ANSWER TO REVIEWER 2:

This paper builds a regional exposure database for several types of critical infrastructure in Central Asia, including industrial, commercial buildings, education and healthcare infrastructure, as well as transportation networks (roads and railways) and crops. The dataset is transboundary as it covers the five central Asian countries that were formerly part of the USSR, and is meant to assess damage to several hazard types including flooding, earthquakes, droughts, etc. This database uses a variety of data sources, several of which have to be spatially disaggregated using assumptions that are reasonable and clearly laid out.
The writing is clear, the presentation and technical work within are high-quality. Aside from a few minor queries regarding data access and presentation (see below), the major obstacle to publication is a lack of explanation on scientific context and literature aside from the central Asia context. The developed database is multi-hazard, multi-asset, and transboundary: how does that compare with existing databases, e.g., developed for other places? In other words: is the paper just a case-study whose experience is disconnected from that of building multi-layer exposure databases in other regions? Authors should bear in mind the journal's Aims & Scope, which does "not encourage" "localised case studies with no broader implications (in other words, ask yourself, what would someone else in another region learn from the case study that you have done; what is the broader context?)."
Thank you for your suggestions. We agree with the reviewer that the manuscript in its current form does not highlight the broader implications of the work and is very focused on the Central Asia context. We re-wrote both introduction and discussion to address this and provide a broader context to the reader.
The work presented here is not only a case-study but provides useful insights on how to develop exposure layers at the regional scale based on the combination of both regional-scale data and information at the country level. We focus our analysis on selected critical infrastructures and exposed assets: healthcare facilities, schools, commercial and industrial buildings, transportation network and agricultural system. The database presented here is also intended to be integrated with the residential buildings exposure layer (Scaini et al., this volume). The two papers differ in the method because for critical infrastructures, there were no exposure layers available at the time of the assignment. In fact, before this work, no publicly-available exposure layers of critical infrastructure to multiple hazards existed for Central Asia. Exposure layers for selected assets were developed in some countries (e.g. Kyrgyz Republic) and for selected infrastructure (e.g. transportation) during past projects which are acknowledged in the manuscript. Developing a regional-scale exposure model was nonetheless required as a first step towards an assessment of potential consequences of floods, earthquakes and landslides that go beyond national boundaries. We therefore needed to collect data from different countries and communities and structure them within a regional-scale database, for which we interacted with a wide range of project partners and stakeholders. Gathering data on critical infrastructure is a known challenge, and we include references on how it is usually done, underlining how we interacted with stakeholders, what kind of data was collected and how it was used. The exposure dataset was developed on a considerably high resolution (100m) which supports the assessment of risk related to floods, for which a much higher resolution in order to provide reliable results with respect to earthquakes.
This was highlighted in the text, also by broadening the context and the state of the art, in order to clarify the novelty of the work and its validity also for other contexts. The introduction, discussion and conclusions have been rewritten accounting for your suggestions as explained in the following sections.

For the paper to fit the journals Aims & Scope, authors need to rethink (and largely rewrite) three sections:

- *Introduction: authors should review literature on making exposure layers for several types of critical infrastructure: what is considered together and for what reasons? How is their database more comprehensive? Or what obstacles does it overcome that other multi-layer database of critical infrastructure didn't have to deal with? Note this is more than just adding a paragraph to pay lip service to what exists: authors need to review exposure databases for the different layers, the multi-layer efforts, and actively situate this work within this literature, independently from the Central Asian context.*

The introduction was modified including a literature review on existing methods for the exposure assessment of critical infrastructure as follows. We also point out the challenges associated with developing exposure datasets for critical infrastructures and underline their relevance in the context of Central Asia. We also merged the new part with the old introduction. Part of the new introduction can be found below.

