

Effects of Vegetation Destruction on the Socio-Economic Well-being of Households within the Soapstone Quarrying Areas of Gucha South Sub-County, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Author GO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors MNM and IGI managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Soapstone quarrying and carving has taken place at the Tabaka region of Gucha South Sub-County for many decades. The activities associated with soapstone quarrying include clearing of vegetation, removal of top soil, earth moving, excavation of the stones and chopping off the unwanted parts of the soapstone. These activities have caused serious environmental impacts in the quarrying areas. This study focused on the effects of vegetation destruction as a result of soapstone quarrying on the socio-economic well-being of households within the quarrying areas of Gucha South Sub-County, Kenya. The objective of the study was to determine the effects of vegetation destruction (loss of cover and biodiversity erosion) by quarrying on the socio-economic well-being of households within the quarry areas. A cross-sectional survey research design was adopted. Purposive sampling procedure was utilized where 102 households were purposively selected based on their nearness to the soapstone quarries. Data collection was done using a

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questionnaire, recording observations and taking photographs. Descriptive (Frequency distribution, percentages, means, median and mode) and Inferential (Regression, Chi-square and ANOVA) statistics were used to analyze the data. The findings of this study indicate that vegetation destruction as a result of soapstone quarrying activities has negative effects on the socio-economic wellbeing of the households found within the soapstone quarrying areas. Thus, there is need to regulate the soapstone quarrying activities. There is also an urgent need for an Environmental Impact Assessment and audit to be carried out to determine the state of the environment in the soapstone quarrying areas.

Keywords: Vegetation destruction; socio-economic; quarrying; wellbeing; households; soapstone.

1. INTRODUCTION

Quarrying is a human activity that is carried out in various parts of the world, which targets the exploitation of rock resources for economic reasons [1]. The quarrying operations involve deforestation and excavation which leads to habitat destruction and erosion of biodiversity in the quarrying areas [2,3]. Generally, all activities associated with quarrying lead directly or indirectly to vegetation destruction at the quarry sites and their neighborhoods. Vegetation destruction includes the altering of vegetation cover and the destruction of landscape, and forest ecosystems around quarries and mines [4,5]. It also refers to the dumping of waste materials from quarries on the surrounding areas, fragmentation of forest land, loss of top soil, nutrients and supportive micro-flora, deforestation, diminished green cover and loss of vegetation [6,7].

Quarrying activities have altered vegetation cover all over the world such as in the forested regions of the Appalachian Mountains, Netherlands, Germany, Ghana, and Nigeria among others [4,7]. In Ethiopia for instance, quarrying for aggregate production has been on the increase for the last three decades due to the high rate of urbanization in the country [8]. As a result, the environmental impacts of both fine and coarse aggregate production have become hard to ignore, especially in the rural areas. According to [6], mining and quarrying, either open cast or underground, destroys landscape, vegetation and forest ecosystems around the quarries and mines. The waste materials that remain after the extraction of usable materials are dumped on the surrounding land, thus causing loss of top soil, nutrients and supportive micro-flora and vegetation. On one hand, quarrying and mining activities leads to the fragmentation of forest land, deforestation and diminished green cover, thus posing a threat to the conservation of plant and animal species in the affected areas. On the

other hand, the aftermath of quarrying includes loss of vegetation, alteration of landscape and the disruption of forest ecosystems [2,6].

According to Akanwa et al. [2,3,7], quarrying and mining have been found to cause land degradation, deforestation and loss of biodiversity. They also cause hydro-geological disturbances, dust and air pollution, water pollution and noise pollution which diminish the well-being of people living near the quarry sites. These findings are consistent with those of [9] who assessed the sociological and ecological impacts of sand and gravel mining in Ghana. According to [9], commercial extraction of sand and gravel in Ghana caused not only land degradation but also encourages desertification through the destruction of economically important trees, especially those that are indigenous in nature, and the clearing of vegetation to pave way for the extraction activities.

Quarrying and mining pose a major hazard to man and the environment by way of deforestation, earth-cutting, overburden, soil erosion, disruption of underground water circulation and air and water pollution. These hazards affect the physical environment and the well-being of the miners and residents near the mines. As a result of these consequences on the environment, questions have been put forth as to whether or not these activities should be allowed to continue [10]. Similar observations have been made by Vandana et al. [11] who contends that mining and quarrying of stones cause significant environmental impacts at the operation sites which include the creation of clusters of ugly scars on the hillrocks, ecological degradation and the destruction of the natural aesthetics of the affected areas[4,11].

