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Impact of Power Generation Project on the Livelihoods of Adjacent Communities in Kenya: A Case Study of Menengai Geothermal Power Project

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Abstract- Geothermal energy has been used for centuries throughout the world. Although geothermal energy is much more environmentally friendly than other types of energy production, there are still aspects of geothermal energy development that can have negative social, economic, and environmental impacts. The aim of this study was to investigate the impact of the Menengai Geothermal Development Project on the adjacent community. Specifically, the study sought to examine the effect of landscape alteration, environmental pollution, population change, and social responsibility activities associated with the project on the livelihood of adjacent communities. The target population of the study comprised of 1120 households situated in a 5 KM radius of the Menengai Geothermal Project. From this population, a sample of 104 participants was selected using clustered random sampling. Data was collected using structured questionnaires, and analyzed using descriptive and the Pearson correlation technique. The statistical program for social sciences (SPSS) was used in the analysis. Results showed that landscape alteration (r= -0.202) and environment pollution (r= -0.260) had statistically significant, negative, but weak relationships with the livelihood of local communities. Social responsibility activities (r= 0.733) had a positive and strong relationship with the livelihoods of local communities. Only population change was found to have an insignificant relationship with community livelihood. The study recommended that geothermal project implementing companies should invest in social responsibility activities in order to optimize impact on community livelihoods. The company should also develop project designs and technologies that minimize landscape alterations and environmental pollution.

Index Terms- Community Livelihood, Environmental Pollution, Landscape Alteration

I. Introduction

In the modern economic environment, society expects corporations to be more socially responsible. The notion that a corporation is an economic institution engaged in the production of goods and services with the end-in-view of maximizing profits and shareholder's value has been de-emphasized and many at times challenged. As a central part of modern society, corporations are viewed as economic institutions with ethical responsibilities to society (Randolph, 2007). The modern corporation is not only concerned about its economic performance and its fiduciary duty to its owners, but also concerned with the well-being of its employees, the welfare of the community, the health of the environment and many other societal concerns.

Given the accelerated demand for energy and especially electric power in Kenya, and the fact that the country relies heavily on hydro power and fossil fuels, the need to expand the energy sector has become a necessity and not an option. The country faces difficult choices to increase the supply of electricity to meet the industrial growth envisioned in the Vision 2030 economic blueprint (KIPPRA, 2007). The fluctuation in international oil prices puts pressure on electricity tariffs. The country's demand for electricity is also growing at a high rate compelling the government to explore options of increasing power supply to the citizens to support economic growth. As a result, the government with the support of many development partners has invested significantly in the development of green energy including: hydro, geothermal, wind and solar power.

According to Moxon (2004), most power projects in the past have given much attention to the technical design and economic issues of the project rather than their environmental and social impacts. For instance, the Akosombo and Kpong dams in Ghana were constructed to purposely generate electricity for the industrial and domestic uses. At the time of the constructions, Environmental Impact Assessment (EIA) was not a planning and management tool available in the country. The projects were driven by economic concerns while their social and environmental impacts were largely ignored.

Realization of power projects inevitably come with changes in the natural environment, lifestyles, and socio- cultural (Johnson et al, 2008). The social impacts are the effects of the society in general and to the host community in particular (De Jesus, 1995). Mwawughanga (2003) cites a wide range of possible social impacts of power projects which include the relocation of affected communities if the project is located in habited areas, which leads to transferring of the people to new environments that may be incompatible leading to lower productivity and destruction of community structures. The projects would also lead to increase in local population due to migrant workers coming to the project which may cause a strain to the available resources and lead to conflicts.

Due to the constructions, landscape alteration affects the hydrology of the construction area. Further, influx of migrant workers may affect the health of the people as a result of increased incidences of epidemics and communicable diseases. However, the project may also result in increased job and business opportunities thus making use of the local skills, improving the incomes and improving the living standards of the people (Mwawughanga, 2003). According to Agbemabiese and Byrne (2005), in order to make power projects sound and sustainable energy alternative, increased attention need to be paid to the environmental and social issues when they are built with respect to achieving efficiency in project planning and management.

Geothermal energy is a source of electricity generation worldwide. Currently, geothermal powersupplies energy needs in more than 24 countries and most of the energy needs in Iceland (Glassley, 2010). TheUnited States is the world's largest producer of geothermal energy, with a current capacity of 3,093megawatts (MW). The largest geothermal development in the world is located at the Geysers north of San Francisco, in Sonoma County, California. Geothermal power is considered a cost effective, reliable,sustainable, and an environmentally friendly alternative to fossil fuels. Because of its dependence onareas of heat transfer that are accessible from the earth surface, geothermal plants have usually been located in the vicinity of tectonic plate boundaries (Matek, 2014)

The Kenya government has commenced the process of realizing 5000 MW of geothermal energy over the next 20 years (Ngugi, 2012), which is envisioned to be the world's largest geothermal power production. Currently, projects whose total capacity exceeds 800 MW are under implementation and an additional 800 MW projects are scheduled to commence in the next five years. It is estimated that the development of the 5000 MW will cost about 18 billion US dollars. The Geothermal Development Company Limited (GDC), a special government vehicle was formed to spearhead exploration and development of geothermal resource in the country. GDC is partly facilitated by the Government of Kenya to meet its mandate and raises the other part of the required resources through credits, external financing and, in future, through steam sales revenues.

Geothermal energy has been used for centuries throughout the world. Recently, because of a push to diversify forms of energy away from fossil fuels, geothermal energy has been researched and utilized to great effect (Berrizbeitia, 2014). Although geothermal energy is much more environmentally friendly than other types of energy production, there are still aspects of geothermal energy development that can have negative social, economic, and environmental impacts. Some of the negative impacts include loss of vegetation, changes in riverine flow patterns and regimes, involuntary resettlement, health problems, loss of cultural values, marginalization of local people, inundating of valuable agricultural land, drought and severe reduction of flow downstream (Tortajada, 2001). The Menengai Geothermal power project is one of the largest geothermal power projects that are currently under implementation in the country. According to the African Development Bank (2013), the project covers an area of 88 KM^2, which was previously used by adjacent communities as agricultural land, livestock grazing land, source of water for domestic use, and tourism attraction. The project has introduced massive civil works in the area, as well as, influx of workers from other regions. Despite its magnitude and existence for over five years, its impact on the livelihood of the adjacent communities has not been established. This study, therefore, sought to analyze how the Menengai Geothermal Power Project has affected the livelihoods of resident communities.

The broad objective of the study was to analyze the impact of Menengai Geothermal Power Project on the livelihoods of adjacent communities. The specific objectives of the study were: to assess the relationship between landscape alteration and the livelihood of communities surrounding the Menengai Geothermal Power Project, to establish the relationship between environmental pollution and the livelihoods of communities around the Menengai Geothermal Power Project, to determine the relationship between population change and the livelihood of communities around the Menengai Geothermal Power Project and to establish the relationship between social responsibility activities and the livelihood of communities around the Menengai Geothermal Power Project.

II. LITERATURE REVIEW

2.1 Landscape Alteration and Livelihood of Communities

Geothermal plants require relatively little land in comparison to nuclear or coal plants and they do not require the damming of rivers or tunnels, open pits or oil spills. They are clean because they neither burn fossil fuels nor produce nuclear waste, and can be sited in farmland and forests and share land with cattle and local wildlife (Noorollahi, 2005). But, geothermal energy must be utilized relatively close to its resource in order to reduce heat and pressure losses and disruption to the landscape. The exploitation can change the landscape and land use because of the required land for drill pads, access roads, steam lines and transmission lines in addition to the power plant (Hunt, 2001).

In many places, the development of geothermal projects has become controversial, mainly because many of the geothermal prospects are within protected zones such as national parks or natural reserves. Withdrawal of reservoir fluid through drill holes can lead to a pressure decline in the reservoir and may cause hot springs to dry up. Reservoir depressurization may also enhance boiling at shallow depths and in this way enhance fumarolic activity. It is difficult to predict these changes before production (Noorollahi, 2005).

