International Journal of Social and Development Concerns

ISSN 2524-1478 (Online)

Vol. 20 | Post COVID-19 Recovery and Sustainable development
Vol. 20 Article 9 | September 2024

Implications of the Standard Gauge Railway (SGR) Construction on the Environment and community livelihoods in Ngong Town, Kajiado North Sub-County, Kenya

Authors: [1]Godknows Makumbe, [2]Aloys Ojore and [3]Beatrice Ndiga
[1,2&3]Tangaza University. **Website:** https://tangaza.ac.ke/
Correspondence: Godknows Makumbe. **Email:** godknowszim@gmail.com
Cite as: *Makumbe, G., Ojore, A., & Ndiga, B. (2024). Implications of the Standard Gauge Railway (SGR) Construction on the Environment and community livelihoods in Ngong Town, Kajiado North Sub-County, Kenya. International Journal of Social and Development Concerns, 20(9), 127–149. https://doi.org/10.5281/zenodo.13751224*

Abstract: *The development of the Standard Gauge Railway has proven to be one of the most important modes of transportation for both freight and passenger services. While this new development provides a positive transformation to formerly undeveloped areas, there have been cases where such developments have had an adverse effect on the environment and the people who reside there. The purpose of this research was to investigate the environmental effects of the Standard Gauge Railway (SGR) construction project on community Livelihoods in Ngong, Kenya's Kajiado County in Kenya. The households in Ngong's four villages, namely Kerarapon, Olepolos, Kibiko, and Kimika were the study's target population. The study employed mixed method approach and descriptive survey research designs. The target population was 510 household members in total. This study used Krejcie & Morgan's (1970) formula to get the sample size. The study sample size was 219, comprising of 211 household members and community leaders, 2 from each village. Both probability and non-probability sampling methods were used in the investigation. The researcher employed a stratified and simple random sample for the 211 household members in their probability sampling. The household head was targeted for quantitative data. For non-probability sampling, purposive sampling was employed to select the 8 community leaders 2 from each community. Data were collected through interviews and a questionnaire for household members. Both quantitative and qualitative data from the acquired data were statistically and thematically analysed.* On the one side, concerns regarding the project's environmental effects included pollution, land degradation, and negative effects on the water supplies in a number of settlements, including Olepolos, Kibiko, and Kerarapon. However, the SGR building project enhanced Kimuka village's ecology. *As such, the general conclusion of the study shows that the SGR project has to a greater extent, negatively affected the community livelihoods of the villages in Ngong, Kajiado North Sub-County in Kenya.*

Key words: *Standard Gauge Railway Project, Construction, environment, community livelihoods, sustainable development*

1.1 Background of the study

Transport infrastructure is the ultimate economic growth enabler as it improves mobility and accessibility in the world. Transport infrastructure, in all of its forms, plays a crucial part in the expansion and development of every nation's economy. Without transport infrastructure that supports inclusive growth,

countries find it difficult to meet basic needs and struggle to improve competitiveness (Shehu, 2018). Among all modes of transport, rail transport plays a significant role.
Globally, following a period of decline, railway transportation is now improving the railways' newly discovered attraction is based on their ability to transport large numbers of freight or passengers in an energy-efficient and environmentally friendly manner (ADB, 2015). It has proven to be more efficient, safer, cost-effective, and environmentally friendly than other modes of transportation such as roadways and planes.

Most industrialized countries, such as the United States of America, China, Japan, and European countries, have made it a priority to increase the use of alternate modes of transportation, such as trains and inland waterways, by introducing metros and suburban rails (ADB, 2015). In Europe, rail transport is a significant contributor to achieving the European strategic ambition of smart, sustainable, and inclusive growth. For example, in terms of modal share, railway transport supplied more than 20% of freight and 25 % of passenger transport in 2019 (Shang & Cao, 2019). The move to standard gauge was made in countries mostly in Europe and Asia, to ensure high loads, better connectivity, and the realization of the potential for faster speeds due to the increased stability offered by the wider footprint. As a result, high-speed passenger services are almost entirely on standard gauge (Irandu & Owilla, 2020).

The African continent is trailing behind in terms of trade development, primarily due to a lack of reliable and adequate transportation infrastructure. Railway transport in Africa is the least developed, leaving road travel to bear the brunt of the transport burden (Chebet, et al., 2021). Since the colonial era, rail transportation infrastructure in most African nations has not been connected or improved enough, leaving the current railway transport facilities totally outward-looking. Limited transport infrastructure is a major impediment to most African countries' economic growth and integration with the global economy (Taylor, 2020).

Regionally, the SGR construction was first put into operation after the governments of Kenya, Uganda, and South Sudan agreed to provide high capacity and affordable rail travel along the Northern route (KRC, 2019). This plan will be fulfilled with a high-capacity, high-speed Railway line that will connect Kenya's Mombasa port to South Sudan's Juba through Uganda and Rwanda, respectively. Kenya was given the duty of building the SGR from Mombasa to the Malaba border (Cheng & Liang, 2011). The intended East African SGR network will use this not only as a trunk line, but it is also expected to play a critical role in enhancing EAC member state collaboration, as well as integrating and boosting the regional economic development (Kunui, Mwobobia, Murangiri, Orengo, & Nguku, 2016).

In Kenya, the transportation sector is the country's main economic driver. The SGR will run from Mombasa to Malaba, Uganda's border town, and then on to Kampala, Uganda's capital city. It began in October 2013 and is split into two phases (KRC, 2019). The first phase, which is already completed, connects Mombasa and Nairobi. Mombasa, Kwale, Kilifi, Taita-Taveta, Makueni, Kajiado, Machakos, and Nairobi are among the counties traversed during this phase (GoK, 2020). The second phase will go from Nairobi to Malaba, the town that marks the boundary between Kenya and Uganda. It is still being built and is split into three portions. Phase 2a links Nairobi to Naivasha; Phase 2b links Naivasha and Kisumu; Phase 2c links Kisumu to Malaba and then to Uganda (KRC, 2019). Since gaining independence in 1963, the SGR is Kenya's largest infrastructure undertaking. (Taylor, 2020). The Mombasa - Malaba SGR project was inaugurated as a result of the meter-gauge railway's deterioration and inefficiency, and

the loss of considerable passengers and freight to the road transit (Irandu & Owilla, 2020). By 2030, the SGR freight volume is predicted to increase from 1.6 million tons (equal to approximately US$ 65 million) to 14.5 million tons (equivalent to approximately US$ 585 million) per year (Todaro & Smith, 2015). Kenya intends to construct a "seamless" and connected Africa through the 2000-kilometre-long transit corridor (LCDA, 2016).

