Proceedings World Geothermal Congress 2010
Bali, Indonesia, 25-29 April 2010

Geothermal Energy, Climate Change and Gender in Kenya

Pacifica F. Achieng Ogola
UNU-GTP, Grensasvegur 9, 108 Reykjavik, Iceland
paoo@unugtp.is, pacieogola@gmail.com

Keywords: Geothermal energy, climate change, gender.

ABSTRACT

Geothermal energy plays a vital role in the context of climate change as a mitigation and adaptation technology. However, the full potential role of geothermal in this regard has not been realized in Kenya, especially in responding to the impacts of climate change at the micro-level where it occurs, meeting gender specific needs and ultimately the UN Millennium Development Goals (MDGs). While geothermal energy is considered the most feasible option for capacity expansion, very little has been done to assess its role in climate change beyond Clean Development Mechanism (CDM) projects. Most unexploited geothermal prospect areas in Kenya experience adverse climate impacts. The development of the resource in these areas could enhance adaptive capacity and resilience of the local people. The paper aims to discuss in general the role geothermal energy should play in mitigation and adaptation to climate change in Kenya and how its utilization can meet different gender economic requirements at the micro-level. Barriers to achieving this with possible recommendations are also discussed.

1. INTRODUCTION

The international response to climate change began with the adoption of the United Nations Framework Convention on Climate Change UNFFCCC in 1992 and the Kyoto Protocol in 1997. The objective of the convention is to stabilize greenhouse gases (GHGs) from anthropogenic sources. To achieve this objective, the Kyoto protocol obligates developed countries to meet their emission reduction targets by at least 5.2% between 2008 and 2012 through three mechanisms; namely: Joint Implementation (JI), Clean Development Mechanism (CDM) and Emission Trading (ET). The CDM is a market based mechanism between Annex I and Non-Annex I countries. Geothermal energy projects are potential CDM projects if implemented as a displacement of thermal plants which are major greenhouse gas emitters. The texts of the Convention also include the need to addresses vulnerability and adaptation related to climate change impacts in developing countries. The need is further emphasized from the earliest IPCC reports to the current IPCC fourth assessment report.

1.1 Current and Future Climate in Africa

Global mean surface temperature is projected to increase between 1.1°C and 6.4°C by 2100; sea levels are projected to rise by 15 to 95 centimetres (6 to 37 inches) by 2100 century. The warming in Africa is likely to be somewhat larger than the global, annual mean warming throughout the continent and in all seasons, with drier subtropical regions (especially arid zones) warming more than the moister tropics (IPCC, 2007). Observational records indicate that annual temperatures in Africa rose approximately 0.5°C over the course of the 20th century.

The GCMs PCM, CISRO-Mk3.0, FGOALS-g1.0 and MRI-DGCM2.3.2 project overall lowest temperature increases while UKMO-HadCM3, IPSL-CM4, MIROC3.2hires and ECHAN5/MPI-OM project strongest temperature increase in Africa. The average rise in temperature between 1980/99 and 2080/99 would be between 3°C and 4°C for the continent as a whole in next 100 years in most scenarios, 1.5 times greater than at the global level (Christoph, 2009). Across all emissions scenarios, temperatures in Africa are expected to increase by between 2°C and 6°C by 2100 (Hulme 2001).

On a global scale, the IPCC projects a 1–2 percent increase in rainfall for every degree of temperature warming (Boko et al., 2007). Arid and semiarid land in Africa is set to increase by between 5% to 8% (between 60-million hectares and 90 million hectares) by the 2080s under a range of climate-change scenarios. Inter annual rainfall variability is large over most of Africa and, for some regions the multi-decadal variability is also substantial. The precipitation bias is less uniform than temperature range, falling between an underestimation of annual precipitation by 86% and over estimation by 139% (IPCC, 2007).

Rainfall is likely to increase in tropical and Eastern Africa by around seven percent, though changes will not be uniform throughout the year, and will likely occur in unpredictable events (Case, 2006). More rain in East Africa could increase the risk of flooding.

Anyah et al. (2006) made predictions of climate change in Kenya between the 2020s and 2100 using an enhanced version of $RegCM_3$ with a higher resolution of 20 km (factoring the topography) than the IPCC GCMs based large grid resolution of 110x110 km^2 According to these results the average annual temperature will rise by between 1°C and 5°C, typically 1°C by the 2020s and 4°C by 2100, the climate is likely to become wetter in both rainy seasons, but particularly during the Short Rains (October to December), bimodal rainfall seasonality will continue, flood events are likely to increase in frequency and severity by 2100, the increase in temperature will lead to an increase in the severity of droughts with increased current frequency, and sea level rise (Figure 1 and 2). By century's end more frequent and intense storms are projected in the southern Indian Ocean; a 2°C – 4°C rise in sea surface temperature could very likely lead to a 10 to 20 per cent increase in cyclone activity on Africa's eastern coast, with implications for populations in both island and coastal communities (Boko et al., 2007). Adwera and Orindi (2008) suggest a 30 cm sea-level rise which is within the Intergovernmental Panel on Climate Change (IPCC) prediction of 18 to 59 cm rise in sea level globally by 2100.

