondents had bought Cell phones. The people engaged in sand harvesting have been able to improve their social income level and are now able to purchase basic electronic goods that are required and to some extent reflect the social economic status of an individual all over the world as agreed by Mensah (2002) that the harvesting of sand and gravel in Ghana has created job for youths.

The study sought to establish whether the family eats better than before the family started harvesting of sand and the results are presented below:

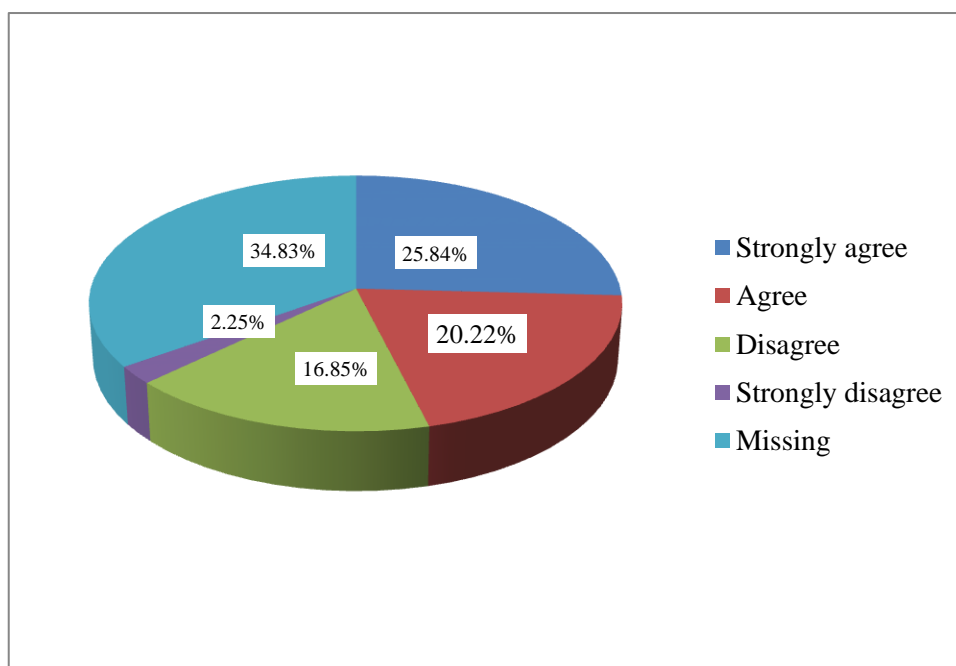


Figure 5.4 Family eats better than before the family started harvesting of sand

Source: Field data, Jan (2015)

Figure 5.4 shows that 25.8% of the respondents strongly agree that the family eats better than before the family started harvesting of sand, 20.2% of the respondents agree that the family eats better than before the family started harvesting of sand while 16.9% of the respondents disagreeing that the family eats better than before the family started harvesting of sand with another 3.4% of the respondents strongly disagreeing that the family eats better than before the family started harvesting of sand. Sand harvesting just like any other economic activity is able to improve the lives of residents in a particular area. Nguru (2008) sand harvesting is an economic activity

that can help empower and improve the people’s living conditions in areas where the activity is done. He further states that social scientists believe that real development lies in the economic empowerment of people and especially at family level.

The study wanted to establish whether the family eats a balanced diet since they engaged in sand harvesting and the results are presented below.

Table 5.5 Family eats a balanced diet since they engaged in sand harvesting.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------------------|-----------|---------|---------------|--------------------|
| Valid | Strongly Agreed | 24 | 27.0 | 41.4 | 41.4 |
| | Agreed | 22 | 24.7 | 37.9 | 79.3 |
| | Disagree | 8 | 9.0 | 13.8 | 93.1 |
| | Strongly disagree | 4 | 4.5 | 6.9 | 100.0 |
| Total | | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.5 shows that 27% of the respondents strongly agreed that the family eats a balanced diet since they engaged in sand harvesting, 24.7% of the respondents agreed that that the family eats a balanced diet since they engaged in sand harvesting with 9% of the respondents disagreeing that that the family eats a balanced diet since they engaged in sand harvesting while 4.5 % of the respondents Strongly disagree that the family eats a balanced diet since they engaged in sand harvesting. Given that the families are able to get some money from sand activities the family is able to buy balanced diet and eat better than they used to before they started the activity.

5.2.8 Health of residents since they started sand harvesting activities

The study had sought to establish whether the people in the area are healthier since the starting of harvesting activities and the results are presented below.

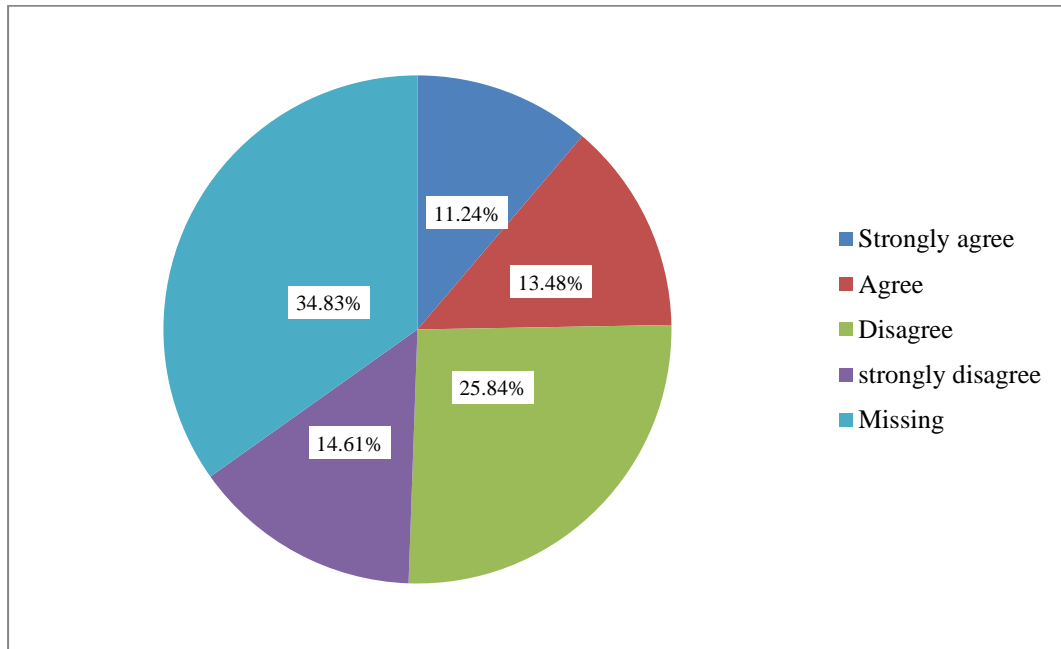


Figure 5.5 people in the area are healthier since they started sand harvesting activities.

Source: Field data, Jan (2015)

Figure 5.5 shows that 11.2 % of the respondents strongly agree that the people in the area are more healthy since they started sand harvesting activities, 13.5% of the respondents agree that people in the area are more healthy since they started harvesting activities while 25.8 % of the respondents disagree that the people in the area are more healthy since they started sand harvesting activities while another 14.6 % strongly disagree that people in the area are more healthy since they started harvesting activities. Better healthy depend on whether one is able to afford better health services. As much as the people are engaged in sand harvesting activities the money they get cannot let them afford better health services though according to Deller and Schreiber (2012) found out that communities that are more heavily dependent on sand harvesting for employment tend to experience greater negative impacts after the mines close than positive impacts while the mines are in operation including the inability to afford basic health requirements.

5.2.9 Employment opportunities

The study wanted to establish whether most of the family members are now occupied since they started sand harvesting in the area and the results are presented below.

