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EIA OF GEOTHERMAL EXPLORATION IN TANZANIA: THE LAWS AND REGULATIONS, EIA PROCESS AND PRELIMINARY EIA OF EXPLORATION DRILLING IN NGOZI AREA, SW-TANZANIA

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ABSTRACT

Ngozi geothermal prospect is located in the Southwest part of Tanzania. The distance from Dar es Salaam to Mbeya is 817 km. Detailed surface exploration has been carried out in the area and exploration drilling is expected to prove the existence of a geothermal resource. Environmental laws and regulations in the country that have to be taken in account during the EIA process are presented. A preliminary EIA of the three main environmental factors that the project is expected to have impact on i.e. noise, land use and social economy, is introduced. Mitigating measures are proposed for the aforementioned impacts. The report aims to provide a basis for future EIA work for geothermal exploration drilling in Tanzania. A detailed Environmental Impact Assessment based on evaluation of baseline data is recommended as a first step to provide a better understanding of the potential impacts and mitigating measures during the development.

1. INTRODUCTION

The United Republic of Tanzania is a large country in Eastern Africa, consisting of Tanzania mainland and Zanzibar. It is located between longitudes 29° and 41° east and latitudes 1° and 12° south. It is bordered by Kenya and Uganda to the north, Rwanda, Burundi and Democratic Republic of Congo to the west, Zambia, Malawi and Mozambique to the south and by the Indian Ocean to the east (NBS, 2012) as shown in Figure 1. It covers a total area of 947,303 km^2 and has a population of estimated 53.47 million inhabitants (2015) (Worldometers, 2016). The population is diverse, composed of several ethnic, linguistic and religious groups.

Tanzania is endowed with diverse forms of energy resources including natural gas, hydro, coal, biomass, geothermal, solar, wind and uranium, most of which have not been optimally utilised. In May 2014, Tanzania's total installed electric generation capacity was 1,583 MW composed of hydro (561.82 MW), natural gas power plants (527 MW) and liquid fuel power plants (495 MW). Tanzania also imports small amount of electricity from Uganda (10 MW), Zambia (5 MW) and Kenya (1 MW) (ESI reform strategy and road map; MEM, 2014a). On the mainland of Tanzania only 24% of the population is connected to electricity. The demand for electricity is growing by 10-15% per year and the main reason is increased

FIGURE 1: Location map (Nations Online Project, 2016)

socio-economic activities. By 2025, the demand is predicted to be around 8,000 MW. Therefore, to meet such demand, the installed capacity must increase to at least 10,000 MW. To nurture the desired socio-economic transformation, the access to modern energy services in an affordable, reliable, sustainable and environmentally-friendly manner is inevitable (MEM, 2014a). Tanzania through its implementing agency TGDC (Tanzania Geothermal Development Company) anticipates to start drilling geothermal exploration wells by the end of 2017 in Ngozi geothermal prospect.

This study is intended to gather important information on the legal issues and the Environmental Impact Assessment (EIA) process in the country to support the preparation of future geothermal development. A preliminary EIA of the most important environmental factors that the Ngozi project is likely to affect; land use, social economy and noise, is introduced.

2. GEOTHERMAL EXPLORATION IN TANZANIA

Geothermal energy has so far not been utilized in Tanzania but is estimated to be a realistic resource. The estimated geothermal potential exceeds 5000 MW (TGDC, 2014). More than 50 areas with geothermal activities, mainly hot springs, have been identified and most of these areas are located in the East African Rift system (EARS) (Figure 2). In Figure 2 are shown the 50 areas with geothermal activity, the four main areas within the red circles, the two subareas where geothermal exploration has been licensed, Rungwe and Mbeya, are shown as red dots.

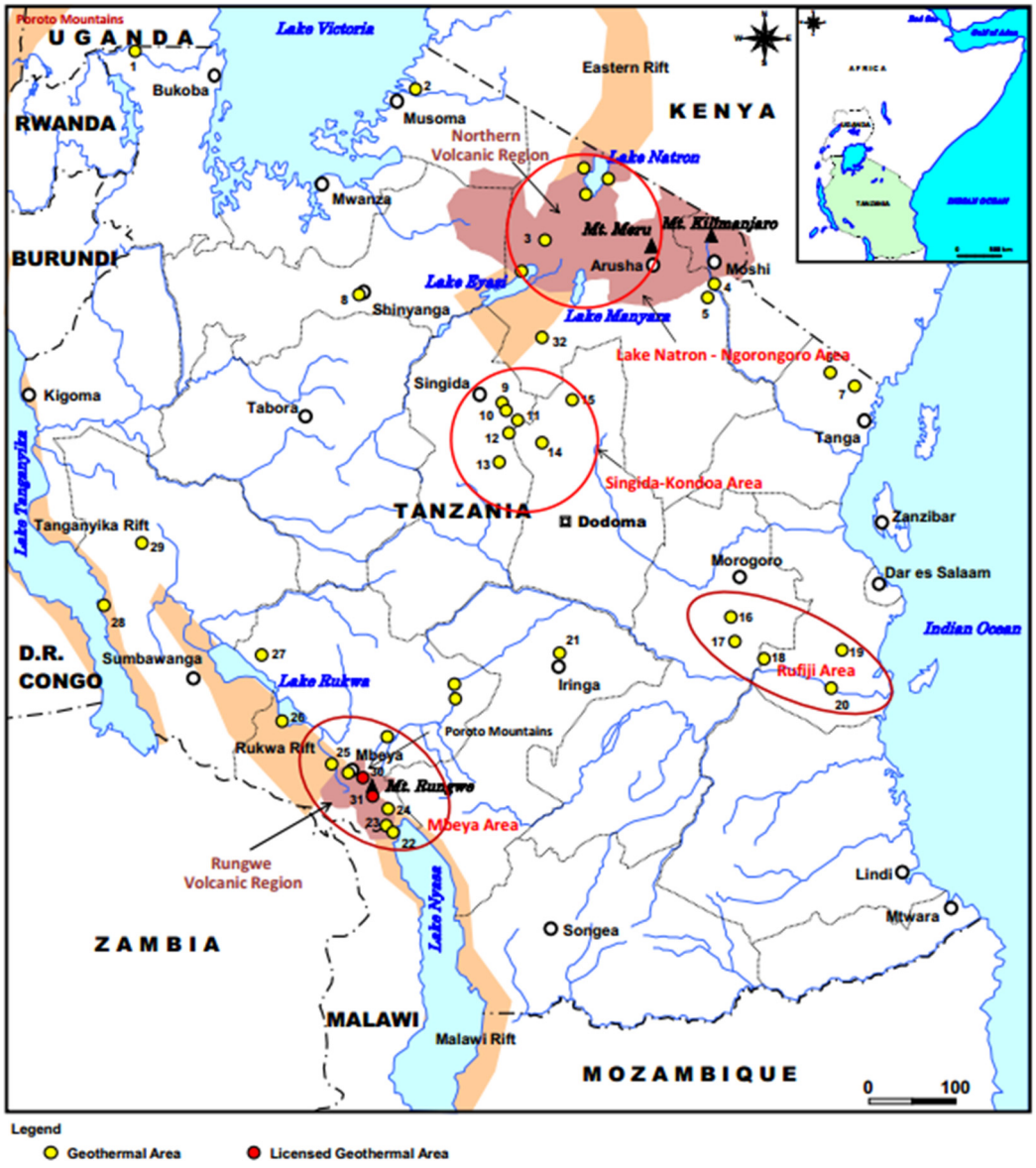

FIGURE 2: Geothermal areas in Tanzania (modified from Mnjokava, 2012)

