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Semarang City Food Risk Disaster Mapping Based on Geographic Information System

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***Abstract*—In the future, climate change, especially temperature increase that occurs throughout the world is expected to pose a high risk both physic and social. As one of the coastal areas in Indonesia that has a high level of vulnerability to sea level rise, currently Semarang has experienced to inundation. Some areas in North Semarang such as Bandar Harjo and Tugu has been inundated and abandoned by its residents for quite a long time. The unavailability of information on disaster hazard prediction maps for future conditions is the background of the need for making accurate and actual flood hazard maps to minimize the impact of disasters. The combination between Geographical Information System (GIS) and Analytical Hierarchy Process (AHP) has been used to analyze and to determine the weight and score the risk map of Semarang City. As a result, 37% (141.403km2) areas of Semarang City are vulnerable to flood. This result is divided into 19 % high vulnerable, 13% moderate and 5% are low. By this, the flood risk map of Semarang City can be used by stakeholders and government to make a safe and resilience city planning.**

Keywords—Flood; GIS; AHP; City Resilience; Disaster

I. INTRODUCTION

In the last three decades, there is the phenomenon of the increasing trend of natural disasters, especially disasters that cannot be predicted when it happened. Over the period 1980-2010, more than four billion people were affected by extreme natural events. The main factors or drivers behind rising economic losses are changes in land use and increases in the concentration of people and capital in high-risk areas, for example, in coastal region exposed to windstorm, in fertile river basin exposed to floods and in urban areas exposed to earthquakes [1].

The flood disaster is a natural occurrence that can happen any time and often results in loss of life, property and objects. Losses due to flood damage to the building are the calculation of loss of valuables, until the opportunity cost of the time everyone cannot go to work and school. Flooding cannot be prevented, but it can be controlled and reduced the impact of losses it caused.

As one of the coastal areas in Indonesia which has a level of vulnerability to sea level rise, currently the city of Semarang has experienced inundation. Some areas in North Semarang have been inundated for quite a long time, such as in the Bandar Harjo area and around the port which is currently abandoned by its residents.

At the end of January to the beginning of February 2017, the North Coast (*Pantura*) route, which is one of the busiest lanes in Java, was paralyzed by flooding and rob which caused traffic in this area to experience constant sluggishness, especially during rush hour. In addition to traffic congestion, floods also inundate and result in damage to infrastructure, industrial environments, offices, education, hospitals and settlements. Losses were increasingly serious and increasing over time, resulting in disruption of national economic activity.

Flooding is the most destructive natural hazard. This disaster hits a sunken to flat area located in the lowlands. Flood control can be distinguished structurally and non-structurally. Physically, the construction of dam checks, dikes and dams while in the non-physical form of mapping hazard-prone areas or at risk of flooding.

Various attempts have been made by the regional government to reduce the risk of flooding in Semarang City, including the normalization of the Kreo, Bringin and Garang Rivers and the construction of a flood control system in Semarang, known as the West Flood Canal and the East Flood Canal. In addition to several preventive mitigation efforts pursued by the Semarang city government, non-structural mitigation efforts in the form of accurate data and information on flood-prone areas can be done by combining several types of maps to determine flood-prone areas that have spatial perspectives or geographic reference.

The unavailability of information on disaster hazard prediction maps 2qbased on prediction data for future conditions, as well as the prediction of losses that can be caused by flooding, is the background of the need for making accurate and actual flood hazard maps as a step to minimize the impact of disasters. Geographical Information System (GIS) can be used as a tool to predict flood-prone areas to be more easily analyzed based on the parameters used [2-7]. In this study, the AHP method is used to determine the weight and score, so that the vulnerability class is very vulnerable, vulnerable, quite vulnerable and not vulnerable.

The aims of this study are: 1) to identify the main factors influence the vulnerability of floods in the city of Semarang; 2) to create Semarang City Flood prone area.

II. METHODOLOGY

A. Research Area

Semarang is located in the northern part of Central Java about 558 km east of Jakarta. Geographically located at coordinates 6º58' Latitude and 110º25' Longitude (Figure 3). It is also located very close to the north coast of Java. Administrative boundaries of Semarang are west to Kendal, east to Demak, south to Semarang Regency and north bounded by Java Sea coastline with a length of 13.6 kilometers.

Since the 1990s, the city, especially in the northern part of the coast and some areas lowland population increased and with rapid urbanization [8]. Increasing number of buildings construction as a result of population growth will lead to increased building load resulting in subsidence. Many of the buildings in the city Semarang affected by land subsidence because of excessive ground water extraction and the burden of high land for settlement [9].

B. Methodology

The AHP approach developed by Thomas Saaty is one of the methods of MCDM (Multi Criteria Decision Making) or decision making with the most frequently used compound criteria [10]. AHP is a method of solving a complex and unstructured problem in its group, arranging these groups into a hierarchical arrangement, incorporating numerical values to replace human perception by carrying out relative comparisons and finally a synthesis is determined to be a high priority element [11-13]. In general, AHP aims to arrange the priorities of various alternative choices and these choices are complex and multi criteria.

