

**FACTORS AFFECTING SAND HARVESTING IN MACHAKOS COUNTY,
KENYA**

BY

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A60/68678/2013

**A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Environmental Governance of the University of Nairobi**

September, 2017

DECLARATION

This Thesis is my original work and has not been presented for a degree in any University.

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DEDICATION

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ABBREVIATIONS AND ACRONYMS

CAP	Chapter of Laws of Kenya
CoK	Constitution of Kenya of 2010
ECD	Early Childhood Development
EMCA	Environmental Management and Coordination Act, Chapter 387 Laws of Kenya
EMP	Environmental Management Plan
FGD	Focus Group Discussion
GoK	Government of Kenya
ILO	International Labour Organization
MPF	Mining Policy Framework
NSHG	National Sand Harvesting Guidelines, 2008
NEMA	National Environment Management Authority
NGO	Non- Governmental Organization
RM	Malaysian Ringgit
RRMA	Riparian Resource Management Association
UN	United Nations
USA	United States of America
USD	United States Dollar
WARMA	Water Resource Management Authority

ABSTRACT

Sand harvesting is practiced in Kenya as an economic activity and is occasioned by a variety of factors. The practice has both positive and negative impacts to livelihoods. It is the negative impacts that occur due to unsustainable methods of sand harvesting that informed this study. Unsustainable scooping methods of this resource have caused soil erosion characterized by deep gullies on both river beds and arable land. The activities have also led to loss of water for livestock and domestic use and rise in crime in most cases. There is need to regulate sand harvesting to guarantee its sustainable use and mitigate its negative impacts. This study sought to analyze the factors leading to increased sand harvesting in Machakos County with a view to regulating the harvesting activities and ensure sustainability. The objectives of the study were to assess the impacts of increased sand harvesting in Machakos County, assess the existing policy, legal and institutional frameworks on sand harvesting in the County and assess strategies used to sustainably manage sand harvesting activities in the County. This study was done in Kathiani, Mwala and Machakos Town Constituencies where sand harvesting is prevalent. Qualitative research design of a descriptive nature was used to get a relatively profound appreciation of sand harvesting through firsthand experience and proper reporting. The sampling frame comprised 81 respondents drawn equitably from three spatial clusters where sand harvesting was prevalent. The clusters included the geographical constituencies of Mwala, Kathiani and Machakos town. From the three clusters, 20 respondents were equitably selected on snow ball basis and were interviewed using a structured questionnaire. Key opinion leaders selected from the local community were engaged through focused group discussions to complement the opinions of the respondents. Data collected during the study was recorded on Microsoft Word and Microsoft Excel spreadsheets and analysed using the G-test of independence. Key findings included that sand harvesting was occasioned by several factors such as demand from the construction industry and the high number of farmers, weak enforcement of laws and regulations, weak institutions and corruption among the institutions and people entrusted with providing leadership. There were very few sand harvesting organized

groups. Other findings showed that sand harvesting led to loss of arable land and vegetation, landslides and degradation of river banks. Key recommendations included restriction of hours of the day when sand harvesting could be allowed (daytime only), enactment of specific regulations on sand harvesting, promotion of commercial packaging of legally harvested sand, sensitization of the public on the existing laws and regulations, re use and recycling of sand, intensification of environmental inspections for purposes of ensuring compliance and construction of sand gabions and dams along the threatened river beds where sand harvesting is practised.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

On a global perspective, it is estimated that among extractable materials mined annually, sand and gravel also known as aggregates, comprise a significant number as well as the most frequently harvested. Almost like a paradox is the fact that even if the aggregates are harvested more frequently among the extractives, the historical data available on their mining is very minimal and this is especially applicable to the cases of developing countries. The data available only stretches back a few decades and this can only serve as an indicator of the haphazard unaccountable nature of mining that prevailed long time ago. This has hampered spreading of information and awareness and definitely complicated environmental assessment (GEAS, 2014).

For decades, sand and gravel have been popular all over the world in the construction of infrastructure. The demand for them has not dwindled but has continued to increase. Sand accumulation as layers of sand deposits in river courses is a dynamic phenomenon. Mostly affected all over the world are rivers as they experience pressure from anthropogenic factors and due to rapid urbanization, among which the haphazard harvesting of sand and gravel is central and notorious. Sand harvesting threatens the sustainability of river ecosystems (Tobergte and Curtis, 2013).

Development can be described as a process of improvement and progression in trade and business. Infrastructure improves with development and with it governments can put up more roads, dams, bridges and schools. Aggregates are extracted from river beds, river

channels, flood plains and are valuable to construction and industry. It is correct to summarize that urbanization can negatively affect the environment (Madyise, 2013).

For thousands of years, sand and gravel, being cheap and naturally accessible resources had been used in Africa for the construction of human habitations, roads and dams. The manner that top soil was removed in accessing the sand resource underneath it was deleterious to the environment. This was especially the case in developing countries of Africa. Today demand has increased with the general improvement of the socio-economic life of mankind in Africa. It was sad to note that as much as the mining of sand and gravel were common in most African states, the practice was not only legal but also illegal due to the ill manner that it was undertaken (Madyise, 2013).

Sand extraction is not only terrestrial but also marine oriented. Beach dunes are a popular source of sand in the world. Beach sand harvesting in Morocco's coastal towns was rampant and destroyed the marine ecosystem especially the mangroves. The harvesting of beach sand from the dunes posed a threat to the adjacent wetlands and significantly prejudiced coastal infrastructure such as beach hotels, by exposing them to sand storms and the rising sea level. It so happened that the once scenic coastal dunes had been replaced with sand pits along the shoreline and that affected the national heritage pride of Morocco. The tourism benefit that the country reaped from having beautiful beaches was at risk as many beaches had been rendered unusable. The Morocco government took the laudable steps of stopping beach mining and instead established new sources of alternative sand for the sake of its future generations (Pilkey *et al.*, 2007).

Building sand is a natural resource and is harvested from river beds and sand dunes. Unsustainable harvesting of the resource is deleterious to the environment and there is therefore a great need to have the activity regulated. Sand harvesting should actually be subjected to Environmental Impact Assessments (EIA) so that its impact on the environment can be controlled. Failure to that leads to natural resource conflict among the river and coastal communities and stakeholders. River beds and sand dunes degradation also follows. In Kilifi and Lamu Counties for instance, sand is harvested from sand dunes to the extent of causing salination of underground fresh water (NEMA, 2008).

Sand dunes protect and conserve underground fresh water and if the sand is overharvested, then a mixing of salty water from the ocean with fresh water from the underground occurs causing salination and degradation of the sand dunes. Just like the case of Morocco, Kenyan tourism was affected as a result of over exploitation of beach sand dunes which otherwise had acted as barriers to flooding risk for the beach communities. The beauty of the beach and the livelihoods of the locals who depended on the sand dunes for water supply were also affected negatively (Wafula, 2013).

Sand harvesting in Kenya continues unabated in a highly unregulated manner that best serves to enrich a few at the expense of the environment. It can be described as the process of extraction of sand from the environment. It is also called 'sand winning' or 'sand mining'. The law in Kenya is apparently inadequate as far as regulation of sand harvesting is concerned. The Mining Act of 1940 did not define building sand as a mineral and therefore did not regulate its extraction. The Act was recently revised with the enactment of the Mining Act, 2016 which still does not consider building sand as one

of the important minerals for regulation. The Act is more concerned with ‘valuable’ minerals such as gold, silver and rare metals.

The Environmental Management and Coordination Act (Amendment,2015) also referred as Chapter 387 Laws of Kenya is also indolent on sand harvesting. The closest it gets is make a general requirement for submission of EIA reports. The law seeks to enforce compliance and without the law, then compliance is not possible. Most sand harvesters are well aware of this predicament and have taken the activity of sand harvesting as private and unregulated. In areas such as Makueni, Machakos, Embu, Kitui, Kilifi and Kajiado Counties, the effects of unregulated sand harvesting are very manifest (Angaluka, 2011) and the low lying areas of Kenya are especially affected (NEMA, 2008).

A sad fact is that corruption and insecurity have grown as the sand harvesters compromise the enforcement agencies for protection and safe passage when transporting sand. Sand harvesters hire illegal machete wielding gangs to provide security against protesting locals, conservationists and even the local Environment Officers. Local leaders have always influenced sand harvesting due to the benefit of winning the electorate (IRIN, 2012). These are events that have been reported to the authorities but no substantive solution has been found. The regime of land laws in Kenya does not address the problem specifically either. The National Environment Management Authority (NEMA) did issue and publish Sand Harvesting Guidelines in the year 2008 and this is the closest that regulation of sand harvesting goes. The guidelines place an emphasis on the need for Environmental Impact Assessment towards sand harvesting and even suggest institutions to manage sand harvesting. It is noteworthy that the guidelines are not

regulations and thus only seek to guide more than enforce compliance. County legislation such as the Machakos County Sand Harvesting Act (2014) is yet to provide a solution and there is thus great need to study the activity of sand harvesting.

1.2 Statement of the problem

Sand harvesting is an activity that is of significant socio- economic benefit to a cross-section of Kenyans. Sand is a building material and therefore a necessity for the many construction projects in the country. Its high demand has fuelled the need for more sand supply. Sand harvesting activities have been going on for many decades regardless of the massive environmental degradation these activities cause. Unsustainable scooping methods of this resource cause various environmental impacts in the areas where sand harvesting occurs. The activities have also led to loss of water for livestock and domestic use (NEMA, 2008).

Demand for sand is increasing in tandem with the need for housing especially in the urban areas and the expanding development activities in the Counties which threaten the environment and require regulation. In order to conserve the sand resource and ensure that extraction is conducted sustainably and in an orderly way, it is important to have effective regulations. That would also ensure that the negative impacts of sand harvesting are provided with mitigation measures (Green, 2012).

Sand harvesting in Kenya is not a new problem and it can be witnessed readily especially in the low lying areas of the Country such as Machakos and Makueni Counties. It was easy to spot heavy tipper trucks used for hauling sand from source to destination. These

heavy trucks used in transporting sand cause environmental degradation by accelerating soil erosion as they are driven over river beds and river banks. They therefore contribute to soil instability. Without proper laws on sand harvesting, the courts would also find themselves at a loss when offenders are arraigned before them and would only end up either discharging the offenders or meting lenient sentences (IRIN, 2012). Although sand harvesting has been going on in various regions of the County, no studies have been conducted to examine the factors contributing to the increased frequency of sand harvesting and the impacts associated with the activity in the County. The regulatory framework governing the activities has also not been assessed. These issues form the backbone of the study.

1.3 Research Questions

The research questions that guided the study were as follows:

- a) Which factors contribute to increased sand harvesting activities in Machakos County?
- b) What are the impacts of sand harvesting and how are the impacts mitigated?
- c) How adequate are the existing policy, legal and institutional frameworks on sand harvesting in the County?

1.4 Objectives of the Study

The primary objective of the study was to examine the factors contributing to increased levels of sand harvesting and the adequacy of the existing regulatory framework on sand harvesting in Machakos County. The specific objectives of the study were to:

- a) Examine the factors contributing to increased sand harvesting activities in Machakos County;
- b) Assess the impact of increased sand harvesting in the County; and
- c) Assess the policy, legal and institutional frameworks on sand harvesting in the County.

1.5 Justification and Significance of the Study

Demand for sand is increasing in tandem with the need for housing especially in the urban areas and the increasing development activities in the Counties and threatening the environment through degradation. There appears to be no literature that directly links the sand harvesting problem to inadequate policy, legal and institutional arrangements. This study sought to bridge that existing gap in literature. In order to achieve the imperatives of conserving the sand resource and ensuring an orderly and sustainable exploitation of sand, there is need for adequate and effective regulation of sand harvesting. In the long run, the effective regulation would also take care of the negative impacts of sand mining through providing mitigation measures. The study sought to make a case on the importance of a better regulatory framework for sand harvesting.

1.6 Scope and Limitations of the Study

The study focused on the management of sand harvesting activities in Machakos County. It was important to assess the impacts of sand harvesting *vis a vis* the challenges associated with the existing regulatory framework to ensure the sand harvesting activities are sustainable and that the environment is managed well. The study analysed existing national laws and the sand harvesting law in Machakos County. Laws in other Counties were not considered since the focus was Machakos County.

The study was limited in several ways. There were few journal publications on the specific subject where sand harvesting was related to regulatory frameworks, a fact which posed a set back to the local literature review. The available funds for the data collection exercise were inadequate and thus could not allow for a much wider respondents base such as visits to more study sites in Machakos County. Time constraints due to exigencies of other duties that may have competed with research work were also a limitation. Another limiting factor was that mining sites were generally dangerous and the researcher had to make security arrangements which may have discouraged a better penetration of the study area.

The limitations afore stated were, however, not perilous to the study. For example, the funds available for the research allowed field visits to over 70% of the identified sites in Machakos County and the results of the data collected and analysed showed a common trend. The possibility of that trend changing by addition of other one or two sites was therefore very slim. Funding for the field visits was complemented by provision of vehicular transport and enumerators by the NEMA. Time off work was taken by the

researcher and this included taking official leave from work with a view of concentrating on this research work.

1.7 Assumptions of the Study

The key assumption was that all the participants interviewed gave real and candid responses during interviews. The phrases ‘sand mining’, ‘sand harvesting’ and ‘sand extraction’ have been used interchangeably with the plausible assumption that they are synonymous. The study also assumed that sand harvesting was practiced in the same manner and intensity among the 3 identified clusters of Kathiani, Mwala and Machakos town . That assumption justified the snow ball selection of 20 respondents from each of the clusters. These assumptions are however not fatal as they do not go to the root of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Studies on sand harvesting have been conducted ranging from the global to local level. This study sought to review the existing studies on the basis of the objectives of the present study. Review of various publications, student papers, internet sources and conference papers was therefore done and written in keeping with the three objectives of the study and that has formed the scope of this chapter. This chapter also contains the conceptual framework of the study.

2.2 Factors contributing to increased sand harvesting

Sand harvesting is a global and regional activity. From the Americas to Asia, sand harvesting presents highly similar issues of concern and impact on the environment. The production of aggregates in the State of California, USA, was increasing at a very high rate compared with the production of other minerals in the State. In California, littoral sand mining was not very alarming as the production occurring in the shore zone was extremely small compared to the long beaches which comprised a lot of sand. This was important in as much as sandy beaches represented a major recreational asset to certain coastal areas of the world (Magoon & Haigen, 2014).

In the USA, over half of the aggregates harvested are used in the making of concrete which is a mixture of sand, gravel and cement. The concrete in turn is used in construction of roads, bricks, building blocks; construction of concrete pipes, and

sometimes mixed with tarmac or asphalt to strengthen them. This concrete industry has existed globally over many centuries and in Africa without exception. In the manufacturing sector, 40% sand was used in the glass making industry, 21% in foundries for casting various products, 6% as abrasive sand while 33% is for miscellaneous production purposes (Madyise, 2013). Sand mining played a significant role in the Malaysian role in as much as the various processes of extraction and processing of sand were harmful to the ecology both real and potentially (Ashraf *et al.*, 2011). The Selangor State of Malaysia was also affected by the sand harvesting production craze. Notwithstanding the existence of sand harvesting regulations and guidelines, it was common to find in Malaysian local newspapers, reports on sand harvesting and how illegal it was.

According to Ashraf *et al* (2011), the unregulated mining of sand was manifestly rampant in the State of Selangor. Selangor would lose a lot of revenue annually due to unregulated harvesting of sand in the State. Affected areas included Bestari Jaya and Kuala Langat, where the harvesting was widely carried out and for periods of over 20 years in some instances. In attempting to address the situation, the Government of Selangor identified close to 30 small sand mining areas but which had a large output in contrast to their geographical size and proceeded to shut down several of them. The concern of the government was no doubt the degradation to the environment caused by the unregulated sand harvesting operations.

It was also reported that the Hulu Selangor district, Kuala Langat and Kuala Selangor districts were also affected by the same situation that had hit Selangor. Only a handful of sand miners were licensed to mine and yet there was a bee hive of activity in almost 30

sites. That was the extent of sand mining being conducted without regulation. The proceeds of sand scooped from illegal mines in the aforesaid districts were sold at prices estimated at RM20 the equivalent of 5 USD per ton, thus creating a multi-million ringgit Malaysian industry. The economic incentive appealed to the State and that created a further problem. The State developed eagerness to tap into or partake from the economic boom brought about by the sale of sand proceeds. The justification was that the profits would be ploughed back to the national treasury (Ashraf *et al.*, 2011).

The statistics around the World indicate that an average of 54 billion tonnes of extractive material was mined on an annual basis and of which, aggregates accounted for the lion share of about 70% and an exponential upsurge in extraction. Of interest is that even if the aggregates formed the larger of extractive materials harvested, there was no real and adequate data save for that recorded in the recent years. The demand for sand was informed by a variety of factors including glass production although its largest use was in construction and reclamation of land for terrestrial purposes. It is reported that China uses up to 60% of the world cement production a fact which can be attributed to population growth and industrialization and that a Chinese national would use almost seven times more cement than an American (GEAS, 2014).

