Response to Reviewer Comments # 2

Natural Hazards and Earth System Sciences (NHESS)

Estimation of the effects of climate change on flood□triggered economic losses in Japan

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Thank you very much for your invaluable comments to improve the quality of the manuscript. We address each of your points as below.

1. Major issues: P 1623, L20: The equation is not properly explained and the indices cannot be right. Throughout the paper it is not clear when monthly and annual data are used.

In the equation, fine resolution factor (Bd) is the main parameter to scale down the GCM precipitation data. Fine resolution factor is the ratio between observed (mesh climate data) and the GCM data for present time frame in 1 km × 1 km resolution. This method assumes that the Bd is a constant factor for the future.

For the estimations and downscales, we used monthly precipitation data. Average annual precipitation data is used to estimate and depict the rate of precipitation increase (eg Fig 3).

2. P 1624, L2: It is not properly explained how to derive the denominator. If it is obtained simply by interpolating between each pixel in the GCM simulation it is a highly unusual approach that is questionable, because the bias of the GCM is not taken into account. From the equation it is not even clear if the authors consider the climate change signal at all or just use the raw input from the GCM without accounting for bias at all. If they do not account for bias it explains the unusual results reported in Figure 1.

To derive the denominator, we use we used the inverse distance weighing method. Therefore, fine resolution factor (Bd) represents the regional characteristics of rainfall that depend on the geographic features of the area. The calculation process includes a bias correction.

3. P 1624, L 14: The formulation of the GEV is mixed together with the estimation principles, making the entire section difficult to read. It is never mentioned which data are used as input to the GEV, perhaps annual maxima? When reformulating the section, please also correct the errors in Equation 6.

Annual maximum daily precipitation is used as input to GEV
This section is reformulated to give better understanding to the reader.
Equation 6 should be corrected as

$$F(x) = \exp\left\{ -\left[1 - \left(\frac{k}{a} \right)(x - c) \right]^{1/k} \right\}$$

4. P 1626, L 7: Again, it is unclear whether annual or monthly data are being used.

24hr extreme rainfall data is used. The statement is modified as " regression analysis was used to develop a relationship between the 24hr extreme rainfall data and the annual mean precipitation data'.

5. P 1626, L 8-10: It is very unclear what has been done. Please clarify.

This section is explained more in details in the revised manuscript.

6. P 1626, L 13: If 20C are used, then please provide more details. That is pretty far from the melting point of water.

It is a serious textual mistake. It should be 2^0C.

7. P 1626, L 18: The reference to Ushiyama and Takara makes it unclear what is part of the reported study and what has been made by others.

Ushiyama and Takara (2003) develop a model to calculate the extreme rainfall using regression line. That process also needs to separate rainfall and snowfall to get the best regression.

8. P 1627, L 5-17: It is not clear how this section is related to the previous section. Exactly what data (monthly/daily/annual) are being used and for what purpose? Please clarify.

This section explains the process followed to convert the monthly maximum rainfall to daily maximum rainfall. As the relationships between monthly and daily rainfalls are different in different seasons, separate regression lines are developed for autumn, winter and spring-summer periods.

This section is explained well in the revised manuscript.

9. P 1629, L 15: Testing an approach on part of a city does not justify extrapolation to an entire country including mountaneous areas etc. There should be some sort of calibration or justification of the approach based on present data and climate.

   Kazama (2002) is a case study in the literature to support the successful application of the model. Kazama (2002) applied the model and verified with field observation. Further Kazama et al (2009) also successfully used the model over entire country.

10. P 1630, L 25: Since all data is at hand it would be nice to see a seasonally adjusted cost function.

It would be good, but this study didn't put any effort to estimate the seasonal change of the cost, only annual average values.

11. P 1632, L2: Please justify "the same way". Equation 15 and 16 does seem to be different.

Here "the same way" means "multiplying office depreciable assets and inventory assets by the damage rate for the flood depth". As residential damage estimated by "multiplying household furniture assets by the damage rate for the flood depth", the term "same way" is used

Of course, equation 15 and 16 are different..!! Equation 15 estimates residential building damage whereas equation 16 estimates office building damage.

12. P 1633, L 24: Please be more specific in this equation. There must be some form of unit cost in USD

Reviewer may highlight the equation 24?? As general asset damage is in USD, the traffic zone damage is estimated in USD. (This equation is defined in the flood control economy investigation manual (MLIT)).

13. P 1634, L6: What does Figure 3 show? Monthly or annual changes? How is the result linked to the theory in section 2?

Fig 3 shows the rates of precipitation increase (based on annual precipitation in 2000 and respective year). Here we used the downscaled rainfall data as explained in section 2.

14. P 1634, L 15: By probabilistic analysis you mean section 2.2 and 2.3?

We mean section 2.2 (GEV analysis)

15. P 1634, L 17: The resolution is not very good, but Figure 4 appears to show larger changes than what is implied by Figure 3? Please clarify.

Please note that the main difference is Fig 3 shows the "rates of precipitation increase" whereas Fig 4 shows the daily extreme rainfall. Therefore changes are obvious.

16. P 1635, L 3-5: That is a very bold statement, given the abundant literature with different results. The result should be discussed in that context.

This statement is supported by Fig 4, where we observed that extreme rainfall is in the order of SRES- B1, A2 and A1B. Anyway the results will be more discussed in the revised manuscript.

17. P 1635, L 13: Please calculate the expected annual costs as explained in e.g. Chow et al (1988). Figure 5 indicate that the contribution of the 5 year return period event to the overall expected annual cost is much larger than the 100 year return period, which the authors should include in their discussion.

Even though it is not clear what exactly reviewer means, we can calculate expected annual cost for each SRES scenario.

18. P 1635, L 25-30: Please clarify. Intuitively it seems wrong that Figure 3 shows changes of 2-14% while Figure 6 shows changes on 10-125%.

Please note that these two figures are different, Fig 3 shows increasing rate of precipitation for selected GCMs whereas Fig 6 shows the Relationship between the increase in extreme rainfall and the increase in potential economic loss.

19. P 1637: I am very uncertain that the methodology is sound and hence I doubt that the conclusions are justified.

We used different GCMs and multi-scenarios, which brings uncertainty as a main concern. We agree that we should conduct uncertainty analysis, but within the scope of the paper our main aim is to highlight the method and it's applicability to use 1km fine resolution economical assessment which is useful for stakeholders as a decision making tool. Anyway with the used data/mechanisms, the proposed relationship is applicable in Japan and it is limited to specific conditions such as steep geography and humid climate in Japan.
Also as highlighted in the manuscript this research calculated flood damage in fine resolution of 1km resolution. Therefore it provides a high accurate spatial distribution of flood damage. Therefore stakeholders/authorities/decision makers can decide priority locations for adaptation/risk mitigation activities.
Taking reviewer's comment, more discussions are added to the revised manuscript.

Minor points:

Thank you for all comments which significantly improve the quality of the manuscript. We have corrected all the minor corrections and manuscript is revised accordingly.