Prototype of Remote Sensing Data and Information System Based on Open Source Technology to Support Disaster Management

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Abstract. Fast, precise and accurate remote sensing information is expected to increase support for disaster management in building an accountable disaster management system, as well as being a reference in disaster emergency response activities, according with Law No.24/ 2007 about disaster management. One of the functions of the Remote Sensing Utilization Center (Pusfatja) is to disseminate remote sensing information to users according to the Law Number 21 of 2013 Article 22 paragraph 1. The purpose of this project is to analyze the web-based information and disaster data systems. The method is used in this project is to make this system using open technology. The steps are taken in this project are identification of technological components and general architecture evaluations to facilitate the development, design and implementation of the system by updating, repeating testing and integrating open source software. The results showed that the system using prototype could implement and teste successfully. The prototype fully operate can be developed so that it can use for decision makers as a response to disaster activities in Indonesia and also as a reference in innovating technology and Geospatial information.

Keywords: Disasters, Emergency Response, Dissemination, Web Mapping, Opensource, Geospatial.

1. Introduction

The State of Indonesia has geographical, geological, hydrological and demographic conditions that enable disasters, whether caused by natural factors, non-natural factors or human factors resulting in human casualties, environmental damage, property loss and psychological impact. In accordance with the mandate of Law No.24 of 2007 on disaster management, the government and regional governments are responsible for the implementation of disaster management, from the pre-disaster stage, during the disaster to after the disaster [1]. The use of geospatial data and information in Indonesia is currently still experiencing various obstacles, one of which is the aspect of geospatial data and information. Many mapping activities that have produced geospatial data and information have been carried out, but the management system has not been given enough attention so that for the development and construction of a disaster management system there are many obstacles and there is still a lack of information and difficulties in accessing. The National Aeronautics and Space Agency in this case the Remote Sensing Application Center (Pusfatja) is ready to carry out the dissemination function of remote sensing information for the users according to the Law of Space Number 21 of 2013 Article 22 paragraph 1.

To overcome the problems mentioned above and support the development of data and information based on remote sensing data to the user in Indonesia. It is therefore necessary to develop the Disaster Management of the National Earth Monitoring System. This system is one of the main supporting facilities for the development and development of disaster mitigation in Indonesia as well as the service process of exchange and dissemination of geospatial data and information on natural disasters between institutions and the wider community both central and local government. One of the technologies that can be used to support it is Remote Sensing Technology and Spatial Information and

Communication Technology. The advantage of such technology is to have a wide, actual, and fast coverage and have excellent historical data. Spatial Information Technology and Communications allow users to obtain remote sensing information easily, quickly and accurately. It is a challenge for Pusfatja to continue to develop methods on the system of data presentation and spatial information remote sensing, especially better disaster information that can be trusted. This study aims to analyze the availability of data management and spatial information in disaster emergency response in Indonesia. So that will know the process of management of data availability and spatial information disaster good and efficient for disaster emergency response information user.

2. Research Methods

This Application Development is carried out with *Prototyping Development Methodology With Open Source Software* [2]. The implementation emphasized on the integration and practicality for the needs of users in the form of multi-application GeoFOSS (*Geospatial Free and Open Source Software*) through a process of revamping various building components to obtain a simple system with the term reengineering, namely the process of technology analysis to identify component components and their relationships and develop systems in a new form.

The stage of gathering requirements or initial requirements in the prototype with Open Source Based Software is carried out by searching for components that can be integrated.

In this study the steps taken are:

- Identify technological components and evaluation of the general architecture to facilitate the development.
- Rapid design and system implementation with repeated test updates and Open Source Software Integration.
- Implementation of prototypes into complete systems that operate in full.

2.1. General Architecture

This system adopts the general architecture of Spatial Information Infrastructure by following the conceptual Software Three-Tiers Archiatecture, compatible with proposal of Geospatial Free and Open Source Software (GeoFOSS) for Spatial Data Infrastructure (SDI) as shown in Figure 1 [3].