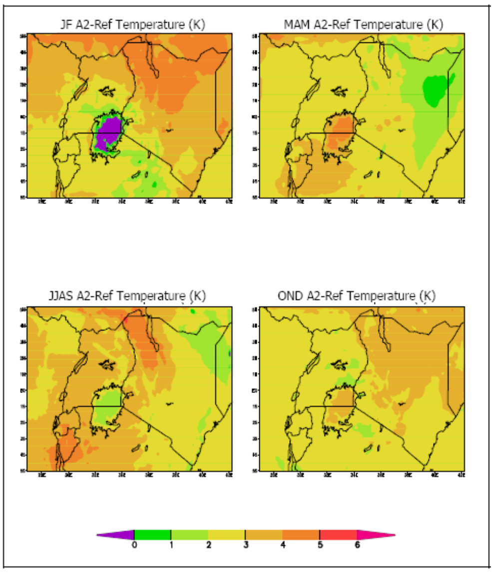

Figure 1:RegCM3 projection results (A2 RF) Temperature (Anyah 2006).

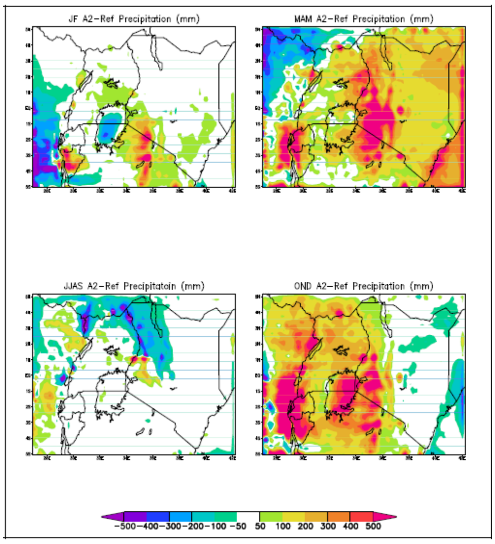

Figure 2: RegCM3 projection results (AR RF) Rainfall (from Anyah 2006).

The UN estimates nine out of every 10 disasters are Climate-related (Holmes, 2008). Climate variability impact hits hardest in poor countries especially sub-Saharan Africa, which have the least access to modern energy technology. Despite the fact that the continent is well endowed with potential renewable energy sources like hydro, geothermal, solar and wind, a large majority of the people living in the rural areas still have no access to electricity and continuously in search of wood fuel. Climate change has thus put an enormous pressure on natural resources and reduced the availability and supply of traditional fuels like fuel wood and charcoal as well as energy from hydropower resources. 75% of the population in sub-Saharan Africa depends on solid fuels from biomass (Figure 3). Energy is recognized as one of the most important inputs for economic growth and human development and thus as an indicator of the level of development and can play a vital role in alleviating the impact of climate change and attainment of the United Nations (UN) Millennium Development Goals (MDGs). The role geothermal can play with in the East African Rift as an indigenous and renewable source of energy in climate change mitigation and adaptation as well as in the attainment of the Millennium Development Goals should be underscored.

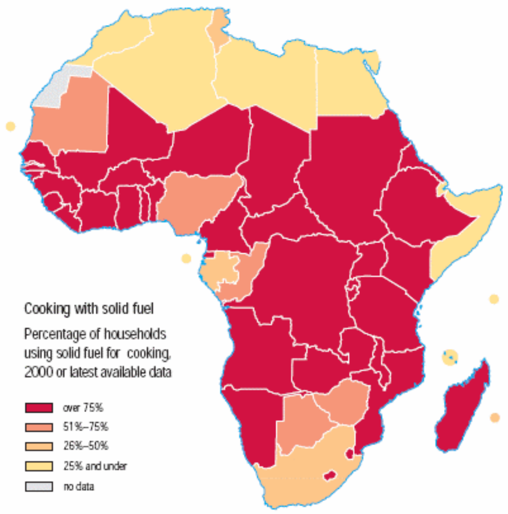

Figure 3: Percentage of households using solid fuel for cooking 2000 or latest available data (adopted from Gordon and others 2004).

1.2 Kenya and Climate Change Experience

Kenya is located on the East African coast and has a total land mass of 582,650 square kilometers (224,962 square miles) with a population of about 39 million people. UN estimates which take into account effects of excess mortality due to HIV aids and a population growth rate of 2.691%. Population census is carried out every decade and one is due before the end of 2009. Almost 70% of Kenya's landmass carrying 30% of the human population is arid and semi arid (ASAL) and is characterized by a rainfall of 500 mm or less annually, high evapo-transpiration rates, little organic matter and poor infrastructure (Figure 4).