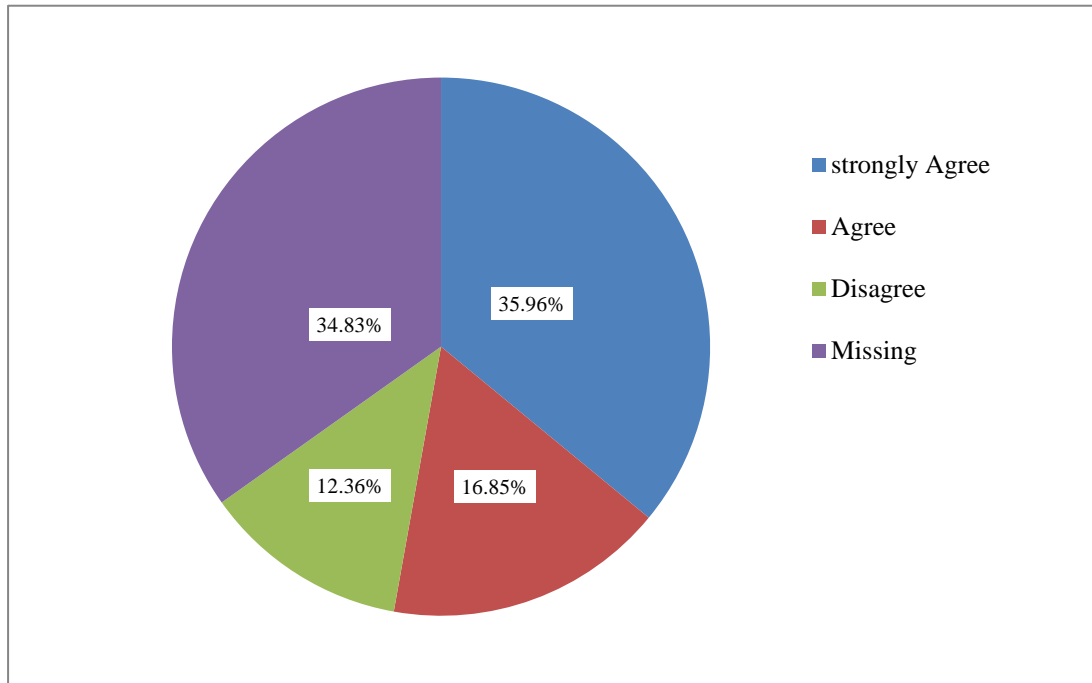


Figure 5.6 Family members are now occupied since they started of sand harvesting in the area.

Source: Field data, Jan (2015)

Figure 5.6 shows that 36 % of the respondents who were interviewed strongly agree that most of the family members are now occupied since they started sand harvesting in the area, 16.9 % agreed that most of the family members are now occupied since they started sand harvesting in the area with another 12.4 % disagreed that most of the family members are now occupied since they started sand harvesting. Sand harvesting has created employment for the people in Kathiani and many are now occupied in the activity.

5.2.10 Income and expenditure

The study sought to establish whether the family earnings have gone up since the start of sand harvesting in the area and the results are presented below:

Table 5.6 Family earnings have gone up since the start of sand harvesting in the area

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------------|-----------|---------|---------------|--------------------|
| Valid | | | | |
| Strongly agreed | 28 | 31.5 | 49.1 | 49.1 |
| Agree | 19 | 21.3 | 33.3 | 82.5 |
| Disagree | 10 | 11.2 | 17.5 | 100.0 |
| Total | 57 | 64.0 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.6 shows that 31.5% of the respondents strongly agree that family earnings have gone up since the start of sand harvesting in the area, 21.3 % agreeing that family earnings have gone up since the start of sand harvesting in the area while 11.2% of the respondents disagreeing that family earnings have gone up since the start of sand harvesting in the area. Sand harvesting have raised the families income and they are able to earn more money than before they started the sand harvesting activities in the area given that the revenue as admitted by Mensah (2002) that is used in most part to meet basic needs of the family including food, to pay tuition for children.

The study sought to establish the family income and expenditure since the start of sand harvesting in the area and the results are presented below.

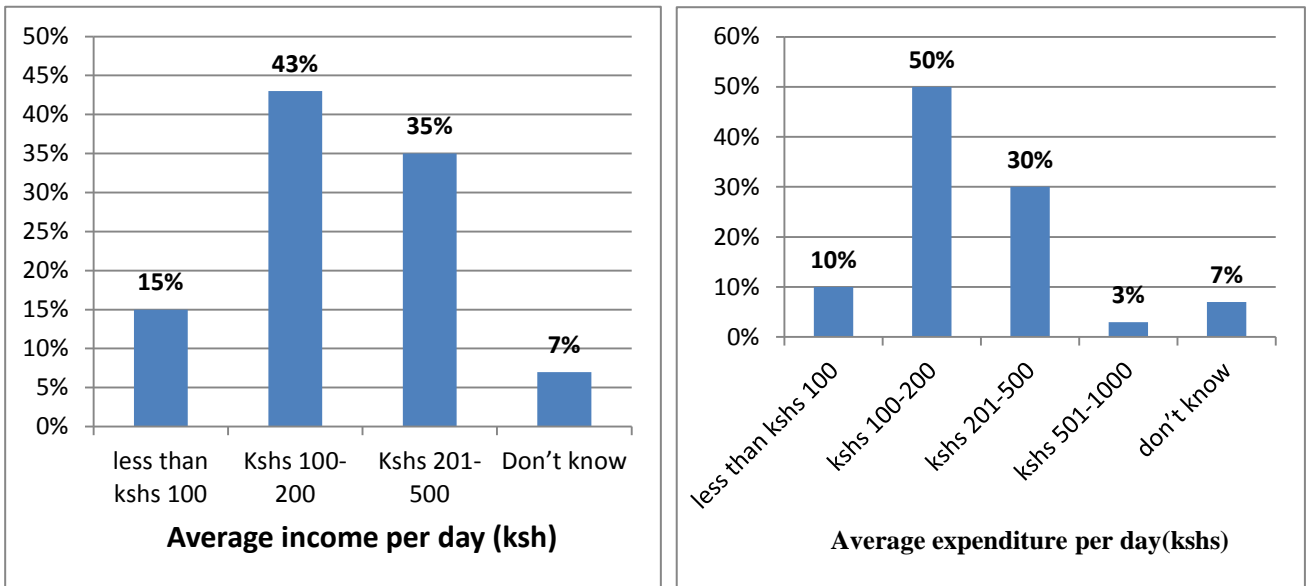


Figure 5.7 Income and expenditure

Source: Field data, Jan (2015)

Figure 5.7 shows that daily income and expenditure pattern depicted a relatively deprived community, with the highest percentage of respondents (43 %) earning between Kshs 100-200 and the highest percentage of respondents (50%) spending between Kshs 100-200 per day, This implies that most earners, spend almost all their income earned per day and therefore less savings.

The study sought to establish whether the people in the area are able to start new businesses from the sand harvesting earnings.

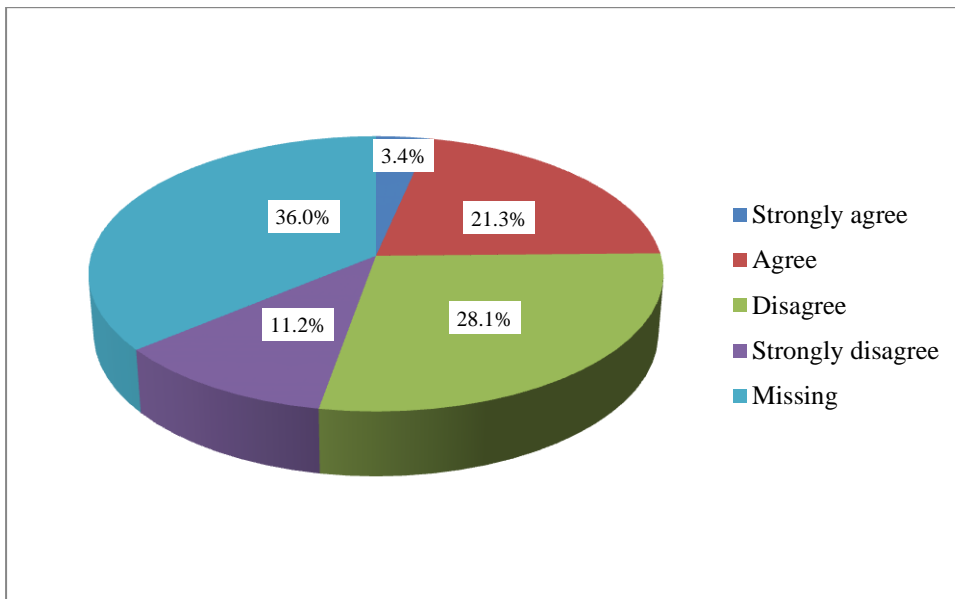


Figure 5.8 People in the area are able to start new business from the sand harvesting earnings.