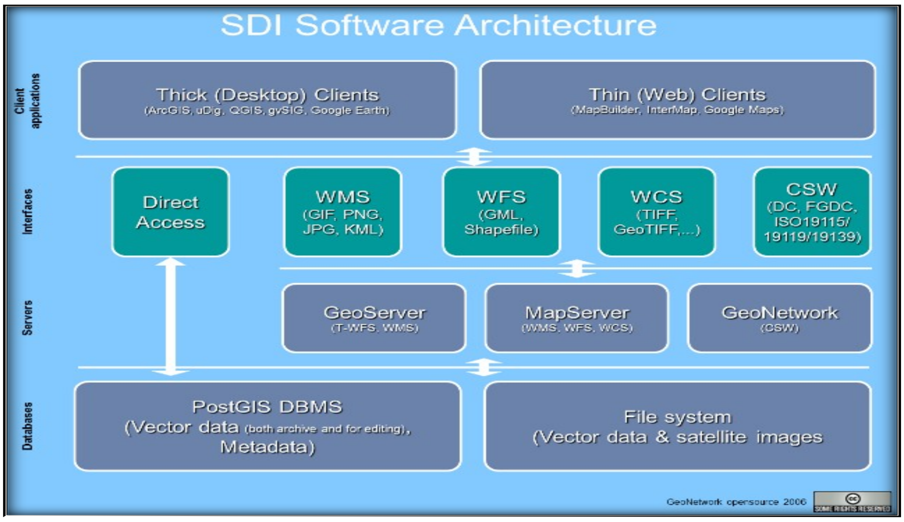

Figure 1. SDI Software Architecture [3].

The architecture is an established design pattern and software architecture, where the functional logical storage process, data access and user interface are developed and maintained as free modules

on separate platforms. *Tier* or *layer* on the architecture allows to be upgraded or replaced independently.
The read operation describes the access flow of information in an architecture, starting from the database layer through the server layer and interfacing to the Desktop GIS application layer or Web Browser. The Write operation describes the reverse information access flow from read operations.
The following sub-section discusses the components and functions of each tier or layer and logical structure of the read and write operations process information.

2.1.1. Data Base Layer. At the bottom tier or layer, integrated, compiled and customized storage in the form of database server and remote sensing information file system in order to achieve more efficient data management.
PostgreSql/PostGIS software [4, 5] is used as a Spatial Database Management System (DBMS) The server is compiled and customized for remote database management of remote sensing information and File governance systems or satellite image raster files in GeoTiff format.

2.1.2. Interface and Server Layer. In the middle layer is compiled, customized and integrated all services that help accessibility to the spatial information repository utilization Remote sensing. The middle layer also provides direct access services to remote sensing information databases with advanced queries and information load analysis. Spatial Information Infrastructure has 3 (Three) main server, namely: Map Server; Web Service Server; and Catalog Server.
Servers distribute and serve the contents of remote sensing information to the web, based on standard interfaces (eg Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS), ISO (19115/139) to facilitate access and use of information remote sensing online.

2.1.3. Application Layer. At the top layer are users and applications. Access to the information content of remote sensing utilization is possible either through the Desktop as well as the Web client. Desktop clients can be software packages with Geovisualization capabilities and GIS Desktop functions, such as GIS software packages (ArcGIS and Quantum GIS) or Map Viewer (Google Earth).
Suatu aplikasi Web GIS terdiri dari tumpukan perangakt lunak (stack of software) yang mampu melayani informasi penginderaan jauh melalui web. Struktur arsitektur akan mempertimbangkan dan mengacu pada komponen-komponen perangkat lunak lengkap untuk memenuhi kebutuhan atau persyaratan yang ditentukan oleh Model Pelaksanaa FreeGis [6].

