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# Development of Web GIS for information of renewable energy in Aceh Province after rehabilitation and reconstruction process

Nizamuddin<sup>1,\*</sup>, Hizir<sup>2</sup>, Ardiansyah<sup>3</sup>, D Pertiwi<sup>1</sup> and P Handayani<sup>1</sup>

<sup>1</sup>Department of Informatics, Faculty of Mathematics and Natural Sciences, Syiah Kuala University, Darussalam, Banda Aceh 23111, Indonesia

<sup>2</sup>Department of Mathematics, Faculty of Mathematics and Natural Sciences, Syiah Kuala University, Darussalam, Banda Aceh 23111, Indonesia

<sup>3</sup>Department of Electrical, Faculty of Engineering, Syiah Kuala University, Darussalam, Banda Aceh 23111, Indonesia

\*email: niz4muddin@unsyiah.ac.id

**Abstract.** There are a lot of renewable energy potentials that is spread in numerous locations in Aceh Province. These potentials can be developed into energy source that can be utilized to fulfill the need of energy in the area. It is unfortunate that the information about the potentials is still hard to find, regardless the abundance of spatial data that were produced during the rehabilitation and reconstruction process, including data related to the renewable energy. Therefore, this research was conducted to develop an application of information technology, especially Web Geographic Information System (GIS) for renewable energy potential. The objective of this research was to fulfill the needs of relevant agencies for the Web GIS-based information technology applications to manage information on renewable energy potential in an interactive and integrated way. This research used components of Free Open Source System (FOSS) to develop a Web-based geospatial information technology application. The component consists of GeoServer as a GIS server, PostgreSQL as a geographic databases management system, QGIS as Desktop GIS for spatial data preparation and GeoExt as the framework in developing user interfaces for the Web GIS. The result of combining those components was a Web GIS that displayed areas with its renewable energy potential which was organized for each area along with legends for the map information. The Web GIS is equipped with search feature and tooltips function to select any areas and bring up detailed information of renewable energy potential of the area.

## 1. Introduction

Aceh is one of the provinces in Indonesia that is rich in oil, gas, and also other minerals. Oil and natural gas, along with other minerals give the largest contribution to Aceh's local revenue. However, the management and utilization of mineral resources and renewable energy in Aceh is facing problems and challenges that increase every year. Exploitation of natural resources that ignore spatial aspects in a continuous manner will cause environmental carrying capacity to be exceeded. This is because the geographical information on mineral and renewable energy potential itself is not integrated with other



geographical information such as utilization of land, including forest protected areas, data infrastructure, and settlements.

This article discusses a solution of the problem of managing information on mineral and renewable energy potential that has been described above. The development of information technology applications, interactive Web-based GIS is one of the solutions for the integration of information on mineral and renewable energy potential in Aceh.

## 2. Literature

### 2.1. Geographic Information System (GIS)

Web-based Geographic Information System or WebGIS is an application that can be accessed via the Internet to manipulate, analyze, store, and use GIS features without having to use GIS software.

### 2.2. Geoserver

GeoServer is open source web server software. GeoServer provides features for reforming, abolishing, inputting, and publishing geospatial data using a Web Feature Service (WFS), which can be done via online and offline [1].

### 2.3. GeoExt

GeoExt is an Open Source JavaScript Framework and used to build GIS-desktop application that provides a web service to make the basics of web based mapping. GeoEXT combines GIS functions of OpenLayers and user interface of Ext JS Library. GeoExt also provides services for accessing information on the services of Open Geospatial Consortium (OCG), the object OpenLayers and other remote sensing data [2].

### 2.4. PostgreSQL

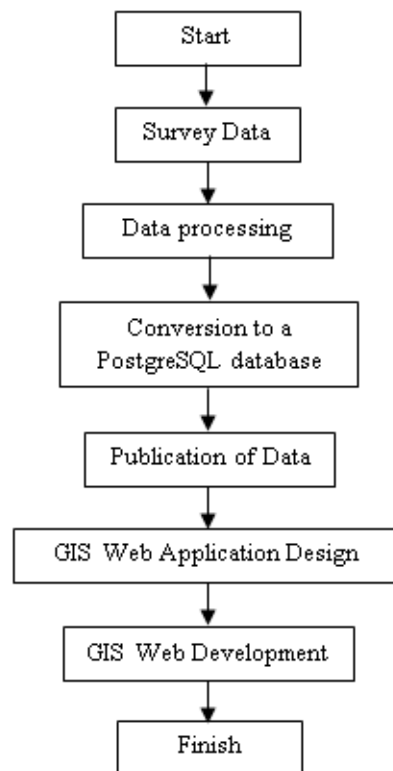
PostgreSQL is one of database (Object-Relational Database Management System) that offers great flexibility, stability and high performance. PostgreSQL database can be used on multiple platforms and supported by many programming languages such as Java, Perl and PHP. PostgreSQL provides flexibility for users to add data types, functions, operators, aggregates function, methods of indexing and procedural languages. One capability of PostgreSQL is to store geospatial objects as data in a database. To accommodate spatial data, PostgreSQL required one spatial extension, which is named PostGIS. This extension also allows users to perform analysis and processing of geospatial data [3].

