eISSN: 3031-9471 | pISSN: 3032-7245 | DOI: 10.69606/geography.v4i3.536

Pubsains

Journal of Geographical Sciences and Education

https://journal.pubsains.com/index.php/jgs

[Research Article]

Check for updates

Effects of Soapstone Quarrying on Agricultural Land in Tabaka Ward, Kisii County, Kenya

Justine Ong'uti Okemwa*, Dickson Kinoti Kibetu, Paul Nyaga Njue, Hanningtone Sitati

Department of Social Sciences, Chuka University, Kenya

*Correspondence: justineokemwa09@gmail.com

Article Info:

Received:
27 May 2026

Accepted:
1 July

Published:
1 September 2026

Keywords:
soapstone;
quarrying;
agricultural land.

Abstract

Soapstone quarrying has been a continuous activity that has altered the natural landscape, in turn affecting agricultural land. In Tabaka Ward, Kisii County, Kenya, the expansion of quarrying activities has led to significant changes in agricultural land-use patterns. This study examined the effects of soapstone quarrying on agricultural land, aiming to determine the extent to which quarrying activities have transformed productive agricultural land. The study combined qualitative and quantitative data gathered from field observations, household surveys, key informant interviews, and photographs. A proportionate stratified random sampling technique was used to select 382 household respondents, while purposive sampling was employed to engage 12 key informants. Quantitative data were analyzed using descriptive statistics and a paired-sample t-test. The results showed that while the average farm size was 2.8 acres, an average of 0.5 acres per farm had been converted to soapstone quarrying. Findings further revealed a 23.8% decline in crop production, severe loss of topsoil, reduction of pasture fields, and an overall loss of arable agricultural land. The paired sample t-test confirmed a statistically significant difference between total farm size and the land allocated to quarrying ($t(381) = 12.884$, $p < 0.001$). The study concluded that soapstone quarrying has radically altered agricultural land use, diminished grazing fields, and lowered overall agricultural productivity.

Informasi Artikel:

Diterima:
27 Mei 2026

Disetujui:
1 Juli 2026

Dipublikasi:
1 September 2026

Kata kunci:
batu sabun;
penambangan;
lahan pertanian.

Abstrak

Penambangan batu sabun merupakan aktivitas yang berlangsung terus-menerus hingga mengubah lanskap alam dan berdampak pada lahan pertanian. Di Kelurahan Tabaka, Kabupaten Kisii, Kenya, meluasnya aktivitas penambangan ini telah memicu perubahan signifikan pada pola penggunaan lahan pertanian. Penelitian ini mengkaji dampak penambangan batu sabun terhadap lahan pertanian dan bertujuan untuk mengukur sejauh mana aktivitas tersebut telah mengubah lahan produktif. Penelitian ini menggabungkan data kualitatif dan kuantitatif yang diperoleh dari observasi lapangan, survei rumah tangga, wawancara informan kunci, serta dokumentasi foto. Pengambilan sampel dilakukan menggunakan teknik proportionate stratified random sampling terhadap 382 responden rumah tangga, serta teknik purposive sampling terhadap 12 informan kunci. Data kuantitatif dianalisis menggunakan statistik deskriptif dan paired-sample t-test. Hasil penelitian menunjukkan bahwa dari rata-rata luas kepemilikan lahan sebesar 2,8 ekar, sekitar 0,5 ekar di antaranya telah beralih fungsi menjadi area penambangan. Selain itu, temuan studi mengungkapkan terjadinya penurunan hasil panen sebesar 23,8%, erosi lapisan tanah atas (topsoil) yang parah, penyempitan area padang rumput, serta hilangnya lahan pertanian subur secara keseluruhan. Uji t sampel berpasangan mengonfirmasi adanya perbedaan

yang signifikan secara statistik antara total luas lahan pertanian dengan luas lahan yang dialokasikan untuk penambangan (t(381) = 12,884, p < 0,001). Penelitian ini menyimpulkan bahwa penambangan batu sabun telah mengubah penggunaan lahan pertanian secara drastis, mengurangi area penggembalaan, dan menurunkan produktivitas sektor pertanian secara keseluruhan.

INTRODUCTION

Globally, the soapstone quarrying industry is one of the most prominent informal sectors. Soapstone products are widely utilized in jewelry making, baby powders, paints, ornaments, vases, and paper filling, among other applications (Akama & Onyambu, 2020). In Southeast Asia, mining and quarrying activities have contributed significantly to vegetation loss, land degradation, and the depletion of vast agricultural areas (Nasir et al., 2023).

Similarly, in Africa—specifically in Ebonyi State, Nigeria—vegetation cover was reduced to 402,855 hectares due to unsustainable quarrying practices (Akanwa et al., 2017). These activities have also triggered biodiversity loss and the destruction of natural habitats (Opondo et al., 2023). Furthermore, Bassey & Okon (2021) observed that by 2021, most farmers in Nigeria had abandoned crop farming, with approximately 7.5% selling their land to quarry operators and 21.3% experiencing lower crop yields in subsequent seasons. Crop production is further impaired by dust generated at quarry sites, which settles on leaves and impedes photosynthesis, thereby negatively affecting overall crop yields (Fugiel et al., 2017).

At the national level, soapstone quarrying in Kenya has significantly altered agricultural land through widespread vegetation clearance and the direct conversion of farmlands into quarry sites. For instance, artisanal miners in Narok Town Ward utilize open-cast quarrying methods, which severely damage land resources, including vegetation cover and soil fertility (Barchok et al., 2024). Likewise, in Igembe South Sub-County, mining activities have reduced agricultural output, polluted local water sources, and degraded the surrounding environment (Muriki et al., 2023).

