A New Proposal for Tsunami Hazard Map Explicitly Indicating Uncertainty of Tsunami Hazard Assessment

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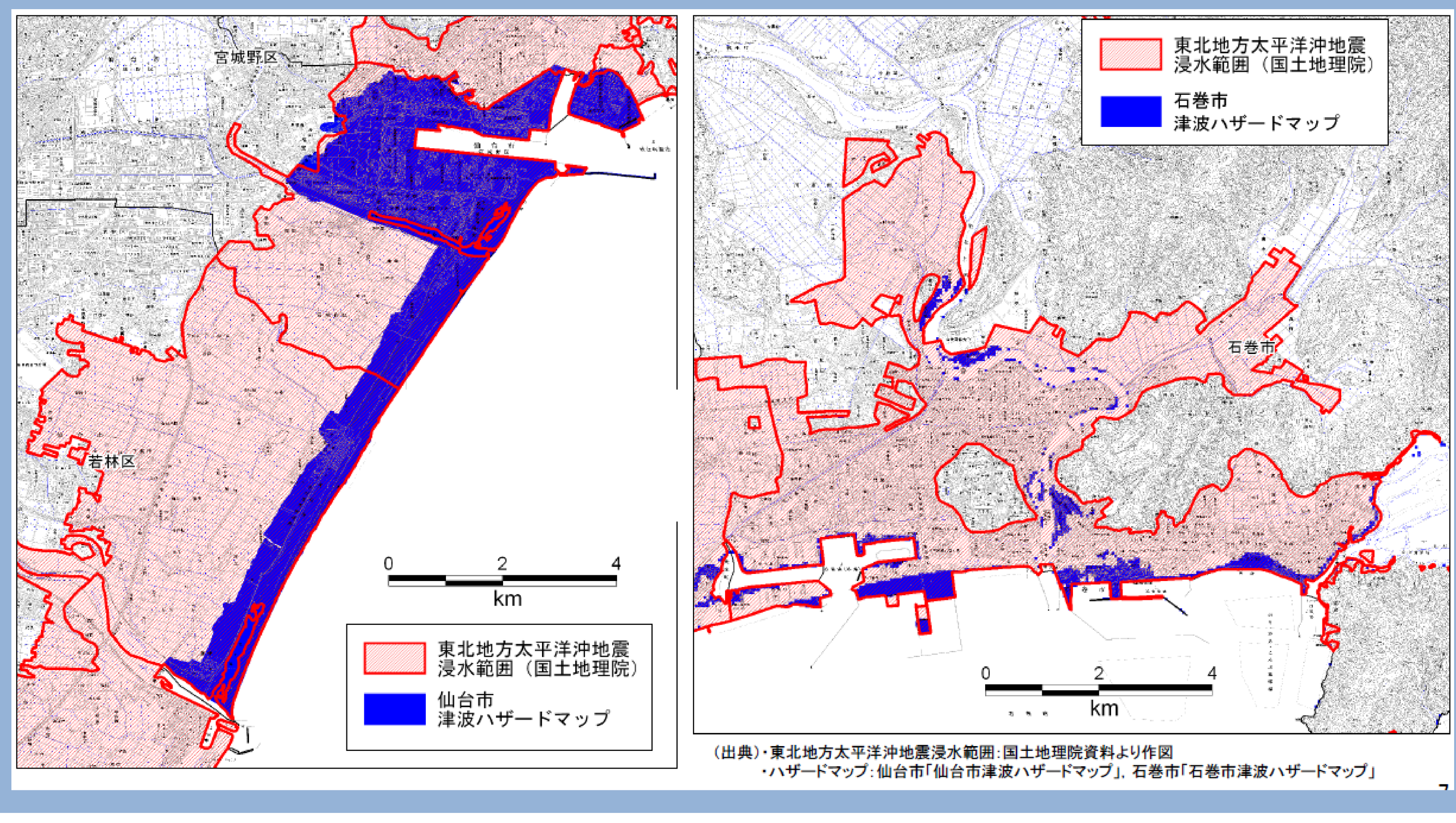
Research Background

Since the tsunami hazard assessment includes large uncertainty, we cannot properly understand the uncertainty when using the only results of the deterministic hazard assessment.

