IMPACTS OF LAND USE CHANGES AROUND OLKARIA GEOTHERMAL STATIONS

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ABSTRACT

In Kenya, the most common form of industrial and domestic energy is electricity. It is generated from three main sources, hydro, geothermal and thermal, but the latter is expensive due to the cost of importation of crude oil for its generation. Kenya's geothermal potential is in excess of 3,000 megawatts (MW) against the current national total generation of 1,117 MW. This form of energy is widely distributed in the Kenya Rift Valley, but currently exploitation is concentrated in Olkaria, Naivasha.

Exploitation of this energy requires a lot of land for the location of the power stations, wells, steam transmission pipes, roads, power transmission lines and residential housing for workers. It also requires a lot of water for drilling and construction. The setting up of the power plants in the study area has attracted other land use activities which too impact on land use and the water from Lake Naivasha, the only available source of potable fresh water for the area residents. There is continuous development and exploitation of the geothermal power resources in the study area.

In order to understand the magnitude of the impacts, aerial photographs, 1975 topographical maps, satellite images for 1975, 1985, 1995, 2003 as well as personal observations since 1986 have been interpreted by use of geographical information systems (GIS) and remote sensing (RS). These reveal intense land use changes which, if not managed, will lead to a lot of social, economic, health and environmental impacts.

The objective of the study was to examine the impacts of land use changes around Olkaria geothermal stations.

Key words: Geothermal, impacts, environment, land use

1.0 INTRODUCTION

Provision of cheap and affordable energy is a big challenge to the Kenya Government. This has led to the intensification of geothermal exploration and exploitation in Olkaria geothermal field to meet electricity demand for the country. Geotherma refered to as the energy from the earth's surface resulting from interactions of waters in the pore spaces with the hot rocks within the crust. The heat creates a convective current that leads to the development of hot water vapour reservoir above the rocks. This is the source of geothermal energy.

The exploitation of geothermal energy necessitates creation of space for power houses and other facilities. The infrastructure accompanying this development compounds the problem of exploitation and utilisation. Olkaria geothermal power development has acted as a growth pole (Pole de croissant), Per roux (1956, 1983) by attracting other resource use activities to the area. These have affected land use within the power stations and around Olkaria, triggering even more competition for other resources in the area.

Power development projects have short and long term impacts, Biswas (1981). Short term impacts occur during the planning, construction and immediate post construction phases of the project. Long term impacts are a result of alterations of ecosystems within and around the power plants, operations of the plant and changing socio-economics of the area in and around the power plants, Barrow (1981).

A typical geothermal well drilled to a depth of 2,200 m utilises up to 100,000 m^3 of water per well till completion. Most wells in Olkaria geothermal field are deeper than 2,200 m and thus consume a lot of water during construction. Geothermal wells are drilled using mud, foam or air. In Olkaria, the mud system is used and the effect of seepage of the drilling fluids into different ecosystems and aquifers together with the disposal and storage of mud pose serious land use impacts.

There are concerns about the impacts of gaseous emissions released in large quantities from the geothermal plants. These include the oxides of sulphur, nitrogen and carbon, some of which when emitted to the atmosphere are transformed by a variety of chemical reactions and deposited in the ecosystem in and around the power plants. These emissions have varying impacts on land uses around Olkaria geothermal power plants.

The intensity of land use changes within the power stations and around Olkaria area has led to the blockage of the wildlife migration corridors as well as the free paths for local communities to Lake Naivasha. These land uses have encroached and almost consumed the whole of the riparian reserve around the lake. This has resulted in clashes between the land users and the local communities who claim that even their wives and livestock are experiencing miscarriage, stillbirths and deaths due to these land use activities and the resulting environmental impacts. The intensity of water extraction from Lake Naivasha has led to receding of the Lake and there are worries over water contamination due to various land uses in the area. There

have been various studies on geothermal power development in Kenya, Ndombi (1981), Bhogal (1980) and Republic of Kenya (1954), among others.