In Kisii County, quarrying operations in Gucha Sub-County, characterized by vegetation clearing and stone excavation from open pits, have contributed substantially to ecological destruction in the surrounding areas (Okong'o et al., 2021). Quarrying in this region occupies approximately 22% of arable farmland. Consequently, many farmers frequently shift between quarrying and farming, particularly during the dry season when agricultural opportunities are limited (Chepchumba, 2018). This seasonal shift has led to diminished agricultural productivity due to continuous land loss and soil degradation.

In Tabaka Ward, soapstone quarrying is a dominant economic activity and a primary source of livelihood for many residents. However, these expanding activities have altered the local landscape and led to worsening environmental degradation, ultimately eroding the agricultural land base that serves as the community's economic backbone.

Previous studies conducted in Tabaka Ward have confirmed that soapstone quarrying causes severe soil erosion, loss of vegetation, and general land degradation. Nevertheless, empirical evidence directly measuring the extent of these impacts on agricultural land remains limited. For instance, Chepchumba (2018) focused broadly on the geomorphic and socioeconomic impacts of quarrying, leaving a research gap regarding its specific effects on agricultural systems. Similarly, while Okong'o et al. (2021) reported vegetation loss due to quarrying, they did not address the direct impacts of this environmental degradation on farmland loss, crop production, or livestock-based livelihoods.

The continued expansion of quarrying activities in Tabaka Ward has accelerated the conversion of farmlands into excavation sites. This trend has drastically reduced pastureland for livestock, land for crop cultivation, and space for agroforestry. Consequently, these land-use shifts have forced farmers to relocate in search of grazing and farming fields, while others have abandoned agriculture altogether—leading to a decline in both cash and food crop production. Given these escalating challenges, this study examined the effects of soapstone quarrying on agricultural land in Tabaka Ward, Kisii County, Kenya, with a specific focus on livestock rearing, crop production, and the conversion of agricultural land into quarry sites.

METHOD

Research Design

This study adopted a mixed-methods research design, systematically combining both quantitative and qualitative approaches to provide a comprehensive understanding of the research problem. Quantitatively, structured survey data were collected from 382 household respondents to measure and evaluate the specific effects of soapstone quarrying on agricultural land. Qualitatively, in-depth interviews were conducted with key informants to gather rich contextual insights. This qualitative component served to complement, triangulate, and

validate the empirical findings obtained from the household surveys, ensuring a more robust analysis of the agricultural land-use transformations.

Research Location

The study was conducted in Tabaka Ward, Gucha South Sub-County, Kisii County, Kenya. The ward is located between latitudes 0.70° and 0.78° South, and longitudes 34.62° to 34.72° East. Tabaka Ward is the epicenter of soapstone quarrying in Kisii County, characterized by intensive quarrying activities alongside smallholder agriculture (KNBS, 2019). The area features high population density and hilly terrain, where arable land is increasingly competing with mining operations. The study covered six sub-locations within the ward: Bomware/Botabori, Bokimai, Bombure, Bonyagwanda, Nyatike, and Iringa. The research location is illustrated in Figure 1.

