



## FACTORS AFFECTING SAND HARVESTING IN MACHAKOS COUNTY, KENYA

## Pharmacology

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## ABSTRACT

Sand harvesting has been going on for many decades despite the massive environmental degradation it causes. Unsustainable scooping methods of this resource have caused soil erosion characterized by deep gullies. The activities also lead to loss of water for livestock and domestic use and rise in crime in most cases. This study sought to analyze the factors leading to increased sand harvesting in the County with a view to regulating the harvesting activities and ensure sustainability. The objectives of the study included assessing the impacts of increased sand harvesting in Machakos County, assess the existing policy, legal and institutional frameworks on sand harvesting in Machakos County and assess strategies used to sustainably manage sand harvesting activities in the County. This study was done in locations of Machakos County 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, at least 20 respondents were equitably selected on a simple random basis and were interviewed using a structured questionnaire. Key opinion leaders selected from the local community were engaged through a focused group discussion to complement the opinions of the respondents. Key findings showed that sand harvesting was occasioned by legion 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. This study recommended the restriction of hours of the day when sand harvesting could be allowed (daytime only), enactment of specific regulations on sand harvesting, promote commercial packaging of legally harvested sand, sensitization of the public on the existing laws and regulations, re use and recycling of sand, intensify environmental inspections for purposes of ensuring compliance and construction of sand gabions and dams along the threatened river beds.

## KEYWORDS

sand harvesting, sustainable, factors, regulations.

## 1.0 Introduction:

For decades, sand and gravel, have been popular all over the world in the construction of infrastructure. The demand 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 or man-made 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 & Curtis, 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. Morocco took the laudable steps of stopping beach mining and instead find new sources of alternative sand for the sake of its future generations (Orrin H pilkey et al., 2007). Building sand is a natural resource and is harvested from river beds and sand dunes. Improper or 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 (NEMA, 2008).

Sand harvesting in Kenya continues unabated in a highly unregulated manner that best serves to enrich a few at the expense of the environment. A sad fact is that corruption and insecurity has grown as the sand harvesters bribe the enforcement agencies such as the Police for protection and safe pass when transporting sand. Sand harvesters hire illegal machete wielding gangs to provide security against protesting locals, conservationists and even the local environment officers. Local politicians have always influenced sand harvesting due to the benefit of winning the electorate (IRIN, 2012). The Policy, Institutional and Legislative framework in Kenya is apparently inadequate as far as regulation of sand harvesting is concerned. The Sand Harvesting Guidelines (2008), the Mining Act (2016) and the Environmental Management and Coordination Act (2015) have manifest shortfalls on the matter of sand harvesting.

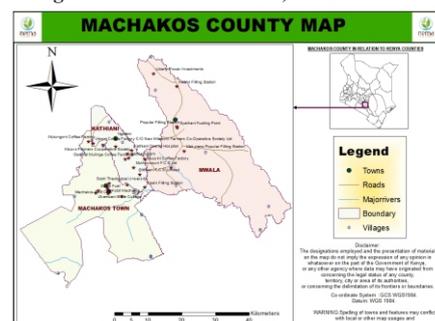
## 2.0 Study area:

The study was undertaken in three Constituencies or geographical

Districts within Machakos County. Machakos County shares its borders with seven other Counties and lies on an area that spans 6208.2 Km<sup>2</sup>. The sub county or the Constituency that is Machakos town covers only 15% of the County. 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. Mwala is the biggest in area coverage in the County while Kathiani is the smallest geographically. However, Kathiani has the highest population density. The total population of the County is recorded as 1,098,584 according to the 2009 Kenya Population and Housing census (GoK, 2013).

The County has diverse physical and landscape features ranging from plateaus to hills and rainfall is widely distributed since some areas of the County are arid while others hilly and well forested. 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. Land user includes Forest, Government Reserve, Townships, Game Reserves, Agriculture, Ranches, Industrialization, mining (sand, coal and precious metals) and pastoralism. The County has several urban centres with the main ones being Machakos town and Mavoko which are almost similar in population. Most of the residents of the County, about 56% are gainfully employed including self-employment (GoK, 2013).

