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GEOSPATIAL FUNCTION IN TSUNAMI DISASTER MITIGATION

* **Olivia Oktorie**
Doctoral Program. Posgraduate. Environmental Science, Universitas Negeri Padang
Email: ochy.oliviaoktorie@gmail.com

*Corresponding Author, Received: January 17, 2020, Revised: March 10, 2020, Accepted: April 21, 2020

ABSTRACT

Geospatial data is generated from a combination of Mapping Science, Remote Sensing and Geography Information System (GIS). Scientifically, GIS is the key in strengthening the geospatial function in determining a location, pathways, and zones of an area, both for preparing disaster mitigation maps, disaster prone zones, and community evacuation locations. GIS has the ability to connect various data at a certain point on the earth, combine them, analyze and finally map the results.

Keywords: **Geospatial, Tsunami, Disaster**

INTRODUCTION

Geospatial data is generated from a combination of Mapping Science, Remote Sensing and Geography Information System (GIS). Scientifically, GIS is the key in strengthening the geospatial function in determining a location, pathways, and zones of an area, both for preparing disaster mitigation maps, disaster prone zones, and community evacuation locations. GIS has the ability to connect various data at a certain point on the earth, combine them, analyze and finally map the results. The data to be processed in GIS is spatial data, that is, data that is geographically oriented and is a location that has a specific coordinate system, as the basis for its reference. So the GIS application can answer several questions such as; location, conditions, trends, patterns and modeling. This ability is what distinguishes GIS from other information systems (Astrini, 2012; Hermon *et al*., 2017; Hermon *et al*., 2018). Novitasari (2011); Hermon *et al* (2018); Hermon (2019), defines GIS as an information system used to enter, store, recall, process, analyze and produce geo-referenced data or geospatial data, to support decision making in planning and managing land use, natural resources, the environment, transportation, city facilities, and other public services.

GIS consists of 5 main components, namely hardware (hardware), software (software), basic data and information (database and information), human resources (human brainware) and policies and procedures (policy and procedures) (PPIDS UNP, 2010; Hermon, 2019; Hermon *et al*., 2019). Basic data is the main component in GIS related to spatial data and various attribute data. Spatial data presents the position or geographical location of an object on the surface of the earth (Hermon, 2019; Hermon *et al*., 2019). The attribute data provides a description or information of an object in the form of numerical information, narrative photo, and so on.

Spatial data are broadly divided into three main types, namely features, points, lines and areas. Spatial data can be obtained from several sources including: (1) Analog map (example: administrative map), i.e. map in printed form. In general analog maps are made with cartographic techniques, most likely have spatial references such as coordinates, scale, wind direction, and so on, (2) Remote sensing system data (including satellite imagery and aerial photography) is the most important data source for GIS because it is available regularly and covers certain areas. This data is usually represented in raster format, (3) Data from field measurements produced based on a separate calculation technique, in general this data is a source of attribute data such as administrative boundaries, parking area points, and so on, and (4) GPS data (Global Positioning System), GPS technology provides an important breakthrough in providing data for GIS, the accuracy of GPS measurements is higher with the development of technology.

Tsunami disaster is a series of ocean waves that can spread with speeds of up to 900 km per hour, mainly caused by earthquakes that occur on the seabed. The speed of a tsunami wave depends on the depth of the sea. At sea with a depth of 7000 m for example, the speed can reach 942.9 km / hour. This speed is almost the same as the jet speed. However, the height of the waves in the middle of the sea is not more than 60 cm (VSI, Department of Energy and Mineral Resources 2010). In contrast to ordinary ocean waves, tsunamis have wavelengths between two peaks of more than 100 km in the high seas and the time difference between wave peaks ranges from 10 minutes to 1 hour. When reaching a shallow beach, bay, or river mouth, this wave decreases its speed, but its wave height increases by tens of meters and is destructive.

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Steps that can be taken to mitigate tsunami disasters (Jokowinarno, 2011): (1) Carry out efforts to protect coastal life, infrastructure and the environment. The development of an early warning system and the building of protective structures are examples of protective measures that can be developed, (2) Increase the understanding and participation of coastal communities towards tidal disaster mitigation activities. This policy can be done in various ways, including socializing and increasing public awareness about natural disasters and environmental damage caused, developing information on disasters and the damage they have caused including developing databases and disaster risk maps, exploring various local wisdoms in disaster mitigation, (3) Increase community preparedness for disasters (Aprihatin *et al*., 2020; Arlym *et al*., 2020; Armaita *et al*., 2020; Asman *et al*., 2020; Barlian, 2010). This policy can be implemented in the following matters: development of systems that support communication for early warning and emergencies, conduct exercises and simulate responses to disasters and damage caused, and disseminate information on stages of disasters and signs accompanying disasters (Chandra *et al*., 2020; Hermon *et al*., 2020; Hermon, 2020; Indika *et al*., 2020), (4) Improve coordination and institutional capacity for disaster mitigation. The implementation of the fourth policy includes the increased role and synergic cooperation of various parties, the development of a coordination forum and program integration between sectors, between bureaucratic levels (Juita *et al*., 2020; Juita *et al*., 2020; Marni *et al*., 2020; Oktorie *et al*., 2019; Oktorie and Bert, 2020; Oktorie *et al*., 2020), (5) Arrange an effective legal umbrella in the effort to realize disaster mitigation efforts, namely by drafting legal products that regulate the implementation of mitigation efforts, developing regulations and guidelines for planning and implementing disaster containment buildings, and implementing regulations and law enforcement related to mitigation (Prarikeslan *et al*., 2020; Suryani *et al*., 2020; Wilis *et al*., 2020; Yanti *et al*., 2020; Yuniarti *et al*., 2020), and (6) Encourage the sustainability of economic activities and increase the welfare of coastal communities through mitigation activities that can increase the economic value of the region, increase the security and comfort of coastal areas for economic activity (Hermon, 2009; Hermon, 2010; Hermon, 2012; Hermon, 2014).

