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Impact of Stone Quarrying on the Environment and the Livelihood of Communities in Mandera County, Kenya

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Authors' contributions

This work was carried out in collaboration between both authors. Authors FLMM and MYM designed the study together. Author MYM collected data. Author FLMM guided author MYM on how to write a manuscript. Author MYM wrote the first draft of this manuscript. Author FLMM then wrote the final manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Stone quarrying is one of the major practices carried out in the world by the construction industry. In Kenya and specifically in Mandera County area, stone quarrying industry has grown rapidly in recent years.
Objective: This study thus aims at examining the impact that stone quarrying has had on the environment and the livelihood of the communities in Mandera County, Kenya.
Methods: Both qualitative and quantitative approaches were used for data collections and analysis.
Results: The study found that stone quarrying has significantly contributed to the incomes of the stone workers, quarry owners and the community. In contrast it was found that stone quarrying also contributes towards negative impacts to the community such as degradation of land and vegetation cover, and affects the health of the residents, for example muscle pain among many quarry workers, cough/asthma, eye problem and malaria.
Conclusion: The study recommends that in response to the negative human and environmental impacts experienced in Mandera County, there is need to use technologies that are user and

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environmentally friendly and rehabilitation of quarries after use if the communities have to continue enjoying the improved livelihood due to stone quarrying.

Keywords: Quarrying; Kenya; Mandera County; livelihood; environment.

1. INTRODUCTION

Stone quarrying is a form of land use method concerned with the extraction of non-fuel and non-metal minerals from rocks [1]. It is usually done by open-cast method using rock drills, explosion of dynamite and use of other methods [2]. Quarrying has environmental and health effects. [3] for instance reports that mining has a number of common stages or activities, each of which has potentially-adverse impacts on the natural environment, society and cultural heritage, the health and safety of mine workers, and communities based in close proximity to operations. Further the operations in stone quarrying, whether small or large-scale, are inherently disruptive to the environment, producing enormous quantities of waste that can have deleterious impacts for decades and that the environmental deterioration caused by stone quarrying occurs mainly as a result of inappropriate and wasteful working practices and rehabilitation measures [3,4]. For instance, some studies in the Northern Region of Ghana and East Gonja District in particular found that commercial extraction of sand and gravel cause land degradation and desertification through destruction of economically important trees mostly indigenous in nature [5,6]. This degradation of environment due to stone quarrying activities has put forth questions as to whether or not the mining activities should be continued [7,4]. Additionally some 4 million people have been reported also to die yearly from acute respiratory problems in developing countries, for the most part being aggravated by environmental pollution emanating from quarrying, sandblasting and emission of dangerous chemicals [8,7,6].

But it has been found on the other hand that in Africa, East Asia, Southeast Asia and Latin America, accessibility to natural resources such as building stones plays a critical role in the provision of livelihood [9]. A livelihood comprises the capabilities, assets (including both material and social resources and activities required for a means of living: a livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future [10].

Many people in rural Africa have reported that the dependence on agricultural output could no longer provide year round security in terms of finance due to continuous decline in farm yields [9,4]. This is not surprising since most of the rural farmers are subject to varying degrees of uncertainty due to climate variability and post-production loss [11]. This has compelled over 500 million people in developing countries to engage in occupations such as small-scale surface mining and quarrying for survival [9, 12]. Accordingly, [13] and [9] argue that since the formal sectors in developing countries have very little potential in terms of job creation the informal sector such as stone quarrying has become an attractive alternative for achieving livelihood needs.

Thus [9,14] have identified that small-scale stone extraction in rural areas is a major source of livelihood in spite of the dangers it poses to the environment and other livelihood activities such as farming. In Mandera County, stone quarrying provides varying economic benefits to the local economy [15]. However it is not yet clear on the impact of stone quarrying on the environment and the livelihood of the communities in Mandera County, Kenya from the review of the current literature [16,17].

