Tsunami Risk Assessment and Temporal Shelter Determinations Using Spatial Analyses

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1. Introduction

Bantul coastal area, which is located in the south of Jogjakarta Province, is one of the famous tourism locations and economic growth centers in Bantul district. This area is listed on a vulnerable tsunami disaster prone (Zone B) in Indonesia because this area directly faces Indian Ocean, and the area has previous tsunami history and locates on potential earthquake area (Figure 1). Also Bantul coastal area does not have enough safety tsunami shelters for tourists as well as local residents.

Base on conditions above, this study purposes an assessment for coastal risk against tsunami hazard. Furthermore, the study arranges an appropriate coastal zone planning as well as shelter location for a mitigation strategy in Bantul coastal area with risk level considerations. This report focuses on zoning of vulnerable area and allocating of safety evacuation sites with using GIS applications.

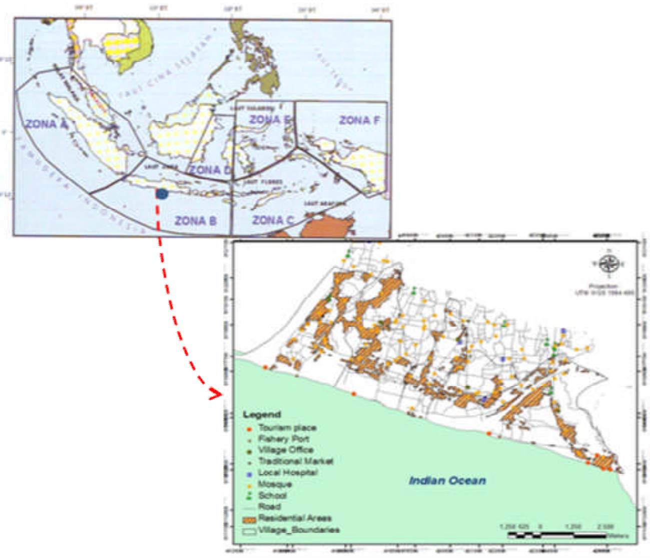

Figure 1. Study Location

2. Risk Factors and Criteria

In this study, the hazard and the vulnerability are important factors to achieve the aims of this study. This study considers two kinds of tsunami height, 5 m and 10 m, as the hazard scenarios to estimate inundation area along the Bantul coast with using both spatial analyses on GIS and the following equation (Berrymann, 2005).

$$Hloss = \frac{167n^2}{Ho^{1/3}} + 5\sin S \qquad (1)$$

where ***Hloss*** is the loss in tsunami height per meter of inundation distance, ***Ho*** is the tsunami height at the coast, n is the surface roughness coefficient and S is the slope.

In the evaluation of hazard level, the inundation depth was divided into four ranges, from 0 to 0.5 m, 0.5 m to 1 m, 1 m to 2 m, and greater than 2 m, with referring the sliding resistance of standing person against tsunami flow (Takahashi, 2005). Based on the evaluation of vulnerability (Yushanonta, 2006), the distance from coastline to landward was also divided into four ranges, from 0 to 0.5 km, 0.5 km to 1.5 km, 1.5 km to 2 km and 2.5 km to 3 km. Furthermore, the slope was divided into four ranges, from 0% to 2%, 2% to 8%, 8% to 15% and greater than >15% (Diposaptono. S and Budiman, 2008).

In the Risk assessments, this study evaluates the risk level from the hazard and the vulnerability with using a following equation (Yushanonta, 2006).

$$R = VxH \qquad (2)$$

where R is the risk level, V is the vulnerability, and H is the hazard.

The simple weighted overlay was used to estimate the risk value including the effect of inundation depth, public facilities, and land use vulnerability.

3. Risk Assessment and Risk Zoning

Figure-2 shows the tsunami inundation area on Case-1 and Case-2, where Case-1 is 10 m tsunami height and Case-2 is 5 m height. The inundated area was estimated 1867.1 ha in Case-1 and 908.5 ha in Case-2. The figure shows that a certain number of residential districts are inundated in Case-1 and Case-2.

