International Journal of Disaster Risk Reduction 10 (2014) 190–200

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

Tsunami vulnerability assessment in the Southern Boso Peninsula, Japan

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ARTICLE INFO

Article history:
Received 26 March 2014
Received in revised form
4 August 2014
Accepted 4 August 2014
Available online 13 August 2014

Keywords:
Boso Peninsula
Tsunami vulnerability
PTVA Model
GIS
Population estimation

ABSTRACT

The Boso Peninsula is located in East Japan north of the Sagami Trough, which has historically given tsunamigenic earthquakes. We have selected the southern part of the peninsula, namely the villages of Aihama and Mera, which belong to the city of Tateyama, and used a tsunami vulnerability assessment tool (Papathoma Tsunami Vulnerability Assessment model) for 358 buildings located there, for a tsunami scenario with a maximum run-up of 10 m. Additionally, we applied a building population estimation model, which allowed us to estimate the population residing in the different vulnerability categories as they resulted from the assessment tool. The results show that 28% of the buildings have very high vulnerability, 16% have high vulnerability and 20% have average vulnerability. For these vulnerability categories the population estimation model showed that from 407 residents, 94 reside in buildings with very high vulnerability, 72 in buildings with high vulnerability and 91 in buildings with average vulnerability. Population demographics of local inhabitants indicate high chances of residents belonging in sensitive age groups, and potentially rendering them more vulnerable during their escape from a tsunami event and the following recovery from it.

1. Introduction

The Boso Peninsula is located in East Japan and to the north of the Sagami Trough. The Sagami Trough is a structure of complex bathymetry with various basins, small troughs and knolls, occurring from the tectonic activity of the Boso Triple Junction [14], and has been characterised as one of the most seismically active locations in Japan [10]. There have been several earthquakes with magnitudes 7–8 in the region [13] with the biggest ones in historic times being the M8.2 earthquake of 1703 and the 1923 M7.9 Kanto earthquake [9].

At the most southern part of the peninsula there is the city of Tateyama, with population of 48.500 people ([12] Census), and again on the most southern part of Tateyama there are the coastal villages of Aihama and Mera (Fig. 1). The city of Tateyama is situated in a flat, smooth coastal plain, while Aihama and Mera are located in a steeper landscape to the south. The two villages show a Holocene tsunami history with tsunami deposits found in the paleo-coastline just to the north of Aihama, aged 7200 BP [9]. Given the historic earthquakes of 1703 and 1923 and the 7200 BP tsunami deposits we selected the city of Tateyama and the villages of Aihama and Mera for our study.

The purpose of our study is (a) to apply a vulnerability assessment tool with prior international application in an inhabited area of Japan with typical characteristics, and (b) to introduce population demographics to the vulnerability assessment using a building population estimation model.

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http://dx.doi.org/10.1016/j.ijdrr.2014.08.001