The study was guided by the Sustainable livelihood Framework (Fig. 1). This approach emphasizes understanding the vulnerability context and the organizational and institutional environment within which poor people draw upon assets of different types in order to implement a livelihood strategy. The livelihoods approach is based on the premise that the asset status of the poor is fundamental to understanding the options open to them, the strategies they adopt to attain livelihoods, the outcomes they aspire to and the vulnerability context under which they operate [18]. [19] distinguishes five categories of assets (or capitals) – natural, social, human, physical and financial. [20] points out that an analysis of assets is a review of what people have (and recognition of what people do not have) rather than an analysis of needs. The asset analysis also considers how access to assets has changed over time, what changes are predicted, what the causes of changes are and how access and control of assets differs between social groups [10].

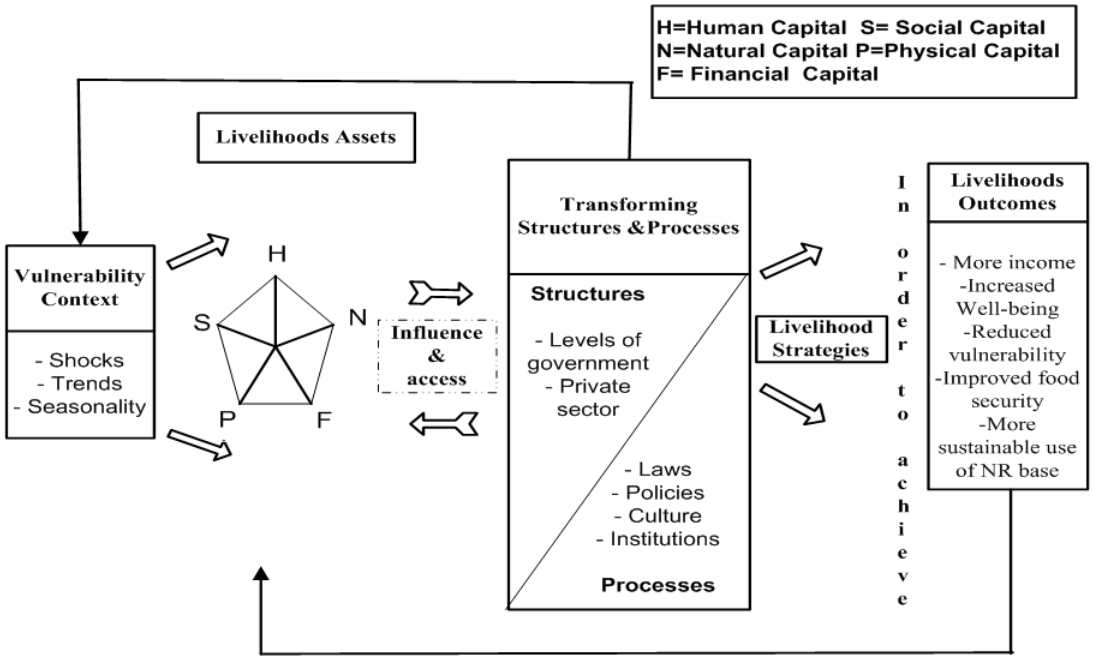


Fig. 1. DFID sustainable livelihood framework [10]

2. METHODOLOGY

Mandera is one of the counties in North Eastern Kenya, previously known as the Northern Frontier districts (NFD) (Fig. 2). It boarders Ethiopia to the North, and Somalia to the West. It covers an area of 25,991.3 sq km with a population of over 1,025,756 people and an annual growth rate of 3.97 percent [15].

The county lies 2°11' to the North and 4°17' to the East. The County is mainly inhabited by Cushitic Somalia speaking people who practice pastoralism as the major economic activity to earn their living. The main livestock reared include camels, cows, goats and sheep among others [16]. Most of these animals are commercially owned by the local entrepreneurs and exported to foreign countries like the Middle East to meet their basic needs and paying school fees. Livestock are also used to clear dowery dues and conflict disputes [21].

The county is classified as ASAL area characterized by dry and hot climatic condition with an annual rainfall of 255 mm. The region has small scale agricultural production with small scale horticultural producers supplying mangoes, pawpaw's, onions, kales and bananas to the local markets [16].