The geothermal areas are mainly located in four parts of the country which are the Northern Volcanic regions such as Kilimanjaro and Ngorongoro near the border with Kenya, in Singida and Kondoa in the central part of the country, in Rufiji in the East Coastal belt, and in the Rungwe volcanic region and Mbeya in the Southwest part. Detailed surface exploration studies have only been carried out in the Southwest part and mostly in the Ngozi geothermal area in Mbeya as it is believed to be the most promising area.

A Swedish consulting group (SWECO) and Virkir Orkint Consulting Group of Iceland conducted geothermal surface exploration in the country from 1976 to 1978. They did temperature measurements in 50 hot springs. The result was that high-temperature areas were identified around Lake Manyara, Lake Natron, Ngorongoro crater and Mbeya. These areas are considered to be promising for further research (SWECO, 1978).

A prefeasibility study focusing on geological mapping, structural geology, rock/fluid sampling and geochemical characterization of thermal and non-thermal fluids, hydrogeological studies and preliminary geophysical surveys were conducted (Kraml et al., 2008). The results of these studies indicated the presence of active faults allowing fluid circulation, abundant meteoric recharge and a young volcanic heat source capable of driving sustained hydrothermal circulation. Chemical and isotopic analyses of surface thermal manifestations pointed to the existence of a high temperature geothermal resource in the Songwe-Ngozi area, Mbeya region. Preliminary geophysical studies pointed to the existence of a geothermal reservoir.

Detailed geophysics (MT and TEM) and additional bathymetric and hydro geochemical studies at Lake Ngozi were carried out. Bathymetric and hydro geochemical studies indicated occurrence of vent/fault structures in the caldera floor, associated with high bottom temperatures and sub lacustrine hydrothermal activity in Lake Ngozi (Kraml et al., 2012). Volcanological and isotopic investigations provide first evidences that a shallow crustal level trachytic magma chamber, associated to caldera structures at Ngozi volcano, is capable of providing a long-lived heat source for hydrothermal circulation in the Ngozi-Songwe area (Kraml et al., 2008). Tectonic investigations have shown that the fluid flow is fault-controlled (fracture permeability). Most thermal springs are aligned along the major NW-SE Rukwa-Malawi Rift trend (long-living, often reactivated, continuous faults). Thermal waters have dominant Na-HCO_3 to Na-(Ca-Mg)-HCO_3 composition, due to high dissolved CO_2 contents, which favours silicate weathering and cation exchange reactions. Additional, progressive fluid/rock interaction causes increase in salinity and Na enrichment in hot spring waters by Ca removal through precipitation of secondary minerals. CO_2-rich fluids derive predominantly from a deep-seated mantle/magmatic source, although local crustal and biogenic contribution may be high.

3. ENVIRONMENTAL LAWS AND REGULATIONS IN TANZANIA

3.1 General

Tanzania responded to international/global environmental processes by enactment of the National Environment Management Act 1983, creating an environmental council (known as National Environment Management Council – NEMC) which became operational in 1986, the formulation and approval of the National Environmental Policy 1997 and the recent Environmental Management Act (EMA) of 2004. Additional, Tanzania has ratified several Multilateral Environmental Agreements. NEMC oversees the environmental management matters in the country. It has the responsibility in the EIA process to make decisions on screening, scoping and Environmental Impact Statements (EIS) and to advice the Minister of the Environment on whether a project should proceed or not.

3.2 Environmental policy

The National Environmental Policy (NEP) was adopted in 1997, at the same time as the country was just beginning to implement its economic transformation programs. The policy includes a framework for environmental planning and management and cross sectoral and sectoral guidelines for environmental governance and management. Table 1 lists sectoral policies that are relevant to geothermal exploration activities in the country.

TABLE 1: Sectoral policies

- National Land Policy, 1995
- Agriculture Policy, 1997
- National Forestry Policy, 1998
- Health Policy, 1998
- National Tourism Policy, 1999
- National Human Settlement Development Policy, 2002
- National Water Policy, 2002
- National Energy Policy, 2003
- National Transport Policy, 2003
- Wildlife Policy of Tanzania, 2007
- Mineral Policy of Tanzania, 2009

3.3 Environmental law

The Environmental Management Act no. 20 was adopted in 2004, at the same time as the process of privatisation of economic development was advanced. The Act includes an implementation framework for the national policy and the legal and institutional framework for sustainable environmental management. Table 2 lists a number of sectoral acts that are relevant to geothermal exploration activities in the country. The key players in environmental management are the National Advisory Committee, Director of Environment, The National Environment Management Council, Regional Secretariat and local government authorities.

TABLE 2: Sectoral acts

- The National Parks Ordinance Act No. 12, 1959
- Petroleum (Exploration and Production) Act No. 27, 1980
- Land Act No. 4, 1999
- Village Land Act No. 5, 1999
- EWURA Act No. 11, 2001
- Forest Act no. 14,2002
- Industrial and Chemical Management Act No. 3, 2003
- Fisheries Act No.22, 2003
- Occupational Health and Safety Act No.5, 2003
- Rural Energy Act No.8, 2005
- Land Use Planning Act No.6, 2007
- Electricity Act No.10, 2008
- Tourism Act No.29, 2008
- Water Resources Management Act No.11, 2009
- Water Supply and Sanitation Act No.12, 2009
- The Wildlife Conservation Act No.5, 2009
- Mining Act No.14, 2010
- Petroleum Act No.8, 2015

3.4 EIA and audit regulations

The EIA and Audit regulations were adopted in 2005 (G.N. No. 349 of 2005). They provide guidelines on how to conduct EIA and environmental audits as provided for EMA. Environmental Impact Assessment and audit regulations emphasize the importance of conducting an EIA before any development project is implemented. The regulation also gives an outline of the nature of development

projects that need an EIA study. The regulations include a public hearing. In addition, the regulations require that an EIA must be conducted by a registered environmental expert, as referred to in part IV section 14 of the regulations and the registration of environmental expert has to be conducted as stipulated in part V of the regulations (G.N. No. 348 of 2005) (United Republic of Tanzania, 2005).