Source: Field data, Jan (2015)

Figure 5.8 shows that 3.4 % of the respondents strongly agree that the people in the area are able to start new businesses from the sand harvesting earnings since the start of sand harvesting in the area ,21.3% agreeing that the people in the area are able to start new businesses from the sand harvesting earnings since the start of sand harvesting in the area while 28.1% of the respondent disagreeing that the people in the area are able to start new businesses from the sand harvesting earnings with another 11.2% strongly disagreeing that the people in the area are able to start new businesses from the sand harvesting earnings. The findings of the study show that people in the area are able to start new businesses from the sand harvesting earnings. Residents are investing the money they get from sand harvesting in small business enterprises.

5.2.11 The youth are engaged

The study sought to establish whether sand harvesting activities have engaged the youth in the area and the results are presented below.

Table 5.7 Sand harvesting has engaged the youth in the area

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------------------|-----------|---------|---------------|--------------------|
| Strongly Agree | 20 | 22.5 | 34.5 | 34.5 |
| Agree | 23 | 25.8 | 39.7 | 74.1 |
| Valid disagree | 8 | 9.0 | 13.8 | 87.9 |
| Strongly Disagree | 7 | 7.9 | 12.1 | 100.0 |
| Total | 58 | 65.2 | 100.0 | |

Source: Field Data, Jan (2015)

Table 5.7 shows that 22.5 % of the respondents strongly agree that sand harvesting has engaged the youth in the area since the start of sand harvesting in the area, 25.8% agreeing that sand harvesting has engaged the youth in the area since the start of Sand harvesting in the area while 9% of the respondent disagreeing that sand harvesting has engaged the youth in the area with another 7.9% strongly disagreeing that sand harvesting has engaged the youth in the area. Sand harvesting has engaged the youth in the area and now many of them are now occupied by the activity (Appendix VII).

5.2.12 Family fall sick less often after joining the sand harvesting activities

The study had also sought to establish whether the family fall sick less often after joining the sand harvesting activities and the results are present below.

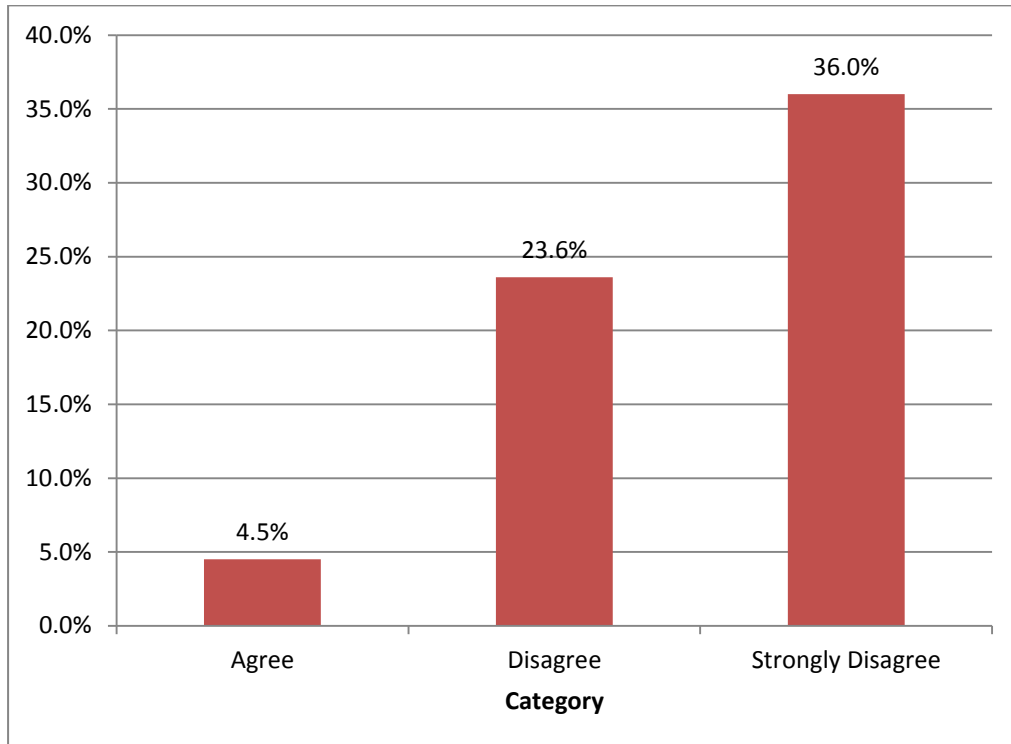


Figure 5.9 Families fall sick less often after joining the sand harvesting activities

Source: Field data, Jan (2015)

Figure 5.9 shows that 4.5 % of the respondents agree that the family fall sick less often after joining the sand harvesting activities, 23.8% of the respondents disagreed that the family fall sick less often after joining the sand harvesting activities while 36.0% of the respondent strongly disagreeing that the family fall sick less often after joining the sand harvesting activities. This shows that there is relationship between sand harvesting and sickness of the family. This is because the sand miners and sand loaders spend a lot of time in water doing the activities thus they are prone to diseases like malaria, bilharzias, and skin diseases.

5.2.13 Accessibility of better health services

The study sought to establish whether the family can afford better medical services after joining the sand harvesting activities and the results are presented below.

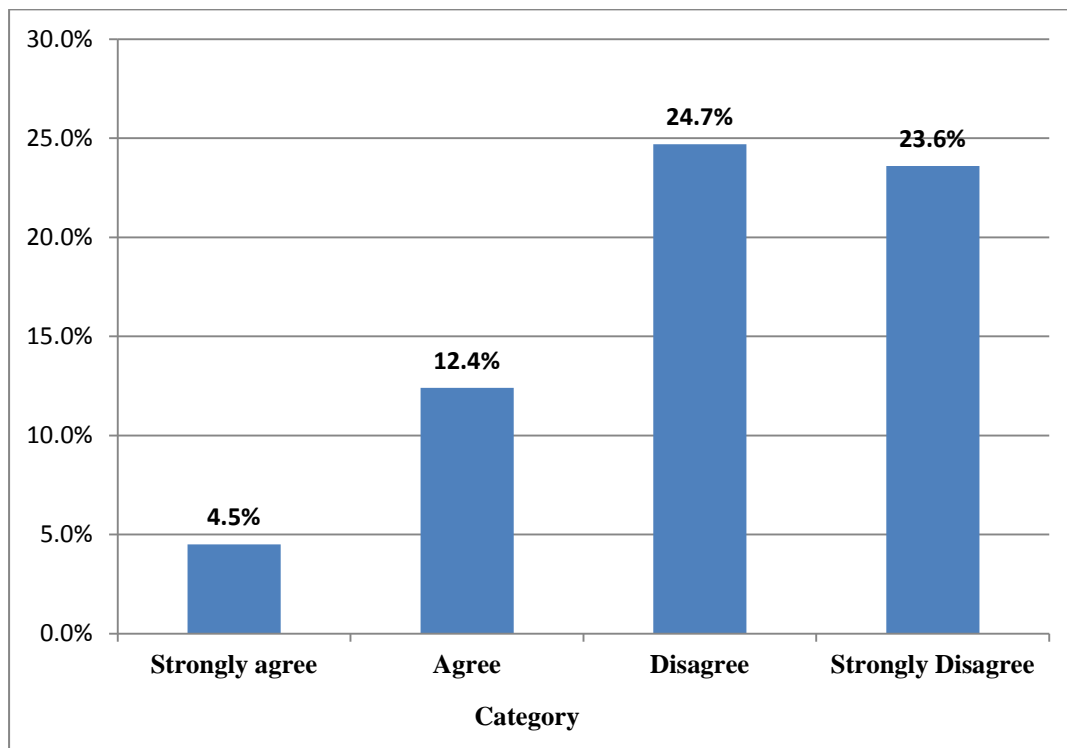


Figure 5.10 Family can afford better medical services

Source: Field data, Jan (2015)

Figure 5.10 shows that 4.5 % of the respondents strongly agree that he family can afford better medical services after joining the sand harvesting activities,12.4% agreeing that he family can afford better medical services after joining the sand harvesting activities while 24.7% of the respondent disagreeing that he family can afford better medical services after joining the sand harvesting activities with another 23.6 % strongly disagreeing that he family can afford better medical services after joining the sand harvesting activities.

The study sought to establish whether the family members go to private hospitals after joining the sand harvesting activities and the results are presented below.

Table 5.8 Family members go to private hospitals after joining the sand harvesting.

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------------------|---------|---------------|--------------------|
| Valid | Disagree | 29 | 32.6 | 50.0 |
| | Strongly disagree | 29 | 32.6 | 100.0 |
| Total | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.8 shows that 32.6 % of the respondents disagreed that that the family members go to private hospitals after joining the sand harvesting activities and 32.6% strongly disagreed that the family members go to private hospitals after joining the sand harvesting activities. The earnings that the people get from harvesting sand cannot help them afford private medical services though they are engaged in the activities.

