THE REAL TIME PARTICIPATORY MAPPING FOR DISASTER AND EMERGENCY PREPAREDNESS MODEL: A Case study of Teachers Involvement in Center Sulawesi-Indonesia

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Abstract

The Real Time Participatory Mapping for Disaster and Emergency Preparedness System (RT-PADEPS) has an significant play role for disaster management. It is an idea to adopt open web standards to share a map services based on Participatory Geographic Information Systems (P-GIS) and Spatial Notification for emergency condition such as disaster, accident, emergency condition, Etc. The objective of this paper is to develop collaborative web Geographic Information System (Web GIS) based on the real-time geotagging emergency occurrence. This model was generated due to a case study aftermath earthquake and tsunami in Palu-Center Sulawesi, Indonesia. This system was not only applied to noticed heartbreak condition, but also it could be used to estimate or analyze a certain area affected by disasters and damage building/facilities. Moreover, it obtained to show the real existing accessibility and the fastest route to impacted area. Finally, the system could connect the user and the authorized agency to inform or take immediate action for handling the emergency condition. Integrating the spatial information with web GIS and mobile platform, it can quickly and accurately collect and share the information as soon as possible implementation.

Keyword: disaster, emergency, GIS, RT-PADEPS, spatial

1. Introduction

Background

Indonesia is located within ring of fire and it is extremely vulnerable by natural disaster. As known that this tropical country has a lot of abundance natural resources, but it has appeared to face a complex geographic conditions. In addition, Indonesia also has human resources that they are distribute in villages level and urban areas. The most area of Indonesia are prone to natural disaster such as earthquake, tsunami, and volcano eruption (Kusumastuti *et al*. 2014), and liquefaction. Government of Indonesia recorded that there are many natural disaster occurred in the period 2000-2018. A couple tragedy, earthquake-tsunami-liquefaction, were happened in Center Sulawesi in September 2018. It can be impacted to the people who live in the vulnerable disaster area such as coastal zone.

A disasters occurrence and following an emergency conditions can be happened anywhere and anytime. In these cases, it is required a quickly and appropriately action in order to carry out a technical assistance by local and national government level and to take care a victim and impacted area aftermath disaster. Instead, reliable system and its easy operation which are adopted and optimized using available resources and facilities at certain locations and regions can be quick handled if we have a model RT-PADEP. As a consequence, human resources are needed to collect, scene and provide a valid source of information. Integrated into spatial technology as tools is expected that human resources can be optimized through Participatory Geographic Information Systems (PGIS) (Forrester and Cinderby, 2015).

The RT-PADEP is an idea to adopt an open web standards for the sharing of map services based on (PGIS) and Spatial Notification for emergency condition such as disaster, accident, emergency condition base on real geo location. This system

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can operate by government, school, volunteer or private institution to support an authorized agency or decision maker for taking quick action and deal with emergencies and post-disaster management processes.

Objective

Objectives of this project are:

1) To develop an integration of web GIS base on real-time geotagging emergency occurrence.
2) To conduct the capacity building of vocational teachers and communities for increasing their attitude, knowledge and skill and improving a participatory mapping of emergencies and disasters preparedness management.

2. Literature Review

Collaborative Mapping of School Community

A risk disaster is a potential loss of life, injury, destroyed, and damaged assets which could occur to a system, society or a community in a specific period of time. It is determined probabilistically as a function of hazard, exposure, vulnerability and capacity (UN-ISDR, 2017). Identifying and quantifying of risk (spatially), will assess leveling of hazard intensity and vulnerability magnitude (Peggion *et al*., 2008). These targets are to optimize source of spatial collaborative information approach using Geographic Information System (GIS) technology.

As known that GIS is the best tools for understanding and collaborating of gathering, managing, and analyzing data. GIS is a framework for gathering, managing, analyzing and integrating divers types of data. Now a day, using an online platform (for instance: web-GIS and/or mobile devices) has improved an unique capability of GIS and analyzed spatial location and organizes layers of information into visualizations. These technology have revealed that they can also use to analyze a deeper insights data to be a patterns, relationships, and situations information (ESRI, 2018). Instead, evolving web-GIS and/or mobile device can help users to make more faster, smarter and accurate decisions on managing natural disaster.

There are a lot of source information to implement GIS technology for gathering data specify for identifying and quantifying of risk spatially. A participatory mapping collaboration through a school community is interested to develop how to manage affected area by disasters. This concept has provided a benefit for the senior vocational school in Indonesia (example: schools can becomes a hub of information rapidly and accurately). In addition, we can also improve understanding and knowledge about mitigation, preparedness, emergency toward an increasing a knowledge aftermath disaster.