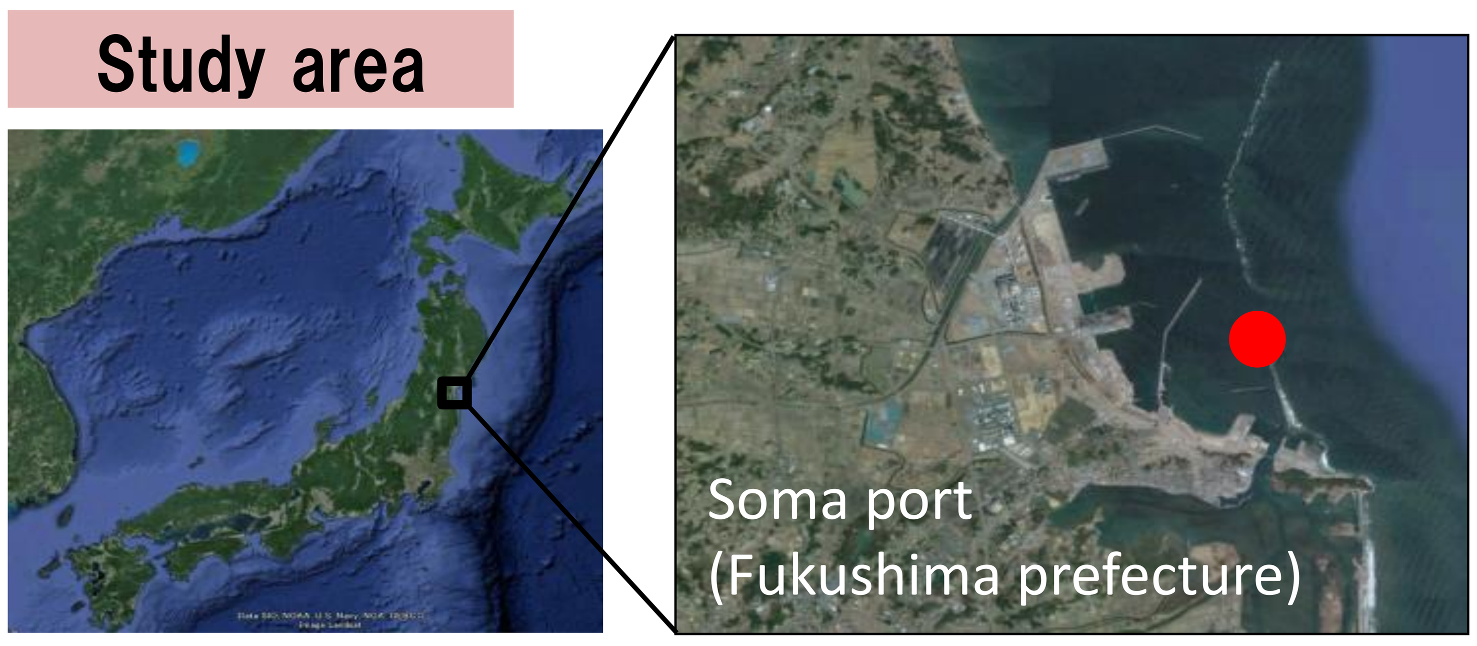
Objective

The objective of this study is:
- to clarify the uncertainty of tsunami hazard assessment.
- to visualize the evaluated uncertainty on the tsunami hazard map.