The study had sought to establish whether the family can afford a medical cover after joining the sand harvesting activities and the results are presented below.

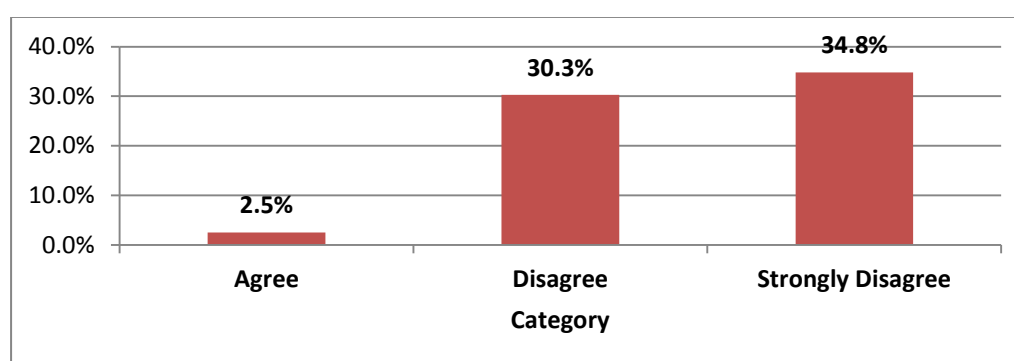


Figure 5.11 Family can afford medical cover after joining sand harvesting activities

Source: Field data, Jan (2015)

Figure 5.11 shows that 2.5 % of the respondents agree that they can afford medical cover after joining sand harvesting activities, 30.3 % of the respondents disagree that the family can afford a medical cover after joining the sand harvesting activities, 34.8% strongly agree that the family can afford a medical cover after joining the sand harvesting activities. The findings show that earnings that the people get from sand harvesting cannot help them afford private medical services though they are engaging in sand harvesting activities.

5.2.14 Education of the children

The study had sought to establish whether the children go to better schools after joining the sand harvesting activities and the results are presented below.

Table 5.9 Children go to better schools after joining the sand harvesting activities

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------------------------|-----------|---------|---------------|--------------------|
| Valid Strongly agree | 6 | 6.7 | 10.3 | 10.3 |
| Valid Agree | 22 | 24.7 | 37.9 | 48.3 |
| Valid Disagree | 15 | 16.9 | 25.9 | 74.1 |
| Valid Strongly disagree | 15 | 16.9 | 25.9 | 100.0 |
| Total | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.9 shows that 6.7 % of the respondents strongly agree that the children go to better schools after joining the sand harvesting activities, 24.7% agreeing that the children go to better schools after joining the sand harvesting activities while 16.9% of the respondent disagreeing or strongly disagreeing that the children go to better schools after joining the sand harvesting activities. The findings of the study shows that the families are engaged in sand harvesting the children go to better schools than before and therefore in terms of children's education the sand harvesting activities have improved the sector.

The study sought to determine whether the family can afford text books and learning materials for the children and the results are presented below.

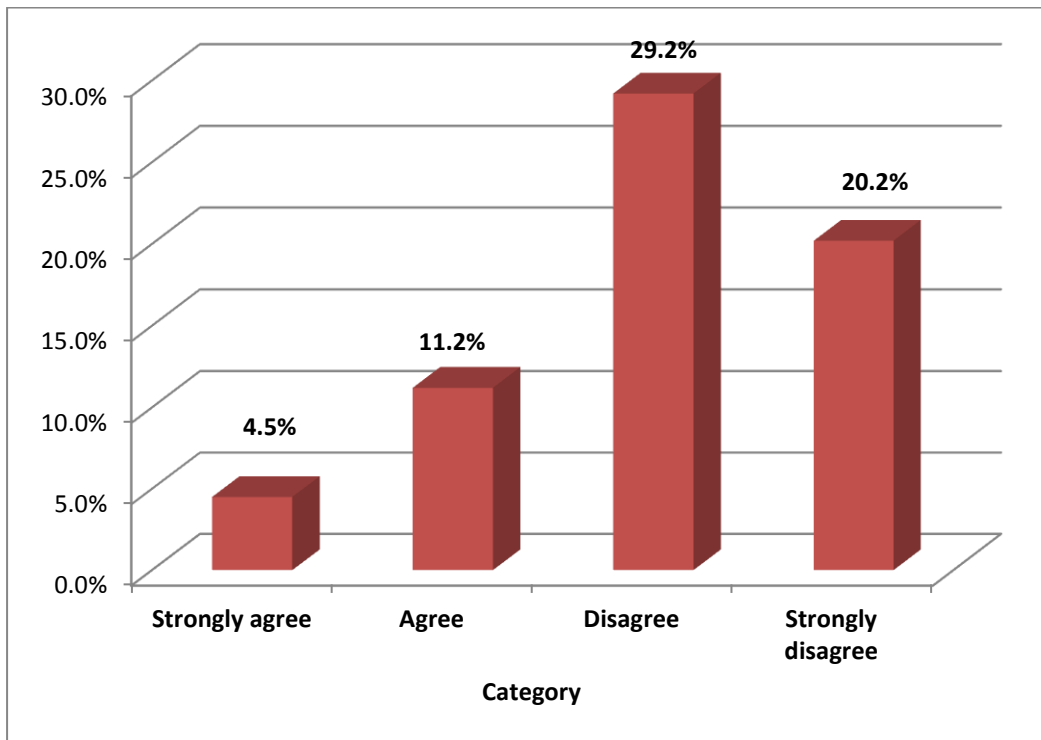


Figure 5.12 Family can afford text books and learning materials for the children
Source: Field data, Jan (2015)

Figure 5.12 shows that 4.5 % of the respondents strongly agree that he family can afford text books and learning materials for the children, 11.2% agreeing that he family can afford text books and learning materials for the children while 29.2% of the respondent disagreeing that the family can afford text books and learning materials for the children with another 20.2 % strongly disagreeing that the family can afford text books and learning materials for the children. The findings of the study show that even though the families are engaged in sand harvesting activities they are not able to afford the required learning materials for their children.

The study sought to establish whether the family can afford tuition for the children and the response was as follows:

Table 5.10 Family can afford tuition for the children

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------------------|---------|---------------|--------------------|
| Valid | Strongly agree | 27 | 30.3 | 46.6 |
| | Agree | 3 | 3.4 | 51.8 |
| | Disagree | 4 | 4.5 | 58.7 |
| | Strongly disagree | 24 | 27.0 | 100.0 |
| Total | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.10 shows that 30.3 % of the respondents strongly agree that the family can afford tuition for the children, 3.4% agreeing that the family can afford tuition for the children while 4.5% of the respondent disagreeing that the family can afford tuition for the children with another 27.0 % strongly disagreeing that the family can afford tuition for the children. The study shows that to some extent the families are able to afford tuition for their children.

5.2.15 Performance of children after joining sand harvesting

The study sought to establish whether the children perform better in school after joining the sand harvesting activities and the results are presented below.

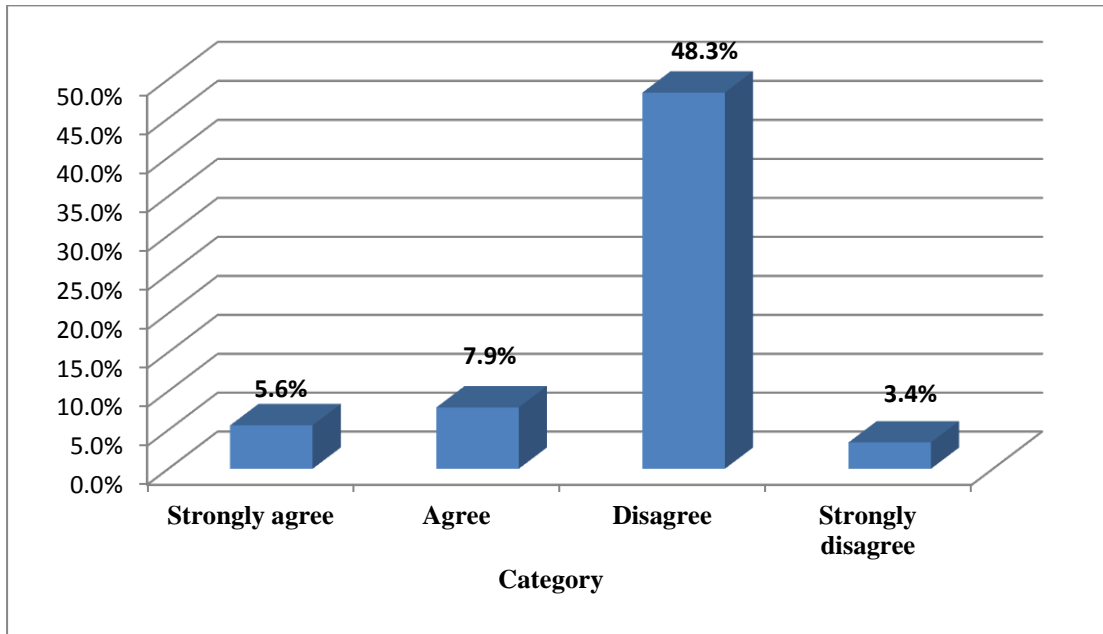


Figure 5.13 Performance of children after joining the sand harvesting

Source: Field data, Jan (2015)