Landscape alterations include use of land, changes to landscape and to natural features. Land surface is needed during the different life cycle stages of a geothermal power plant, and this may be temporal mainly during construction, reclamation or permanent mainly during operation (Rybach, 2005). Geothermal energy production is focused at the resource below the subsurface and, thus, the manipulation, alteration and depletion of the geothermal reservoir is associated with the use of underground resources. Equivalent to the assessment of fossil fuel or open pit mining, however, this is not considered a critical environmental issue. However, studies show that the land alterations affect the surrounding communities significantly.

According to Bayer et al., (2013) a general assessment of social impacts in geothermal projects is hardly possible. However, geothermal energy production often is concentrated in regions with extraordinary landscapes, which are touristic attractions with mud pools, geysers, fumaroles and steaming ground, and are often remote and pristine (DeJesus, 1995). By extinction of geothermal surface features, and industrial development in such regions, there is a high risk that land of high social value is lost. This includes the prominent role of such landscapes and geothermal features for indigenous people, ethnic, religious and social groups that have traditional ties to the land, such as in New Zealand (Fukutina, 2012)

Investigations into the socio-economic and environmental impact of geothermal energy on the rural poor in Kenya focusing on Olkaria geothermal energy revealed that the landscape alteration during implementation of the project had a far reaching effect to the surrounding communities (Mariita, 2002). To a large extent, the severity of drought depends upon the level of resources exploitation in the area. The report established that, soil erosion was generally severe unless the land is carefully managed. This had a negative impact on the Maasai communities living in the area whose main source of livelihood was pastoralist.

2.2 Impact of Environmental Pollution on Community Livelihood

Proponents of geothermal power development claim a number of benefits in support of their projects. First, they insist that geothermal power generation is 'clean', that is, it has fewer environmental consequences than other sources of power generation (Rosenberg, Bodaly and Usher, 1995). In an imperfect world, geothermal power is a form of energy which has the fewest imperfections of all. It is virtually non-polluting. Contrary to these sentiments, Rosenberg (1995) argues that large scale geothermal development produces a broad range of environmental impacts. Chief among these impacts are landscape destruction, contamination of food webs by mercury, and possibly the evolution of greenhouse gases.

The extent to which geothermal exploitation affects the environment is proportional to the scale of its exploitation (Dickson &Fanell, 2005). In general, the environmental effect is more significant in plants with geothermal direct-use applications and potentially greater in the case of conventional back-pressure or condensing power-plants. This is particularly relevant in regards to air quality. Although geothermal power plants are environmentally active because of their renewable energy status, they pose an environmental threat because of hydrogen sulphide gas that is contained in most geothermal steam sources. If not correctly disposed, this gas can cause health and safety problems. Although the consequences of air quality pollution may be high, the probability of such events is considered low for which it is deemed an acceptable risk (Peralta, et al., 2013).

An analysis of the Argonne National Laboratory concluded that geothermal waters pose a large potential risk to water quality, if released into the environment, due to high concentrations of toxics including antimony, arsenic, lead, and mercury, but that the risk of release can be virtually eliminated through proper design and engineering controls (Clark, Harto, Sullivan & Wang, 2011). Nonetheless, the release of toxic substances, especially hydrogen sulfide remains of concern. Geothermal adversely affects communities where wastes are not properly managed as geothermal process waters are offensive smelling from hydrogen sulfide and contaminated with ammonia, mercury, radon, arsenic and boron. Geothermal fluids can be processed in a completely closed-loop system and then re injected, mitigating these problems.

Noise emissions are most critical during exploration and well drilling. Since the installation of wells is often not finished when geo fluid production starts, and during operation new ones are continuously drilled to increase or maintain production level, for injection, temporal noise problems are potentially present during the entire life cycle of a plant (Vezmar, Spajic, Topic &Sljivac, 2014). Geothermal development projects are also associated with increased risk of seismic events, land subsidence or lifting, which may also be seen as a threat to local biodiversity (Berrizbeita, 2014). Higher noise levels are also found closer to geothermal projects, as a result of vehicular movements. Rodriguez and Arevalo (2007) also found well pads, power plants, access roads, and pipelines associated with geothermal development impeded the natural flow of rainwater causing disturbances such as flooding among local communities.

Other concerns raised regarding the impact of geothermal project on the environment include the increasing dust levels and smells the project could bring if it expands towards their homesteads, a rise in respiratory diseases (asthma), eye problems, colds and flu's, displacement/ resettlement from their present homes, the reduction in land size(s) as the project expands (Bw'Obuya, 2002). Pipes that carry steam from wells to power production stations can also pose significant threat to wildlife. Further the reduction in grazing land for their wildlife can also be viewed a negative environmental impact of geothermal development project, Vezmar, Spajic, Topic and Sljivac (2014) noted that in most cases, geothermal wells, power plants, and power grids take up valuable space that was previous used as grazing land for wildlife and livestock for local communities.

2.3 Population Changes in Adjacent Communities

Mega infrastructure projects lead to drastic changes in the population of adjacent communities. This was evident in Rossour and Malan (2007) study where it was found that the Berg River Dam project led to massive in-migration that changed the demographic and cultural scape of adjacent communities. Barrantes (2006) while focusing on the socio-economic consequences of geothermal development in less developed regions of Las Pailas, argued that public acceptance of the project and integration of new workers in the existing indigenous social community could presents a potential social impact. Evidence of population changes among communities surrounding the OlKaria Geothermal Project was also found in Bw'Obuya's (2002) study where it was revealed that only 1.4% of the work force at Olkaria East was from the local community.

In their study of the social economic impacts of the Olkaria Geothermal exploitation on the adjacent Maasai Communities, Mariita (2002) found that the project had led to a reduction in family size due to the gradual decrease in land sizes. Further, there was an increase in miscarriages or children being born with deformities or retardation as the project expended harmful pollutants in addition to erosion of their cultural values by outsiders. Some residents cited displacement or resettlement from their present homes. Influx of new population into the construction sites on the other hand had some positive impacts. The study revealed that the greatest benefits were the mushrooming of shopping centres, water and sale of souvenirs to tourists at the cultural centre. This resulted in increased income levels and subsequent rise in living standards and quality of life of residents. In addition, the employees of the geothermal plant provided market for sale of animal products.

In their study to establish the impact of a geothermal power plant on a poor rural community in the Olkaria geothermal power plant in Naivasha,Bw'Obuya (2002) sought opinions from five families who used to stay in the area before the projects and revealed several impacts of the projects on their social economic lives. The families revealed that they were simply asked to move without any compensation and barred from grazing within the game park. However, they appreciated the permission to use some of KenGen facilities such as transport, schools, and shops. They were especially grateful to KenGen for providing them with piped water, which reduced cases of water borne diseases like cholera and typhoid. Some claimed that bathing in the KenGen effluent waters has assisted them in managing some skin ailments. Most of them said that the noise or gas emissions did not discomfort them in any way. Neither as far as they know have any of their animals been hurt by the project facilities.

Another study conducted by Anon (2013), in Romania, to determine the community perceptions on mining in relation to the level of involvement revealed that mining companies actively involved in community life and acted as part of the community. Further, they liaised with the local people on a very frequent basis, with communication and consultation being more frequent than was observed across the other sites discussed in different countries. As a result, the RoşiaMontană community had by far the highest level of people considering themselves to be sufficiently engaged by the mining company. Similarly, RoşiaMontană also had the highest level of people rating the mining company as improving in how they met public expectations. Additionally, 96 % of respondents felt positive about mining in general. This may reflect the importance people place on mining to their overall identity/heritage/traditions, where all the people responding considered it important and also the high level of community involvement in the mining.

Local communities, governments, and local organizations have increased awareness of the effect of large scale industrial activity in their environments. The expectation is that there will be a complete disclosure of all the potential impact of the industrial activity. Because of the large number of variables involved in an operation such as geothermal energy extraction, consideration of all the possible consequences of the activity may not be possible which may lead to community opposition to geothermal energy projects. In particularly sensitive areas, the development of geothermal sources may not be feasible. For example, there is an ongoing debate whether the development of geothermal energy is even an option in Wildlife Conservation areas in Kenya, in spite of the immense social needs of the community that would be addressed by such industrial activity (Oduor, 2010). In addition, there is an increasing conflict of interest between the growth of the tourism industry, population growth and resort community development with their high demands for water and the needs of the geothermal plant. This applies specifically to the Long Valley Caldera Geothermal Area.