**Figure 1: A map of the study area showing the key sand harvesting sites of Machakos town, Kathiani and Mwala**



### 3.0 Materials and Methods

#### 3.1 Study design, sampling and data collection

A descriptive qualitative research was used to adopt a completely randomized block design in answering why the sand harvesting situation is the way it is in Machakos County. Qualitative research helped in examining the independent variables of the study as they were by posing exploratory questions to a set of respondents and then recording their responses. It is termed exploratory because the nature of questions should be open ended and not closed-ended hypotheses (Elliott & Timulak, 2005). 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.

The respondent base comprised 81 entities drawn from three spatial clusters/constituencies where sand harvesting is practised: Mwala, Kathiani and Machakos town. These formed the study sites. 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. From the three clusters, simple random sampling was conducted on residents close to the sand harvesting sites to select at least 20+1 respondents who were interviewed using a structured questionnaire. Key opinion leaders such as the Machakos County Government Environment Officials, the National Environment Management Authority Officials, the Local Administration especially area Chiefs, and 1 organized sand harvesting group 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.

Both primary and secondary data were gathered and several methods used in order to cross check the obtained information. Secondary data comprised of desktop review of published material. The purpose was to guarantee reliability of the collected data and thereby improved the validity of the data. 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 & Timulak, 2005). 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).

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). 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. This was the only organized sand harvesting group that was identified by the research team but its input was comprehensive. The group shed positive light about the advantages of sand harvesting by organized groups as opposed to by individuals.

Participant observation as a method of data collection was also employed. It is in some ways both the most natural and the most challenging of qualitative data collection method. 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.

#### 3.2 Data analysis

Data was entered in Microsoft Excel spreadsheets for cross tabulation purposes and analysis conducted using the very software. 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.

Every response in the 81 questionnaires was fed into the Excel spreadsheet and 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 is 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 and *Chi*-square test of independence were used to analyse the results of the study

### 4.0 Results and discussions

The following factors contributing to increased sand harvesting in Machakos County were analysed.

#### 4.1 Gender

Out of the 81 respondents interviewed, 58 were male and 23 female. There were more males available for interviews. Therefore out of the total study sample of 81, 72% were male and 28% female. 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. A Chi-square 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, ( $\chi^2_{(1, N=81)} = 1.37, p > 0.242$ ). Sand harvesting in Machakos County is therefore gender independent although a higher number of males tend to harvest sand compared to females.

According to (Hinton et al., 2003) approximately 30% of the world's artisanal miners are women who occupy 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 by (Hinton et al., 2003) was addressing a different type of artisanal mining (metals and not sand), the finding on gender representation does not present a very different outcome from the result of the present study of Machakos County.

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 may now be much higher (Hinton et al., 2003). Women make up well over 10 percent to even 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.

#### 4.2 Age

The age of the respondents was classified into four categories. The percentage distribution of the respondents per age category was: Children (<18 years); 3%, Youth (18-30 years); 28%, Middle age (30-50 years); 42% and Old people >50; 27%. 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 (78%) do sand harvesting than all other age classes.

Since young children under 18 years of age are exposed to sand harvesting, that is why more youths were found to dominate sand harvesting in the County. This may be explained by several factors such as youth unemployment and energy because sand harvesting is a masculine 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 old people in the County practice sand harvesting than those who don't mainly, because they own

resources such as land, Lorries or have the capital to do the business. The research team did not find significant studies that co related the age factor with sand harvesting. However according to (NEMA, 2007), there was a strong recommendation to ensure sand loaders are over 18 years of age and therefore rid the activity of minors.

#### 4.3 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  $G_{(1, N=81)} = 0.165$ ,  $p > 0.684$ . Equally true is that both the married and single people in the County practice sand harvesting. 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. More married people were more dependent on sand harvesting than singles and that could be explained by the fact that sand harvesting being largely illegal, posed a higher security risk to the harvesters and married couples were more risk cautious.

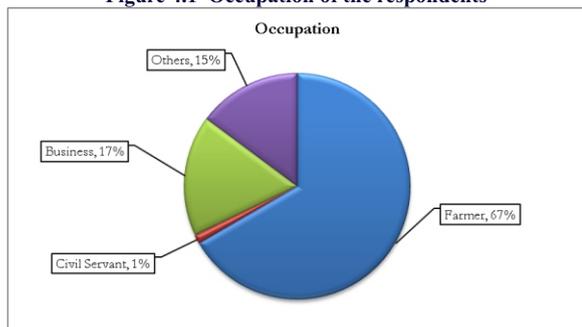
According to (Ayenagbo et al., 2011) while commenting on a study conducted in Togo, 60% of sand harvesters were married with 38% being singles and 2% widows and widowers. This statistic demonstrates a concurrence with the results of the subject study of Machakos County.

