MITIGATING CLIMATE CHANGE THROUGH UTILIZATION OF GEOTHERMAL SOURCED ENERGY

Kamanga T.F, Chisenga C., Tsokonombwe G, Kaonga H.
Geological Survey Department
P.O Box 27
Zomba
MALAWI
tamarakamanga@gmail.com

ABSTRACT

Almost 98% of Malawi's electricity needs are provided by hydropower using Shire River cascaded hydro schemes and Wovwe mini hydro plant which is unreliable as it is prone to siltation and drought which results to low electricity output. Energy supply deficiencies cause interruptions to processes that require energy as an input. About 90% of Malawi's population use wood and charcoal for fuel. As such, alternative innovative source of energy is needed in order to diversify from existing sources. Geothermal energy offers significant potential in terms of climate change mitigation. Being an indigenous resource, it is reliable, environmentally clean and relatively economically viable, renewable energy resource and a technology that has been underutilized for too long. Malawi Government in MDGS II realizes that a well-developed and efficient energy system is vital for industrial, mining and tourism development and that the diversified use of energy will augment energy supply from hydro power plants and will improve the energy generation mix. Malawi's location in the active continental divergent zones in the East African Rift System (EARS) holds significant potential for commercially exploitable geothermal resources. Studies by UNEP and GEF indicate that Malawi has a geothermal potential of up to 4000MW, hence the need to develop the energy source. It is against this background that further detailed geothermal exploration and exploitation programs be planned to appraise potential prospects. Geothermal energy would help reduce land degradation and ultimately, mitigating climate change and if it was utilized as an alternative source of energy as it would reduce the reliance on biomass.

1.0 INTRODUCTION

Malawi lies at the southern end of the East African Rift System (EARS) within latitudes 9˚S and 18˚S and longitudes 32°E and 36°E. This location provides convective/conductive systems of high heat fluxes from the crustal rocks which provide favourable conditions for geothermal resource reservoir as manifested through earth's interior heat escaping to the surface through hot springs across the country. Geothermal power exploitation has numerous advantages over other energy sources. Among the benefits of geothermal power are the near zero emissions (true for modern closed cycle systems that re-inject water back to the earth's crust), and the little space required for geothermal power development compared to other energy sources such as coal fired plants . Geothermal power plants require approximately 11% of the total land used by coal fired plants and 12-30% of land occupied by other renewable technologies. Using today's technology, Africa has the potential to generate 9,000 MW of energy from geothermal power. Of this potential, only 57MW has been tapped in Kenya, and less than 2MW in Ethiopia.

Several studies have been conducted to assess Malawi's geothermal potential but definite conclusions are yet to be made. Earliest works dates as far the past two centuries (1890's) but yielded too little for geothermal energy development. Though ICEADA (2012) opines that, so far, assessed geothermal resources could not add power supply significantly to the electricity Gondwe *et al* (2013) indicated that recent assessment of the field resulted in the delineation of 6 to 7 groups of springs with appropriate temperatures and geology for electricity generation of up to 200MW. Currently, Malawi Government, private firms and various regional and global players in the geothermal energy sector

continue to define the future of geothermal energy in Malawi. 21 major hot springs spread across the country, with some registering gas discharges. The highest recorded temperature, at Chiweta in Rumphi, stands at 79.3°C. Recently, as reported by Gondwe *et al*, an exercise aimed at classifying hot springs in Malawi, resulted in about 14 more unknown hot springs being recorded including the third hottest (Mtondoro) at 74°C. The use of renewable sources of energy like Geothermal is less polluting, compared to that of non-renewable sources. Specifically, increased reliance on renewable sources of energy is a key element of efforts to avert climate change as it reduces dependence on fossil fuels.