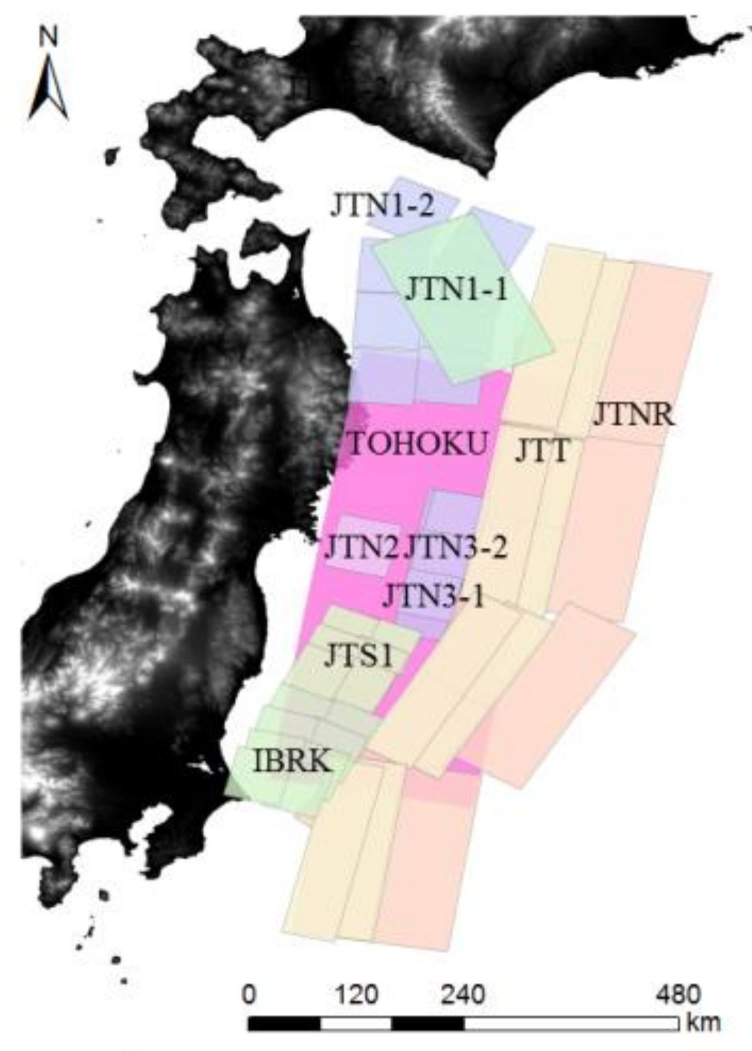
By doing this, for example, local residents who utilize tsunami hazard map can properly understand the uncertainty of the tsunami hazard assessment, resulting that it might make a good impact on their decision-making for disaster prevention.