3.5 International conventions

When developing a project, it is important to take into account several international agreements. In most countries, laws on EIA exist and are founded partly on Multilateral Environmental Agreements (MEAs), such as The Espoo (EIA) Convention, 1997, and the Rio Declaration, 1992. It is well known that projects have to comply with requirements from international banks if the project is to be funded by them. The investment banks, like the World Bank (WB), African Development Bank (AfDB), European Investment Bank (EIB) and Japanese Bank for International Cooperation (JBIC), have environmental safeguards to ensure that projects financed by them are not only based on the precautionary principle and preventative actions but also mitigations and sustainable development. A good example is the World Bank Operation Policy 4.01 on Environmental Assessment and the World Bank Operation Policy 4.12 on involuntary resettlement/relocation and compensation.

3.6 Conclusions on environmental laws and regulations

The key act, regulation and policy for geothermal development that need to be fulfilled are the EMA 2004, NEP 1997 and EIA and audit regulations, 2005. It is important for a developer who plans to develop geothermal resources, to study sectoral acts and policies from the very beginning to secure that the project is in accordance with these. The most important sectoral acts and policies in Table 1 and 2 that the developer must fulfil are Land Act, Industrial and Chemical Management Act, Occupational Health and Safety Act, Land Use Planning Act, Electricity Act, Water Resources Management Act, Water Supply and Sanitation Act, National Land Policy, Health Policy, National Water Policy, National Energy Policy and National Transport Policy. However, the laws and policies to be considered for geothermal development are largely dependent on where the project is located. Considering the policy and laws on environment in the country, there is a need to inform the public on all the environmental consequences of a project as it is important for the people to be aware of the economic value of the goods and services they obtain from the environment and the project could have positive and negative impacts on those. There is also a need to review, in close corporation with the government, environmental experts and development partners, the current policy, the National Environmental Policy of 1997 and update, to take into account the issues of globalisation, transformation economic and climate change.

4. ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PRACTICE IN TANZANIA

4.1 General information

Environmental Impact Assessment (EIA) can simply be defined as a systematic examination to determine whether or not a policy, programme, plan or a project will have any adverse impacts on the environment, nature or society. It is also an important management tool for improving the long-term viability of projects. The role of EIA for sustainable development was highlighted at the United Nations Conference on Environment and Development (UNCED) in 1992, as principle 17 of the Rio Declaration states:

´´EIA, as a national instrument, shall be undertaken for proposed activities that are likely to have significant adverse impact on the environment and are subject to a decision of a competent national authority´´

Tanzania is a signatory of the Rio Declaration. In 1996, African environment ministers, including Tanzania, reaffirmed this commitment and pledged to formalise the use of EIA within legislative frameworks at the project, program and policy levels. Now the Environmental Management Act Cap 191 from 2004 and the Environmental Impact Assessment and Audit Regulations from 2005 emphasize the importance of conducting an EIA before any development project is implemented (Mwalyosi et al., 1999).

4.2 EIA process in Tanzania

The EIA process is described in the FOURTH SCHEDULE of the EIA and audit regulations G.N. No. 349, 2005. The timeframe and key responsibilities are shown in Table 3. Currently, all EIA projects are being administered at the National level by NEMC. In Figure 3 is the EIA process in Tanzania better explained and the picture makes it easy for different stakeholders to see where they are involved and what their responsibilities are in the EIA process. In the following text there are the phases I to V of the EIA process explained.

TABLE 3: The EIA process in Tanzania

Activity	Documents	Responsible	Timeframe
Phase I: Project registration Screening decision	Project registration to NEMC (submit 10 copies of project brief)	Developer and EIA Expert NEMC	Unlimited time for Developer for field work and report writing 45 days to do screening
Phase II: Scoping study Scoping decision	Scoping report with ToR (submit 5 copies to NEMC for approval)	Developer and EIA Expert NEMC	Unlimited time for Developer for field work and report writing 30 days for NEMC to review and approve/make a decision
Phase III: EIA study Review (NEMC and TAC)	Draft EIS to NEMC (submit 15 copies)	Developer and EIA Expert NEMC/TAC	Unlimited time for Developer for field work and report writing 30 days for NEMC and TAC to review
Phse IV: Review of Draft EIS (Developer by incorporating the comments)	Final EIS to NEMC (submit 5 copies)	Developer, EIA Expert	Unlimited time for Developer to prepare final EIS
Phase V: Review and issuance of EIA certificate	Approval process and EIA certificate	NEMC and Minister of Environment	30 days for Minister of Environment to review final EIS

Phase I

Project registration

In the first step of the EIA process a developer or proponent registers a project at the National Environment Management Council (NEMC) by submitting a project brief, a filled application form together with the pre described fee (as described in Part III Sections 5–11 of the EIA regulations). The project brief has to include information about the nature, location, activities and design of the project, the materials to be used, products and by-products, generated wastes and the methods of their disposal. It has also to include a description of the potential environmental impacts and possible mitigation measures, plan for health and safety of the workers, the economic and soci-cultural impacts to the local community and the nation in general.

Screening

NEMC does the screening, built on the project brief and the application information, to determine whether an EIA should be undertaken. NEMC submits a copy of the project brief to the relevant