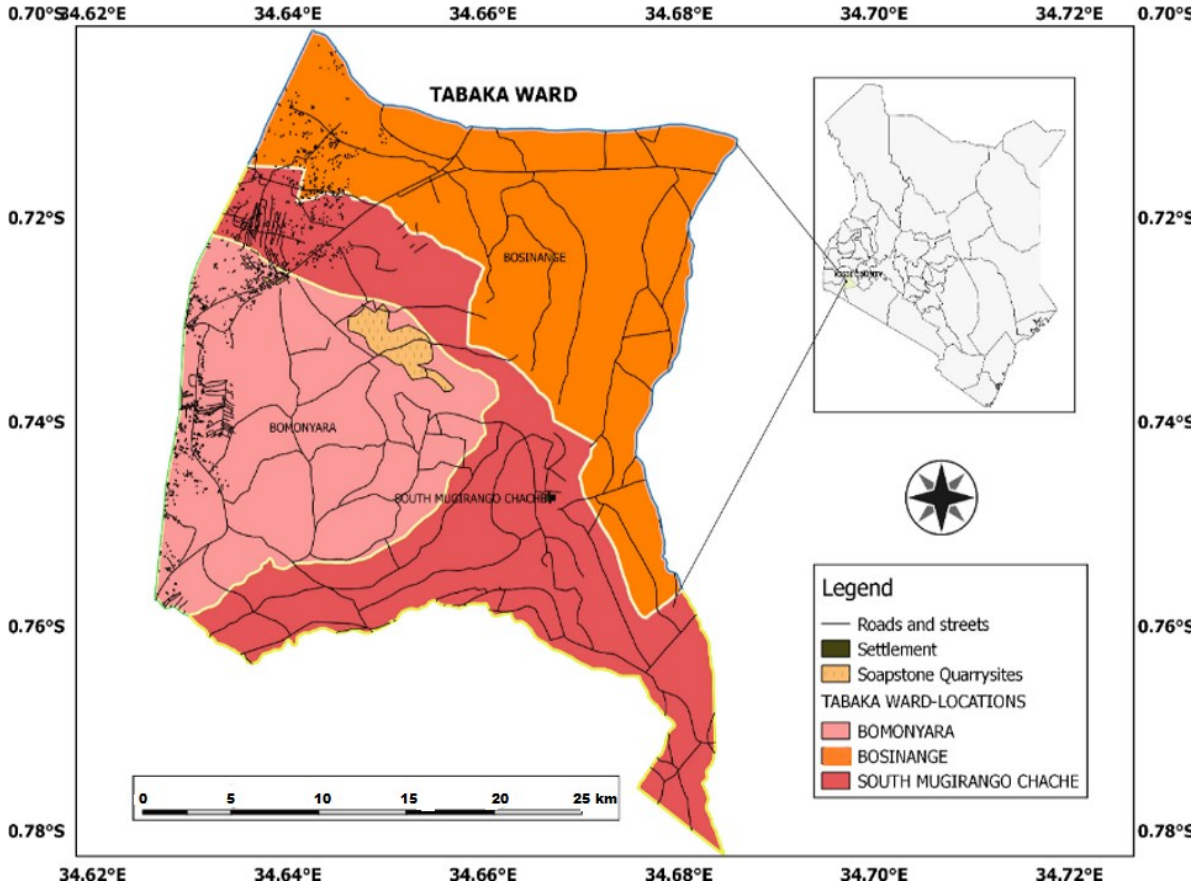

Figure 1. Map of Tabaka Ward

Geologically, the soil composition of Kisii County consists of approximately 75% red volcanic soils rich in organic matter, with the remaining 25% comprising clay, red loams, and sandy soils (Kisii County Government, 2018). Within this geological setting, Tabaka Ward is dominated by rich steatite (soapstone) deposits. However, ongoing and intensive quarrying of these deposits has progressively encroached upon and disrupted local agricultural activities.

Hypotheses

The study tested two opposing hypotheses regarding the environmental and spatial impacts of mining activities in the region. The null hypothesis (H_0) posited that soapstone quarrying has no statistically significant effect on agricultural land in Tabaka Ward, Kisii County, Kenya. Conversely, the alternative hypothesis (H_1) asserted that soapstone quarrying exerts a statistically significant effect on agricultural land, driving substantial transformations in land-use patterns, soil productivity, and farm sizes across the study area.

Population and Sampling

The target population comprised 8,419 households distributed across Tabaka Ward. From this population, a sample size of 382 household respondents was calculated using Equation 1 (Yamane, 1973).

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

where n is the required sample size, N is the total target population (8,419), and e is the margin of error at a 95%

confidence level (0.05). Based on this equation, *n* is obtained as 382.

To ensure adequate geographical representation and minimize selection bias, Tabaka Ward was stratified into six administrative sub-locations as sampling strata. Proportional stratified sampling was applied to allocate the overall sample size across each sub-location based on its relative household density. Finally, simple random sampling was used to select the individual household respondents within each stratum, as detailed in Table 1.

Table 1. Sample Size Distribution

Sub-location	Household Population	Sample Size
Bombure	1,795	82
Bonyagwanda	1,523	69
Bomware/Botabori	1,635	74
Bokimai	1,263	57
Nyatike	1,344	61
Iringa	859	39
Total	**8,419**	**382**

In addition to the household survey, purposive sampling was employed to select key informants with specialized knowledge and long-standing awareness of soapstone quarrying activities in the study area. The key informants comprised local sub-chiefs, chiefs, and the Head of the Department of Water, Environment, Natural Resources, and Climate Change. These individuals were selected to provide expert insights and qualitative context regarding the broader environmental, administrative, and spatial impacts of quarrying activities on local agricultural lands.

Data Collection Techniques

Data collection employed a combination of structured household surveys, key informant interviews, and direct field observations. Structured questionnaires were administered to household heads to gather quantitative data regarding farm sizes, land areas converted to soapstone quarrying, and livestock management practices. Complementarily, semi-structured interview guides were used with key informants, including local chiefs, sub-chiefs, and the Head of the Department of Water, Environment, Natural Resources, and Climate Change, to capture qualitative perspectives on the broader impacts of quarrying on agricultural land. Furthermore, direct field observations were systematically conducted using an observation checklist, supported by photographic documentation to capture visible indicators of landscape transformation, such as abandoned quarry pits, degraded pasture fields, and encroached farmlands.

Data Analysis Techniques

Quantitative data collected from household respondents were entered, cleaned, and coded in Microsoft Excel before being exported to the Statistical Package for the Social Sciences (SPSS) Version 27 for analysis. Descriptive statistics, including percentages, means, standard deviations, and frequency distributions, were computed to analyze variables related to farm size, crop production, livestock rearing, and land allocation for quarrying activities.

To test the research hypothesis, inferential statistics were employed. Specifically, a paired-sample t-test was conducted to assess whether a statistically significant difference existed between the average overall farm size and the size of land converted to soapstone quarrying. The threshold for statistical significance was set at a 95% confidence level ($\alpha = 0.05$, $p < 0.05$).

Qualitative data obtained from key informant interviews were analyzed using thematic analysis. The qualitative narratives were transcribed, coded, and categorized into dominant themes aligned with the research objectives, including impacts on crop production, livestock keeping, and quarry expansion. Field observations and photographic evidence were further integrated to contextualize, corroborate, and triangulate both quantitative and qualitative findings.

Accuracy Testing

The research instruments were tested for validity and reliability before the actual data collection process. Content validity was established through expert review. University supervisors and experts in geography and research methodology evaluated the questionnaire and key informant interview guides. These validators assessed the items for clarity, relevance, comprehensiveness, and alignment with the study objectives. Constructive feedback, corrections, and suggestions provided during the validation process were incorporated into the final revision of the instruments before data collection commenced.

