

Response to review comments by Anonymous Referee #2 (R2)

General comments:

R2.1 This article develops the socio-spatial vulnerability of 16 coastal districts of Bangladesh based on the vulnerability indicators at district levels. The contribution of this analysis is not new, as the authors have already shown in their literature review that a growing body of literature describes how vulnerable the coastal communities in Bangladesh are. In this paper, the specification that I see is the combination of people and place vulnerability to compare the districts, which are mostly known from various studies.

Authors' response: Literature on cyclonic flooding vulnerability along the coast of Bangladesh typically examines either physical or social characteristics of the vulnerability to this hazard. This paper takes slightly different approach: it argues the need to consider the socio-spatial specific context which transcends the classical social and economic responses to integrate physical and infrastructural conditions as a basis of understanding and addressing cyclonic flooding vulnerabilities.

First, it sets out the framework in which cyclonic flooding vulnerability should be placed and shows the issue tied to its indicators. Indeed, majority of authors does not explain really the conceptual framework underlying their vulnerability assessment, making more difficult to interpret and re-use their results for scientists and stakeholders.

Moreover, lots of studies used a large set of indicators (Quader et al. 2017), which are reduced to smaller uncorrelated factors set using statistical methods, such as the principal components analysis, it raises as a consequence complex issues of number of principal components to retain, their significance, and the normalization choice, among other. Contrariwise, we analyzed the relevant indicators related to the cyclonic flooding vulnerability based on expert knowledge from a strict literature review. The literature review is a rich source to understand the main causes, translated as indicators, of social-spatial vulnerability to cyclonic flooding, their relative importance and interactions. Improved incorporation of the regional context helps to select significant indicators, at total 17 in our case, that not only reflect vulnerability as a state (e.g. poverty, age), but also as a situation (e.g. house type, shelter capacity).

Finally, an overview of the conceptualization of socio-spatial cyclonic flooding vulnerability is presented through the SSVI. It is a simple computation of index which has a more understandable construction and appears easier to replicate for decision makers. Furthermore, unlike other studies which have developed physical or social cyclonic flooding vulnerability assessment, in our study, cyclone hazard flooding has been considered and incorporated in the social vulnerability model (i.e. SSVI).

This paper contributes to bring a paradigm shift, considering the integrated socio-spatial vulnerability, and new perspective to assess the vulnerability to cyclonic coastal flooding. It provides a framework for future research on the topic of integrated socio-spatial vulnerability assessments to cyclonic floods, as a basis for adaptation strategies.

Specific comments:

R2.2 I am a bit concerned about the literature search portal, like google is not such confident sources for academic publication searches. Then it is needed to describe how the final list of the review prepared, based on what criteria the article was selected for review, i.e. exclusion criteria must be written in the methodology section.

Authors' response: We should remind here first of all that we used four traditional academic citation databases: ISTEEX, Science Direct, Scopus and Web of Science. In addition, we chose to complete our analysis with the literature extracted from Google Scholar (GS) database. There are several reasons for

this choice: GS is free to use (which is not the case of Scopus and of Web of Science); and although it has been shown that the majority of literature identified using Web of Science was also found using GS (Haddaway et al. 2015), it has also demonstrated that a large fraction (9–30%) of highly-cited documents in the Social Sciences and Humanities could be invisible to Web of Science and Scopus (Martin-Martin et al. 2018). Here, our primary area of concern is the vulnerability of the population to cyclonic flooding, therefore we felt it was important to complete this classical literature analysis with also the results from GS database. (see also answer to comment R1.5 and R1.6).

We propose to modify and add this sentence in the main text to justify the use of GS database search engine (section 4.1 Methodology):

“Four traditional academic citation databases: ISTEEX, Science Direct, Scopus and Web of Science were used for the literature review process. In addition, we completed the analysis with the literature extracted from Google Scholar database. Despite it has been shown that the majority of literature identified using Web of Science was also found using Google Scholar (Haddaway et al. 2015), it has also demonstrated that a large fraction (9–30%) of highly-cited documents in the Social Sciences and Humanities could be invisible to Web of Science and Scopus (Martin-Martin et al. 2018).”