In Bali, Indonesia, geothermal development is limited due to severe religious, cultural, as well as, environmental concerns by the public. Currently, for example, the Balinese community, religious leaders, and the local government do not accept a planned 163 MW plant at Bedugul in Bali (Rybach&Mongillo, 2006). Some followers of traditional Hawaiian religious practices were convinced that geothermal power is harmful. Whereas many natural beauties in nature parks and other protected areas can be excluded from geothermal development, thermal springs (mainly their flow-rate) are often influenced by nearby geothermal fluid production wells. Frequently, the effects become visible only after a certain time (Fukutina, 2012). Large-scale hydro-geological effects from geothermal power generation may mitigate the productivity of hot springs, and thus it competes with the tourist sector.

2.4 Corporate Social Responsibility Programs and Community's Livelihood

Corporate Social Responsibilities (CSR) are strategies put in place by corporations or firms to conduct their business in a way that is ethical and society friendly beyond the legal requirement (Schieng, 2009). CSR can involve a range of activities such as working in partnership with local communities, socially sensitive investment, developing relationships with employees, customers and their families, and involving in activities for environmental conservation and sustainability. CSR activities require engagement with internal and external stakeholders, it enables enterprises to better anticipate and take advantage of fast changing societal expectations and operating conditions (European Commission, 2011). Social responsibility enterprises can build long-term employee, consumer and citizen trust as a basis for sustainable business models.

The concept of social responsibility is also gaining popularity in the project management field. Schieng (2009) noted that many project managers were using social responsibility initiatives as strategies for increasing the reputation of their projects thereby reducing risks related to disputes. Most social responsibility programs focus on sharing the economic benefits of projects with local communities. Mwangi (2010) pointed out that, negative social impacts of geothermal development can be minimized with the involvement of local communities through effective corporate social responsibility policies. According to KenGen (2010) the company used social responsibility programs in adding value to the communities living around its area of operation. The overall goal of the company was to build and nurture relationships with the communities and stakeholders.

In a study to evaluate the social aspects of geothermal development in Olkaria Geothermal project, in Kenya, Gachau (2011) found that some of the corporate social responsibility projects engaged by the Kengen Company at the Olkaria geothermal station include: educational support through secondary and university scholarships, water provision to the communities for domestic and livestock use, and promotion of social afforestation. The company also provided transport to schools for educational tours and participation in education days and dancing competitions, and to the local community for shopping and visiting medical facilities. These CSR activities affected community livelihoods by enabling access to education, sanitation and health facilities in addition to enhancing movement in and out of the villages.

In another study, Rodriguez and Arevalo (2007) found that the LaGeo Geothermal Development Project in El Salvador provided deeper solutions to health and education needs of local communities. The project managers also worked together with local communities to initiate self-sustaining programs such as allowing communities to plant and harvest non-subsistence level crops such as bananas on project land. The condensate run-off water from the power plant could be used for irrigation purposes. In his study, Mariita (2012) recommended policy and institutional measures that would see the Maasai Communities living around the Olkaria Geothermal Project enjoy a wide range of socio-economic benefits. These measures include the installation of a formal Environmental Management System (EMS), involving communities in making decisions that may have adverse impact on them, and involving communities actively in planning and implementation of CSR activities.

2.5 Impact on Livelihood

Geothermal exploitation has been found to have a mixed impact on the livelihood on the communities surrounding. The provision of energy to remote areas, and creation of job opportunities are the positive effects. Local communities, however, typically have only a marginal direct employment benefit, since mostly specialized people are needed for exploration, drilling and plant operation (Mariita, 2012). Instead, retail trade, health care and social assistance, accommodation and food services sectors often provide potential new sources of jobs for local communities (Rybach, 2006). Barrantes (2006) while focusing on the socio-economic consequences, consequences of geothermal development in less developed regions of Las Pailas geothermal argued that public acceptance of the project and integration of new workers in the existing indigenous social community could presents a potential social impact.

2.6Critique of Existing Literature and Research Gaps

Although researchers have undertaken rigorous efforts for environment impact assessment on power projects, the geographic scope of the studies has been limited. The region-specific studies have yielded mixed results. On one hand, they may confirm the need for region-specific policy design. On the other hand, the existing studies do not provide external validity for regions with new projects being undertaken. Notably, many more studies have been conducted in the western world than in Africa. This could suggest that the western countries pay more attention to impacts the power projects bring economically, socially and environmentally, and accordingly, have undertaken more efforts in mitigating the negative issues. In addition, most studies are conducted on the basis of single period data. Panel data analyses are limited, thus the findings from previous analysis in certain regions may not be valid to the other regions.

Various studies have been advanced which acknowledge the social impact of geothermal development projects in various parts of the world. Dickson &Fanell, (2005) and Fukutina, (2012) outline the importance of community involvement and consideration in enhancing success of geothermal projects and so was (Anon, 2013). However, majority of the studies sought to document the eminent or potential impacts. Mwangi (2010) pointed out that; socioeconomic impacts in geothermal development were eminent affecting on the Maasai culture and way of life in Olkaria also supported by (Mariita, 2002). However, the studies failed to explicitly bring out how the project social impacts translated to the livelihoods of families living around in the long term. Similarly, the KenGen (2010) report on the social responsibility programs at Olkaria focused on the immediate outcomes of the CSR programmes. The balance between the negative and the positive long term effects were overlooked. The extent to which geothermal exploitation affects the environment is proportional to the scale of its exploitation. However, no comprehensive study has been done to relate the geothermal projects social impacts and the long term effects on the livelihood of the communities where these projects are located.

III. RESEARCH METHODOLOGY

This research adopted a descriptive research design and case study approach by selecting the Menengai Geothermal Power Project. Descriptive design refers to a set of methods and procedures that describe variables. Descriptive studies portray the variables by answering who, what and how (Babbie, 2002). The case study approach was preferred because it allows an in-depth study rather than breadth. In addition, it placed more emphasis on the full analysis of one restricted study area or set of conditions with respect to interrelations and distinctions that make the case unique in character. In this study, the design allowed an in depth enquiry on the effects of Geothermal Power project to the livelihoods of the adjacent communities. Case study techniques are of immense value in taking decisions regarding several management problems case (Schilder, 2001).

The study population comprises the entire group of individuals, objects, items cases, articles or things with common attributes or characteristics existing in space at a particular point of time (Majumdar, 2005). According to a feasibility study conducted by the African Development Bank (2011), there are 1120 households in the areas surrounding the Menengai Geothermal Field spanning across two Sub Counties: Bahati and Rongai. The study sought information from households around the project site. These are the persons who are directly affected by the project activities; therefore, can give insights on the extent to which the project affects their livelihoods. The target population will therefore be 1120 households living around the Menengai Geothermal Project.

The sampling frame was constructed by considering households surrounding Menengai Geothermal project. This was done with the help of the local leaders in the two sub counties including the area chiefs, assistant chiefs, and village elders.From the target population, the researcher applied a sample calculation formula by Nassiuma (2000) to determine the number of households to be considered in the study.

$n= (Nc_v^{2)} / (c_v^2 + (N-1) e^2)$

Where n= Sample size

N= Population

C_v= Coefficient of variation (0.5)

e= Tolerance at desired level of confidence (0.05)

The formula determined that 104 households were desirable and would produce meaningful data about the population.The 104 households were selected using the clustered random sampling technique. Clustered random sampling is a technique which entails dividing the population into groups of heterogeneous characteristics, and then selecting participants from each group randomly. This type of sampling was chosen owing to the fact the target population is spread between two sub counties. In this study, the two sub-Counties (Rongai and Bahati), were treated as clusters and 52 household selected from each using random sample methods.

The study made use of primary data. To assist the researcher to gather the primary data, a structured questionnaire that accommodated all the critical aspects of study was designed. The structured format allowed the inclusion of closed-ended question items, which were essential in limiting response details while facilitating timely statistical analysis. The questionnaires were administered by the researcher to the respondents on a pick and drop basis so as to limit interference and also ensure privacy. The drop and pick method was used to collect primary data.

