Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2019-139-AC2, 2019

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Tsunami risk assessment for multiple buildings by considering spatial correlation of wave height using copulas" *by* Yo Fukutani et al.

Yo Fukutani et al.

fukutani@kanto-gakuin.ac.jp

Received and published: 16 September 2019

Dear Anonymous Referee #2,

We have considered carefully the peer-reviewed comments from you and revised our manuscript. Authors' one-on-one comments are as follows. Also, we have attached the revised manuscript as a supplement material.

We declare that this work is original and has not been published elsewhere nor is it currently under consideration for publication elsewhere. Please address all correspondence concerning this manuscript to me. Thank you for your consideration of this.

Yo Fukutani

Authors comments to the Anonymous Referee #2

My major concern with this study is the assumption of the uniform slip on the rupture. This is never the case in a real earthquake, and it was shown in many tsunami studies that tsunami wave heights and runup values in the near field are highly sensitive to the slip distribution in the rupture area. Both towns, Oiso and Miura, are located in the near field with respect to the simulated tsunami sources (the ten Regions), and in some cases even within the rupture area of the earthquake. In my experience, the sensitivity of tsunami heights and runup values to the slip distribution is higher than that to the slip amount and depth of the fault (given that the fault depth was varied by small amounts). If the goal of the paper was to demonstrate only the proof of concept of using response surface and copulas, this needs to be stated clearly in the abstract.

Thank you for pointing this out. The purpose of this study is not to identify parameters that affect tsunami hazards, but to demonstrate a method for tsunami risk assessment using response surface and copulas. This has been clarified in the second sentence of the abstract. There are many parameters that affect tsunami hazards such as tsunami wave height and runup height. There are also many tsunami studies that show inhomogeneous slip has a great impact on tsunami hazards, but this is not the focal point of this study. We have added more details on the uncertainty of tsunami hazard assessment and references from Page 3 - line 23 to Page 4 - line 5 in the revised manuscript as follows:

Tsunami hazard assessment has many uncertainties in each process of tsunami generation, propagation, and run-up. Even considering only the earthquake source parameters that are the basis for calculating the initial displaced water level of the tsunami,

there are fault length, fault width, fault depth, slip amount, rake, strike, and dip. The temporal and spatial changes of all these parameters more or less affect the tsunami hazard assessment. Numerous studies on the effect of earthquake source parameters on the initial displaced water level of tsunamis have been conducted (e.g., Hwang and Divoky 1970; Ward 1982; Ng et al. 1991; Pelayo and Wiens 1992; Whitmore 1993; Geist and Yoshioka 1996; Geist 1999; Song et al. 2005). These studies reported that fault slip was an important factor governing tsunami intensity. In addition, the Sagami Trough, which is the target earthquake of this study, has a complex crustal structure in the area where the Pacific Plate, the Philippine Sea Plate, and the North American Plate meet. Therefore, the depth where the Sagami Trough earthquake occurs is considered uncertain. Therefore, in this study, we decided to consider only the tsunami hazard uncertainty caused by the changes of slip amount and fault depth as an example. The heterogeneity of fault slip is an equally important factor, but we did not consider non-uniform slip distribution for purposes of simplicity. It is an important issue in the future to evaluate the heterogeneity of fault slip by response surface methodology. This is true for both slip heterogeneity and other fault parameters. For the above reasons, we model maximum tsunami wave height considering tsunami wave uncertainty with Eq. (2) after conducting tsunami numerical simulation with a nonlinear long wave equation.

Specific comments 1. It is not clear from the abstract that the considered buildings from the same portfolio are located far away from each other. It would be nice to define “portfolio of buildings” for readers who are not familiar with the civil engineering terminology.

Thank you for pointing this out. We have deleted the word portfolio in the abstract in consideration of readers who are unfamiliar with the term. We have added the sentence

“it is noted that portfolio means a collection of assets held by an institution or a private individual” to the Introduction. Also, we have clearly indicated in the abstract that we evaluated buildings that are far away from each other.

---

2. A figure that shows the geographical region described in the study, including the Sagami trough, should be included. This figure can be referenced at the beginning of Section 3.

Thank you for pointing this out. We have included a new figure in Fig. 2, which includes the Sagami Trough earthquake and other major subduction earthquakes around Japan.

---

3. It is not clear why each earthquake source needs to be represented by thousands of subfaults if the slip on the rupture is uniform.

Thank you for pointing this out. In tsunami numerical simulation we commonly assume a rectangular earthquake fault. Therefore, when considering an earthquake occurrence area with a complicated shape such as the Sagami Trough earthquake, it is necessary to generate the earthquake fault for tsunami numerical simulation by aggregating thousands of rectangular subfaults, even if the slip on the rupture is uniform.

---

4. Technical corrections - Page 1, line 20: this sentence is not grammatically correct.

Thank you for pointing this out. We have modified the sentence.

- Page 2, line 27: refer to Figure 2 for locations.

Thank you for pointing this out. We have added the reference to Fig. 2.

- Page 5, line 9: needs to be “affect”

Thank you for pointing this out. We have modified it.

- Page 5, line 10: reference the new figure that shows the study area

---

Thank you for pointing this out. We have referenced the new figure in Fig.2 that clearly shows the study area.

- Page 6, line 33: it is probably “all possible uncertainties”

Thank you for pointing this out. We have modified it.

- Page 9, line 6: it is probably “agencies”

Thank you for pointing this out. We have modified it.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-139/nhess-2019-139-AC2-supplement.pdf

---

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2019-139, 2019.