MODELLING OF GEOTHERMAL POTENTIAL AREAS ALONG PART OF THE KENYAN RIFT USING REMOTE SENSING AND GIS

MARY WANDIA MACHARIA

A Thesis Submitted in Partial Fulfillment for the award of the Degree of Doctor of Philosophy in Geomatics and Geospatial Information Science, in the Institute of Geomatics, GIS & Remote Sensing, Dedan Kimathi University of Technology

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DECLARATION

This thesis is my original work and has not been presented in any university/institution for a degree or for consideration of any certification.

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ABSTRACT

Geothermal power is one of the safest and environment friendly energy sources globally. Kenya has been employing different methods of geothermal exploration. These methods include geophysical, geochemical and geological, which involve ground survey exploration to map geothermal indicators. GIS and Remote Sensing are powerful tools in geothermal exploration. The application of these tools has been on the rise owing to advances in technology for modelling geothermal indicators, consequently lowering the cost of exploration and remarkably improving on the ability to manage different geo scientific datasets efficiently. The objective of this study was to model for geothermal potential exploration along part of the Kenyan Rift using low cost methods – GIS and Remote Sensing. A comprehensive review of geothermal energy indicators was undertaken with emphasis on the indicators that would be mapped using GIS and Remote Sensing. After review, some geothermal indicators were identified for mapping using GIS and Remote Sensing method. A Geothermal exploration model was designed and developed to derive the identified indicators which are, Geothermal Heat Flux (GHF), Land Surface Temperature (LST), geology and environmental suitability. Multi Criteria Analysis was used to combine the indicators. Weighting of all the four model results to obtain the final geothermal potential results represented on the map was done by inclusion of the geothermal sector experts' opinion. The geothermal potential exploration map showed areas with high potential resource, moderate potential and low potential. Validation data was available for 5 sites (Menengai, Eburru, Longonot, Olkaria and Suswa) where ground field survey had been carried out by KenGen and GDC using geophysics, geochemistry and geology methods. Validation from a comparison of results depicting high geothermal potential areas generated from GIS and Remote Sensing method, and corresponding results derived using the ground survey methods showed good correlation with over 50% agreement where detailed exploration data had been provided. Results from application of the model have also revealed new areas with high geothermal potential which may be investigated further. The model developed and used in this research has demonstrated that GIS and Remote Sensing using the freely available datasets provide low cost methodology which has been effectively used to derive geothermal indicators that match with detailed geoscientific survey. A comparative cost analysis was done for Olkaria field (204km²) in Kenya which has been explored using different methodologies and the results showed that costs of ground survey methods are three times higher than costs of remote sensing, though the two methods have unique advantages. This method would be applicable and suitable for countries which have not exploited their geothermal resource. The geothermal exploration map would be very useful as a guide to geo scientists as they carry out detailed exploration because they would narrow then down to specific areas, thus reducing cost of exploration.