A pilot study was conducted in a comparable non-sampled area to evaluate the clarity, suitability, and internal consistency of the household questionnaire, allowing for the identification and rectification of ambiguous items. Instrument reliability was quantitatively measured using Cronbach's alpha

coefficient. In accordance with Kombo & Tromp (2006), a reliability threshold of 0.70 or higher is considered acceptable for social science research. The questionnaire yielded an overall Cronbach's alpha coefficient of 0.87. The value demonstrates high internal consistency and confirms the instrument's reliability for full-scale data collection.

RESULT AND DISCUSSION

A comparison was made between farm size and land under quarrying to reveal the size of land occupied by soapstone quarrying that could otherwise have been utilized for agricultural purposes. The study compared the proportion of farmers' land and that under soapstone quarrying (Table 2).

Table 2. Land Size

	Mean	N	Std. Deviation
Farm Size (Acres)	2.8	382	3.2
Land Under Soapstone Quarrying	0.5	382	2.2

Based on Table 2, the average agricultural land size was 2.8 acres, while an average of 0.5 acres was under soapstone quarrying across Tabaka Ward. Although the average land area occupied by quarrying activities was smaller compared to that of agriculture, it indicates that these activities still affect agricultural land through soil erosion, land fragmentation, and reduced agricultural production. The relatively high standard deviation of 3.2 acres for farm size reveals a wide variation in farm sizes among households, with some owning less than an acre and others holding up to 6 acres. Regarding quarries, the standard deviation of 2.2 acres also signified a relatively high variation, as some respondents did not practice quarrying on their land.

A paired-sample t-test was conducted to compare the average agricultural farm size and the land area under soapstone quarrying among the 382 respondents to ascertain whether a difference existed between agricultural farm size and land under quarrying. The findings of the paired t-test are presented in Table 3.

Table 3. Paired t-test Comparing Farm Size and Land under Quarrying

	t	df	Sig. (2-tailed)
Farm Size vs Land under Quarrying (Acres)	12.884	381	0.001

Table 3 shows a statistically significant difference between the two land uses. The paired-sample t-test confirmed a statistically significant disparity between total farm size and the portion lost to quarrying ($t(381) = 12.88$, $p < 0.001$). This statistical significance highlights that while agriculture remains the major land use, quarrying has systematically fragmented a significant, non-trivial portion of smallholder productive land (0.5 out of 2.8 acres on average). However, even this small proportion of land under quarrying has a significant impact on plot fragmentation, crop displacement, and land degradation.

According to Mu'adi et al. (2020), activities with better economic returns lead to the conversion of productive agricultural land into other uses. This supports the findings of this study, where the economic significance of soapstone quarrying in Tabaka Ward has encouraged residents to set aside land for soapstone extraction activities, resulting in less land being available for crop production and livestock grazing.

Soapstone Quarrying Effects on Crop Production

The study investigated the different crops grown by the household respondents. Some of the crops observed to be grown in the area included maize, onions, kales, bananas, groundnuts, cassava, sweet potatoes, tea, coffee, sorghum, sugarcane, pawpaw, tomatoes, millet, avocados, black nightshade, and cabbage. Photographs of some of these crop plantations are shown in Figure 2 below.

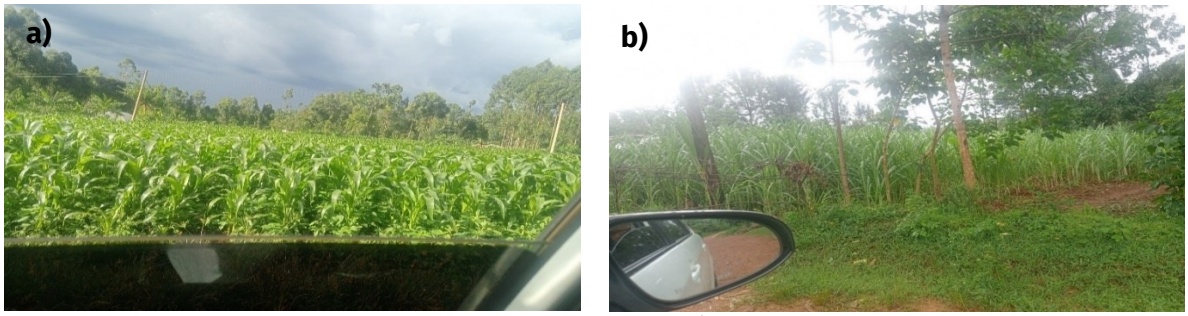

Figure 2. Agricultural Crop Plantations in Tabaka Ward: a) A Maize Farm in Iringa Sub-location; b) Sugarcane Plantation in Bokimai Sub-location

The study further investigated the effects of quarrying on crop yields. Among the 382 household respondents surveyed, the study sought to determine whether they had observed any effects of quarrying activities on crop yields. The results are shown in Figure 3 below.

Based on Figure 3, only 91 (23.8%) respondents noticed the effects of quarrying activities on crop yields. These effects were more recognized in soapstone-intensive sub-locations such as Bomware/Botabori (36.5%) and Bombure (30.5%). In contrast, in sub-locations like Nyatike (8.2%) and Iringa (10.3%), soapstone quarrying had the least effect on crop yields because these areas have fewer quarrying activities. Bonyagwanda (26.1%) and Bokimai (21.1%) were affected.

