

# Use of GIS in Geothermal Resource Database Management- The case of AGID Web-GIS

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## ABSTRACT

One of the major and greatest challenges facing geothermal professionals is the assimilation, dissemination, and management of the ever growing quantity of digital information on geothermal energy exploration and development. In order to overcome these challenges, the way information, data, and knowledge are preserved, utilized, shared and disseminated must change. The geothermal community is in need of systems that not only provide digital data, but as importantly, provide tools that allow users to manipulate, query, select, and cross-reference data sets with efficiency and speed.

The work involved in geothermal exploratory activities can be simplified by means of a Web-based Geographical Information System (GIS). Web based GIS (also called internet GIS or on line GIS) is a network-based geographic information service that utilizes both wired and wireless Internet to access geographic information and analytical tools in delivering GIS services. Use of web mapping and or feature services coupled with Relational Database Management Systems (RDBMS) is critical in helping and managing the regions geothermal resources for key decision making, planning and also provides the users with an innovative and interactive way to access the spatial geothermal information over the internet/intranet. This system and service application provides a variety of functionalities such as; browse map mode, querying, navigation system, user requiring service, search region and displaying spatial distribution of geothermal information, map editing and printing from the web interface.

This paper investigates and discusses the importance and contribution of the Africa Geothermal Inventory Database (AGID) Web-Geographic Information System (GIS) to the African region. It describes the role of GIS in handling the complex spatial data mix encountered in geothermal field and contribution in decision making processes and the way forward.

## **1. Introduction**

The United Nations Environment Africa Geothermal Inventory Database (AGID) is an information sharing platform and hub for Geothermal related information in the African Rift countries. It aims at promoting the exploration, development and utilization of geothermal energy resources by storing, compiling and integrating of geothermal related information in the region and sharing it with end users both public and private geothermal players. AGID is an inventory of manpower, equipment's, laboratories, and project reports and publications of work done in the respective countries and geothermal fields as well as levels of geothermal development in different sites within the Argeo member countries. Although this information is contained in a relational database system, efforts have been done to implement spatial distribution of these resources in a web based GIS portal.

## **2. Background**

The existence of exploitable geothermal potential in the African Rift countries, while essential, is only a prerequisite for a successful geothermal development effort. To fast track investments for geothermal development in these countries, availability of sufficiently accurate geothermal resource data and other relevant information is fundamental. Information is the first key element supporting the development of a geothermal project or program (ESMAP. 2012).

The country governments have an important role to play in making geothermal resource information available to potential developers and investors. The objective of AGID is to catalyze geothermal investment in the region by providing geothermal related data and information to potential investors; therefore with inputs from member countries, AGID tries to bridge this gap by creating a pool of geothermal information on the region. At a minimum, the Africa Geothermal Inventory Database (AGID) shares public records on such geothermal attributes in the member countries as a one stop shop for investors and developers for rapid appraisal of the status, progress and on-going programs and projects in enhancing geothermal development in the region.

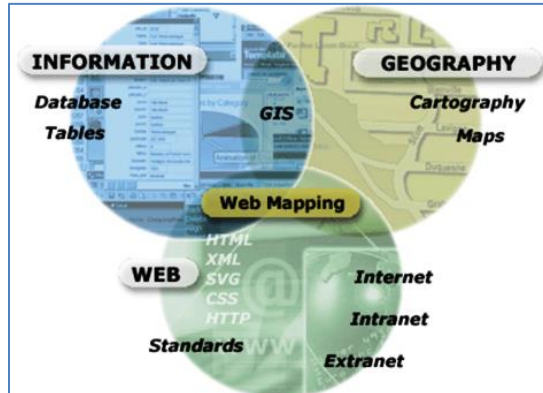
## **3. AGID Web Based GIS**

Web GIS is a type of distributed information system, comprising of at least a server and a client, where the server is a GIS server and the client is a web browser (Fu, P. 2015, Fu, P., & Sun, J. 2010). This is a way of disseminating information via geographical data sharing by integrating different data formats. This has been utilized for communicating geothermal information in the region by improving on the database tables and associating them with geography of the African rift geothermal member countries which include Burundi, Comoros, DR Congo, Djibouti, Eritrea, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania Uganda and Zambia.