Demand for aggregates fuelled the need for new infrastructure and also the need to refurbish the already present constructions or infrastructure such as roads, houses, dams and bridges. This demand was also fuelled by economic development which in turn relied on the availability of the aggregates. Aggregates being natural resources, any problem with demand was easily cured by intensified extraction. Until recently sand was traditionally extracted only from land and its sources which include sand pits, quarries

and riverbeds. Presently, the trend has changed to include sources from beach sand in the coastal areas due to the unreliability of inland resources and the high demand. Sand is extracted from mostly beach sand dunes by the coastal shores as opposed to the in-stream sand mining. In-stream aggregates however remain metal structures caused by salination. Sand from deserts was least preferred and could not be used for making concrete or as material for reclamation of coastal land. This was because desert winds would cause the sand to develop rounded grains that could not bind well with aggregates (GEAS, 2014).

In the United Arab Emirates, the City of Dubai has several of the world's most amazing features in terms of buildings especially hotels and commercial premises. The buildings are designed in a modern way and some are built right in the middle of the sea and especially the sky scrapers. Undoubtedly, with the amazing architecture there had to have been heavy impact on the supporting environment and the demand for sand. Aggregate sources are the same all over the world. Sand is either extracted in-stream, from coastal sand dunes or from the desert. At some point, Dubai had to import sand from Australia to build the Burj Khalifa tower after its own marine sand resources got exhausted. It is recorded that real estate faced such a boom in Dubai that in 2013, supply for office space in the heart of Dubai exceeded demand. Other Palm projects included the Palm Jebel Ali, and then the World Islands Project. The required an estimated 451 million tonnes of sand to build. It is noteworthy that much of the aggregates used in construction was used in reclaiming part of the sea so as to create land on which to erect the towering sky scrapers (GEAS, 2014).

To the far east, a similar scenario to that in Dubai was witnessed. Singapore being a small country in geographical size, required more terrestrial space for its infrastructure

development. The population of people in Singapore was fuelling the need as it had tripled from 1960 to the year 2010. There was also an industrial revolution in the Country and in response Singapore had reclaimed its land area by more than 20% by the year 2010. To reclaim land from the sea, this was the only way of increasing its geographical land surface, required use of aggregates. In a study conducted in 2014, it was reported that Singapore was the largest importer of sand in the world, having imported over half a billion tonnes of sand in the last 2 decades (GEAS, 2014).

Natural resources are either renewable or non-renewable. River sand is both a non-renewable and renewable natural resource. If sand is extracted from a source, say a river bed, to an acceptable or sustainable level that allows replenishment with the next rains, then the resulting environmental problems of sand mining will be nil or minimal. Conversely, it is true to state that scooping of sand from a river bed in a manner that can only be termed as excess or unsustainable, will only cause river degradation and in which case the resource can be termed as non renewable. The renewability of the sand resource can therefore be said to depend on man (Padmalal *et al.*, 2007)

Indiscriminate or haphazard extraction of river sand had turned the rivers of Kerala State in India, to such levels that renewal of the natural system was no longer possible. The situation was so dire that it called for government intervention on high priority basis if the natural riverine character in most of the rivers of the State was to be restored. An environmental impact assessment study would be critical in such situations so as to balance between development and the environment (Padmalal *et al.*, 2007)

The benefits of sand as a resource are plenty. The notion that sand is only a mineral or a building material is a misconception. Beach dune sand provides a habitat for lobsters, crabs and other crustacean species and marine life, acts as a buffer for beachside communities and investors against strong tidal waves and storm. Sand is vital in ensuring water retention both in in-stream sources and also in beach sand dunes. As part of rehabilitation, it is important to refill used mines with top soil (Saviour & Stalin, 2010).

According to Saviour & Stalin (2010), in India, it seemed that the illegal miners of sand were all powerful, everywhere and all knowing as the government could hardly stop them. Mining, unless properly regulated, could have adverse environmental and social consequences. The reports on illegal mining across the States of India were quite frequent and so were the complaints from friends of the environment who would advocate against the adverse environmental impacts. Illegal sand excavation by organized gangs where sand was mined in order to cater for the construction need of the local villages and government offices, was a common occurrence.

In the southwesterly coast of India, rivers were severely affected by anthropogenic factors including indiscriminate extraction of construction grade sand. For example, the seven rivers that drained the Vembanad lake catchments were mostly affected as they provided the source for aggregates used in coming up with one of the fastest developing urban-cum-industrial centre called the Kochi City. The quantity of in stream mining was about 40 times higher than the set sustainable levels and this affected the state of river beds imposing extensive damage to the ecology of the river ecosystems (Padmalal *et al*, 2007).

While examining the issue of mining of sand, a study was conducted on three villages in Maharashtra, India. It was observed that there was a boom on the demand for sand globally and as the demand was growing, aggregates were being mined faster than nature could replenish and as such unsustainable. Globally, India came third after the USA and China in the construction industry and which was an indicator of the demand for sand and gravel. Mining in India was both regulated and unregulated although even the state of regulation was hampered by the lack of a good working regulatory and monitoring framework for sustainable excavation of sand. The Mumbai High Court in deciding on a petition filed by friends of the environment in the year 2010, issued a ban on sand mining (Madyise, 2013).

In most developing countries, Governments depend on the use of natural resources such as sand and gravel for economic development. In a study by Lawal (2011), it was shown that Nigerians economic power increased with the increase of readily available loans and raises in salaries for the employed. In consequence, they turned to building more quality houses and buildings which in turn put on pressure on sand and its sources. In Kenya, a similar trend was observed where sand mining had contributed to better infrastructure. The same trend was also observed in Botswana and Zimbabwe (Madyise, 2013).

According to Mwangi (2008), there was great concern especially among the environmentalists with the way the environment was ravaged by excessive loss of top soil affiliated to sand mining in Africa. It was noted that for a very many years, sand and gravel had been the base materials for infrastructure and housing development in Africa. Presently, the demand for sand has increased in tandem with the socio-economic life of Africans (Madyise, 2013).

Lawal (2011) compared and contrasted the operations of aggregate mining both on arable land and in-stream or riverine sources in the Minna Emirate Council of Niger State. Beneficiaries of the proceeds to sand harvesting included the government. On the other hand, farmers were disadvantaged because they lost pasture land to sand pits where mining was conducted on arable land. The sand pits would leave large exposed pits reminiscent of used mines and whenever the pits were not decommissioned or closed well, they would pose danger to both humans and animals. The same problem faced by farmers was experienced by the wildlife agencies or wildlife conservancies (Madyise, 2013).

According to a IRIN (2012), the dozen sand carrying heavy tipper trucks that would make their way to and from the banks of rivers near Lake Victoria fuelled Kenya's real estate boom and the local labour market at the peril of environmental conservation. Sand harvesting along River Nzoia had the potential risk of displacing some 7,000 people due to frequent flash flooding. Once sand is harvested, there was always the issue of storage. Storage may be at source or *enroute* or even at destination but always on the land surface and therefore caused destruction of surface areas otherwise covered with vegetation or crops for agriculture purposes. Besides the environmental impacts, there were related social and health problems such as prostitution and high school drop-out rate leading to serious social and health problems (Mbathi *et al*, 2000).

In areas such as Makueni, Machakos, Embu, Kitui ,Kilifi and Kajiado Counties, the effects of unregulated sand harvesting are very manifest (ANGALUKA, 2011). Lower Eastern Kenya is especially affected (NEMA, 2008). Local leaders have always influenced sand harvesting due to the benefit of winning the electorate (IRIN, 2012).

These are events that have been reported to the authorities but without solutions being availed. It was important to make suggestions for better ways of doing things, for example through greater local involvement and stricter enforcement of regulations all with a view of protecting the environment for present and future generations (Mbathi *et al*, 2000).

According to Augustine (2013), a baseline study showed that mining of sand was a big problem in the greater Machakos District and the larger lower eastern region of the former Eastern Province. Most of the sand used for construction, especially in Nairobi and the surrounding satellite towns was harvested from *Ukambani*, mainly in the Sub Counties of Makindu, Kilome, Machakos Town, Mwala, Yatta, Kangundo and Masinga. The economic activity of sand mining prospered but resultantly, streams around Machakos, Kangundo, Kathiani, and Mwala were badly affected. Even though and indeed more positively, the demand for this raw material in the building and construction industries was bound to increase with the proposal to upgrade Nairobi into a metropolis.

2.3 Impacts of sand harvesting

The issue of sand harvesting is not new in the society. There have been many attempted interventions to curb illegal sand harvesting but in vain. The activity has continually led to destruction of the environment, change of river flow, conflicts over resources use, water scarcity in the region, oil spills in the rivers, high levels of school drop outs, high rates of alcoholism and drug abuse, high rates of unwanted pregnancies, road damages

and high rates of HIV infections, among other many ills (Kitunga and Murungi, 2013). These are not remote but direct results of illegal sand harvesting.

Turbidity of streams which is generally a form of pollution that changes the colour of water due to dirt, is caused by wash-water discharge, storm runoff, and dredging activities from improper sand and gravel operations (Ashraf *et al*, 2011). River sediments consist of matter that has settled in the river usually from disintegration of rocks and the river bed. These include pebbles, granules, boulders, sand, silt and clay all in particulate form. The bigger or coarser particles will obey the law of gravity and settle at the bottom of the river while the finer particles progressively deposit further downstream. (Padmalal *et al*, 2007).

It is imperative to understand the negative impacts of extraction of alluvial material such as sand on riverine sources. The physical habitat characteristics of a river or stream such as the level of the bed, the width and depth of the river channel, depth, stream discharge velocity, turbidity, and temperature are very important and changing these characteristics will affect the plant and animal life in the riverine that depend on those characteristics based on the ecosystem approach (Hill and Kleynhans, 1999).

The imperative of conserving and rehabilitating sources of sand for future use cannot be gainsaid. Governments around the world should make policy that towards environmentally sustainable development. It is important that all sand harvesting projects be taken through an environmental impact assessment (EIA) and monitoring program and thus minimizes negative impacts to the environment. Frequent monitoring could be undertaken through environmental audits. Measures towards mitigation included

restraints on mining for example by setting the maximum depth, hours of mining and other measure that will enable the source to regenerate. Other possible measures could include repairing and rehabilitation of used mines (Madyise, 2013).

In order to address the problems caused by unregulated sand and gravel mining and mitigate or prevent the ill impacts to the environment, pragmatic and explicit laws and regulations should be enacted by countries in a participatory manner so as to facilitate enforcement and compliance at all levels within the social settings. In Ghana, a study conducted to examine the social and ecological impacts of gravel mining in East Gonja District showed a decline in the size of arable farmlands caused by the impacts of gravel mining in the district. This represented 33% of the total respondents. Disused quarry pits also presented additional negative impacts as the pits would keep pools of dirty surface run off and serve as breeding ground for insects such as mosquitoes especially in rainy season (Musah, 2009).

According to a recent study conducted in Kathiani sub county of Machakos County on the effects of sand harvesting on the environment and educational outcomes, interviews with head teachers revealed that the effects of sand harvesting on environment included: lack of water, loss of times in search of water and the noise from lorries interfering with learning, flooding which makes roads impassable, lack of concentration , pupils are affected by waterborne diseases causing coughing among pupils (County & Nthambi, 2015).

The study sought to establish whether the destruction of the environment caused by sand harvesting has an impact on education. Pupils were interviewed through the heads of

schools and the results showed that 69 pupils (86.3%) connected the destruction of the environment as a result of sand harvesting with education while 11 pupils (13.7%) said it had no effect. The Area Education Officer was of the view that environmental degradation as a result of sand harvesting affected education negatively. The findings showed that majority of head teachers (70.0%) indicated that environmental destruction caused by sand harvesting affects education as it leads to insufficient water for the school followed by 50.0% who said pupils are introduced to drugs while 40.0% said it has led to the destruction of roads leading to school causing lateness (County and Nthambi, 2015).

2.4 Policy, Legal and Institutional frameworks on Sand Harvesting

The regulatory framework on sand harvesting can be classified into policy, legal and institutional arrangements. Literature was reviewed on those 3 areas starting from the global to local perspective.

2.4.1 Policy framework

Whilst it can be argued that policy leaders such as the political class should take appropriate measures on setting policy, the mining of aggregates (sand and gravel) may not have caught the attention of politicians and perhaps because sand scarcity was not yet a problem that would threaten the economy or livelihoods significantly. According to experts, sand harvesting on a large-scale or activities that involved land reclamation required a proper scientific assessment such as an EIA before they could be allowed.

Such an assessment was to show a controlled acceptable impact on the environment (GEAS, 2014).

International conventions once ratified and domesticated by participating States can constitute a source of policy. Extraction of marine or coastal aggregates is for cost effective purposes, carried out at close proximity to landing ports and at shallow water depths and therefore would be under national jurisdictions as opposed to international or foreign waters. The same cost benefit approach applies to extraction of marine aggregates in the Exclusive Economic Zones or the Continental Shelf, where coastal states exercise sovereign rights to explore and exploit natural resources. There is need to have appropriate national policies to provide guidance (GEAS, 2014).

There are several applicable international conventions such as the United Nation Convention on the Law of the Sea, 1982 (UNCLOS) which provides for the delimitation of maritime zones and regulates rights and obligations in respect of usage, development and preservation of these zones, including resource mining. A number of regional conventions have been ratified with the aim of minimizing the impact of human activities and that include, directly or indirectly, references to aggregate exploitation. These include the Convention for the Protection of the Marine Environment of the North East Atlantic, 1992 (OSPAR Convention), the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), the Convention for the Protection of the Mediterranean Sea against Pollution, 1976, and Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, 1995 (Barcelona Convention). However, there are no specific guidelines for the management of marine aggregates extraction under the Barcelona Convention (Janerio, 1992).

In a study conducted by (Keller *et al.*, 2014) on the Dominican Republic Mining Policy Framework, it was stated that the first pillar of the Mining Policy Framework (MPF) focused on the general law and policy framework regulating the permitting processes and encouraged a mature modern legislative system with clear lines of responsibility and accountability. This combination of regulations serves as a basis for good governance and sustainable development. The Mining Policy Framework recommendations under this pillar fall into categories that address the ongoing generation of and equal access to geological information, the periodic revision and updating of mining legislation and policies and a permitting process.

In Ghana, land degradation and the environmental burden from the extraction of natural resources and related activities have been significant. The government, had however taken substantial action to address these challenges. In 1991, Ghana adopted a National Environmental Policy for “ensuring a sound management of resources and the environment, and to avoid any exploitation of these resources in a manner that might cause irreparable damage to the environment”. According to the policy, EIA must ensure that entities dealing with sand and mining “demonstrate that the project has been planned in an environmentally sensitive manner and that appropriate pre-emptive or mitigating measures and safeguards have been integrated into the projects design”. The Environmental Protection Council which is the management body of the Environment Protection Agency of Ghana, in collaboration with the Minerals Commission, promulgated guidelines mandating environmental impact assessment for mining activities in the country (Musah, 2009).

Governance is exercised and legitimized by institutions (Paavola & Adger, 2005). According to Patti *et al* (2011), governance is a key pillar of natural resource management and the principles of sound governance such as accountability, transparency, participation, and the rule of law, are equally central in natural resources management and resource users are well informed and implemented equitably. Further, they advocate for fair, just and transparent governance and regulated use of natural resources as a key for peace and sustainable development worldwide (Robin & Stephen, 2004).

Weak governance can reduce the incentives of people to manage their resources for the long term. The people therefore suffer from lack of motivation or will to manage their natural resources wisely as a culture of ‘don’t care’ sets in. It is worse when the governed people see the high and mighty over run with impunity the institutions that are meant to be pillars of corporate governance. Ineffective management of common property resources can often lead to competition, over exploitation and eventually the degradation of the resource itself (Augustine, 2013). In Kenya, some of the policy documents that govern sand harvesting include the Kenya Vision 2030, the National Minerals and Mining Policy (2016) and the Environment Policy (2014). Kenya’s Vision 2030 aims at achieving an economic growth rate of 10% by the year 2030. Under its social pillar, one of the flagship strategies advocated for by Vision 2030 is efficient use of natural resources. The Environment Policy (2014), being sessional paper number 10 of 2014, addresses the issue of sand harvesting in the light of sand as a mineral and makes one policy statement being to promote and implement mechanisms for sustainable harvesting of sand and mining activities. The Policy is authored by the Cabinet Secretary for Environment and Natural Resources on behalf of the Government of Kenya.

Through the National Minerals and Mining Policy of 2016, the government proposes the best and most efficient use of its minerals and also a sound environmental strategy to ensure a proper development of the sector that takes care of both the present and future generation. The policy also recommends the creation of mitigation mechanisms such as stabilization funds to cushion investments from negative effects of cyclic mineral prices and other external factors. Since investment in the minerals and mining sector is relatively risky and capital intensive, the Policy advocates for the provision of a variety of fiscal incentives. The policy addresses itself to the need for benefit sharing of resources and enshrines the principle of intergenerational equity by prescribing various measures aimed at bequeathing future generations with benefits from mineral wealth both directly through immediate returns or indirectly. In order to effectively regulate activities in the minerals and mining sector, the Policy proposes the enactment of a simple, clear and transparent legislative framework (www.mining.go.ke accessed on 24th October 2016).

The social guidelines of the National Sand Harvesting Guidelines of 2008 principally consider the social welfare of the people working in the sand industry. They, however, remain blanket policies with weak implementation mechanisms. The policy is silent on implementation procedures. The social considerations of the policy guidelines include a requirement that sand loaders to be above 18 years of age (Augustine, 2013). It is, however, not clear whether the guidelines fall under policy or legal framework. Musah (2009) and Augustine (2013) discuss the policy and legal frameworks on sand harvesting although they seem to make no distinction between policy and legal arrangements.