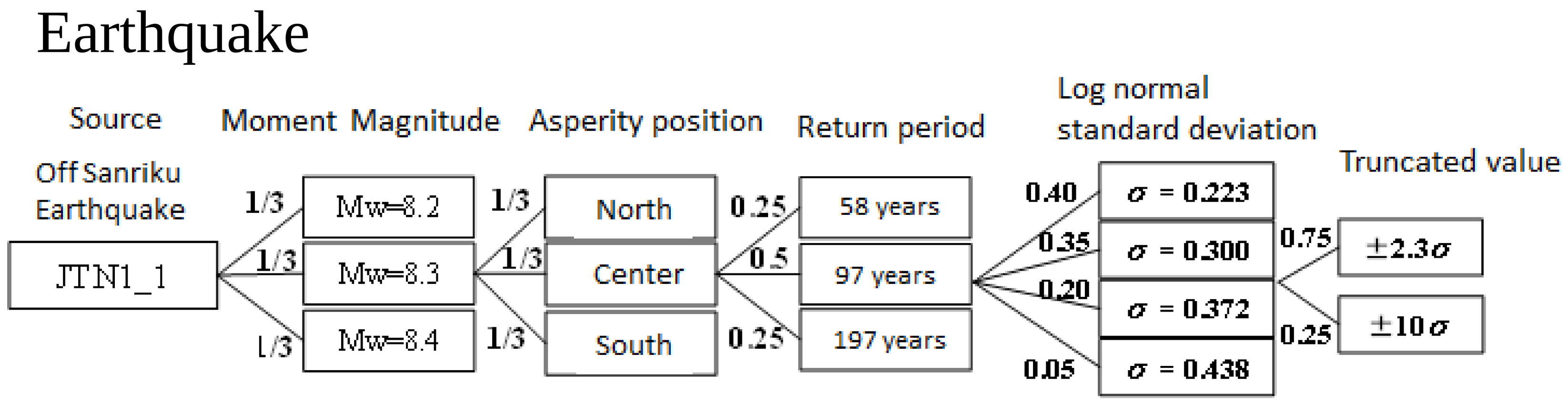
Study area



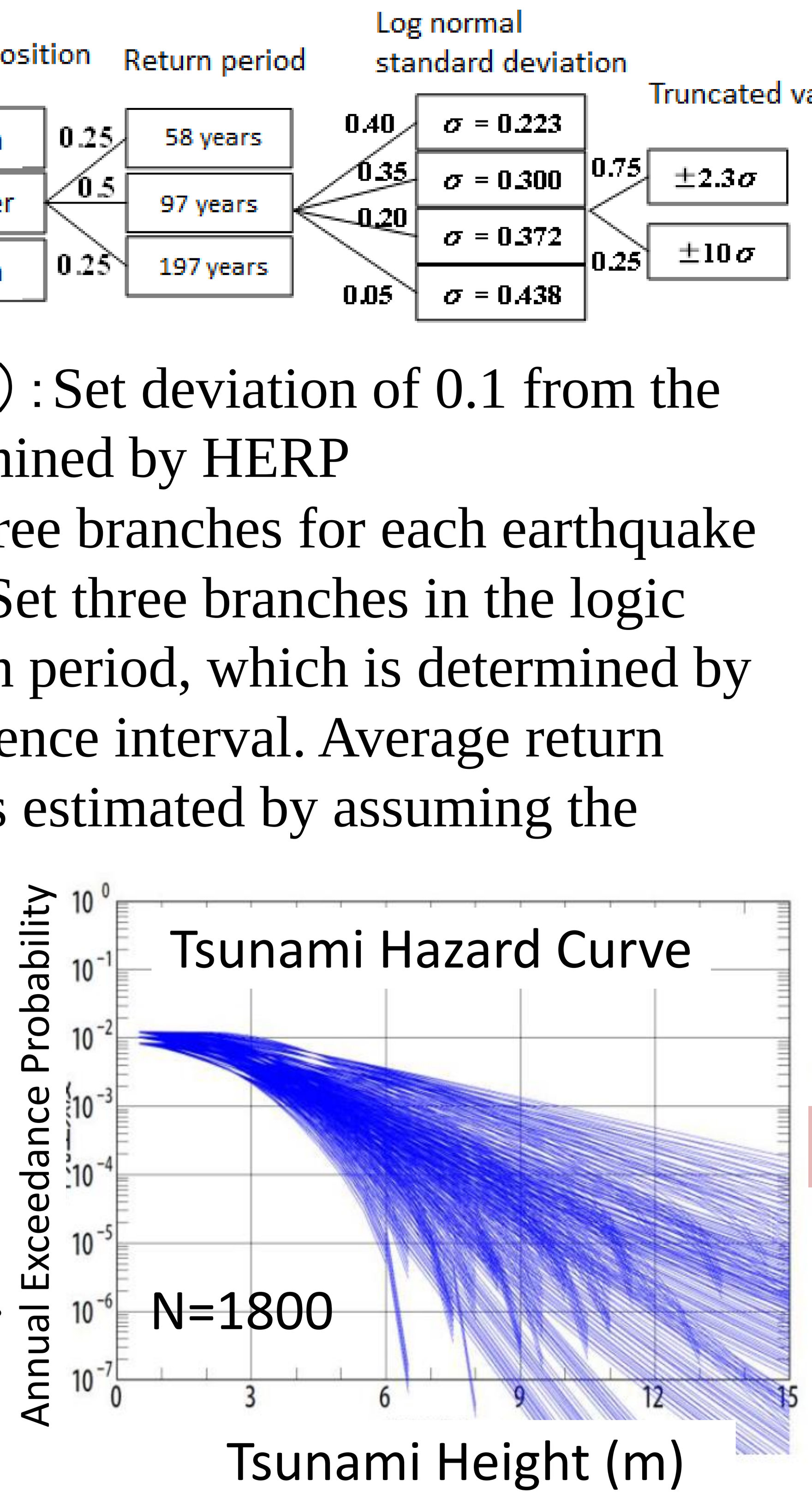
Target earthquake zones



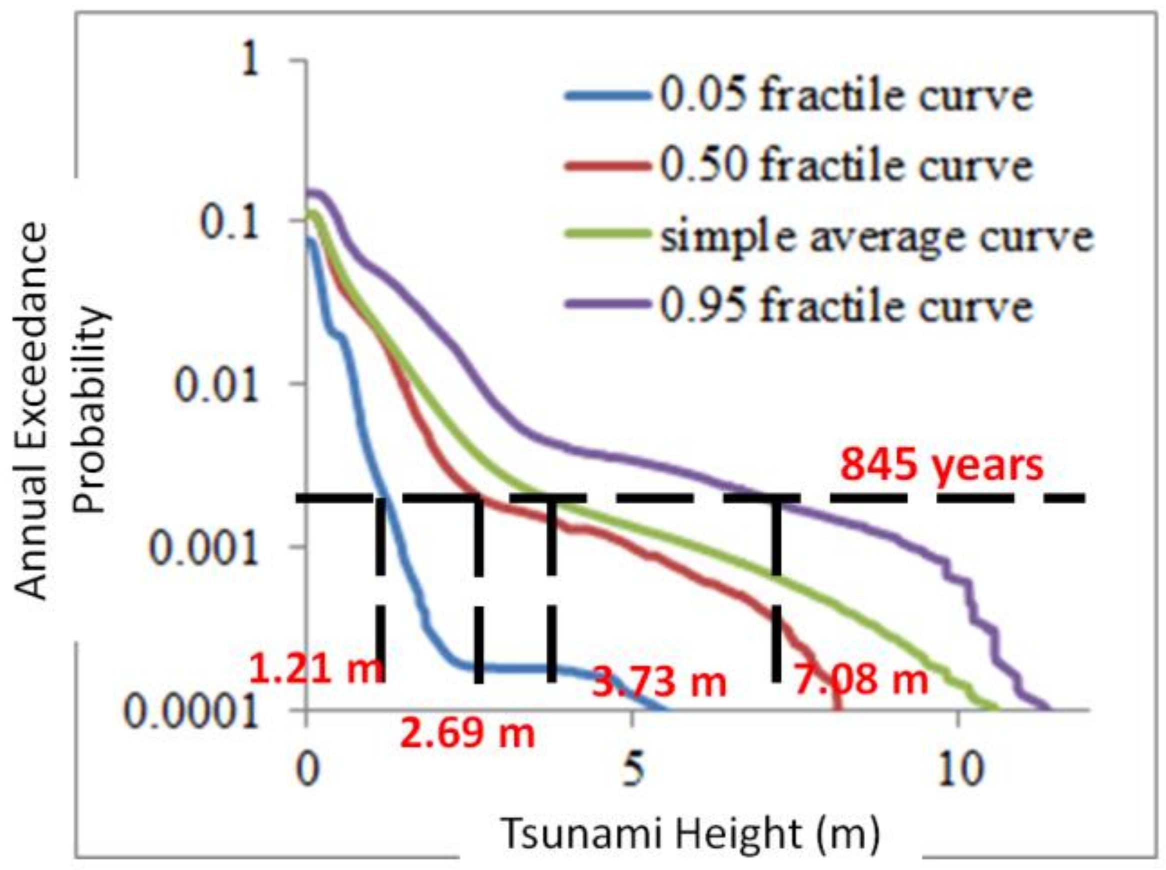
-We selected eleven earthquake zones including Tohoku earthquake fault along the Japan trench for stochastic tsunami hazard assessment.
-We used a portion of earthquake zones, which are used in probabilistic seismic hazard map by HERP* in Japan.
-Based on the earthquake information, we implemented a lot of tsunami numerical simulations.
-We constructed logic trees corresponding to each earthquake zone.
-Below is an example of logic tree for the off Sanriku Earthquake



-Moment Magnitude (Mw) : Set deviation of 0.1 from the moment magnitude determined by HERP
-Asperity Position : Set three branches for each earthquake
-Average Return Period : Set three branches in the logic trees for the average return period, which is determined by HERP, considering confidence interval. Average return period of the earthquake is estimated by assuming the Poisson distribution
-Lognormal standard deviation and truncated value : values of Annaka (2007)'s study
-Numbers of all branches in the logic trees are 1800.
-Therefore, we can obtain 1800 hazard curves.