Figure 5.13 shows that 5.6 % of the respondents strongly agree that the children perform better in school after joining the sand harvesting activities, 7.9% agreeing that the children perform better in school after joining the sand harvesting activities while 48.3% of the respondent disagreeing that the children perform better in school after joining the sand harvesting activities with another 3.4 % strongly disagreeing that the children perform better in school after joining the sand harvesting activities. The study shows that sand harvesting has no relation to better performance on children in the area that means students' performance deteriorate when they engage in sand harvesting.

5.2.16 Socio-economic challenges

The study had sought to establish whether farming has been affected by sand harvesting in the area and the results are presented below:

Table 5.11 Farming has been affected by sand harvesting in the area

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-----|-----------|---------|---------------|--------------------|
| Valid | No | 23 | 25.8 | 39.7 | 39.7 |
| | Yes | 35 | 39.3 | 60.3 | 100.0 |
| Total | | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.11 shows that 25.8% of the respondents farming has been affected by sand harvesting in the area while 39.3 % of the respondents felt that farming has not been affected by sand harvesting in the area. The findings show that sand harvesting has affected them in many ways given that sand harvesting is not controlled. Farmers experienced challenges like their crops were destroyed by Lorries and the land were degraded (Appendix VIII). Once the Lorries pass through the farmer's farms they are given Ksh.100 for compensation which is very low.

The study had sought to establish whether sand harvesting contributed to environmental degradation in the area and the results are presented below:

Table 5.12 Contribution of sand harvesting to environmental degradation

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-----|-----------|---------|---------------|--------------------|
| Valid | Yes | 45 | 50.6 | 77.6 | 77.6 |
| | No | 13 | 14.6 | 22.4 | 100.0 |
| Total | | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.12 shows that 50.6% of the respondents attested that sand harvesting contributed to environmental degradation, while 14.6% felt that sand harvesting does not contribute to environmental degradation. The reason was that sand harvesting was uncontrolled and scooping took place in the river banks that caused a lot of soil erosion (Appendix IX). This is in line with Mensah(2002) in his study in Ghana found out that the main effects of uncontrolled sand harvesting included loss of land (19.2 per cent),destruction of beach(18.2 percent),destruction of road 16.5 percent and loss of vegetation (12.2 percent)(Appendix VI).

The study sought to establish whether sand harvesting as an economic activity contributed to social ill (drug abuse) among the youth in the area and the results are presented below.

Table 5.13 Contribution of sand harvesting to drug abuse

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-----|-----------|---------|---------------|--------------------|
| Valid | yes | 50 | 56.2 | 86.2 | 86.2 |
| | No | 8 | 9.0 | 13.8 | 100.0 |
| Total | | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.13 shows that 56.2% of the respondents attested that sand harvesting contributed to social ill such as drug abuse by young loaders while 9.0 % don't support. Drug abuse in the area is attributed to prolonged interaction of the young pupils and adults who are in the sand harvesting industry.

The study sought to establish whether sand harvesting as an economic activity has contributed to school dropout among the youth in the area and the results are presented below.

Table 5.14 School dropout in the area among the youths

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-----|-----------|---------|---------------|--------------------|
| Valid | Yes | 26 | 29.2 | 44.8 | 44.8 |
| | No | 32 | 36.0 | 55.2 | 100.0 |
| Total | | 58 | 65.2 | 100.0 | |

Source: Field data, Jan (2015)

Table 5.14 shows that 29.2 % of the respondents attested that sand harvesting contributed to school dropout in Kathiani division, while 36.0 % felt sand harvesting does not contribute to school dropout. The findings are in agreement with Mutiso (2012) on a study on education in Kathiani found out that pupils tend to drop out starting at standard six and reach a peak at standard seven just before getting to their final year of the primary school cycle, at standard eight level. This is because they are attracted by the sand harvesting activities quite prevalent in the study locale to make a few coins.

5.3 Summary of findings on the unstructured responses

The study sought to establish what the sand miners earn per day and the study found out that the sand miners earned between Ksh 2500 to Ksh 3500 per lorry depending on demand and whether the sand is available in the river. On how much drivers earned per lorry the study established that the drivers earned from between Ksh 300 to Ksh 500 depending on the distance that the lorry had to cover. There was no definite answer on how much the sand loaders earned on a single day as these depended on whether there was sand to be transported but the respondents said that they are given Ksh 200 to share among themselves per lorry. This is because during rainy season the sand increases in the river bed and decrease with high magnitude during dry season.

The study had sought from the respondents on what are the socio-economic challenges that are posed by sand harvesting in the area. The findings of the study shows that most of the respondents felt that as much as sand harvesting was a good economic activity though it faced a number of socio-economic challenges for example; underpayment of loaders, increase in the number of middle men, low sand prices and exploitation by transporters, reduction of sand quantity during dry season, temporary bans by NEMA, Provincial administration, politicians and councils (Appendix V).

5.4. Hypotheses testing

The study used chi-square to test the research null hypotheses because the study required the test of independence of variables in order answer relevant questions. Under chi-square, if the calculated value is larger or equal to α (0.05) then reject null hypothesis (H_0) then accept the alternative hypothesis (H_A). The chi-square was calculated using the following equation.

$$\chi^2 = \sum \frac{(\text{observed} - \text{expected})^2}{\text{Expected}}$$

5.4.1 Hypothesis one

H₀: There is no significant relationship between sand harvesting and job creation in Kathiani Division. The result is presented below:

Table 5.15 Family earnings have gone up since the start of sand harvesting

| | Observed N | Expected N |
|----------------|------------|------------|
| Strongly agree | 28 | 19.7 |
| Agree | 19 | 19.7 |
| Disagree | 12 | 19.7 |
| Total | 59 | |

Test Statistics

| | | | Family earnings have gone up since the start of sand harvesting |
|------------------|----------------|-------------|---|
| Chi-Square | | | 6.542 ^a |
| df | | | 2 |
| Asymp. Sig. | | | .038 |
| Monte Carlo Sig. | | | .033 ^b |
| Sig. | 95% Confidence | Lower Bound | .000 |
| | Interval | Upper Bound | .079 |

Source: Field data, Jan (2015)

The calculated Chi-square (χ^2) is 6.5421 while the critical value at 0.05 significance level is 5.991, hence null hypothesis is rejected. That is, there is statistically significant relationship between sand harvesting activities and job creation among the people living in Kathiani Division.

5.4.2 Hypothesis two

Ho: There is no significant relationship between sand harvesting and improved living conditions among people living in Kathiani Division.

Table:5.16 Results on improved living conditions

| | Observed N | Expected N |
|-------------------|------------|------------|
| Strongly Agree | 22 | 14.5 |
| Agree | 18 | 14.5 |
| Disagree | 14 | 14.5 |
| Strongly disagree | 4 | 14.5 |
| Total | 58 | |

Test Statistics

| | | | Family eats better than before sand harvesting |
|------------------|-------------------------|-------------|--|
| Chi-Square | | | 12.345 ^a |
| df | | | 3 |
| Asymp. Sig. | | | .006 |
| Monte Carlo Sig. | | | .008 ^b |
| Sig. | 95% Confidence Interval | Lower Bound | .002 |
| | | Upper Bound | .014 |

Source: Field data, Jan (2015)

The calculated Chi-square (χ^2) is 12.345 while the critical value at 0.05 significance level is 7.82 hence null hypotheses is rejected. That is, there is statistically significant relationship between sand harvesting activities and improved living conditions among the people living in Kathiani Division.