Prior to the main study, a pilot study was conducted with 30 respondents from the sample size. This process helped to refine the questionnaire, enhance its legibility and minimize the chances of misinterpretation. An item analysis was done on the questionnaire to establish whether the objectives and items measure actually what the study intends. A content validity test was then done by computing the validity index basing on four (4) point scale of relevant, quite relevant, somewhat relevant, and not relevant. The proportion of relevant and quite relevant was computed from three experts. All the proportions were above 0.5 indicating that the questions were relevant to the study. To improve on reliability in this study, piloting of the questionnaires was done among 10 selected households adjacent to the Menengai Geothermal Project. These members were then not allowed to participate in the actual study to avoid contamination of the study sample. The pilot questionnaires were analyzed for reliability using the Cronbach's reliability test. The judgment on reliability of tools was based on FraenkelandWallen (2000) guidelines which state that an alpha value of 0.7 infers that the tools are adequate and can be adopted for the study without amendments. Questions in each study variable gave a Cronbach alpha value that is greater 0.7; hence, they were all adopted for the study.

This section outlines the methodologies that were employed in analysis of data. Kothari (2004) defines data analysis as the process of computation of certain indices or measures along with searching for patterns of the relationship that exist among the data group. The study used SPSS software to facilitate empirical analysis of data.

Data collected from the field was compiled, sorted, and coded into a coding sheet and analyzed using a computerized data analysis package known as SPSS 21.0. Data analysis was done to generate a view of how the objectives were to be achieved. This was done using descriptive statistics, which saw the use of frequency distribution table, mean and standard deviation. In this study, inferential analysis was used to arrive at conclusion regarding the effect the geothermal project has on the livelihood of local communities. The Pearson correlation technique was used in the analysis.

The mean, median, percentage, mode and standard deviation are the most commonly used descriptive statistics. The mean, percentages and standard deviation was used in this study to give a description of the data. A descriptive profile of the respondents was first done, followed by a presentation of the variables using descriptive statistics.

IV. RESEARCH FINDINGS AND DISCUSSION

4.1. Introduction

The goal of this study is to examine the impact of the Menengai Geothermal Project on the livelihoods of adjacent communities. Data related to this research issue was collected and analyzed. This chapter presents and discusses the research findings. The chapter is organized into several sections including the response rate, demographic characteristics of the sample, descriptive analysis, and inferential analysis.

4.2 Response Rate

Out of the 104 questionnaires that were distributed, 96 were duly completed and returned to the researcher. This figure represents a response rate of 96.3% which according to Mugenda and Mugenda (2003) is sufficient to facilitate statistical analysis and minimize non-response bias.

Table 4.1: Response Rate

	Frequency	**Percentage**
Response	96	96.3
Non-Response	8	3.7
Total	**104**	**100**

4.3 Pilot Test Results

The reliability of an instrument refers to its ability to produce consistent and stable measurements. Bagozzi (1994) explains that reliability can be seen from two sides: reliability (the extent of accuracy) and unreliability (the extent of inaccuracy). The most common reliability coefficient is Cronbach's alpha which estimates internal consistency by determining how all items on a test relate to all other items and to the total test- internal coherence of data. The reliability is expressed as a coefficient between 0 and 1.00. The higher the coefficient, the more reliable is the test. The reliability of this instrument was evaluated through Cronbach Alpha which measures the internal consistency. Cronbach Alpha value is widely used to verify the reliability of the construct. The results are presented in Table 4.2.

Table 4.2: Cronbachs Alpha Results

Variable	**N of Items**	**Cronbach's Alpha**
Landscape Alteration	7	0.727
Environmental Pollution	7	0.806
Population Change	7	0.834
Social Responsibility Activities	7	0.932
Livelihood	8	0.902

The cronbach's alpha test for all the variables was over 0.7 which indicates that the study was reliable as per Kothari (2004).

4.4 Demographic Characteristics of the Sample

The researcher sought to establish the demographic characteristics of the terms as regards to gender, age, and education level. According to Sifers, Puddy, Warren, and Roberts (2002) analyzing the demographic traits of the sample helps the researchers and research consumers to determine whether the sample was a close representation of the study population; hence, it enables them to judge the generalization of the findings.

4.4.1 Gender Distribution

As shown in Table 4.3, a majority of the respondents (64.6%) were male while 35.4% were female. This distribution match expectations as the study mainly targeted the heads of the 104 households to be the key informants. It is also consistent with data from Kenya National Bureau of Statistics (2013), which shows that seven out of ten households are headed by males.

Table 4.3: Gender Distribution of Participants

	Frequency	Percentage
Male	62	64.6
Female	34	35.4
Total	**96**	**100**

4.4.2 Age Distribution

In terms of age, many participants (54.2%) fall in the 25 to 50 years age bracket, 37.5% were above 50 years, and 8.3% were below the age of 25 years. This finding is congruent with Otieno, Omiti, Nyanamba, and McCullough (2009) who found that the average age of household heads in peri-urban areas in Kenya is 43.33 years.

Table 4.4: Age Distribution of Participants

	Frequency	Percentage
Less than 25 years	8	8.3
25- 50 years	52	54.2
Above 50 years	36	37.5
Total	**96**	**100**

4.4.3 Education Distribution

A majority of the participants (36.5%) had secondary level education, 34.4% had college level education, 17.7% had university level education, 8.3 had primary level of education, and 3.1 had no formal education. The finding is also in line with the study by Otieno, Omiti, Nyanamba, and McCullough (2009) where it was found that 57.5% of household heads in peri-urban areas had secondary education and above.

Table 4.5: Education Distribution of Respondents

	Frequency	Percentage
No Formal Education	3	3.1
Primary Level	8	8.3
Secondary Level	35	36.5
College Level	33	34.4
University Level	17	17.7
Total	**96**	**100**

4.5. Descriptive Analysis

Descriptive analysis focuses on summarizing the data so as to establish trends and patterns (Vaus, 2013). In this study, descriptive statistics were used to establish patterns regarding landscape alteration, environmental pollution, population changes, and social responsibility activities associated with the Menengai Geothermal Project, as well as, the livelihoods of adjacent communities.

4.5.1 Descriptive Analysis of Landscape Alterations

A significant way in which geothermal projects may affect livelihoods of adjacent communities is by altering an areas landscape. In order to determine the extent to which the Menengai Geothermal Projects has led to landscape alterations, participants were asked to respond to a set of statements on five point scale ranging from strongly disagree to strongly agree. The first statement was whether the Menengai Geothermal Project had led to alterations to the area's landscape. As shown in Table 4.6, the mean of responses to this statement was 3.20, which suggests that a majority of the participants were indifferent regarding whether the project had caused landscape alterations.

The second statement was that the project had led to displacement of community members from their land. The mean response to this statement was 2.41, which suggest that a majority of the participants disagreed with the statement. This finding is consistent with the study by Noorollahi (2005) where it was found that many of the geothermal prospects are within protected zones such as national parks or natural reserves; hence, their exploitation rarely displaces local communities from the land. This is, indeed, the case in the Menengai Geothermal project situated in the Menengai Caldera, which is a protected zone.

Regarding the statement that the Menengai project had led to destruction of scenery, the mean for the responses was 2.54, which suggest that a majority of participants were indifferent on this issue. This finding is different from DeJesus (1995) who found that geothermal energy production often is concentrated in regions with extraordinary landscapes, which are touristic attractions with mud pools, geysers, fumaroles and steaming ground, and are often remote and pristine. By extinction of geothermal surface features, and industrial development in such regions, there is a high risk that land of high tourist and scenic value is lost. However, the finding is consistent with Bayer et al., (2013) who found that a general assessment of social impacts in geothermal projects is hardly possible where projects take place in protected zones.

A majority of participants also disagreed with the statements that landscape alterations caused by the project had a negative impact on livestock, agricultural production, and open space and recreation opportunities for local people. The findings may be explained by the fact that the Menengai Geothermal Projected is located in an areas that was previous a protected zone and not human settlement (African Development Bank, 2011). The finding is also consistent with Noorollahi (2005) who argued that geothermal plants require relatively little land in comparison to most industrial project; hence, these projects have little negative impact associated with the displacement of local communities. However, as indicated by a mean of 2.51, many participants were indifferent on whether the project had led to alterations that have had a negative impact on wildlife and tourism.