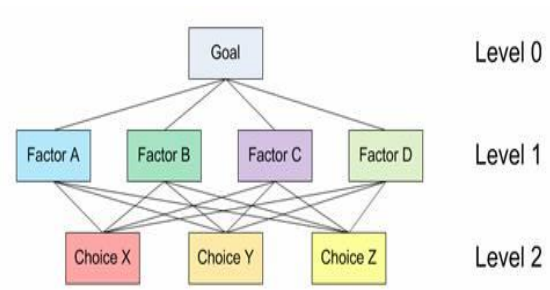

Fig. 1 Analytical Hierarchy Process Concept

1. Arrange a paired comparison matrix for each criterion. Pairwise comparisons are carried out for criteria and alternative assessments.
2. Make normalized decision matrix. The step to get the value from the normalized decision matrix is done by dividing the value in column 1 row 1 by the number from column 1, and so on.
3. Calculate the weight of each criterion. In the calculation, to obtain the weight of each criterion that is by summing the results of the normalized matrix calculation.
4. Multiplication of each value comparison criteria with weights. Multiplication of each value comparison criteria with weights is done to obtain the total value of the criteria.

Data were obtained from the government of Semarang in the form of basic maps of Semarang City, slope maps, soil type maps, land use maps, hydrological maps and rainfall maps.

The map of each parameter is in shp format, then scoring is done on each parameter attribute data. The process of filling the score as in the table that has been determined based on the effect on flooding, where a score of 5 is given to the parameter attribute data which has a large influence on flooding in the city of Semarang. Then, after the scoring process is carried out, the parameters are weighted based on the calculation from the AHP method. The scoring and weighting processes are done in ArcGIS software.

The problems that exist within determining the flood prone areas of the City of Semarang, based on the level of importance of parameters or criteria determined by experts from the Regional Development Planning Agency to determine the flood prone areas of Semarang City as follows:

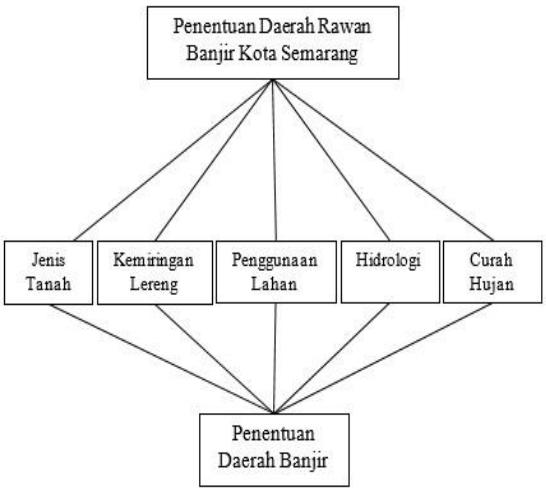

Fig 2. Analytical Process

III. RESULTS AND DISCUSSION

The combination between Geographical Information System (GIS) and Analytical Hierarchy Process (AHP) has been used to analyze and to determine the weight and score the risk map of Semarang City. As a result, 37% (141.403km2) areas of Semarang City are vulnerable to flood. This result is divided into 19 % high vulnerable, 13% moderate and 5% are low. By this, the flood risk map of Semarang City can be used by stakeholders and government to make a safe and resilience city planning.

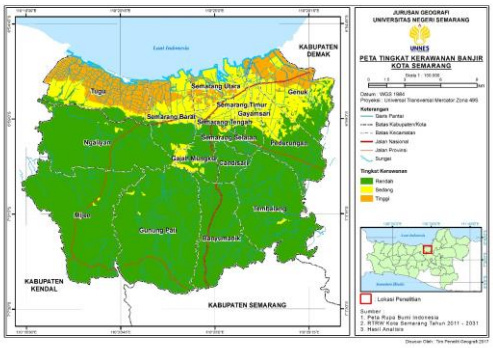

Fig 3. Flood Risk Map of Semarang City

The environmental effects of tidal flood have been affecting drinking water and sanitation systems in inundated areas. People in inundated areas experience changes in water color, taste and smell due to tidal flood. Drinking water becomes polluted and creates water related diseases. The common effects of flooding are waste overflow, bad smell and sanitation infrastructures damage. Consequently, the environmental effects and health effects of flood are linked to each other, and the decreasing quality of water and sanitation system affects people's health conditions.

IV. CONCLUSION

Natural hazards cannot be predicted and controlled, but accurate information about disasters especially related to hydro meteorological hazards helps the community to prepare themselves to mitigate and to reduce the impact of disasters. Early warning systems and disaster knowledges combine with the community preparedness lead to the better community response to disasters and help the community to reduce disaster losses.

Since 1980, hydro meteorological ("hydromet") hazards such as floods and droughts, are the most causes disaster losses in the world. As some studies indicate that the number of natural hazard as the impact of climate change increases in the last three decades. The importance of disaster mitigation cannot be underscored particularly in the challenging atmosphere of environmental and climate changes. These issues become more serious in developing countries. Since in the most developing countries, the level of people awareness on disaster related issues is very low, the more actions need to be done in this countries in order to reduce disaster losses. One of them is by providing adequate and appropriate information about disaster in their surrounding area.

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