Martín-Martín, A., Orduna-Malea, E. & Delgado López-Cózar, E. Coverage of highly-cited documents in Google Scholar, Web of Science, and Scopus: a multidisciplinary comparison. Scientometrics 116, 2175–2188 (2018). <https://doi.org/10.1007/s11192-018-2820-9>

Haddaway NR, Collins AM, Congblin D, Kirk S (2015) The Role of Google Scholar in Evidence Reviews and Its Applicability to Grey Literature Searching. PLoS ONE 10(9): e0138237. <https://doi.org/10.1371/journal.pone.0138237>

Considering, the review process applied for collecting articles, as mentioned section 4.1, was used to pick up only the articles responding to the following search sequence, in the electronic databases, were considered: (“coastal flood*” OR “sea-level rise” OR “Storm surge” OR “Cyclonic storm” OR “Disaster risk reduction”) AND (“Bangladesh” OR “Brahmaputra delta”) AND (“*vulnerability” OR “human exposure” OR “coping*”). (see also answer to comment R1.2 and R1.7).

We propose to add this paragraph in the main text to clarify our review process (section 4.1):

“The initial search used inclusion criteria to be sure the first selected range of articles focused on studies about vulnerability to cyclonic floods in Bangladesh. A second selection of the first range of articles screened documents one by one to check if they explored vulnerability to cyclones and if they specifically did focus on areas placed in coastal Bangladesh, and not vulnerability to river flood for instance.”

R2.3 Although the literature review is well-organized and written, I would suggest that the author recheck a few recent scholarships, which may add new dimensions in vulnerability indicators.

Authors' response: Please, see also answers to comment R1.3 of the Referee#1.

Adnan et al. (2019) Have coastal embankments reduced flooding in Bangladesh? Science of The Total Environment, Volume 682, Pages 405-416

Authors' response: Adnan et al. (2019) analyzed the beneficial and harmful impacts of embankment construction on the territories. They focused on pluvial, fluvio-tidal and cyclonic floods and compared observed and modelled floods, with and without polders. As in Islam et al. (2019), this article focuses

on flooding, i.e. on the hazard, and not on the socio-spatial vulnerability to cyclonic flooding. This article was not therefore considered by our literature review process. (see also answer to comment R1.3).

Islam Feroz et al. (2019) Flood risk assessment due to cyclone-induced dike breaching in coastal areas of Bangladesh, *Nat. Hazards Earth Syst. Sci.*, 19, 353–368, 2019

Authors' response: The main objective of Islam et al. (2019) is to estimate the exposed areas to storm surge flood of the polder 48 (Patuakhali district), using a hydrodynamic model under different scenarios in a context of climate change (tide, sea level, dike breach and cyclone landfall angle). This article focuses on flooding, i.e. on the hazard, and not on the population/territory vulnerability to cyclonic flooding. This article was not therefore considered by our literature review process. (see also answer to comment R1.3).

Younus, M.A.F. (2017) An assessment of vulnerability and adaptation to cyclones through impact assessment guidelines: a bottom-up case study from Bangladesh coast. *Nat Hazards* 89, 1437–1459

Authors' response: Younus et al. (2017) proposes an assessment of vulnerability based on a qualitative approach (by participatory rapid appraisal with semi-structured questions and groups of discussion) with the population of the Bawalkor village (Barguna district). Several high vulnerability issues are identified like seed-bed damage, primary occupation loss or culture fishpond loss. A second part of this study concerns adaptation issues (need to reconstruct the shelter, need relief from the interest of loan for 1 year after the disaster, need to reconstruct roads, etc). While interesting in its approach, this article does not identify key variables defining population/territory vulnerability to cyclonic flooding at the district level based on variables available in public databases. It was therefore not retained in our literature review process. (see also answer to comment R1.3).