Table 4.6: Descriptive Analysis of Landscape Alterations

Statement	N	Min.	Max.	Mean	S.D
The Menengai Geothermal Project has led to alterations to the area's landscape	96	1	5	3.20	1.253
The Geothermal Project has led to displacement of community members from their land	96	1	5	2.41	1.196
The Geothermal Project has led to destruction of scenery	96	1	5	2.54	1.104
Landscape alterations have had a negative impact on livestock	96	1	5	2.46	1.104
Landscape alterations have had a negative impact on agricultural production	96	1	5	2.31	1.079
Landscape alterations have had a negative impact on wildlife and tourism	96	1	5	2.51	1.152
The project has reduced open space and recreation opportunities for local people	96	1	5	2.40	1.165
Valid N (listwise)	96				

4.5.2 Descriptive Analysis of Environmental Pollution

The second variable that formed the focus of the study was environment pollution caused by the Menengai Geothermal Project. As suggested in the theory of Asset Vulnerability suggests, a new project can affect the livelihood of local community by affect labor and human capital (Moser, 1998). Environment pollution from a given project can have a significant impact on labor and human capital by affecting the health of local population. Participants were asked to respond to a set on statements aimed at examining patterns of environment pollution associated with the Menengai Geothermal Project.

The first statement was that the project had increased air pollution within the locality. The mean of responses to this statement was 2.78, which suggest that a majority of the respondent neither agreed nor disagreed with the statement. The finding reflects the inconsistency that characterizes previous studies on the environment impact of geothermal projects. A study by Rosenberg, Bodaly and Usher (1995) insisted that geothermal power generation has fewer consequences on the quality of air because it entails little emission of gases. Contrary to these sentiments, Rosenberg (1995) argued that geothermal development produces a broad range of environmental impacts including possible evolution of greenhouse gases.

The second statement was that the project had increased pollution of community water resources. A mean of 2.36 suggests that many of the respondents disagreed with the statement. This finding concurs Clark, Harto, Sullivan and Wang (2011) who found that althoughgeothermal waters pose a large potential risk to water quality, if released into the environment, due to high concentrations of toxics including antimony, arsenic, lead, and mercury, the risk of release can be virtually eliminated through proper design and engineering controls. It could be that the management of the Menengai Geothermal Project has instituted proper design and engineering controls for preventing release of toxics.

The third statement was that the project had led to destruction of scenery. A mean of 2.48 indicates that a majority of the participants were indifferent on this issue. The finding is different from DeJesus (1995) who found that geothermal energy production often has a negative effect on extraordinary landscapes such pools, geysers, fumaroles, and steaming ground, which are touristic attractions. In regard to soil pollution, a majority of the respondents (mean= 2.29) refuted the statement that the Menengai Project had contributed to soil pollution. This finding also contradicts Rosenberg (1995) who found that large scale geothermal development produces a broad range of waste products that can lead to contamination of soil. Mariita (2002) also found that the OlKaria Geothermal project has resulted in loss of vegetation in the area increasing the level of soil erosion.

Table 4.7: Descriptive Analysis of Environmental Pollution

Statement	N	Min.	Max.	Mean	S.D
The project has increased air pollution within the area	96	1	5	2.78	1.097
The project has increased pollution of community water resources	96	1	5	2.36	1.125
The project has led to destruction of scenery	96	1	5	2.48	1.205

Waste from project has increased level of soil pollution	96	1	5	2.29	1.132
The level of noise pollution has increased as result of the project	96	1	5	2.97	1.244
The project exert pressure on natural resources such as water	96	1	5	2.40	1.128
The project has led to excessive increase in temperatures within the area	96	1	5	2.32	1.100
Valid N (listwise)	96				

As indicated by a mean of 2.97, a majority of the participants were indifferent regarding whether the Menengai Project had resulted in noise pollution. This finding does not correspond with that Vezmar, Spajic, Topic and Sljivac (2014) where it was found that noise emissions are most critical during exploration and drilling of geothermal wells. Berrizbeita, (2014) also found that higher noise levels were a common incident closer to geothermal projects as a result of vehicular movements. A majority of the respondent disagreed with the statements that the Menengai Project had exerted pressure on natural resources and led to excessive increase in temperatures within the area.

4.5.3 Descriptive Analysis of Population Changes

Massive projects often lead to changes to the human population due to immigration of workers into the project area. The theory of Asset Vulnerability suggests that such a change can have an impact on the local community by affecting relationships between community members (Moser, 1998). In regard to whether the Menengai Geothermal Project has resulted in changes to the local population, a majority of the participants as indicated by a mean of 3.57 (see Table 4.8) were in agreement that the project had resulted in an increase in human population with the area.

The finding is consistent with the study byRossour and Malan (2007) where it was found that the Berg River Dam project led to massive in-migration that changed the demographic and cultural scape of adjacent communities. Bw'Obuya (2002) also found that there was evidence of population changes among communities surrounding the OlKaria Geothermal Project with only 1.4% of the workforce at project being drawn from local community.

A significant indicator that can serve as evidence of population changes within an area is increased congestion on the roads, in public facilities such schools and hospitals, and in the neighborhoods. However, a majority of the respondents (mean= 2.95) neither agree nor disagreed with the statement that the Menengai Project had caused congestion in their area. The finding is not in line with Hyari, El-Mashaleh, and Rababeh (2015) who found that the population influx that accompanies the commencement of major projects within an area leads to overcrowding, congestion, and sustained pressure on local services. However, the finding can be explained by the local of the Menengai Project in a peri-urban area where congestion may not be a significant problem. It may also be explained by the expansion of public facilities such as roads, schools, and healthcare establishment, which might have reverse the impact of the population influx.

Impact of project on local population can also be in the form of transfer of knowledge, skills, and technology. When asked about this issue, a majority of the participants (mean= 4.10) agreed that the Menengai projects had led to the diffusion of skills, knowledge, and technology to local people. The finding is in agreement with Rossouw and Malan (2007), who also found that Berg River Dam Project in South Africa had facilitated the transfer of skills to local people leading to an improvement in their social capital. Another way in which a project can impact local population is by increasing conflicts. A mean of 2.43 indicates that a majority of study participants disagreed with the statement that the Menengai project had led to increased conflicts within the local communities.

Mega projects can also affect local populations by weakening the cultural values of the people. As shown in Table 4.8, a majority of the participants were indifferent regarding this issue. The finding fails to affirm that study by Rossouw and Malan (2007) where it was found that Berg River Dam Project resulted in the erosion of cultural systems of local communities. However, as Phelan and Dawes (2013) explain, mega projects only have a significant cultural effect with local communities are ill prepared for the disruption. It could be that the communities adjacent to the Menengai Project were adequately prepared for the disruption given that the area is close to Nakuru town, which is highly cosmopolitan.

The commission of large project can also result in increase in crime rates within an area due to influx of people. However, a mean of 2.35 indicates that a majority of the respondents did not think that the Menengai Project had led to increased crime rates in their area. The finding is not congruent with Loney (2013), who found that major projects results in increased crime rates among Aboriginal communities in Australia. The projects were also associated with other negative impacts such as alcoholism, teenage pregnancies, school dropout, and family break-up. Another change that a project may bring to the local population is increment in the prices of assets, goods, and services. When asked whether the Menengai project had resulted in an increase in the cost of goods and services, a majority of the participant neither agreed nor disagreed with the claim.

Table 4.8: Descriptive Analysis of Population Changes

Statement	N	Min.	Max.	Mean	S.D
The project has increased human population in the area	96	1	5	3.37	1.154
The project has contributed to congestion in the area	96	1	5	2.95	1.080
The project has led to the transfer on knowledge, skills, and technology to local people	96	1	5	4.10	.989

The project has increased conflicts within the community	96	1	5	2.43	1.158
The project has weakened the cultural values of local people	96	1	5	2.67	1.220
The project has increased crime in the area	96	1	5	2.35	1.187
The project has led to an increase in prices of goods and services in the area	96	1	5	3.15	1.114
Valid N (listwise)	96				

4.5.4 Descriptive Analysis of Social Responsibility Activities

The concept of corporate social responsibility has gain impetus within the project management realm. Many projects use CSR activities as a strategy for minimizing conflicts with local communities and for increasing the legitimacy and support for the project. This section examines social responsibilities activities undertaken by the Menengai Geothermal Project. A significant aspect of social responsibility activities entails providing employment opportunities for local people. Participants were asked whether Menengai project has created employment for local people.