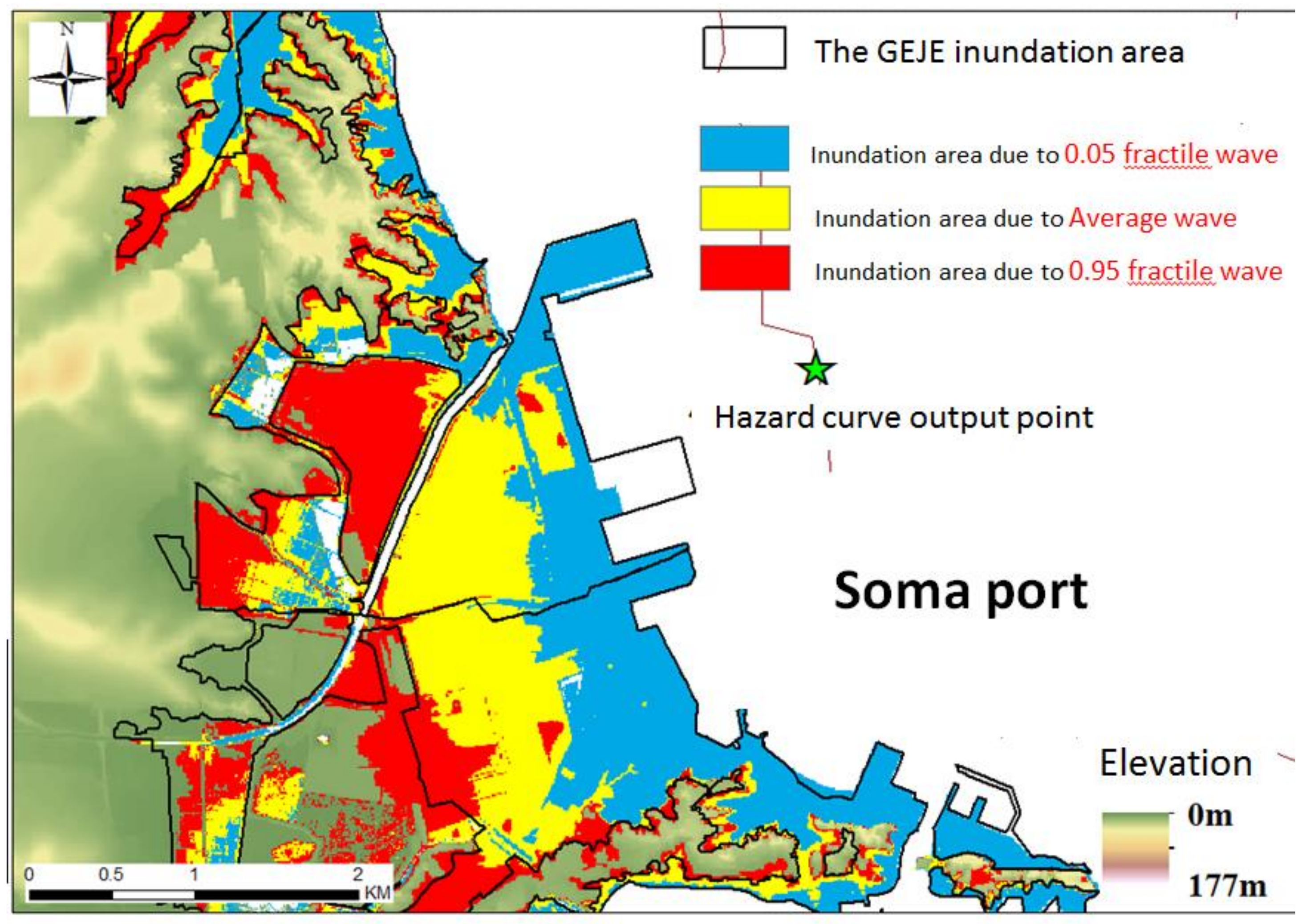
Tsunami hazard curve at off the Soma port



-After statistical treatment of the results of logic tree calculation, we can obtain fractile tsunami hazard curves (5% fractile, 50% fractile and 95% fractile) and Simple average curve.
-We can evaluate uncertainty of tsunami height from these curves.
-For example, average tsunami height with return period of about 845 years is 3.73 m.
-5% fractile wave is 1.21m, 50% fractile wave is 2.69m, 95% fractile wave is 7.08m.
-Tsunami heights with even one return period basically have a high level of uncertainty.

Tsunami hazard map explicitly indicating uncertainty

-The below map is tsunami hazard map explicitly indicating uncertainty of tsunami hazard assessment.
-The blue area is inundation area due to 0.05 fractile wave, the yellow one is for Average wave and the red one is for 0.95 fractile wave.
-The black line is the inundation area due to the Tohoku earthquake.
-At least in theory, the return period of these inundation area is about 845 years.
-As shown in the map, there exists a high level of uncertainty in the tsunami hazard assessment.



Tsunami hazard map due to tsunami with return period of about 845 years

-We tend to focus on inundation area with one return period, but it is very important to evaluate, quantify and visualize the uncertainty of the assessment!!

References

Annaka, T., Satake, K., Sakakiyama, T., Yanagisawa, K., and N. Shuto (2007), Logic-tree approach for probabilistic tsunami hazard analysis and its applications to the Japanese coasts, Pure Appl. Geophys., 164, 577–592.
Fukutani, Y., Suppasri, A., and F. Imamura (2014), Stochastic analysis and uncertainty assessment of tsunami wave height using a random source parameter model that targets a Tohoku-type earthquake fault, Stochastic Environmental Research and Risk Assessment, doi 10.1007/s00477-014-0966-4.
Fukutani, Y., Suppasri, A., Abe, Y., and F. Imamura (2014), Stochastic evaluation of tsunami inundation and quantitative estimating tsunami risk, Journal of Japan Society of Civil Engineers, Ser. B2 (Coastal Engineering), 70(2), I_1381-I-1385. (in Japanese)