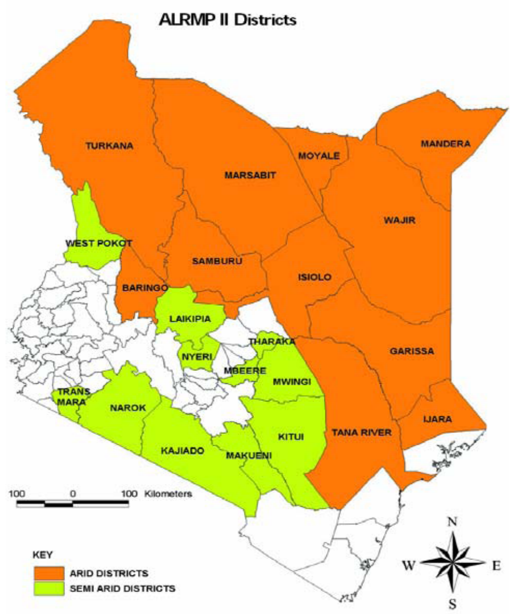

Figure 4: Arid and Semi Arid lands (Arid Lands Resource Management Project (ALRMP) Government of Kenya 2005.

According to Oxfam International (2006), climate change introduces an additonal uncertainity in exising vulnerabilities in ASAL and impacts are being felt with increasing fequency and magnitude as shown on Table 1.

Table 1: Drought incidences in Kenya. : Drought incidences in Kenya.

Year	Type of Disaster	Area of coverage	No. of People Affected by Droughts
2004-2006	Drought	Widespread	3.5 million
1999/2000	Drought	Widespread	4.4 million
1995/96	Drought	Widespread	1.4 million
1991/92	Drought	Arid/Semi Arid Zones	1.5 million
1983/84	Drought	Widespread	200,000
1980	Drought	Widespread	40,000
1977	Drought	Widespread	20,000
1975	Drought	Widespread	16,000
1971	Drought	Widespread	

Source: **Oxfam International (2006): Making the case: A national drought contingency fund for Kenya, Oxfam Briefing Paper, 89**

The remaining 30% of the landmass carry the rest of the population thus exerting an enormous pressure on existing natural resources especially forests and soil. The high elevation areas receive a bimodal rainfall of up to 2000 mm per year. 75% of the population earns their living from agriculture which depends on reliable rainfall. Agriculture accounts for one third of the Gross Domestic Product (GDP) and earns 70% of export earnings. As a result, it has a major role in the economy and consequently has a direct effect on the country's vulnerability to climate change (UNDP) (http://www.ke.undp.org/KenyaDisasterProfile.pdf).

Flooding will also affect urban areas, river valleys and the fringes of Lake Victoria. The impact of floods will lead to increase in landslides, crop loss, destruction of infrastructure and homes, high malarial incidence, and water borne diseases. Farming communities in the Kano plains, Budalangi and Lower Tana River Basin are displaced annually and their agricultural production reduced by 50% about once in every three years (Nyangena W, 2007).

Climate change will thus have a net negative impact on economic growth, both on a macro and a micro scale. in sectors such as health, agriculture, livestock, environment, hydropower generation and tourism. Generally, floods cost Kenya about 5.5% of its GDP every 7 years causing capital losses, drought costs about 8% of the GDP every 5 years causing production losses and a long term fiscal liability of about 2.4% of the GDP per annum. Climate shocks are equally devastating at the household level (Downing et. al., 2008).

Anticipated effects of climatic change on agricultural subsistence, commercial production, food security, access to safe drinking water, use of forests, infrastructure development, and energy and water supply are devastating. Agricultural production in Kenya is the lifeline of 75% the rural population and provides for 70% of the labor force (Ongwae 2005). Though it is the highest contributor to Kenya's GDP, a significant amount is still lost due to poor infrastructure, lack of small rurally based industries to preserve food during bumper harvests. Most agricultural produce is sold at throwaway prices or disposed of due to lack of proper storage and refrigeration facilities resulting in food shortage during the dry/drought season. This is worsened by the fact that subsistence agriculture is mostly rain fed. The fluctuations between drought and bumper harvests can be controlled by ensuring that the local communities have access to energy not just to preserve food for subsistence but for economic empowerment. Meat processing facilities can also be installed in pastoral areas to reduce the impact of drought through loss of animals by farmers and these can be extended to non-food crops.

1.3 Electricity and Rural Energy

The current generation mix in Kenya is composed of Hydro 744 MW, Thermal 441 MW (KenGen 152 MW, IPP-155 MW, REF-9 MW, Emergency 150 MW), Geothermal 165 MW (KenGen 115 MW, IPP-50 MW), Cogeneration from Mumias sugar 34 MW, Wind 5.45 MW (5.1 MW new Ngong Wind) giving a total installed capacity of 1355 MW. The country plans to increase capacity from geothermal to about 1500 MW by 2018. Additional thermal projects which are expected to be online within this fiscal year are the Rabai diesel plant at 86 MW, an additional 52 MW from IberAfrica, Emergency power 140 MW, Kipevu III 120 MW by December 2010, and 300 MW of Coal by 2015. In order to reduce capacity expansion through thermal plants, development of geothermal energy must be fast-tracked.