Vegetation destruction due to unsustainable quarrying practices in Nigeria has diminished the role played by vegetation cover in reducing the global impacts of climate change [12] Rapid

globalization, rise in technology, the fast rate of population growth and the perceived diminution of nature's worth for human psychological, emotional and physical health has caused a disconnect between humanity and the natural environment [13]. The widening gap of this disconnect has caused the world's prospects of achieving human wellbeing to weaken within the world's dominant economic development paradigms. As a result there is more emphasis on the economic gains from the environment with very little care of the sustainability of the natural resources. When the gains are not forthcoming, distress may set in and the result is reduced well-being of the affected people.

Studies have shown that quarrying activities such as those involved in the extraction of limestone produce highly alkaline and reactive dusts while others such as coal mining produce acidic dusts which cause air pollution [14]. Air pollution caused by quarrying and mining activities causes serious effects to human beings, other animals and plants near the quarrying sites. In human beings the dust can cause health problems such as respiratory diseases. Discomfort caused by disease reduces the well-being of the affected people. In plants, the effects include blocking and damaging the internal structures and abrasion of leaves and cuticles, as well as chemical effects which may affect long-term survival of the plants [15]. This may lead to poor growth and development of plants due to reduced primary productivity thus causing reduced vegetation cover on the land. When these effects occur on crops, harvests will be reduced leading to economic losses to farmers. Economic losses can contribute to stress and conflicts in families in the affected areas.

In Kenya, [16] carried out a study to examine the impacts of stone quarrying on the environment and the livelihood of communities in Mandera County. The findings of the study indicate that about 63.4% of the respondents had the view that land and vegetation have been degraded due to stone quarrying. According to the findings of the study, 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. Land and vegetation degradation results in reduced plant diversity and vegetation cover at the quarry sites. Despite these effects, stone quarrying continues to be relied upon as an economic activity where it fetches about Kshs. 18000 per month [17]. This

has given stone quarrying an ever increasing impetus for its exploitation.

Socio-economic wellbeing refers to the economic and social development of the residents in communities that live within the quarry sites [18]. This includes both the social and economic benefits accruing from soapstone quarrying that directly or indirectly goes to the members of the resident community. The benefits range from diversification of the local economy, provision of complementary business and services, social ties with other communities, health and safety of households, improved standards of living, security, spiritual fulfillment, state of environmental control, emotions, affiliations and a sense of belonging to the community. Therefore, socio-economic wellbeing can be summed up as the social, economic and environmental footprint arising from soapstone mining activities in a given mining area.

According to Afeni and Adeogun [19], socio-economic wellbeing associated with mining and quarrying includes both positive and negative effects on the host community and the mine workers. Other than providing employment and other positive effects, quarrying and mining activities may cause related diseases, and air, water and noise pollution [2]. Other negative effects include reduction in crop production, negligence of education by students and parents, settlement and overcrowding, increase in crime rate, increase in resource based conflicts due to competition for the scarce resources and overburden on social amenities [18]. These effects may reduce the quality of life and lower the standards of living for the people living within the quarrying areas.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out at the soapstone quarrying areas of Gucha South Sub-County in Kisii County, Kenya. The soapstone mines are found in three sub-locations of Tabaka location which are Bosinange, Bomonyara and Tabaka sub-locations. The sub-county is located about 40 Km south of Kisii town, the capital of Kisii County. Residents of the sub-county engage in small scale farming, with maize, sugar cane, bananas and tea being the main crops grown in the area. The area is warm throughout the year with average rainfall of about 1500 mm per annum [20].