The study set out to analyse the impacts of the land use changes around Olkaria geothermal stations in Naivasha Division, Rift valley Province, Kenya, from the year 1975 to 2005.

2.0 METHODOLOGY

The field investigations to map areas affected by the intense land use activities associated with geothermal power development was done through travelling by vehicle and on foot in the Olkaria power field and the adjoining areas between April and July, 2005.

Different land uses were marked on a digital topographical map (Sheet 133/4, Longonot of scale 1:50, 000, Survey of Kenya, 1975) using a geographical positioning system (GPS) – Germini 12 x L. The use of the (GPS) was to assist in exact site location of impact areas.

Digital satellite imagery for 1975, 1985, 1995 and2003 were obtained from the Naivasha Municipal Council water and sanitation department. The different land use changes at Olkaria and surrounding areas were mapped using digital (GIS), Esri-Arcview GIS 3.2a software. The GIS software enabled the superimposition of different epochs of land uses into a digital topographic map sheet 133/4, survey of Kenya, 1975.

Remote sensing (RS) was used in the interpretation of aerial photography using translucent tracing paper, a simple pocket stereoscope, China pencil, pen and rubber. The different physical and topographic features appearing on the aerial photos in the study area were traced to come up with the different land use maps.

Questionnaires were prepared, pre-tested in the field and corrected wherever necessary before final field administration. These questionnaires were coded and analysed using MS excel and Statistical Package for Social Scientist (SPSS) for responses.

In this field survey, Longonot area was the control point. This is because over the different epochs of investigations, i.e., 1975, 1985, 1995 and 2003, it hadn't seen any kind of growth, but was instead dying out from the labour camp that it was.

3.0 RESULTS AND DISCUSSION

From the study, it was evident that, there were a lot of land use changes within the geothermal fields, with corresponding land use activities in the area along Moi Southlake Road. The analysis of 1975 satellite image showed the land use in the study area was mostly for grass and fodder. The riparian reserve was extensive and area coverage by Lake Naivasha and the riparian very distinctive. There was no geothermal power plant and no commercial land use in the study area (Figure 2).

In 1981, Olkaria I geothermal power station went online, generating the first 15 MW of power. The infrastructure for the power plant consisted of the power stations, steam transmission pipes, few geothermal wells, roads and staff quarters at Moi Southlake Road for Kenya Electricity Generating Company (KenGen) staff members. More staff for the power plant were housed at the geothermal field. Although there were some changes in the land use to accommodate the Olkaria I power development both in the geothermal field and around Moi Southlake Road, the land use wasn't so intense. Around Lake Naivasha, the riparian reserve was still undisturbed to any noticeable levels (Figure 3).

Field survey, satellite image and aerial photographs analysis and interpretation for 2005 were very shocking. They showed intense land use activities within the geothermal field and around the power company staff quarters at Moi Southlake Road. There were seven identified and demarcated geothermal fields. Three of the identified geothermal fields are generating (Olkaria I, II, and III), and more wells have been drilled to harness the geothermal steam. The three generating fields have been supported by appropriate infrastructure, i.e., power houses, roads, steam pipes, staff houses and electricity transmission lines (Figure 4, plates 1 and 2).

The location of KenGen staff quarters on Moi Southlake Road and the provision of infrastructure within the staff quarters led to even more land use to the area. Along the Moi southlake Road, the labour camps of DCK and KenGen transformed to trading centre to service the KenGen staff members.

The transformation to trading centres of the labour camps next to KenGen without appropriate infrastructure and development plans has turned this area into slum settlements. The influence of KeGen developments to the transformation of these trading centres is very evident. This is because there are more developments very close to KenGen as compared to other earlier labour camps at Longonot which lies midway between Naivasha and Olkaria. Karagita labour camp has been transformed to trading centre because of its proximity to Naivasha town, leaving Longonot to die off.