The current over-dependency on hydro puts the country at a higher risk due to drought and deforestation of catchment areas. The impact of drought on hydropower production was very significant during the prolonged 1999/2000 drought and the precedings droughts, most recent being 2009, leading to power rationing and the engagement of emergency power providers (Aggreko PLC intertantional) who will provide 250MW by the end of October 2009 (Figure 5). The poor hydrology has also affected small and pico hydro run by organised local communities. The above situation has caused increased demand for more specialized and accurate weather and climate predictions and advice (Samuel W. Muchemi Kenya Meteorological Department, pers. comm.).

Figure 5: Containerized gensets from Aggreko for Emergency power (temporary measure).

Electrification only serves 15% of the population comprising of 46% urban population and only 4% of the rural population (Theuri 2007). Much of the national energy balance consists not of fossil fuels but rather "non-commercial energy" or "traditional fuels" – wood, charcoal, animal dung, and crop residues freely collected and used by rural households for cooking and heating (Cecelski 2000). Traditional biomass fuel use in developing countries is blamed for the massive tropical deforestation and the use of crop residue on soil erosion. For a long time, discussion on meeting rural energy needs has been focused on planting more trees and using more energy efficient stoves despite the fact that energy needs are broader and gender sensitive. These discussions were focused more on meeting domestic energy needs, addressing indoor air pollution and saving time spent on fuel wood collection without much emphasis on energy as a means to economic empowerment of different genders in the rural areas.

In the recent past however, donor interest and funding for rural electrification and small scale decentralized renewable energy systems like small hydro, solar, wind, biogas and geothermal plants has increased (Dutta 2005).

The Kenyan government under the Energy Act No. 12 of 2006 section 67 has established a Rural Electrification Authority (REA) whose objective is to electrify all public facilities in rural areas through off-grid or decentralized systems (Energy Act 2006). Their goal is to increase the proportion of rural areas connected to electricity from 4% in 2003 to 10% by 2010 and 20% by 2020 (REA Strategic Plan 2008-2012). So far, the REA focuses on small off-grid systems like isolated diesel generators, small hydro systems, geothermal, solar and wind (REA 2007).

The Vision 2030 targets connecting one million households between 2008 -2012 and it is projected that out of the one million, 650,000 will be in rural areas where the majority of the population lives and the remaining 350,000 in urban areas. This goal will be met by both Kenya Power and Lighting Company Ltd (KPLC) and REA (Kenya Vision 2030).

Additionally, in May 2009, the Government of Kenya in its power sector restructuring formed the Geothermal Development Company (GDC) to fast track its development. Though GDC is still in its infancy, it is expected to contribute significantly in meeting the energy demands of the country through geothermal resources.

There is still a lack of a comprehensive rural electrification master plan and a lack of appropriate regulations to support rural electrification.

1.4 Gender Differences and Commonalities in Energy Needs

Gender is a concept which refers to a system of socially defined roles, privileges, attributes and relationships between men and women which are learned and not biologically determined (Dutta 2005). Thus gender equality is equal enjoyment by women and men of socially valued goods, opportunities, resources and rewards and equal participation in decision making. This does not mean that women and men become the same but that their opportunities and life chances are equal.

Yet most energy policy debate and legislative frameworks have taken a gender neutral approach to energy pricing, rural energy policy and energy technology. As a result, energy policies have continued to fail to recognize the differences in the needs and assets of women and men (Clancy et al., 2002).

Men and women also face their social, economic and environmental reality in different ways; how they participate is also different and is closely related to age, socio-economic class and culture. Women, like men, have particular socially conditioned vulnerabilities and capacities; these have developed through the socialization process and, therefore, must be dealt with accordingly (UNDP 2009).

Gender differences are also based on division of tasks, rights and responsibilities and along sexual lines. Gender differences and commonalities in most societies in Kenya are more cultural than biological. Since women do not exist in isolation from men, focusing on their needs alone is inadequate and hence the need to differentiate their needs. The term gender is used to describe this differentiation.

2. GEOTHERMAL ENERGY, CLIMATE AND GENDER

Contribution of geothermal energy in Kenya in the next few years is going to be very significant. The unexploited potential currently stands at 3000 MW (Omenda 2008). The country´s strategy of capacity expansion through geothermal development is also articulated in its Energy Act 2006. Although these plans have been made, adequate policies and financial mechanisms also need to be put forward to ensure positive social and economic benefits at the micro level for the local communities.

Geothermal energy, being the most stable indigenous energy of the future within the Eastern Africa region, should play a vital role in meeting energy needs of both the urban and rural communities and act in climate change mitigation and adaptation technology with a significant economic impact.