2.4.2 Legal framework

Legal and frameworks complement policy. As a matter of fact, it is policy that sets out the direction bringing about legal instruments and institutions. It is the law that establishes institutions or an institutional framework and conversely, institutions are a creature of the law or of legislative frameworks. When a municipal law establishes a Committee, an Authority or a National Council to implement certain functions of that law, then an institution is established. A good example is the National Environment Management Authority (NEMA) established at section 7 of the Environmental Management and Coordination Act (EMCA), Cap 387 Laws of Kenya for purposes of being the principal instrument of the government and exercising general supervision on matters of environmental management in Kenya.

Kenya has diverse legal underpinnings geared towards protection and sustainable protection of natural resources. The statutes are most times duplicative, disintegrated and uncoordinated making their implementation intricate. Their interactions are more complex, sometimes overlapping, other times competing amongst the various stakeholders. Deficiency of a reliable and conclusive legal framework for sand harvesting industry in Kenya has resulted to multifaceted conditions, which directly or indirectly affect the overall operations. There is a large number of National and County laws that affect the artisanal and large scale sand industry, directly or indirectly, which among others, include the Constitution of Kenya of 2010, the Environmental Management and Coordination Act (EMCA), The National Sand Harvesting Guidelines of 2007, The Mining Act of 2016, County Government Act of 2012 and the Environmental Impact Assessment and Audit Regulations of 2003 (Augustine, 2013).

The Constitution of Kenya of 2010 as the supreme law of Kenya, enshrines principles for management of the environment. An entire chapter, being chapter five, of the Constitution is dedicated to land and environment. Subject to the County Government Act of 2012, County governments are encouraged to deposit the proceeds of sand cess to environmental conservation activities and local community projects in the County. Sand cess is a form of levy collected from sand transporters along the Kenyan roads. Every County government is required to implement this requirement.

In a study conducted in Ghana by Musah (2009) on sand and gravel mining in East Gonja District (EGD), It was concluded that compliance to regulations was weak and compliance levels low. This study also addressed issues of public awareness and compliance with existing regulation. In studying the principal law on environment in Kenya, the EMCA, the following provisions become manifest. Exploitation of natural resources should incorporate considerations that touch on the need to safeguard the interests of future generations while protecting the needs of the present generations, appropriate incentives through enabling legal and tax regimes geared at encouraging environmental compliance. An example would be a reward and ranking scheme targeted at the most compliant business companies which would then published and rewarded openly. Also recommended is the need to have methods for building national awareness through environmental education on the importance of sustainable use of the environment and natural resources for national development.

The EMCA sets out operational guidelines for the planning and management of the environment and natural resources and identifies actual or likely problems that may affect the natural resources and the broader environment context in which they exist. For any

person(s) to be granted an approval to harvest sand, an Environmental Impact Assessment (EIA) for the river or affected part of the river must be done and an EIA License issued in accordance with the applicable law. Consequent initial and annual Environmental Audits (EAs) must be undertaken for such approvals granted after the EIA to be renewed every subsequent year.

The Land Act of 2012 also has provisions for protection of land based resources where the National Land Commission is required to make rules and regulations for the proper conservation of land based natural resources. According to the Land Act of 2012, the Commission is also expected to have measures in place for protecting critical ecosystems and habitats such as sand harvesting areas, provide mechanisms and procedure for registration of natural resources, provide incentives for communities and individuals to invest in income generating natural resource conservation programmes, formulate and issue procedures on public participation in the management and utilization of land based natural resources not forgetting benefit sharing to the affected communities.

The National Sand Harvesting Guidelines of 2008 (NSHG) stand out as the most spelt out 'regulations' towards sand harvesting. The NSHG have covered multifaceted areas on sand harvesting in Kenya; which include environmental and social considerations. The accomplishment of these guidelines is still very weak, considering the prevailing indicators largely non compliance, wrecked sceneries, land degradation and environmental degradation are widespread conditions in sand mining areas, suggesting failures to protection of resources (Augustine, 2013). There remains a big gap in actualization of these environmental considerations; sadly, in most sand harvesting areas, these stipulations remain just that, stipulations. There are no stipulations on the punitive

measures that should be undertaken if these provisions are not adhered to. Thus, they are as good as non-existent and the results have been piteously disastrous. The National Sand Harvesting Guidelines are certainly not satisfactory as the challenges of sand harvesting remain on the rise (Augustine, 2013).

At the local scene, the County Government of Machakos drawing from the principle of devolution enshrined in the Kenyan Constitution (2010), has enacted as a County legislation which is the Machakos County Sand Harvesting Act (2014) which provides for an apex Sand Harvesting and Management Committee, designation of sand harvesting sites, river bed and lakeshore harvesting ,hours of harvesting and transporting sand, licensing of harvesting, sale of sand, environmental impact assessments, and Enforcement mechanisms (GoK, 2014). This piece of legislation, albeit novel, is a good attempt at addressing the ills associated with sand harvesting.

2.4.3 Institutional Frameworks

World over, institutions play a pivotal role in management of sand harvesting activities. Good institutional frameworks are a result of good governance. The International Institute for Environment and Development (2000) ascertains that there is need to look at sustainability in mineral resource development from a multidimensional, multi angle and holistic perspective, and goes further to enlist the main themes that would define sustainability in artisanal mining to include social, environmental and economic concerns. Social concerns relate to issues such as human rights of the indigenous people and ethnic minorities and community empowerment, with regards to artisanal mining. Economically, of great importance would be issues of wealth generation and distribution,

financial drivers, and artisanal mining market cycles. While environmental concerns would be defined by the nature and processes of the material flows and effects to the physical and natural environments, the end uses and waste disposals. Other themes that would be of important consideration include information and transparency with regard to artisanal mining (Augustine, 2013).

In Botswana, the most notable environmental effects of sand and gravel mining are not unique but common with most other countries. They include damage to the riverbanks and beds by machines used for mining, destruction of wells, and water pollution due to engine oils from the machinery and vehicles used, reduction of the water aquifers and loss of riparian habitats resulting in loss of flora and fauna. In the social and economic sense, sand and gravel harvesting is a source of livelihood as it provides income and employment opportunities (Audit,P. 2012). The Institutions in Botswana charged with management of matters related to sand harvesting include the Department of Mines (DoM) under the Ministry of Minerals, Energy and Water Resources (MMEWR) which was established to provide reliable, effective and efficient administrative services, policies, programmes and legislation for mineral exploitation and minimise degradation of the environment (Audit, 2012).

Augustine (2013) in discussing institutional frameworks on sand harvesting in Kenya, listed a few institutions such as NEMA, District Environment Committees, Community Based Organizations and Riparian Resource Management Associations that govern sand harvesting. The study only scratched the surface and did not address itself in detail on institutional frameworks. In Kenya, relevant institutions that influence or address matters of sand harvesting include the Ministry or State department responsible for matters

environment, natural resources and mining, the National Environment Management Authority (NEMA), Water Resource Management Authority (WARMA), Riparian Resource Management Associations (RRMA), County Environment Committees (CEC), Community Based Organizations (CBOs), Non Governmental Organizations (NGOs) and Cooperative Societies.

The NSHG provide for formation of District Environmental Committees (now called County Environment Committees), which should further establish local Riparian Resource Management Associations (RRMA) mandated with sustainable management of sand harvesting activities. However, this has remained a delusion in most of these areas, with barely having any institutional representation (Augustine, 2013). The RRMA is expected to demand for Environmental Impact Assessment before sand extractions, as well as carry out annual Environmental Audits in sand harvesting areas, ensure the provisions of the NSHG are implemented for example, that sand scooping does not exceed six (6) feet in depth (Augustine, 2013).

It is unfortunate that most of the above functions of RRMA's do not happen. Ensuring rehabilitation of the sand harvested sites and other environmental damage associated with harvesting and transportation of sand is a mandate expected to be undertaken by the RRMA's. Preparation of an environmental management plan for sand harvesting areas is a requirement of the institution, of which the sand harvesters should adhere to, but that largely remains unaccomplished. The composition of the association has no regard for environmental experts, and suggests for inclusion of community representatives including landowners, two representatives each from women, the youth, elders and religious organizations.

The Machakos County Sand Harvesting Committee is fairly recent and was established by sections 4 and 5 of the Machakos Sand Harvesting Act of 2014. Its functions include maintaining a register of all sand dealers, advising County Executive Committee members on the structure and operations of sand harvesting and related activities, ensuring that sand harvesting activities are compliant with this Act and any national norms and standards, ensuring sustainable exploitation and utilization of sand resource, collaborate with other environmental agencies in management of environment as relates to matters of sand harvesting, formulate environmental conservancy programmes in relation to sand harvesting, recommend to the executive committee member designated sand harvesting areas for gazettelement and recommend designated roads for transportation of sand and other excavated material as per the law. The Committee should also approve the establishment of such number of Sand Harvesting Associations as it may deem fit and in accordance with the law relating to the registration of associations, self-help groups and community based organizations (GoK, 2014).

The National Environment Management Authority (NEMA) was established by section 7 of the EMCA Cap 387 of the Laws of Kenya. Its key roles include reviewing Environmental Impact Assessment (EIA) reports and granting of such approvals as may be necessary or appropriate, issuing guidelines in consultation with relevant Lead Agencies for the management of the environment in lakes and rivers as required under section 42(4) of the EMCA. To this effect, the National Sand Harvesting Guidelines have been issued and rolled out to guide environmental management in sand harvesting sites through public/social effective social organization and environmentally sound sand harvesting practices.

Community Based Organizations with the help of NGOs had been in the forefront in awareness, prevention and alleviation campaign of environmental degradation due to adverse effects of human activities including mining and quarrying. A good example is the Kituo Cha Sheria which has initiated several legal suits at the Machakos Law Courts seeking to challenge the authority's laxity in curbing illegal sand harvesting. A case on point is *Machakos High Court Petition 163 of 2011, Kituo cha Sheria vs NEMA and Others* where sand harvesting along river Muangini in Machakos County was challenged in Court and the Court ordered that law enforcement take charge of the situation (Sangor & Petitioner, 2011). Miners lacked other options for sustaining their livelihoods and were therefore least troubled about sustainability of the sand resource. For the miners, working under the governance of CBO's was not promising or assuring unless the local government played a key partnership or co-management role with the CBO's. The miners believed that a strict regulatory approach was inferior to a voluntary mechanism (Court, 2010).

The National Environment Management Authority (NEMA) has been sued severally, among other respondents, for failure to protect local communities against sand harvesting effects. The courts in a 2012 decision ordered NEMA and other relevant government security agencies to provide security to the locals and protect the legitimate miners of sand (Sangor & Petitioner, 2011). Natural resource (sand) conflicts are also very common. Locals in areas where sand is available contest for the resource with foreign harvesters from distant areas who approach in gangs and harvest sand even in the dark of the night. Politicians who attempt to come to the rescue of their constituents have been

reported as making empty and unenforceable declarations and promises not based on existing law (Sangor & Petitioner, 2011).

Increasingly, the NEMA Machakos office has had to deal with reported incidents related to sand harvesting in the financial year 2012 / 2013. About 47 per cent of all environmental incidents reported at the NEMA County office were sand harvesting related. The activity is structured such that the sand dealers (i.e. the transporters) buy and sell the commodity mostly from the local youth, land owners and riparian land owners. The bulk of the money remains with the dealers. The locals have little to show for it despite the commodity allegedly fetching good returns in the market (Kitunga and Murungi, 2013).

2.5 Sustainable sand harvesting strategies

The principle of sustainability is not a new concept. Agenda 21 at paragraph 10.1 states that “land is normally defined as a physical entity in terms of its topography and spatial nature; a broader integrative view also includes natural resources such as the soils, minerals, water and biota that the land comprises. These components are organized in ecosystems which provide a variety of services essential to the maintenance of the integrity of life-support systems and the productive capacity of the environment. Land resources are used in ways that take advantage of all these characteristics” (Janerio, 1992).

Most soil mining affects the environment and as Saviour (2012) noted, India as a country was working hard to tackle the negative impacts of soil mining or sand mining. Sand harvesters are required by law to operate under an Environmental Management Plan (EMP) which sets out the parameters to be observed during a project cycle from commissioning to decommissioning. Potential impacts of projects are known in advance and incorporated into the early stages of development planning right from project inception (Saviour & Stalin, 2010).

In Sri Lanka and with a view to understand sustainability of riverbed sand mining, three major rivers were used as a case study to examine available alternative management options for sustainable sand mining. The alternatives floated by the case study pointed towards a total mining ban as a preservative approach. Another alternative was to restrict access of miners to vulnerable sites (conservative approach) and lastly just doing nothing (indolent approach). A fourth possible alternative included establishing an environmental trust fund that would support sand harvesting at the community level by way of providing a capital base for the community miners. All the foregoing four options were assessed and analyzed with a view of getting the best performing option (Court, 2010). In this study, these options were also assessed in arriving at the recommendation.

2.6 Conceptual framework

The conceptual framework of the Study was based on various variables whose interaction would inform sustainable sand harvesting in Machakos County. The variables are as shown in Figure 2.1.

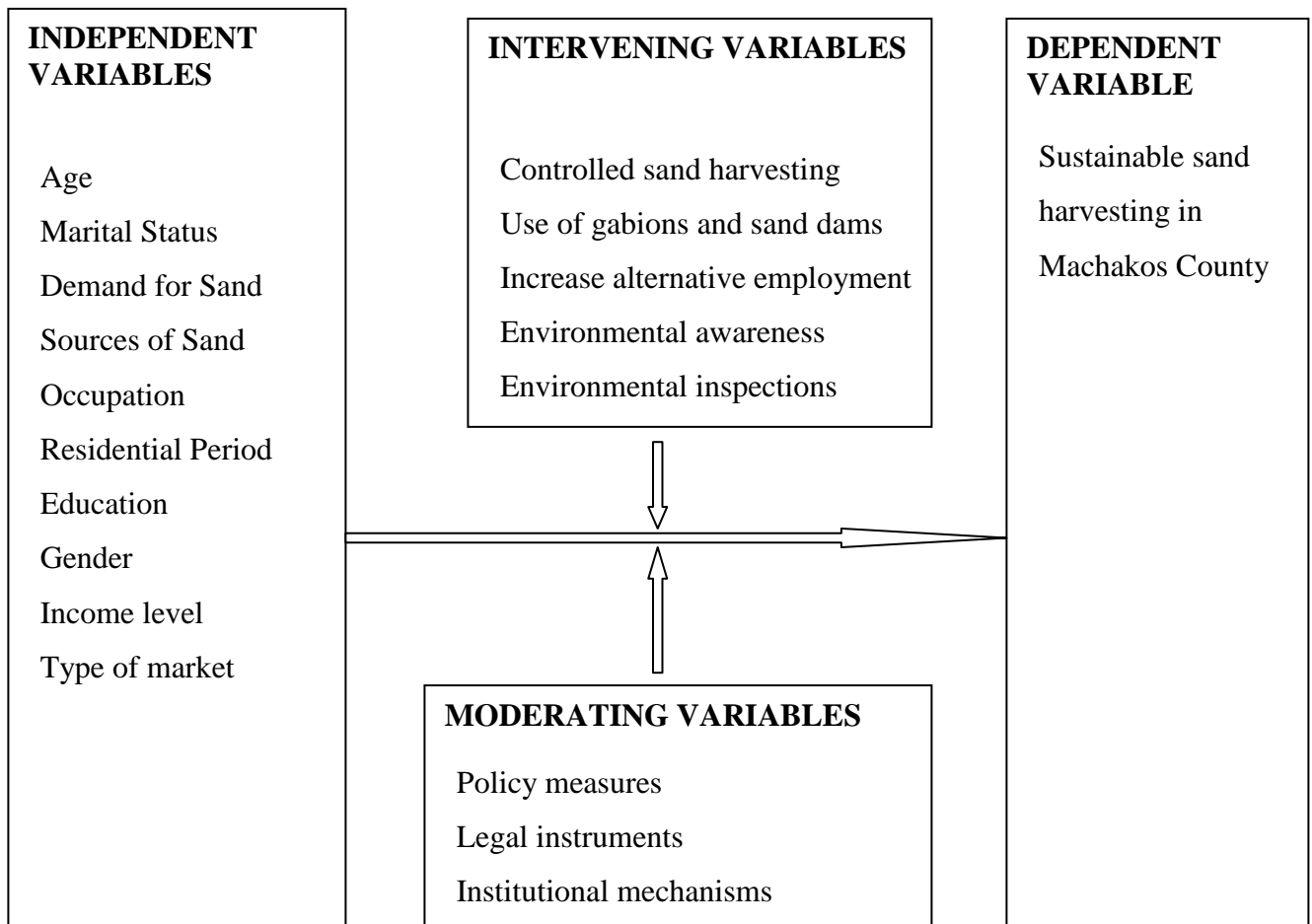


Figure 2.1 Various variables that inform sustainable harvesting of sand in Machakos County in Kenya

The independent variables such as demand for sand, age, gender and education contribute to increased sand harvesting. The independent variables act as factors leading

to sand harvesting either by increasing or reducing its preponderance. For sand harvesting to be sustainably practiced, certain moderating variables such as policy, legal and institutional mechanisms ought to be in place. There is therefore need for good policy, laws and institutions of good corporate governance. If existing institutions do not demonstrate good governance and instead become dens of corruption, then sustainable sand harvesting will be impossible. Equally true is that intervening variables such as good sand harvesting practices will contribute to sustainable sand harvesting. These good practices include building of sand dams or gabions to protect river beds or the controlling of sand harvesting through time regulation or rotation of sand sources. Other interventions will include controlled sand mining by policy makers like the county government and vegetation stabilization. Increased employment opportunities and environmental awareness would also help to reduce negative impacts of sand mining. Other interventions would include encouraging participation in community based organizations hence reducing the effect of possible social conflicts (Tobergte & Curtis, 2013).