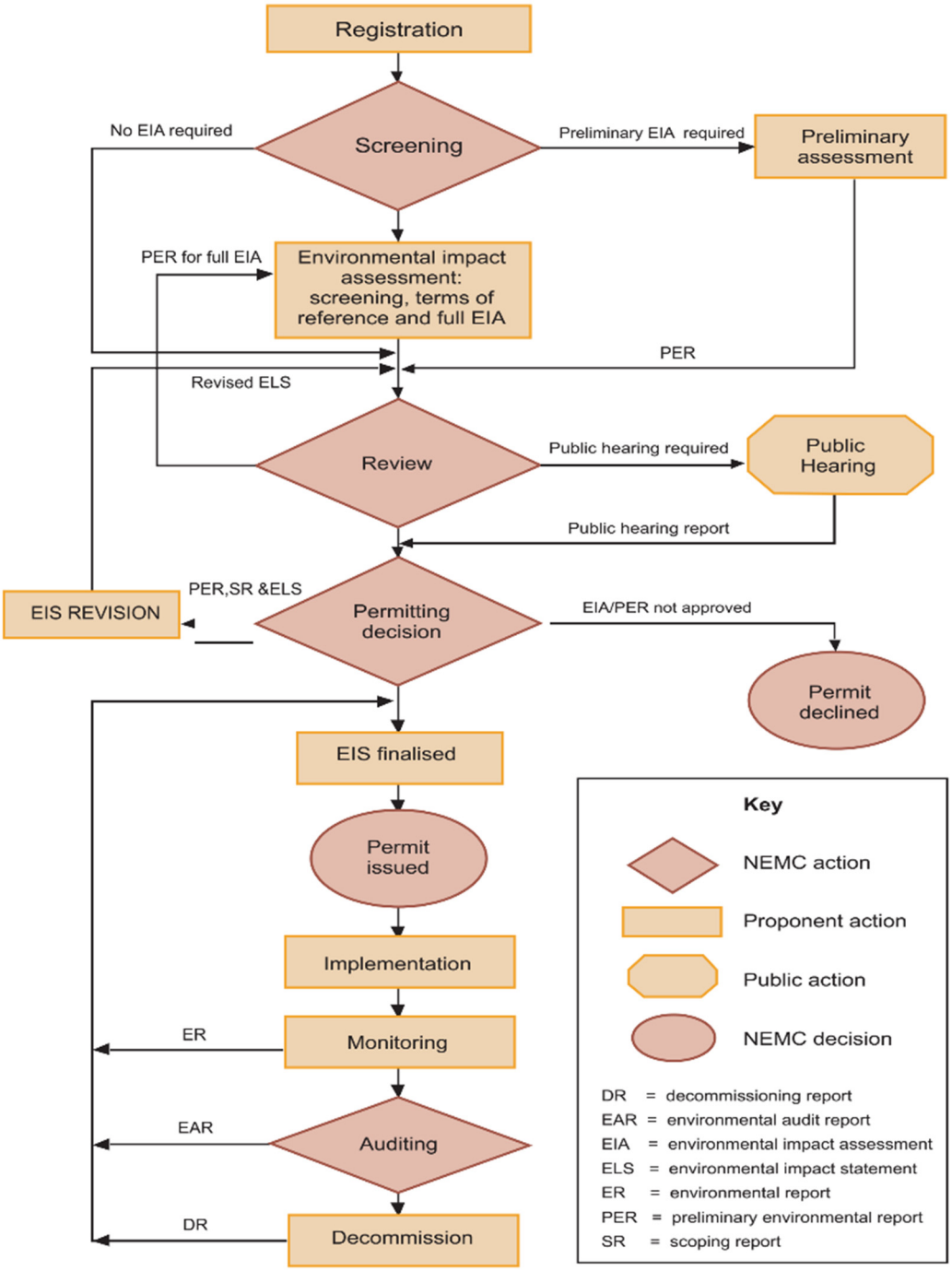

FIGURE 3: EIA administration (MEM, 2014b)

ministries or public agencies and the relevant local environmental management officer. Where more than one district is involved a copy is sent to the relevant regional secretariat, for their comments. They have 21 days to deliver their comments. The screening decision must be taken by NEMC within 45 days from the date of submission of the project brief. When NEMC finds that the project has or may have significant impacts on the environment, the proponent has to undertake EIA or undertake a preliminary assessment when more information is required to determine a screening decision. When NEMC finds that the project will not have significant negative impacts on the environment, it does not require an EIA and may be recommended to the Minister of environment for approval of the project.

Phase II

Scoping and terms of reference

When NEMC decides that an EIA is necessary the developer carries out a scoping study. The scoping process involves the preparation of the scoping document which is submitted to the same parties as in a screening process. The document is built on the existing information and involves e.g. a description of the project and the environment where the project is planned. It includes an identification of environmental factors that the project may have potential positive and/or negative impacts on and expected boundaries of the project (special, temporal and institutional). It further contains a description of which areas might be affected by different parts of the project and a map or description of the area that needs to be studied to gain baseline information for the valuation of possible impacts on the environment. It also describes the projects' alternatives that will be assessed and compared in the EIS, list of stakeholders to be consulted, public participation and last but not least is a Terms of Reference (ToR). The ToR must be very precise because it is a description of what information will be gathered, which studies/research is needed and how the information and results will be come forward in the EIS (text, tables, pictures, maps etc.). The ToR is a checklist for NEMC to compare the EIS and to what the EIS must comply. In the EIA process and preparation of the EIS the developer must follow the scoping document or otherwise explain why he is not doing so.

Phase III

Impact assessment

The EIA process involves impact identification, prediction, evaluation and mitigations of relevant effects of a development proposal before major decisions are taken or a project is permitted. In the process a variety of appropriate techniques and approaches are used. The assessment must be in accordance with the ToR and has to take into account the concerns and views of the key stakeholders (those who are or are likely to be affected by the project) as well as from relevant governmental agencies and the public. The main part of the assessment is the gathering of necessary information on the environment, evaluating the impacts and writing the EIS. The process also includes the assessment of relevant alternatives and leads to recommendation of the most appropriate options. An important part of the process could also include actions to minimise negative impacts of the project by changing the original project or reducing the impacts. If the project does still have negative impacts after these actions mitigation measures must be introduced. A project can also contribute to social development and environmental conservation. Preparation of a monitoring plan and environmental and social management plan can also be a part of the EIA process with details about institutional responsibilities, monitoring framework, parameters to be monitored, indicators for monitoring and costs of monitoring where appropriate. The time taken to carry out an EIA depends on the type of a project, its complexity, availability of environmental information and the research that needs to be carried out.

Preparation of an environmental impact statement

An EIS is a detailed report prepared by a developer and submitted to the NEMC. Part V of the EIA and the audit regulation of 2005 inform about the content of an EIS. It must include all important components relating to the project in accordance with the scoping decision i.e. approval of a ToR. In the EIS there has to be a non-technical summary both in Swahili and English, stating the key findings, conclusions and recommendations of the assessment.

Phase IV

Review process of environmental impact statement

The review of an EIS is done by the NEMC in collaboration with the Cross Sectoral Technical Advisory Committee adhering to the review criteria (Part VI of the EIA and audit regulations, 2005). The NEMC has 30 days to finish the review. It may call for a public hearing and public review of the EIS. The NEMC submits to the minister of environment a review report with its recommendations and all documents used in the review process for approval or disapproval.

Phase V

Permit issued

The minister has to make a decision on an EIS within 30 days of receiving the recommendations from NEMC. The decision, including a justification, must be given out in written form. The Minister can either approve or not approve the EIS, an approval can be attached to specified conditions which the developer has to meet.

Environmental monitoring and auditing

Environmental monitoring is done by NEMC to evaluate the performance of the mitigation measures addressed in the Environmental and Social Management Plan as well as in the Monitoring Plan. The developer conducts an internal monitoring of an ongoing project to ensure that the project is in accordance with the Ministers' decision, licences and that the mitigation measures are effective. The NEMC conducts three types of auditing, an implementation/enforcement audit, a performance/regulatory audit and an impact prediction audit.

Decommissioning

Decommissioning at the end of a projects' life, involves rehabilitation of the land and ecological restoration, tearing of the project infrastructure, and dismantling of equipment and machinery. The developer prepares a decommissioning plan either as a part of the EIS or separately and submits it to the NEMC for approval. According to the Environmental Management Act, 2004, decommission will be done by the developer at his own cost (United Republic of Tanzania, 2004).