R2.4 Though the authors have mentioned based on their reviews that cyclonic storms are the major environmental threat in the coastal districts, also the tidal-surge induced floods needed to be considered, and the severity of vulnerability due to such tidal-surged induced inundations can change overall land use and livelihood pattern of the people. An example can be taken from cyclone Aila 2009, which also motivates people to shift from shrimp to rice cultivation which is absent in their discussion. Authors are suggested to revisit such land use transformation.

Authors' response: We agree with your comment that multiple physical processes are responsible for flooding at various spatial and temporal scale - including pluvial, fluvio-tidal, tidal, and cyclone-induced storm surge flooding (e.g., Haque et al. 2018). In this study, we focus only on the cyclone-induced storm surge flood hazard. However, it is important to note here that, in our modelling of the storm surge flooding probability, the tidal dynamics and riverine flow from Ganges, Brahmaputra, and Meghna are included. Please see our reply to point R1.4 concerning the flood complexity in coastal zone.

Concerning the land use transformation, according to our literature review, the transformation of land use following a disaster is rather a matter of the resilience of populations and their adaptive capacity, i.e. finding solutions to adapt to the new environmental constraints, as soil salinization (Hoque et al., 2017). Moreover, at the district scale, the land use is quite homogeneous and corresponds largely to agricultural areas.

Hoque, S. F., C. H. Quinn, and S. Sallu. 2017. Resilience, political ecology, and well-being: an interdisciplinary approach to understanding social-ecological change in coastal Bangladesh. Ecology and Society 22(2):45. <https://doi.org/10.5751/ES-09422-220245>

R2.5 Temporal migration or translocal livelihood is one of the major aspects of the vulnerability constructs of the people living in this region. However, the author has not taken into consideration this

displacement indicator into their vulnerability index. Taking the displacement indicator of each district might result in different vulnerability indexes for major cities (i.e. districts).

Authors' response: Concerning the temporary, seasonal, or cyclical migration, from our literature review, only one article (Mallick and Vogt 2013) mentioned to taking a displacement indicator in the cyclonic flooding vulnerability estimation. However, this indicator was more mentioned as a post-disaster adaptation strategy (e.g.; Younus and Sharna 2014; Sultana, 2010; Rahman et al. 2014; Mallick et al., 2017).

Even though there are historical patterns and systems of mobility of the Bangladeshi households, as strategy to cope with agricultural and environmental variability (Afsar, 2003; Call et al. 2017), the linkage between seasonal/temporal migrations and cyclonic flooding vulnerability is not straightforward. These processes are not a one-off phenomenon that occur in a specific place at a fixed date, making it difficult to measure. Kartiki (2013) showed that it is largely landless and poorest agricultural labourers who temporally/seasonally migrate. Seasonal migration, until six months, usually involves one or two male members of the household, migrating to nearby urban areas. If the temporal/seasonal migration is planned and remunerative this allows livelihood diversification of the household, asset accumulation and increases children school attendance (Kartiki (2013); Mobakar et al. 2002). Therefore, this temporal/seasonal displacement could be reduced indirectly the cyclonic flooding vulnerability. However, it is often the men, the heads of households, who migrate temporarily to find work. The rest of the household remains in place. The women are responsible for protecting and conserving goods and food, and in the event of a cyclone warning, they are reluctant to make the decision to evacuate. This means caring for all the people present (children and elderly) and taking them to a shelter, sometimes far away, leaving behind all their belongings and food reserves, which can then be stolen or destroyed. In this case a household without head household is indeed more vulnerable than a household where the household is complete. Thus, in this case, this temporal/seasonal displacement could increase indirectly the cyclonic flooding vulnerability.

Afsar, R. Internal migration and the development nexus: the case of Bangladesh. In: Regional Conference on Migration, Development and Pro-Poor Policy Choices in Asia. 2003. p. 22-24.

Call, M. A., Gray, C., Yunus, M., & Emch, M. (2017). Disruption, not displacement: Environmental variability and temporary migration in Bangladesh. Global Environmental Change, 46, 157-165.