The county is also well endowed with different types of rocks which include among others granite and gneiss *migmatite* rocks (Fig. 2.) [22].

To answer the study objective, purposeful sampling was used for all the study respondents namely: 45 quarry men, 45 community members (30 male and 15 male), 3 chiefs, the Chairman of the council of elders, 2 NGO officials, a NEMA official, 2 revenue officers from Mandera South and Mandera West sub-county, and director for Environment Mandera County.

Questionnaires were administered to all the respondents. Participant observation was also used as a source of information. Published and unpublished books documents such as, Government and International Reports, Journals, Newspapers and Magazines and internet sources used as sources of information for the study.

The quantitative data collected was analyzed using Statistical Programme for Social Scientists (SPSS) and the simple statistics generated were presented in charts, graphs and tables. While the qualitative data collected was coded based on particular groups for example the codes for Household Questionnaires were coded as HQ 001 to HQ 090 because the research utilized 90 respondents and the one for key informant were coded as K1 001 to KI 010 since the research used 10 respondents to answer the study objective [23].

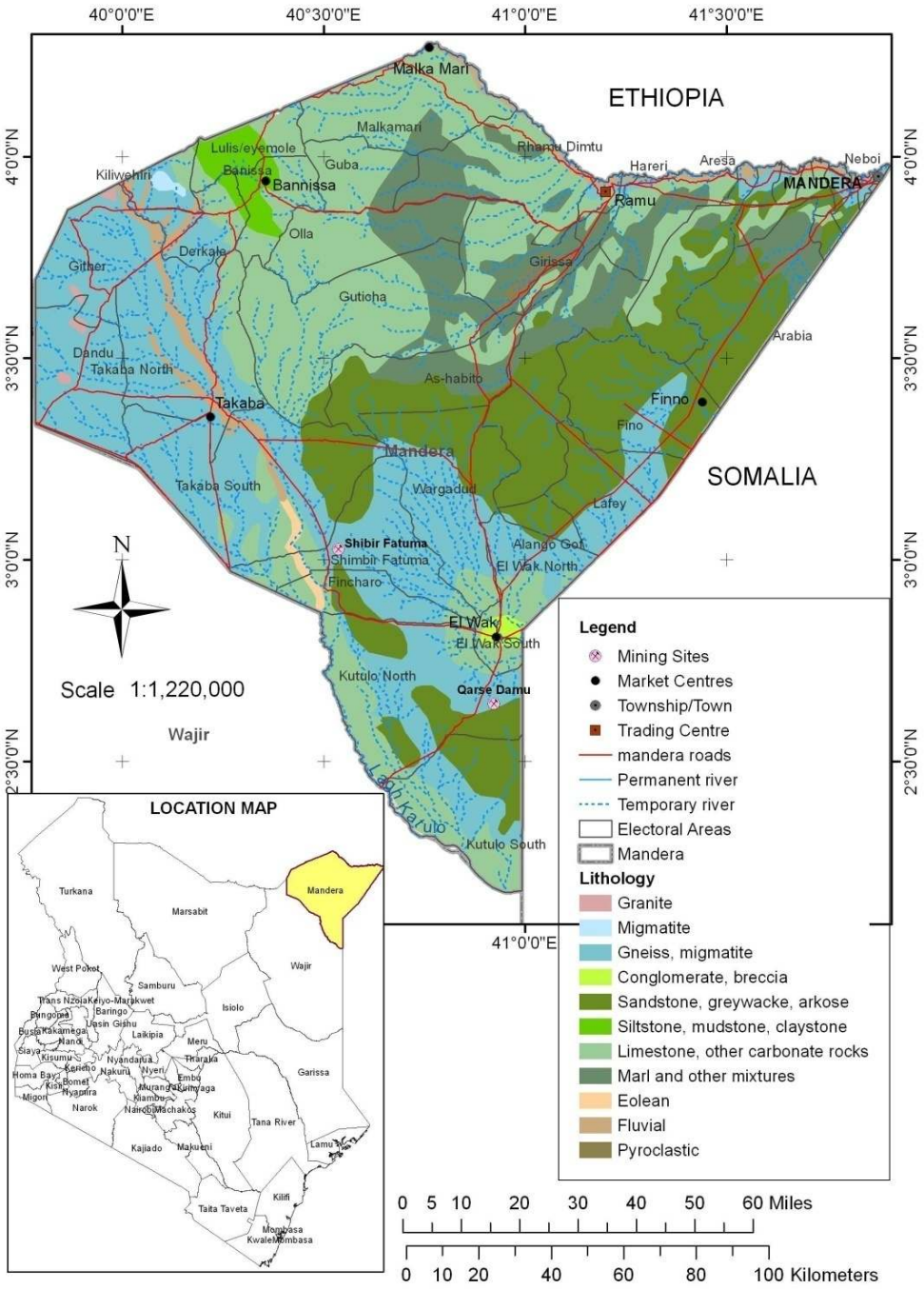


Fig. 2. The study areas: Qarsa Damu and Shimpir fatuma and their lithology
(Source Authors)

3. RESULTS AND DISCUSSION