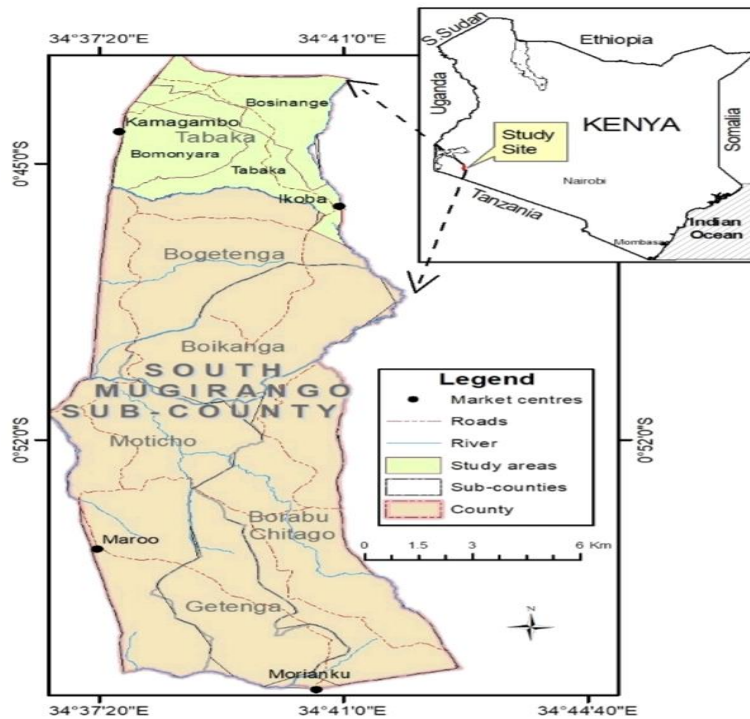


Fig. 1. Map of Gucha south (South Mugirango) sub-county

2.2 Materials

This study employed a cross sectional survey research design where data was collected using a questionnaire and observation schedules [21]. A camera was used for taking photographs of the quarry sites while a tape measure was used for measuring the area and size of the quarries. This design was appropriate for this study because information about vegetation destruction as a result of soapstone quarrying activities was collected at one point in time thus saving the researcher time and resources for the study.

2.3 Methods

2.3.1 Sampling

This study utilized quantitative methods where a structured questionnaire was used to collect data from participants. The study targeted twenty-eight quarries in the Tabaka region, which are owned by households. The sample size for the study was selected using purposive sampling technique. Purposive sampling technique is a type of sampling in which the researcher selects samples based on a certain purpose [22]. This technique was used to select participants for this study because it helped to increase the utility of

the findings of the study. The technique was preferred for this study because the quarry owners, households and residents near the quarries are the ones who experience any effects from the quarrying activities on the environment and hence they were targeted so that they could give the most appropriate responses to the study. In this study, three quarries were used for piloting while the study sample was selected from the remaining twenty-five quarries. The sample size for the study was 102 comprising of fifty quarry owners, two from each quarry, and fifty two residents from the neighborhood within a distance of one kilometer from the quarries.

2.3.2 Data collection

Data collection for this study was done using questionnaires, observations and taking of photographs. Observations were made and pictures taken to show the existence and extent of vegetation destruction as a result of soapstone quarrying activities. Measurements were also made to determine the size to the quarries and land affected by quarrying activities. Loss of plant cover was determined by measuring the land area covered by plants and the area that was bare, without plant cover. Photographs were also taken to show the extent of loss of plant cover.

Loss of plant diversity was determined by recording the different species of plants available in the study area. This was obtained from the household heads who were interviewed. Socio-economic well-being was measured using a rating scale for the indicator items in the questionnaire.

2.3.3 Data analysis

Data collected was tabulated and analyzed quantitatively by calculating frequencies and percentages where applicable. A regression analysis was also run for analyzing the data to show how the impacts of vegetation destruction as a result of quarrying activities affect the socio-economic well-being of quarry owners and residents within the soapstone quarrying areas. This was aided by the use of the Statistical Packages for Social Sciences (SPSS) version 22.0.

3. RESULTS AND DISCUSSION

3.1 Loss of Vegetation Cover

Vegetation cover which is an independent variable in this study was operationalized as an index involving three indicators, which were: (i) loss of plant diversity which was indicated by the number of different plant species, (ii) loss of plant cover and (iii) soil erosion features such as presence of gullies, and soil loss. The results show that soapstone quarrying activities lead to vegetation cover destruction which exposes the soil to agents of erosion (Figs. 2 and 3). These findings are similar to those of [2,3,5,7]. Observations made at quarry sites indicate that quarrying activities have tremendously reduced vegetation cover at the quarry sites and the formation of heaps of soapstone wastes. The heaps cause scars on the land and destroy the aesthetics of the area. These findings concur with those of [4,11] who found out that quarrying activities lead to the formation of ugly scars on hillrocks and also destroy the aesthetics of the affected areas. The soapstone debris and dust are non-biodegradable and therefore their disposal was found to be a menace to plant growth. The dust settles on the leaves of plants near the quarries and thus limiting primary productivity. This may affect the long term survival of the plants. This observation is consistent with that of [15] who has noted that dust from quarries affect plants by way of blocking and damaging their internal structures and abrasion of leaves and cuticles leading to

poor growth and development of the plants. All these damaging effects results in loss of vegetation cover at the quarry site as shown in Fig. 2.