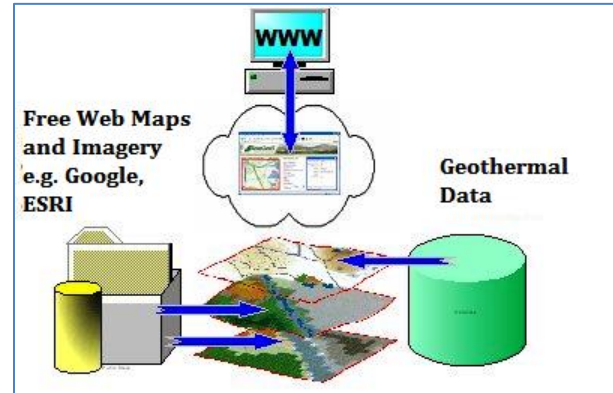
This was implemented using the free version of the ArcGIS online account from Environmental Systems Research Institute (Esri) .The architecture of the implementation is as shown figure 1 and 2 below ( Liu, X., Han, J., Zhong, Y., Han, C., & He, X. 2009), Naqi, S. A., Akhter, N., & Ali, N. 2010, Sugumaran, R., & Degroote, J. 2010).

To realize the need for an inventory of available technical and human resources in the domain of geothermal energy resource exploration and development in the region, AGID amasses information on manpower, equipment's, laboratories, publications, projects undertaken, capacity

building opportunities, organizations and stakeholders. The implementation of the AGID web based GIS was a transformational process of data from database tables and spatial relationship creation utilizing geography, web maps and imagery. This helped in sharing this information on web maps.