Given Kenya's geostrategic location, there is little doubt that the initiative will be beneficial for Kenya, the East African region, the continent of Africa, and the rest of the world. According to Murithi, (2015), and Apura & Dylan, (2016), it is anticipated that upon completion, local businesses will have the ability to participate in delivering services to the SGR stations, based on the notion of open access. The SGR is expected to be a catalyst in improving socio-economic activities such as the mobility of goods and people, increasing regional trade opportunities, cost-effective means of transporting goods, reduced transportation and maintenance costs, and fewer road accidents (Irandu & Evaristus, 2017). As it prioritizes national economic growth, the SGR is also viewed as the mainframe around which an integrated national transportation system is created. The standard gauge railway is one of Kenya's biggest infrastructure projects that aimed to achieve long-term development goals and is expected to project the country to a globally competitive and prosperous economy whilst improving the livelihoods of the people (Atwori, Juma, Gogo, Abdulkadr, & David, 2020).

The project was undertaken by a Chinese construction company, China Road, and Bridge Corporation (CRBC) and is projected to run from Mombasa to Malaba (Kibwage, 2012). The aim of the SGR project was to simplify transport operations across borders and reduce travel costs while benefiting the economies of Kenya and the neighboring states. The construction of the SGR line involved both social-economic and environmental effects such as the employment of both skilled and semi-skilled workers, displacements, and the subsequent resettlement of communities where the line transverses as well as pollution and destruction of water catchment areas. The construction of phase one of the SGR from Mombasa to Nairobi has resulted in growth in a variety of sectors, including residential and commercial areas, educational and job opportunities, mostly in regions surrounding its corridor. The SGR can be viewed as a regional integrating tool because it handles more than 60% of Mombasa port traffic bound for various markets in Kenya and beyond (Lang'at, 2017). More than 11.2 million tons of goods are transported between Uganda and Kenya each year. Thus, the SGR facilitates freight movement not just on Kenyan roadways but also in surrounding landlocked East African member nations (Xinhua, 2018). Furthermore, the overarching goal of the National Corridor Integration Project (NCIP) of jointly building and running a contemporary efficient dependable, and high-speed capacity railway transport is progressively being accomplished (NCIP, 2018).

The 2010 Kenyan constitution's guiding principles serve as a guide for infrastructure development. The Republic of Kenya's constitution is therefore its highest law. The constitution offered a comprehensive framework for integrating infrastructure and transportation improvements like the SGR project. Both the present and the future facets of development are governed by this framework. Additionally, it is where all national and sectoral legislative policies, as well as institutional, regulatory, and legal frameworks, are developed. Section 42 of the constitution, inside the Bill of Rights states that, *"every person has the right to have the environment which includes the right to have environmental protection for the benefit of the present and the future generation through the legislature and other measures"* (GOK, 2010). Additionally, Chapter 5 of the Constitution lays forth the fundamental principles on which all

environmental laws are based. The nation's commitment to protect the environment and stop practices and actions that could endanger the environment is also outlined in Part 2 of Chapter 5 of the constitution (GOK, 2010). In this way, Article 69 of the constitution states that *"the state shall ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources and ensure sustainable sharing of the accruing benefits"* (GOK, 2010). In a similar vein, the SGR project as well as any other activity or project carried out within the Republic of Kenya must conform to the state's vision for the environment as well as the constitutional guarantee of everyone's right to a clean and healthy environment. Additionally, it ought to offer compensation to everyone who has had their right to a clean and healthy environment violated. Savage *et al* (2019) highlights that with the fast expansion in infrastructure development megaprojects across Kenya, their socio-economic effects on local populations is a less-studied topic. The SGR project has had various effects, particularly on the environment and the community along the railway line. These effects have varying implications on the lives of the local people in Ngong. This study focused on the effects of the Standard Gauge Railway construction on community livelihoods in Ngong town, Kajiado North Sub County.

1.2 Statement of the Problem

The construction of the Standard Gauge Railway megaproject has influenced communities in technical skills development and job opportunities. Despite such benefits and the need to achieve long-awaited social-economic growth, environmental accountability, and social transformation, there is a growing socio-economic impact of the SGR construction (Nyumba, et al., 2019). According to a study on the impact of the SGR on the national economy in the East African Community regional economic bloc, the study found out that SGR has significantly influenced the lives of the communities living along the line through job creation and compensation as a result of resettlement (Nyumba et.al., 2019) and (Okita, et al., 2017). Many other literatures carried out in Africa, especially in the East African Region revolved around economic gains by states as a result of the construction of SGR (Senelwa, 2016). However, a number of studies did not consider the environmental effects of SGR which is key to human existence. Environmental effects, land acquisition, displacement, and social ills, which lead to changes in community livelihoods, are the ultimate drivers of changes in community livelihoods (Apura& Dylan, 2016; Mahiri, 2017). Considering the above observation, there was a need for more research on the effects of SGR construction on the environment and the community livelihoods in Ngong Town, Kajiado Sub County, Kenya.

1.3 Objective of the Study

To establish the environmental effects of the Standard Gauge Railway line (SGR) construction community livelihoods in Ngong Town, Kajiado North Sub-County, Kenya.

1.4 Significance of the Study

This study is crucial because it will provide relevant information about the effects of SGR on the environment and community livelihoods. The findings from this study will also serve as a guide for government agencies and other developing partners in charting a course for delivering successful and long-term projects. Furthermore, the information gathered on the impact of SGR construction in Kenya will help all stakeholders benchmark the long-term feasibility of future initiatives. To have the best interests of humans and the environment in any project, it is critical to be proactive and look beyond the

advantages, as well as to collaborate with the local community, NGOs, and government organizations. This study aims to add to existing knowledge, address issues, and provide background information to research organizations, individual researchers, and academics interested in conducting additional research in this field.

1.5 Scope and Delimitations of the Study

The study was conducted in Ngong town, Kajiado Sub County. This is due to the SGR's construction having a range of effects on these communities, most notably on their ecology and livelihoods. The study was carried out in the communities of Kerarapon, Kibiko, Olepolos, and Kimuka. The researcher also focused on the leader of the local organization that works in all four areas. The researcher then collected data on the environmental effects of the SGR construction on community's livelihoods. The research took place in Kajiado Sub County, in Ngong town.

1.6 Limitations of the study

The neighborhood members' uneasiness and reluctance to inform a stranger about their issues because of the construction would be the first barrier. The researcher resolved this problem by enlisting the help of local authorities (community leaders, association leaders, and church leaders) who are dealing with comparable problems and seeking answers. This established a positive relationship with them and fostered trust, ensuring them that the researcher is looking out for their best interests. Second, since the study location is cosmopolitan in nature, the study was conducted in English, and in cases where English is a barrier for some participants who are not conversant in English language, a response in local language was acceptable. To tackle this problem, the researcher enlisted the help of research assistants who are proficient in English as well as all the local languages spoken in the study region.