#### 4.4 Occupation

Sixty seven percent (67%) of the respondents were farmers, 15% do other types of jobs, 17% were business people and only 1% was a civil servant. 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  $G_{(3, N=81)} = 1.974$ ,  $p > 0.578$ .

It is noteworthy that more farmers, business people and other professionals except civil servants in the County practice sand harvesting as illustrated in Figure 4.1. This can be explained by the fact that save for the civil servants who would be working in various towns from time to time, the others were normally resident in the County.

Figure 4.1 Occupation of the respondents



In discussing this result, no studies relating occupation type with sand harvesting were found. Occupation type is therefore significant to the extent demonstrated in this study. Farmers were more pre disposed to the activity of sand harvesting than civil servants although they were not the only category that practiced sand harvesting.

#### 4.5 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 and 11% had no families. This information was obtained from the answers in the questionnaires given by the respondents. 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 including those without families. In discussing this result, no studies co relating family size and sand harvesting were available. Family size is not a significant factor contributing to increased sand harvesting.

#### 4.6 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. The period of residence in the location significantly affects sand harvesting since  $G_{(2, N=81)} = 2.267$ ,  $p > 0.332$ . The longer the residential period of the people in the location the more they tend to sand harvest as shown.

In discussing this result, no studies co-relating residential period and sand harvesting were available. The longer the duration of living in the County, the higher the likelihood of engaging in sand harvesting. This could be explained to mean that after 5 years of living in the County, a certain phenomenon such as land ownership and conforming to what neighbouring residents would do, would influence sand harvesting activities. From the semi structured interviews and the participants' observation methodology, it was apparent that residents would move from tenants and become land owners after a period of at least 5 years.

#### 4.7 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%. 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 of Machakos 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. It is generally low lying with the highest altitude being around 2000m above sea level (GoK, 2013). There a very few instances of sand harvesting being practiced on arable land and in most of those few cases, it is where the arable land has been reclaimed from land that was previously a river bed either after a river has changed its course or had completely dried up.

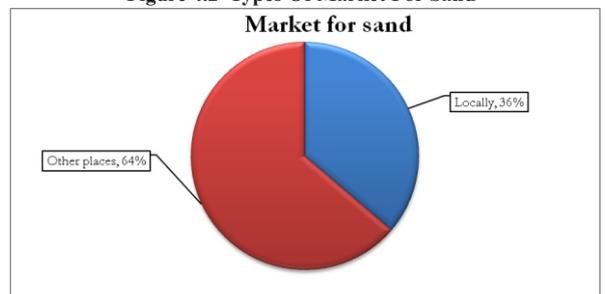
#### 4.6 Demand for Sand

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. 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.

#### 4.9. 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 as illustrated in the pie chart figure 4.2. 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.

Figure 4.2 Types Of Market For Sand



It is therefore factual to state that markets for sand that are beyond Machakos such as Nairobi and its suburbs are a significant factor that contributes to increased sand harvesting in the County. This finding is in consensus with other findings such as that made by (Bolen, 1991) on a study conducted in the United States of America when he stated that production of industrial sand and gravel in 1995 increased to 28.2

million metric tons, about 3% more than 1994's production. 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 promoted by the Nairobi market.

### 5.0 Conclusions and recommendations

This study concludes that there were several factors that contributed to increased sand harvesting in Machakos County. It also concludes that there are many negative impacts to the environment occasioned by sand harvesting. Another manifest conclusion is the fact that the policy, legal and institutional frameworks on sand harvesting are not working properly. 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 and its environs.

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 included promoting commercial packaging of legally harvested sand into weighted bags and thus giving sand harvesting a more legitimate face, creating public awareness on the available laws especially the Machakos County Sand Harvesting Act of 2014, constructing sand dams and gabions along river beds during the dry seasons so as to act as sand catchments when the rains start and further research on alternatives to river sand with a view of reducing the high demand for the commodity.

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