The mushrooming of land use activities around Olkaria housing project is posing serious impacts to Lake Naivasha, with disappearance of riparian reserve, blockade of public corridors towards the lake, thus creating social conflict. From the field study, 91% of the residents interviewed depend on Lake Naivasha water for their daily use (Figure 4), but intense land use activities pose a danger to the very important water source. It became very worrying, as 87% of the residents interviewed complained that the Olkaria geothermal power plants have had a serious impact on their daily lives. (Figure 4) and pose a serious environmental threat to Lake Naivasha.

4.0 CONCLUSION

The ecosystem around Olkaria is rich in biodiversity and Lake Naivasha is the only source of potable water to majority of the area residents as well as the wildlife at the

Hell's Gate National Park. The intensity of the land use changes poses a major threat to fragile ecosystem of the Lake Naivasha basin. The current total power generation from Olkaria is 123 MW and there are plans to increase this to 600 MW by 2015. This will lead to more serious land use impacts, affecting other resource uses as well as the environment.

In order to sustainably exploit the geothermal energy in Olkaria, The government through Naivasha Municipal Council should develop a structure plan for Lake Naivasha basin. This will guide all developments within the basin to ensure sustainable resource use in the area.

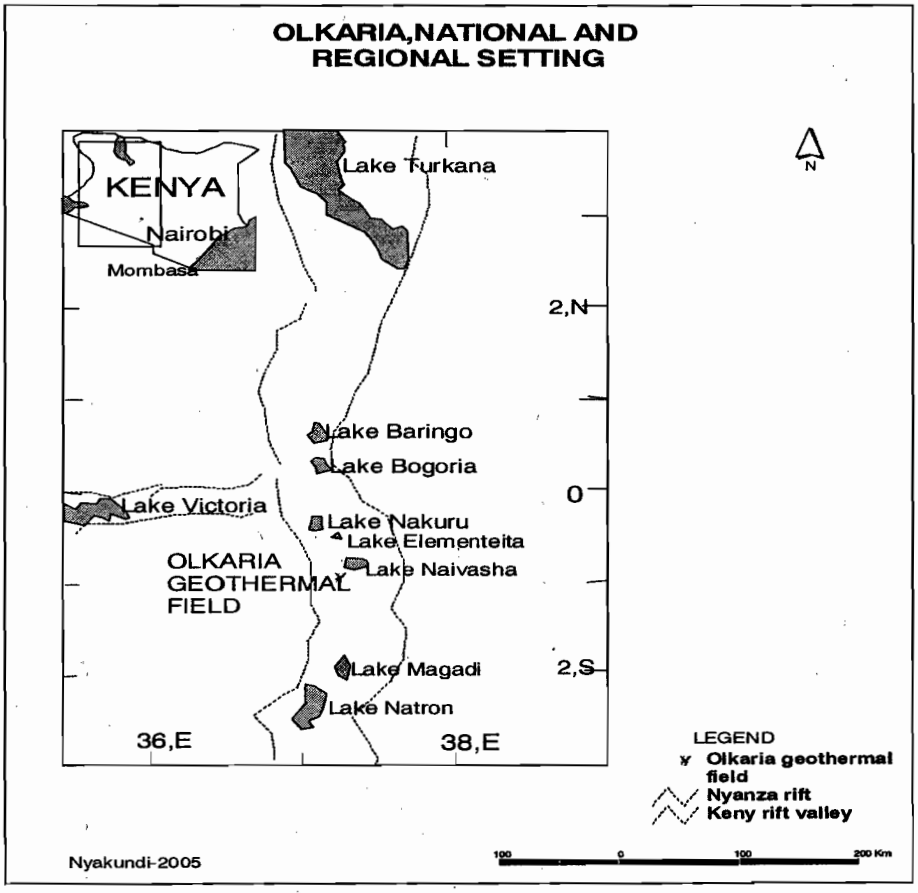

Figure 1: Location of the study area

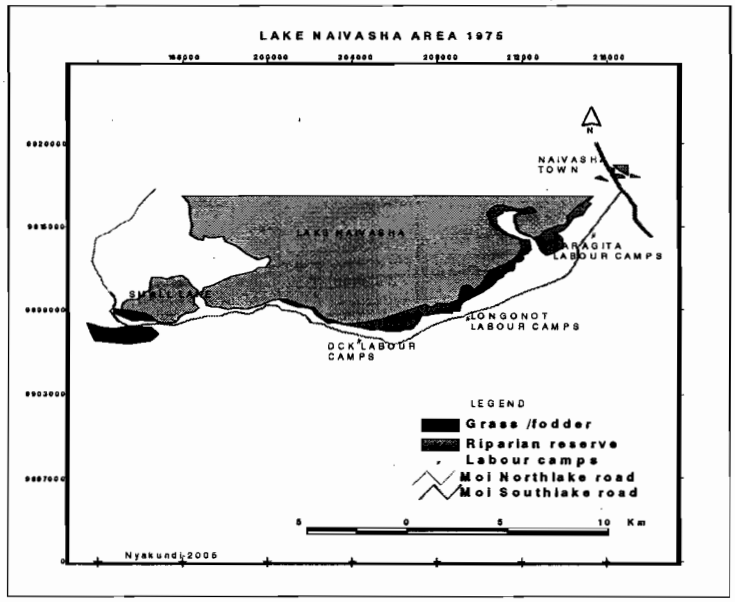

Figure 2: Olkaria area in 1975, very little land use activity

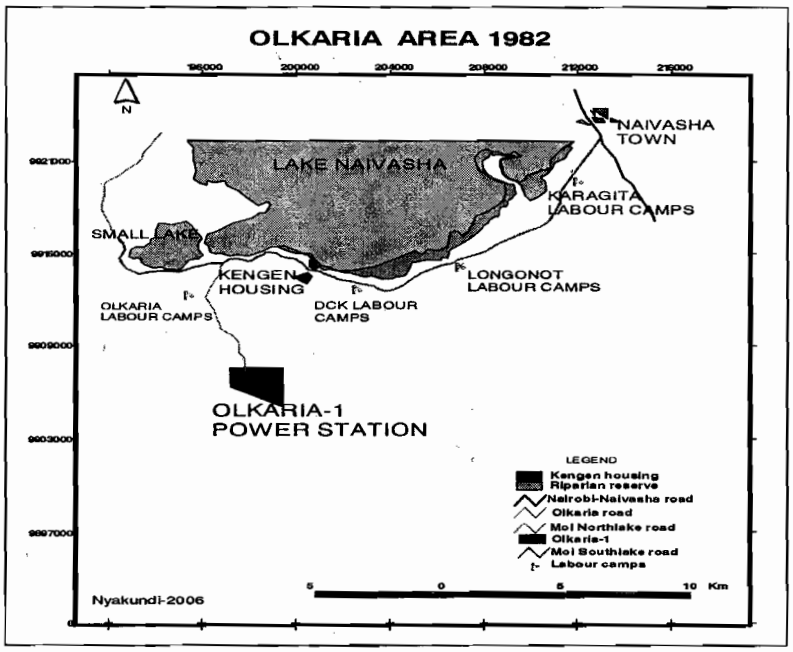

Figure 3: In 1982, Olkaria I was online with some slight change in land use activities in the field and Moi Southlake Road