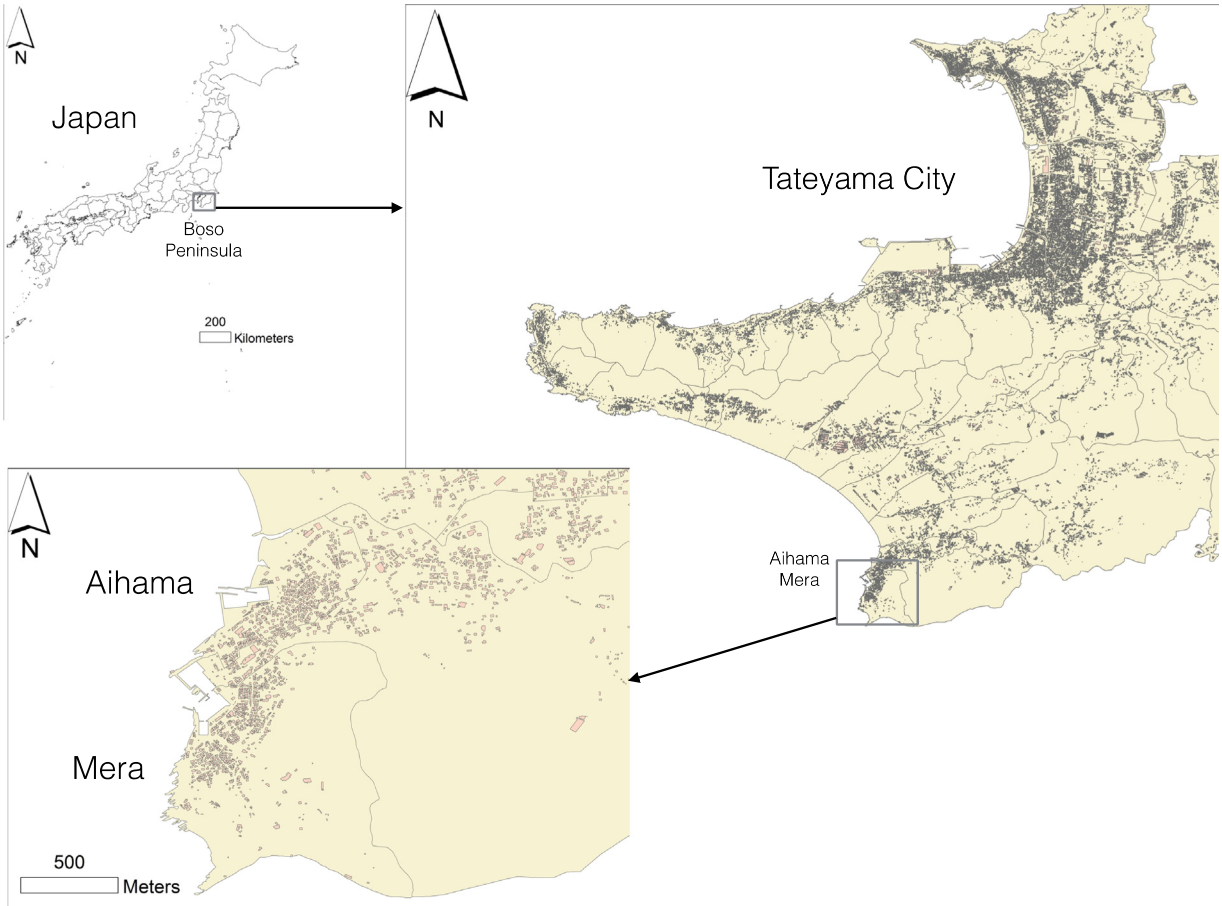

Fig. 1. Location of the Southern Boso Peninsula, Tateyama City, and the villages of Aihama and Mera.

2. Building population estimation for the city of Tateyama

We utilised a GIS method that would allow us to estimate the population distribution in the City of Tateyama. While the Japanese census records the number of residents in every building, this information is not available to the public due to privacy concerns. The best spatial distribution population data offered by the Japanese National Statistics Bureau is a 500 m mesh with night-time population attributes ([12] Census) (Fig. 2).

In order to do a detailed spatial analysis of the inundation scenario and the vulnerability assessment, we used a building population estimation tool developed by Lwin and Murayama [11]. This GIS tool uses population distribution meshes like the ones described above, as well as building footprint data, and it estimates the number of people in each building of a given area. The tool has two possible ways of estimation; the areametric, which uses the surface of the building footprint as the base of the estimation, and the volumetric, which uses the surface of the footprint, as well as the number of floors of each building to estimate the number of people located in it. See Lwin and Murayama [11] for the full description of this method.

We obtained the building footprint data for the whole city of Tateyama from the Geospatial Authority of Japan. Unfortunately, the dataset has no other information about the buildings, such as the number of their floors or their use. As such, we ran the tool for 39.000 buildings in Tateyama using the areametric approach, and were able to estimate the building population for the whole city. Due to the lack of data in the building footprints we were unable to distinguish between residences and other buildings, possibly assigning a population value to some buildings, which are otherwise unpopulated. We considered this limitation to be of little significance, as population is naturally mobile, and the census data we obtained was only for residents who naturally move throughout the day. Moreover, in our vulnerability assessment areas of Aihama and Mera, the majority of buildings are residences, and further reducing the instances of miscalculations. Part of the result of the building population estimation can be seen in Fig. 3.

3. Inundation scenario

Historically there have been tsunamis affecting the area, but little is known about their characteristics. As a worst-case scenario we consider a tsunami originating