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Dual mitigation system : database system combination of EWS and APRS for disaster management (case study: Malang southern coast)

Aji Kusumaning Asri[a], Herfina Elyaa, Novita Duantari[a], Enira Suryaningsih[a], Leryan Dona Dony Donovan Victoria[a] *

[a]*ITS, Keputih, Surabaya and 60111, Indonesia*

Abstract

Malang Southern Coast is one of the areas highly potential in earthquake and tsunami. An effective mitigation system is needed to manage them. Dual Mitigation System is a system combining Indonesia Tsunami Early Warning System (INA-TEWS) and Automatic Packet Reporting System (APRS). INA-TEWS is a warning system when the earthquake or tsunami takes place. APRS is a radio system to share information digitally. Radio wave can work in emergency situation. The methodology used is by analyzing earthquake data as a foundation of location determination to Dual Mitigation application system. The location of Dual Mitigation System was tested by evacuation process speed and information of APRS. The results show that this system is an effective early warning system employing INA-TEWS data and it gives evacuation process in about 4-6 minutes and 7-10 minutes faster using vehicle and without vehicle by APRS compared to the existing conventional method.

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Keywords: APRS; Dual Mitigation System; Earthquake; INA-TEWS

1. Introduction

The tsunami is named from the Japanese words *tsu* which mean harbor and *nami* which means waves. Tsunamis are caused by any large-scale disturbance of the sea floor (Bulat, 2010). Since the Indian Ocean tsunami of 26

* Corresponding author. Tel.: +6285745053534; fax: +0-000-000-0000 .
E-mail address: akusumaning@gmail.com

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December 2004, there has been a surge of interest in developing early warning systems to cater to the needs of all countries and all hazards (Basher, 2006).

To reduce the victims disaster mitigation system is needed. Tsunami Early Warning System is a warning system when earthquake or tsunami happened. The system is made by microwave sensors that respond the wave with tsunami potential (Bulat, 2010). Communication of evacuation method is *Handy Talky*, rig, and *Single Side Band* (*Perka BNPB No. 3 Tahun 2014*).

In East Java, Malang Regency is a one of area with the high potential of earthquake and tsunami (*Maemunah,2014*). A large earthquake of magnitude M_w 7.6 (M_S 7.2) occurred off the southeast coast of Java Island, Indonesia at 01h 17m local time on June 3, 1994. The epicenter was at 10.5°S, 113,0°E (by NEIC, USGS) at 240 km from the nearest coast. (*Tsuji, 1995*).

Contingency planning is a planning to the unpredictable condition to prevent critical or emergency situation based on a scenario, purpose and determining technical action (*Perka BNPB No. 24, 2010).* In this paper, we introduce Dual Mitigation System as a mitigation system when earthquake and tsunami disaster happened.

Dual Mitigation System is combination system by Indonesia Tsunami Early Warning System (INA-TEWS) and Automatic Packet Reporting System (APRS). Early APRS known by Automatic Positioning Reporting System. APRS is a system of digital data delivery, improved by radio amateur in 1980 era. This system is used to send the location information based on geographical coordinate (*Dear, 2010*). Dual Mitigation System is a system that has never existed before. Using this system is expected can work effectively before, during, and after earthquake and tsunami. Because of this, this study is to test the effectiveness of *Dual Mitigation System* to disaster mitigation.

2. Methods

2.1. Tool and Data

Tools that is used in this research are GPS (Global Positioning System) Garmin Etrex 30 with 5 m resolution, Baofeng UV-82 Dual Band (HT/Communication Radio), Smartphone, Stationary. Software that is used in this research are PostgreSQL as data base system software, ArcGIS 10.2.2 as 3D modeling software, AutoCAD as evacuation route map software, and Microsoft Excel as data processor software.

Data that is used in this research are primary and secondary data. The secondary data are: earthquake data of Malang Regency in 2010-2015, DEM SRTM (Digital Elevation Model Shuttle Radar Topography Mission) data with 30 meter resolution around Malang Regency, Bathymetry data with 1 km resolution around Malang Southern Coast. And the primary data is the result of direct survey in Sendang Biru village using GPS and HT (APRS Tracker)

2.2. Determining of Disaster Prone Area

The determining of the area is based on secondary data got from Geophysics, Climatology, Meteorology Agency (BMKG) Tretes II of East Java. The data is resulted by analyzing process of INA-TEWS (Indonesia Tsunami Early Warning System). Earthquake wave recorded by seismograph and sent to Very Small Aperture Terminal (VSAT). The result is analyzed again using seismologist analyzing, sensor buoys and tide gauge. The analyzing result sent to INA-TEWS center in BMKG using VPN (Virtual Private Network) and retrieved by Decision Support System (DSS). DSS using four perspective to analyze. The perspectives are situation, observation, decision and product. The final result is seismisity data that sent using Digital Video Broadcasting or DVB (Lembaga Penelitian dan Pengembangan Kesejahteraan Sosial, 2010

Disaster-prone Area Map 2010 describe that south Banyuwangi to Pacitan is a disaster-prone area of earthquake and tsunami with > 8 MMI (Modified Mercally Intensity) scale (www.vsi.esdm.go.id, 2010). Sendang Biru village was chosen based special factor, there are:

a. Earthquake data in 8°-10°S and 112°-113°E between 2010 and 2015
b. Earthquake and 14 meter tsunami in 1994 with the magnitude 7,2 and the victim more than 250 people.

The data of epicenter locations is over layed with bathymetry and DEM SRTM data to make 3D Modelling using ArcGIS 10.2.2. Bathymetry data is got from GEBCO (General Bathymetric Chart of the Oceans) and DEM SRTM from USGS (United States Geological Survey).