2.2. Open Technology Survey
The open source technology survey focused on Open Source Software packages released under the General Public License (GPL) -like license, adopted by an active community, supports standard, stable and reliable formats [7].
The main technology and the Implementation Model are chosen in order to manage, discover, analyze and disseminate information, so that the System can be built and operated easily. The following software is considered and involved in the design of the prototype of the above-mentioned system. [6]**:**

- PostgreSQL Software (http://www.postgresql.org/). PostgreSQL is a very sophisticated open source DBMS,
- PostGis Software (http://Postgis.refractions.net/). PostGis adds support for geographic objects to the PostgreSQL DBMS, following OpenGIS Simple Features Specification for SQL,
- Geoserver Software (http://geoserver.org) is the most widely used WebGIS software.
- PyWPS Software (http: //pywps.wald.org intevation.org). PyWPS implements Web Processing Service (WPS) standards, provides geoprocessing functions,
- GeoNetwork Software (http://geonetwork-open source.org/), GeoNetwork is a catalog application for managing spatially referenced resources,
- OpenLayers Software (http://openlayers.org/). OpenLayers provides the Javascrtipt Application Program Interface (API) to integrate dynamic maps into web pages with ease.

- GeoNode software. GeoNode is a Geospatial Content Management System. GeoNode is built from open source project components: PostGis, GeoServer, Pycsw - CSW Metadata Catalog, Geospatial Pyton Libraries and OpenLayers-GeoEx

2.3. Web GIS Application Method

There are several stages done in the development of geographic information system application of this geography, namely: 1) Define the system - Development of GIS Web applications and the arrangement of integration and presentation of dynamic spatial visualization of geospatial information; 2) Determine the software component - This activity only takes into account GeoFOSS; 3) Building a prototype - This activity is intended to develop prototypes that have been defined by Installed, configured and Customize; 4) Determining and populating information - sets of information used in the form of geospatial information as well as integrating into GIS Web applications; 5) Test and evaluation - this activity is carried out to ensure all functions of the system are available and running as expected; 6) Operation and system support - GIS Web Application enters the operational and support stage. During the operation of the GIS Web application needs support in the form of maintenance.

Soft-line technology used in data presentation systems and remote sensing information is OGC-rated software, namely: GeoNode application. GeoNode is a geospatial content management system, a platform for the management and publication of geospatial data. It is a more mature and stable open source software project under a consistent and easy-to-use interface that allows users to share data and create interactive maps.

GeoNode is an open source project developed to support the development of web-based geographic information platform information and spatial data infrastructure [8]. GeoNode [9] is designed to be further developed and can be integrated on existing platforms and can be one of the nodes application of spatial data infrastructure (IDS).

GeoNode is built from the open source project component, the GeoNode component is: 1) PostGis - Spatial Databases [4, 5]; 2) GeoSever - OGC services [10]; 3) Pycsw - CSW Catalog metadata [11]; 4) GeodDjango [12]; 5) OpenLayers and GeoExt [13].

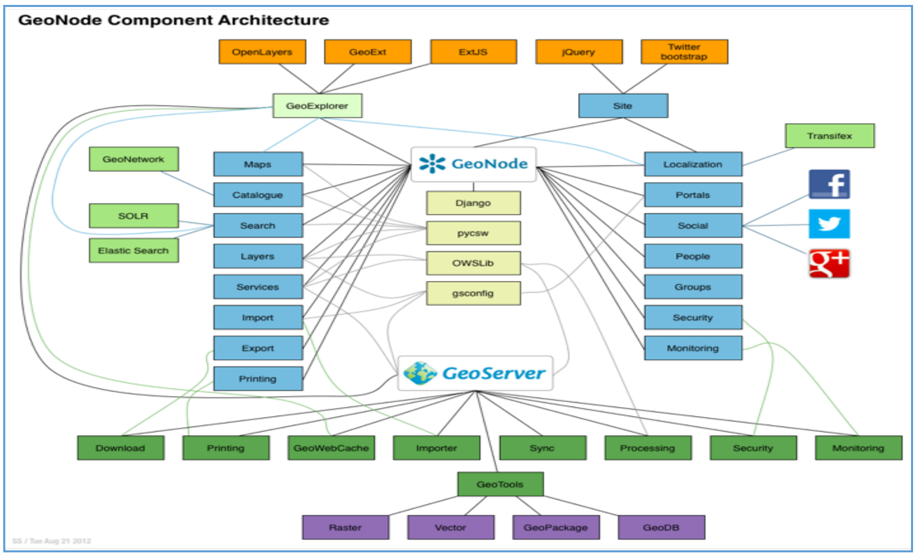

Figure 2. Geonode Architecture.

