Vulnerable Areas to Floods in Ishinomaki, Japan

Data Source: MLIT Japan
GCS: GSC_JGD_2000
PCS: JGD_2000_Japan_Zone_10

CEE 187
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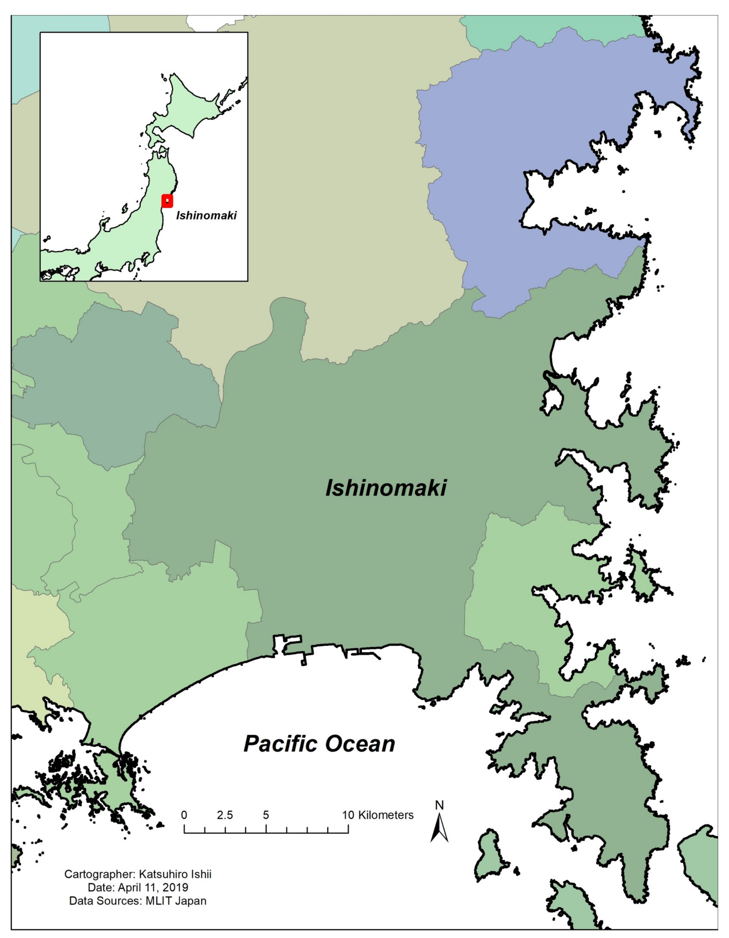
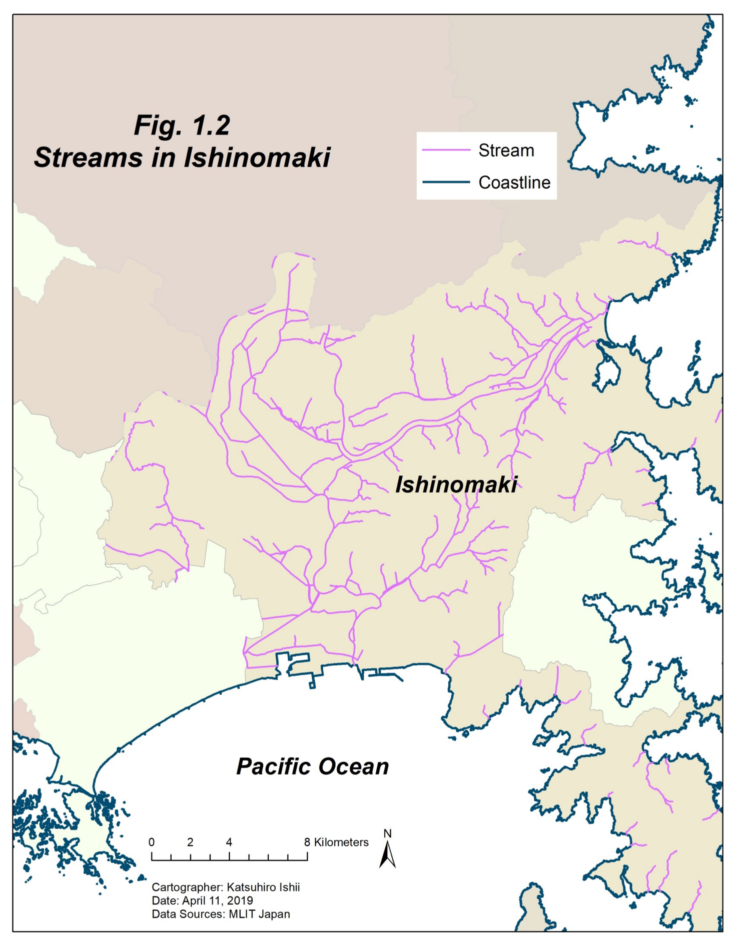
Introduction