As shown in Table 4.9, the mean response to the statement is 4.50, which suggests that a majority of the respondents agreed that the project has created employment for local people. The study is consistent with Mariita (2012) who found that Olkaria Geothermal Project had provided employment opportunities for local people. It was, however, noted that the employment benefit was marginal because the project required specialized skills, which was lacking among local communities. Another social responsibility activity that a project may undertake is to provide business opportunities for local people. When asked to respond to this issue, a majority of the research participants were in agreement with the claim that the Menengai project had created a market for local produce (mean= 4.18) and created business opportunities for local people (mean= 4.21).

Another aspect of social responsibility entails improving social amenities and infrastructure for the local people. A majority of the respondents were also in agreement that the Menengai project has led to improvement of social amenities (mean= 4.24) such water and contributed to the development of key infrastructure such as roads and electricity (mean= 4.33). These findings are consistent withGachau (2011) who found that the Olkaria Geothermal Project engaged in activities such as water provision to the communities for domestic and livestock use, promotion of social afforestation, provision of transport to schools for educational tours, and to the local community for shopping and visiting medical facilities.

Table 4.9: Descriptive Analysis of Social Responsibility Activities

Statement	N	Min.	Max.	Mean	S.D.
The project has created employment for local people	96	1	5	4.50	.894
The project has created a market for local produce	96	1	5	4.18	.995
The project has created business opportunities for local people	96	1	5	4.21	.928
The project has led to improvement of social amenities in the area	96	1	5	4.24	.981
The project has benefited the community through social initiatives such as construction of schools	96	1	5	4.28	1.023
The project has led to improvement of key infrastructure such as road and electricity	96	1	5	4.33	1.002
The project has increased tourism activities in the area	96	1	5	3.96	.983
Valid N (listwise)	96				

4.5.5 Descriptive Analysis of Livelihoods of Local Communities

Community livelihood refers to the set of activities which members of the community need in order to secure the basic necessities of life (Mariita, 2006). This section analyzes patterns in the community livelihood since the Menengai Project was introduced. One of the significant indicate of improved livelihood is the improvement of the general wellbeing of community members. When participants were asked about their wellbeing, the mean of the responses was 4.30 (see Table 4.10), which suggests that a majority of the participants were in agreement that their overall wellbeing has improvement after the commencement of the Menengai project. A standard deviation of 0.908 suggests that the responses of the majority of participants did vary from mean by more than 0.9 units.

The findings are not consistent with Loney (2013) who found that hydropower projects caused trauma to local communities resulting in diminishing wellbeing. Obiozo and Smallwood (2014), however, explained that impact of project on community wellbeing is dependent on the readiness of the community and the design of the project. This explanation suggests that the findings may be attributed to the fact that the local community in the Menengai Project well adequately prepared for the project. The finding could also suggests' that the Menengai Project was designed in a fashion that minimized negative impact on community wellbeing.

Another indicator of community livelihood is ease of access to healthcare services. Health is an important human capital as the absence of good health can significantly affect the productivity of community members (Moser, 2006). When asked to respond to the claim that it is now easier to access healthcare services today that 5v years ago when the project had not taken root, the mean of responses was 4.19. This mean indicates that a majority of the respondent supported the claim. The finding is consistent with Gachau (2011), who found that the OlKaria Geothermal Project had increased community access to healthcare services by building dispensaries, equipping local hospitals, donating ambulances, and providing locals with transport to and from Naivasha town where they could get advanced health services.

Another measure that can be used to assess communities' livelihood is the cost of living. Cost of living affects the livelihood of local people by affecting their access to goods, services, and productive assets such as vehicle and machinery. When asked about the cost of living after the commencement of the project, a majority of the participants supported the claim (mean= 3.81) that the cost of living had increased after the commencement of the Menengai Project. This finding is congruent with Rossouw and Malan (2007), who found that Berg River Dam Project in South Africa had led to immigration of people into the area resulting in a spike in the prices of goods, services, and assets.

Another major indicator of community livelihood is household income. A majority of the participants (mean= 3.92) reported that their household income had increased in the past 5 years. The findings are consistent with Mariita (2012) and Gachau (2011) who found that the Olkaria Geothermal Project had resulted in job creation, business opportunities, and better access to essential services, all of which have an impact on household income. The levels of joblessness, security, household spending were also used as measures of community livelihood. As shown in Table 4.10, a majority of respondents agreed that the level of joblessness has declined (mean=3.99), security has improved (mean= 4.01), and household spending has increased (mean= 3.75) after the commencement of the Menengai Geothermal Project.

Table 4.10: Descriptive Analysis of Community Livelihoods

Statement	N	Min.	Max.	Mean	S D.
The overall wellbeing of the community has improved after the commencement of the project	96	1	5	4.30	.908
It is easier to access healthcare services today than 5 years ago	96	1	5	4.19	1.019
The cost of living has increased after the commencement of the project	96	1	5	3.81	1.098
Our household income has increased in the past 5 years	96	1	5	3.92	.981
The level of joblessness in the community has declined over the past five years	96	1	5	3.99	.827
Security in the area has generally improved since the onset of the project	96	1	5	4.01	.923
Our household spending has increased in the last five years	96	1	5	3.75	1.016
Valid N (listwise)	96				

4.6 Inferential Analysis

Inferential analysis focuses on arriving at conclusions that extends beyond the immediate data (Vaus, 2013). In this study, inferential analysis has been used to arrive at conclusion regarding the effect the geothermal project on the livelihood of local communities. The Pearson correlation technique was used in the analysis.

4.6.1 Relationship between Landscape Alteration and Community Livelihood

The first objective of the study was to assess the relationship between landscape alteration and the livelihood of communities living around the Menengai Geothermal Power Project. When the two variables were correlated, the Pearson Correlation test gave a p-value of 0.049 (see Table 4.11). Since this value is less than 0.05, it suggests the existence of a statistically significant relationship between landscape alteration and the livelihoods of communities at the 0.05 level of significance. This finding is consistent with the study by Noorollahi (2005) where it was found that geothermal project displaced local communities from farmland and leading to a negative effect on the livelihoods. The Pearson Correlation Coefficient (r) was -0.202. According to Sharma (2012), a negative coefficient indicate that the existence of an inverse relationship between the variables being compared. This implies that an increase in landscape alteration due to geothermal exploration activities would results to a decline in the livelihood of local community. This finding also reinforces the findings by Noorollahi (2005) where it was found that geothermal projects separated local communities from essential resources such as farmland grazing fields. Loney (2013) also found that huge hydropower project had a negative effect on the aboriginal communities because they interfered with forest lands, which were a major source of their livelihood.

Sharma also explained that a coefficient between 0.1 and 0.3 signifies a weak relationship; a coefficient between 0.4 and 0.7 signifies that the relationship is of moderate strength, and a coefficient that is greater than 0.7 indicates the existence of a strong relationship. The coefficient of -0.202 suggests that although the relationship between landscape alteration and community livelihood is statistically significant, the link between the two variables is weak.

Table 4.11: Correlation between Landscape Alteration and Community Livelihood

		Landscape Alteration
Livelihood	Pearson Correlation	-.202*
	Sig. (2-tailed)	.049
	N	96

*. Correlation is significant at the 0.05 level (2-tailed).

4.6.2 Relationship between Environmental Pollution and Community Livelihood

The second objective of the study was to establish the relationship between environmental pollution and the livelihoods of communities around the Menengai Geothermal Power Project. As shown in Table 4.12, the Pearson correlation test gave a p-value of 0.01, which indicates that there is a statistically significant relationship between environmental pollution caused by geothermal project and the livelihoods of local communities. The finding is congruent with the study by Vezmar, Spajic, Topic and Sljivac (2014) where it was found that environmental pollution from geothermal projects was statistically correlated with loss of livelihood among local communities.