CHAPTER THREE: STUDY DESIGN AND METHODOLOGY

3.1 Introduction

This chapter discusses the design used in the study and the methods applied to collect data, analyze it and present it with a view of arriving at conclusions and recommendations. Information on the study site where the research was done is also provided in the chapter.

3.2 Study area

The study area comprised of three Constituencies or geographical Districts in Machakos County as shown in Figure 3.1.

3.2.1 Location and size

Machakos County is located strategically. It shares its borders with seven other Counties. To the north lies the Counties of Embu, Murang'a and Kiambu. To the south lies Makueni County and to the East Kitui County. To the west lies Nairobi and Kajiado Counties. Machakos County lies on an area that spans 6208.2 Km² and noteworthy is that the sub county or the Constituency that is Machakos town covers only a 15% of it. Kathiani covers an even smaller space of about 3% with Mwala taking the larger area at about 16% of the County. Machakos County lies between latitudes 0°45'South and 1°31'South and longitudes 36°45'East and 37°45'East (GoK, 2013).

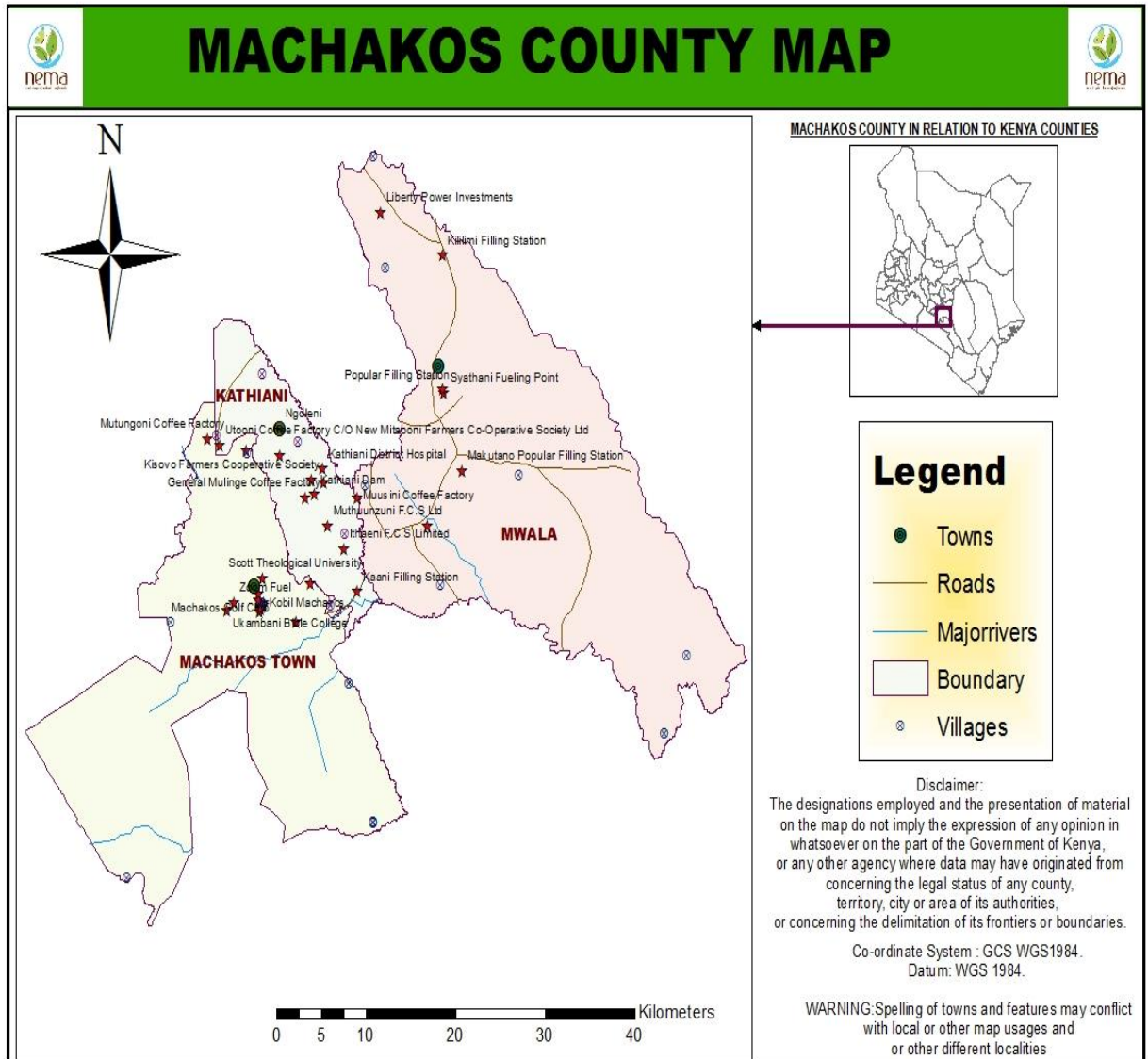


Figure 3.1 A map of the study area showing the key sand harvesting sites of Machakos town, Kathiani and Mwala

3.2.1 Population

As seen in the foregoing statement on location and size of the 3 study sites, Mwala is among those with the biggest area coverage in the County while Kathiani is among the

smallest geographically. However, Kathiani has among the highest population density. It is therefore true to state that geographical area or size is not necessarily relative to population density. The total population of the County is recorded as 1,098,584 according to the 2009 Kenya Population and Housing census. It was projected to increase exponentially every year (GoK, 2013).

3.2.2 Physical characteristics

Machakos County has diverse physical and landscape features. In the middle of the County are hills and a small plateau rising to about 2000m above sea level. Westward, the County has a large plateau elevated to about 1600m. The lowest altitude in the County is at about 790m with the highest about 2000m above sea level. In the North West the County is very hilly. The vegetation across the entire County depends on the altitude of any given area/location. The soils are generally well drained shallow, dark red clay soils particularly in the plains. Rainfall is widely distributed since some areas of the County are arid while others hilly and well forested. The plains are characterized by less rain and acacia type of vegetation. Kathiani and Mwala fall under this category of plains (GoK, 2013).

3.2.3 Ecological conditions

Machakos County has two important rivers running through it. The Tana and Athi rivers run through Machakos County substantially. They are also the main sources of water and sand harvesting. The Masinga dam within Masinga Sub County which is the largest Sub County lies in the County and occupies a land mass of approximately 1,402.8 Km². The

Yatta plateau which is situated within the Yatta Sub County is also resident in Machakos County . Machakos County has County and private forests which comprise about eight per cent of the total land area in the County distributed in various parts of the County. These forests contribute to the water catchment areas existing in the County such as the *Kiima Kimwe* and Iveti hills (GoK, 2013).

3.2.4 Climatic conditions

The annual rainfall patterns in the County are highly variable with an average rainfall of between 500 mm and 1300 mm. Just like the other parts of Kenya, the short rains occur in October and December while the long rains are from March to May although rainfall patterns are changing due to the effects of climate change. July is the coldest month while October and March are the warmest. Average temperature lies at 24 degrees Celsius throughout the year. The highland areas receive more rain than the low lying areas of Kathiani, Machakos town and Mwala (GoK, 2013).

3.2.5 Land use

Just like in Kenya generally, land in Machakos has a sentimental value and land ownership is deemed affluent or a position of privilege. Land use includes Forest, Government Reserve, Townships, Game Reserves, Agriculture, Ranches, Industrialization, mining (sand, coal and precious metals) and pastoralism. The County recently developed and launched a Spatial plan dubbed the Physical Development Plan (GoK, 2013).

3.2.6 Level of urbanization and education

The County has several urban centres with the main ones being Machakos town and Mavoko which are almost similar in population. The population of Machakos town and Mavoko town can be majorly attributed to the concentration of industries in the two towns. The nature of industries range from meat processing, steel and foundry works and agriculture all attracting a huge labour force (GoK, 2013).

The County has 1,736 Early Childhood Development (ECD) centres, 688 primary schools and 190 secondary schools. The introduction of the free primary education increases the enrolment of children into primary school. This has led to a strain on the infrastructure of the primary schools particularly the classrooms, toilets and laboratories. Though primary education, secondary education and universities has not been devolved to the County government, the County is keen on cooperation with the National government to ensure that the infrastructure mentioned above takes into account the growing enrolment rates. Since the ECD and the village polytechnics have been devolved, the County government has set aside a budget to ensure that the number and quality of ECD centers increases (GoK, 2013).

The County has one medical training institution (MTC) located in Machakos town and two private universities namely Daystar University and Scotts Christian University which are situated in Mavoko and Machakos Town constituencies, respectively. Other universities such as University of Nairobi, Kenyatta University, Africa Nazarene University, St. Pauls University and Jomo Kenyatta University of Agriculture and Technology have also opened various campuses in the County. Most of the campuses are

situated in Machakos town. The institutions have created opportunities for the youth to acquire skills and knowledge (GoK, 2013).

3.2.7 Primary occupation

Most of the residents of the County, about 56% are gainfully employed including self-employment. The labour force population is reported to increase exponentially every year by about 2% since 2009 to 2017. This increase in labour force translates to the need to put strategies in place to ensure there is significant economic activity which will ensure that there is significant employment creation to absorb the growing labour force. One of the strategies that the County is looking at is establishment of industries aimed at value addition particularly for agricultural products, an indicator of farming as a primary occupation (GoK, 2013).

3.3 Sampling Design

A descriptive qualitative research was used in answering why the sand harvesting situation was the way it was in Machakos County. In qualitative research, a researcher would enquire on how people learn about and make sense of their daily lives. To achieve this, simple and flexible strategies that are sensitive to societal tendencies are best. In a qualitative interview, interviewees are allowed to share their experiences as opposed to being asked rigid and set questions (Hox and Boeje, 2005). Qualitative research methods come in many forms or types, encompassing various approaches sometimes based on the nature of research being conducted. According to Polkinghorne (1983), all qualitative research methods rely not on numerical data but lingual, and adopt meaning-based rather

than statistical forms of data analysis. Qualitative research helps in examining the independent variables of a study as they are by posing exploratory questions to a set of respondents and then recording their responses. It does not rely on perspectives outside the set of respondents. It is termed exploratory because the nature of questions should be open ended and not closed-ended hypotheses (Elliott and Timulak, 2005). Desktop analysis of the legislation applicable to sand harvesting was conducted drawing from the personal experience of the researcher in matters sand mining and his role as an official of a Government regulator. Data was gathered using questionnaires from the residents in the study area. Though descriptive research can be both quantitative and qualitative, in this study it was used in the qualitative sense to analyse the current state of sand harvesting in Machakos County.

3.4 Sampling procedures

The respondent base comprised 81 entities drawn from three spatial clusters/constituencies of Mwala, Kathiani and Machakos town where sand harvesting is practiced. These clusters formed the study site. There was no total population of sand harvesters since there was no record of registered sand harvesters reason being that the activity was largely practiced informally and even discreetly. Machakos town had the largest population and Kathiani had the largest population density in Machakos County (GoK, 2013). From the three clusters, snowball sampling method was employed on residents close to the sand harvesting sites to select at least 20 + 1 respondents who were subsequently interviewed using a structured questionnaire. The snowball approach was used due to the fact that there was no record of the total sand harvesters in the study area

from which a mathematical formulae of selecting a sample size could be employed. Key opinion leaders such as the Machakos County Government Environment Officials, the National Environment Management Authority Officials, the Local Administration especially area Chiefs, and organized sand harvesting groups formed additional respondents and were engaged through a separate questionnaire designed as a semi structured interview and focused group discussion to complement the opinions of the local people. There was need to have a more structured survey tool for this latter group as it comprised of more informed respondents.

3.5 Data collection methods

Primary data refers to data gathered specifically for a certain research goal whereas secondary data refers to data originally gathered for a different purpose but used for another research goal (Hox and Boeje, 2005). Both primary and secondary data were used in this study in order to cross check the obtained information. The purpose was to guarantee reliability of the collected data and thereby improved the validity of the data. Combining methods gave a more nuanced picture, as it brought in different interpretations and dimension of the same phenomenon. The various methods used to collect primary data were questionnaires, semi-structured interviews, focus group discussions and participants' observation. Face to face interviews were held with the help of semi-structured and unstructured questionnaires. Respondents or participants are asked to provide their stories or responses about particular experiences elaborately (Elliott and Timulak, 2005). Although it is a common practice to analyze data collected for other

research projects and apply it as secondary data, such data is considered to be less of a source and is scarcely used, except by social historians (Boeje and Hox, 2005).

3.5.1 Use of Questionnaires

Questionnaire surveys were employed in the beginning of field work in order to get an idea of the socio-economic situation of the various stakeholders and actors and to get a quick overview of the issues related to sand harvesting. The questionnaires were designed to generate quantitative data that could translate into statistics and were varied to fit the different categories of intended respondents. The benefits of questionnaires include the ability to collect both subjective and objective data in a large sample of the study population in order to obtain results that are statistically significant especially when resources are limited. It is a good tool for the protection of the privacy of the participants (Abawi, 2013).

The questionnaires used were administered by the research team on a face to face interviews save for those distributed to the Key opinion leaders such as the Machakos County Government Environment Officials, the National Environment Management Authority Officials, the Local Administration especially area Chiefs, organized sand harvesting groups. This latter group was given the questionnaires to fill and the results collected at a later date. A sample of the questionnaires used appears as annexure 1 to this Thesis.

3.5.2 Semi-structured interviews

Open ended questions were used hand in hand with the questionnaire surveys by way of incorporating semi structured questions in the questionnaires and also developing a separate interview guide that contained broad questions to guide the research team. Semi-structured interviews included a number of planned questions, but the interviewer had more freedom to modify the wording and order of questions. The advantages of such interviews include the ability to collect complete information with greater understanding, ability to get more personal, as compared to questionnaires and thus allowing higher response rates. Interviews also allow for more control over the order and flow of questions (Abawi, 2013). Semi structured interviews provided very useful qualitative data. Interviews with key informants were also undertaken.

3.5.3 Focus Group Discussions

During the field work, one focus group from a registered sand harvesting group in a site in Mwala Sub County was set up and used in the data collection exercise for purposes of collecting data from a larger number of common thinking respondents. It consisted of transporters, land owners and loaders in the sand harvesting community. This was the only organized sand harvesting group that was identified but its input was comprehensive. Sand harvesting by its very nature was an informal activity and was practiced almost clandestinely. It was almost impossible to find any organized sand harvesting group. The group shed positive light about the advantages of sand harvesting by organized groups as opposed to by individuals.

A focus group discussion (FGD) is said to be a good way to gather together people from similar backgrounds or experiences to discuss a specific topic of interest. The group of participants is guided by a moderator (or group facilitator) who introduces topics for discussion and helps the group to participate in a lively and natural discussion amongst themselves (Manoranjitham and Jacob, 2007).

The strength of FGD relies on allowing the participants to agree or disagree with each other so that it provides an insight into how a group thinks about an issue, about the range of opinion and ideas, and the inconsistencies and variation that exists in a particular community in terms of beliefs and their experiences and practices (Manoranjitham & Jacob, 2007). River bed degradation was more a result of individual harvesters as opposed to the organized groups. There was an apparent sense of accountability among the group members.

3.5.4 Participants' Observation

It was important to study the organized sand harvesting groups especially their culture with a view of understanding their way of life. Participant observation is in some ways both the most natural and the most challenging of qualitative data collection methods. It connects the researcher to the most basic of human experiences, discovering through immersion and participation the hows and whys of human behavior in a particular context. Such discovery is natural in that all of us have done this repeatedly throughout our lives, learning what it means to be members of our own families, our ethnic and national cultures, our work groups, and our personal circles and associations (Boeje and Hox, 2005).

The challenge of harnessing this innate capability for participant observation is that when we are participant observers in a more formal sense, we must, at least a little, systematize and organize an inherently fluid process. This means not only being a player in a particular social milieu but also fulfilling the role of researcher which is taking notes; recording voices, sounds, and images; and asking questions that are designed to uncover the meaning behind the behaviors (Guest *et al.*, 2013). Observation was done both overtly and covertly as the situation dictated.

3.6 Data Analysis

The study relied on both primary and secondary data. The former comprised data from the actual field visits using questionnaires, semi structured interviews, FGD's and participants' observation. The source of secondary data was various census data, online journals, workshop papers and policy briefs. Data was entered in Microsoft Excel spreadsheets for cross tabulation purposes and analysis conducted using the G-Test of independence. According to Hargett (2006), data analysis with a good statistical program isn't really difficult. It does not require much knowledge of mathematics, and it doesn't require knowledge of the formulas that the program uses to do the analyses. It really only requires a "clean" spreadsheet that's analysis-ready, a clear idea of what evaluation questions you want the data to answer, attention to detail and a relaxed frame of mind.