3.2 Loss of Plant Diversity

This indicator was assessed by determining the number of the different plant species found on the household farms. The household heads were asked to state the number and the species of the different trees planted and those that are naturally growing in their farms. The data was then analysed in terms of total tree numbers and the number of different species and the results are summarised in Table 1.

Table 1. Number of trees in the farms

Type of trees	Frequency	Percentage
0.00	7	6.9
1.00	12	11.8
2.00	22	21.6
3.00	23	22.5
4.00	11	10.8
5.00	12	11.8
6.00	8	7.8
7.00	2	2.0
8.00	3	2.9
9.00	2	2.0
Total	102	100.0

Mean 3.2±.205; Median 3, Mode 3, Std. dev 2.07, Min 0, Max 9, Range 9

3.3 Loss of Plant Cover

Loss of plant cover due to soapstone quarrying was used as an indicator to gauge the loss of vegetation cover. Plant loss is associated with the cutting down of trees to pave way for quarrying activities and create roads to the quarry sites and with heaping of the wastes at the quarry sites. This indicator was assessed using two items; percent of the area covered by plants compared to the bare areas and the number of trees per unit area. The high value (6) of the sum of these two items indicated high plant cover and lower value (0) indicated bare areas, without cover of any plant. The analysis is shown in Table 2 and 3.

3.4 Socio-economic Well-being

The socioeconomic wellbeing of the households was conceptualized as an index involving 32 indicators. The index of the household socioeconomic wellbeing was assessed using 32

indicator items grouped into 7 categories (Table 4). The household heads within the study area were asked to rate (or gauge) their household level of wellbeing based on the 32 indicators of socioeconomic wellbeing using a 10-point semantic differential scale, which ranged between 1 and 10 (1 being Very Low level and 10 Very High level). The scores for each indicator were added together and a mean calculated. Then all the scores for all the indicators were added together to form an index of socio-economic wellbeing of the households found within the soapstone quarrying areas. The internal reliability of the created socio-economic wellbeing index was determined using the Cronbach's alpha (α). It was calculated and found to be .841, which was acceptable. The 32 indicators, their frequency distribution and their descriptive statistics are shown in Table 4.

The index of household socioeconomic wellbeing developed from the 32 indicators was grouped into six categories in order to indicate the level of socioeconomic wellbeing as follows: .01 - .99 Extremely Low, 1.0 – 2.99 Very Low; 3.0 – 4.99

Low; 5.0 – 6.99 Moderate; 7.0 – 8.99 High; 9.0 – 10.0 Very High as shown in Table 5.

Table 2. Assessment of plant loss

Value of plant loss	Frequency	Percent
0.00	10	9.8
1.00	16	15.7
2.00	38	37.3
3.00	18	17.6
4.00	13	12.7
5.00	6	5.9
6.00	1	1.0
Total	102	100.0

Mean 2.2±.134; Median 2, Mode 2, Std. dev 1.361, Min 0, Max 6, Range 6

The mean of the socioeconomic wellbeing of the community was 6.43 (Medium level) and ranged from 0.38 (extremely low) to 9.53 (Very high). This results show that most households had a medium level of wellbeing, hence the community is positively benefiting from soapstone quarrying activities.



Fig. 2. Loss of vegetation cover



Fig. 3. Land where quarrying has not taken place

3.5 Regression Analysis

This study sought to find out how vegetation destruction by soapstone quarrying activities affect the socio-economic wellbeing of households found within the soapstone quarrying areas of Gucha South Sub-County in Kisii County. A linear regression analysis was carried out to determine the effect of vegetation destruction the socio-economic wellbeing of the households. The vegetation destruction formed the independent variables while the socioeconomic wellbeing formed the dependent variable. The results of the regression are indicated in table 6.