The correlation coefficient is negative, which suggest the existence of an inverse relationship between environmental pollution and community livelihoods. This implies that an increase in environmental pollution by the project would result in a decline in the livelihoods of local communities. This finding concurs with Bw'Obuya (2002) who found that the Olkaria Geothermal Project in Kenya was marred by concerns regarding environmental issues such as increasing dust levels and smells the project, a rise in respiratory diseases (asthma), eye problems, and colds and flu's. These effects have a negative impact on the communities' human capital resulting in a decline in the communities' livelihood. The coefficient of 0.260 indicates that, although statistically significant, the relationship between environmental pollution and livelihoods of local communities is weak.

Table 4.12: Correlation between Environmental Pollution and Community Livelihood

		Environmental Pollution
Livelihood	Pearson Correlation	-.260*
	Sig. (2-tailed)	.011
	N	96

*. Correlation is significant at the 0.05 level (2-tailed).

4.6.3 Relationship between Population Change and Community Livelihood

The third objective of the study is to determine the relationship between population change and the livelihood of communities around the Menengai Geothermal Power Project. When the two variables were correlated, the Pearson test gave a p-value of 0.367 (see Table 4.13). Since this value is greater than 0.05, it indicates that there is no statistically significant relationship between population change caused by geothermal projects and the livelihoods of local communities. The finding is not consistent with Rossouw and Malan (2007) who found that Berg River Dam Project in South African led to changes in the local population due to immigration of workers. This population change was statistically associated with changes in the way of life of the local people.

Table 4.13: Correlation between Population Change and Community Livelihood

		Population Change
Livelihood	Pearson Correlation	.093
	Sig. (2-tailed)	.367
	N	96

The final objective of the study was to establish the relationship between social responsibility activities initiated by the implementing company and the livelihood of communities around the Menengai Geothermal Power Project. The two variables were correlated using the Pearson correlation technique yielding a p-value of 0.000 (see Table 4.14). This value indicates that there is a statistically significant relationship between social responsibility activities of the project and community livelihoods at the 0.01 level of significance. The finding is in line with the study by Maliganya, Salatiel, and Renatus (2013) where it was found that there was a significant relationship between CSR initiatives undertaken by the Geita Gold Mine in Tanzania and the livelihoods of adjacent communities.

Table 4.14: Correlation between SR Activities and Community Livelihood

		Social Responsibility Activities
Livelihood	Pearson Correlation	.733**
	Sig. (2-tailed)	.000
	N	96

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation coefficient (r) is positive, which indicate the existence of a direct relationship between social responsibility activities of the project and the livelihoods of local communities. This implies that an increase in social responsibility activities will result in improvement in the livelihoods of local people. Gachau (2011) also found that the livelihoods of communities adjacent to the Olkaria Geothermal Project were boosted by CSR activities such building of schools and dispensaries and provision of water. The coefficient of 0.733 suggests that the relationship between social responsibility activities and the livelihoods of local communities is strong.

4.7 Summary of Model

The chapter presented the data analysis, findings and interpretation. Results were presented in tables, percentages and Pearson Correlation coefficient. Both the descriptive and inferential statistics was done. The findings of the study indicated that there is astatistically significant relationship between Landscape alteration, environmental pollution and the livelihoods of communities living around. Population change was found that there is no statistically significant relationship between population change caused by geothermal projects and the livelihoods of local communities.

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The first objective was to assess the relationship between landscape alterations caused by the geothermal project the livelihoods of local communities. Descriptive statistics suggests that the geothermal project did not cause major alteration to the landscape. A majority of the respondents were indifferent when asked whether the project had resulted in landscape alteration and rejected claims that the project had displaced them from their land or resulted in decreased livestock and agricultural productivity. The Pearson correlation test showed that there was a statistically significant and negative relationship between landscape alteration and livelihoods of local communities. This relationship was, however, weak.

The second objective was to establish the relationship between environmental pollution caused by the project and the livelihoods of adjacent communities. Descriptive statistics indicate that the Menengai Project has not caused major environmental pollution. A majority of participants were either indifferent or rejected statements suggesting that the project had resulted in various forms of environment pollutions. The Pearson Correlation test shows that there is a statistically significant, negative, but weak relationship between environmental pollution and the livelihoods of local communities.

The third objective of the study was to determine the relationship between population changes caused by the geothermal project and the livelihoods of local communities. Descriptive analysis revealed that the Menengai Project had indeed led to an increase human population. A majority of the respondents also supported the claim that the project had resulted in the diffusion of skills and technology to the local people. However, a majority of the participants were either indifferent or rejected claims that the project had caused congestion in the area, resulted in the erosion of cultural value, increased crime in the area, and resulted in an increase in the prices of goods and services. The Pearson Correlation test showed that there was no statistically significant relationship between population changes and the livelihoods of local communities.

The final objective of the study was to establish the relationship between social responsibility activities undertaken by the Menengai Geothermal Project and livelihoods of local communities. Descriptive statistics showed that the Menengai Project has invested in a wide variety of social responsibility initiative including creating employment to local people, providing business opportunities, developing local infrastructure and social amenities, and providing market for local products. The Pearson Correlation test showed that there was a statistically significant, positive, and strong relationship between social responsibility activities of the project and the livelihoods of local communities.

5.2 Conclusion

Findings of the study have led to the conclusion that there is a significant association between geothermal power projects and the livelihoods of adjacent communities. Results showed that three out of the four aspects of geothermal project that were being investigated (landscape alteration, environment pollution, population change, and social responsibility activities) had statistically significant relationship with the livelihood of local communities. Only population change was found to have an insignificant relationship with community livelihood. Landscape alteration (r= -0.202) and environment pollution (r=-0.260) were found to have negative and weak relationships with the livelihoods of local communities. Social responsibility activities (r= 0.733) had a positive and strong relationship with the livelihoods of local communities

5.3Recommendations

Findings suggest that geothermal project implementing companies should focus on design project in ways that minimizes landscape alteration. Available data has showed that these aspects of geothermal project have an inverse relationship with the livelihood of local communities. Therefore, project implementing companies should invest in designs, technologies, and practices that minimize the alteration of landscape. Doing so would also reduce resistance to the project and create a good rapport for the project among key stakeholders such as regulators, financiers, and lobby groups resulting in higher probability for success.

The research has found out that environmental pollution has an inverse relationship with the livelihoods of local communities. Controlled engineering processes should be used by the project to ensure harmful substances aren't released to the environment. This will ensure an improvement in the health of residents and thus would provide labor requirements sufficiently as per Asset vulnerability framework.

Population change didn't produce a statistically significant relationship when correlated with the livelihoods of local communities. Expansion of public facilities such as roads, schools, and healthcare establishment should be enhanced since they have reverse impact on population influx.

The findings on CSR have significant implications to the Menengai Geothermal Project implementing company and companies involved in similar projects. First, the findings suggest that such companies should increase investment in social responsibility activities. Data has shown that CSR activities have the strongest link with the livelihood of local communities. Therefore, investing in such activities will result in optimal benefit for local communities, which will, in turn, reduce resistance, increase financiers interest in the project, and increase ownership of the project.

5.4 Suggestions for Future Studies

The current study only focused on four aspects of geothermal projects: landscape alteration, environmental pollution, population change, and social responsibility initiatives. There are other aspects of geothermal projects that may have an impact on the livelihoods of local communities including displacement of local communities and potential land grabs. Future studies should examine these aspects. The study was also limited to answering questions regarding what relationship existing between the project aspects and community livelihoods, and the direction of these relationships because of the quantitative approach used. It could not provide answer regarding why these relationships exist. A qualitative in depth study is needed to uncover the reason behind these relationships.

REFERENCES

[1] African Development Bank (2013). *Environmental and Social Impact Assessment Summary of Menengai Geothermal Power Project*.Retrieved on May 1, 2016, from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Environmental-and-Social-Assessments/Kenya-Menengai.pdf.

[2] Barrantes M. (2006) Geo-environmental aspects for the development of Las Pailas geothermal field, Guanacaste, Costa Rica.The United Nations University Geothermal training programme.