1.7 The Conceptual framework

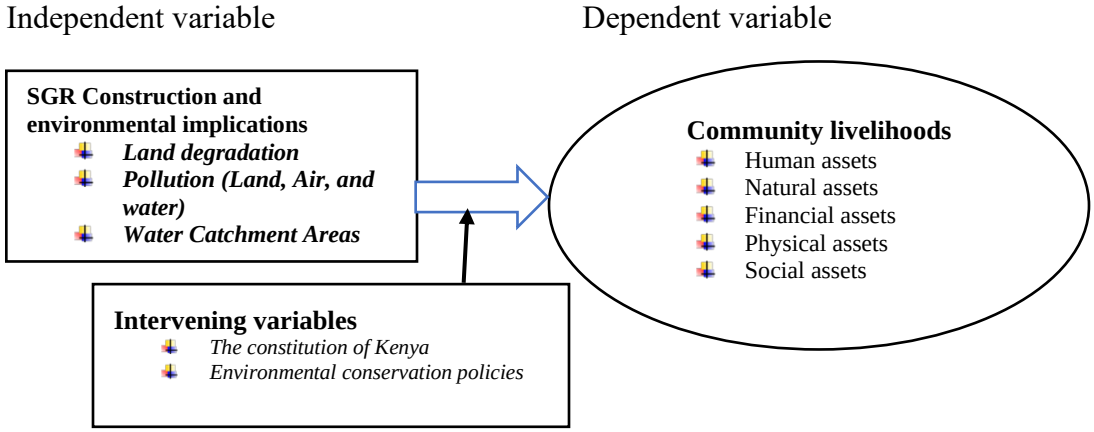

Figure 1: The Conceptual framework
Source: Own Conceptualization, 2024

1.8 Literature review

In this section, theoretical and empirical literature reviews will be presented.

1.8.1 Modernization theory

Modernization theory began to surface among intellectuals after the Second World War (WW2) and is attributed to Walt Rostow. Modernization theory leads one to understand how states carry out economic developments and how the same economic development affects the social, economic and environmental structures of society. Modernization theory argues that economic development is key for any state to modernize and that both Citizens and the government play a role in achieving economic development. Thus, for economic development to be achieved, a country must change social, economic, cultural, and moral values. Ogoko (2016) noted that the primary goal of economic development as fronted by modernization theory is to improve citizens' quality of life, increase the Gross National Product (GNP), and promote sustainable development. Economic development entails promoting economic growth and structural change, as well as improving the general welfare of the population, through both private and public channels (Todaro & Smith, 2015).

Rodney (1972) argued that the central claim of modernization theory is that economic development occurs in a well-planned coherent and predictable pattern and that a society is in a process of constant evolution moving from, a simple, undifferentiated system to a complex, highly differentiated system the most complex of these being modern industrial societies (Harris, 1989). Walt Rostow (1973) thought that the only way for a country to transform economically is to evolve from a traditional society to a modern society to embrace mass production. Therefore, development as the core subject of modernization theory is an unstoppable process that must be embraced in order to achieve a transformative society that is able to achieve its current and future needs.

Modernisation theory examines five stages of linear development commonly recognised by scholars as the development ladder (Zambarati, 2018). Walt Rostow (1973) thought that the only way for a country to transform is to follow the five stages outlined below: traditional society, preconditions for take-off, take-off, mature drive, and age of mass production. All these stages show how modernization is considered by Rostow as an evolution in socio-economic change that is unified by a set stage extending from traditional to modern. Each stage of economic development is distinguished by a few traits where the socio-economic and environmental structures of the society are affected at times to the benefit of the beneficiary society or to its detriment. The modernization theory presents a crucial understanding of the effects of economic development in society. It helps to explain the relationship between economic development as an inevitable occurrence in society and the socio-economic and environmental consequence of its occurrence in the societies it happens.

According to Rostov (1973), to achieve economic development, economic, social and environmental structures of the society are affected for a holistic transformative society. In light of the SGR project as one of the key economic development projects in Kenya, the social, economic and environmental landscapes have been affected within all the areas of its operation. The SGR project displaced the communities living around the construction line. Despite receiving compensation for their lost land, many did not invest well the money they receive due to poor financial management expertise. As a result, the communities suffered both socially in terms of displacements and disruptions and economically due to the loss of reliance on menial job opportunities from the SGR construction. Equally, the construction

of the SGR project affected the water catchment area due to deforestation to create a way for the SGR line.

The shortcoming of modernization theory is that, as a transformation process, it just centralizes traditions and modernity, as traditional values must be lost to achieve modernity. According to Webster (1984), this pushes for urbanisation and industrialisation or the push for modernity necessitates a nation to adopt alternative lifestyles. There is a contention that, the variables and the values of modernization seem to be incompatible with other variables such as socioeconomic contexts that the traditional and the modern fail to relate with each other in a given era. Commenting on the theory's basic premise that claims that humanity ought to undergo a complete societal change involving technology, production and consumption, Chaudhary (2013) noted that these modifications tend to perpetuate a cultural shift, emphasizing the importance of an individual rather than the traditional community approach. It might also be argued that modernisation theory fails to weave together modern values, attitudes, and behaviour, as well as the progress that results. Thus, the critique of Blackmore and Cooksey (1989) sheds light on why modernity has failed to explain today's world. As a result, modernisation is a development and necessitates a complete departure from tradition, necessitating the abolition of everything traditional in the process. This theory is relevant to this research because it espouses that while modernization theory appears to be promising and applicable, in reality, every country has fluctuations and different experiences as it progresses, and no two countries are alike when it comes to development. Finding similar results from the same development programs in different countries and areas is extremely challenging. As a result of the prescriptions of modernization theory, states establish their own political, economic, and social institutions that are distinct from one another. in the same line, this theory cannot weave together the promises of development and the traditional lifestyles of the local people where the SGR is being constructed without having either negative or positive environmental effects on community livelihoods.

1.8.1 Empirical review

The Environmental Effects

This section discusses the environmental effects of infrastructure development. This section gives a global, regional and the national perspective. The main focus is on pollution and environmental degradation.

The SGR Construction and Pollution

Globally, environmental conservation presents a major challenge in terms of economic development. Many urban cities are grappling with the balance of environmental conservation and expansion of many large infrastructural projects such as rail transport. According to Kennedy (2015), Rail transport opens links rural communities to urban communities through the supply of raw materials to the villages and the supply of foodstuff to the city. Rail transport, therefore, transverses the different topographical regions including the forest and mountains. In Brazil for example, the rail transport transverse through the Amazon rain forest, which is not only the largest tropical forest in the world but also a provider of

essential ecosystem services for Brazil's agricultural sector. Therefore, railway construction projects have adverse environmental impacts such as deforestation.