The data collected was taken through content analysis technique where the data was fed into a Microsoft Excel data sheet in readiness for analysis. Every response in the filled questionnaires was categorized as per the questions in the questionnaire. This was with a view of coding the information so that results based on a particular code or question can

be pooled together for tabulation (University, 2004). The aim was to make sense of the data collected and to highlight the important messages, features or findings. Researchers regard content analysis as a flexible method for analyzing text data (Hsieh & Shannon, 2005). G-test of independence was used to analyse the results of the study. G-test can be used for elaborate statistical designs as well as for simpler designs (MacDonald, 2008).

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This Chapter presents the results of the data gathered and analyzed during the study. The various independent variables were assessed with a view to finding out how they contribute to the dependent variable which is sustainable sand harvesting in Machakos County. Presentation of results was done with the aid of Tables and Figures and as per the study objectives. The results are then discussed as they are presented.

4.2 Factors contributing to increased sand harvesting in Machakos County

Various factors were examined with a view to ascertaining their relevance to increased sand harvesting activities in the County. The key factors were gender, age, marital status, occupation, family size, residential period, sources of sand, demand for sand and type of market for sand.

4.2.1 Gender

Out of the 81 respondents interviewed, 58 were male and 23 female. There were more males available for the interviews compared to women. This means that out of the total study sample of 81, 72% were male and 28% female (Figure 4.1). Out of these respondents, 60% of the males and 50% of the females agreed that they practice sand harvesting representing 36 males and 11 females respectively (Fig.4.2).

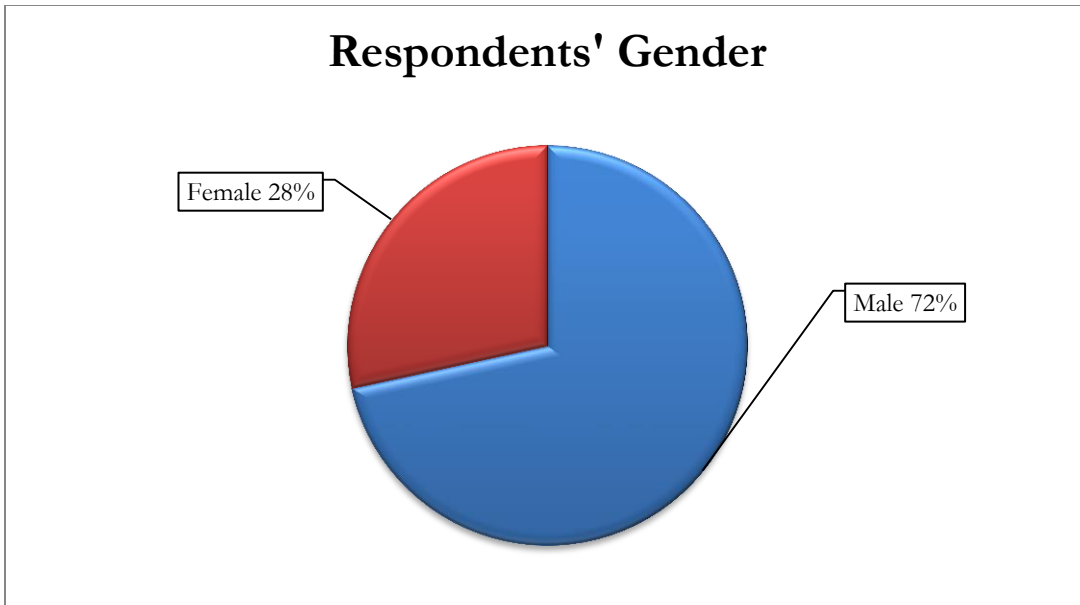


Figure 4.1 Gender composition of respondents used in the Study

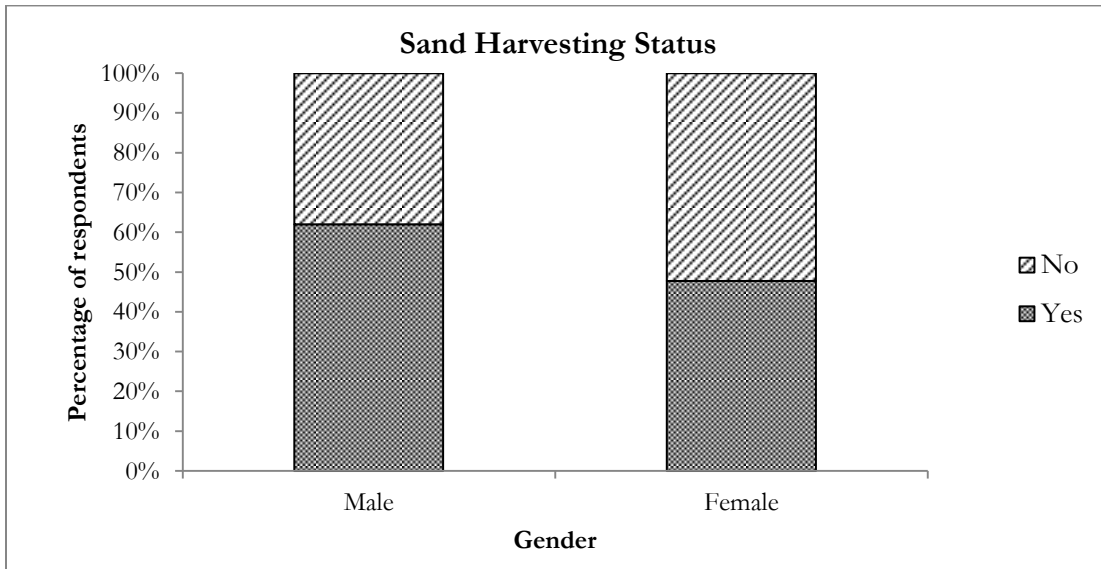


Figure 4.2 Gender comparison of respondents showing proportion of sand harvesters in Machakos County

A G- test of independence was performed to examine the relation between gender and sand harvesting in Machakos County. There was no significant relationship between these two variables, $G_{(1, N=81)} = 1.37, p > 0.242$). Sand harvesting in Machakos County is therefore gender independent although a higher number of males tend to harvest sand compared to females as shown in Figure 4.1.

According to Hinton *et al.*, (2003), approximately 30% of the world's artisanal miners are women who undertake a number of roles ranging from labour intensive mining methods to the processing aspect of artisanal mining, including amalgamation with mercury in the case of gold extraction. As processing activities are often conducted in the home, women and their families can be at great risk from mercury poisoning and silicosis. In many cases, the roles of women in artisanal mining communities differ significantly from those of men, and extend well beyond direct participation in mining activities. Though the study Hinton *et al.*, (2003) addressed a different type of artisanal mining (metals and not sand), the finding on gender representation is akin to the result of the present study of Machakos County as both relate to artisanal or small scale mining.

According to Eftimi *et al.*, (2012), among the more than 20 million artisanal and small-scale miners active around the world, the proportion of women miners was estimated at about 30 percent in 2003; their involvement could be much higher (Hinton *et al.*, 2003). Women make up between 10 percent to more than 50 percent of miners in some Asian countries. In Latin America, they comprise approximately 10–30 percent; in Africa, women may make up anywhere from 40 to 100 percent of the workforce. It is, therefore, true to state that gender is not a factor that significantly contributes to increase in sand harvesting since women practice sand harvesting just as much as men.

4.2.2 Age

The age of the respondents was classified into four categories. The percentage distribution of the respondents per age category is shown in Figure 4.3 indicating: Children (<18 years); 3%, Youth (18-30 years); 28%, Middle age (30-50 years); 42% and Older people >50; 27%.

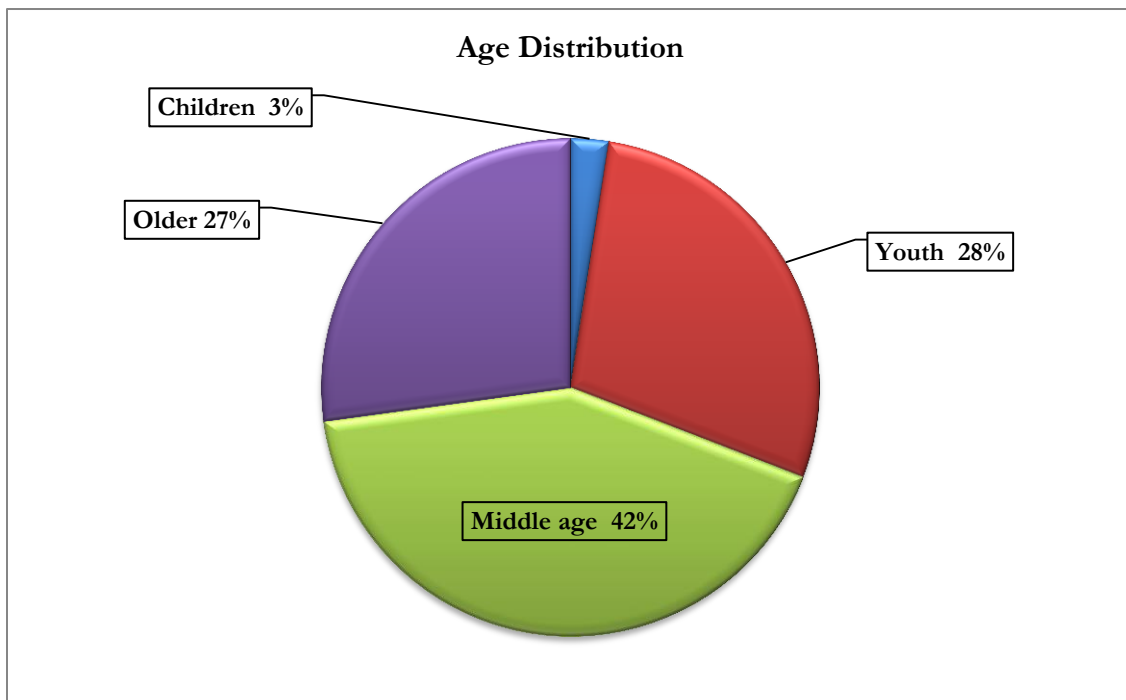


Figure 4.3 Age distribution of the respondents involved in sand harvesting in Machakos County

A G-test of independence showed that there is no significant difference between age group and sand harvesting in Machakos County since $G_{(3, N=81)} = 6.004, p > 0.111$. This shows that all age classes do practice sand harvesting in the County; hence age is not a major factor affecting sand harvesting although more youths (28%) do sand harvesting than all other age classes as shown in Figure 4.4. This information was obtained through

the questionnaires and interviews where 78% of the respondents that admitted to the practice of sand harvesting, were youth.

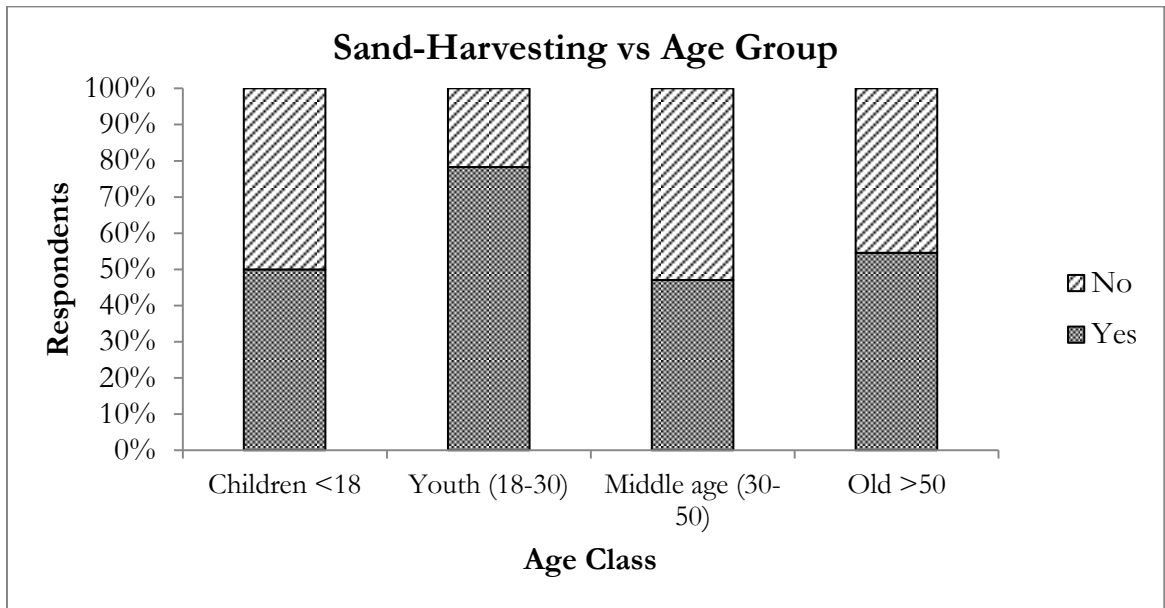


Figure 4.4 Comparison of those who practice sand harvesting by age group in Machakos County

Young children under 18 years of age are involved in sand harvesting and so more youths were found to dominate sand harvesting in the County. The information on the minors was obtained by interviewing their guardians at home since most of them were school drop outs. This may be explained by several factors such as youth unemployment and physical strength because sand harvesting is a masculine oriented job. The middle aged people are found to be less involved in the practice since majority are employed or have emigrated to urban centers in search of better jobs. More older people in the County practice sand harvesting than those who don't because they own resources such as land, transport lorries or have the capital to do the business.

Although the researcher did not find significant studies that co related the age factor with sand harvesting, NEMA (2007) strongly recommended that sand loaders be over 18 years of age to rid the activity of minors. A policy direction or law was necessary to effect that recommendation and which would see less of school dropout cases and more of responsible sand harvesting (NEMA, 2007).

4.2.3 Marital Status

81% of the respondents were married whilst 19% were single. A G - test of independence established that sand harvesting in the County is independent of the marital status of the residents with $G_{(1, N=81)} = 0.165, p > 0.684$.

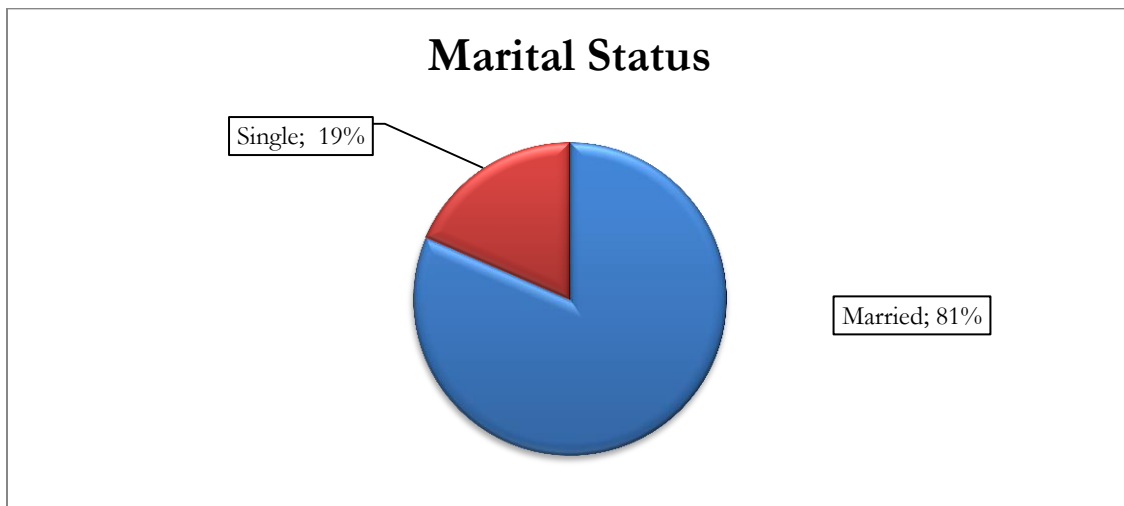


Figure 4.5 Marital status of the respondents who practise sand harvesting in Machakos County

Equally true is that both the married and single people in the County who practice sand harvesting are more than those who do not as shown in Figure 4.6. Among the married interviewees, 60% practiced sand harvesting as opposed to 50% among the single ones.

This is attributable to the fact that sand harvesting is a source of livelihood to many in the County and both the married and single people compete for the resource although at varying degrees.

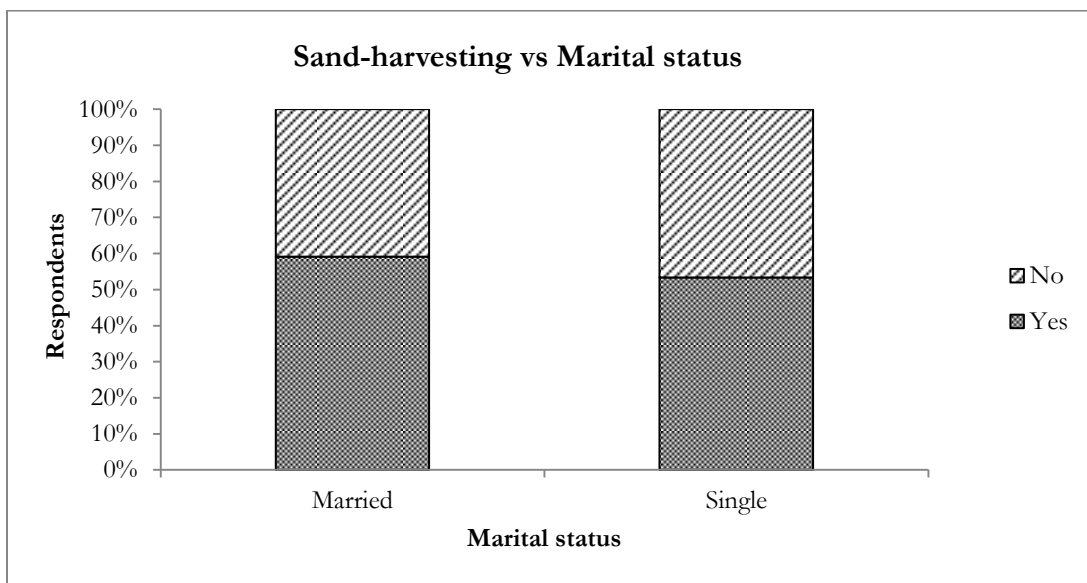


Figure 4.6 Relationship between marital status and sand harvesting in Machakos County

Ayenagbo *et al.*, (2011), in a study conducted in Togo found that 60% of sand harvesters were married with 38% being singles and 2% widows and widowers. This finding demonstrates a concurrence with the results of the current study at Machakos County.