**Figure 1: Integration of information and geography to a web mapping environment**

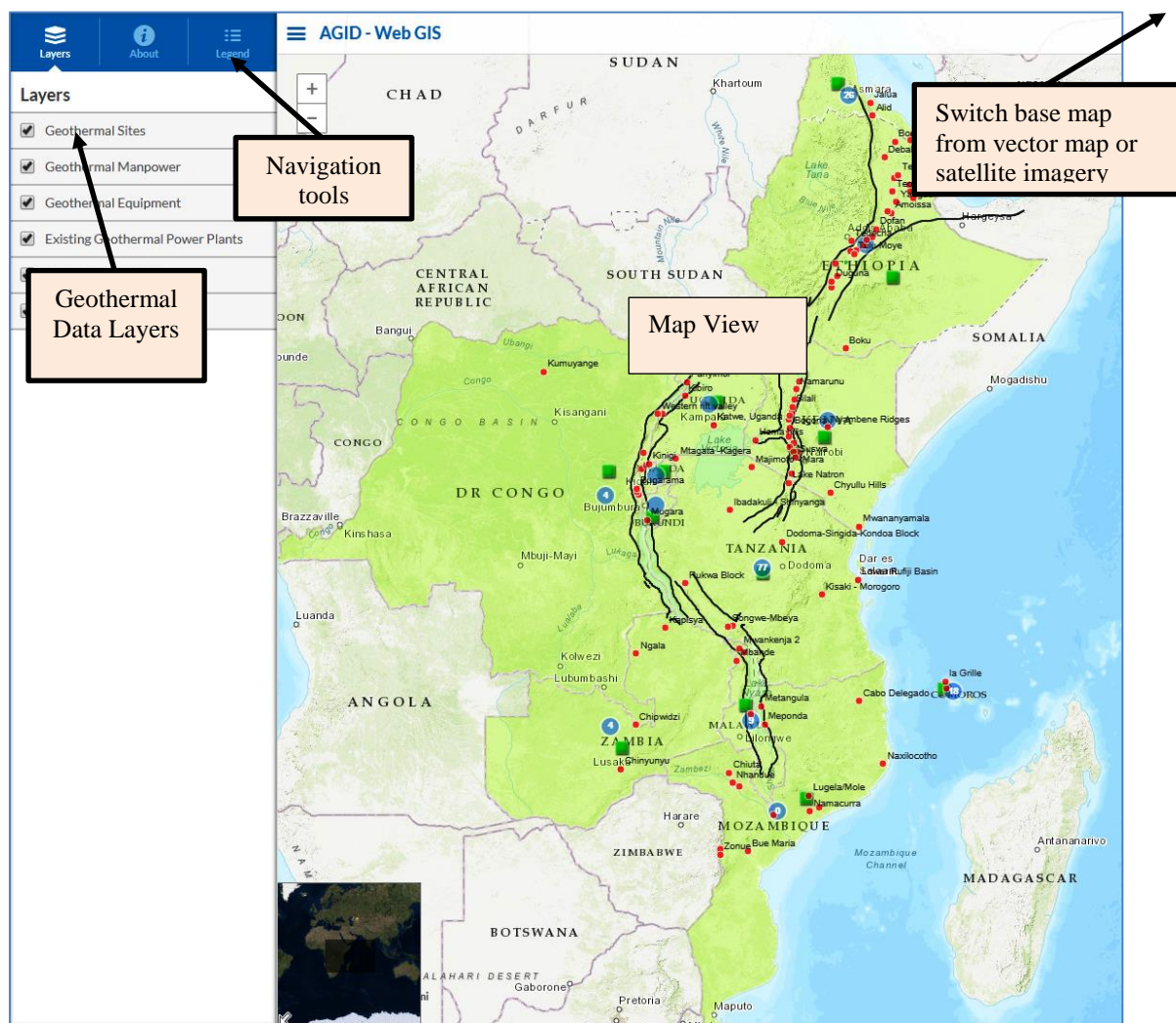


**Figure 2: Schematic presentation of the web mapping components**

The schematic presentations above (Figure 1 and 2) modified from Esri, 2017 show how the AGID database was revolutionized from the initial relational database design to take advantage of geography and free web maps and satellite imagery. This has enhanced sharing of information on geothermal development in the region.



**Figure 3: Overview of the AGID web GIS**



**Figure 4: Features of the AGID web GIS**

The AGID web GIS has 6 layers overlaid in a base map of raster (satellite imagery) or vector. These layers are; all the proven geothermal sites, the manpower distribution, geothermal equipment's per country, existing geothermal power plants, the East African rift valley and the Argeo countries. The interface has an option of navigating through these features for detailed information, turning the feature's on and off, customized pop ups as shown in figure 5 for geothermal equipment, geothermal sites, geothermal manpower and country information, and customizing map print outs. Apart from the records of the data in the AGID database by using the satellite imagery base map, one can take advantage of the infographics of the geothermal sites. Web based GIS can give a lot of information on geothermal sites and associated development activities allowing building positive relations between the stakeholders through sharing of data in the form of an easily navigated map displaying relevant data to the user.