Africa is currently experiencing serious environmental challenges including land degradation, deforestation, and biodiversity loss rendering the continent extremely vulnerable to climate change (Tobias, 2021). Africa's economic growth in infrastructure has significantly contributed to environmental degradation. Despite the advantages and the need to address the increasing demand for environmental accountability. Chauzel, Xiqing, Gongsheng, and Giraudoux, (2015) revealed that there is an increasing awareness of the impact on the natural environment, particularly in remote and fragile ecosystems with a low human population, disadvantaged and marginalized groups. The primary themes that have evolved as a result of these effects are ecosystem deterioration, fragmentation, destruction, and truncation into smaller isolated regions that may be unable to maintain or sustain the habitats (Tobias, 2021). Furthermore, Tobias (2021) and Collier (2014) found that although railway construction may share an impact with other human activities, it has a unique impact associated with its linear form constituting disturbance corridors, that disrupt the natural, and more homogeneous landscape.

While infrastructure projects, such as SGR construction, can be compelled to reduce environmental impact, there is always a major indirect effect that local communities directly attach to the project. Tobias et al., (2021), Lang'at (2018) and Risper (2019) voiced concerns about the contamination of soil, air, and water bodies during the construction and operation of the SGR. Along with the building sites, there is a lot of chemical dumping in streams, littering, and oil spillage. Chemicals and cement from mixing construction vehicles were dumped in streams in large numbers (Chome, 2020).

Waste management is a concern, which is defined as a failure to properly dispose of construction waste in the construction camp using proper waste disposal processes (Lesuitis, 2020). Oil spills in Kibwezi County, pollution of the Thwake River, and contamination of the Athi River in Machakos County are examples of such incidents that occurred between 2015 and 2018 (Jadwab, Muradi, & Kerby, 2018). This waste ends up in streams utilized for residential purposes, animal drinking, and other agricultural purposes. The local community suffers as a result of this because they rely on the water from these rivers for domestic purposes (drinking, cooking, cleaning, bathing, and so on) to support their livelihoods. The rivers and streams offer drinking water for livestock, irrigation for horticulture, and domestic use. As a result of the pollution, the polluted land is no longer suitable for the cultivation of particular cash crops for certain markets, affecting their source of income (Blanquart & Koning, 2017).

Railway construction projects, such as the SGR, have been heavily criticized for their effects on local community sustainability (Kennedy, 2015). According to Dowden, (2015), Lyons, (2016) and Wang, Xue, & Zhao, (2019) recently the effects of the infrastructure development project have been receiving more attention and debate because of the pursuit of direct economic growth in both the region and the sector. The existing literature in Kenya has both a contextual and methodological gaps.

On the one hand, according to the literature evaluations, the majority of the scientific studies mainly focused on statistical results (Lin, Sidaways, & Woon, 2019), projected the effects of the SGR project and its contribution to Kenya's and the East African community's economic growth (Savege, et al., 2019), the SGR's contribution to the development of peace, tourism, environmental protection, (Guo, et al.,

2021) and SGR's link between economic growth, repayment of foreign borrowed money, and job creation (Rowerdder, Woon, & Sidaway, 2020). Also, Rowerdder, Woon & Sidaway, (2020) found that other literature focused on how SGR construction reshaped the geopolitics and geo-economics while creating new geographies of development in east Africa. However, Popp (2017), found out that despite the fact that the SGR construction has a similar impact as other transportation projects, less is known about the direct and indirect impact of the railway construction on the local population (Dorsey, Olsson, & Rew, 2015). Also, Lin, Sidaways & Woon, (2019), found that Some studies are lacking the exploration of visual effects on the local community analysis (Lin, Sidaways, & Woon, 2019).

1.9 Study design and methods

This study employed a mixed-methods research approach and survey research design. The qualitative method was useful in gathering vital in-depth information from the community under investigation since it allows participants to speak and express themselves in a language familiar to them about their experiences with the SGR's impact on environment and community livelihoods. Mixed methods approach enables triangulation of data collection methods. The Standard Guage Railway project in Ngong Town, Kajiado North Sub-County, Kenya, was studied in the villages along its route. The 42.6 square kilometer-large Ngong Area is situated in the north sub-county of Kajiado on the eastern flank of the Kenya Rift Valley. The region is located at an altitude of roughly 1800 meters above sea level. According to Semera and Ole-Lenku (2022), the region is roughly bordered by Latitude 1° 19' S and 1° 27' S and Longitude 36° 37' E and 36° 45' E. According to Semera and Ole-Lenku (2022), the area is the soft water catchment zone and responsible aquifers of Fault zones directly to the east. The area's springs and boreholes, which are a significant supply of water, also catch some of the precipitation that falls above ground, replenishing the area's aquifers. The population of the Ngong area is anticipated to be about 187549 people, with a population density of 51 people per square kilometre, according to the Kajiado County integrated plan of 2018–2022 (Semera and Ole-Lenku, 2022). Traditional small- and medium-scale farming and pastoralism, with the primary stocks being cattle, goats, and sheep, are the main economic activity. The land is also regarded as a crucial component of industry and growth in this county. The majority of the residents of the Ngong region, however, serve as a labor force for both Kajiado County and the neighboring county of Nairobi City. The SGR construction, which involved tunneling a railway line under a mountain, was the focus of the study in this area. While uncommon in Kenya and this region, its impacts on the local population were unusual. However, a handful of the above-mentioned villages—Kibiko, Olepolos, Kerarapon, and Kimuka—have been impacted by the SGR.

The target populations of the study were households from four different villages, namely Kibiko, Ole Polos, Kerarapon and Kimuka in the Ngong area. According to the Environmental and Social Impact Assessment report on SGR construction, 130, 120, 160 and 100 families were affected by the SGR within Kibiko, Olepolos, Kerarapon and Kimuka villages respectively (Hobbs & Juffe-, 2022). This is also in line with the statistics provided by the 2019 Kenya National Census (KNBS, 2019). Thus, this study targeted 510 households from Kerarapon, Kibiko, Olepolos and Kimuka Villages. The researcher also targeted eight leaders from a Community-Based Organization namely, the Kerarapon Water Project, an organization that has been present in all the four villages under study. The Kerarapon Water project has 2 leaders who are representatives from villages in Ngong.

Sample Size and Sampling Procedures

This study used Krejcie & Morgan's (1970) formula to get the sample size of the research.

$$S = \frac{x^2 NP(1-P)}{d^2\,(N-1) + X^2\,P(1-P)}$$

Where,

S = required sample size

X^2 = that table value of the chi-square for one degree of freedom at the desired confidence level (3.841)

N = the population size

P = the population proportion (assumed to be 0.5 since this would provide the maximum sample size)

d = the degree of occurrence expressed as a proportion (.05)

$$S = \frac{3.841 \times 510 \times 0.5 \times 0.5}{(0.05)^2 \times (510-1) + 3.841 \times 0.5 \times 0.5}$$

$$S = \frac{489.7275}{2.23275}$$

Therefore S = 219 Participants who will take part in the study

The total population is 510, and the study's sample size was 219 participants, as demonstrated by the formula.