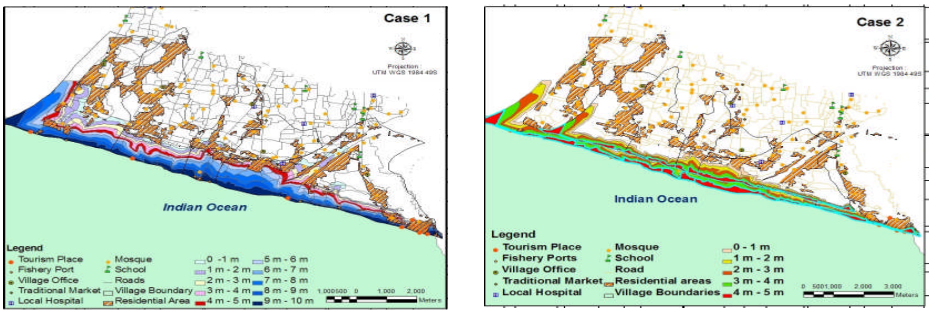

Figure 2. Map of Inundation Area.

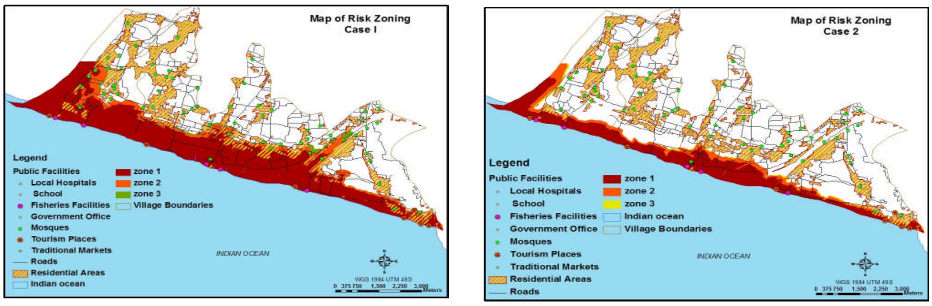

Figure 3. Map of Risk Zoning.

Figure 3 illustrates the risk zone estimated from Eq.-2 for Case-1 and Case-2. The risk zone in Figure 3 was evaluated with three sub zones, where Zone-1 means high risk area, Zone-2 means moderate risk area, and Zone-3 means low risk area. In Case-1 the risk areas of Zone-1 is 1588.084 ha, Zone-2 is 207.91 ha and Zone-3 is 49.56 ha. While in Case-2, Zone-1 is 688.018 ha, Zone-2 is 185.65 ha, and Zone-3 is 23.819 ha. These results indicate that all fishery ports and a certain number of tourism places along Bantul coast are located in the high risk zone (Zone-1) against tsunami hazards both in Case-1 and Case-2. Many residential areas also have tsunami risk. For example in Case-1, 252.51 ha residential areas are located in risk zones and also 38.65 ha residential areas in Case-2.

4. Shelter Site Planning

In this study, a use of mosque was considered as an alternative evacuation shelter. In the 2004 Sumatera Tsunami, some mosques in Aceh had survived even under the large tsunami attack (Diposaptono S. and Budiman, 2008). From the result of spatial analysis on GIS, this study suggests 14 mosques as temporal evacuation shelter in scenario of Case-1 (Figure 4).

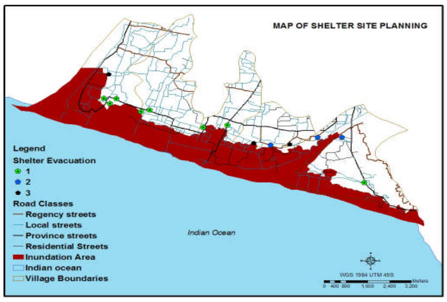

Figure 4. Map of Temporal Shelter Evacuation

5. Conclusions

This study indicates that all fisheries facilities, a certain number of tourism places, and many residential areas along Bantul coast are in the high risk zone against tsunami hazard. Also, this study suggests 14 mosques as temporal evacuation shelter in the most serious scenario. The method used in this study is very simple, and be able to easily evaluate the risk zone as well as the location of effective shelters against tsunami attack.

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