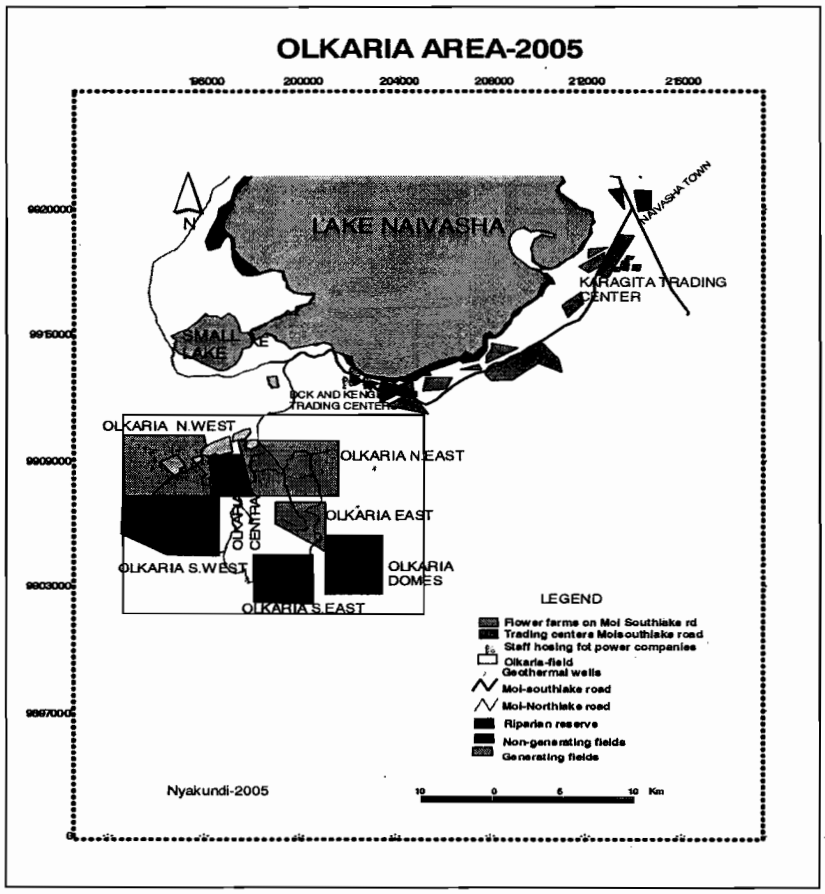

Figure 4: The intensity of land use in 2005

FIGURE-V

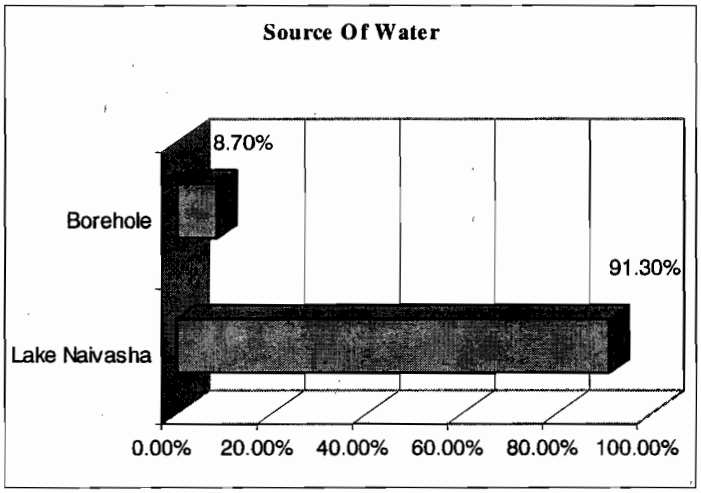

Figure 5
Source- Field survey 2004

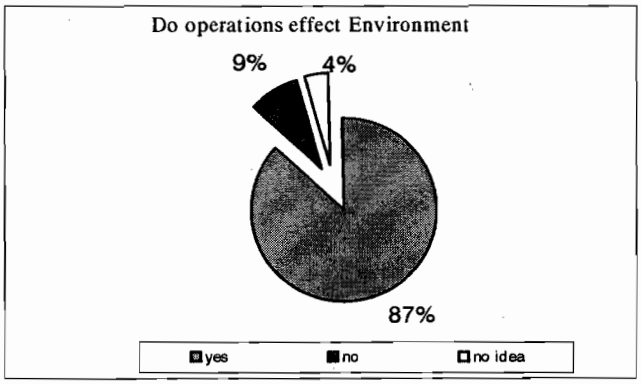

Figure 6
Source-Field survey 2004

PLATES 1, 2- AND AT THE KENGEN HOUSING ESTATES
Source- Field survey 2004 and 2005