The responses on the decline in crop production can be attributed to quarrying activities, which remove the fertile topsoil containing nutrients and organic matter needed for crop growth. Soil degradation diminishes the ability of farmland to support crop production (Wang, 2022). Moreover, dust from the excavation, cutting, and transportation of soapstone may settle on crop leaves, lowering light interception and photosynthetic efficiency (Kameswaran et al., 2019). Reduced photosynthetic activity hinders plant growth, consequently leading to lower crop yields.

Among those affected by quarrying activities, the study sought further to investigate the specific effects on crop production that they had observed. From the findings, some respondents pointed out that they relied more on soapstone quarrying activities than agriculture and therefore had less time for farming, which affected crop production. Other household respondents noted walking long distances in search of food, the constant expansion of quarrying activities toward agricultural fields reducing crop production, a high preference for quarrying activities due to better income than agriculture, low yields resulting from rocky and infertile soils, and the loss of pollinators due to ecosystem disruption.

The results of this study are also supported by the Sustainable Livelihoods Framework, which highlights the significance of natural capital in supporting rural livelihoods (Opiyo et al., 2024). Agricultural land serves as the main natural capital for households in Tabaka Ward. With increasing quarrying operations, there is a decrease in the availability and quality of this resource, which negatively impacts the agricultural livelihood base (Mensah & Amoah, 2024). In addition, some respondents indicated a diversion of labor from farming to quarrying operations due to the immediate financial benefits of quarrying compared to farming. This shift in labor could also lead to decreased agricultural productivity.

On the other hand, one key informant, a sub-chief, indicated positive effects, noting that households could use the income generated from quarrying activities to purchase agricultural inputs like high-quality seeds and fertilizers, as well as to pay farm workers, which indirectly contributes to agricultural production. The sub-chief added that this income could also be used to buy food or rent farmland elsewhere.

Conversely, another sub-chief observed that quarrying constantly converted agricultural land into quarry sites and increased soil sedimentation from quarry rocks, leading to a decline in agricultural productivity This decline was attributed to soil erosion, the conversion

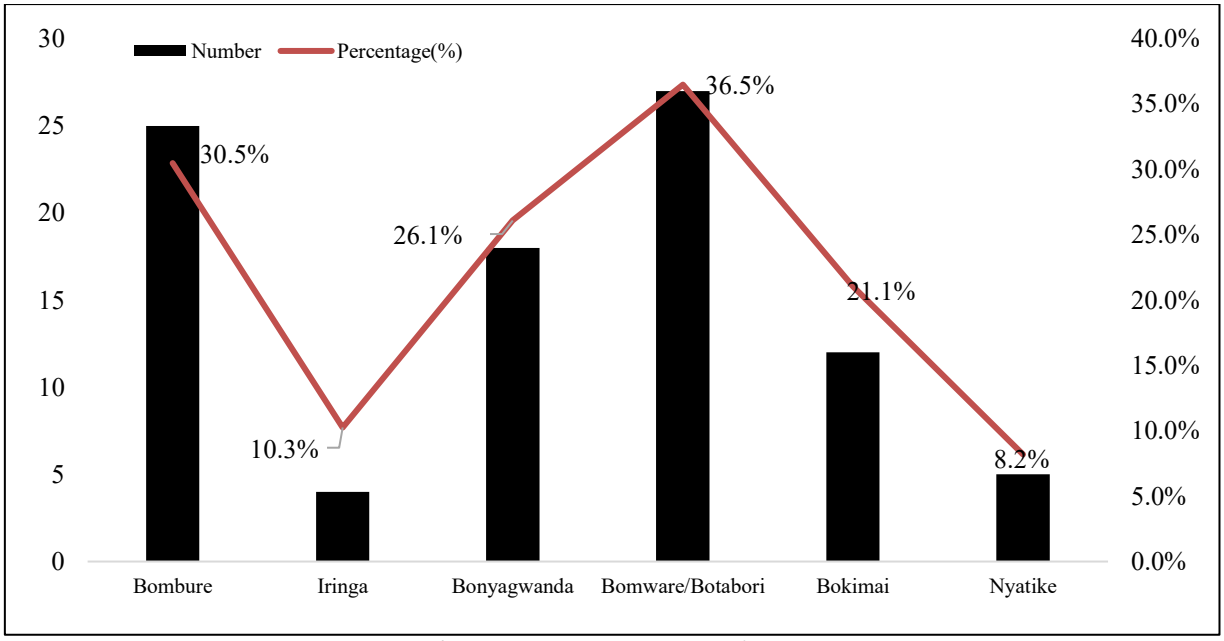

Figure 3. Effects on Crop Yields

Figure 4. Soapstone Quarrying Degraded Land

agricultural land to quarry sites, and dust deposition on crop leaves, reducing photosynthesis. This process was also evident from a photograph taken in Bomware/Botabori Sub-location showing soapstone derelict land, as displayed in Figure 4.

Additionally, one key informant, a chief, also confirmed that many crop fields were rendered infertile in sub-locations like Bomware/Botabori and Bokimai due to the removal of topsoil, making them unsuitable for crop farming. This was also in line with the findings of Kameswaran et al. (2019), emphasizing that the decline in crop yield is associated with dust emissions, which clog crop leaves, thereby reducing photosynthesis.

Soapstone Quarrying Effects on Livestock

Besides crop farming, livestock rearing was also affected by soapstone quarrying activities. The study evaluated the types of livestock kept across the six sub-locations. From the responses, 76.4% of the respondents practiced both cattle and poultry farming, 56.5% reared goats, 17.8% sheep, 6.5% rabbits, 5.0% donkeys, 2.1% pigs, and 3.1% of the respondents mentioned other livestock, which included dogs and cats (Table 4).