The purpose of this paper was to examine the impacts of stone quarrying on the environment and the livelihood of communities in Mandera County, Kenya. About 63.4% of the respondents had the view that land and vegetation has been degraded (Plates 1 and 2) due to stone quarrying. The map below (Fig. 3) also indicates that there is high land degradation in the quarrying areas.

About 16.6% of the respondents reported that they were faced with air pollution, while 14.4% of the respondents reported noise as a major challenge [9,8]. Only (5.6%) reported water pollution as a problem [8] (Table 1).

We also sought to understand the state of the land before stone quarrying was introduced therefore we asked the respondents to explain the type of land use before the introduction of quarrying. Majority of the respondents (66.7%) reported that the land was mainly used as grazing land for livestock [21]. About 26.7% of the respondents indicated that the land was mainly used as a water catchment area and 4.4% of the respondents reported that the land was mainly used for growing crops. Only 2.2% of the respondent reported that the land was not in use (Fig. 4). The above findings justifies the fact that since many of people in Mandera County practice pastoralism (rearing of livestock) as there source of livelihood, they mainly use land for grazing of their livestock and the fact that most of quarry sites are on hills which mainly serve as a water catchment area.

Table 1. The impact of quarrying on the environment

Effects	Frequency	Percentage (%)
Degradation of land and vegetation	57	63.4
Water pollution	5	5.6
Air pollution	15	16.6
Noise pollution	13	14.4

