Evaluation of Service Area against Tsunami Hazard with Using Network Analysis on GIS

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1. Introduction

In recent years, both geographic information systems (GIS) and network analysis are burgeoning fields, characterized by rapid methodological and scientific advances. A geographic information system (GIS) is a digital computer application designed for the capture, storage, manipulation, analysis and display of geographic information. Wijatmiko, et al. [2008] have investigated that GIS model could performed as useful tools not only to conduct spatial analysis but also to determine evacuation service area and evacuation route risk level as tsunami disaster mitigation plan. Simulation of service area base on risk scenario due to dangers area and inundated area by blocking road are further investigated in this study.

2. Tsunami Inundation Scenarios

Hyuga city is one of the cities in Miyazaki Prefecture, Kyushu Island, Japan which is located near the coast. There are three existing areas of seismic activity around the Hyuga city that may execute large tsunamis, namely: Tonankai, Nankai, and Hyuganada. Takahashi [2005], base on historical data, reported that the occurrence probabilities within 30 years of subduction zone earthquakes at Tonankai, Nankai, and Hyuganada are 60% occurred around 8.1 Richter scale, 50% occurred around 8.4, and 10% occurred around 7.6, respectively. Therefore in order to simulate the worst case scenario on tsunami attack in Hyuga city, this study applied Tonankai-Nankai seismic activity as the generated tsunami source. **Fig-1** shows inundation area on Hyuga city base on Tonankai-Nankai historical data. The local government has provided 20 infrastructures that could be used to store refugee as an evacuation place. The evacuation places firstly were made in case of earthquake and flood disaster. **Fig-1** shows that there are 7 of 20 evacuation places which are inundated by tsunami attack base on Tonankai-Nankai seismic.

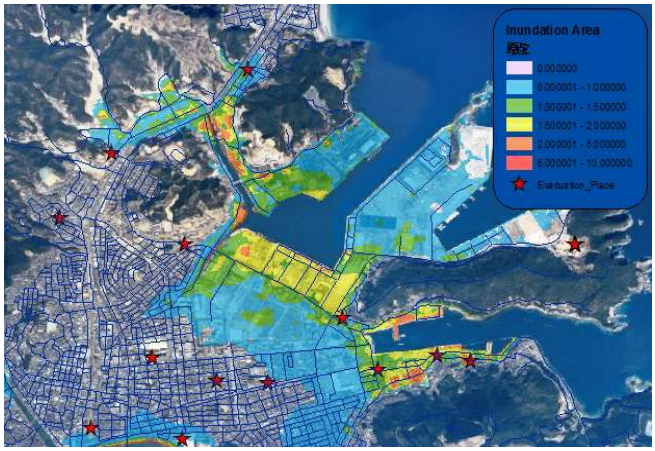

Fig-1. Inundation area and evacuation places for Earthquake and flood disaster

3. Service Areas Simulation Using GIS and Discussions

Service areas are defined as areas where refugees have a sufficient amount of time to travel from their house to the evacuation buildings shelters before tsunami attack. Wijatmiko, et al. [2008] has calculated that the travel time of tsunami wave from the Tonankai-Nankai seismic activity areas to the shoreline of Hyuga city will approximately takes 25 minutes. It was calculated that the maximum evacuation route distance to the evacuation buildings shelters is 1 km. Thus, the service areas were generated based on 1 km distance. With using ArcGIS Network Analyst, we can generate evacuation service areas around any location on a road network. There are 6 cases that describe the possibilities condition occurred while tsunami attack were applied. The scenarios can be seen in **Table 1.** Case-1 uses all of facilities as evacuation building, while

Table 1 Scenario for service area simulation

Scenario	Evacuation Building Used	Blocking Road
Case-1	all (20 facilities)	unblocking
Case-2	free from inundation (13 facilities)	unblocking
Case-3	free from inundation (13 facilities)	on main road
Case-4	free from inundation (13 facilities)	on road with risk level higher than 8
Case-5	free from inundation (13 facilities)	on road with risk level higher than 7
Case-6	free from inundation (13 facilities)	on road with risk level higher than 6

others case do not use some facilities because of tsunami inundation scenario. In case of blocking road, Case-1 and Case-2 are using road network without blocking. It means that the road network can be used as evacuation route while tsunami occurs. Case-3 was simulated with blocking on main road, meanwhile the Case-4, Case-5, and Case 6 were simulated with blocking whose road risk level were higher than 8, 7, and 6 respectively. Wijatmiko, et al. [2008] have investigated road risk level by using GIS base on 5 criteria, such as distance length, route safety situation, route capacity, slope condition and inundation depth.