Table 3. Vegetation cover

Type of trees	Frequency	Percent
0.00	7	6.9
1.00	2	2.0
2.00	11	10.8
3.00	5	4.9
4.00	17	16.7
5.00	19	18.6
6.00	5	4.9
7.00	7	6.9
8.00	10	9.8
9.00	5	4.9
10.00	4	3.9
11.00	5	4.9
12.00	2	2.0
13.00	3	2.9
Total	102	100.0

Mean 5.5 ± 1.34; Median 5, Mode 5, Std. dev 3.352, Min 0, Max 14, Range 14

The regression analysis indicates that vegetation cover had a positive and significant effect ($\beta = .889$, $p = .001$) on the socioeconomic wellbeing of the households found within the mining areas. Therefore it can be concluded that vegetation cover enhanced the wellbeing of the households in the quarrying areas of Gucha South Sub-County.

3.6 Comparison of the Household Wellbeing within the Study Area

The chi-square test was used to check the differences in the distribution of the levels of socioeconomic wellbeing among the households found within the soapstone quarries. The chi-square test revealed significant differences among the categories. The category of High was

significantly ($p < .001$) higher than the other categories. This meant that the households within the soapstone mining areas were mainly having a wellbeing level of between 7.0 and 8.99. The categories of extremely low, very low and very high had lower values. The results of the chi-square test are shown in Table 7.

To determine whether there is a statistical significant difference in the wellbeing of households located in different areas in relation to the quarries (near, medium and far) within the soapstone mining areas, a mean comparison test was performed using ANOVA. This was performed to test the differences in the means of household socioeconomic wellbeing of the households that were near, middle and far from the soapstone quarries. The mean differences among the households in the different localities within the study area were analysed using the Analysis of Variance (ANOVA) and the results are shown in Table 8.

The one-way ANOVA, $F(2, 101) = 461.81$, $MSE = 28.68$, $p = .001$, demonstrated that there were positive statistically significant differences among the households in the three localities (near, medium and far) within the soapstone quarrying areas. The households near the quarries had lower wellbeing compared to the households that were far from the quarries. This means that the quarries affected the household's socioeconomic wellbeing and the effects were dependent on the location of the household with respect to the quarry. The lower wellbeing of households near the quarry sites can be attributed to the negative effects of soapstone quarrying. This finding is consistent with that of [4] who carried out their study in India and found out that quarrying activities pose social challenges to the immediate communities in the quarrying areas. These challenges were diverse ranging from threats to health and safety, increased crimes, spread of diseases and escalation of resource based conflicts. These challenges will lower the households' socio-economic wellbeing [2]. The findings can be explained in light of those of [11] who has noted that stone quarrying activities in Mandera County are associated with some health problems on the members of the community. Health problems associated with soapstone quarrying, such as accidents affect those who directly take part in the quarrying, usually owners, relatives and those who reside very close to the quarries.

Table 4. Socio-economic wellbeing of the households

Indicator Items	Rating by the quarry owners and Households					
	Mean	Median	Mode	Std dev	Range	α
Standard of living	7.43	8.58	9.67	2.96	10.00	.874
Food provision						
Shelter						
Clothing						
Capital						
Assets						
Work						
Good health	6.44	7.50	9.50	3.12	10.00	.772
Health services						
Cost of health						
Safety	5.16	6.16	0.00	3.40	10.00	.822
Peace of mind						
Constant Fear						
Constant Worry						
Social Relations	7.33	8.33	9.33	2.84	10.00	.812
With Community						
With Family						
Good Community						
Spiritual fulfillment	5.12	5.00	5.00	3.38	10.00	.744
Belief in God						
Worship area						
Environment	6.15	6.31	5.63	2.80	14.5	.892
Politics						
Physical Material						
Services						
Access to resources						
Skills						
Knowledge						
Loans						
Information						
Emotions andAffiliations	7.30	8.10	9.40	2.75	10.00	.881
Respect						
Part of community						
Social obligations						
Listened to						
Help others						

n=102, Scale range: 0=Extremely Low and 10= Very High

The results of this study further indicate that quarrying activities have greatly reduced vegetation cover in the quarrying areas. These findings are similar to those of studies that were carried out in Ethiopia [3,13], Nigeria [7] and Ethiopia [8]. These studies have noted that stone quarrying activities in different countries has led to reduced vegetation cover in the quarrying areas. This is as a result of clearing the vegetation to pave way for soapstone quarrying and making of roads to access the quarries [2]. Vegetation cover was found by the study to have a positive and significant effect on the socio-economic well-being of households. These results are in line with the findings of [2,5,10]

whose studies found out that quarrying activities have led to land degradation, deforestation, loss of biodiversity, hydrological disturbances, dust and air pollution and noise pollution. Reduced vegetation cover can also be attributed to dust pollution from the quarries. As [10] has noted, dust from quarries is known to be responsible for the damage to vegetation by way of settling on leaf surfaces thereby reducing primary productivity. This causes stunted growth and even drying up of some plants. All these effects have a negative implication on the socioeconomic wellbeing of the communities in the quarrying areas [12]. Conversely, adequate vegetation cover will mitigate these effects and

hence lead to enhanced socio-economic wellbeing of households and the respective communities in the soapstone quarrying areas.