The study used both probability and non-probability sampling techniques. For the probability sampling, the researcher used stratified and simple random sampling techniques. The researcher noted that the number of households in the village varied, for it was a total of 510 for the four villages. As such, to allow the researcher to get accurate estimates for all villages connected to this study, and to ensure a sample that reflect representative balance for all villages, stratified sampling according to population of the households in a village was used. Thus, from Kerarapon, the researcher selected 70 participants representing 32% of the total sample size because it has the highest number of households that are affected and is very close to the SGR Tunnel construction site. While in the Kimuka community, the researcher selected 41 participants representing 19% of the total population because it has a little population in relation to other villages. Kibiko and Olepolos communities lie on the southern side of the SGR and they share almost the same landscape and population characteristics, hence the researcher selected 50 participants representing 23% from each village respectively. Therefore, the percentages total to 97% (S=211). The number of participants for each community was determined by the number of affected areas according to both the Environmental and Social Impact Assessment report (2022), 2019 KNBA and the *Nyumba Kumi* register from different communities. Thus, stratified sampling was used to select households within the different communities, namely, Kibiko, Olepolos, Kimuka and Kerarapon. This selection of participants was done to fit the following criteria. Firstly, the priority was the household leader, thus the father, and in case where the father is absent the mother becomes the priority. Secondly, the participant should have been someone who has stayed in the area of study for at least two years to the time the research was contacted. This helped the researcher to maintain the full range of population diversity inside a sample size of 219. Accordingly, simple random sampling was used on each village selecting household leaders who have lived in one of the communities for at least two years to the time of the research. Thus 70 people from Kerarapon, 50 people from Kibiko, 50 people from Olepolos and 41 people from Kimuka were selected to give a representative sample of 211 people.

For non-probability sampling, Purposive sampling was also used to select the 8 CBO leaders of the Kerarapon Water project representing 3% of the sample population. The researcher also selected two community leaders purposively from each of the four villages. This is demonstrated in Table 1.

Table 1: Sample Size & Sampling Procedures

Cluster	Population	Sample Size	Sampling Technique
Kibiko Village	122	50	Stratified and random sampling
Kerarapon Village	160	70	Stratified and random sampling
Kimuka Village	100	41	Stratified and random sampling
Olepolos Village	120	50	Stratified and random sampling
CBO Leaders	8	8	Purposive Sampling
Total	510	219	

Source: ***Researcher 2023***

Data Collection Instruments

The study used a mixed methods research technique to collect both qualitative and quantitative data. While interviews were used to acquire qualitative data, Questionnaires were used to collect scheduled quantitative data. The questionnaire was administered to 211 participants. Out of these, 50 participants were from the Kibiko and Olepolos communities respectively, 41 participants were from the Kimuka community and 70 participants were from the Kerarapon community. One of the devices used for data collecting is the interview schedule. In most situations, they involve questions asked orally in a face-to-face dialogue between the researcher and the respondent. (Creswell, 2013). The interview allows the researcher to have control over the questions. While at the same time obtaining the requisite information on the influence of the SGR project in Ngong Town, Kajiado North Sub-County, Kenya. The researcher used structured interviews, which involve a set of predetermined questions. This technique was chosen to provide a comparability of responses from different respondents in the study. Interviews were scheduled and carried out with leaders chosen from the four communities affected by the construction of the SGR, namely Kerarapon, Kibiko, Olepolos and Kimuka. The study used a mixed data collection and analysis method. Data gathered on the ground via questionnaires and interviews were analyzed using statistical techniques quantitatively and using verbatims qualitatively respectively. Qualitative data was coded for anonymity purposes.

1.10 Presentation and discussion of the findings

Response Rate

In this study, 211 questionnaires were distributed to participants. The participants were from 4 different villages namely, Kerarapon, Kibiko, Kimuka and Olepolos. In Kerarapon, out of 70 questionnaires that were distributed, 60 questionnaires were returned. In this village, the response rate was 92.86%. Out of 50 questionnaires that were in Kibiko, 45 questionnaires were returned. In this village, the response rate was 90%. In Kimuka, 41 questionnaires were distributed and 37 were returned. The response rate in this

village is 90.24%. And also, 50 questionnaires were distributed in the Olepolos village and 47 were returned, representing a 94% response rate in that village. This information is shown in Table 2.

Table 2: Participant Response Rate

Participants Category	Sample	Response	No response	% response rate
Kerarapon	70	65	5	92.86%
Kibiko	50	45	5	90%
Olepolos	50	47	3	94%
Kimuka	41	37	4	90.24%
Sub Total	**211**	**194**	**17**	**91.78%**
% of the Total		**91.78%**	**8.22%**	

Source: ***Field data, 2024***

Therefore, out of 211 questionnaires that were distributed, only 194 questionnaires were answered and returned to the researcher. The overall response rate for the questionnaires was participants 91.78%. And the questionnaires that were not returned represented 8.22%. The researcher also had a schedule to conduct interviews with the community leaders from the 4 villages. Out of 8 leaders who were being expected, only 5 leaders were present for the interview while the other 3 (37.5 %) were not available for the scheduled interview. The response rate for the community leaders was 62.5%. This is demonstrated in Table 3.

Table 3: Response Rate for all Participants

Participants Category	**Sample**	**Response**	**No Response**	**% Response Rate**
4 villages Combined	211	194	17	91.94%
Community Leaders	8	5	3	62.5%
Sub-Total	**219**	**199**	**20**	
% of the Total		**90.87%**	**9.13%**	**90.87%**

Source: ***Field data, 2024***

Only 194 of the 211 community members who received questionnaires and answered them and returned them back are shown in the table as participants. Additionally, it demonstrates that only 5 of the 8 leaders where available for the scheduled interview. As a result, 194 people responded overall, accounting for 90.87% of the participants. However, 20 individuals did not respond, accounting for 9.13% of the total responses.

Gender

As demonstrated in Table 5, the gender distribution of the study's participants is, male respondents made up 92 participants, or 46.6% of the total, while female participants made up 107 participants or 53.8%.

Table 4: Gender Distribution of Respondents

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	92	46.2	46.2	46.2
Female	107	53.8	53.8	53.8
Total	199	100.0	100.0	100.0

Source: ***Field data, 2024***

Age of the Participants

The participants' age range is shown in Table 5. The findings show that 82 people or 41.2% were between the ages of 25 and 35. There were 83 participants, or 41.7% of the total, aged between the ages of 36 and 45. Additionally, it demonstrates that there were 26, or 13.9%, of the population between the ages of 46 and 54. The smallest group, those 55 and older, had 7 participants, or 3.5% of the total population.

Table 5: Age of the Participants

Age Bracket	Frequency	Percent	Valid Percent	Cumulative Percent
25-35yrs	82	41.2	41.2	41.2
36-45yrs	83	41.7	41.7	82.9
46-54yrs	26	13.1	13.1	96.0
55yrs and above	7	3.5	3.5	99.5
Total	199	100.0	100.0	100.0

Source: ***Field data, 2024***

Education Level for the Participants

The education levels of all participants are shown in Table 6.