In late June to mid-July 2018, torrential rain in southern Japan caused severe floods. The property damage is estimated at least 9.86 billion dollars, and there are 225 fatalities and 13 missing. We have never experienced this size of disaster caused by rain. However, we often experienced smaller floods at many places in Japan; moreover, we are expecting this kind of devastating floods in the near future because of the climate change. Therefore, the importance of preparing for the natural disasters has been increasing in our community. This project analyses the impact of flood events to the population, then identifies vulnerable areas to floods in Ishinomaki, Japan.



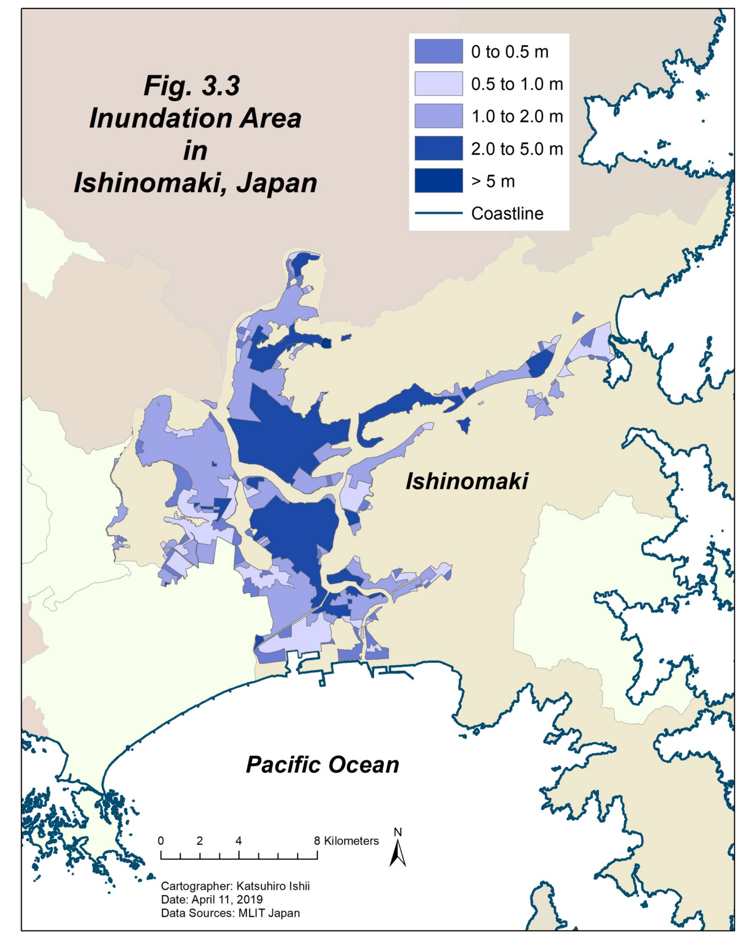


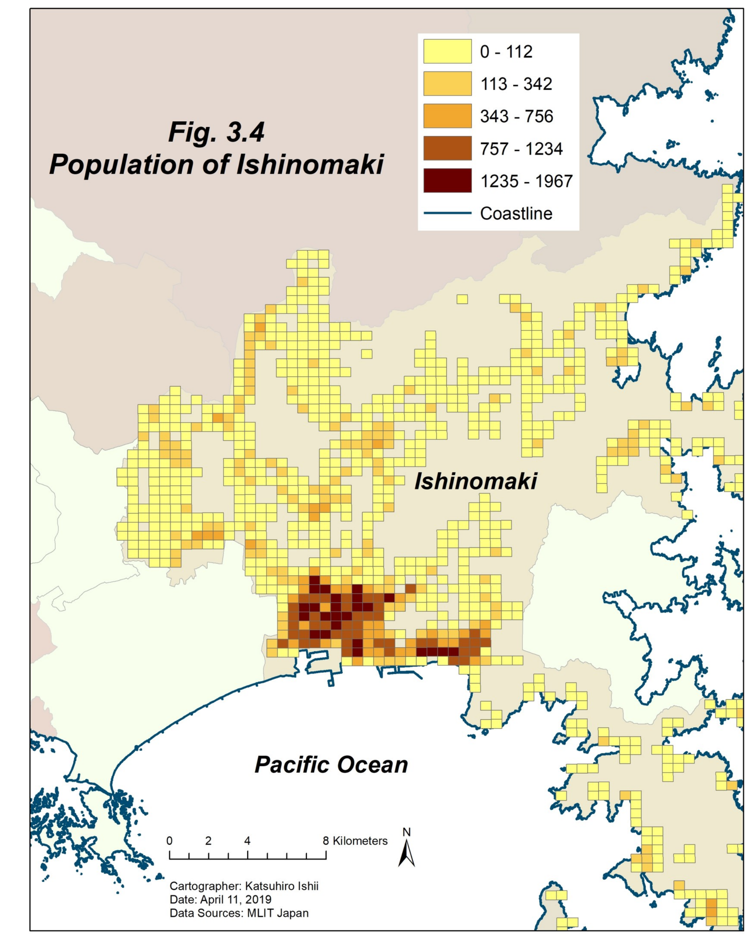