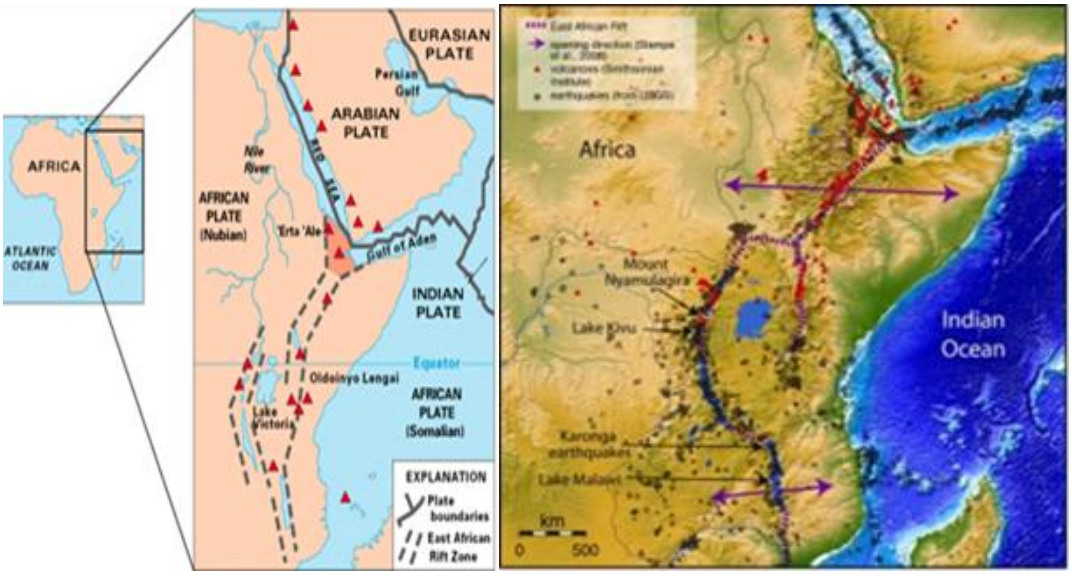

Fig 1. Location of Malawi in the East African Rift System
(After *State of the Art*, The Earth Institute of Columbia University
http://blogs.ei.columbia.edu/2010/02/05/continental-breakup-in-east-africa)

2.0 GEOTHERMAL MANIFESTATION

Geothermal activity is manifested generally in hot springs by the occurrence of cold/warm springs, steaming/gas bubbles and altered rock/grounds. These hot springs are mainly aligned along the major NW-SE faults which correspond with the major NW-SE rift trend that control the long-term development of northern Malawi rift basin (Delvaux et al.,2010). Sulphur deposits have been observed at Ngala and Mbande (Dulanya, 2006) which may be indicative of the presence of degassing magma bodies. Other manifestations in the form of gas bubbles have been found in several parts of Karonga basin in Northern Malawi that may suggest geothermal activity.

Almost 21 major hot springs have been mapped in the country. The highest recorded temperature, at Chiweta spring in Rumphi, stands at 79.3°C. Recently, as reported by Gondwe *et al*, an exercise aimed at classifying hot springs in Malawi, resulted in about 14 more unknown hot springs being recorded including the third hottest (Mtondoro) at 74°C (Table 1). The exercise further resulted in categorizing the streams into 6 to 7 groups basing on their temperatures and geological settings as regards their potential for electricity generation. The presence of surface manifestations in Malawi such as thermal springs, seismicity, fault features is evidence of a regional active tectonism in the region which may contribute to fluid flow(Dulanya etal 2015).However, local mapping of the faults and superficial structures are necessary in order to understand better the relationship between faulting and geothermal activity.

Table 1; New recorded hot springs

Hot spring name	Easting (UTM)	Northing (UTM)	Altitude (m)	Stream temperature (°C)	Current use
Mtomdoro	610536	8 665522	564	74	Washing and bathing
Julaye village	654117	8 237664	225	55	Drinking water (from borehole)
Chiyagha	618316	8 721422	705	49	Washing and bathing
Kajilirwe 1	610144	8 716255	703	49	Washing and bathing
Tisola	686533	8 212845	98	48.5	Washing
Kajilirwe 2	610172	8 716299	704	46	Washing and bathing
Chadongo 1	616078	8 714909	603	42	Washing and bathing
Mwaya	618821	8 721677	727	42	
Karwe	635878	8 718265	527	42	
Chadongo 2	616097	8 714699	610	39.6	Washing and bathing
Saka 1	607229	8 717700	856	36	Washing and bathing
Kajilirwe 3	609564	8 716489	702	33	
Chimaliro	623411	8 686536	512	26	