GeoNode applies GeoServer as an application that functions as a webGIS service. GeoServer allows us to publish data from various sources using protocols and standards from OGC.

The Catalog and metadata system is also supported by GeoNode by applying pycsw as a catalog and metadata service provider. GeoNode supports OGC standard services: 1) Web Map Service (WMS) for map drawing; 2) Web Feature Service (WFS) for vector information; 3) Web Coverage Service (WCS) for raster information; 4) Catalog Service for Web (CSW) for catalog information.
GeoNode is built using authentication framework and integrated with GeoServer. Layer and map ownership and permissions can be used to share data. These rights include, read, write, and make changes to the permissions. Data can be presented publicly or specifically to other users or user groups. GeoNode allows users to upload and manage spatial data over the web.
The uploaded spatial data can be used as web service according to OGC standard ie WMS and WFS [14]. Such spatial data may be available and may be processed by other users in creating maps and cartography. Supported features include: GeoExtpoler client, cartographic editor, interactive multi layer map, and can share and include maps in other web.
GeoNode can serve as a geospatial portal that provides spatial data exploration and search. GeoNode makes it easy to do visualization and use of the spatial data and allows users to upload and manage spatial data over the web.

3. Results and Discussion

Prototype system for presenting data and remote sensing information to support disaster management. This system is built on the web by using GeoNode application.
With this system is expected the user can access the spatial information disaster quickly and accurately online through the web browser. Spatial information is stored in a DBMS spatial database that uses PostGis software. Spatial information is in the form of layers, thematic maps, and some documents.

3.1. Layer

Layer is the main component of GeoNode. Layers are publication resources that represent spatial data sources in the form of raster data or vector data. Layers can be associated with metadata, ratings, and comments.
These layers are grouped by specific categories that include: Climatology Meteorology Atmosphere, Elevation, Environment, Farming, Location, Oceans. These layers contain the results of information extraction from remote sensing satellite imagery that has been widely used by the community. The following is an example of a layer view.

3.2. Map

The Map is one of the main components of GeoNode. Map consists of various Layer and style/Legend of the layer. Layers can be spatial data contained in local servers in GeoNode as well as spatial data coming from servers outside of GeoNode served from other WMS (Web Map Services) servers or by web service layers like Google or MapQuest. WMS is part of the Open Geospatial Consortium standard that manages the delivery of processed data to users via tools. By clicking on the map link, we will get a list of all published maps.
Maps can be created based on uploaded layers, combine them with existing layers and layers coming from web services, then share the resulting map for public view. Figure 3 sample map view (map) designed on the system. The Map (Map) in Figure 3 is constructed from the tsunami and earthquake disaster response layers in Palu (Central Sulawesi). Another example picture of 4 maps made tsunami disastern response layers in the Sunda Strait. Figure 5 flood disaster response map in Cilacap.