5. NGOZI GEOTHERMAL FIELD

5.1 General description of the area

Ngozi geothermal area is located in Rungwe and Mbeya rural districts in Mbeya region, in the southwest of Tanzania. The area is accessible by aeroplanes, TAZARA railway or roads from Dar es Salaam to Zambia. The distance from Dar es Salaam to Mbeya is 817 km and it takes 12 hours to travel by bus and 1.30 hours by air. However, the accessibility is difficult from Mbeya towards Ngozi and Rungwe volcanoes due to rugged and steep terrain. The existing roads are tarmacked within Mbeya town and untarmacked towards Ngozi geothermal area, thus there will be a need to rebuild the existing roads and construct new ones. The area is at the borders of the Poroto Ridge Forest Reserve and Itunza Forest Reserve. All forests belong to Tanzania Forest Services Agency of the Ministry of Natural Resources and Tourism. These forests are core attraction for tourists, who frequently come to see the amazing landscape, scenery and vegetation. Hiking to the top of the mountains is popular among tourists to have a good view of the Great Rift Valley. Monkey and bird species are also found in the forest.

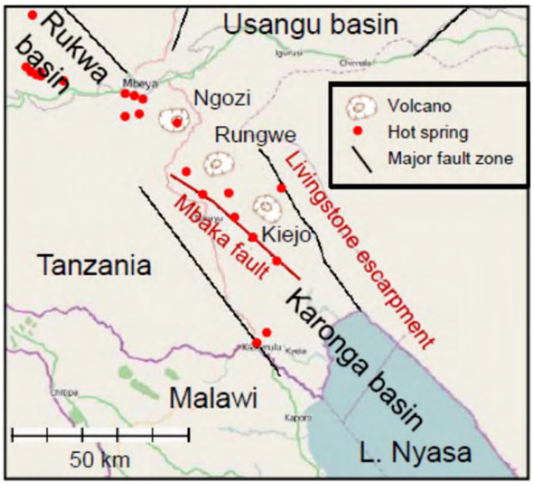

FIGURE 4: Rungwe volcanic complex with the Ngozi, Rungwe and Kiejo volcanos (Kraml et al., 2012)

5.2 Geoscientific exploration

The field is located within a rift-rift-rift triple junction (Rukwa Basin, Karonga Basin and Usangu Basin) (Fontijn et al., 2012) (Figure 3). In the area are also the quaternary volcanoes, Mbeya, Rungwe, Kiejo and Ngozi. There are many volcanic cones around volcanic mountains forming a structural line which is NW-SE oriented as shown in Figure 4. K-Ar dating of younger volcanic rocks and U-Th dating of the Songwe travertine

show that Ngozi geothermal system started to be active around 360 ka ago (Delvaux et al 2010). The magmatic activity in Mbeya area started in Miocene times. The last eruption in the Rungwe area occurred in Kiejo about 200 years ago (Harkin, 1960). Most of the thermal springs in the area are aligned along the major NW-SE rift trend. The results from the electromagnetic surveys (TEM, MT) show zones of low resistivity in the Ngozi area, which can possibly be correlated to alteration zones formed by geothermal activity (GEOTHERM, 2006).

5.3 Description of the environment

This section describes the existing environment in the area and draws a picture of what environmental factors might potentially be impacted by the exploration drilling. It gives a general overview of the study area, including the community, the climate, soil condition and land use, flora and fauna, the available water sources and the existing infrastructure (mainly the road conditions). However, detailed baseline studies should be carried out in the area to provide information for possible future changes and to minimise negative impacts.

The community
The project area is located in two districts, Rungwe and Mbeya rural in Mbeya Region. The two districts have a population of about 650,000 people and the number of each gender is equal. The population density is 39 persons per km^2. The region is considered to be moderately densely populated compared to the rest of Tanzania (United Republic of Tanzania, 2013). The main indigenous ethnic groups are the Nyakyusa, Ndali and Safwa. Most of the ethnic groups are predominantly agro-pastoralists and their main economic activities are agriculture and livestock keeping. The crops cultivated are maize, wheat, pyrethrum, coffee, beans, bananas and Irish potatoes. These are both food and cash crops. Small scale farming occupies the largest portion of the area but there are a few large plantations of tea and coffee (Figure 5).

FIGURE 5: A) Tea plantation in Rungwe area. B) Irish potatoes farming (field study, March 2015)

Climate
The climate of the Mbeya region is generally tropical with marked seasonal and altitudinal temperature variations and a sharply defined dry season (dry cooler conditions and a fairly constant southerly wind from June to October) and rainy season (wetter and warmer conditions from November to May). The temperatures in the region vary according to altitude but generally range from about 16°C in the highlands to 30°C in the lowlands. The rain distribution is strongly influenced by topography and is highest in high mountain ranges like the Poroto Mountains. Around Rungwe the rain is about 2500 mm/year which is more than twice the annual rain amount in the Mbeya-Songwe area (1000 mm/yr) (Branchu et al., 2005).

Soil condition and land use
The area has thick volcanic soils suitable for intensive agricultural production as well as for grazing livestock, mainly cattle, sheep and goats. In the higher areas/in the mountains there is also deep fertile soil and which is intensively used for agricultural purposes.

Flora
The most dominant vegetation types are evergreen and semi evergreen species. These include indigenous trees, planted trees, grassland, bushland, miombo woodlands, bushed grassland, bush-shru bland, shrub-grassland and rock outcrops (Figure 6). Topography, soil type, drainage and rock structure seem to have a big influence on the geographic distribution of these vegetation types. The largest open grassland consists of *Eucalyptus spp "mikaratusi", Cynodon spp* and *Digitaris spp* and is found in the relatively flat areas of the Rungwe volcanic mountain.