## 3. Research Methods

Web GIS development process flow to integrate the information of mineral potential and renewable energy in Aceh can be seen in Figure 1. The method used in this study was established based on the study of the literature on the potential of mining and renewable energy in the area. The data were obtained by collecting data directly from the relevant departments or agencies in the city or district and also from the annual reports of the relevant subject in the province.

Identification, verification and standardization were the next step that must be done during the data processing stage. This stage was conducted to determine the aspects of data and information were correct and to ensure all the data were going to be published were in conformity with the standards of geospatial data. The next stage was to build a geodatabase using PostgreSQL with the PostGIS extension. All of the data that have been verified was inserted into the database.

Publishing online geospatial data and information services were the most important stage in the development of a Web-based geospatial information technology application. The Web-based GIS utilized this service, which allow geospatial data and information to be accessed from anywhere using a web browser or a desktop GIS. This study used GeoServer software to publish geospatial data into an online service.



**Figure 1.** Process Flow Diagram of Web GIS Development

Architectural design for Web GIS to integrate information of renewable energy was implemented using Open Source applications of OpenGeoSuite. WebGIS application system architecture was supported by the GeoServer application, PostgreSQL database, OpenLayers and Framework GeoEXT. The complete list of software used for developing the Web GIS is shown in Table 1.

**Table 1.** Software used for developing the Web GIS

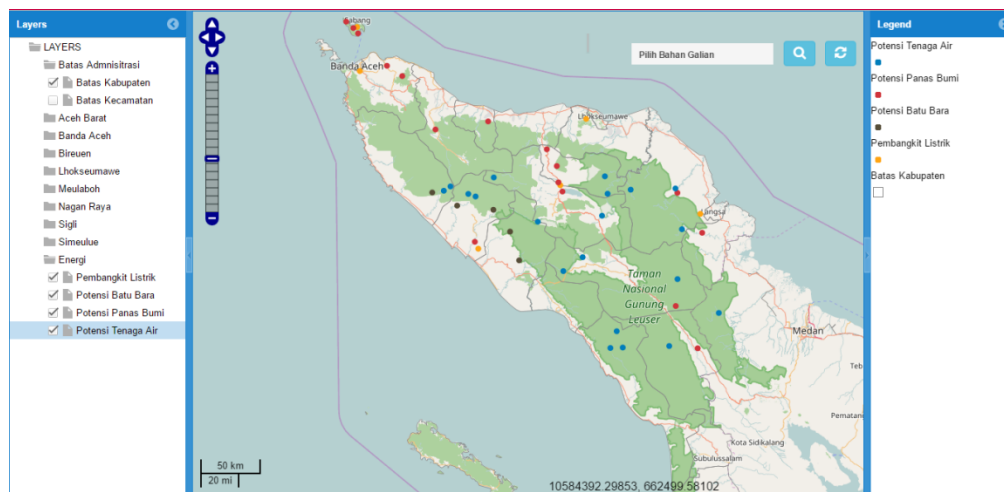
Application	Purpose
PostgreSQL/PostGIS	Database server with spatial extension
GeoServer	GIS Server for publishing OGC web services (WMS, WFS)
JavaScript	Programming Language
Openlayers/GeoExt	Library for WebGIS GUI
Apache	Server for Web GIS

#### 4. Result and Discuss

After all of the research stages were carried out, the Web GIS for mineral and renewable energy potential of Aceh Province was realized. The GUI of the Web GIS is shown in Figure 2. The main page of the Web GIS shows the whole map of Aceh which is equipped with a list of map layers of mineral and renewable energy potential in Aceh. The important features included in the Web GIS are as the followings:

- **Legend**, which explains the meaning of symbols used on maps displayed in the Web GIS. Legend will appear every time a spatial data layer on the left panel is enabled via check boxes.

- **Map layers**, which is a menu list of maps related to mineral and renewable energy sources that appear on the left side. The list is organized as tree layout of folders. The folders are added in order of the registered layer name so they will appear organized. They are labeled with districts or cities in the province. Guests can access the information about the locations of renewable energy in each district or cities. Renewable energy information includes geothermal energy and hydropower.
- **Tools Map Navigation**, which is a feature used or navigating the map, such as zoom-in and zoom-out to change the scale of the map.
- **Popup Information**, which displays that additional detail information on a feature in the map. The information is shown in the form of material name, area code and minerals information. Popup will appear when user clicks on one area of the map. This process of showing extra details for each feature on the map utilizes WMSGetFeatureInfo from the OpenLayers library.
- **Search Menu**, which serves as a search menu that can be used by users to search information based on the attributes of the map layer. Users can search for mineral deposits that is scattered in several districts or cities. To perform a search, user can choose the name of mineral to be searched, and then press the search button on the right side. Results of the search will be shown as symbolized points in the current map layer.



**Figure 2.** Main Display of the Web GIS

## 5. Conclusion

The study has developed a WebGIS application that displays spatial and non-spatial information regarding mineral and renewable energy potential in Aceh which organized by the district. The application can facilitate user in finding information on renewable energy potential, such as potential of geothermal and hydroelectric power in the province.

## References

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