Simulation result of service area base on the 6 scenarios can be seen in **Fig-2.** The result shows some areas that people can reach evacuation place while tsunami occurs. The areas of each scenario are then compared with that of in Case-1. As described in **Fig-2**, the largest reduction area of service area is in Case-3. Therefore, it can be concluded that the worse scenario on evacuation mitigation plan is in Case-3. It can be said that the main road in this case have the important role in evacuation routes. In this study we recommended that, in order to make the best evacuation plan, the stake holders should reduce the risk possibilities on main road so that the main road can be used freely when tsunami occur.

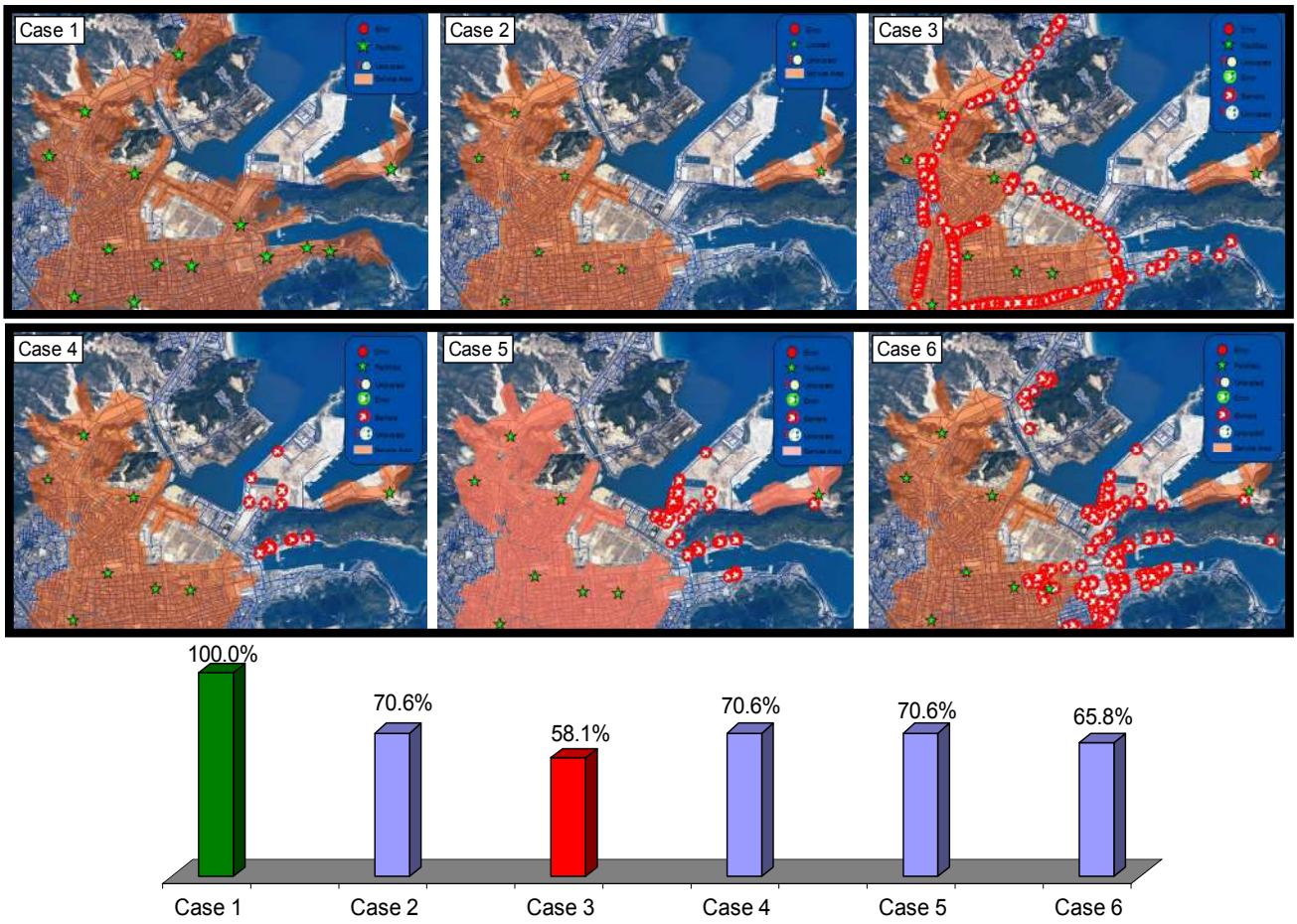

Fig-2 Simulation result of service area base on the 6 scenarios

4. Conclusions

In this study, a high performance of GIS model was developed to simulate the risk scenarios when tsunami occurs. GIS is a useful tool not only to generate evacuation service area but also to simulate the risk scenarios base on the possibilities condition in the study area.

5. References

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