5.4.3 Hypothesis three

H₀: There is no significant relationship between sand harvesting activities and better education among people living in Kathiani Division.

Table 5.17 Results on affordability of tuition for the children

| | Observed N | Expected N |
|-------------------|------------|------------|
| Strongly agree | 27 | 14.5 |
| Agree | 3 | 14.5 |
| Disagree | 4 | 14.5 |
| Strongly disagree | 24 | 14.5 |
| Total | 58 | |

Test Statistics

| Family can afford tuition for the children | |
|--|---------------------|
| Chi-Square | 33.724 ^a |
| df | 3 |
| Asymp. Sig. | .000 |

Source: Field data, Jan (2015)

The calculated Chi-square (χ^2) is 33.724 while the critical value at 0.05 significance level is 7.815, hence null hypothesis is rejected. That is, there is statistically significant relationship between sand harvesting activities and quality of education among the people living in Kathiani Division.

5.4.4 Hypothesis four

H₀: There is no significant relationship between sand harvesting activities and better health services among people living in Kathiani Division.

Table 5.18 Results on better medical services

| | Observed N | Expected N |
|-------------------|------------|------------|
| Strongly agree | 4 | 14.5 |
| Agree | 11 | 14.5 |
| Disagree | 22 | 14.5 |
| strongly disagree | 21 | 14.5 |
| Total | 58 | |

| Test Statistics | |
|---|---------------------|
| Family members can afford better medical services after joining sand harvesting | |
| Chi-Square | 15.241 ^a |
| df | 3 |
| Asymp. Sig. | .002 |

Source: Field data, Jan (2015)

The calculated Chi-square (χ^2) is 15.241 while the critical value at 0.05 significance level is 7.815, hence null hypothesis is rejected. That is, there is statistically significant relationship between sand harvesting activities and accessibility of better health services among the people living in Kathiani Division.

From the findings, the study found out that sand harvesting activities have affected the socio- economic lives of the residents of Kathiani Division. Their job opportunities in the area, the residents have improved living conditions than before sand harvesting, children have better education and finally residents can now access better health services.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter contains the summary of findings obtained from respondents, conclusions made and recommendations on the socio-economic effects of sand harvesting in river Thwake, Machakos County, Kathiani division, Kenya

6.2 Summary of the findings

The study shows that 20.2 % of the respondents worked as drivers, 21.3 % of the respondents who participated in the study were sand miners 23.6 % were sand loaders working in the industry. The study shows that all the categories in the sand industry were well represented in the study and therefore the findings were as representative as possible.

The study also shows that 36 % of the respondents who participated in the study strongly agree that most of the family members are now occupied since they started sand harvesting in the area, 16.9 % agreed that most of the family members are now occupied since they started sand harvesting in the area with another 12.4 % disagreed that most of the family members are now occupied since they started sand harvesting.

The findings of the study shows that 3.4 % of the respondents strongly agree that the people in the area are able to start new businesses from the sand harvesting earnings since the start of sand harvesting in the area ,21.3 % agreeing that the people in the area are able to start new businesses from the sand harvesting earnings since the start of sand harvesting in the area while 28.1% of the respondent disagreeing that the people in the area are able to start new businesses from the sand harvesting earnings with another 11.2% strongly disagreeing that the people in the area are able to start new businesses from the sand harvesting earnings.

The finding of the study shows that 11.2 % of the respondents strongly agree that the respondents in the area are more healthy since the starting of harvesting activities,13.5% of the respondents agree that residents are healthy since they started sand harvesting activities while 25.8 % of the respondents disagree that in the area residents are healthy since they started sand harvesting activities while another 14.6 %

strongly disagree that in the area residents are healthy since they started sand harvesting activities.

The study also shows that 25.8 % of the respondents agreed that the family can afford quality food nowadays, 9.0 % of the respondents disagreed that the family can afford quality food nowadays with only 4.5% the respondents strongly disagreed that the family of the respondents who are involved in sand harvesting can afford quality food nowadays.

The findings of the study shows that 4.5 % of the respondents strongly agree that the family can afford text books and learning equipment for the children, 11.2% agreeing that he family can afford text books and learning equipment for the children while 29.2% of the respondents disagreeing that the family can afford text books and learning equipment for the children with another 20.2 % strongly disagreeing that the family can afford text books and learning equipment for the children.

The findings of the study shows that 4.5 % of the respondents strongly agree that the family can afford tuition for the children, 3.4% agreeing that the family can afford tuition for the children while 30.3% of the respondent disagreeing that the family can afford tuition for the children with another 27.0 % strongly disagreeing that the family can afford tuition for the children.

The findings of the study shows that 5.6 % of the respondents strongly agree that the children perform better in school after joining the sand harvesting activities,7.9% agreeing that the children perform better in school after joining the sand harvesting activities while 48.3% of the respondent disagreeing that the children perform better in school after joining the sand harvesting activities with another 3.4 % strongly disagreeing that the children perform better in school after joining the sand harvesting activities.

The findings of the study shows that 5.6 % of the respondents strongly agree that the family can access better medical Services after joining the sand harvesting activities,18% agreeing that the family can access better medical Services after joining the sand harvesting activities while 28.1% of the respondent disagreeing that the family can access better medical services after joining the sand harvesting

activities with another 13.5 % strongly disagreeing that the family can access better medical services after joining the sand harvesting activities.

The findings of the study shows that 4.5 % of the respondents strongly agree that the family can afford better medical services after joining the sand harvesting activities,12.4% agreeing that the family can afford better medical services after joining the sand harvesting activities while 24.7% of the respondent disagreeing that the family can afford better medical services after joining the sand harvesting activities with another 23.6 % strongly disagreeing that the family can afford better medical services after joining the sand harvesting activities.

The findings of the study shows that 30.3 % of the respondents disagree that the family can afford a medical cover after joining the sand harvesting activities,34.8% strongly agree that the family can afford a medical cover after joining the sand harvesting activities.

The findings of the study shows that 25.8% of the respondents farming had been affected by sand harvesting in the area while 39.3 % of the respondents felt that farming had not been affected by sand harvesting in the area. The respondents said that sand harvesting had also contributed to soil erosion especially around the river banks. They were also concerned that many of the residents of Kathiani were engaged in sand harvesting at the expense of crop farming. They were of the opinion that the concerned authorities should take precaution on what best should be done to ensure that the river banks are well protected.

6.3 Conclusions

Sand harvesting has socio-economic effects in Kathiani division given that some of the family members are now occupied since they started sand harvesting in the area. The study shows that these earnings are invested in the other business given people in the area are able to start new businesses from the sand harvesting earnings. A good number of the respondents feel that the families of the people who are engaged in sand harvesting can now afford quality food nowadays. On the part of education although the people are more occupied a big number of the respondents feel that still the families cannot afford text books and learning materials for the children and are not able to take their children to better school or even pay for them tuition on holidays and weekends.

The findings of the study also shows that even as the people are more engaged in sand harvesting their families cannot access better medical services after joining the sand harvesting activities. The findings of the study also shows that the earnings from sand harvesting cannot afford them a good medical cover and that when they fall sick they cannot afford proper medical services from a private facility. It can be drawn from the study that sand harvesting has very little positive effects on the socio-economic lives of the people of Kathiani.

6.4 Recommendations

1. There is need for the authorities to develop ways that can ensure that the people of Kathiani benefit from the sand harvesting that takes place in the area. There is also need for cooperative societies to be started in order to ensure that the sand miners are able to negotiate for better prices from the sand mine. The government should come up with policies that can eradicate the middle men who exploit the residents and sell the sand for higher prices to contractors from the city and road construction companies that are doing the super highways.
2. The local authority should initiate the creation of industries to pack sand which will then be sold in hardware stores like cement. This will make sand harvesters gain more benefits from the activities.
3. Given that sand harvesting can lead to soil erosion and degradation there is need for the concerned authorities such as NEMA to enforce sand harvesting policies that can ensure that soil erosion is well controlled and managed to the benefit of the residents of Kathiani Division.
4. The government needs also to encourage the people of Kathiani to also engage in other economic activities such as farming to reduce the over reliance on sand harvesting as this will ensure that much environmental degradation is realized.
5. To carry out SIA to optimize positive effects and mitigate negative effects of sand harvesting.