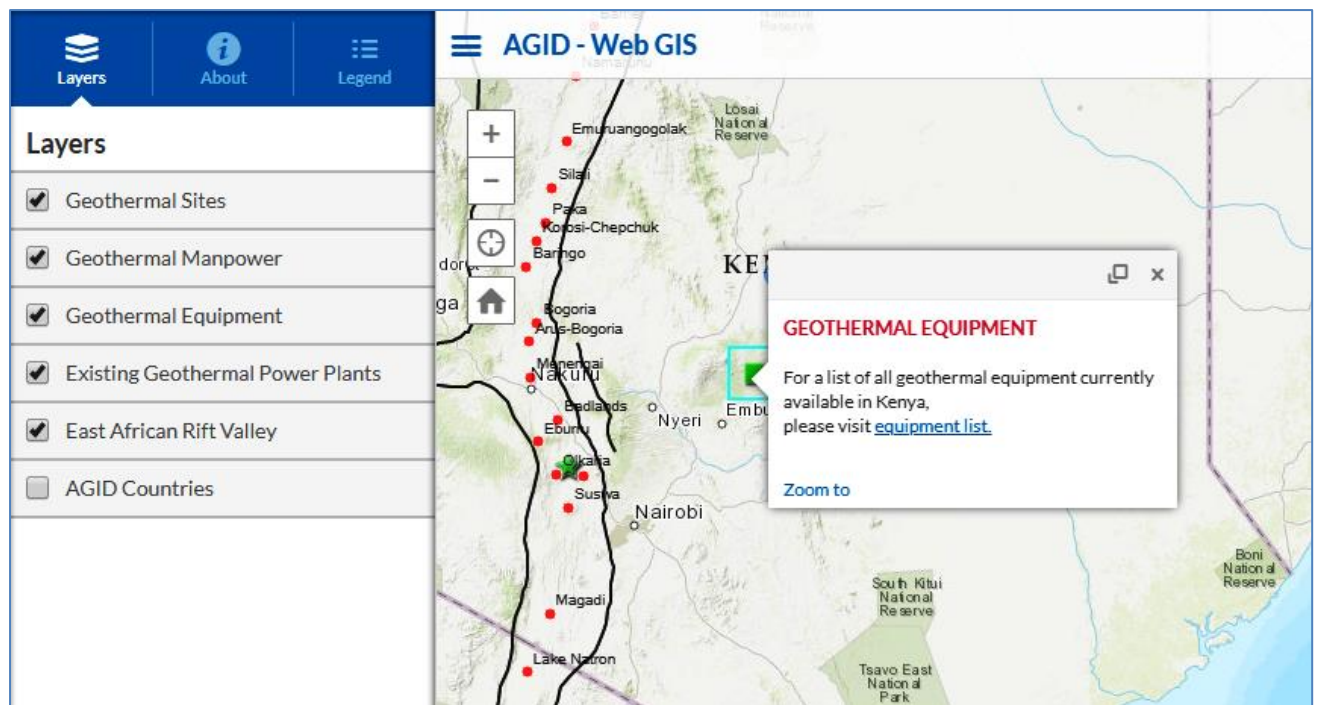


Figure 5: customized feature pop ups

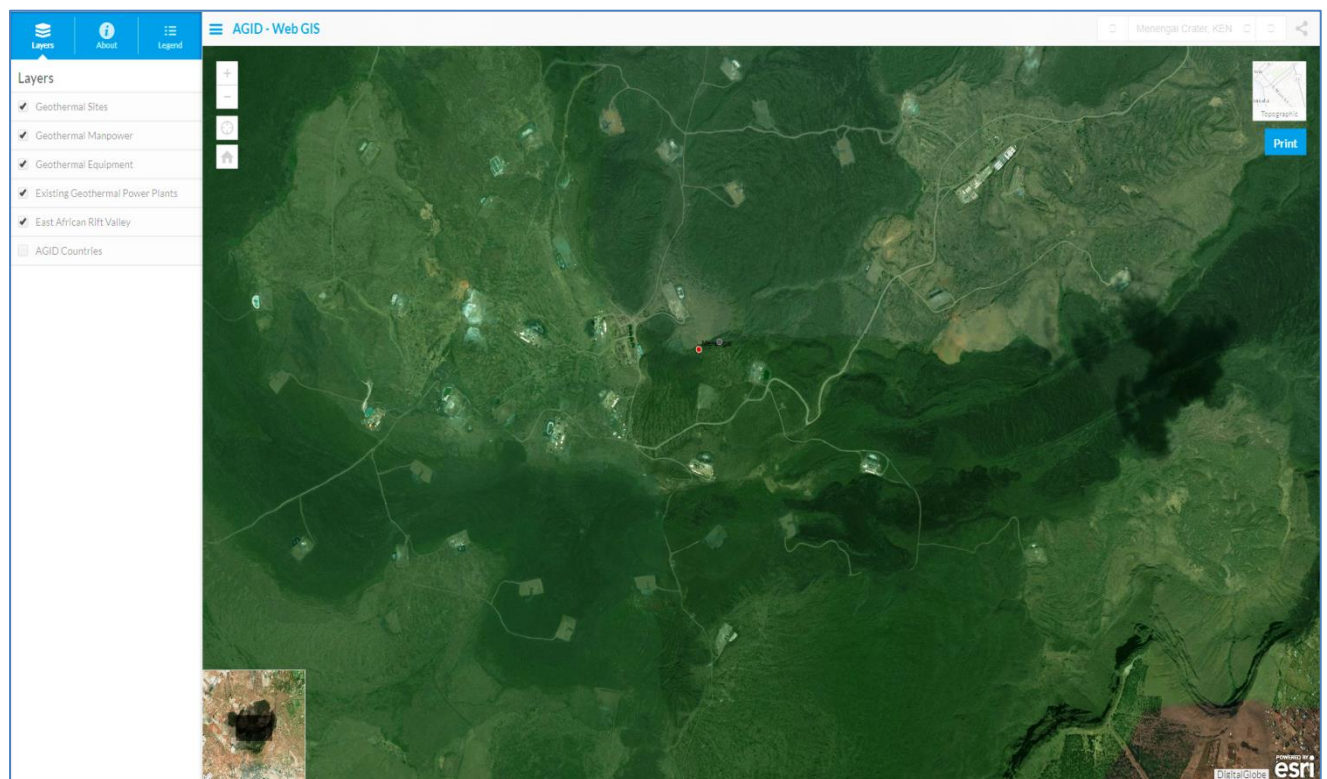
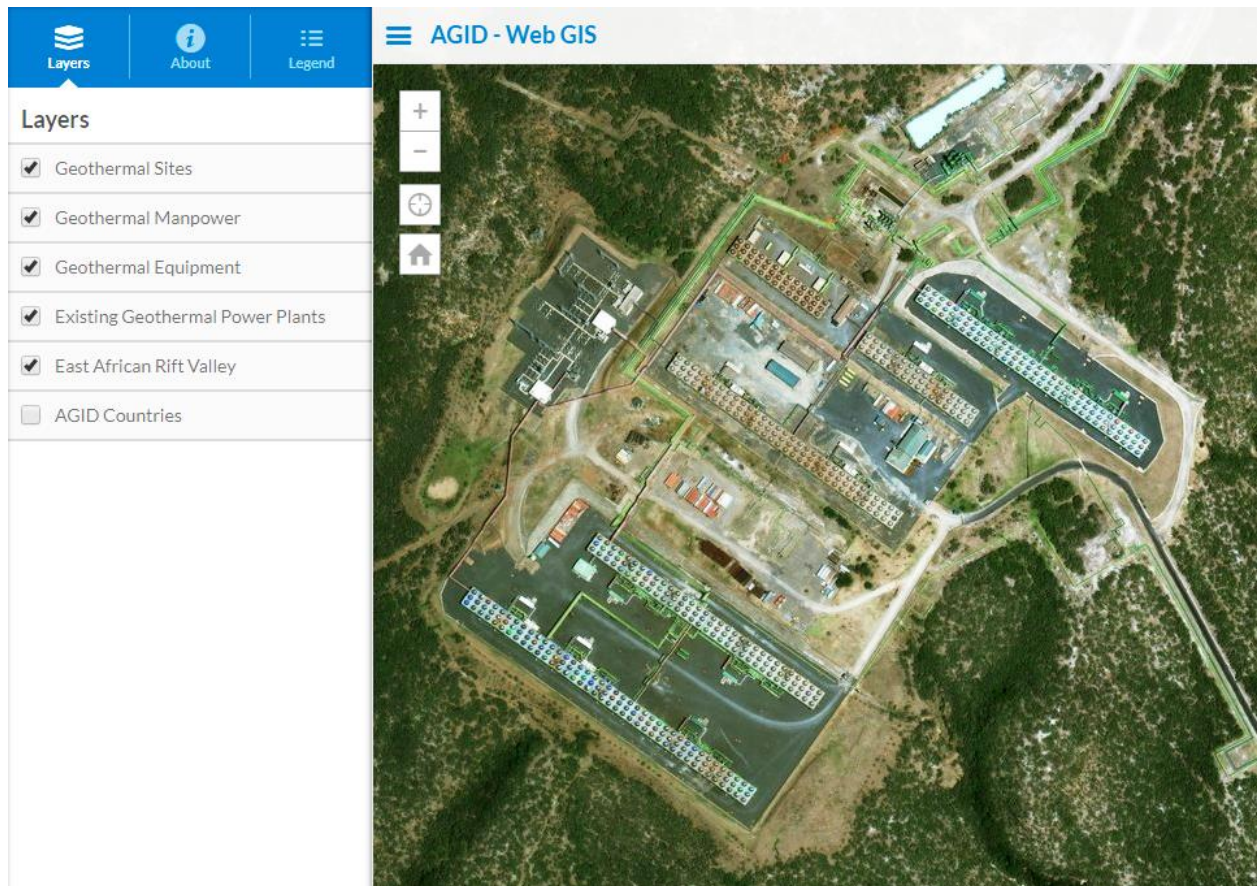


Figure 6: satellite imagery showing geothermal activities in Menengai field



**Figure 7: satellite imagery showing geothermal power plant in Olkaria field**

#### **4. Conclusion and recommendation**

The growing demand for a comprehensive collection of geothermal related information in the region, from private and public sectors, as well as other stakeholders in the region will only be achieved by having updated information available in the AGID platform. These calls for concerted efforts from the focal persons to populate the database with country information and data that will be in extension spatially shared in the AGID web GIS.

Web based GIS allows building positive relations between the authority and individual citizens, businesses, investors and tourists. GIS embedded into the authorities' web page promotes building positive relations with the public via sharing the data in the form of an easily navigated map displaying data relevant to the user. Therefore, AGID Web GIS can inform the public and conduct an on-going campaign to promote regional development of geothermal energy as a renewable source of energy.

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