Ishinomaki has the Kitakami River that is the largest river in the northern part of Japan. This city has not experienced severe flooding caused by rain yet, but it is easy to imagine that severe flooding along the Kitakami River results a huge impact to this area. In fact, this river is the main reason for the flood inundation caused by Tsunami in March 2011. Also, a number of smaller streams are in the city, and they have many cross nodes where flooding happens constantly (Fig. 1.2).

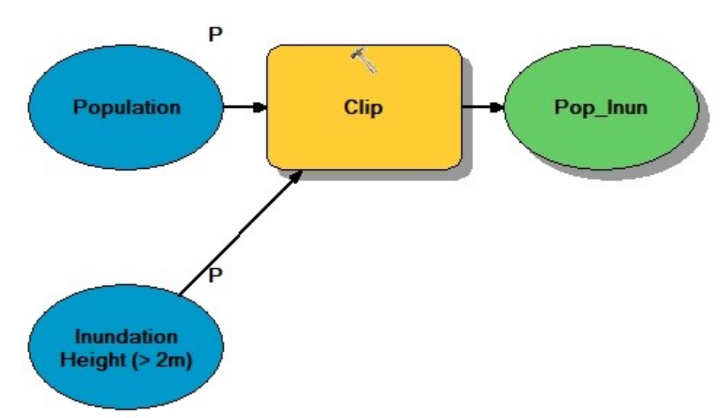
Methods

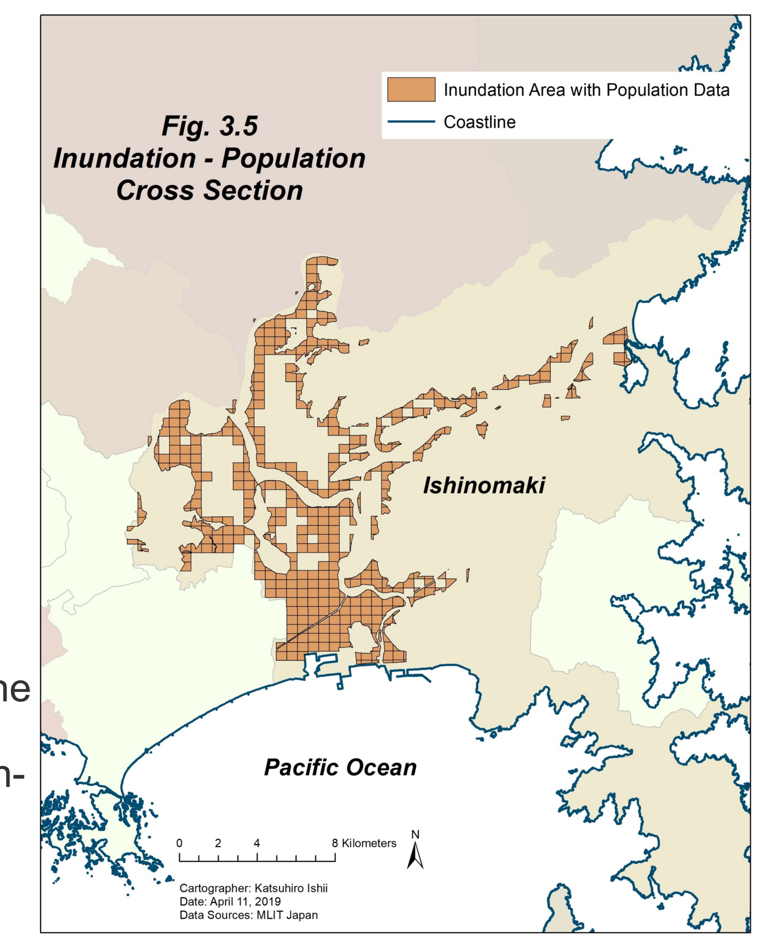
The following results are required:
1.The number of people who live in the inundation areas (Fig. 3.5)
2.Vulnerable areas to flood events

For the first part, the extract tool called "clip" from the Analysis tool is ArcGIS is used. Input layers are Fig. 3.3 and Fig. 3.4. After generating Fig. 3.5, we perform the statistics function on the "Inundation Area with Population Data" layer. It returns the first result.