Participatory Mapping

Participatory mapping is the "bottom-up approach" that allows the communities to create maps for a certain users. In contrast to the traditional "top-down approach", relying on those with the power and resources to create maps that it will benefit the masses either directly or indirectly (Warner, 2015). With some modification and newer tools, participatory mapping approach can implement with interactive, rapid and accurately. The contributors can send and share data and information to support decision makers to carry out actions or policies base on spatial analysis every time and everywhere.

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Cloud Computing

Cloud computing is technology to distribute data processing in which some scalable information resources and their capacities are provided as a service to multiple external customers through Internet technology. There are three basic concept of cloud computing, as follow: first, **IaaS** (Infrastructure as a Service) – A computer infrastructure, typically presented in the form of virtualization. Is a service within the concept of cloud hosting. Second, **PaaS** (Platform as a Service) – An integrated platform for the development, deployment, testing and support of web-applications. Presented as a service on the basis of the concept of cloud hosting. And third, **SaaS** (Software as a service) – Is the business model of software license, which involves the development and support of the software vendor. Customers also have the opportunity to pay and use of SaaS, usually through the Internet. In this research, SaaS (Software as a service) concept will implementing by geo-processing service application for spatial data. Connecting information base on locations and data sharing using interactive interface will increase the ability of the system and the community that will use it.

Methodology

Project Site

There were two locations which was trial for the implementation of the Real Time Participatory Mapping for Disaster and Emergency Preparedness System, namely the Palu City and Sigi, Center Sulawesi.

Figure 1. Project Location

Required Data

Several types of spatial data were used in this project. Imagery, base map and thematic data were obtained from the government's portals. The validation data were acquired by direct field survey. All requirement data as shown in Table 1.

No.	Data	Scale/Resolution	Format	Source
A	**Imagery Data**			
1	Very High/High Resolution Imagery Data	0,5 -20 m	raster	Government, Private
2	DEM	10 m	raster	Government, Private
B	**Base Map Data**			
1	Administration	1:25.000	vector	Government, Private
2	Road Network	1:25.000	vector	Government, Private
3	Facilities (School, Hospital, Police Office, Evacuation route and point, etc.	1:25.000	vector	Government, Private
4	Contour	1:25.000	vector	Government, Private
5	Land Cover	1:25.000	vector	Government, Private
C	**Thematic Data**			
1	Historical Disaster	1:50.000	vector	Government, Private
2	Climate	1:50.000	vector	Government, Private
4	Regional Spatial Plan	1:50.000	vector	Government
5	Population	1:50.000	vector	Government

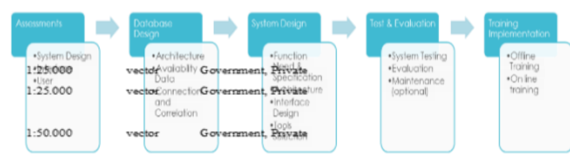

Table 1. Data Required

Method

This Project was focus on developing database and formatting various standard spatial data, development The RD-PADEPS and community training. Those activities were used for processing data from various scale and resolution with preprocessing and spatial analysis approach. Web-GIS of The RD-PADEPS were consist of three main components (Figure 2).

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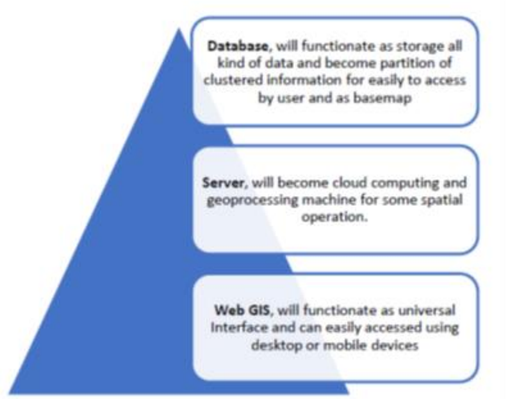

Figure 2. Main components Real Time Participatory Mapping for Disaster and Emergency Preparedness System

The development of the RT-PADEPS was divided to five major steps of design, namely: assessment, database design, system design, test & evaluation, and training implementation (Figure 3).