Table 6: Education Level of the Participant

Education Level	Frequency	Percent	Valid Percent	Cumulative Percent
Primary Level	0	0.0	0.0	0.0
Secondary level	35	17.6	17.6	17.6
Post Secondary Level	164	82.4	82.4	100.0
Total	199	100.0	100.0	

Source: ***Field data, 2024***

As can be seen in Table 6, none of the participants had only primary school as their highest level of education. Additionally, 35 participants, or 17.6%, had secondary education as their greatest level of education. However, 164 participants, or 82.4%, had a post-secondary level as their greatest level of education.

Residential Location

The residential areas where the respondents reside are depicted in Figure 2. The 67 participants, or 34%, said they were from Kerarapon. In the Kibiko, 46 participants or 24% participated. Additionally, 46 participants (23% of the total) said they reside in Olepolos. A total of 38 participants (19% of the total participants) where from Kimuka.

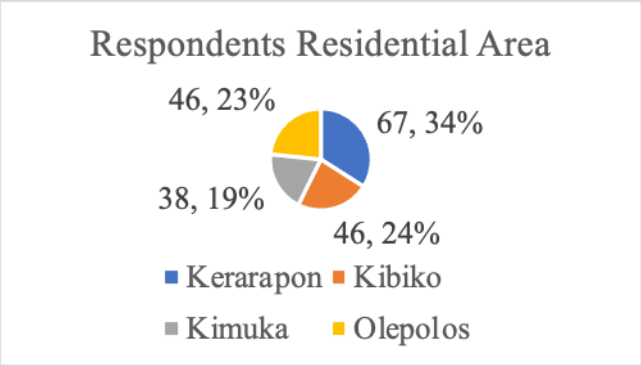

Figure 2: ***Residential Location***
Source: ***Field data, 2024***

Duration of Stay in Ngong Town

The information in table 7 reveals how long each participant had stayed at their current place of residence.

Table 7: Duration of Stay in Ngong

Duration of Stay	Frequency	Percent	Valid Percent	Cumulative Percent
2 - 10 years	69	34.7	34.7	34.7
10-20 yrs.	77	38.7	38.7	73.4
20-30 yrs.	30	15.1	15.1	88.4
30 years and above	23	11.6	11.6	100.0
Total	199	100.0	100.0	

Source: ***Field data, 2024***

According to the aforementioned data, only 69 individuals, or 34.7%, had stayed in their current area for not more than ten years. About 77 participants, or 38.7%, said they had lived in their current village for 10 to 20 years. 30, or 15.1%, of the population, have lived in their current location for between 20 and 30 years. Additionally, it shows that 23 participants, or 11.6%, have stayed in their current village for more than 30yrs.

Environmental Effects of the SGR Project on Community Livelihoods

In this section, there were three themes that dominated namely: effects of the SGR on environmental degradation, pollution, and water catchment areas.

Table 8: Statistics on Environmental Effects of the SGR Project on Community Livelihoods
Central tendency statistics

	The SGR construction has contributed to Environmental Degradation within Ngong, Kajiado County	The SGR construction has brought about Water, Land and Air pollution in Ngong, Kajiado County	The SGR construction activities have affected water catchment areas both Man-made and natural within Ngong, Kajiado County
N	194	194	194
Missing	0	0	0
Mean	4.2835	4.1392	3.9433
Mode	4.00[a]	4.00[a]	4.00
Std. Deviation	.70309	.99544	.87088

Source: ***Field data, 2024***

The SGR construction has contributed to Environmental Degradation within Ngong, Kajiado County

The above table 8, shows that the mean was 4.28 when it came to the topic of whether the SGR had any effect on environmental degradation in Ngong, Kajiado County. The mode for the notion of whether the SGR had any effect on environmental degradation in Ngong is 4. The mode and the mean show that most respondents strongly believe that the SGR has had negative effects on the environment. Still, the Std. deviation of 0.703, shows that the is a greater skewedness of the data. Thus, it also shows that there are some outliers who did not think that the SGR had caused any effect on environmental deterioration in Ngong, Kajiado County.

Also, as demonstrated on Figure 3, out of 194 participants, 154 participants (or 71%) said that the SGR contributed to environmental degradation, whereas 40 respondents (or 21%) said it did not contribute to environmental degradation.

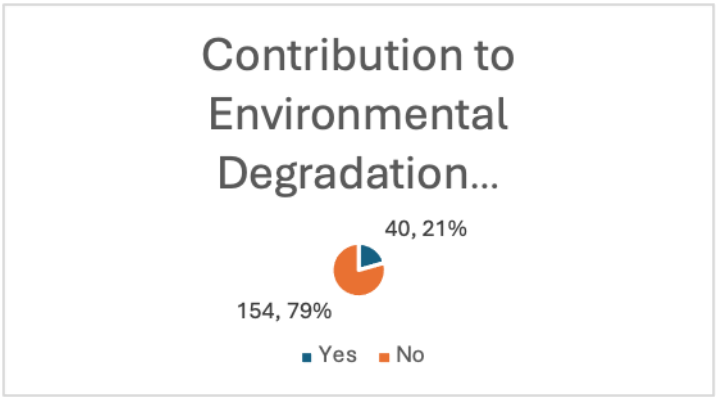

Figure 3: ***Contribution to Environmental Degradation***
Source: ***Field data, 2024***

The SGR construction has brought about Water, Land and Air pollution in Ngong , Kajiado County

The same holds true for whether the SGR development caused water, land, and air pollution in Ngong, Kajiado County. The mean score of 4.14 and the mode of 4 which strongly suggests that the participants strongly agreed that the SGR contributed to air, water, and land pollution. However, standard deviation of 0.995 shows that there is a great variability or skewedness of the data, which can suggest that there are some few individuals who did not believe that the SGR development caused water, land, and air pollution in Ngong, Kajiado County.

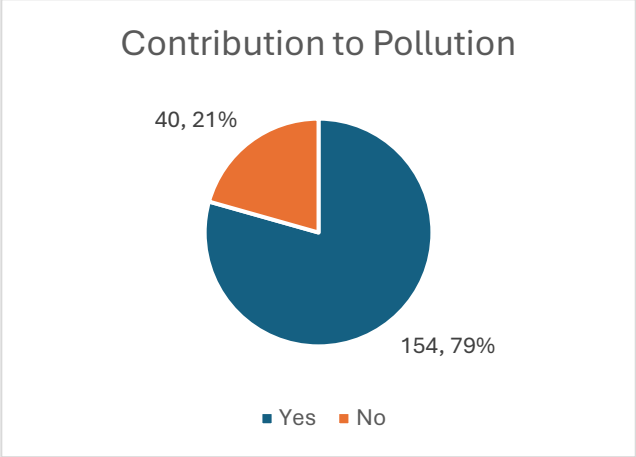

Figure 4: ***Contribution to Pollution***
Source: ***Field data, 2024***

In the same line, out of the 194 participants, 79% (n = 154) agreed that the SGR project caused pollution in the Ngong Area in Kajiado County, while 21% (n=40) did not agree that the SGR caused pollution in Ngong Area Kajiado county.