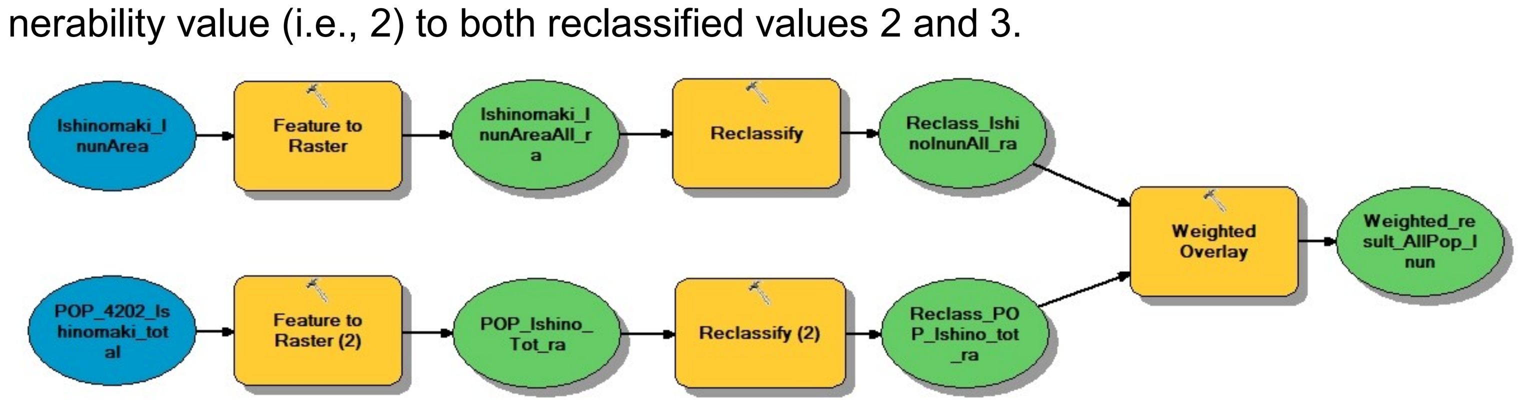




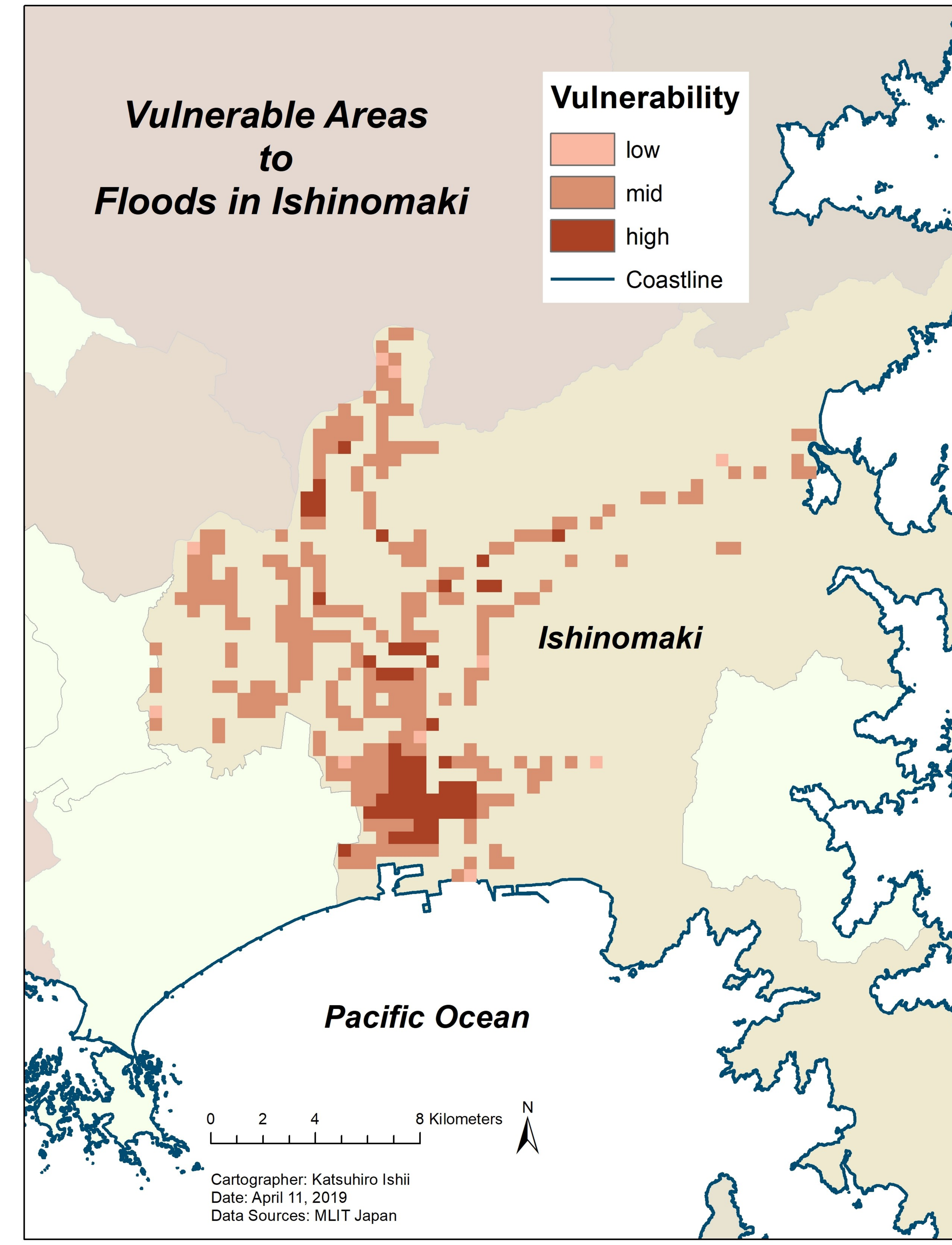




The vulnerable area is defined as: The area contains people who will be affected by the floods. The weighted overlay function from the spatial analyst tools in ArcGIS is used to identify the area. Before performing this function, we need to convert Fig. 3.3 and Fig. 3.4 to raster files, then reclassify their values to four categories. Then, we use those reclassified raster data as inputs of the weighted overlay function [2]. As the previous work [4] shows more population needs more time and space to evacuate. Thus, larger population is related to the higher vulnerability in our context [1] [4]. In addition, the higher inundation height causes considerable damage to properties and relates to the higher vulnerability as well. Since we consider those two factors are equally important [3] [4], both of the percent influences are set as fifty percent. For each scale value, the values between 1 and 3 are assigned to obtain three levels of vulnerable areas (i.e., low, mid, and high). Our reclassified values are between 1 to 4. So, we assign the mid level vulnerability value (i.e., 2) to both reclassified values 2 and 3.



Conclusion



