ANSWER TO REVIEWERS

REVIEWER 1

The paper presents a new exposure model providing information on population and residential buildings in five Central Asian Countries, namely Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan. The model, mainly aiming at supporting seismic risk assessment, is updating and further advancing a former model developed within the framework of the EMCA (Earthquake Model Central Asia) in several aspects. At regional and transnational scale the authors improved the spatial resolution of the model by leveraging high-resolution proxies obtained by open-source data. At national scale up-to-date authoritative have been also considered and integrated by expert consultations. This is already a significant and useful achievement considering the challenges related with collecting and integrating information on exposure in data-scarce regions. Furthermore, the authors projected the updated model to a relatively far future (2080) to investigate the possible changes in exposure in the region based on different SSPs and related urbanization models. Although such projection is likely affected by strong uncertainties, it would still be very useful for risk assessment under non-stationary conditions. In fact, although seismic hazard can be considered stationary over the considered time-frame, the dynamics of exposure already proved to be instrumental in driving the expected risk over the next decades and a better consideration of such dynamics might improve both short- and longer-term risk mitigation and climate change adaptation efforts. The authors in particular estimate the expected relative differences in building replacement cost (considering no variation in usd/m2) between current and future, which provides useful insights on the possible change in seismic risk, but fall a bit short in exploring the interplay between the population change and the urbanization process, which would perhaps allow further considerations on the possible spatial pattern of future risk in the region. Overall the paper is well designed and written and would provide a interesting and useful contribution to the topic of exposure modelling.

Thank you very much for your suggestions. We replied to all the points raised by the reviewer. We emphasized the importance of tackling exposure variability to improve risk assessment methodologies and acknowledged the limitations of the approach presented here. Please find attached our responses to each comment.

Detailed comments / clarifications needed

line 161 - is the population value used only to spatially distribute buildings and the number of buildings is provided at the oblast scale by the most recent housing census?
Yes, recent building census data was collected for Kazakhstan and Uzbekistan and the number of buildings in each typology was distributed on the original model of Pittore et al (2020). The population value was used to spatially distribute buildings. We specified this in the manuscript.

line 220 - typo ("g dife")
The typo was corrected

note: in general I find the term "replacement cost" better than "reconstruction cost" since in practice in case of reconstruction (after an event) the building typologies, building pratices and used materials would be the same.
We understand your comment and we agree with you. The term 'reconstruction cost' was used here after the suggestion of the World Bank analysts because they wanted to give emphasis to the cost associated with the reconstruction process and to the potential of reconstructing buildings using more recent technologies and avoiding deprecated typologies. However, we did not explicitly account for unit costs and/or assess additional expenses such as debris removal, fees or material cost in the cost per square meter provided by local partners. We therefore renamed to 'replacement cost' through the manuscript. The difficulty of gathering such data and of defining the reconstruction cost was also subject of discussion during the workshops organized with local stakeholders. We included a sentence on the limitations associated with assessing the reconstruction costs in the discussion, and underlined the importance of gathering such costs with specific procedures, for example workshops involving practitioners and stakeholders.

Lines 276 - 284: it would useful to provide a more precise idea of the expected change in urbanization based on the Chen et al. model for the three considered SSPs, including (in the results section) for instance a table with the difference in the estimated values of the different urbanized areas in the different countries and according to the various SSPs.

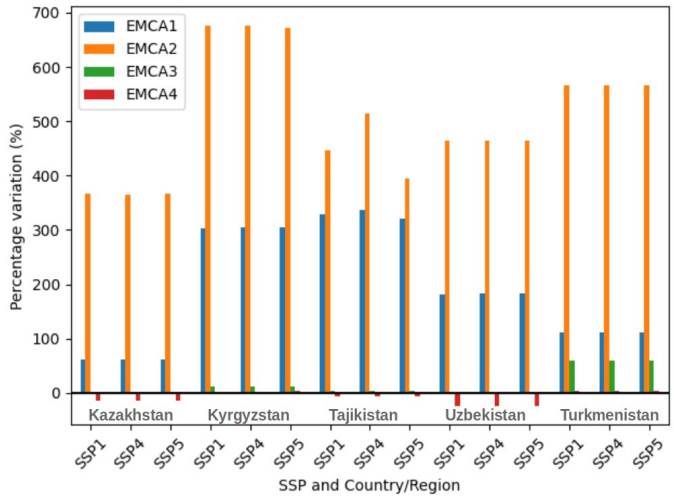
We included a table that summarizes the expected urban area changes at the national scale between the GHSL dataset and the projections of Chen et al. (2020). The largest variations are expected in Kazakhstan, where the urban area is expected to increase of more than 160% under the three SSPs. Substantial changes are also expected in Kyrgyz Republic (between 80 and 90%) and Turkmenistan (between 65 and 85%). Lower percentages are found in Tajikistan and Uzbekistan, ranging between 30 and 40%. The table is found below and was included in the manuscript:

Country	SSP	Urban area in 2015 (Km2)	Urban area in 2080 (Km2)	Difference (%)
Kazakhstan	SSP1	1722	4761	176
	SSP4	1722	4706	173
	SSP5	1722	4582	166
Kyrgyz Republic	SSP1	359	687	91
	SSP4	359	671	87
	SSP5	359	657	83
Tajikistan	SSP1	504	698	38
	SSP4	504	675	34
	SSP5	504	665	32
Uzbekistan	SSP1	3279	4529	38
	SSP4	3279	4379	34
	SSP5	3279	4365	33
Turkmenistan	SSP1	419	776	85
	SSP4	419	736	76
	SSP5	419	697	66
TOTAL	SSP1	6283	11451	82
	SSP4	6283	11167	78
	SSP5	6283	10966	75

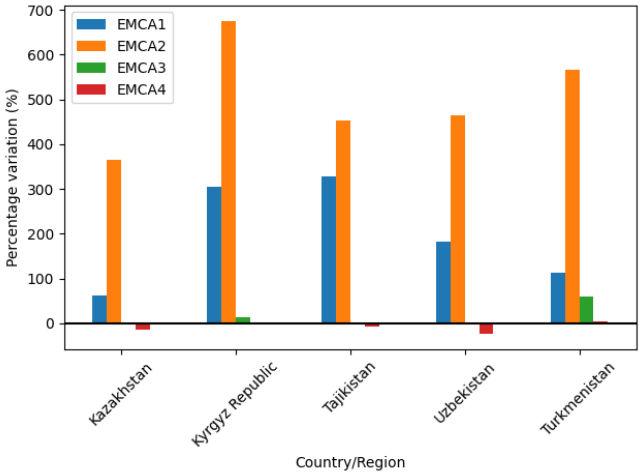
Table 5 / Fig 5: it would interesting to provide or discuss variations in the replacement/reconstruction costs for the different building typologies (which in turn depend on the interplay between population and changed urbanization).

Yes, the variation of reconstruction costs depends on the urbanization, because the replacement of deprecated typologies happens only in areas that are expected to be classified as urban in 2080. We estimated the percentage variation of reconstruction costs for each EMCA typology. The variation was computed for each SSP and also on the average values obtained for the three SSPs, as follows.

Percentage variation for each EMCA typology, SSP and country:



Percentage variation for each EMCA typology and country averaged over the three SSPs:



The figure showing the average variations was added as Fig. 5b in the revised manuscript.

The larger variation is expected for EMCA2, followed by EMCA1. Both typologies are expected to undergo a progressive replacement with more recent typologies. In particular, URM buildings are replaced with RM which has higher costs per square meter. Similarly, EMCA2 buildings of type RC4 are replaced with RC3 with a conversion factor of 0.8, for which there is a larger number of buildings and subsequently a higher total replacement cost. The variation is larger in Kyrgyz Republic and Tajikistan where in particular the cost associated with the EMCA1 type sees a stronger increase. The larger differences in reconstruction costs between SSPs are seen for Tajikistan, as also mentioned when commenting the general results. The only typology associated with a negative cost variation is EMCA4, because part of the buildings are replaced with EMCA1 typology. EMCA types 5 and 6 are not included as they not suffer changes. These considerations were added to the manuscript together with the new figure.

Line 377 - typo ("us")
The typo was corrected

Line 389 - it is indicated a possible application in case of floods, but the building typologies are specifically targeted at earthquake risk. The authors should warn that, although the model can be considered for other hazards, it might be sub-optimal or anyway an euristic or probabilistic mapping should be considered to fit to other types of vulnerabilities (see, e.g., Zapata et al., https://nhess.copernicus.org/preprints/nhess-2022-183/nhess-2022-183.pdf)
Yes, we agree with your comment. In principle, the exposure model should support regional-scale risk assessment, but it would be simplistic to apply this model at sub-national and local scale because, despite its resolution is higher, it does not account for all the characteristics deemed relevant for assessing impacts caused by floods. A classical multi-hazard approach (i.e. using different vulnerability functions for each building class in the exposure model, such as in Coccia et al., 2023) could be complemented with other approaches that account for cumulative damage such as, for example, earthquake and tsunami (Gomez Zapata et al., 2022). We included a sentence in the manuscript to explain this. In the context of Cental Asia, this approach might potentially be applied to earthquake-induced landslides which are common in the region (Saponaro et al., 2014).

line 392 - typo ("building")
The typo was corrected

line 394 - 395: rephrasing necessary to improve readability of sentence
The sentence was rephrased to explain what we meant. The 2080 layers presented here offer a starting point for the definition of risk mitigation strategies both at regional and national scale. For example, they can help identifying the typologies that are more prone to generate losses and/or to generate financial risk. Under these considerations, they might be replaced in the future with less vulnerable residential building

typologies, as envisaged by many expert and practitioners in the region during exposure development workshops (Peresan et al., 2023).

line 396 - typo ("top")
The typo was corrected

Line 412 - Authors mention the "strong urbanization" but in the results this specific aspect is not shown and discussed in enough detail (see comments above).
We included a new table that shows the increase of urban areas in each country of Central Asia under the three considered SSPs. We also include a sentence that explains that the urbanization is already evident in Central Asia and has started in the 2000s with an average cities growth rate of 9 to 11% (UNESCAP, 2013). We also added a sentence in the discussion explaining that here we did not consider the interaction between population, urbanization and GPD, but that future work should explore the interplay between the population change and the urbanization process and how they affect exposure and risk indicators, which addresses one of the general comments of the reviewer.