6.5 Suggestions for further Studies

There is need for more studies on how to benefit more from sand harvesting activities and on the factors that affect effective management of sand harvesting in Kenya.

Riverine vegetation and soil erosion: there is need to research on the effects of sand harvesting on vegetation cover along river and the effects of loss vegetation in soil erosion and the resultant flood plain within study area.

Sand harvesting and water resources: research should be carried out to determine the effects of sand harvesting on water resources both on river and ground water sources since this is ASAL area.

REFERENCES

- Arwa, George Augustine (2012). *Sustainable Governance for artisanal Sand harvesting, Case of Kangonde location, Masinga district, M.A project.*
- Auty, R.M. (1993). *Sustainable development in mineral economies: The resource curse thesis.*
- Ayenagbo *et. al* (2011). The transportation and marketing implications of sand and gravel and its environmental impact in Lome Togo. *Journal of Economics and International Finance* vol 3(3) pp 125-138.
- Baker, B.H. (1954). *Geology of southern Machakos District.* Survey of Kenya
- Binoy, A.M, Shiney V. & Kicho P. (2013). *River sand inflow assessment and Optimal Sand Harvesting Policy Development,* Karela, India.
- Borges *et al* (2002). *Dune, Bluff and Beach erosion due to exhaustion and sand mining-the case of Santa Barbara Beach, Sao Miguel (Azores, Portugal),* journal of coastal research.
- Cutter, S.L & H.R William (2004). *Exploitation conservation preservation: A Geographical perspective on Natural resource use,* 4th edition, United States of America.
- Cooper, H.M (1988). *The structure of knowledge synthesis knowledge in society,* vol, 1, pp, 104-126.
- Davies, T.C & Mathus E.M (1996). *Geology and the environment in Kenya,* journal of African earth.
- Deller, S.C & Schreiber, A. (2012). Franc sand mining and community economic development. *Agricultural and applied Economics. Staff Paper.*565.
- EEA (2007). *European Environment Agency Annual Report.* Copenhagen: EEA.
- Egget, R. (2006). Mining, sustainability and sustainable development. In p Maxwell(ed.), *Australian mineral Economics, Ausimm Monograph* 24.
- Government of Kenya, (1999). *Environmental Management and Co-ordination Act.*
- Government of Kenya, (2010). *Kenya Economic Survey,* Published 2010.
- Government of Kenya, (2009). *Kenya Integrated Household Budget Survey (KIHBS).*
- Hunker, H.L. *et al.*, (1964). *Introduction to World natural Resources.* New York.
- Hawken, P., Lovins A., & Lovins L.H (1999). *Natural capitalism creating the next industrial revolution.* little, brown: Boston.
- IRIN (2012). *Sand harvesting threatens to displace thousands.* Kenya.

- International Labour Organization, (ILO). (1999b). *Small-scale mining on the increase in developing countries*. <http://www.ILO.org/global>.
- Kitetu, J., & Rowan, J. (1997). *Integrated environmental assessment applied to river sand harvesting in Kenya In sustainable development in a Developing world – integrated socioeconomic appraisal and Environmental Assessment* (Edited by Patrick C.K and Lee N).
- Kondolf, G.M. (1994). *Hungry water: effect of dam and gravel mining on river channels*. Department of Landscape Architecture and Environmental Planning, University of California.
- Keller, E.A. (1992). *Environmental geology*, University of California, Suata.
- Mensah, J.V (2002). *Cause and effect of coastal Sand harvesting in Ghana*. Cape Coast, Ghana, 70-86.
- Mugenda, A.G. & Mugenda O. (1999). *Research Methods. Quantitative and Qualitative approaches*. Nairobi: University Printing Press.
- Musyimi, M.M. (1993). Impact of sand harvesting on Environment and Land use in Masinga Division, Kenya. *Paper presented on the 14th National Workshop on soil and water management*.
- Mutiso, V.N (2012). *Impact of sand harvesting on education in Kathiani district, Machakos County, Kenya*. MA project.
- Mutisya, D.N. (2006). Sand harvesting and its environmental and socioeconomic effects in arid and semi-arid Kenya. *World Association and water conservation*, 82-90.
- Macharia. (2004). *Gateway to land and water information-Kenya National Report*. Food and Agriculture Organization of the United Nations, Rome.
- Muchena, F.N. (2008). *Indicators for Sustainable Land Management in Kenya's Context*. GEF Land Degradation Focal Area Indicators, ETC-East Africa. Nairobi. Kenya.
- Mwaura, S. K. (2013). The Effects of Sand Harvesting on Economic Growth in Kenya with case study of Machakos County. *International Journal of Social Sciences and Entrepreneurship*, 1 (5), 342-350.
- Machakos County Strategic plan draft, (2013). *From third world to first word in one generation*.
- National Environmental Management Authority (2007). *National sand harvesting Guideline*. Government printers.
- Naveen, M.S. (2012), *Environmental impact of soil and sand harvesting*. A review, *International journal of science, Environment and technology*, vol1, 125-134

- Nguru, P.M. (2008). *Impact of Sand harvesting on the environment in Mjanaheri – Areas Magarini Division, Kenya* .M.A project.
- Ombour, J. (2010). *Standard digital news*. Kenya
- PEN (2009). *Sand harvesting case study*, Machakos district, Kenya.
- Republic of Kenya, (2009). *Kenya Population and housing Census*, volume II, Kenya National Bureau of Statistics, Nairobi, 2010b.
- Padmalal, D., Maya K., Screebla, & Sreeja R. (2008). *Environmental effects of river sand mining*. a case from the river catchments of Vembanad Lake, southwest coast of India. *Environ Geol* 54:879-889.
- Ralph, J. (1978). *Farm Management Hand Book of Kenya*: Ministry of Agriculture. Vol. II/A: Nairobi: Government Printers.
- Ruckelshaus, W.D. (1989). *Toward a sustainable world*, *Scientific American* 261(3):166-175. *Science*, Vol 23.No 4.
- Sonak *et al.*, (2009) Strategic assessment of the magnitude and impacts of sand mining in Poyang lake, China.
- Survey of Kenya, (1975) *Topographical Map of Kathiani division*.
- Sen, A. (1989). Development as Capacity Expansion. *Journal of Development planning* 19:41-58.
- Thomas *et al.*, (2003). *Artisanal and small scale mining. Challenges and opportunities*. Nottingham, UK. Russel press Ltd.
- United Nations Department of Economic and Social affairs (2003). *Poverty eradication and sustainable Livelihood. Focusing on artisanal mining communities*.
- Welmer, W. and Becker-Platen .D (2002). Sustainable development and the exploitation of mineral and energy resources: *A Review*.
- Wu G *et al.*, (2007). *Concurrent monitoring of vessels and water turbidity enhance the strength of evidence in remotely sensed dredging impact assessment*. *Water Res* 41:3271-3280.
- Watson, J. (2001). *How to determine a sample size*: Tipsheet #60, University Park, PA: Penn state cooperative extension.
- World Commission on Environment, (1987). Report of the World Commission on Environment and Development: *Our Common Future*. Ottawa, Canada

Appendix 1: Tables for finding a base sample size

Appendix 1: Tables^a for Finding a Base Sample Size^b
 +/- 5% Margin of Error^c

| Population | Sample Size | | | | |
|------------|-------------|-----|-----|-----|------------------|
| | Variability | | | | |
| | 50% | 40% | 30% | 20% | 10% ^d |
| 100 * | 81 | 79 | 83 | 50 | 37 |
| 125 | 96 | 93 | 72 | 58 | 40 |
| 150 | 110 | 107 | 80 | 60 | 42 |
| 175 | 122 | 119 | 87 | 64 | 44 |
| 200 | 134 | 130 | 93 | 67 | 45 |
| 225 | 144 | 140 | 98 | 70 | 46 |
| 250 | 154 | 149 | 102 | 72 | 47 |
| 275 | 163 | 158 | 106 | 74 | 48 |
| 300 | 172 | 165 | 109 | 76 | 49 |
| 325 | 180 | 173 | 113 | 77 | 50 |
| 350 | 187 | 180 | 115 | 79 | 50 |
| 375 | 194 | 186 | 118 | 80 | 51 |
| 400 | 201 | 192 | 120 | 81 | 51 |
| 425 | 207 | 197 | 122 | 82 | 51 |
| 450 | 212 | 203 | 124 | 83 | 52 |
| 500 | 222 | 212 | 128 | 84 | 52 |
| 600 | 240 | 228 | 134 | 87 | 53 |
| 700 | 255 | 242 | 138 | 88 | 54 |
| 800 | 267 | 252 | 142 | 90 | 54 |
| 900 | 277 | 262 | 144 | 91 | 55 |
| 1,000 | 286 | 269 | 147 | 92 | 55 |
| 2,000 | 333 | 311 | 158 | 98 | 57 |
| 3,000 | 353 | 328 | 163 | 98 | 57 |
| 4,000 | 364 | 338 | 165 | 99 | 58 |
| 5,000 | 370 | 343 | 166 | 99 | 58 |
| 6,000 | 375 | 347 | 167 | 100 | 58 |
| 7,000 | 378 | 350 | 168 | 100 | 58 |
| 8,000 | 381 | 353 | 168 | 100 | 58 |
| 9,000 | 383 | 354 | 169 | 100 | 58 |
| 10,000 | 385 | 356 | 169 | 100 | 58 |
| 15,000 | 390 | 360 | 170 | 101 | 58 |
| 20,000 | 392 | 362 | 171 | 101 | 58 |
| 25,000 | 394 | 363 | 171 | 101 | 58 |
| 50,000 | 397 | 366 | 172 | 101 | 58 |
| 100,000 | 398 | 367 | 172 | 101 | 58 |