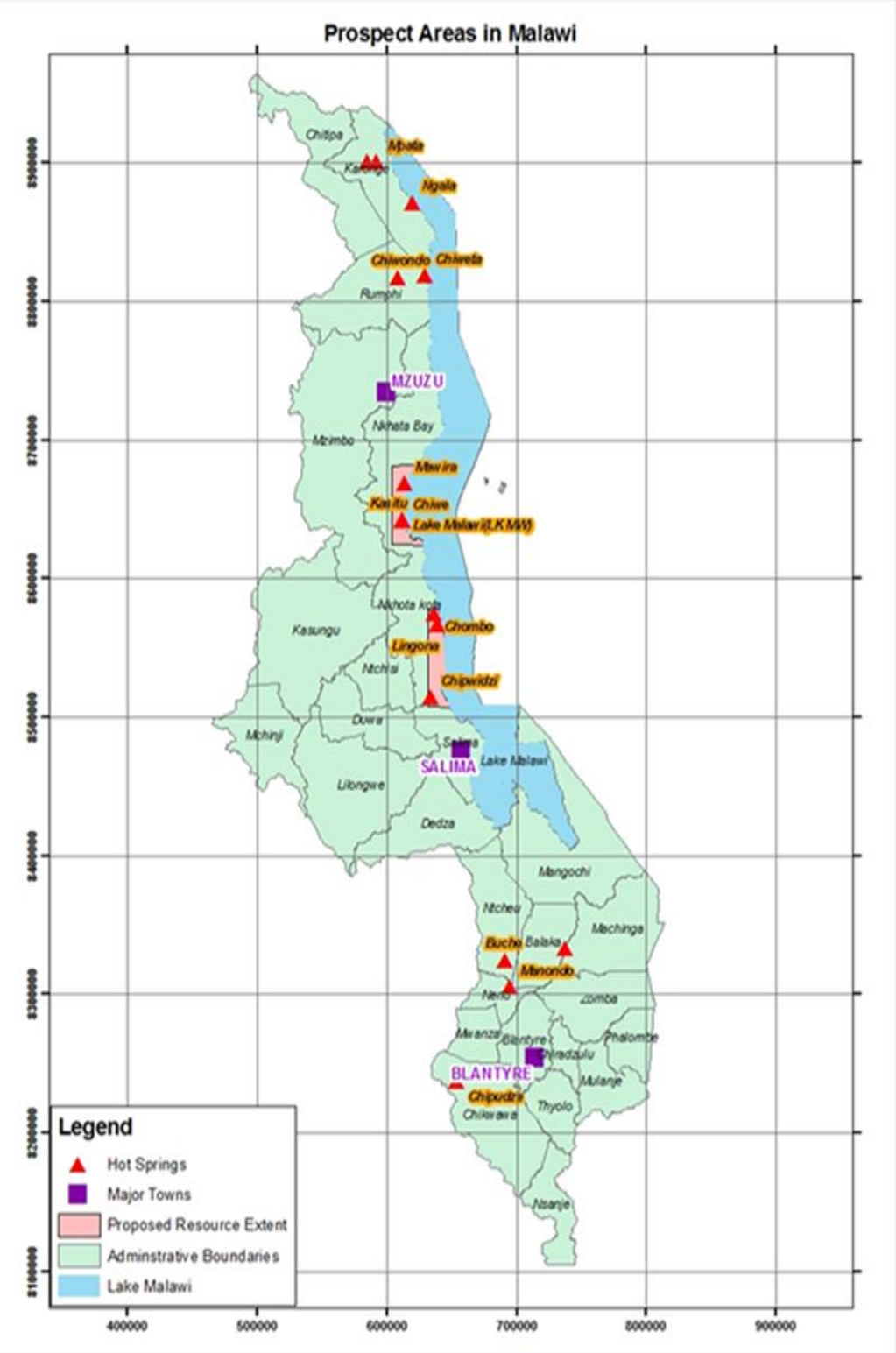

Fig 2. Map showing geothermal prospected area in Malawi

3.0 CLIMATE CHANGE AND GEOTHERMAL ENERGY

One of the challenges the country is facing is being able to meet the energy needs of the various sectors in the country. Energy supply deficiencies are common which result in interruptions to processes that require energy as an input. A prominent example is the national electrical energy system which is accessible to less than 1% of the rural population and is unreliable. From 2008 statistics, about 90% of Malawi's population use wood for fuel and charcoal production, accounting for about 88.5% of the country's energy requirements, 6.4% comes from petroleum, 2.8% from electricity and 2.4% from coal. Households account for 83% of all energy consumption, with industry taking 12%, transport taking 4% and the service sector taking 1%. Statistics show that 85.7% of the population use paraffin in hurricane and pressure lamps for lighting, 7.2% use electricity, 2.2% use candles, 2.6% use firewood and 1.4% use other means of alternatives for lighting. For cooking, 88% of the population use fire-wood, 8% use charcoal, 2% use electricity, 1% use paraffin and 1% use other means such as crop residues, animal dung and those not mentioned above.

Traditional biomass energy use has serious environmental drawbacks. The indoor air pollution from unvented biofuel cooking stoves is a major contributor to respiratory illnesses in Malawi. Reliance on biomass especially in the form of charcoal has resulted in land degradation and deforestation hence climate change. Further still, almost 98% of Malawi's electricity needs are provided by hydropower using Shire River cascaded hydro schemes and Wovwe mini hydro plant which is unreliable as it is prone to siltation and drought which results to low electricity output. Alternative innovative source of energy is needed in order to diversify from existing sources. Geothermal energy, just like other renewable energy sources such as solar, wind and hydro, offers significant potential in terms of climate change mitigation. Being an indigenous resource, it is reliable, environmentally clean and economically viable, renewable energy resource and a technology that has been underutilized for too long.