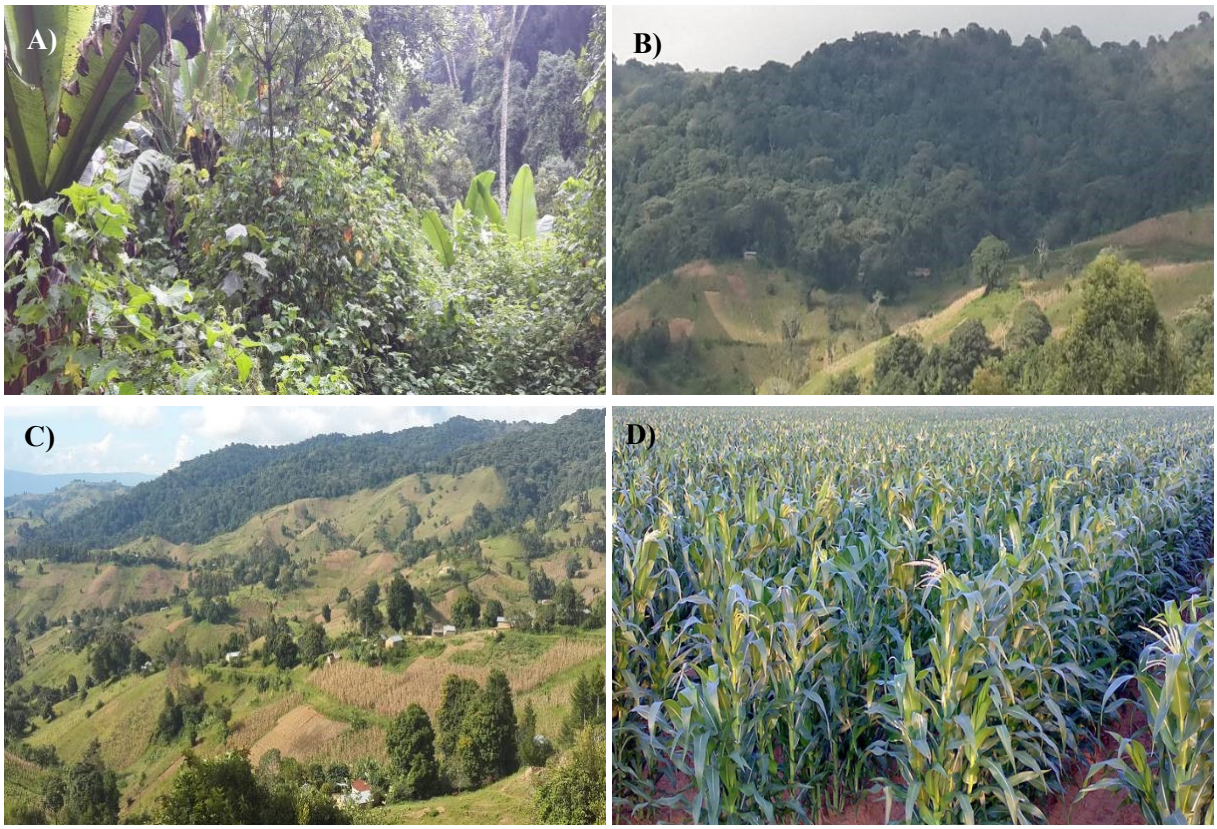

FIGURE 6: A) and B) vegetation type within Poroto forest reserve. C) Miombo woodlands with scattered settlement in the proposed project area. D) Maize plantation around the project area (field study, March 2015)

Fauna
The fauna consists of domestic animals and few wild animal species. They include different bird species, baboons and monkeys such as small black monkeys, different species of small and large snakes and wild animals like mongoose are common. Most of the domestic animals are zero grazing (indoor grazing), especially cows and chickens, however goats are mostly found grazing in the open grassland.

Water sources
The water sources in the area are mainly seasonal rivers which are the Mwanyilu, Sawazia, Mwatisi, Mawe and Mwambalizi rivers that discharge water to Lake Ngozi. There are permanent rivers close to the proposed drilling sites, namely river Halanzi, Mwanzalala, Mpwata, but also drilled well and springs that flow throughout the year can be found. However, the Mbeya urban water and seweage authority (MBEYA UWSA) provides water services in many villages around the project area. The drainage pattern is formed mainly by the topography of the area. The drainage pattern is directed northwestward

towards Lake Rukwa, northeastward towards Usangu flat and southwards towards Lake Malawi (Gibert et al. 2002).

5.4 Description of the proposed project

Geoscientific studies where carried out to select the locations of the four exploration wells. The four wells are located in farmlands and at the border of the Poroto and Itunza forest reserves (Figure 7). The project involves drilling of 4 exploration wells by the end of 2017, and the goal is to prove/confirm the existence of a geothermal resource that can be utilized for production of electricity. The wells will be 1500-2000 m deep but before the drilling can start several activities need to be completed. The Ngozi geothermal field is in a remote area and therefore significant site preparation is required. Construction of new roads and reinforcement of current roads for carrying heavy equipment to the drilling sites is crucial. The new roads are estimated to be 2.5 km long and 6 m wide and the existing roads will be similar after the reconstruction. A typical well pad is required with an area of roughly 100 m × 50 m including buffer space around the equipment and structures. There is a need for 100,000 m^3 of water for the drilling of one well and therefore construction of pump stations and pipes is necessary. A total of 50 people are working on a drill rig. A campus with temporarily houses for workers will be installed with drinking water supply and sewage. The drilling one well takes about 60 days and it is estimated that 8 months will be need for drilling four wells. Testing of wells after drilling can be estimated to take three months. If an exploration well indicated that the geothermal resource is suitable for processing steam