Qualifications

- This table assumes a 95% confidence level, identifying a risk of 1 in 20 that actual error is larger than the margin of error (greater than 5%).
- Base sample size should be increased to take into consideration potential non-response.
- A five percent margin of error indicates willingness to accept an estimate within +/- 5 of the given value.
- When the estimated population with the smaller attribute or concept is less than 10 percent, the sample may need to be increased.
- The assumption of normal population is poor for 5% precision levels when the population is 100 or less. The entire population should be sampled, or a lesser precision accepted.



Source: Watson, 2001

APPENDIX II

RESEARCH QUESTIONNAIRE

Below is a questionnaire on “the socio-economic effects of sand harvesting in river Thwake, Machakos County, Kathiani division, Kenya” which you are requested to fill. Please read carefully and give your responses on the socio-economic effects of sand harvesting in river Thwake, Machakos County, Kenya by ticking [] or by filling in the blank spaces. Information obtained from this questionnaire will be treated with uttermost confidentiality.

SECTION A : GENERAL INFORMATION

Stakeholder number:

Gps location S:

E:

(i) Questions on Stakeholders

| Education Levels of the family | No of adults | | No of children | |
|--------------------------------|--------------|--------|----------------|--------|
| | Male | Female | Male | Female |
| No education | | | | |
| Primary | | | | |
| Secondary | | | | |
| College | | | | |

(ii) Do you work as in the Sand Industry?

Yes No

(iii) If Yes, What is your category?

Sand Miner Sand Loaders Driver

Section B: Living Conditions

(1) Which livestock do you own?

| How many [...] does your household own. | Is this more ,less or the same before sand harvesting | How many [...] Did you eat last season sell last season. |
|---|---|--|
| Goats/Sheep | | |
| Bulls | | |
| Cows | | |
| Donkey | | |
| Pigs | | |

(2) Assets, implements and income

| How many [...] Does your household own? | How many[] did your household own before sand harvesting. |
|---|--|
| Motorcycles | |
| Bicycles | |
| Carts/wheelbarrow | |
| Ploughs | |
| Motor vehicle | |
| Transistor radio | |
| Television set | |
| Cell phone | |
| Generator | |
| Others | |

(3) To what extent do you agree to the following regarding the type of food that is eaten by the households since being involved in sand harvesting? Indicate your response based on a 4-point scale by using a tick (√) or X to mark the applicable box.

| | 1.Strongly agree | 2.Agree | 3.Disagree | 4.Strongly Disagree |
|--|------------------|---------|------------|---------------------|
| The family eats better than before the family started harvesting of sand | | | | |
| The family eats a balanced diet | | | | |
| The people in the area are more healthy | | | | |
| The family can afford quality food nowadays | | | | |

Section C: Job creation

- (i) How many Lorries do the sand loaders load per/day.....
- (ii) How much does the sand miners earn per/day
- (iii) How much does the drivers earn per/days
- (iv) How much does the sand loaders earn per lorry.....
- (v) What is the average income per day.....
- (vi) What is the average expenditure per day
- (vii) To what extent do you agree to the following regarding the job Creation?

Indicate your response based on a 4-point scale by using a tick (√) or X to mark the applicable box.

| | 1.Strongly agree | 2.Agree | 3.Disagree | 4.Strongly Disagree |
|---|------------------|---------|------------|---------------------|
| Most of the family members are now occupied | | | | |
| The family can earnings have gone up | | | | |
| The people in the area are able to start new businesses from the sand harvesting earnings | | | | |
| Sand harvesting has engaged the youth in the area | | | | |

Section D: Accessibility of Better Health Services

To what extent do you agree to the following regarding the family ability to affordability of medical service? Indicate your response based on a 4-point scale by using a tick (√) or X to mark the applicable box.

| | 1.Strongly agree | 2.Agree | 3.Disagree | 4.Strongly Disagree |
|--|------------------|---------|------------|---------------------|
| The family fall sick less often after joining the sand harvesting activities | | | | |
| The family can access better medical services after joining the sand harvesting activities | | | | |
| The family can afford better medical services after joining the sand harvesting activities | | | | |
| The family members go to private hospitals after joining the sand harvesting activities | | | | |
| The family can afford a medical cover after joining the sand harvesting activities | | | | |

Section E: Better Education

To what extent do you agree to the following regarding the family ability to affordability of better education? Indicate your response based on a 4-point scale by using a tick (√) or X to mark the applicable box.

| | 1.Strongly agree | 2.Agree | 3.Disagree | 4.Strongly Disagree |
|--|------------------|---------|------------|---------------------|
| The children go to better schools after joining the sand harvesting activities | | | | |
| The family can text books and learning equipments for the children | | | | |
| The family can afford tuition for the children | | | | |
| The children perform better in school after joining the sand harvesting activities | | | | |

Section E: Socio-economic Challenges

(i)What are the socio-economic challenges that are posed by sand harvesting in the area.....

(ii)In your opinion has sand harvesting contributed to environmental degradation?

Yes No.....

If yes please state how.....

(iii)In your opinion has farming been affected by sand harvesting in the area

Yes No.....

If yes please state how.....

(iv) In your opinion does sand harvesting contribute to social ill (drug abuse) among the youth in the area?

Yes..... No.....

If yes please state how.....

(iv) In your opinion does sand harvesting contribute to school drop outs among youths in the area?

Yes No.....

If yes please state how.....

Thank you for your participation

APPENDIX I11

RESEARCH WORK PLAN

| ACTIVITY | JAN 2014 | | | | FEB 2015 | | | JUNE 2015 | | |
|-----------------------------------|----------|-----|-----|-----|----------|---|---------|-----------|---------|---------|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 and 4 | 1 | 2 and 3 | 4 |
| Problem Formulation | *** | | | | | | | | | |
| Preparation of research questions | | *** | *** | | | | | | | |
| Compiling | | | | *** | *** | | | | | |
| Project Defense | | | | | | * | *** | | | |
| Field Data Collection | | | | | | | *** | *** | | |
| Data Analysis Report Writing | | | | | | | | | *** | |
| Presentation | | | | | | | | | | ** * |

Table I N.B: Activities on the Research Management Table are indicated by the following symbols: ***

APPENDIX IV
PLAN BUDGET

| No | Item | Amount | |
|----|-----------------------------|---------------|-----------|
| | | Kshs | Cts |
| 1 | Stationeries | 15,800 | 00 |
| 2 | Telephone and Internet cost | 6,600 | 00 |
| 3 | Typing work | 10,000 | 00 |
| 4 | Photocopies and journals | 6,700 | 00 |
| 5 | Travelling cost | 10,500 | 00 |
| 6 | Contingencies | 8,000 | 00 |
| | Total | 57,600 | 00 |

Appendix V: Demonstration due to sand harvesting in Kathiani Division



Source: Field data Jan (2015)

APPENDIX VI: Road conditions in Kathiani Division



Source: Field data Jan (2015)

APPENDIX VII: Sand harvesting activities in Kathiani Division



Source: Field data Jan (2015)

Appendix VIII: Farming affected by sand harvesting



NB/ cowpeas on the left side affected by dust and destroyed by Lorries

Source: Field data Jan (2015)

APPENDIX IX: Sand harvesting activities in Kathiani Division



Source: Field data Jan (2015)