Further, the study examined the number of respondents who had noticed the effects of soapstone quarrying on livestock, with 76 (19.9%) of the respondents noticing these effects (Figure 5).

Based on Figure 5, Bonyagwanda recorded the highest percentage of respondents who noticed the effects of soapstone quarrying on livestock (29.0%), followed by Bokimai (24.6%). This implied that livestock from these sub-locations were the most affected. In Bombure Sub-location, 23.2% of the respondents and 21.6% in Bomware/Botabori recorded relatively high responses

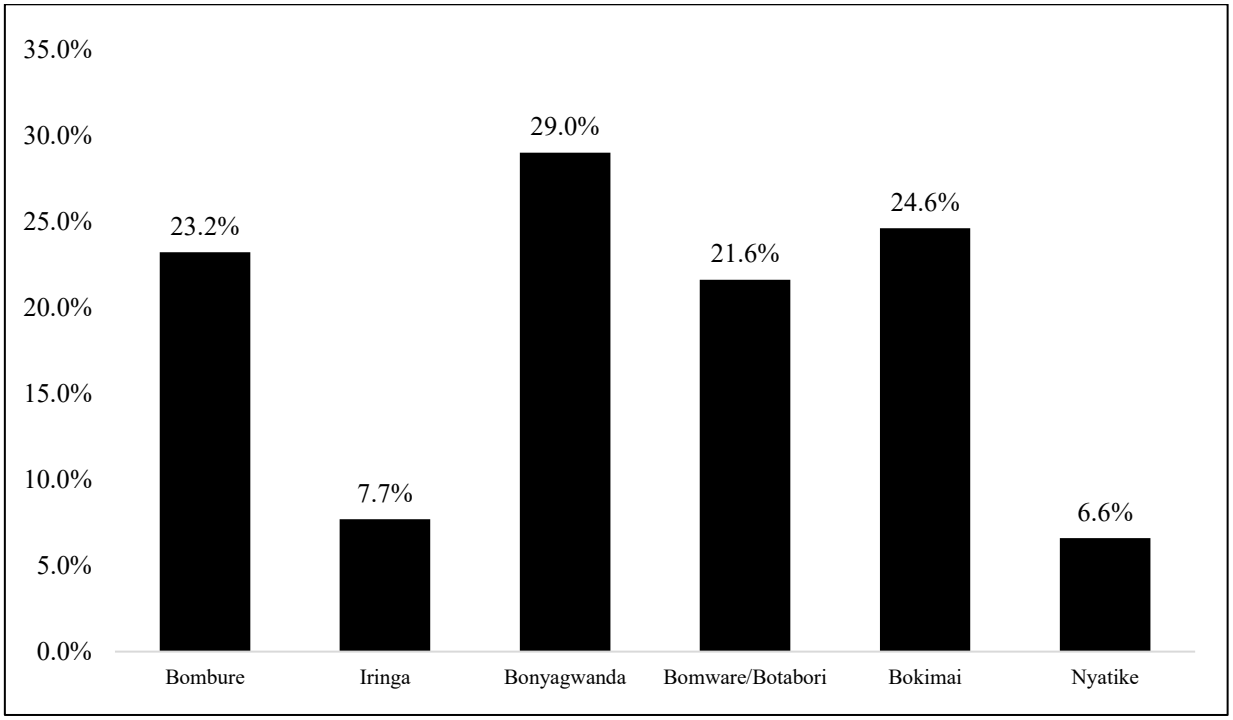

Figure 5. Percentage Response of Noticed Effects on Livestock

which suggested that soapstone quarrying activities had a moderate impact on livestock rearing. On the other hand, Iringa (7.7%) and Nyatike (6.6%) reported the lowest percentage of responses, indicating that quarrying is almost inactive or has less impact on livestock in these sub-locations.

The effects of quarrying on livestock production can be linked with changes in grazing resources and environmental conditions. The expansion of quarrying activities reduces the amount of land available for pasture and grazing (Oyda, 2021). Consequently, as pasture becomes scarce, livestock owners are forced to travel in search of pasture, which increases management and production costs (Hadush, 2020).

Additionally, among the respondents who noticed the effects of quarrying on livestock, the study investigated the specific effects they had observed. Some respondents mentioned keeping lower numbers of livestock compared to crop farming. The extensive quarrying fields left land bare, and dust clogged pasture feeds such as grass and fodder. Some observed that their livestock could fall into open quarry pits, leading to injuries and sudden deaths. This was supported by research conducted by Hinkle & Corrigan (2020), which indicates that stagnant water in quarry pits can harbor pests and diseases affecting domesticated animals. These findings were also in line with a study by Lund & Blanchette (2023), who emphasized that open pits endanger the lives of livestock. This was also evident from the photograph taken at the Rionchomba quarry site showing an open quarry pit that could endanger livestock (Figure 6).