Table 5. Index of Wellbeing of the Households found within quarry areas

Wellbeing categories	Frequency	Percent
.01-.99	7	6.9
1-2.99	7	6.9
3-4.99	5	4.9
5-6.99	32	31.4
7-8.99	42	41.2
9-10	9	8.8
Total	102	100.0

Mean 6.42±.241; Median 6.97, Mode 9.40, Std. dev 2.43, Min 0.00, Max 10, Range 10

The findings of this study indicate that although households near the quarries (quarry owners) had a low index, generally on average, all other households within the soapstone quarrying areas had a high well-being index that ranged between 7.0 and 8.99. This high levels of household socioeconomic wellbeing within the soapstone quarrying areas could be associated with three main factors. The first factor is due to the fact that socio-economic wellbeing is determined by the level of income from the

soapstone quarrying activities. Soapstone quarrying and carving is an economic venture within the study area from which each household earns an average monthly income of about Kshs. 18000 [11]. The second aspect is that the community has lived in the area for a long time and they are used to the conditions of the soapstone areas. The people living in the households within the soapstone quarrying areas have been resident in this place for a long period of time thus creating spiritual and emotional bonds with the culture, practices and the resources within the area. They have willingly accepted that quarrying is part of their economic ventures that provides them with their basic needs and livelihood. The third aspect is the perception of the environmental problems created by the soapstone quarrying. The community knowledge of the impact of the environmental problems generated by the soapstone quarrying activities is low. The members of the community focus on the economic benefits of quarrying and rarely pay attention to the consequences of the quarrying activities. The members of the community are not aware or don't associate environmental problems with the quarrying activities and thus they continue extracting the stones from the quarries without any regard of the effects of these activities on the environment.

Table 6. Regression coefficients for vegetation cover

Model	Unstandardized Coefficients		Standardized Coefficients	T	p
	B	Std. Error	Beta		
(Constant)	1.077	.297		3.620	.000
vegetation cover	.588	.030	.889	19.373	.000

a. Dependent Variable: mean wellbeing

Table 7. Wellbeing categories and chi-square test

Categories	Observed N	Expected N	Residual	Statistics
0.01-.99 (Extremely Low)	7	17.0	-10.0	$\chi^2 = 74.00$ df = 5 $p < .001$
1-2.99 (Very Low)	7	17.0	-10.0	
3-4.99 (Low)	5	17.0	-12.0	
5-6.99 (Medium)	32	17.0	15.0	
7-8.99 (High)	42	17.0	25.0	
9-10 (Very High)	9	17.0	-8.0	
Total	102			

Table 8. Mean differences in the socioeconomic wellbeing of the different localities using ANOVA

Distance from quarry	N	Mean	Std. deviation	Std. error	Min	Max
0 - 100m (Near)	15	9.18	5.629	1.453	2.65	24.90
101 – 200m (Medium)	36	43.07	5.570	0.928	28.67	48.63
201-300 (Far)	51	56.81	5.118	0.716	49.01	66.74
Total	102	44.96	17.041	1.687	2.65	66.74

4. CONCLUSION

Soapstone quarrying activities have contributed greatly to vegetation destruction in the soapstone quarrying areas. The activities associated with quarrying include clearing of all vegetation cover and excavation of the stones from open pits. These activities and processes cause damage to natural forests thus reducing vegetation cover. The remains of the stones are heaped on open grounds where they destroy grass and other small plants, thus exposing the soil to agents of erosion. The findings of this study, indicate a trend in which socioeconomic wellbeing increase as you move away from the quarries. This is due to the fact that the impacts of vegetation destruction are usually felt directly by the quarry owners as opposed to the residents far from the quarries but who are engaged in quarrying activities. It can therefore be concluded that vegetation destruction due to quarrying activities has a negative influence on the socio-economic well-being of quarry owners.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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