The SGR construction activities have affected water catchment areas both Man-made and natural within Ngong, Kajiado County

The mean response to the question of whether the SGR construction in Ngong, Kajiado County negatively affected both natural and man-made water catchment areas was 3.94, and the mode was 4. This indicates that most participants strongly agree that the SGR construction has a negative effect on water catchment regions. Yet the Standard deviation of 0.871shows that there is a greater variability of the data, which can also suggest that there are some individuals who did not believe that the SGR had negative effects on both natural and man-made water catchment areas in Ngong, Kajiado County.

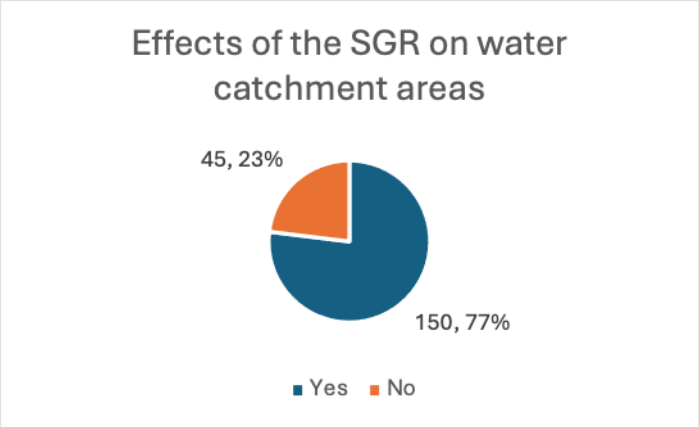

Figure 5: ***Effects of the SGR on water catchment areas***
Source: ***Field data, 2024***

Similarly, when discussing the effects of the SGR on water catchment areas, out of 194 participants, 150 (or 77%) remarked that the SGR construction hurt water catchment areas. However 27% (n=45) of the participants claimed that the SGR construction in the Ngong Area, Kajiado County, had good effects on water catchment areas as demonstrated by figure 5.

Deforestation

Deforestation is the theme that emerged in regards to the effects of Environmental Degradation on community livelihoods because of the Construction of SGR in Ngong Town, Kajiado North Sub-County. One of the community leaders stated, "*the forest was greatly affected as it was cleared to pave the way for the project".* In the same line, another participant noted*, "the SGR was built where trees had grown, this means that the trees had to be cut down for the project to take place".* However, there were few who few believed that, there was no Environmental degradation as an effect of the SGR construction. Those of this opinion reasoned that it was inevitable for some trees to be cut down and some excavation for development to take place.

The effects of pollution on community livelihoods because of the Construction of SGR in Ngong Town, Kajiado North Sub-County

The major themes that emerged from the effects of pollution on community livelihoods because of the Construction of SGR in Ngong Town, Kajiado North Sub-County, includes Air, Land, And Water Pollution.

Air Pollution

Majority of the participants confirmed the presence of air pollution as a result of construction-related dust from quarries and construction site dust from construction vehicles driving on dusty roads, and exhaust from large machinery. A participant noted, *'the vehicle should go at a modest speed*, or *the corporation should install speed bumps to slow down traffic"*. In the same line, another participant stated, "*that to lessen the amount of dust produced*, *the SGR needs to supply clean water to sprinkle dust roads where the trucks move".* Thus, raising concerns that it would be harmful to their health.

Water pollution

Water pollution was experienced due to poor chemical disposal which spilt into water streams and wetlands, rendering most of the water unfit for both human and animal drinking as well as other domestic use. A participant reported, *"the chemical disposal pit at the Ngong tunnel, was constructed next to a stream, and chemical spill-over from the pit ended up in the steam. And that contamination affects communities and wildlife that depend on that stream for water".* Thus, the residents of the Ngong town, are sceptical and reluctant to use the water from the open streams for either domestic or farming purposes.

Land Pollution

Land pollution was also experienced. In response to land pollution, on one hand, most participants identified issues around the contamination of Land, during the construction of the SGR. The main issue that was of concern to the community members was the improper disposal of chemicals or hazardous dumping of chemicals and extracted soils in the forest. Also, contamination rose from disturbance of the soil, tunnelling, contamination of the environment and water bodies and aquifers, soil compacting, excavation, and movement of heavy vehicles. On other hand, one of the main mentioned hazards in the communities is the unfilled pit in the Ngong hills near the entrance to the SGR tunnel. This ranges from dumping of extracted material from the tunnel in Ngong hills to leaving most of the pits that were created by gravel extraction uncovered. A participant claimed that "*the pits create a danger to the community in various ways, such as by accommodating a significant amount of water during the rainy season, creating a high risk of animals or children falling in it."* Additionally, *"there is a high likelihood that the pits have turned into the breeding ground for vectors like mosquitoes & bilharzia-causing vectors and they can also be a hiding place for criminals and drug abuse perpetrators",* another participant reported.

The same was also reported by Nyumba, (2021), who stated that oil spills as observed by local officials in the Kibwezi area, pollution of the Thange River in 2015, and in May 2019 in Machakos then contaminated Athi River have had a greater impact on the downstream communities given that it provides water for cultivation, which is the main economic activity in the area (Nyumba, et al., 2021). This led to the suspension of the use of the Thange River for irrigation, livestock watering and domestic purposes. However, some few participants claimed that the SGR project did not contribute to pollution in the Ngong Area of Kajiado County stated, that some instances of air, land, and water contamination were bound to occur while such a project was being built. Another issue that came up was the claim that the contractor was required to fix some of the construction-related issues as soon as the project was finished, as was stated in the environmental and social impact assessment that was done before to the project's start.

The effects Water Catchment Areas disruption on community livelihoods because of the Construction of SGR in Ngong Town, Kajiado North Sub-County

Regarding the effects Water Catchment Areas disruption on community livelihoods because of the Construction of SGR in Ngong Town, Kajiado North Sub-County, the theme emerged is the Effect of the SGR on Water Catchment Areas.