OLKARIA-2 GEOTHERMAL STATION

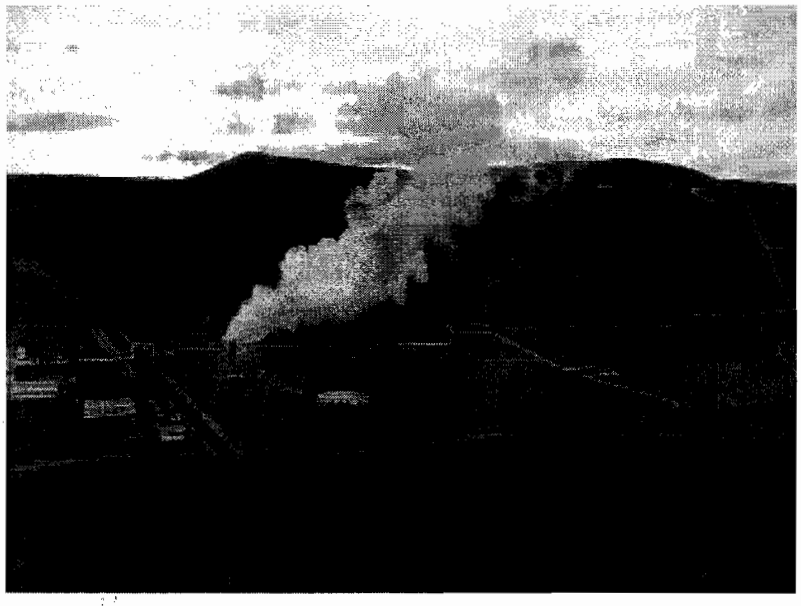

Plate 1: Olkaria power field

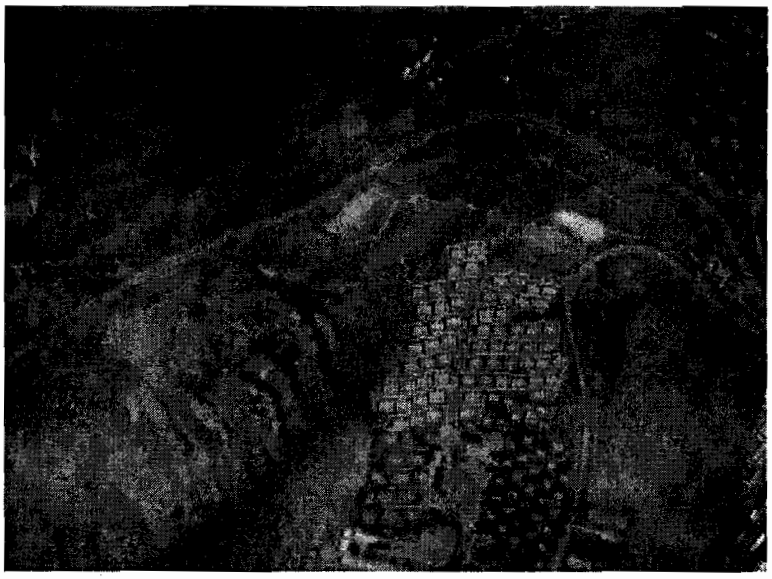

Plate 2: KenGen staff housing, 2005

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REFERENCES

BisWas A. K. (1981) Health impacts of Hydropower Development. Biswas & Associates Oxford/oxford (U.K)

Bhogal B. S. (1980). Electrical Resistivity Investigations at the Olkaria geothermal Field, Kenya. *Geothermal Resources Journal,* Trans., 4, pp 9 -12.

François Perroux (1983). A New Concept of Development, *Institute de Sciences Economiques Appliqueées* (ISEA)

François Perroux, (1956). Prises de vue sur la croissance de l'économie française, *Income and Wealth, Institute de Sciences Economiques Appliqueées* (ISEA)

Republic of Kenya (1954). Geology of Naivasha Area. Government Printer, Nairobi, pp 52 - 61.

Ndombi J. M. (1981). The Structure of the Shallow Crust Beneath Olkaria Geothermal Field, Kenya. *Jour. Volcanology Geoth Res.*, pp 237 - 251.