The most fundamental question is what role will geothermal capacity expansion within the African Rift system play in not only meeting countries’ energy needs, emission reductions required under the Kyoto protocol (or the next protocol) as a mitigation option but at the same time have a gender differentiated impact at the grass-root level. CDM projects should therefore go beyond mitigation and ensure sustainable local benefits.

2.1 Role of Geothermal Energy in Climate Change Mitigation and the Gender Perspective

Mitigation options in the energy sector may be classified into those that improve energy efficiency and those that reduce the use of carbon-intensive fuels (The number of CDM projects were obtained from UNFCCC website and are subject to change depending on the rate of registration). Geothermal CDM projects use methodology for grid connected generation from renewable sources. Small scale CDM methodologies would apply for decentralized systems.

The Clean Development Mechanism (CDM) is one of three flexibility mechanisms established under the 1997 Kyoto Protocol, and it is the only mechanism open to participation by parties from both industrialized and developing countries. The objectives of the CDM are i) to help Annex I Parties to meet their emissions targets and ii) to assist non-Annex I Parties to achieve sustainable development and avoid future emissions. It was hoped *inter alia* that the flexible mechanisms would trigger investment, speed up technology transfer and ultimately help bring countries onto a lower carbon trajectory (Desanker 2005).

The effectiveness of geothermal energy and greenhouse gas mitigation has been proven through the Clean Development Mechanism (CDM) of the Kyoto protocol. There are few geothermal certified CDM projects in comparison to other renewable projects. This could be attributed to investment risks associated with geothermal development as well as the lead time in such developments in-comparison to wind, solar, landfill, energy efficiency and biomass projects which dominate the energy portfolio under CDM statistics. Some of the geothermal projects that are already generating Certified Emission Reductions (CERs) are listed on the UNFCCC website and summarized in Table 2 (The number of CDM projects were obtained from UNFCCC website and are subject to change depending on the rate of registration). There are several other geothermal projects in the pipeline which are still in the process registration.

Table 2: Registered Geothermal CDM projects.

Country	Project	Average annual emission reduction *tonnes of CO2 e.q.*	Total *tonnes CO_2/year*	Period
Papua New Guinea	Lihir Geothermal project 55MW. Initial 33MW followed by 22 MW	278,904	2,789,037	10 years (2006-2016)
Philippines	Nasulo geothermal project 20 MW	74,975	524,825	7 years (2009-2015)
Indonesia	Dajarat Unit III 110MW	652,173	4,565,211	7years (2006 -2013)
Indonesia	Wayang Wingu phase II. West Java. 117MW	804,099	5,628,695	7 years
Nicaragua	San Jacinto Tizate 66MW (532,000 MWh per year.)	280,703	1,964,919	7 years (2005 -2011)
Kenya	Olkaria III phase II 36 MW (OrPower 4)	171, 265	1,198,852	7 years renewable twice (2009-2015)

With the expected capacity expansion plan for geothermal energy in Kenya, most of the earmarked geothermal projects are expected to be CDM or comply with the requirements of the next protocol. While this might be the case, the global distribution of CDM projects is uneven with Africa having the least. The uneven distribution of CDM project activities reflects, first of all, the uneven state of economic development and the different attractiveness for investment of many developing countries. It is not surprising that investment in CDM activities largely follow trends in foreign direct investment (FDI). Though sub-Saharan Africa is still lagging behind in CDM projects, it is hoped that the geothermal projects will attract CDM investments along the East African Rift system and compete equally with other renewable energy projects internationally.

Geothermal CDM projects can be linked to gender through its objective of achieving sustainable development and the Millennium Development Goals. While the climate change debate is natural science driven, sustainable development is framed as a social human science. These two have continued to run in parallel and should be closely linked (Olsen 2005).

Under CDM, the measure for sustainable development is defined by the Designated National Authority (DNA) which is usually in the form of a checklist including key areas, of social, environmental, economic and technological well being, or it is just an EIA report. Unfortunately, a sustainable development criterion as required in the project design document (PDD) is not monitored like the GHG emissions to verify that they are real and measurable. When the designated operating entities (DOEs) verify the project's GHG reductions, the contribution to sustainable development is not included in the assessment and it is not a requirement at the international level or at the national level that sustainable development benefits are actually realized. In the absence of an international sustainability standard, sustainable development is usually not visible in Non Annex 1 countries that have implemented CDM projects (Brunt & Knechtel 2005). The lack of a clear definition of sustainable development by DNAs leads to the question of who should really ascertain sustainability of CDM projects and how. Additionally, in most sustainability criteria of the Non-Annex 1 countries, the gender dimension is often lacking and the actual benefits realized by the local community are often shaky and often do not aid in alleviating the impacts of climate change.

The sustainable development of CDM projects can easily be monitored through the projects impacts on the attainment of the Millennium Development Goals in the surrounding area.