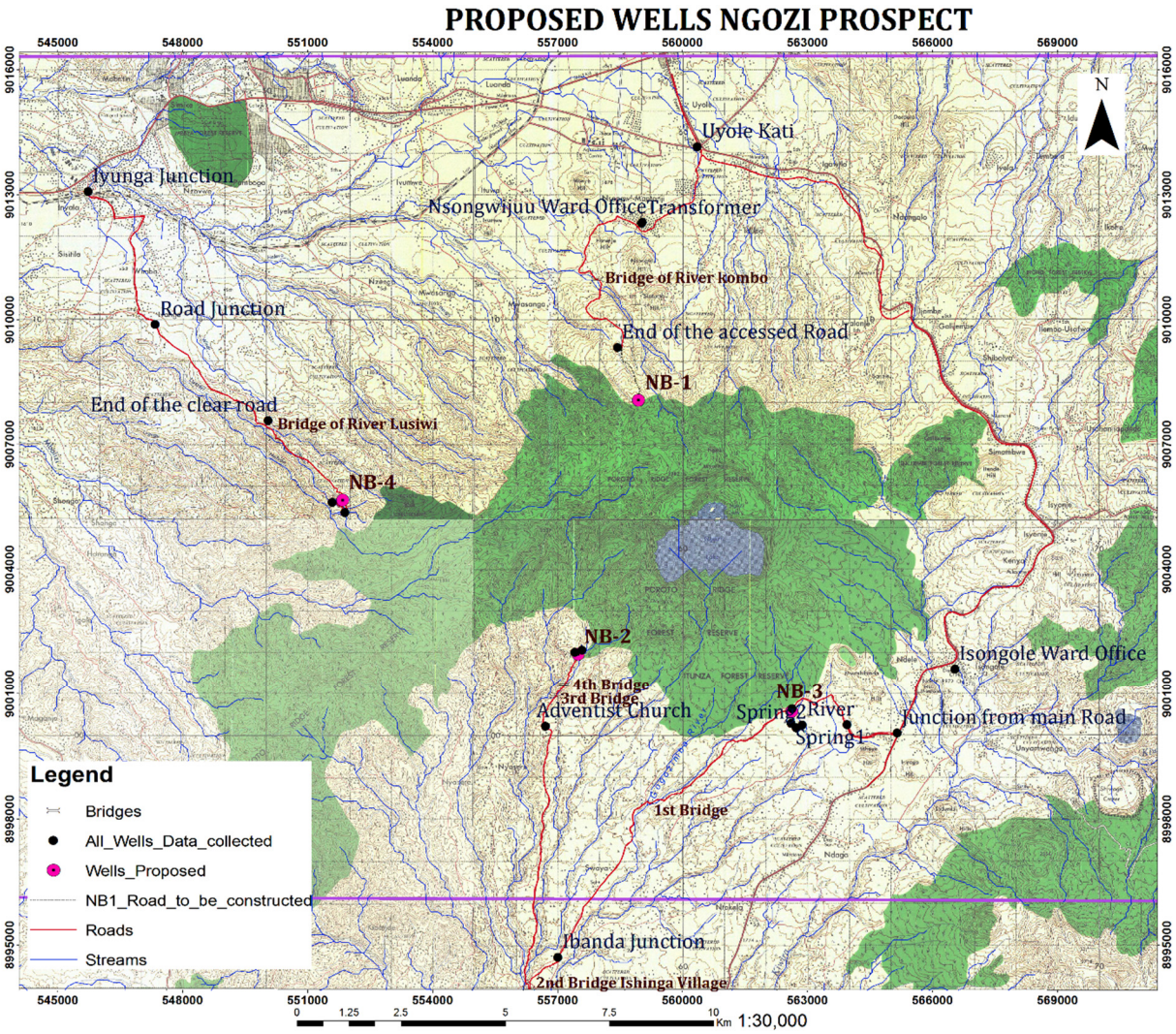

FIGURE 7: Location of the proposed drill wells (TGDC, 2016)

and generation of electricity then it is most likely that more wells will be drilled and a power plant will be built. The construction area might therefore expand depending on the size of the power plant and the need for power lines to the nearest substation.

6. PRELIMINARY ENVIRONMENTAL ASSESSMENT AND MITIGATIONS

Three environmental factors, land use, society and economics and noise, have been chosen to be dealt with in this preliminary EIA. These factors are considered to be among the key factors likely to be affected by the project and accompanying activities. When preparing the EIA of a project the scoping report is the leading document that determines the extent and approach of the EIA study. The scoping report has to be done according to part III of the EIA and Audit Regulation G.M. No. 349 from 2005.

A short review of the scoping report for the Ngozi Geothermal Prospect, May 2015, raises questions on both the structure of the report and the content. The review of that report might indicate that a review of the EIA and Audit Regulation/2005 should be made. The first remark is a lack of more detailed maps of the area in the scoping report. Detailed maps must be part of the background information as they are necessary to draw conclusions on the potential impact of the project and choose the research area for the study of different environmental factors providing necessary information in the assessment process.

The EIA and Audit Regulation of 2005, require that the scoping report includes details of potential negative and positive impacts of the project. It is necessary to explain how the developer must carry out the assessment of the environmental impact of the environmental factors; that is, whether and what available data, research, and sources he will use in the assessment process and how he could carry out data compilation and research for the purpose of the EIA. It is also necessary to describe where, when, and how the developer intends to conduct surveys or carry out measurements, how he intends to process the data, what methods will be used to assess environmental impacts, and how he intends to present the results in the EIS.

6.1 Land use

Four sites have been chosen for the drilling of wells. The drilling sites are located in cultivated land, and the sites will require the acquisition of the land from the owners. The land is needed for construction of the drilling pad, which usually requires 100 m × 50 m and 30 m × 50 m × 2 m for construction ponds at the drill site. This area can become much bigger if the exploration drilling is successful and a power plant is constructed that may require several km^2 depending on the geothermal resource and the amount of electricity produced. Most of the existing roads found in the field are gravel roads that need maintenance/rebuilt to allow transport of heavy equipment to the drilling site. Sites NB-1 and NB-2 need most likely road improvement. In NB-1 the existing road is passing through populated area, with houses close to the road and widening of the road to 6 m might have impact on the people living close by. At this moment there is no information available on exactly how many people will be affected or if houses need to be moved, but such information is necessary. On the road to site NB-2 are four small bridges (Figure 8), new bridges are necessary for the transport of heavy equipment and the road needs to be rebuilt.

The roads to sites NB-3 and NB-4 need to be rebuilt, but the roads are lying through cultivated land and not very close to houses. In all cases, there is a need for a detailed survey to be included in the official EIA where markings for new roads have been set out in the land and also for the area needed for rebuilding existing roads. In this survey, the existing land use, existing infrastructure and number of houses and people affected by the project are noted. Therefore, it has to be a priority to collect various data and make maps in different scales. It is also important to see how the drilling project, with all related constructions, fits into the master plan of the area, by communication with the local authorities.

FIGURE 8: Existing bridges toward drill site NB-2 (Field Study, June 2016)

If a power plant will be built in those sites these roads will be rebuilt for additional heavy machinery traffic. The land area needed for such a power plant will also increase a lot from what is needed for an exploration well.

Land acquisition is delicate and should therefore be carefully planned at an early stage of the EIA process to fulfil national and international regulations. Negotiation on land acquisition and compensation are the best options in land acquisition. The Tanzania Land Act, 1999, confirms the National Land Policy directive which specifies that all land is public land, vested by the President as trustee on behalf of all citizens. The Act lays down fundamental principles for occupying and using the land. Among them is the principle that any land user shall ensure that land is used productively and that any use complies with the principles of sustainable development.

The project area is in agricultural land with scattered settlements. The main impact will be loss of farmland for the local community and it may cause involuntary resettlement. It is therefore important to consider in the beginning of the EIA process the process of land acquisition which must be in accordance with Section 10 (1) of the Land (Compensation Claims) Regulation, 2001. The Regulation Assessment of Value for Compensation states "...the basis for assessment of the value of any land shall be the market value of such land". The institutional actor for population resettlement and compensation in the country is the Ministry of Lands, Housing and Human Settlements Development. However, before the compensation is paid, compensation schedules need to get approval from the Ward Executive Officer,

Land Officer, District Commissioner and Regional Commissioner of the respective ward, district and region.

The World Bank policy on involuntary resettlement (OP 4.12) applies to all land acquisition, impact on assets, negative impact on livelihood and/or any changes in access to resources due to a subproject, irrespective of whether or not affected persons must move to another location.

The project will have permanent direct impacts on the land mainly by building access roads and drilling pads. This can impact agricultural activities due to loss of available land for crops and livestock grazing in the area. Traffic on roads can also have impacts on livestock grazing because of noise, dust and possible collision.

In the official EIA process, all the main existing infrastructure and land use must be shown on maps and the proposed project, roads, drill pads etc., to assess how they fit in the environment to make it possible to evaluate the impacts they have. Improved access roads can also have positive impacts as they will reduce the transport cost for the local community making it easier to transport and sell their agricultural products and by that raising their living standard. This must be thoroughly described and assessed in the coming EIA process. The project proponent ‘s main goal and best result from the EIA process must be to locate all necessary constructions, roads, drilling pads, workers’ facilities etc. so that they minimize the impacts on existing land use (i.e. households, agricultural, grazing land, nature reserves, surface manifestations etc.). There exist surface manifestations in the area that form recreational spots for locals and tourists. Local people used to believe bathing in hot spring water could cure skin disorders. If the result of the EIA is that the project will have unavoidable negative impacts compensation measures must be used and they must be introduced in the EIA study.