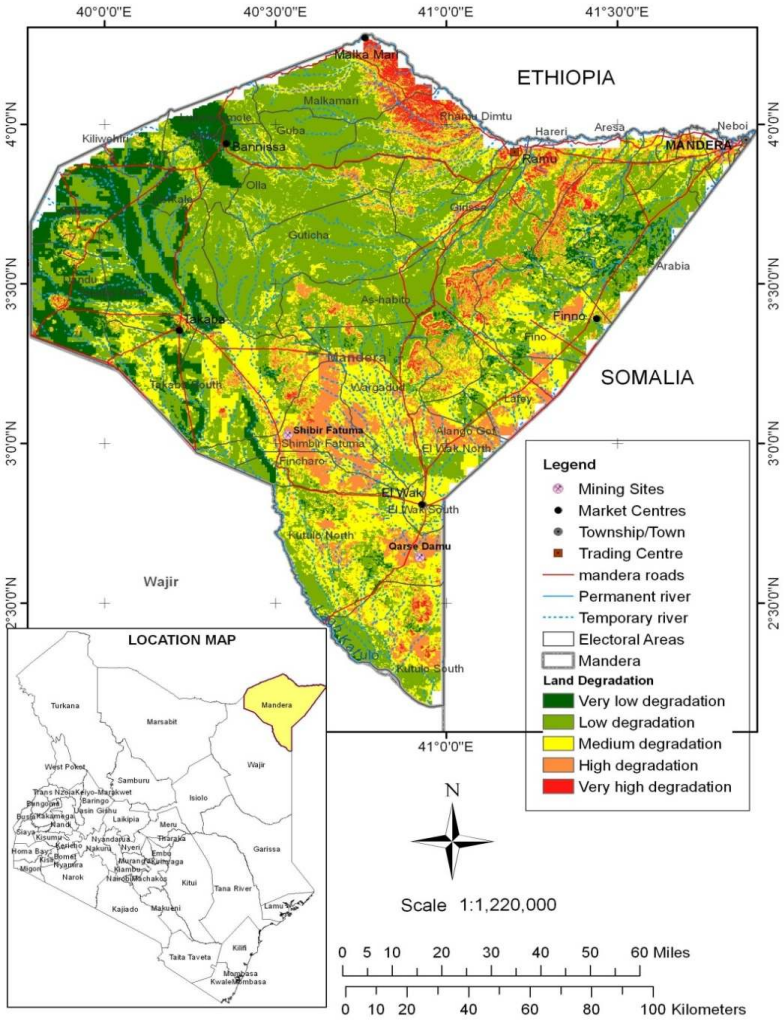


Fig. 3. Land degradation in the quarrying areas
(Source Authors)

Plate 1. Big hole showing land degradation left after quarrying of gneiss migmatite rocks
(Researchers photo)

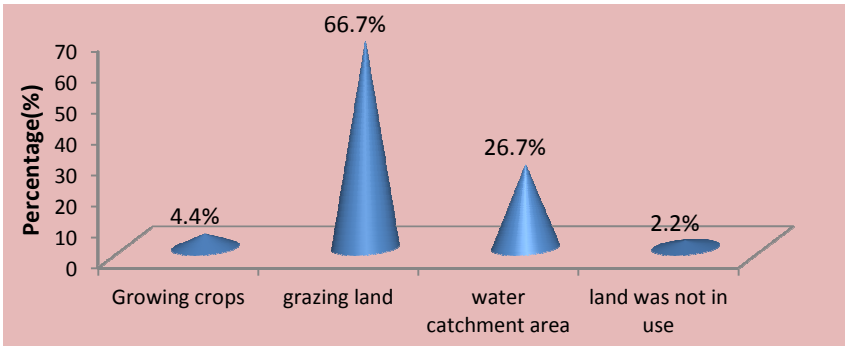
Plate 2. State of the soil: Pieces of gneiss migmatite rocks after quarrying
(Researchers Photo)

It also became apparent that quarrying has contributed greatly to the economy of Mandera County. We asked the quarry workers how much income they get from quarrying per month (Table 2). Majority of the respondents (67%) indicated that the income they get from stone quarrying ranges between Kshs. 10,001-50,000, about 22 get income of about Kshs. 50,000 and above. While 8.8% get income of between Kshs. 1001-10,000 and only 1% of the respondents get less than Kshs. 1000. This implies that stone quarrying is a well paying economic activity as justified by 67% of the respondents. It was established that those who mainly receive very low income are those who work in the quarry partly and are engaged in other activities.

We were further interested to know how stone quarrying had impacted on the incomes of the general quarrying communities (Fig. 5). Majority of the respondents (45%) indicated that they get monthly income of between Kshs. 1001-10,000, 22% reported they get between Kshs. 10,000-50,000 and only 11% of the respondents reported that they get monthly income of Kshs. 50,001 and above. Surprisingly, only 22% of the respondents reported that they only get less than 1000 per month from stone quarrying. A detailed interview to find out who are these households earning Kshs. 50,000 and above found that this were mainly the quarry owners. Majority of members of the community do not highly benefit financially from the quarries. Many of the respondents who get monthly income of 10,001-50,000 were found to be casual workers who load and offload trucks which transport stones.