Malawi Government in MDGS II realizes that a well-developed and efficient energy system is vital for industrial, mining and tourism development. Geothermal energy offers increased generation, transmission and distribution of electricity. Furthermore, recent studies by UNEP and GEF indicate that Malawi has a geothermal potential of up to 4000MW, hence the need to develop the energy source. With the maximum electricity demand pegged at 360MW .Government plans to generate up to 833 MW by 2017. The increasing demand for energy resources both local and regional, calls for exploitation of other renewable sources of energy such as geothermal energy. The diversified use of geothermal energy augments energy supply from hydro power plants and improves the generation mix. It avoids vulnerability to drought and oil price fluctuations. Thus the opportunity presented by geothermal resources as a renewable energy cannot be overemphasized and hence should be given keen attention in the energy generation mix.

4.0 CONCLUSION

It is thus against this background that further detailed exploration and exploitation programs be planned to appraise potential prospects and consequently help in mitigating climate change and land degradation through plummeting the overreliance of biomass energy.

REFERENCES

Kalindekafe L.N.S. (2003). *Geothermal energy potential for Malawi*, Geological Survey of Malawi, Zomba.

Zuze Dulanya, (2006). *Geothermal resources of Malawi*, Geological survey of Malawi, Zomba.
Bennet J. D. and Carter G. S., (1973). *The geology and Mineral Resources of Malawi*, Government Press, Zomba.

Donna Shillington. *Continental Breakup in East Africa,* http://blogs.ei.columbia.edu/2010/02/05/continental-breakup-in-east-africa visited on 16th September,2015

Zuze Dulanya, Ake Sivertun and Nury Morales-Simfors. (2015). *Structural and Stratigraphic Controls of Malawi's Hotsprings: a Review* https://pangea.stanford.edu/ERE/db/WGC/papers/WGC/2015/11019.pdf, Visited on 15th September, 2015

Kondwani Gondwe, Gift Tsokonombwe and Alistair Allen. (2012). *Geothermal Development in Malawi – a Country Update, Proceedings 4th African Rift Geothermal Conference* Nairobi, Kenya.