There is an enormous potential of untapped geothermal heat from waste water from the Olkaria power plants which can be harnessed and used in the nearby greenhouses, hotels ranches and tourist spas. So far, only one flower and horticultural company around Lake Naivasha out of more than 50 is utilizing geothermal energy. The rest are still dependent on electricity from the grid and pesticides. Direct utilization of geothermal in Olkaria and surrounding can significantly bring down the amount and costs of energy incurred by these businesses as well as generate CERs.

The expansion of geothermal utilization in the area would also lead to creation of more employment opportunities especially for women because horticultural and floricultural sector is heavily dependent on women. This would enormously contribute in the attainment of the Millennium Development Goals in the area.

Further research is needed on the cost benefit analysis of both high temperature and low temperature potential of geothermal utilization in the Olkaria and surrounding; including further assessment on the role geothermal energy has played in the attainment of the MDGs.

Other than benefits accrued from investments by businesses and institutions, the role geothermal energy can play in mitigating dependency on wood fuel and kerosene through electrification is enormous.

Energy is critical in the daily lives of women in both rural and urban areas in developing countries. Since electrification only serves 15% of Kenyans and mainly urban areas as stated above, men tend to move to urban areas thus creating gender disparity in terms of access to modern energy. The lack of adequate energy services has been caused by energy planning processes, policies and projects that ignore the gender specific needs of women. This problem will persist unless these national energy policies are expanded or improved (Karlsson1999).

While the burden of household energy supplies and services remains largely the responsibility of women, access to modern energy carriers, like clean fuels and electricity, affects both men and women differently depending on the energy applications they are most involved in.

2.2 Role of Geothermal Energy in Climate Change Adaptation and the Gender Perspective

Adaptation to climate change is vital in reducing impacts that are currently taking place and increase resistance to future impacts. The thirteenth session of the Conference of Parties (COP 13) in Bali in December 2007 adopted the Bali Action plan in its Decision/1 CP.13 which identifies adaptation as one of the five key building blocks required to strengthen future response to climate change.

Improved access to energy resources and services plays a crucial role in the sustainable development of developing countries and therefore in improving adaptive capacity (South Center 2008). While CDM benefits are accrued from geothermal development, the possibilities of using this type of energy in assisting communities to adapt to the impact of climate change should be achieved simultaneously to create a win-win situation.

Most geothermal potential resources occur within the arid and semi arid areas (ASAL) along the Kenyan Rift system among pastoral indigenous communities e.g. Maasai (Olkaria, Suswa, Longonot and Magadi), Tungen, Jemps (Baringo Bogoria, Korosi), Pokot Turkana where drought is also prevalent. Figure 6 shows a drought map of Kenya with geothermal potential areas in Kenya. There is a sharp contrast between the areas surrounding Olkaria geothermal field and other unexploited potential fields in the country. Unlike Olkaria whose development was accelerated by the presence of the geothermal power plants, these regions are under-developed and lack the necessary infrastructure.

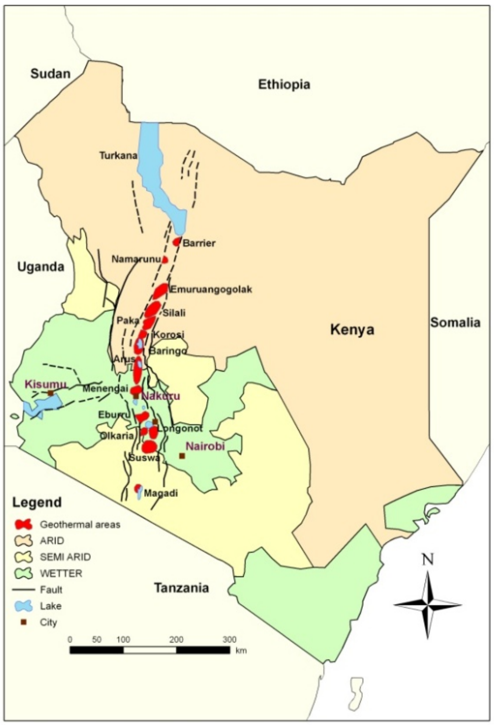

Figure 6: Map of geothermal resource overlaid on Kenya Aridity Map above. (Overlaid by the author).

They also experience extreme climatic effects, such as flash floods and droughts which result in hunger, total loss of livestock, death and injuries and may affect women and men in different ways, depending on the means at their disposal. These communities are most vulnerable to climate change impacts because they have fewer resources to adapt socially, technologically and financially despite the enormous geothermal and wind energy potential in these regions.

Geothermal energy can be harnessed to make a significant difference in reducing the impact of climate change and economic losses incurred by the local communities as a result of extreme weather conditions.

Access to affordable energy resources and services has a positive impact on the quality of life and sustainable livelihood, increases economic opportunities and consequently reduces demographic pressure and dependency on the natural environment, thereby improving adaptation capacity.