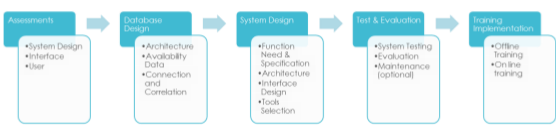

Figure 3. Development of System Design Processes

Architecture

The RT-PADEPS was an optimizing capability of Geo-processing services. Geo-processing service is the powerful analytic capability of ArcGIS to the World Wide Web. A geo-processing service contains one or more geo-processing tasks and will running on a server, where its execution and outputs are managed by the server (ESRI, 2018). User will be divided into two categories: (1) admin with full management capability, and (2) user with limited capability. This method is way to link, analyze and publish spatial data with easily. Figure 4 present a detail architecture of Geo-processing Service.

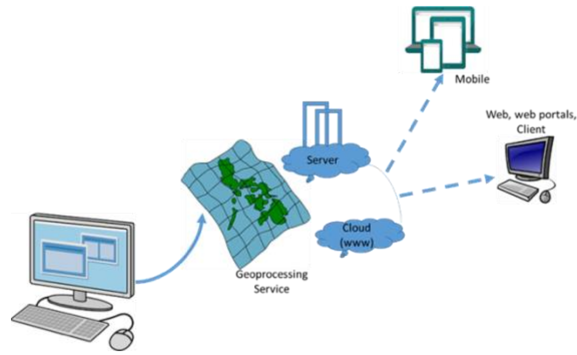

Figure 4. Geo-processing Service

Expected Result

Expected result from this project was web-GIS application that it can be implemented for participatory mapping for disaster and emergency management. It can easily accessed using desktop and mobile devices and it will be supported emergency action and as decision support from authorized agencies as well. The design model of the RT PADEPS is presented in Figure 5.

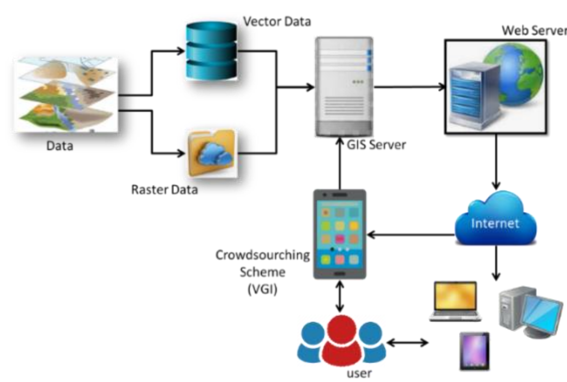

Figure 5. The RT-PADEPS Design Model Expectation Output

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3. Briefly Result and Discussion

Focus Group Discussion (FGD) and Rapid Survey

Several activities were initiated and implemented by BIOTROP SEAMEO as the initial stage to develop the RT-PADEP Project. Those activities were carried out using Focus Group Discussion (FGD) to assess an disaster impact within affected area. FGD was conducted in The State of Vocational High School 1 of Sigi (later it is called SMKN 1 Sigi). This event was attended by teachers of this school. This activity was focused to explore and assess appropriate data and information on disaster affected areas in Sigi Regency. Meanwhile, spatial data collection and rapid survey were conducted using drones in **several disaster impacted areas, both in the** school environment and in several other affected locations.

FGD result shown that all building of SMKN 1 Sigi had appeared on damage condition that they were hit by an earthquake on 28 September 2018. Regarding this FGD, the participant proposed three programs as follow: (1) School building reconstruction; (2) Rehabilitation school garden, including fruit garden development; and (3) increasing capacity on disaster mitigation and risk reduction management. The last program is highly related with the RT-PADEPS. The FGD's participant mentioned that they did not have any management system how to assess and calculate lost and damage of the facilities and building because they did not have any appropriate data base before disaster.

Prototype of System

Base on the result of assessment, team researchers were initiated the RT-PADEPS as a case study of Center Sulawesi affected area aftermath disaster. The RT-PADEPS designed a prototype of the model. The main interface was consist of several facilities i.e. layer data, main map interface and graphical interface. Layer data displayed all supporting format data such as vector data, rater data and numeric data. Main map interface shown and overlay all data from several sources and the graphical sub system displayed a graph format of existing data. The base map of main interface data can change using some types of data i.e. topographical data, open street map (OSM) data, imagery data or administration data. A detail of prototype of interface the RT-PADEPS prototype system is presented in Figure 7.