Figure 6. Stagnant Water in an Open Rionchomba Quarry Pit

Table 4. Percentage Responses on Livestock

Sub-location	Cattle	Goats	Poultry	Donkeys	Sheep	Pigs	Rabbits	Others
Bombure (82)	79.3	65.9	89.0	8.5	18.3	0.0	8.5	0.0
Iringa (39)	64.1	41.0	71.8	7.7	10.3	2.6	5.1	2.6
Bonyagwanda (69)	78.3	65.2	78.3	7.2	18.8	2.9	8.7	4.3
Bomware/ Botabori (74)	66.2	41.9	79.7	1.4	18.9	2.7	2.7	6.8
Bokimai (57)	87.7	59.6	73.7	3.5	15.8	1.8	7.0	3.5
Nyatike (61)	80.3	59.0	59.0	1.6	21.3	3.3	6.6	1.6
Mean (382)	**76.4**	**56.5**	**76.4**	**5.0**	**17.8**	**2.1**	**6.5**	**3.1**

These data findings were supported by a key informant, a sub-chief, who mentioned that quarrying mostly affected grazing fields and grass availability. Noise pollution was also reported to cause behavioral changes in cattle and poultry. The extraction of soapstone in Tabaka Ward usually involves manual excavation, including stone cutting and sometimes rock breaking, which contributes to significant noise in the quarry areas (Yator, 2024). Noise pollution from these activities, especially in areas with a high concentration of quarries, disturbs domesticated animals, which may affect their grazing behaviors and movement patterns. According to Clark & Dunn (2022), noisy environments usually trigger long-term fear in animals. Additionally, high levels of noise pollution may lead to animal injuries, especially to tissues and other body organs such as ear bones (Erbe et al., 2022).

The study primarily focused on household perceptions and field observations regarding the effects of soapstone quarrying on agricultural land in Tabaka Ward. Although the sample size was adequate for statistical analysis, the results represent only one ward and may not fully reflect other quarrying regions.

The study recommends quantifying the impacts of quarrying activities on agricultural land through longitudinal assessments, geospatial land-use change analysis, and direct measurements of agricultural productivity. Additionally, the generalizability of the findings would be enhanced by conducting similar studies in other quarrying regions to support sustainable quarry management policies. This is supported by previous studies, such as Opondo et al. (2023) and Muriki et al. (2023), which emphasize integrating environmental monitoring and land restoration measures into extractive industries to reduce long-term ecological degradation.

CONCLUSION

The study concludes that soapstone quarrying in Tabaka Ward has resulted in considerable agricultural land loss. The null hypothesis, which stated that there are no significant effects of soapstone quarrying on agricultural land in Tabaka Ward, Kisii County, Kenya, was rejected. A paired t-test indicated a significant difference between the land under agriculture and that under quarrying activities ($t(381) = 12.884$, $p < 0.001$), indicating a significant transformation of agricultural land. Quarrying has destroyed natural vegetation, disrupted agricultural activities, and reduced land productivity. While soapstone quarrying is a major local economic activity providing employment opportunities and livelihoods, its benefits are overshadowed by land degradation, declining crop yields, shortages of pastureland, and the continuous expansion of quarry sites into farmlands.

Hence, based on these findings, the study recommends that the National Environment Management Authority (NEMA) enforce strict regulations on land restoration efforts by quarry operators, such as backfilling abandoned open quarry pits with soil. This will restore land productivity for farming and protect livestock from injuries. Furthermore, there is a need to adopt sustainable quarrying practices to safeguard agricultural land and rural livelihoods in Tabaka Ward, Kisii County, Kenya.

ACKNOWLEDGMENT

I express my gratitude to Dr. Kinoti Kibetu and Dr. Paul Njue for their immense contribution to my work as supervisors, and to Mr. Hanningtone Sitati for his assistance with the statistical analysis in this study. I also acknowledge the Chuka University fraternity for their support whenever needed and for providing a conducive environment throughout my studies, as well as reviewers and the editor of the Journal of Geographical Sciences and Education for their help in improving the quality of the manuscript.

AUTHOR CONTRIBUTIONS

Justine Ong'uti Okemwa: conceptualization, methodology, investigation, data curation, visualization, and writing—original draft preparation; **Dickson Kinoti Kibetu**: supervision, methodology, map preparation, visualization, and validation; **Paul Nyaga Njue**: supervision, methodology, validation, and writing—review and editing; **Hanningtone Sitati**: data analysis, results interpretation, validation and review. All authors have read and agreed to the published version of the manuscript.

FUNDING

This research received no external funding.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCE

Akama, J., & Onyambu, M. (2020). The Role of the Gusii Soapstone Industry in Promoting Sustainable Livelihoods: A Historical Perspective. *African Journal of Hospitality, Tourism and Leisure, 9*(1), 1-12.

Akanwa, A. O., Okeke, F. I., Nnodu, V. C., & Iortyom, E. T. (2017). Quarrying and Its Effect on Vegetation Cover for a Sustainable Development Using High-Resolution Satellite Image and GIS. *Environmental Earth Sciences*, *76*, 505. https://doi.org/10.1007/s12665-017-6844-x

Barchok, F. K., Mabwoga, S. O., & Kirui, S. (2024). Assessment of Land Cover Change Due to Stone Quarrying in Narok Town Ward. *Journal of the Kenya National Commission for UNESCO, 4*(2), 1-11. https://doi.org/10.62049/jkncu.v4i2.109

Bassey, P. E., & Okon, N. P. (2021). Perspectives and Experiences of the Effects of Quarrying on the Environment and Agricultural Activities of the Quarry Communities in Akamkpa Local Government Area of Cross River State, Nigeria. *International Journal of Science Academic Research*, *2*(07), 1767-1773.

Chepchumba, T. (2018). *Effects of Soapstone Quarrying on Geomorphic and Socio- Economic Activities in*

Tabaka Region, Kisii County-Kenya (Thesis, [Kenya]: Department of Geography, Kenyatta University).