Energy and technology choices toward a low carbon intensive mix are crucial in addressing climate change mitigation and adaptation as well as accelerating the attainment of the UN MDGs.

It is important to recognize that the current energy needs for the country are supplied through grid connected electricity and therefore most investments are likely to go towards high temperature utilization rather than low temperature utilization. A mix can however be achieved with both government and private sector investments. Geothermal energy would also have to compete with other low carbon technologies like solar and wind energy which can be harnessed in abundance in these regions.

According to Mouldi (2002), low temperature geothermal water is used for crop irrigation in Southern Tunisia and for laundry purposes. Several other technologies are being used in different parts of the world which can easily be adapted to meet the needs of these communities. This however must be consistent with economic activities and the needs values and aspirations of the people.

There is a need for further research on the effectiveness of geothermal energy's utilization in climate change adaptation in both high and low temperature situations within the Kenyan rift valley at the micro-level and how these efforts lead to attainment of the Millennium Development Goals. The scope will cover grid based rural electrification projects and small scale decentralized geothermal systems.

In their productive role, women are more involved in natural resource management, small agri-business development, and activities aimed at household survival (Paolisso and Gammage 1996). Men need energy for small scale rural based industries like carpentry, tailoring, barber shops, battery charging, blacksmith shops and others.

In dry places along the Kenyan Rift, such systems would enhance food processing and preservation, grain grinding (posho mills), intensive farming (livestock and crop), tourism, fish farming, fabric dying, access to water through pumping /irrigation, and small scale rural industries in order to divert over dependence from the natural environment. The result would be a major shift from the current focus on meeting rural energy needs through improved stoves and planting woodlots without tangible economic benefits to more meaningful energy supply to different gender interests.

Gender specific audits are required for every community to determine the specific environmental, social, economic and gender benefits that the use of geothermal energy would deliver.

3. IMPLEMENTATION BARRIERS

Though the above may sound plausible, there are several barriers that have to be addressed before reasonable results can be achieved. The barriers can broadly be divided into three categories i.e., financial, technological and legal barriers.

3.1 Financial Barriers.

Affordability and non-access to electricity is one of the major barriers to the successful implementation of climate friendly technologies in Kenya and sub Saharan Africa as a whole. Most of the rural communities cannot afford electricity from the outset and may need assistance in the initial stages.

According to government statistics, 56% of Kenyans live below the poverty line.

Well managed Micro Finance Schemes could be a possible option in aiding community efforts towards adaptation. Geothermal development also demands high investment costs, which is mostly donor sourced.

At the national level, a very meagre budget is allocated to small and medium scale renewable energy technologies as compared to the conventional energy sector. Financial mechanisms also do not reflect gender priorities and needs. Gender analysis of all budget lines and financial instruments for climate change is needed to ensure gender-sensitive investments in programmes for adaptation, mitigation, technology transfer and capacity building.

Low private sector participation in energy provision to the rural areas has also slowed down energy development in general.

3.2 Technological Barriers

The introduction of unfamiliar technologies for adaptation requires the development of technical skills. Some technologies are not fully commercial, increasing the perceived risk for private investment. Besides, some technologies are more complex to operate and maintain than others.

Technological development related to climate change should take into account gender specific priorities and needs and make full use of present knowledge and expertise, including traditional practices. Differentiated gender role and involvement in the development of new technologies can ensure that they are user-friendly, effective and sustainable.

In terms of grid electricity, there is low accessibility and connectivity in remote rural areas of Kenya especially in areas occupied by nomads in temporary makeshifts.

3.3 Legal and Policy Barriers

There is generally a lack of a comprehensive rural electrification plan and effective regulations to support it at the macro and micro levels. Developing geothermal energy in such a setup might overlook the need for utilization of this resource at the micro (local) level to address the impact of climate change.

Gender perspectives are currently not mainstreamed into the national policies, action plans and other measures for sustainable development and climate change. Integrating adaptation to climate change into national policy- and decision-making, allows for amplification of benefits across a wider area and over a longer period of time. A gender sensitive policy would ensure that the needs of both men and women are met. Integrating the gender approach is also helpful in designing and implementing policies, programmes and projects that lead to greater equity and equality. In particular, it may contribute to building more capacity to adapt to and mitigate climate change, insofar as it affords a clearer and more complete view of the relations people have built with ecosystems.

Some of the challenges can be met through public-private partnerships and micro financing.

4. CONCLUSIONS

There is no doubt that geothermal energy can be used effectively in addressing climate change challenges. Geothermal development plans in Kenya have mainly focused on the clean development mechanism without a more wide-ranging climate change perspective that would have an impact at the grassroots level. Extensive research is still required to highlight specific benefits and additional funding sources that can be used to maximize the benefits of geothermal manifestations in these climate vulnerable regions. The creation of large geothermal CDM projects in the midst of climate devastated communities without a meaningful link with the grassroots communities is a drawback towards economic development. Without the above intervention, climate change will make it even more difficult for the country to break out of poverty and achieve its sustainable development objectives.