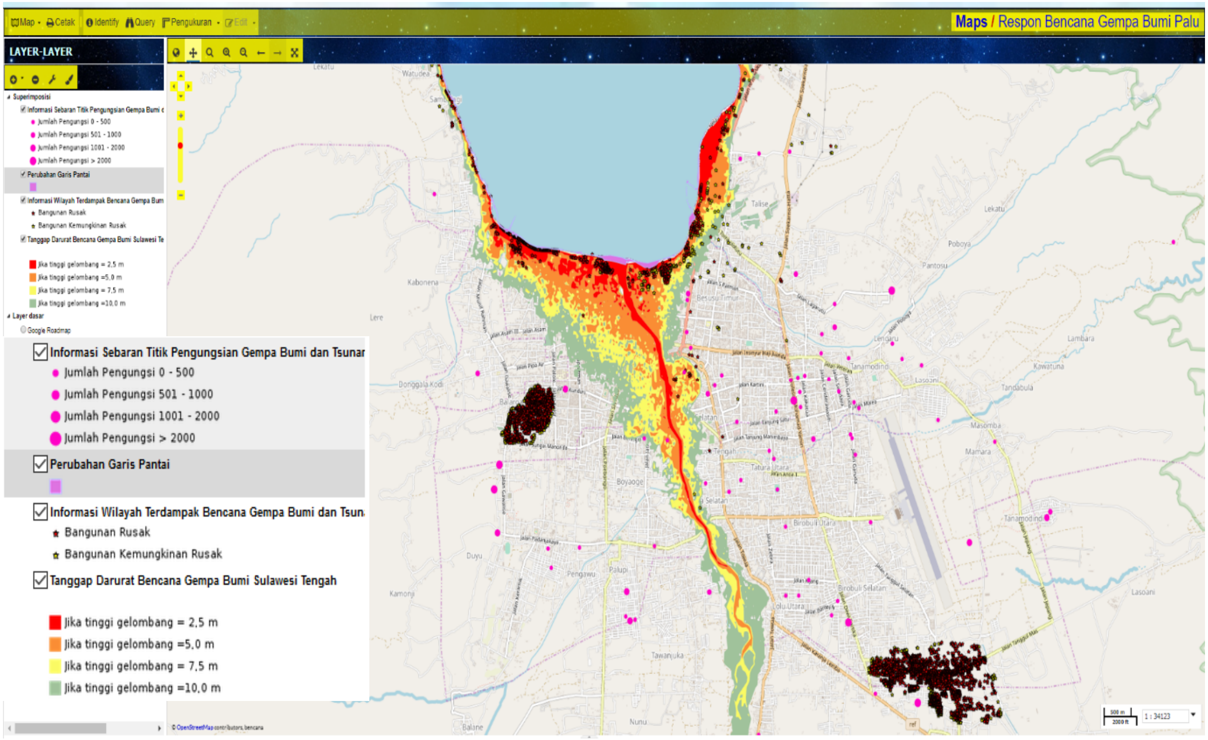

Figure 3. Map of earthquake disaster response in Palu (Central Sulawesi).