4.2.4 Occupation

Sixty seven percent (67%) of the respondents were farmers, 15% had various types of jobs, 17% were business people and only 1% was a civil servant (See Figure 4.7). None of the respondents stated that they were unemployed presumably because farming however small scale, was considered as an occupation. The type of occupation of the people of Machakos County does not significantly affect the practice of sand harvesting as demonstrated by a G-test of independence since $G_{(3, N=81)} = 1.974, p > 0.578$.

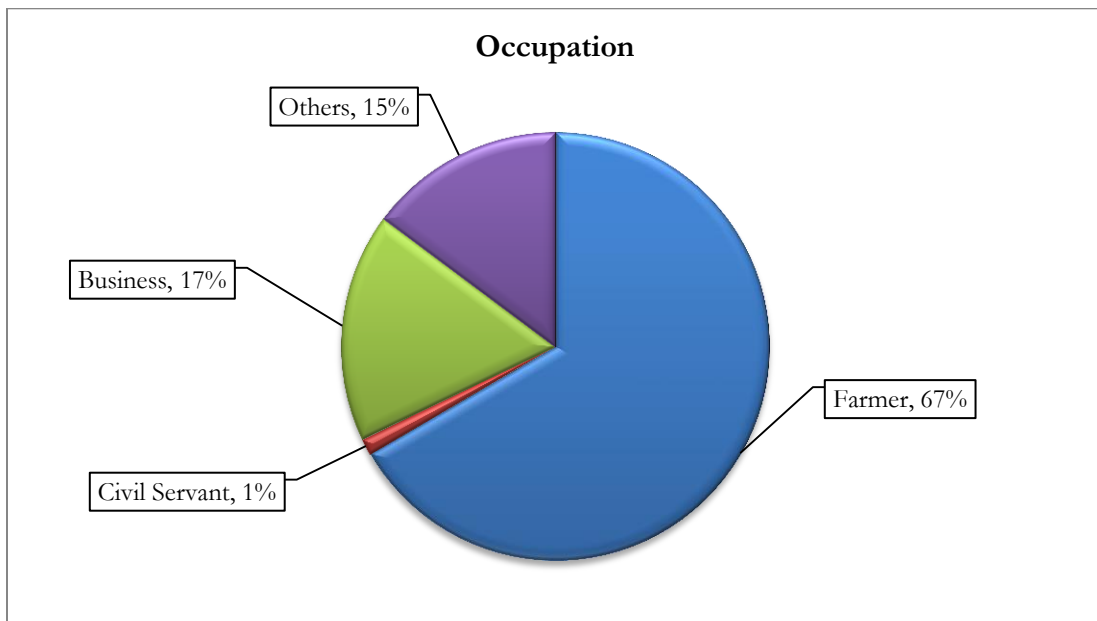


Figure 4.7 Occupation of the respondents who practice sand harvesting in Machakos County

It is noteworthy that more farmers, business people and other professionals except civil servants in the County practice sand harvesting as illustrated in Figure 4.8. This can be

explained by the fact that save for the civil servants who would be working in various towns from time to time due to the possibility of job transfers, the others were normally resident in the County.

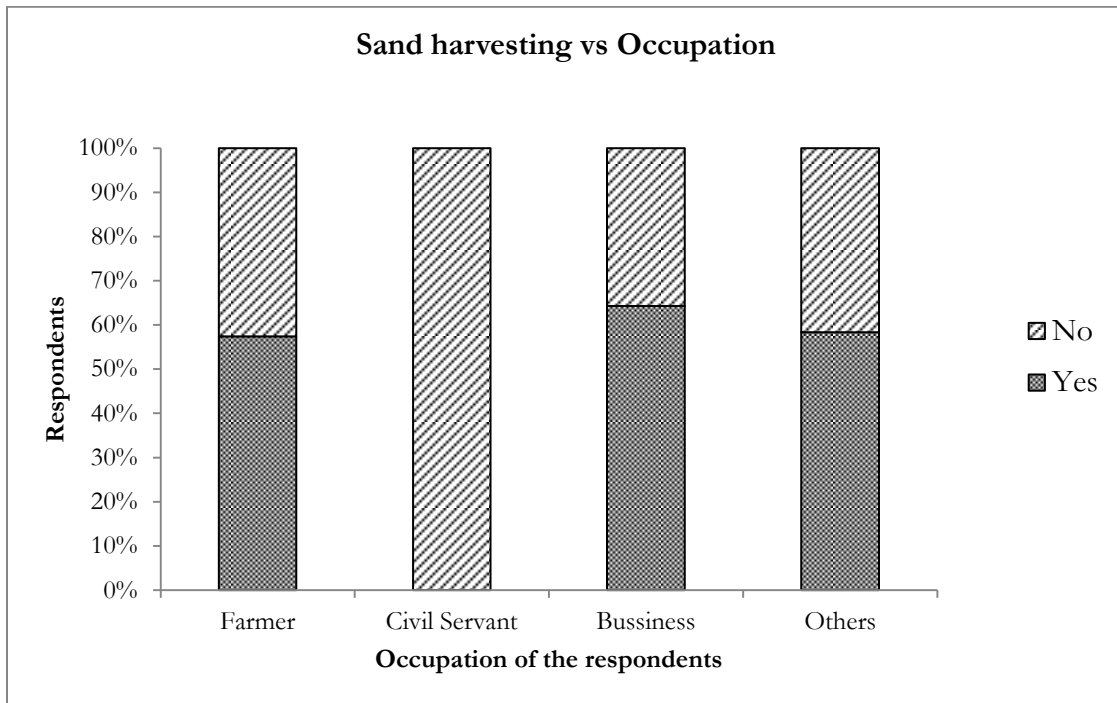


Figure 4.8 Relationship between different occupations and sand harvesting in Machakos County

In discussing this result, no studies relating occupation type with sand harvesting were found. The type of occupation is therefore significantly influenced by sand harvesting in the County. Business persons and farmers were more pre disposed to sand harvesting than civil servants. A plausible explanation was that sand harvesting being practiced largely informally and almost illegally, civil servants as employees of the government, would be more averse to the practice.

4.2.5 Family size

Majority of the respondents (59%) had a medium sized family of 2-5 members, 26% had larger families of 6-10 members whilst only 4% had an extra-large family of over 10 members while 11% had no families (Figure 4.9).

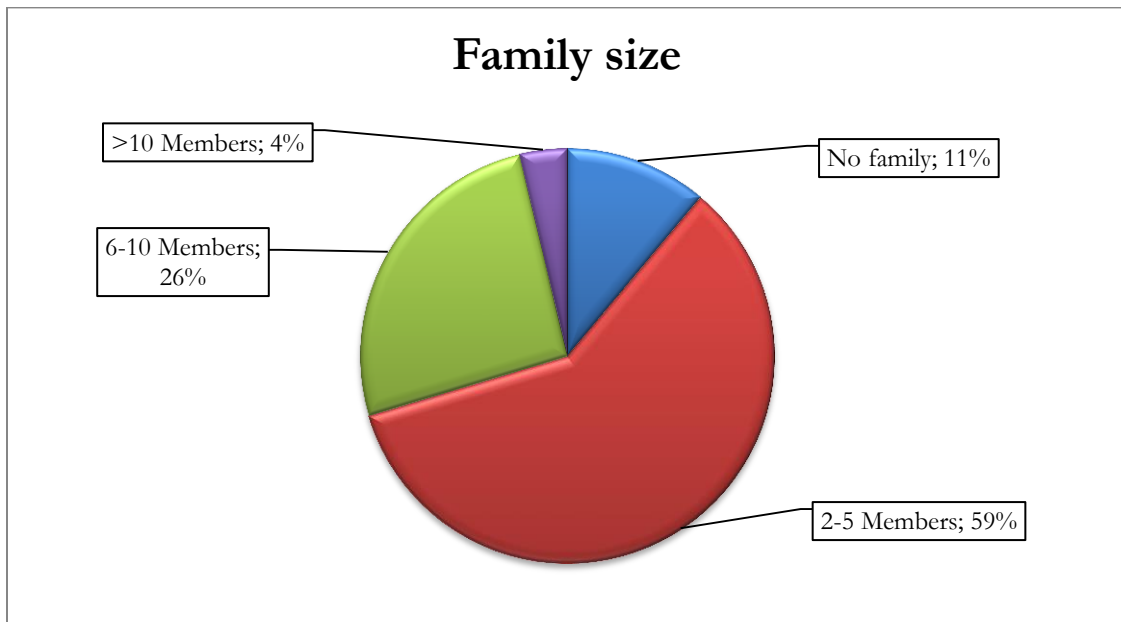


Figure 4.9 Family size of respondents who practise sand harvesting in Machakos County

The family size of the people of Machakos County does not significantly affect sand harvesting as shown by a G-test of independence since $G_{(3, N=81)} = 5.612, p > 0.132$. It was found that the respondents were dependent on sand harvesting irrespective of their family size (Figure 4.10). In comparing this result with others, no previous studies relating family size to sand harvesting were available. Family size is not a significant factor contributing to increased sand harvesting since each family size category had an

over 40% score on sand harvesting as seen in the Figure 4.10. it is evident that out of the interviewees without family, 65% of them relied on sand harvesting as opposed to the extra large families of ten plus members that entirely relied on sand harvesting. The group that was least dependent on sand harvesting was that of six to ten members.

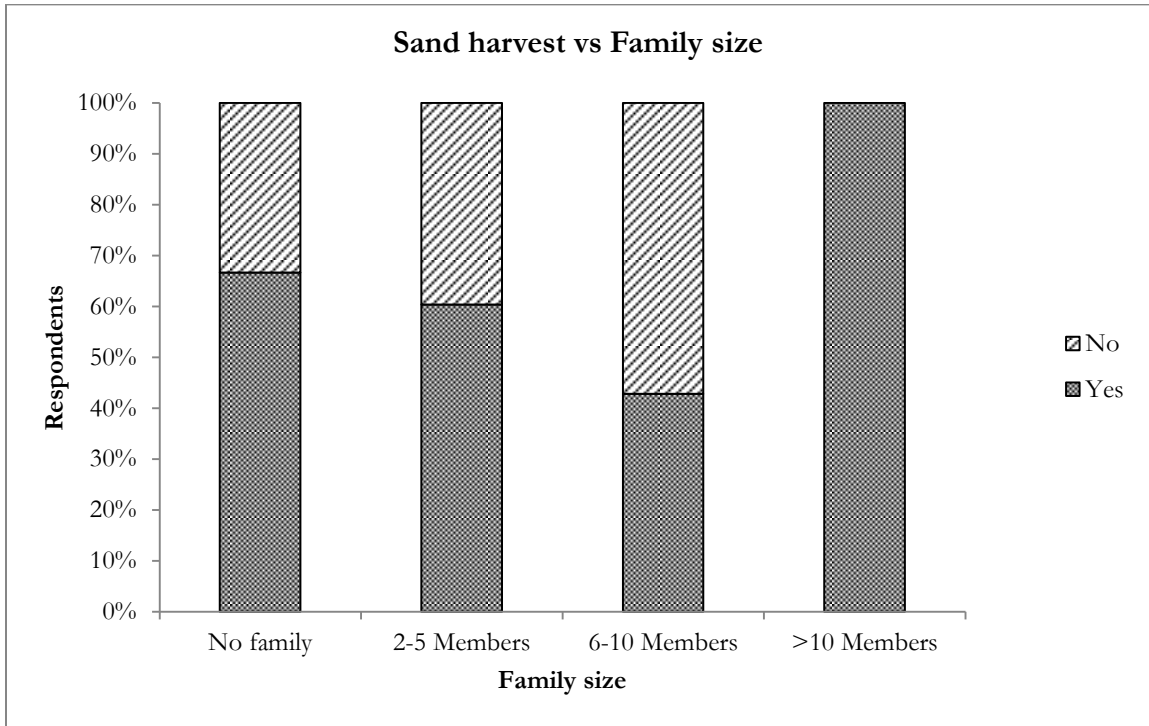


Figure 4.10 Sand harvesting against family size in Machakos County

4.2.6 Residential Period

Fifty nine percent (59%) of the respondents had lived in the County for over 10 years. 36% had lived for a period of between 5 to 10 years while only 5% had lived there for a period of less than 5 years (Figure 4.11).

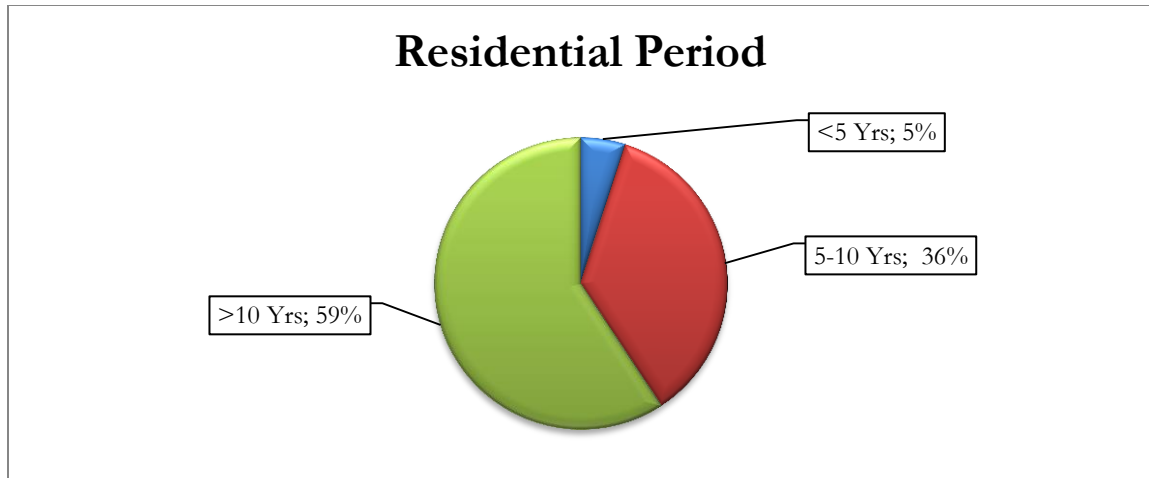


Figure 4.11 Residential period of respondents who practise sand harvesting in Machakos County

The period of residence in the location significantly affected sand harvesting since $G_{(2, N=81)} = 2.267, p > 0.332$. Residents under 5 years developed as sand harvesters as they grew their skills and perhaps responded to the status quo but after staying on for about ten years the tendency to harvest sand changed back downward. The study explains that after a long residency, the residents would probably change their occupations to more formal and permanent ones. Sand harvesting was more predominant among the 5 to 10 years group as shown in Figure 4.12. The data was captured from the respondents' during the data collection process. In discussing this result, no studies co-relating residential period and sand harvesting were available.

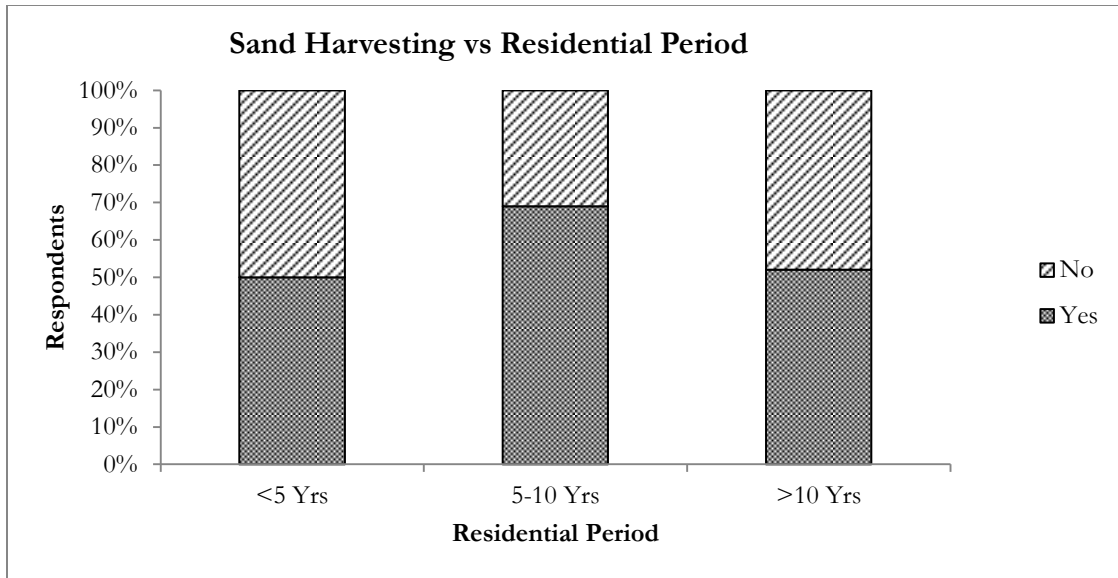


Figure 4.12 Sand harvesting against residential period of the people in the County

4.2.7 Sources of Sand

It was established that river beds and banks are the main sources of sand in the County with 90% of the respondents' indicating so and that arable land is the minor source of sand in Machakos at 10% (Figure 4.13).