Kartiki, K. (2011). Climate change and migration: a case study from rural Bangladesh. Gender & Development, 19(1), 23-38.

Mobarak, A. M., & Reimão, M. E. (2020). Seasonal Poverty and Seasonal Migration in Asia. Asian Development Review, 37(1), 1-42.

R2.6 Data collected from different years and sources raise the homogeneity in nature and the temporality of analysis. I propose to describe these as limitations.

Authors' response: The dataset periods used in this study vary between 2010 and 2018, but the major part comes from the BBS census of 2014. This is a strong limitation, but no public databases are available for more recent dates. For example, Das et al. (2020), Mullick et al. (2019) and Rabby et al. (2019) used the census of 2011.

Following this recommendation, we propose to add this text in the beginning of the new sub-section 6.2 Representativeness and quality of the data:

“A first limitation concerns the availability of dataset to construct the SSVI. Indeed, the dataset used for this study was produced at different dates: from 2010 for the poverty level, to 2018 for

paved/unpaved roads. However, the main information defining social vulnerability comes from the BBS Census of 2014, which gives some homogeneity to the description of the socio-demographic characteristics of the population.”

R2.7 Besides the flood risks management is not very new in Bangladesh; it has a long history, including the polderization and adopted indigenous knowledge. It would be great if the author could add/review how the flood risk management knowledge evolved in these coastal settings and justify why their study related to coastal flooding's socio-spatial vulnerability index is essential. Polderization and the recent Delta Plan 2100 should be taken into consideration.

Authors' response: Risk management strategies are outlined in Section 3 Region study. They mention the reclamation policy since the 1960s, and the Cyclone Preparedness Program in the 1970s. However, nothing is specified for future years. We propose to mention the Delta Plan 2100 in the discussion section (see also answer to comment R1.11).

“Our results, for example, can help in the deployment of the Flood risk Management Strategies of the Delta Plan 2100 on the districts identified as failing on this dimension of vulnerability. Sub-strategies FR 1.1, 1.2 and 1.3 (Protection by development and improvements of embankments, barriers and water control structures (including ring dikes) for economic priority zones and major urban centres; Construct adaptive and flood-storm-surge resilient building; Adopt spatial planning and flood hazard zoning based on intensity of flood) for example correspond to the *Cyclone protection and exposure dimension* of the SSVI, for which Shariatpur and Jhalokati districts appear to be the most vulnerable (figure 4).”

Delta Plan 2100,

http://plancomm.portal.gov.bd/sites/default/files/files/plancomm.portal.gov.bd/files/dc5b06a1_3a45_4ec7_951e_a9feac1ef783/BDP%202100%20Abridged%20Version%20English.pdf

R2.8 The authors also address the cyclone shelter and evacuation process into the indicator lists. However, they do not mention how the community people decide the location of those cyclone shelter cum primary schools or any other community infrastructure and how the social elite controls the planning procedures.

Authors' response: Following the recommendation of the Referee #2 and #1, we propose to add this paragraph in the discussion section (see also answer to comment R1.10).

“The shelter capacity is another example of variables that does not seems always representative of the situation on the field. It can be assumed that existence of cyclone shelters reduces people's exposure and therefore their vulnerability. However, presence of cyclone shelters in close proximity to homes, within a radius of 1 to 1.5km, does not mean they are useful and used. Like mentioned by Mallick et al. 2017, shelters are not placed on territories in a way that can accommodate as many people as possible and be accessible, but are rather near the supreme classes. These buildings are not always maintained and do not meet the requirements expected by the local society: Men and women are in a same mixed place, there are no women-only sanitary facilities, and there can be a certain amount of insecurity (Kulatunga et al., 2014; Saha, 2015).”

R2.9 These are significant short-comings along with the revision of the motivations of the study. I would suggest that authors specify why their contribution is novel despite having a larger body of literature on vulnerability assessment of coastal Bangladesh.

Authors' response: Please see our previous replies to points R2.1; and R1.1 and R1.11 concerning the novelty of the study.