[3] Bayer, P., Rybach, B., Blum, P., Brauchler, R. (2013) Review on life cycle environmental effects of geothermal power generation.*Journal of Renewable and Sustainable Energy*

[4] Berrizbeitia, D (2014) Environmental Impacts of Geothermal Energy Generation And Utilization Volcanos of the Eastern Sierra Nevada – G190. Hamburger, Rupp and Taranovic

[5] Berrizbeitia, L. (2014). Environmental impact of geothermal energy generation and utilization.

[6] Clark, E, Harto, B., Sullivan, J., & Wang, M. (2011) Water use in the development and operation of geothermal power plants. Argonne National Laboratory.

[7] DeJesus A. (1995) Socio-economic impacts of geothermal development. World geothermal congress, IGA pre-congress course Pisa, Italy.

[8] Dickson M, Fanelli M. (2005) Geothermal energy : utilization and technology. Sterling, VA: Earthscan;. Xviii, 205

[9] Fraenkel, J., &Wallen, N. (2000).*How to Design and Evaluate Research in Education*. New York: McGraw-Hill Publishing Co.

[10] Fukutina K. (2012) The Waikato regional geothermal resource.Waikato Regional Council Technical Report 102012.

[11] Gachau, E (2011) Social Aspects Of Geothermal Development – A Case Of Olkaria Geothermal Project In Kenya. A paper presented at Short Course VI on Exploration for Geothermal Resources, organized by UNU-GTP, GDC and KenGen, at Lake Bogoria and Lake Naivasha, Kenya, Oct. 27 – Nov. 18.

[12] Glassley W (2010) Geothermal energy: renewable energy and the environment. Boca Raton: CRC Press; 2010. xxi, 290

[13] Gravetter, R., and Forzano, S. (2003). *Research Methods for Behavioural Sciences*. Belmont: Wardsworth

[14] Haugh, H. (2012). The importance of theory in social enterprise research.*Social Enterprise Journal, 8* (1), 7- 15.

[15] Hunt, T (2001) Five lectures on environmental effects of geothermal utilization. UNU-GTP, Iceland, report 1.

[16] KIPPRA (2007).Strategies for Securing Energy Supply in Kenya.The Kenya Institute for Public Policy Research and Analysis Policy Research and Analysis.*Policy Brief No. 7/2007.*

[17] Lederach, J.P. and Thapa, P. (2012) Staying True in Nepal: Understanding Community Mediation Through Action Research, *The Asia Foundation.*

[18] Mariita, N. (2012). The impact of large renewable energy development on the poor: Environmental and socio-economic impact of a geothermal power plant on a poor rural community in Kenya. *United Nations University Geothermal Training Program, 9* (108), 21- 26.

[19] Matek B. (2014) Annual U.S. & Global Geothermal Power Production Report. Geothermal Energy Association Reports [Internet]

[20] Moser, C. (1998). The asset vulnerability framework: Reassessing urban poverty reduction strategies. *World Development.*

[21] Moser, C. (2006). Asset-based Approaches to Poverty Reduction in a Globalized Context.Retrieved on May1, 2016 from http://www.brookings.edu/~/media/research/files/papers/2006/11/sustainabledevelopment%20moser/200611moser.pdf.

[22] Mugenda, A., & Mugenda, O. (2003). *Research methods: Quantitative & Qualitative Approaches*. Nairobi: African Center for Technology Studies.

[23] Mwangi, M (2010) Environmental and Socio-Economic Issues of Geothermal Development in Kenya.*GRC Bulletin.*

[24] Mwawughanga, F (2003) comparison of environmental aspects of geothermal and hydropower development based on case studies from Kenya and Iceland. Report *Number 17*. United Nations University, Iceland.

[25] Nassiuma, D. (2000). *Survey sampling: Theory and methods*. Njoro, Kenya: Egerton University Press.

[26] Ngugi, P (2012) Financing the Kenya Geothermal Vision. *Paper presented at "Short Course on Geothermal Development and Geothermal Wells*, organized by UNU-GTP and LaGeo, in Santa Tecla, El Salvador.

[27] Noorollahi, Y., (2005) Applications of GIS and remote sensing in exploration and environmental management of Námafjall geothermal area, N-Iceland.University of Iceland, MSc thesis, UNU-GTP, Iceland, report.

[28] Oduor, J. (2010) Environmental and Social Considerations in Geothermal Development.FIG Congress 2010 Facing the Challenges – Building the Capacity; April 11-16, 2010; Sydney, Australia.

[29] Peralta O, Castro T, Durón M, Salcido A, Celada-Murillo A-T, Navarro-González R, et al. (2013) H2S emissions from Cerro Prieto geothermal power plant, Mexico, and air pollutants measurements in the area.Geothermics.

[30] Randolph, A. (2007) Integrating Environment as a Core Business Value: Perspective on Corporate Social Responsibility. Bangkok, Thailand: Society of Petroleum Engineers.

[31] Rodriguez, J. &Arevalo, A. (2007).Geothermal, the environment, and neighboring communities.*United Nations University Geothermal Training Program, 9* (108), 21- 26.

[32] Rossouw, N., & Malan, S. (2007). The importance of theory in shaping social impact monitoring: Lessons from the Berg River Dam, South Africa. *Impact Assessment and Project Appraisal*

[33] Rybach L., &Mongillo, M. (2006) *Geothermal sustainability a review with identified research needs*. Geothermal Resources Council Transactions.

[34] Rybach, L. (2005) Environmental aspects of geothermal development and utilization, and related legal, institutional and social implications. In: K Popovski, editor, Proceedings of the world geothermal congress short pre and post congress courses; 24–29 April. Antalya, Turkey.

[35] Schieng, M. (2009).The model of corporate social responsibility in project management.*Business Theory and Practice, 10* (4), 315- 321.

[36] Shapiro, I. (2006). Extending the Framework of Inquiry : Theories of Change in Conflict Interventions. Bergh of Handbook.

[37] Stein, D &Valters, C (2012). Understanding 'theory of change' in International development: a review of existing knowledge. JSRP Paper 1.JSRP and TAF collaborative project.

[38] Vezmar, S., Spajic, A., Topic, D., &Slijivac D. (2014).Positive and negative impacts of renewable energy sources.*International Journal of Electrical and Computer Engineering System, 5* (2), 15- 23.

[39] Weiss, C (1995). Nothing as Practical as Good Theory: Exploring Theory-Based Evaluation for Comprehensive Community Initiatives for Children and Families (Connell, J, Kubisch, A, Schorr, L, and Weiss, C. (Eds.) 'New Approaches to Evaluating Community Initiatives' ed.). Washington, DC: Aspen Institute.

[40] African Development Bank (2011). *Menengai Geothermal Development Project Appraisal Report.*Retrieved June 23, 2015, from http://www.climateinvestmentfunds.org/cifnet/sites/default/files/Kenya%20 Menegai%20Geothermal%20Development.

[41] Sifers, K., Puddy, R., Warren, J., & Roberts, M. (2002).Reporting of demographics, methodology, and ethical procedures in journals in pediatric and child psychology.*Journal of Pediatric Psychology, 27* (1), 19- 25.

[42] Kenya National Bureau of Statistics (2013).*Kenya Integrated Household Survey.* Retrieved June 2, 2016 from http://kenya.socrata.com/api/assets/BD46451B-3158-4698-8E38-6703631AB578.

[43] Otieno, D., Omiti, J., Nyanamba, T., & McCullough, E. (2009). Market participation by vegetable farmers in Kenya: A comparison of rural and peri-urban areas. *African Journal of Agricultural Research, 4* (5), 451- 460.

[44] Vaus, D. (2013).*Survey in Social Research.*New York, NY: Routledge Publishers.

[45] Hyari, K., El-Mashaleh, M., &Rababeh, S. (2015). Framework for managing the traffic impacts of building construction projects. *Journal of Construction in Developing Countries, 20* (2), 97- 113.

[46] Phelan, A., & Dawes, L. (2013).Megaprojects, affected communities, and sustainability decision-making.*Sustainable Engineering Society, 4* (2), 42-51.

[47] Loney, M. (2013). Social problems, community trauma, and hydro project impacts. *The Australian Journal of Native Studies, 7* (1), 57- 78.

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