SGR effects on Water catchment areas

On One hand, the major theme that emerged was that the SGR brought about a negative effect on water catchment areas. Of this opinion were mainly participants from Kerarapon, Kibiko and Olepolos. Thus, Water sources like rivers, wetlands, springs, and meadows have been diverted through tunnel drilling in the Ngong highlands. As a result, messing up with the local aquifers has had a significant impact on the community's established water source. The following were some of the responses: According to a community leader, *"the introduction of the SGR project has resulted in the loss of our water supplies"*. Additionally, another respondent reported, "*we never run out of water in Kerarapon, Kibiko, or Olepolos, but it was only when they started drilling that the water sources started depleted".* Furthermore, another community representatives remarked "*the introduction of the SGR development caused issues for the underground water, and that the underground tunnel that was built on Ngong Hills is entirely to blame"*. Also, according to another community representative reported, *"the tunnel in Ngong Hill interfered with the underground water streams in the area".* Likewise, *"Vegetation near the water catchment regions was destroyed, River started drying up, and wetlands also dried up",* another participant reported. The SGR has had a detrimental effect on several communities' water catchment areas, including Kerarapon Kibiko and Olepolos. Even after the prolonged rains, the area never fully recovered, even though this was a lengthy process. The catchment areas and springs of Kerarapon were dried up. Due to the rivers and water sources drying up, the villages are currently experiencing a water deficit.

On the other hand, few participants stated that the water catchment areas had improved. This is attributed to the Kimuka community, where the SGR has brought positive change. The water from the tunnel is now a blessing to a community that had no water for a very long period because of the Tunnel Drilling in Ngong Hills. A participant reported, "*the SGR has improved our livelihoods by providing flowing water*." Similarly, another participant remarked, *"Our animals have water to drink thanks to the SGR."* This is advantageous for the neighbourhood. Consequently, the experience of the residents of Ngong as a result of the environmental effect of the SGR on their livelihood is not an isolated event. The mobility and health of various species, as well as the management of the world's climate, depend heavily on surface water and wetlands. The depletion of water aquifers has indirectly threatened the livelihoods, health, and well-being of the communities who rely on them as well as several downstream consumers that depend on naturally produced clean water. (Sang, Olago, Nyumba, Merchant, & Thorn, 2022). This can also affect the quality of water and increase the risk of conflict as Kerarapon has become a water-stressed area. (Andy & Darks, 2022). As a result of the SGR tunnelling into the Ngong hills, natural water springs and fountains may be lost.

The conflict parallels the 'growth versus ecology' paradox in the sustainable development concept that sparked several arguments three decades ago. (Hajer, et al., 2015). The China-led infrastructure concept, which prioritizes connectivity and mobility as requirements for economic progress, has also run afoul of the Kenyan local view, which emphasizes social and environmental welfare, cultural practices, and environmental preservation. Other villages where the SGR passed through share the complaints made by respondents in the Ngong Area about the socioeconomic and environmental effects of the SGR. In the same vein, Wafula (2018) highlighted that the project has directly impacted more than 1000 Kajiado County inhabitants, in addition to schools, rivers, and national parks. This is also in line with what CEPAL, (2018) noted that, Development and Conflicts Related to Infrastructure Construction, rural and

indigenous populations typically suffer the brunt of the unfavourable externalities of such projects required for natural development (CEPAL, 2018). It is also argued that projects of this kind affect people's livelihoods and living conditions without their expectations of a better life necessarily being met (Zhu, Mwangi, & Hu, 2022). The justification is consistent with the majority of results about the SGR's growing effects, which in turn pose a threat to the livelihoods of the nearby community.

The two opposing sides of the sustainable development goals, where some argue for maintaining global economic growth while others urge for protecting the environment from deterioration (Gupta & Vegelin, 2016), created tension in several development projects, particularly significant projects like the SGR in Kenya. The socio-economic and environmental implications of the SGR appear to be a double-edged sword in nations where agriculture, tourism, and other means of livelihood significantly depend on the natural environment and animals. Therefore, modernization and industrialization, although promoting economic progress, may jeopardize environmental protection, as well as endanger community livelihoods and sustainable development. In addition to the conflict between environmental conservation and economic growth, the SGR appears to have had simultaneous positive and negative effects in several areas, highlighting the dual nature of the SGR's socioeconomic and environmental consequences on community livelihoods. Since the SGR's implementation, local communities have noted several paradoxical outcomes, including both efficiency and hassles. The loss of vegetation and biomass, which has a significant impact on the provision of ecosystem services including carbon storage and sequestration and provision of clean water, is another direct effect of construction and other transportation infrastructure (Sang, Olago, Nyumba, Merchant, & Thorn, 2022). In addition to destabilizing groundwater, this also affects water seepage during wet seasons. This has an undesirable effect on efforts to mitigate climate change globally and also raises atmospheric greenhouse gas levels (Sang, Olago, Nyumba, Merchant, & Thorn, 2022).

1.11 Conclusion

In the study aimed at examining the environmental effects of the SGR project on community livelihoods in Ngong, Kajiado North Subcounty, four communities namely Kerarapon, Kibiko, Olepolos, and Kimuka participated. Community leaders from the community-based organization were chosen to participate in addition to individual home representatives. It was acknowledged that some people's lives had improved as a result of the settlement. The area of concern on Environmental effects, the study focused on environmental degradation, pollution, and the impact on water catchment areas. The study found out that, 80% of the participants agreed that the SGR contributed to environmental degradation. Land contamination, incorrect chemical disposal, the removal of soil from a building site, and leaving an open pit unattended were among the concerns brought up. Consequently, 80% of the participants indicated that the SGR construction project had polluted the environment. Land, air, and water contamination are the three categories of pollution. Land degradation was strongly related to the issues highlighted about land contamination. Thus, inappropriate chemical and material disposal, as well as exposed pits and extracted materials from the tunnel, pose a threat to society in a variety of ways. Dust from construction sites, quarries, and construction vehicles traveling on dust roads were mentioned as problems with air pollution. Poor chemical disposal from construction sites that flowed and spilt into streams and wetlands rendered the water unfit for domestic use were some of the issues mentioned regarding water pollution. Regarding the effects of the SGR project on water catchment areas, 80% of the participants responded that the SGR project had affected the water catchment areas negatively. Water contamination was one of the difficulties mentioned, but it wasn't the only one. Thus, the claim that the SGR tunnel's construction

in the Ngong Hills has had adverse effects on the region's springs, streams, and boreholes. However, despite the detrimental effects on communities like Kerarapon Kibiko and Olepolos, Kimuka village benefited from the construction of the SGR (tunnel) project. The livelihoods of the locals of Kimuka village have improved because of the water that emerges from the SGR tunnel constructed through Ngong hills.

1.12 Recommendations

In this section, the paper shall present recommendations for both policy makers and for further research.

I. When designing other projects of a similar size and scope, policies that encourage environmentally responsible initiatives and mitigation strategies for negative effects ought to be enforced.
II. There is a need for Investigations into the private infrastructure that was harmed because of SGR project activities.
III. Issues that were listed in the environmental assessment study report that was completed before the project's ground-breaking need to be followed up on. Notably, to reduce dust emissions and make the roads more accommodating, it is necessary to repair the roads that were damaged by large construction equipment as well as the ones that connect the neighbourhood to the SGR station.

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