The link between gender, energy and climate change has neither been well articulated at local nor international level. Though some efforts are currently being made, the impact is very low on the ground. Geothermal energy must be developed in integrated approaches that provide the poor with more choice in climate change adaptation options and economic benefits beyond GHG mitigation.

This being part of a research idea scheduled for mid 2010, the exact impacts of geothermal on climate change adaptation and mitigation will be assessed in two very distinct and constrating areas e.g. the developed Olkaria geothermal field and the undeveloped Baringo field where some of the most vulnerable indigenous communities reside.

REFERENCES

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. and Yanda, P: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge U.K., (2007), 433–467.

Brunt, C., & Knechtel, A.: Delivering Sustainable Development Benefits Through the Clean Development Mechanism. A background paper for the COP-11 Side Event: Promoting the developmental benefits of the CDM: An African Case Study, (2005).

Cecelski, E.: Enabling Equitable Access to Rural Electrification. Current Thinking and Major Activities in Energy, Poverty and Gender, Briefing Paper prepared for a Brainstorming Meeting on Asia Alternative Energy Policy and Project Development Support: The World Bank, Washington, DC, 2000, 29pp.

Christopher, C.: Climate Change Impact on sub-Saharan Africa? An overview and analysis of scenarios and models. Discusion paper 3/2009, German Development Institute (2009), 36pp.

Christy, J.R., Norris, W.B., and McNider, R.T.,: Surface Temperature Variations in East Africa and Possible Causes. *J. Climate, in press,* (2009).

Clancy, J. S., Skutsch M.M., and Batchelor, S., :The Gender Energy Poverty Nexus: Finding Energy To

Address Gender Concerns in Development. Prepared under DFID contract CNTR998521, (2002).

Desanker P.V.: The Kyoto Protocol and the CDM in Africa: a good idea but… Unasylva 222, Vol. 56, 2005, Department of Geography, Penn State University, University Park, Pennsylvania, United States, (2005), 26pp.

Dutta, S., Role of Women in Rural Energy Programmes: Issues, Problems and International Institute for Sustainable Development: *Vulnerability and Adaptation in Developing Countries*.http://www.iisd.org/pdf/2007/climate_bg_vulnerability_adap.pdf, (2005), 5pp.

Government of Kenya (GoK): Vision 2030, Gok, 2005

Holmes, J. :The Need for collaboration' in Forced Migration Review: Climate Change and Displacement, Issue 31, October 2008, Oxford Refugee Studies Centre, (2008).

Hulme, M., Doherty, R. M., Ngara, T., New, M. G., and Lister, D. 2001. African Climate Change: 1900-2001. Climate Res., 17, 145-168.

Intergovernmental Panel on Climate Change (IPCC), .: *Climate Change 2007: The Physical Science Basis.* IPCC WGI Fourth Assessment Report, online: http://www.ipcc.ch/ (2007).

Karlsson Gail, V.: Appendix 2 of Report on Regional Workshop from Southern Africa, UNDP Energy and Women Project, Pretoria (1999).

Mouldi, B. M. : Geothermal Utilization in Agriculture in Kebeli Region, Southern Tunisia, GHC Bulleting, (2002), p 27-32.

Nyangena, W.: Climate Change Impacts, Vulnerability and Adaptation in Kenya: Case of DFID programs and projects – An Economics Cost Benefit Analysis of Adaptation Options (2007).

Olsen, K.: The Clean Development Mechanism's contribution to Sustainable Development, mimeo, Copenhagen. (2005).

Omenda, P. :Status for Geothermal Exploration in Kenya and Future Plans for its Development, lecture paper of the Short Course III on Exploration for Geothermal Resources organized by UNU-GTP and KenGen, at Lake Naivasha, Kenya, October 24 - November 17, (2008).

Ongwae J.: Coping with Drought and Climate Change in Kenya. Project Advisory Committee Meeting held in UNDP/DDC, Nairobi, (2005).

Paolisso M., and Gammage S.,: Women's Responses to Environmental Degradation: Poverty and Demographic Constraints - Case studies from Latin America, International Centre for Research on Women (ICRW), 1996

Parikh J. K.: Gender issues in energy policy, Energy policy, (1995) Vol.23, No.9, 745-754

Rural Electrification Authority Strategic Plan 2008-2012, Kenya, (2007).

South Center.: The Role of Decentralized Renewable Energy Technologies in Adaptation to Climate Change in Developing Countries. Analytical Note SC/GGDP/AN/ENV/5. Geneva Switzerland, (2008), 31pp.

Theuri, D.: Access to Modern Energy Services, Gender Face of Modern Technologies. ENERGIA News Vol 10 nr 1 (2007), 3pp.

United Nations Development Program Resource Guide on Gender and Climate Change, UNDP, (2009), 151pp.