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MAPPING TEMPORARY EVACUATION SITES (TES)

Disaster risk reduction efforts that are being developed by the Government through the National Disaster Management Agency (BNPB) especially those related to earthquake and tsunami natural disasters are building temporary evacuation sites (TES). This building serves as a temporary evacuation site / location just before the tsunami. This building is needed on an environmental scale so that people immediately reach safe heights so as to avoid being hit by tsunami currents. The aspect of building structure is a major consideration because buildings must remain sturdy and withstand the brunt of tsunamis and earthquake shocks that usually occur before and after. This building can also be multi-functional without losing its main function.

The Concept of Temporary Evacuation Location Building (TES) includes the following aspects (National Disaster Management Agency, 2013): (1) Has a capacity of around 250 people with an estimated space requirement of 0.7 - 1 m2 / person, (2) Altitude of at least 15 m from ground level, (3) Under normal circumstances the space at an altitude of 0-15 m from the building can be utilized by various community interests such as worship, shared space, etc. which does not require additional furniture either fixed (fix / built in) or can be moved (movable), (4) Easy to build quickly, (5) Structurally resistant to earthquakes and tsunamis, and (6) Can have functions that are versatile for community activities but do not lose its main function.

The main condition for the final evacuation location of the FES is that the location must be outside the tsunami hazard zone. The final evacuation location (FES) indicators / prerequisites are as follows: (1) Availability of sufficient area / open space, (2) Easily accessible to disaster victims and helpers, (3) Sufficiently protected from the immediate or indirect range of danger from disaster, (4) Availability of shelter / temporary space especially for vulnerable groups (elderly, infants, pregnant women, disabled), (5) The availability of easy access to mobilization (safer location movement) quickly, (6) Availability of adequate communication facilities that are connected to the emergency organizational structure, (7) Availability of first aid kits (emergency kits), (8) Availability of adequate transportation access (transportation mobilization) which will lead to safer places quickly, and (9) Availability of evacuation route maps that are easy to read and understand quickly. In carrying out the use of GPS (Global Positioning

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System) aids are needed to find out the latitude and longitude coordinates at locations affected by the tsunami disaster then the distance to the coastline of that location is measured. Conduct a field survey to take the coordinates of each building that has the potential as a temporary evacuation site (TES).

The concept of Temporary Evacuation Shelter (TES) Building includes the following aspects (National Disaster Management Agency, 2013): (1) Has a capacity of around 250 people with an estimated space requirement of 0.7 - 1 m2 / person, (2) Altitude of at least 15 m from ground level, (3) Under normal circumstances the space at an altitude of 0-15 m from the building can be utilized by various community interests such as worship, shared space, etc. which does not require additional furniture either fixed (fix / built in) or can be moved (movable), (4) Easy to build quickly, (5) Structurally resistant to earthquakes and tsunamis, and (6) Can have functions that are versatile for community activities but do not lose its main function.

SPATIAL PLANNING BASED ON TSUNAMI DISASTER MITIGATION

Determine building points that can be used as temporary evacuation sites and then be applied digitally using the Network Analysis application on the ArcGIS 10.1 device The way to find out the existing TES is to inventory the TES that have not been registered by using measurements and field checks using meters and GPS to determine the coordinates of the TES. The method for determining safe distance to reach TES refers to the Institute of Fire Safety and Disaster Preparedness Japan in Budiharjo (2006) explained that the speed of evacuation = 0.75 m / sec (walking speed of Older People) Evacuation process time = 12 minutes = 12 x 60 seconds = 720 seconds, the distance from the TES ≤ 720 seconds x 0.751 m / sec = 540.72 m = 541 m. From these calculations, the distance between TES of 541 m was processed using the network analyst method contained in ArcGIS 10.1 software. The parameters required are road networks, residential areas and tsunami inundation zones. The network analyst process is carried out in stages so that areas prone to tsunami inundation have an alternative TES, thus there are no more residential areas that are not covered by an alternative TES.

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Tsunami prone zoning map issued by the Center for Volcanology and Geological Disaster Mitigation-Geological Agency of the Ministry of Energy and Mineral Resources is needed to determine the distribution of tsunami inundation areas. Contour data obtained from the SRTM (Shuttle Radar Topography Mission) are used to determine the altitude points of vulnerable areas and the proposed TES and FES locations. Existing TES data issued by the Maritime and Fisheries Service Office in 2013, then used the results of the 2015 mid-population census (SUPAS) of the population of West Sumatra Province issued by BPS of West Sumatra Province. This data is needed to calculate the population of Padang City residents in 2015 (Hermon *et al.*, (2020). After being in the TES for about 2-3 hours waiting until there was no earthquake and tsunami (Hermon, 2015; Hermon, 2016; Hermon, 2016; Hermon, 2017) then the residents headed to the proposed FES (Final Evacuation Site) located on the hill. The determination of the proposed FES is based on the boundary between inundation prone areas and safe areas so that the proposed FES is in contours above 15 meters.

CONCLUSION

Perform digital analysis using the Arc GIS 10.1 application between a map of the tsunami inundation zone. Locations that were affected by the disaster were observed whether land use as settlements, plantations, fields and others. Interviews were conducted with local residents to find out the knowledge capacity of the population towards disasters, what steps people took when the disaster occurred. The results of observations which consist of observation points of the location of disaster threats, measurements of the distance of damage from the coastline and interviews with local residents are outlined in the questionnaire as analysis material.

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