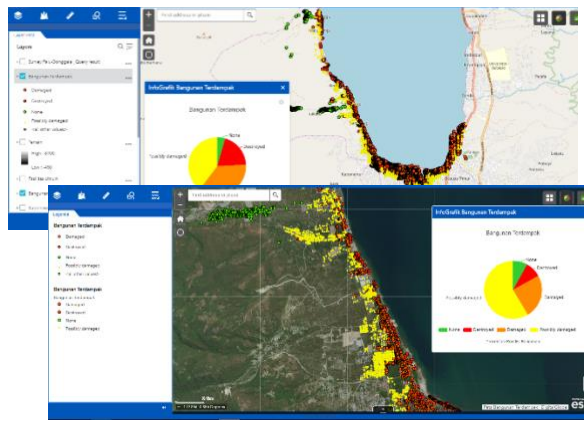

Figure 7. Prototype of Interface Real Time Participatory Mapping for Disaster and Emergency Preparedness System

Capability of the RT-PADEPS is the system that it can be directly presented area, building or facilities that affected by disaster. The information can be calculated using data and information that they were collected and sent from the contributor i.e. school community.

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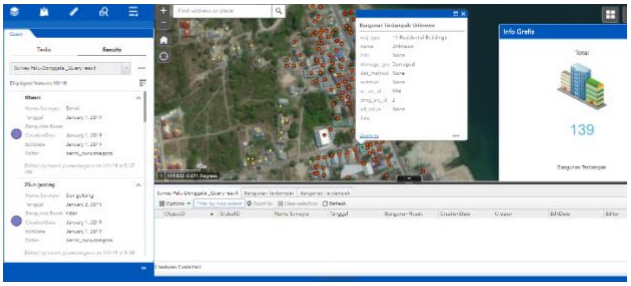

Figure 8. Real Time Participatory Data

Regarding an initiation development, The RT-PADES system also allowed us to compare the existing condition between before and after disaster using time series imagery data with swipe menu. Figure 8 present swipe menu for comparing before and after disaster.

Figure 8. Swipe Menu for Comparing Before and After Disaster

Future Model Development

BIOTROP Spatial Development Planning

SEAMEO (Southeast Asian Ministers of Education Organization) was established in 1965 through the SEAMEO Charter signed by seven (7) South East Asia countries. The signing of the charter marked the establishment of this center. At present there are 21 specialist institutions that undertake training and research programs in various fields of education, science, and culture. SEAMEO BIOTROP, the Southeast Asian Regional Centre for Tropical Biology is one of the centres. Related to the BIOTROP Mission that is "To provide scientific knowledge and build capacities of institutions and communities in conserving and managing tropical biology sustainably for the well-being of communities and the environment of Southeast Asia", development of spatial technology will become important concern.

BIOTROP has comprehensive spatial laboratory namely Remote Sensing and Ecology Lab. With several mapping equipment support, software and spatial databases, BIOTROP is become a leading centre in developing spatial technology and research and welcome for cooperation and collaboration project and research.

Roadmap Model Development

This prototype model still requires to be development and refinement, both in terms of infrastructure, capabilities and facilities that can be operate properly. In addition, it also requirement of funding support from other institutions to overcome on development of a disaster management system. For next phase, this prototype will be used on dissemination and testing for a training course on disaster mitigation and management for school that it will be conducted on 2019. A detail roadmap for RD-PADEPS as shown in Figure 9.

Figure 9. Roadmap of Real Time Participatory Mapping for Disaster and Emergency Preparedness System Presented

Modul Development

According to a prototype RD-PADEPS, Seameo Biotrop has defined two module training for the vocational teachers. *First one*, it will be used for fundamental-intermediate target of content. Regarding an assessment result, this level was

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consist of 8 topics as follow: (1) Introduction of emergency and disaster management, (2) Introduction GIS & remote sensing technology, (3) Introducing GIS software and tools (license and open source), (4) Utilizing GIS software and tools (license and open source), (5) Produce and editing spatial data, (6) Introduction of spatial analysis and image analysis for participatory mapping of disaster and emergency preparedness, (7) Layout, print, publishing map, and (8) Field trip (survey and practice).

Second one, the module has developed for advance target level and it was also consist of 8 topics, as follow: (1) data analysis for emergency and disaster management, (2) Introduction web-GIS, (3) Spatial data query, (4) Spatial model implementation for participatory mapping for disaster and emergency preparedness, (5) Using participatory mapping for disaster and emergency preparedness system and geoprocessing service, (6) Spatial analysis and image analysis for participatory mapping for disaster and emergency preparedness, (7) Layout, print, publishing map, and (8) Field trip (survey and practice)

Conclusion

As a case study basis, the RT-PADEPS is still needed improvement before it will be implemented for vocational senior high school. Instead, any other case studies and input data to be data base within GISweb as trial and error to become a good model on disaster mitigation and risk reduction management,

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