Table 2. Income per month from stone quarrying workers

Income per month in ksh	Frequency	Percentage (%)
Less than 1000	1	2.2
1001-10,000	4	8.8
10,001-50,000	30	67
50,001`and above	10	22



Land use before quarrying

Fig. 4. Land use before quarrying

Table 3. Income earning per truck

Rock type	10 tone truck (500 feets) Kshs.	15 tones truck (1,200 feets) Kshs.	25 tones truck (1,500 feets) in Kshs.
Hard core	5,000	12,000	15,000
Dimension stones (feet square)	26,000	47,000	68,000

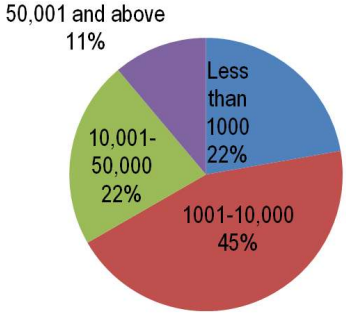


Fig. 5. Income per month from stone quarrying for community members

The trucks owners who transport stones also benefit from stone quarrying. For instance, through informal discussion, one truck owner gave a summary of the income per truck per trip as follows (Table 3).

Overall the comparison between the average income obtained by the quarry workers and that of the local community revealed that those who benefit most are the quarry workers as shown in (Table 2). But nevertheless it can be concluded that quarrying can improve the financial base of communities.

It was also found that stone quarrying had significantly contributed to physical assets for instance the development of roads, schools and health centrers and social capital for instance the encouragement of more migrants to settle at the quarry sites to tap income from them. The following explanation represents the views of the interviewed households:

> The quarry was initially, an enclosed farm with no roads passing through it to connect to the next village. Today however, there are murram roads winding down the hill to enable passage of trucks and pickups carrying stone products from the once enclosed, inaccessible hill. The roads have not only enhanced the movement of goods and services between the quarry site and the neighbouring areas but they have also encouraged more settlement of migrants hence establishment of settlements. The increasing population has also contributed to the development of services such as schools and health centres in the area (HHQ 035).

Due to the increase in population, physical assets such as the constructions of houses to meet the demand of the increasing population were also observed to have increase to accommodate the workers in schools and health centres in the area.

From informal and formal interviews, and participant observations also established that stone quarrying activities have contributed to the growth of financial assets. For instance, many trading centres, retail shops, food selling places

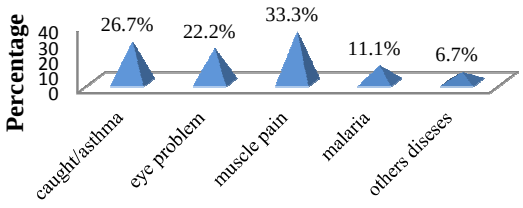


Fig. 6. Figure showing common diseases

and an increase in motorbike transport in the trading centers adjacent to the quarry. [19] points out that financial assets include, cash, credit/debts, savings and other economic assets including basic infrastructure and production equipment which, he argues, are essential to the pursuit of a livelihood strategy.

Stone quarrying in Mandera County was however found to be associated with some health implications to the communities (Fig. 6) For instance, when study respondents were asked on the impact of stone quarrying to the health communities, majority of them (33.3%) reported muscle pain as a health problem associated with quarrying. This is justified by the fact that they use very crude tools for extraction and trimming of the stones. The lifting of heavy stones during loading and offloading of vehicles also caused muscle pain among many quarry workers. About 26.7% of the respondents complained of cough/asthma [8,7,6], 22.2% of them complained of eyes a result of the continued presence of dust during quarrying and particulate matter in the air caused by big stone transportation trucks [9,8,7,6] and continued destruction of vegetation cover [6]. While 11.1% of the respondents complained of malaria. Cases of malaria are common during rainy seasons in which the quarrying pits are filled with water thus creating breeding grounds for mosquitoes [9]. These findings confirm the fact that quarrying can affect human capital.

4. CONCLUSION AND RECOMMENDATION

The purpose of this paper was to examine the impact of stone quarrying on the environment and the livelihood of communities in Mandera County, Kenya. The Sustainable Livelihood Framework was used as a guideline for answering this objective. It can be concluded that there is potential that stone quarrying may contribute significantly on the improvement of the financial social and physical capitals of stone quarrying communities. Stone quarrying can also affect the sustainability of communities natural capitals for example land and vegetation cover and human capital due to pollution thus affect their health. There is need to use technologies that are user and environmentally friendly and rehabilitation of quarries after use if the communities will have to continue enjoying the improved livelihood due to stone quarrying.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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