Clark, F., & Dunn, J. (2022, August 24). This is How Noise Pollution Can Harm Animals. *Anglia Ruskin University*. Retrieved from https://www.aru.ac.uk/news/noise-pollution-is-hurting-animals

Erbe, C., Dent, M. L., Gannon, W. L., McCauley, R. D., Römer, H., Southall, B. L., Stansbury, A. L., Stoeger, A. S., & Thomas, J. A. (2022). The Effects of Noise on Animals. In *Exploring Animal Behavior through Sound: Volume 1: Methods* (pp. 459-506). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-97540-1_13

Fugiel, A., Burchart-Korol, D., Czaplicka-Kolarz, K., & Smoliński, A. (2017). Environmental Impact and Damage Categories Caused by Air Pollution Emissions from Mining and Quarrying Sectors of European Countries. *Journal of Cleaner Production*, *143*, 159-168. https://doi.org/10.1016/j.jclepro.2016.12.136

Hadush, M. (2020). Examining the effect of animal resource scarcity on farm labor and farm production in Northern Ethiopia. *Journal of Agricultural and Applied Economics*, *52*(2), 264-287. https://doi.org/10.1017/aae.2019.43

Hinkle, N. C., & Corrigan, R. M. (2020). External Parasites and Poultry Pests. In D. E. Swayne (Ed.), *Diseases of Poultry* (14th ed., pp. 1131–1156). John Wiley & Sons. https://doi.org/10.1002/9781119371199.ch26

Kameswaran, S., Gunavathi, Y., & Krishna, P. G. (2019). Dust Pollution and its Influence on Vegetation-A Critical Analysis. *Research journal of Life sciences, Bioinformatics, Pharmaceutical and Chemical sciences*, *5*(1), 341-363. https://doi.org/10.26479/2019.0501.31

Kisii County Government. (2018). *Kisii County Integrated Development Plan 2018-2022*. Repository.kippra.or.ke. Retrieved from https://repository.kippra.or.ke/handle/123456789/1315

KNBS. (2019). *2019 Kenya Population and Housing Census: Volume II.* Retrieved from https://housingfinanceafrica.org/app/uploads/VOLUME-II-KPHC-2019. pdf

Kombo, D. K., & Tromp, D. L. (2006*). Proposal and Thesis Writing: An Introduction*. Paulines Publications Africa.

Lund, M. A., & Blanchette, M. L. (2023). Closing Pit Lakes as Aquatic Ecosystems: Risk, Reality, and Future Uses. *Wiley Interdisciplinary Reviews: Water*, *10*(4), e1648. https://doi.org/10.1002/wat2.1648

Mensah, J., & Amoah, J. O. (2024). Impact of Stone Quarrying on Sustainable Livelihoods and Environment in Selected Communities in Ghana: Implications for the Sustainable Development Goals. *Society & Natural Resources, 37*(8), 1140-1159. https://doi.org/10.1080/08941920.2024.2335389

Mu'adi, S., Maksum, A., Hakim, M. L., & Umanailo, M. C. B. (2020). Transfer of Function Agricultural Land. In *Proceedings of the International Conference on Industrial Engineering and Operations Management* (pp. 2568–2574). IEOM Society International. https://ieomsociety.org/ieom2020/papers/873.pdf

Muriki, J. G., Wambugu, S., & Obando, J. (2023). The spatial distribution of quarry stone mining sites in Igembe South Sub-county Meru County, Kenya. *Journal of Humanities and Social Sciences (JHSS)*, *2*(1), 120-129. https://doi.org/10.51317/jhss.v2i1.440

Nasir, S. B., Ang, M. L. E., Nath, T. K., Owen, J., Tritto, A., & Lechner, A. M. (2023). Modelling Past and Future Land-Use Changes from Mining, Agriculture, Industry and Biodiversity in a Rapidly Developing Southeast Asian Region. *Integrative Conservation*, *2*(1), 43-61. https://doi.org/10.1002/inc3.17

Okong'o, G., Mutinda, M. N., & Imaita, I. G. (2021). Effects of Vegetation Destruction on the Socio-Economic Well-being of Households within the Soapstone Quarrying Areas of Gucha South Sub-County, Kenya. *International Journal of Environment and Climate Change*, *11*(1), 22-32.

Opiyo, S. B., Opinde, G., & Letema, S. (2024). A Perspective of Sustainable Livelihood Framework in Analysis of Sustainability of Rural Community Livelihoods: Evidence from Migori River Watershed in Kenya. *International Journal of River Basin Management*, *22*(4), 627-643. https://doi.org/10.1080/15715124.2023.2216019

Opondo, E. O., Ajayi, D. D., & Makindi, S. M. (2023). Impacts of Quarrying Activities on the Environment and Livelihood of People in Border II Sub-location, Nyando Sub-county, Kisumu County, Kenya. *Environmental Quality Management*, *32*(3), 147-160. https://doi.org/10.1002/tqem.21881

Oyda, S. (2021). Assessing the Impact of Stone Quarrying on the Landscape, Crop and Grazing Land Degradation in Loma Bosa District, Dawuro Zone, Southern Ethiopia. *International Journal of Scientific Research in Civil Engineering, 5*(2), 79-91.

Wang, X. (2022). Managing Land Carrying Capacity: Key to Achieving Sustainable Production Systems

for Food Security. *Land, 11*(4), 484. https://doi.org/10.3390/land11040484

Yamane, T. (1973). *Statistics: An Introductory Analysis* (3rd ed.). Harper & Row.

Yator, M. J. (2024). *Status of Occupational Safety and Health of Soapstone Mine Workers in Tabaka, Kisii County, Kenya* (Thesis, [Kenya]: Jomo Kenyatta University of Agriculture and Technology, Institute of Energy and Environmental Technology).