Response Letter to Reviewers Comments on nhess-2019-166

Many thanks for the quick response from the editor and the reviewers. The manuscript has been improved substantially based on the constructive comments of the reviewers.

(The highlighted parts are added to the revised paper)

Response to Comments of Reviewer #3

General Comment: The manuscript described an interesting idea on looking at the flood damage caused by ENSO. A case study in Kan River Basin, Iran was presented. The manuscript is well organized and easy to follow. However, I think the current results are not convincing enough, because huge uncertainties from the 6-step were ignored. Extrapolation without acknowledging uncertainties can mislead the result. Thus, I recommend return the manuscript to authors for major revision.

Response: Many thanks for your comments. The manuscript has been improved substantially based on your constructive comments.

Major comments:

Comment #1: In methodology section, authors presented a 6-step method to investigate the flood damage from ENSO. In each of those steps, there are uncertainties. In particular, the paper steps I, II, III and VI are based on probabilistic models, in which uncertainties cannot be avoid. The main issue is that when putting those 6 steps in series the uncertainty can be exploded. This makes the result meaningless when having huge uncertainty. When estimating the relationship between rainfall variation and SOI, large uncertainty should exist on the slope as shown in Figure 2. The results derived from Eq 3 should also have a large uncertainty. When bringing this uncertainty into next steps, the final results may be very different from what has been found right now.

Response: Thank you for your valuable comments over the methodology. We agree that there are uncertainties in every step. However, most of the uncertainties can be assessed quantitatively or constrained by the observations. These uncertainties have been quantitatively assessed in the paper, e.g. considering different probability for %-increase in the rainfall. In the revision, we have summarized the uncertainties in every step and provided brief discussions on the limitations:

Step I: noted that there is uncertainty in the optimal number of categories that may influence the lag time between the precipitation in the basin and SOI.

Step II: Rainfall increases in the El Nino years are different and considering an average value for the flood damage analysis cannot provide an acceptable result. It is better to consider the uncertainties in a specific way. The employed probabilistic method for considering the rainfall increase percentiles can cover some of these uncertainties.

Step III: This is a limitation in our methodology in which the increase percentile for the rainfall for every return period has been considered the same.

Step VI: In this section, with the help of GIS tool and the land use maps which were obtained from the local municipality, a simple analysis of damages to the buildings and their contents, and the agriculture is carried out. In this step just five Sub-basins of Imamzadeh Davood, Rendan, Sangan, Sulaghan and Keshar are considered; because of lack of land use maps, low population, and low development in the other sub-basins. For this regard, applying the inundation map on the land use maps, the average depth of inundation and area of inundation for every land use category are calculated. Then from the damage-elevation curves, percentile of damage to the land uses can be estimated. Finally, the damage cost to each of land uses is calculated by the average economic value of one unit of that land use. It should be noted that for agricultural damage analysis in every sub-basin, two dominant products of cherry and apple were identified and based on the percentage of each of them, average crop number per unit area and value of each crop, the damage analysis was performed. Percentages of crops, number of them per unit area and their economic value as well as values of different assets in the flood plain are obtained by several field survey, interviews with the local authorities and local inhabitants, and engineering judgment.

Minor comments:

Comment #2: There are some constant values in equation 2 and 4. Authors need to justify these numbers.

Response: We have now justified these numbers as follows:

Equation 4: The constant value 0.2 in Eq. (4) is selected based on SCS recommendation. SCS has proposed the initial losses can be estimated as I_a=0.2S (Ponce and Hawkins 1996). We did not have any estimate for this losses therefore, the SCS recommendation was taken for Kan River Basin.

$$P_e = \frac{(P - I_a)^2}{P + 0.8S}$$

Substitution of I_a=0.2S in the above equation

$$P_e = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad \text{Eq. (4)}$$

where P is rainfall; and S is storage potential. Moreover, Clark instantaneous unit hydrograph method is applied to transform the effective rainfall into runoff (Q).

Equation 2: When dealing with large sets of numbers, Sturge's rule (Sturges 1926) can be used to choose the number of categories. Sturge's rule is widely used in the statistical packages like excel for making histograms. According to Sturge's rule the data range should be split into K equally spaced classes where:

$$K = 1 + \log_2(n)$$

where n is the number of data. Changing the logarithm to the base of 10, we have:

$$K = 1 + 3.322\log_{10}(n) \qquad \text{Eq. (2)}$$

Reference:

- Ponce, V. and Hawkins, R. 1996. Runoff Curve Number Has It Reached Maturity Journal of Hydrologic Engineering, 1, 11-19.
- Sturges, H. 1926. The choice of a class-interval. J. Amer. Statist. Assoc., 21, 65-66.