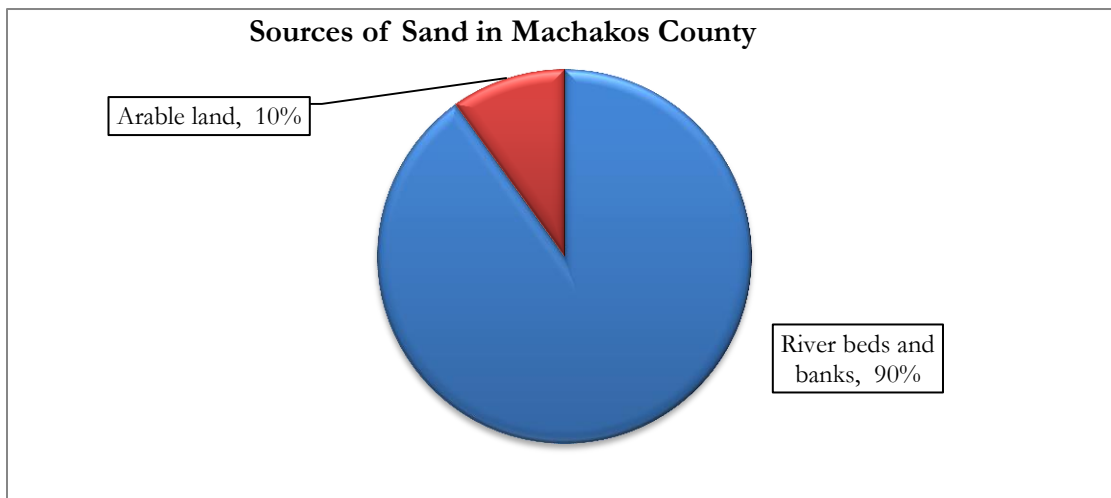


Figure 4.13 Sources of Sand in Machakos County

The data was gathered from the questionnaires collected from the respondents and also results from the semi structured interviews held with NEMA, Local administration and the County Government. Sand harvesting is significantly dependent on the sand source in Machakos County as established by a G-test of independence since $G_{(1, N=81)} = 3.993$, $p < 0.046$. Over 62% of sand harvesters in the County obtain sand from river sources. Sand availability in river banks and beds is therefore a contributing factor for increased sand harvesting in Machakos County.

The ecological and topography of Machakos County is a good pointer towards the availability of sand in the County. The County is generally low lying with the highest altitude being around 2000m above sea level (GoK, 2013). There were very few instances of sand harvesting being practiced on arable land and in most of those few cases, it is where the arable land had been reclaimed from land that was previously a river bed either after a river has changed its course or had completely dried up. An example of sand harvesting on arable land is shown in Figure 4.14.



Figure 4.14 A photo showing sand harvesting on arable land in Kathiani Constituency (photo taken on 23.3.2015)

4.2.8 Demand for Sand

Commercial and subsistence/domestic demand for sand in Machakos County compete with commercial building and construction activities having 56% and domestic use with 44% of sand harvested in the County.

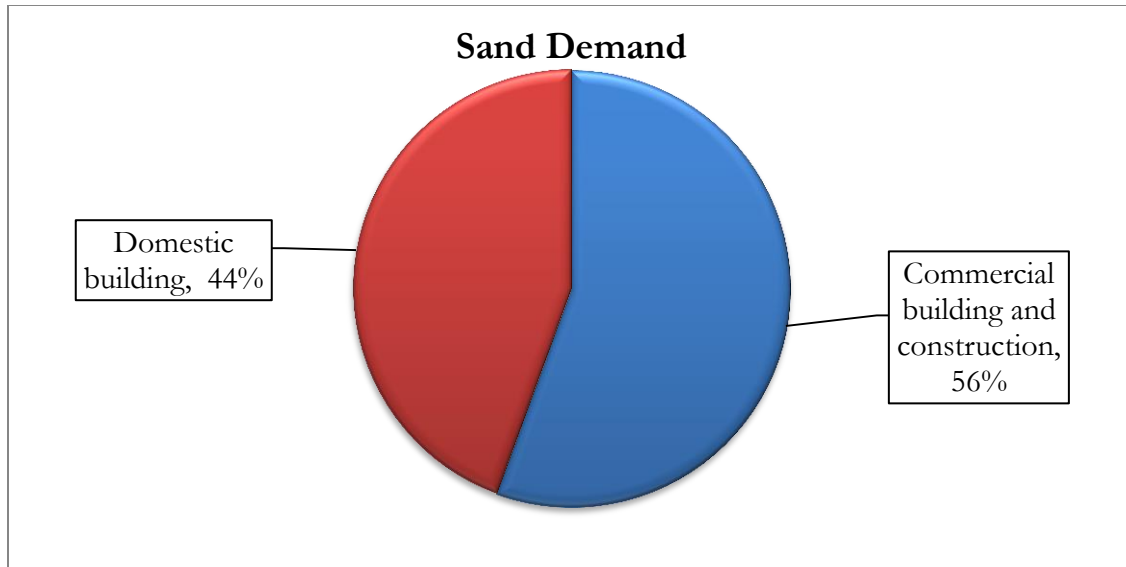


Figure 4.15 Proportion of demand for sand for commercial vs domestic purposes in Machakos County

Sand harvesting in Machakos County is dependent on the demand and use of sand as established by the G-test of independence since $G(2, N=81) = 30.506, p < 0.0001$. The demand for sand for commercial buildings and construction in the County is a significant determining factor contributing to sand harvesting activities especially in Machakos Town Constituency as seen in Figure 4.16.

The demand for sand can be attributed to increasing urbanization and growth of human population including commercial activities which require construction of facilities and amenities. Sand is a major ingredient in construction work and will no doubt be on high demand in such cases of urbanization.

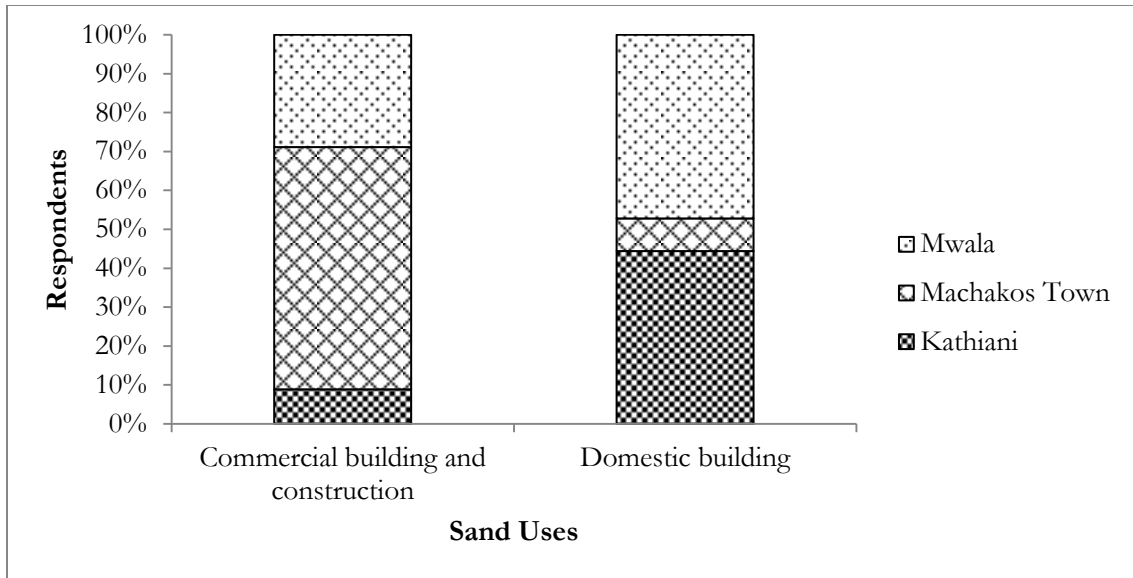


Figure 4.16 Sand demand for commercial and domestic use in Mwala, Machakos Town and Kathiani Constituencies of Machakos Town

4.2.9 Type of Market for Sand

Sixty four percent (64%) of the sand harvested in the County is transported and sold outside the County and only 36% is used locally (Figure 4.17).

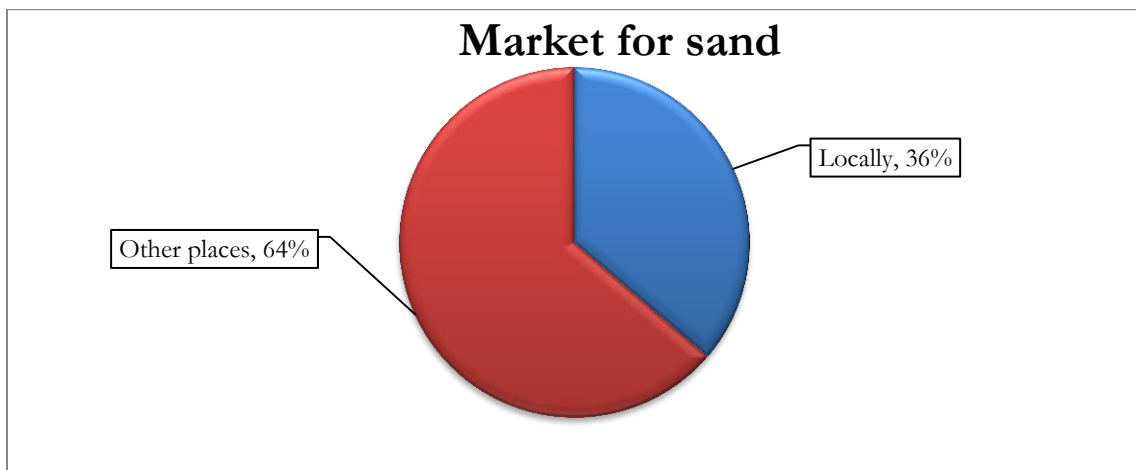


Figure 4.17 Type of market for sand harvested in Machakos County

There is a significant relationship between sand harvesting in the County and the market since $G_{(6, N=81)} = 57.733$, $p < 0.0001$. The availability of market for sand outside the County is a key determining factor of sand harvesting with Nairobi County and its suburbs being the main markets (Fig 4.18).

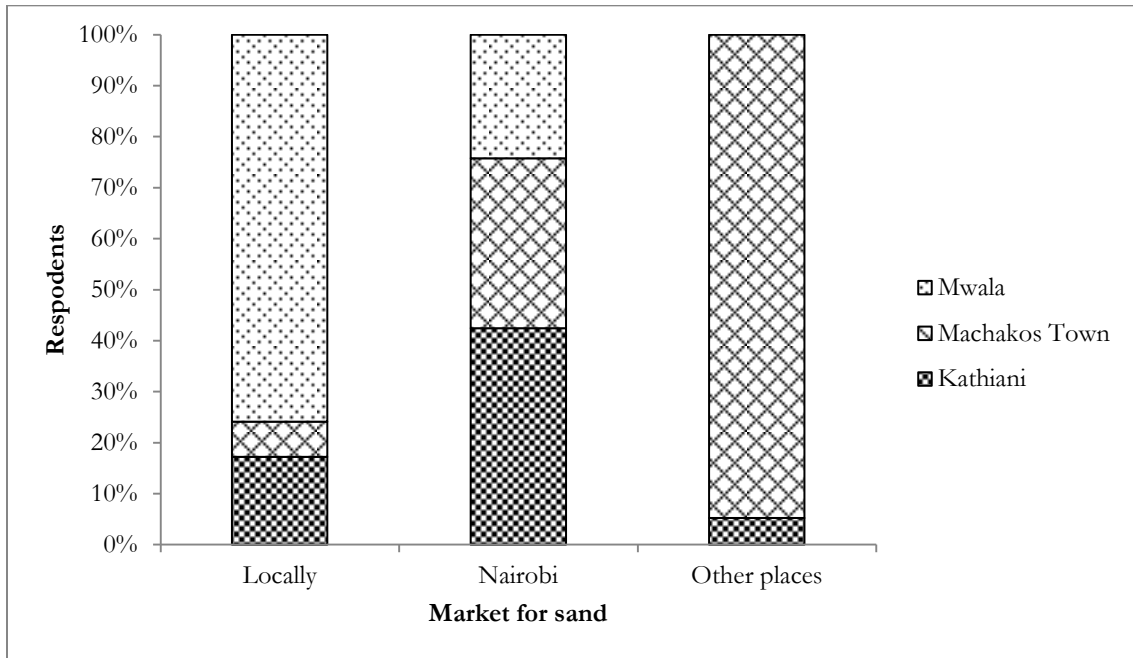


Figure 4.18 Sand markets for sand harvested from Machakos County

It is therefore clear that markets for sand without Machakos such as Nairobi and its suburbs are a significant factor that contributes to increased sand harvesting in the County. This finding was gathered from data collected using questionnaires and semi structured interviews held with the local administration, NEMA and the County Government. This finding agrees with other findings such as that made by Bolen (1991) which established that production of industrial sand and gravel in 1995 increased to 28.2 million metric tons, about 3% more than 1994's production in the United States of America. That production increased in response to greater demand for many uses

including: blast, filtration, and traction sand; fiber, flat, and specialty glass sand; for silica used in chemicals and as filler; and in the “whole grain filler/building products” category. Nairobi being more urbanized and densely populated than Machakos County, sand harvested in Machakos inevitably must be influenced by various activities and growth of Nairobi City County.

4.3 Impacts of sand harvesting

Data on the impacts of sand harvesting in Machakos County was gathered in 2 ways. The 81 respondents interviewed by way of the questionnaire survey were given an opportunity to indicate what the socio-economic and ecological impacts of sand harvesting were. The question included a checklist of many possible impacts, mostly negative. Secondly, a semi structured interview guide was developed and shared with the Local administration, NEMA Machakos Office and the County Government department responsible for matters environment.

Significantly there was established many negative impacts of sand harvesting in Machakos County using the G test of independence since $G(9, N=81) = 158.995, p < 0.0001$. Loss of water, soil erosion and landslides were identified as the main adverse impacts of sand harvesting (>50%). These impacts were both environmental and socio-economic as shown in Figure 4.19. Drug abuse, vegetation loss, insecurity, loss of arable land, school dropout, noise and disturbance and spread of diseases were the key negative impacts affecting the people and environment where sand harvesting is practised in Machakos County in a descending order (Figure 4.19).

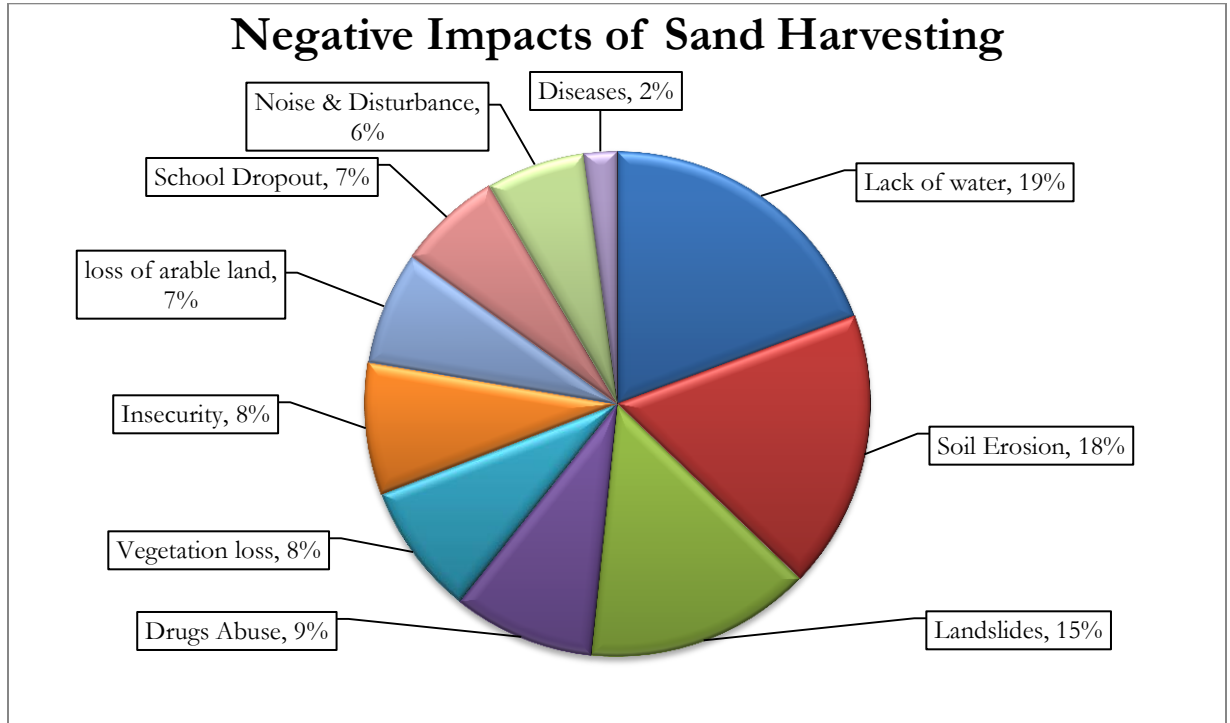


Figure 4.19 Negative impacts of sand harvesting in Machakos County

The Figure 4.19 demonstrates that the interviewees held different opinions on what the negative effects of sand harvesting in Machakos County were. It is also clear that none of the interviewees pointed at zero negative impact. The largest negative impact was lack of water and the least significant being the risk of diseases. By and large, the interviewees were agreed that the negative impacts of sand harvesting in the Machakos County could not be gainsaid.