6.2 Social and economic impact

Developing a new geothermal project in an area may cause changes in the daily life and habits and even future settlement of the local people. Despite the benefits of the project to the community, it may still become difficult to get social acceptance in the short run. The area where the proposed drilling of exploration wells will take place is agricultural land with different type of food and cash crops, maize, Irish potatoes, coffee, rice etc. The ethnic groups found in the area are Safwa and Nyakyusa. Livestock keeping is also part of the activity in the area, the main animals kept are cattle, goats and sheep, mostly grazed in open grassland. The roads to the drill sites need improvement, which will have direct impact on the people living close to them, specially the roads to NB-1 and NB-4 as they located through quite densely populated areas. The best option would be to divert the road, but a detail analysis is required to come up with the best option for this. In the official EIA process we need to gather various kinds of data which form the base to build the evaluation of possible impacts on the society.

The impacts can then be divided into short- and long term, positive and negative impacts and have to be dealt with in the text. Creation of jobs during drilling, e.g. the opportunity for catering services for the workers around the drill rig can be grouped as positive impact of the project. Short term negative impacts could be fencing off grazing and agriculture areas for security which will be reopened after the drilling. A drilling project of several months may result in a small temporary increase in the local population. Long term positive impacts could be new market opportunities for the local populations as boarding needs to be provided for the workers. Improvement of roads could improve local living conditions as it can help farmers to transport and sell their agricultural products, and even national, depending on how many people are involved. Roads improvement can also increase tourism, as it could attract more tourists to the area, who come and hike in the mountains. An example of long term negative impacts could be displacement of people, land acquisition and resettlement of evacuated people. A good example of social impacts from a drilling activity can be found in Kenya, East African, where about 50 people were hired to work in connection with one drill rig. It is expected that all casual staff would work for at least six months for the completion of 3 exploration wells. It is anticipated that monitoring wells and

production wells would be drilled later, depending on exploration results and the availability of funds. The drilling activity would not require additional houses because the drill crew would have a camp site. The best way to motivate the local people is to encourage maximum recruitment of labour from the nearby community wherever necessary and reducing the number of employees moving into the project area especially casual workers. Also, the local society could benefit from the project, at least short term, by providing food to the staff, both those that come in the beginning preparing roads, well pads, water pipes, sewages construction and the people on the drill rig. The agriculture products in the area that locals provide today, e.g. Irish potatoes, maize and the grazing animals they keep could increase because of the demand from people working in the project. This could lead to a positive long term impact, more agriculture and transport to other areas by the new road.

6.3 Noise

The project is in a rural area and the background noise level can be considered very low in general. Therefore, the drilling activities will have a significant impact to the residents and livestock, as they are the potential receptors. The Tanzania Bureau of Standards (TBS) set the noise level limits for residential area to 50 dB(A) at day time and 35 dB(A) at night time, for industrial areas it is 70 dB(A) at day time and 60 dB(A) at night time (Table 4) (TZS932: 2007) (Tanzania Bureau of Standards, 2007).

TABLE 4: Maximum permissible levels for general environment

Facility	**Noise limits dba (Leq)**	
	Day (6:00 AM - 10:00 PM)	**Night (10:00 PM - 6:00 AM)**
Any building used as hospital, convalescent home, home for the elderly, sanatorium, and learning institutions, conference rooms, public library, and environmental and recreational site	45	35
Residential building	50	35
Mixed residential (with some commercial and entertainment)	55	45
Residential and Industry/small scale production and commerce	60	50
Industrial area	70	60

Noise levels will be raised during site preparation, drilling and testing (blowing) of wells. Noise distribution is dependent on the vegetation cover, topography and landscape. Therefore, the selection of drilling sites can have considerable impact on the noise level in the area. Noise from drilling is generally in the range of 70-100 dB(A) in 10 m distance from the source depending on the equipment used. In this case, all drilling equipment will fulfil strictest standards regarding noise levels. Highest noise levels can be expected to be 92 dB(A) at a 2 m distance. At 80 m distance, it has dropped to below 70 dB(A) and at 550 m distance the sound level is below 45 dB(A).

Noise from discharging wells or testing wells ranges from 70 to100 dB(A). At a range of 1,000-1,400 m the sound level has fallen below the 45 dB(A) level.

The rise in noise level is temporary and limited to the drilling and testing period that can last for approximately 6 months at individual wells.. As mentioned above, this is quite depending on terrain and surface. The sources of noise in geothermal development activity are well drilling, testing, construction and plant operations. In drilling, the drilling fluid is either air or mud with air drilling rigs being much louder (120 dBA) than mud drilling (up to 80 dBA) (Table 5). It is important to monitor ambient noise levels to determine noise intensity, frequency and duration before and during development.

TABLE 5: Noise from different drilling activities (Hunt, 2001)

Activity	Noise level (dBA)
Air drilling	120 (80 with suitable muffling)
Discharging well after drilling	Up to 120
Well testing	70-110 (if silencer used)
Heavy machinery	Up to 90
Well bleeding	Up to 85 (65 if rock muffler is used)
Mud drilling	Up to 80
Diesel engine to operate compressors and electricity	45-55 (if suitable muffling is used)

The test wells are often bleeding for many months/years and can produce noise of high frequency which may not be harmful but disturbing in the neighbourhood. Wells that are blowing into a silencer produce low frequency sound that can travel long distance and be heard up to 15 km away but damped readjusted significantly in forested/vegetated areas. This noise is normally not harmful but can be disturbing especially for tourists/recreation people who are visiting the area for hiking in the mountain. Effects of noise range from relatively minor such as temporary task interference and irritation to more severe and permanent effects such as sleep loss, physiological stress, speech impairment and loss of hearing. The extent of harm is related directly to the frequency and duration of exposure. Animal behaviour is also affected by excessive noise, which has been shown to cause changes in the size, weight, reproductive activity and behaviour of farm animals.

7. CONCLUSIONS

This preliminary assessment was prepared to give a general picture on future EIA studies in the Ngozi area, that is to be conducted in accordance with national laws and international requirements. The laws and procedures in Tanzania provide the main guidelines that need to be followed in order to fulfil the requirements to obtain the certificate of authorization for geothermal exploration drilling. The study showed that the project will have the most impact on land use, social economics and noise. The drilling sites are in agriculture land. The most important thing is to conduct a baseline study in the area, acquire most recent detailed maps that will help predicting the impacts together with maps made in the EIA process. A more comprehensive EIA must be done for geothermal exploration drilling in the Ngozi area.

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