The result shows that the highest vulnerable area tends to have larger population and an inundation height more than 1m. In fact, most of the highest vulnerable areas are placed at the urban site where the region for public facilities, such as hospitals, government offices, and schools. Each colored square in the map is a 500m mesh, and we have 10 squares for low vulnerability, 264 squares for mid vulnerability, and 60 squares for high vulnerability. Now, we can see the number of people who live in the inundation area (Fig. 3.5). According to the statistics function in ArcGIS, the inundation area has 117,182 people. Since the total population is 160,826, 73% of residents will be affected by the flood event.

References:

1. Guha-Sapir, D., Rodriguez-Llanes, J. M., & Jakubicka, T. (2011). Using disaster footprints, population databases and GIS to overcome persistent problems for human impact assessment in flood events. *Natural Hazards,58*(3), 845-852.

2. Basharat, M., Shah, H. R., & Hameed, N. (2016). Landslide susceptibility mapping using GIS and weighted overlay method: A case study from NW Himalayas, Pakistan. *Arabian Journal of Geosciences, 9*(4).

3. Fernández, D., & Lutz, M. (2010). Urban flood hazard zoning in Tucumán Province, Argentina, using GIS and multicriteria decision analysis. *Engineering Geology, 111*(1-4), 90-98.

4. Chakraborty, J., Tobin, G. A., & Montz, B. E. (2005). Population Evacuation: Assessing Spatial Variability in Geophysical Risk and Social Vulnerability to Natural Hazards. *Natural Hazards Review, 6*(1), 23-33.