Is Yokohama Ready for the Next Earthquake?

An Earthquake Risk Assessment of Yokohama, Japan

Introduction

Japan is an earthquake-prone country, which is located in the Ring of Fire (also known as the Circum-Pacific Belt) where numerous volcanic eruptions and earthquakes occur. According to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan, around 18.5% of the earthquakes with magnitude of 6.0+ in the world occur in Japan. In the past decades, Japan has experienced a number of destructive earthquakes, such as 1923 Great Kanto Earthquake, 1995 Great Hanshin Earthquake and 2011 Tohoku Earthquake, causing thousands of deaths and catastrophic damage to the urban area. The Japanese Government predicts that there is a 70% chance of a earthquake with magnitude of 7.0+ striking the Kanto region in the next 30 years. Thus, the goal of this study is to identify the high risk areas in Yokohama in the event of a catastrophic earthquake.

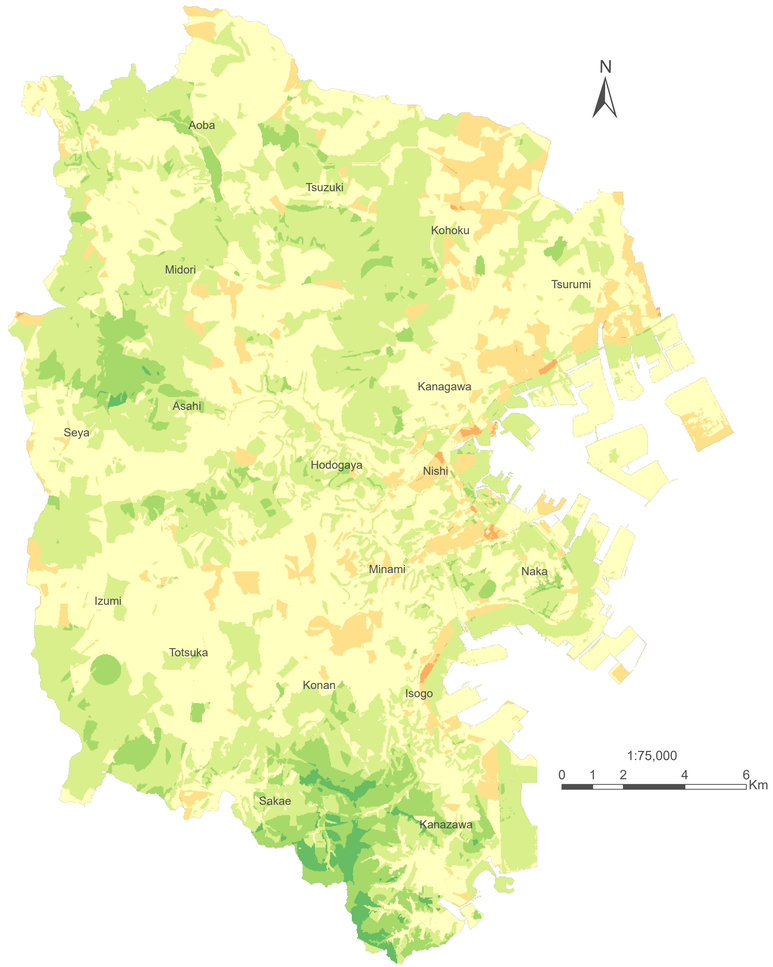
Study Area

Yokohama (横浜) is the capital city of Kanagawa Prefecture. It is located in the southwest of Tokyo and within the Kanto region of Japan. It is the second most populous city in Japan after Tokyo, with a population of 3.78 million in 2020.

Methodology

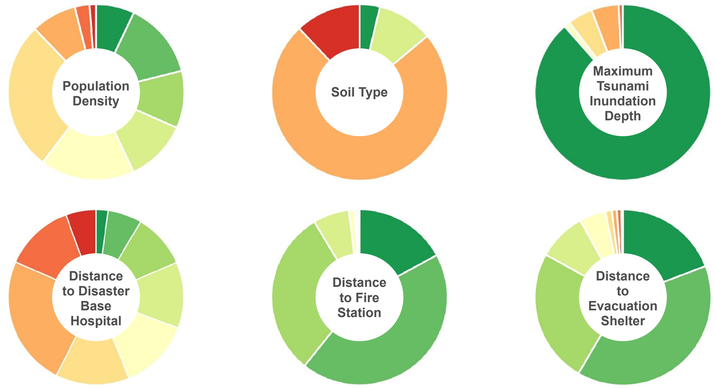
Multi-Criteria Decision Analysis (MCDA) was conducted to identify the high risk areas in Yokohama, based on the following criteria: (1) Population Density, (2) Soil Type, (3) Distance to Disaster Base Hospital, (4) Distance to Fire Station, (5) Distance to Evacuation Shelter, and (6) Maximum Tsunami Inundation Depth (based on the government's prediction). The risk surfaces for each criteria were then generated, and the weightings for each criteria were determined using Analytical Hierarchy Process (AHP), which involves mathematically evaluating paired comparisons based on the relative importance. Once the weightings for each criteria were determined, the final risk surface was generated using the Weighted Overlay Tool. The risk surfaces for each criteria are shown below:

Results



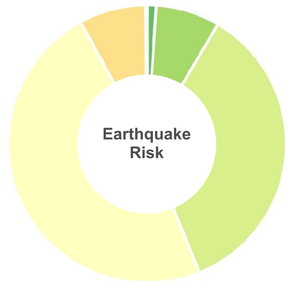
Discussion

The risk distributions for each criteria are shown below:

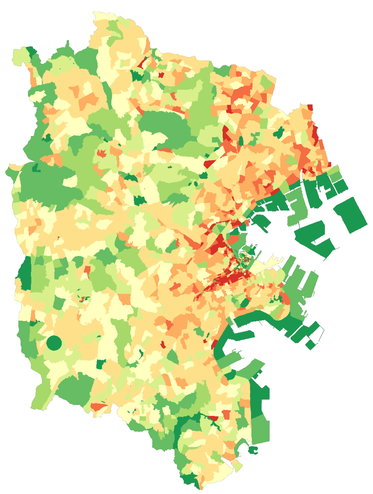


Based on the criteria results, most of the areas in Yokohama contain soils which are vulnerable during an earthquake. Although the soil risk is unavoidable, it can be minimized by enforcing building regulations to ensure that all buildings are earthquake-resistance and are built to survive a catastrophic earthquake. The Japanese Government should also improve the community access to the disaster base hospitals, especially in the southwest area of Yokohama.

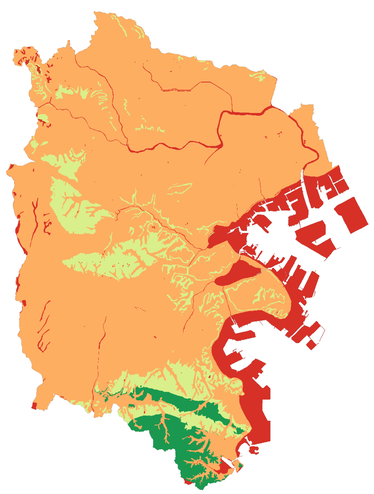
Based on the final result shown on the left, Yokohama is generally safe in the event of an earthquake. 92% of the area (401.55 km2) is classified as low risk or moderate risk, and only 8% of the area (34.71 km2) is classified as high risk. These relative high risk areas are concentrated in the eastern area of Yokohama with high population density. Therefore, the Japanese Government should focus in enhancing community preparedness in these areas to minimize the impact of a catastrophic earthquake in the future.



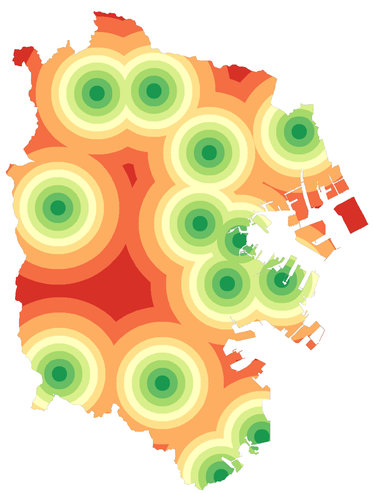
Lowest Risk | Very Low Risk | Low Risk | Moderately Low Risk | Moderate Risk | Moderately High Risk | High Risk | Very High Risk | Highest Risk



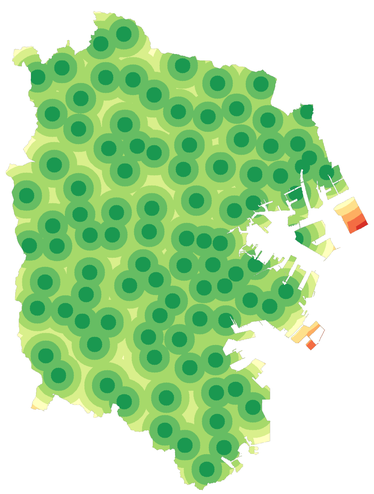
Population Density
36%



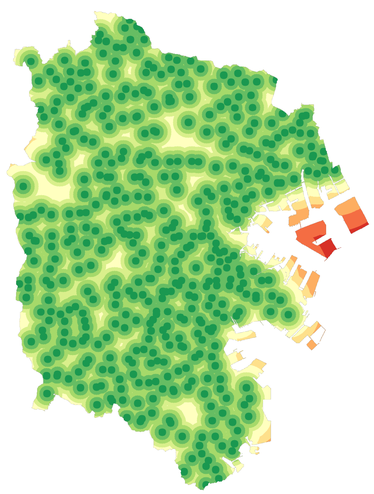
Soil Type
23%



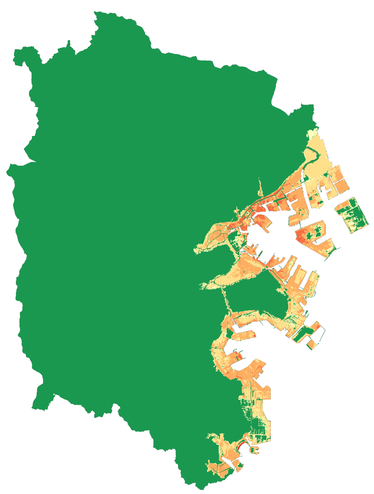
Distance to Disaster Base Hospital
13%



Distance to Fire Station
13%



Distance to Evacuation Shelter
9%



Max Tsunami Inundation Depth
6%

Source: Statistics of Japan: Census/2015; MLIT of Japan: Fundamental Land Classification Survey (1:50,000), Medical Institution/2020, Fire Department/2012, Evacuation Facility/2012, Tsunami Inundation Assumption/2020

Map Created and Designed by Peggy Wong on Apr 28, 2022