The impacts of sand harvesting in Machakos County established by this study are very identical with those established by many other authors of different studies. For example, according to County and Nthambi (2015), the effects of sand harvesting on the environment included: lack of water, loss of times in search of water and the noise from

lorries interfering with learning, flooding which makes roads impassable, lack of concentration among pupils waterborne diseases causing coughing among pupils. NEMA (2013), advocated for sustainable sand harvesting since unsustainable scooping of sand causes soil erosion, negatively impacting biodiversity, changing river courses leading to fluctuating flow of rivers. Sand harvesting also leads to loss of water for livestock and domestic use (Augustine, 2013). Evidentially, sand harvesting brings with it negative impacts to the environment.

4.4 Policy, Legal and Institutional frameworks on sand harvesting in Machakos County

The existing policy, legal and institutional frameworks on sand harvesting in the County were analysed as follows.

4.4.1 Policy framework

Between those who practiced sand harvesting in Machakos County and those who did not, there was no consensus as to whether there was policy on sand harvesting and if there was, whether that policy was adequate. Policy was understood as general government direction. None of the 81 respondents were aware of any government policy on sand harvesting. The only respondents aware of government policy were NEMA and the County Government of Machakos. It can therefore be said that there was total lack of awareness on government policy on sand harvesting in Machakos County.

In 1991, Ghana adopted a National Environmental Policy for “ensuring a sound management of resources and the environment, and to avoid any exploitation of these

resources in a manner that might cause irreparable damage to the environment” (Ebenezer, 1991). In 1994, the Environmental Protection Council, in collaboration with the Minerals Commission, adopted guidelines mandating environmental impact assessment for mining activities in the country (Minerals Commission and Environmental Protection Council, 1994). According to the policy, environmental impact assessments must ensure that companies that deal with sand and mining “demonstrate that the project has been planned in an environmentally sensitive manner and that appropriate pre-emptive or mitigative measures and safeguards have been integrated into the projects design” (Musah, 2009).

The Government of Kenya adopted the National Environment Policy in 2014, being sessional paper No. 10 of 2014. The Policy makes a policy statement to the effect that the Government plans to promote and implement mechanisms for sustainable sand harvesting and mining (GoK, 2014b). Though this Policy has been in the draft stages for many years, awareness levels among the Machakos respondents was very low.

In Machakos County, the situation in Ghana as observed by Musah (2009) applies with equal measure. The County does not have a County Policy on sand harvesting but is guided by the National Environment Policy since that is the overarching requirement of the Kenya Constitution for all the Kenya Counties. The GoK has set Policy on Environmental Impact Assessments (EIA) and provided a requirement for sand harvesting to be subjected to EIA. Policy is indeed in place but awareness levels of residents and sand harvesters are deplorable.

4.4.2 Legal framework

Majority (51%) of the sand harvested in Machakos County is haphazardly harvested without an Environmental Impact Assessment (EIA) and or control measures. The respondents did not understand the legal instruments governing sand harvesting in the County although most of them were aware of the role of NEMA as a regulator on EIA's. G-test of independence established that most sand harvesting activities were conducted haphazardly and without regard to the requirement to conduct an EIA since $G_{(2, N=81)} = 1.360, p > 0.507$ (Figure 4.20).

In a study conducted by Musah (2009) in East Gonja District (EGD) of Ghana, out of 30 respondents interviewed in EGD, 27 (90%) knew of the existence of state regulation. Also, 22 (73%) indicated the existence of a regulation on the minimum size of a mine to require a permit. However, 25% of the respondents indicated non-compliance with the regulation, and that no closure standards or specification guidelines for reclamation were available.

According to a study by Augustine (2013), a Task Force was set up to develop a policy and regulatory framework for Artisanal Mining (ASM) and it made amendments to the related laws on land, minerals and taxation all touching on artisanal mining demonstrating the necessity of having an enabling policy and regulatory framework. The study agrees with these findings that a suitable legislative framework for small scale or artisanal sand mining be formulated.

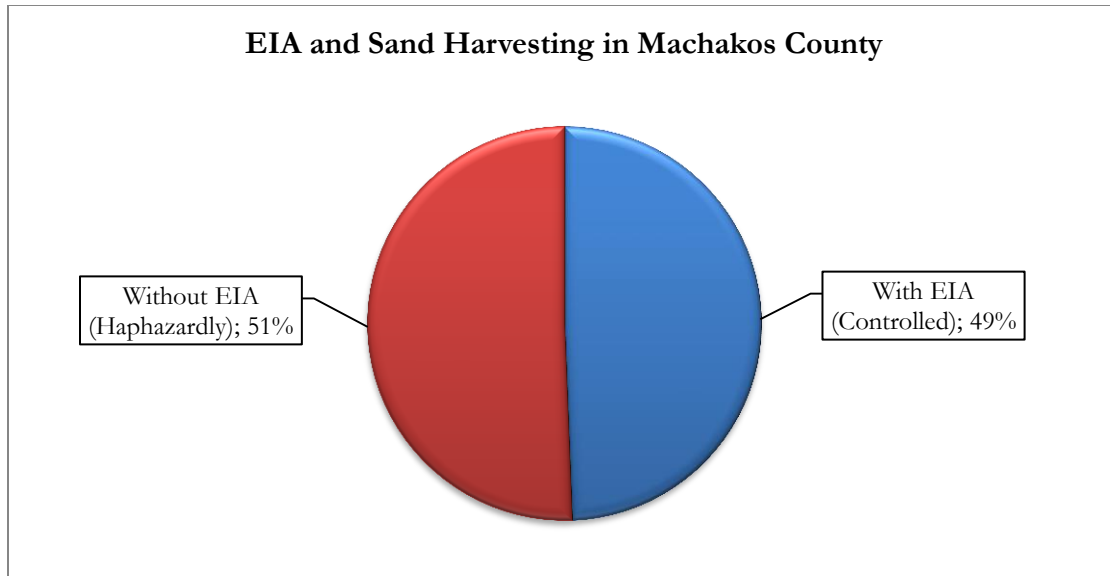


Figure 4.20 Compliance with legal framework on EIA in sand Harvesting in Machakos County

Figure 4.20 shows the distinction between the sand harvesting activities conducted without an EIA and this is what is referred to as ‘haphazard’ as opposed to the sand harvesting activities controlled by an EIA report. The latter is referred to as controlled since that is the very essence of an EIA study. Impacts are assessed with a view to enhancing the positive and mitigating the negative (GoK, 2014a).

Data on the opinion of the sand harvesters and non-sand harvesters on the challenges facing sand regulation in the County was also collected and it varied significantly since $G_{(4, N=81)} = 30.697, p < 0.0001$. The main challenges identified were inadequate law, lack of law and corruption in regulating sand harvesting (Figure 4.21).

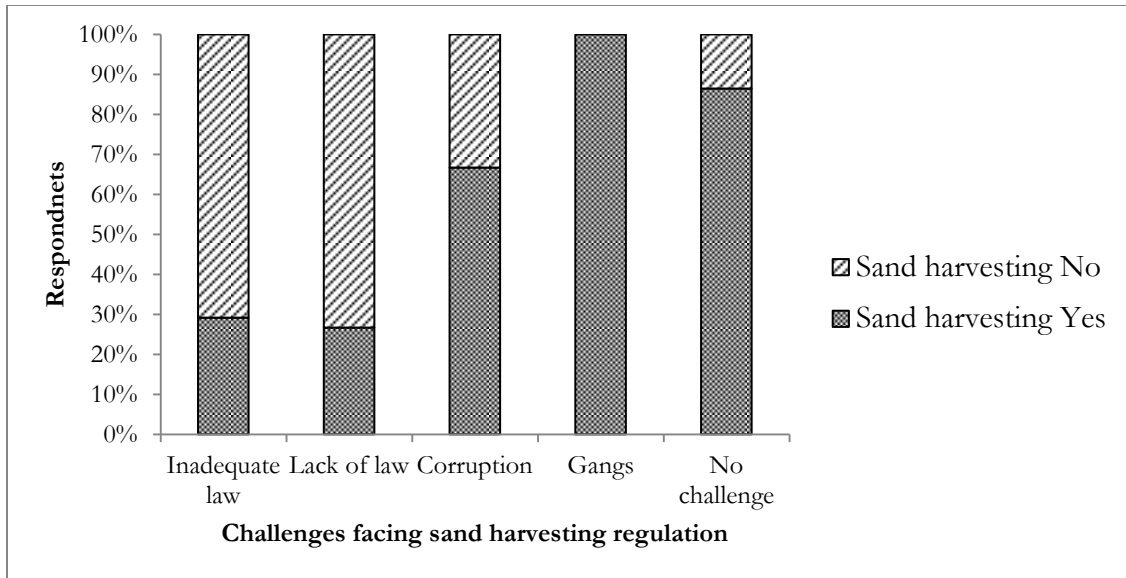


Figure 4.21 Challenges facing sand harvesting regulations in Machakos County

The law under discussion was the EMCA of 1999 and its amended version of 2015 both now referred to as EMCA Cap 387 of the Laws of Kenya, subsidiary legislation such as the EIA Regulations (Legal Notice 101 of 2003), the Machakos County Sand Harvesting Act of 2014 and the National Sand Harvesting Guidelines of 2007. Out of the respondents who entered a response on the adequacy or lack of existing laws, 70% said that sand harvesting in the County was not adequately regulated with the balance 30% saying it was. The challenge in that case was inadequate law. Out of the respondents who entered a response on lack of law on sand harvesting in Machakos County, 73% said that sand harvesting in the County was not adequately regulated with the balance 27% saying it was. The challenge in that case was lack of relevant laws. Out of the respondents who entered a response on corruption as a challenge facing sand harvesting regulation, 33% said that sand harvesting in the County was not adequately regulated while 66% said it was. A larger respondent base of 32 could not single out a challenge but went ahead to

state that sand harvesting in the County was not adequately regulated at 13% with the balance 86% stating that there was adequate regulation.

4.4.3 Institutional framework:

Sand harvesting in Machakos County is regulated by significantly different institutions as indicated in Figure 4.22. G- test of independence, $G_{(8, N = 81)} = 25.9, p < 0.001$. The National Environment Management Authority (NEMA) is the main regulating institution followed by the Local Administration (County Commissioner, Chief and local administration police) then the County Government of Machakos (Figure 4.22).

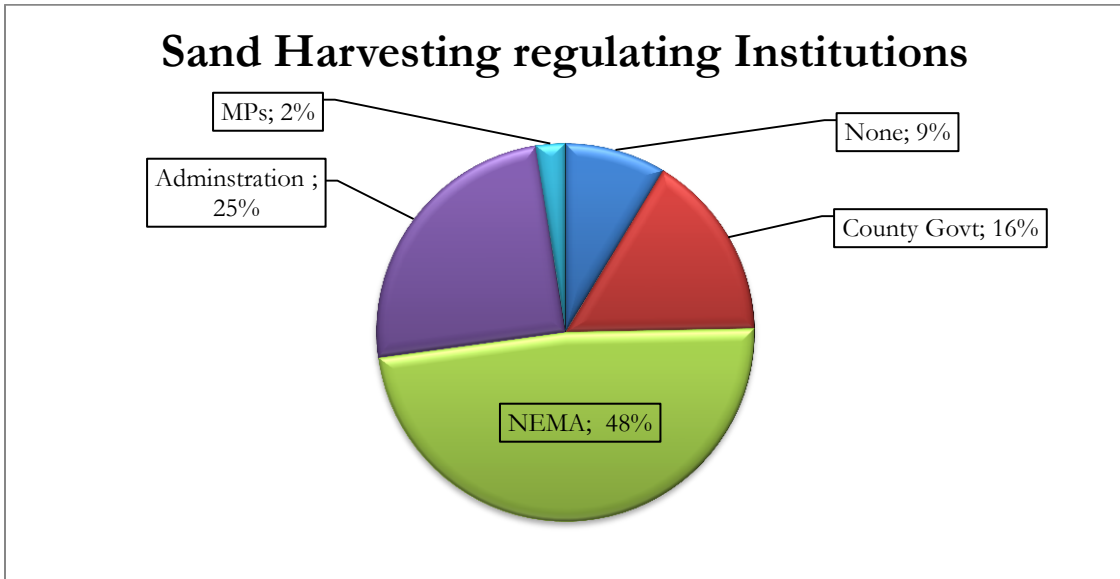


Figure 4.22 Sand Harvesting regulating Institutions in Machakos County

The above data was gathered from the responses given through the questionnaires administered on the 81 respondents and also the results of the semi structured interviews conducted on the institutions such as NEMA, County government and the Local

Administration. It was interesting to establish that 9% of the respondents returned an indifferent response and which can be attributed to ignorance.

The findings of the study agrees with Augustine (2013) and points to the fact that there are several government institutions with regulatory powers either perceived or real on sand harvesting activities and that there is deficiency of a reliable and conclusive policy and institutional framework for sand harvesting industry in Kenya leading to multifaceted conditions, which directly or indirectly affect the overall operations (Augustine, 2013).

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the study findings, the conclusion and recommendations from the study.

5.2 Summary of findings

There were several factors that were found responsible for increased sand harvesting in Machakos County. These included demand for sand for the expanding building industry, availability of external markets for sand, type of occupation of the respondents, family size of the respondents and the residential period of the respondents in the County. There were very few sand harvesting groups as much of the harvesting activity was undertaken by individuals or groups that did not have any organized set up. The impacts of sand harvesting to the environment ranged from loss of vegetation in cases where sand was harvested from arable land, lack of water due to destruction of water catchments, soil erosion and landslides due to degradation and non rehabilitation of sand pits, school dropout due to the attractiveness of quick money and spread of communicable diseases. The policy, legal and institutional framework on sand harvesting in the County was weak. Most residents were not aware of the existing policy and laws and equally true was the fact that enforcement was weak. The current state of sand harvesting was therefore not sustainable.

5.3 Conclusion

Arising from the study findings, this study concludes that among the several factors that contributed to increased sand harvesting in Machakos County, some were more significant than others. Demand for sand for the expanding building industry, available of external markets for sand and the residential period of the respondents in the County were more significant than the occupation and family size of the respondents. The practice of sand harvesting in the County had so many negative impacts to the environment that any positive impacts would be outweighed. These included soil erosion and landslides caused by irresponsible scooping methods degraded the environment and flew in the face of sustainable development, spread of diseases, loss of vegetation cover, insecurity, lack of water, loss of arable land, school dropout, noise pollution and drug abuse. The policy, legal and institutional arrangements were inadequate to ensure sustainable sand harvesting in the County. This was made worse by the low levels of awareness among the respondents in the County. The governmental institutional framework in Machakos County right from the County government Officials to the Local Chiefs was doing very little in ensuring safe and sustainable sand harvesting practices. Sand harvesting in Machakos County was a socio-economic activity and mainly influenced by demand for the commodity in Nairobi City County and its environs.

5.4 Recommendations

Various recommendations arise from this study to ensure sustainable management of sand harvesting in the County and other places where sand harvesting is an economic activity.

The recommendations include Policy, Operational and those for further research.

5.4.1 Policy recommendations

Some of the key policy recommendations include:

- i) Promoting commercial packaging of legally harvested sand into weighted bags and thus giving sand harvesting a more legitimate face; and
- ii) Create awareness on and implement the National Environment Policy (2014).

5.4.2 Operational recommendations

Some of the operational recommendations include:

- i) Creating public awareness on the available laws especially the Machakos County Sand Harvesting Act of 2014;
- ii) Inculcating good or positive sand harvesting practices right from the local administration to the locals by creating a sense of responsibility;
- iii) Closing and rehabilitating river banks and beds already destroyed by sand harvesting activities;

- iv) Constructing sand dams and gabions along river beds during the dry seasons so as to act as sand catchments when the rains start; and
- v) Intensifying environmental inspections to check on compliance with existing legal mechanisms.

5.4.3 Recommendations for further research

This study recommends further research work along various lines. Firstly, the scope of the study could be expanded to cover more respondents and other study sites where sand harvesting activities occur. Secondly, research should also be conducted to determine the extent of environmental damage associated with sand harvesting. It is also recommended that research on alternatives to river sand be conducted with a view of reducing the high demand for the commodity in the County. A Study should also be conducted to examine the implications of using arable land as a source of sand in the County.

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APPENDIX

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|------------------------------------|---------|---------|
| 1. Questionnaire template | Annex 1 | Page 85 |
| 2. Semi structured interview guide | Annex 2 | Page 87 |