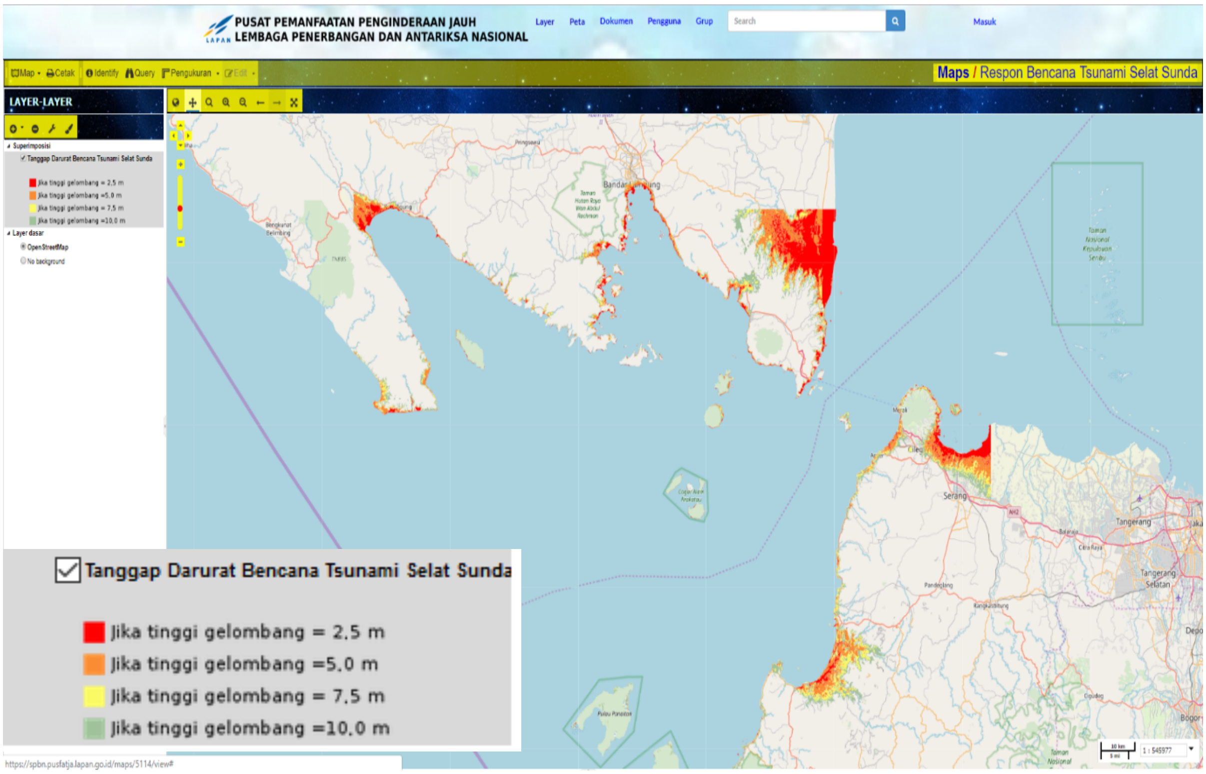

Figure 4. Map of Tsunami Disaster respones on sunda strait.

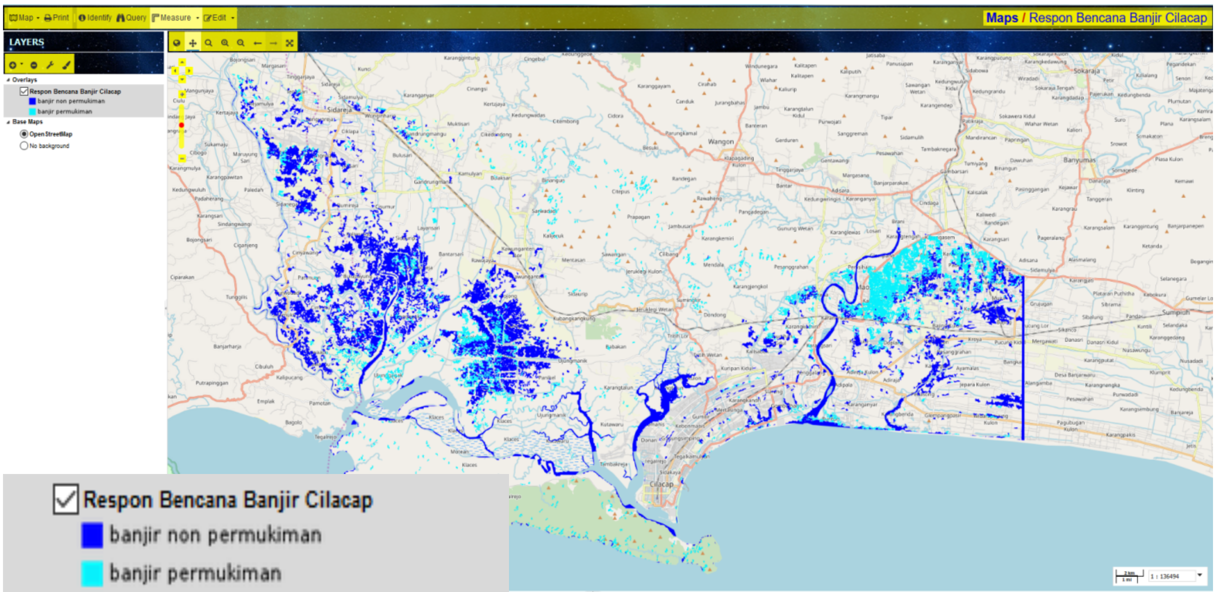

Figure 5. Flood disaster response map in Cilacap (Central Java).

In Map view there are a number of facilities / tools such as facilities based on export map into image file or html; facilities for printing maps; facility for object layer identification based on attribute table; facility to perform Query based on attribute table; facilities to measure distance and extent;

Figure 6. Facilities / Tools in Map.

4. Conclusions

Application of data presentation system and remote sensing information based on open source is expected to disseminate spatial and textual information of remote sensing utilization result implemented by Pusfatja LAPAN. This system integrates all the information results of remote sensing utilization and provides ease of access that is widely reachable by the user community.
Users can easily apply dynamic spatial visualization presentations, perform web mapping operations functions and spatial analysis of remote sensing-related information utilization to support and realize disaster preparedness and response so that management of Indonesian goes well.
Presentation system application of data and information based on Open Source allows its users to create and innovate in modifying the system according to the needs and characteristics of each. It is expected that this system can bridge between the users concerned especially in the scope of the utilization of national remote sensing.

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