Exposure assessment is the process of collecting information on the type, characteristics and spatial distribution of assets potentially damageable by natural or man-made hazards. Exposure layers are therefore paramount for Disaster Risk Reduction (DRR) as they allow developing strategies to cope with disasters (Nirandjan et al., 2022). Critical infrastructure plays a paramount role in the risk management cycle, as its failures can exacerbate the impact of disasters (Forzieri et al., 2018, 2022; Koks, 2022). Assessing exposure of critical infrastructure is a particularly challenging assignment because of their inherent complexity and the difficulty of modeling their mutual interactions (Pant et al., 2016). Many existing global and regional disaster risk models focus on residential buildings or populations, with lesser examples for critical infrastructures, mainly focused on transportation and supply networks (Koks et al., 2019; Agryroudis et al., 2020, Karatzetzou et al., 2022; Mukherjee et al., 2023). Very few works (e.g. Crowley et al., 2020) include commercial and industrial buildings, despite their socio-economic relevance for national *and global economies and their role in the generation of cascading impacts (e.g. Krausmann and Cruz, 2021). This is partially justified by the incompleteness and inconsistency of existing geospatial information related to critical infrastructure with respect to residential buildings and population data (Batista e Silva et al., 2019). This is one of the reason why critical infrastructure is often modeled through assumptions on infrastructure density rather than detailed asset mapping (Koks et al., 2019). The lack of data is not always fulfilled by remote sensing due to the difficulty of identifying some infrastructures (e.g. buried supply networks), as discussed by Taubenbock and GeiB (2014). To tackle this, it is paramount to access data from national authorities and research institutes who have access to more detailed and reliable information. According to Rathnayaka et al. (2022), establishing a dialogue between stakeholders and the scientific community is a challenge in the development of critical infrastructure exposure databases, and is strongly connected with the difficulty of gathering data, in particular in data-scarce region. They highlight the need for establishing a standardized exposure data collection, which is particularly relevant when assessing exposure to multiple hazards. Another limitation of exposure datasets is that they often not include country-based reconstruction costs which are difficult to retrieve in particular for critical infrastructure, limiting the reliability of financial risk assessment associated to disasters. This is particularly relevant for croplands exposure assessment, whose exposure to floods (Zhang et al., 2023) and drought (Venkatappa et al., 2021) is increasing.*

Once collected, spatial and non-spatial data can be combined to assess exposure of critical infrastructures to single hazards, e.g. for floods (e.g. Fekete et al., 2017, Pant et al., 2018). Such studies are extremely relevant but, in order to be combined into regional and global-scale assessments, there is a strong need for harmonization (Batista e Silva et al., 2019). In addition, critical infrastructure is exposed to multiple hazards which can potentially overlap and interact in space and time (Tilloy et al., 2019).

In this study, we assembled the first regionally consistent exposure database of critical infrastructure for Central Asia, addressing the aforementioned challenges. Central Asia Fig. (1) includes 5 countries (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan) which are diverse in terms of language, currency and socio-economic conditions. The region encompasses a wide variety of climatic areas and geological settings and is prone to multiple hazards such as floods (UNECE 2017; Coccia et al., this volume), earthquakes (Ulomov et al., 1999; Bindi et al., 2012; Ullah et al., 2015) and landslides, often triggered by natural events such as earthquakes, floods, rainfall and snowmelt (Saponaro et al., 2014; Strom and Abdrakhmatov, 2017). The type and spatial distribution of floods and landslides is also expected to vary due to climate change, which is strongly affecting the region. Another emerging hazard in Central Asia is drought (Zhang et al., 2019) which might affect the region by disrupting productive activities and exacerbating water management conflicts. Past exposure assessment in the region were mostly focused on residential buildings (Pittore et al., 2020). However, critical infrastructure is also relevant in the context of Central Asia, and should not be overlooked when performing a comprehensive damage/risk assessment for the region.

The dataset developed here includes three types of critical infrastructure: non-residential buildings of different types (e.g. residential, commercial, industrial), transportation and croplands. Non-residential buildings comprise workplaces (e.g. industrial sites, commercial buildings), services (e.g. public offices, schools) and other facilities that are extremely relevant in case of emergencies (e.g. hospitals) and can suffer both physical consequences (e.g. buildings structural damage) and indirect damages, such as the production disruption due to power blackouts and its related financial consequences. The transportation system is a paramount asset as it enables both the people movement and the transportation of goods across the Central Asia region. Due to its strategic regional and global importance, and has undergone strong changes in the last decades, also in the context of the Silk Road initiative (Shaikova et al., 2023). Croplands are extremely relevant for the Central Asia economies as they guarantee both food security and economic development. The primary sector (agriculture, forestry and fishing) accounts for the 26 and 24% of Uzbekistan and Tajikistan GDP, respectively (World Bank 2 , 2020). The share of national GDP in Kyrgyz Republic and Turkmenistan is 14 and 11%, while the lowest value is associated with Kazakhstan (5%). Cotton and cereals (in particular, wheat) are the dominating cropping system in all Central Asia countries (Kienzler et al., 2012) and account for a fraction of cropland area that varies between 30% in Turkmenistan) and 80% in Kyrgyz Republic (FAO, 2019). However, they are threatened by a number of hazardous phenomena, including floods and drought, often exacerbated by climate change and water management issues (Punkari et al., 2014; Li, 2020).

Despite their importance for disaster risk reduction purposes, regional-scale exposure datasets are not currently available in Central Asia for the three aforementioned exposed asset types (non-residential buildings, transportation and croplands). An effort is therefore required in order to assemble national and regional-scale exposure layers and integrate the available data sources and knowledge, which are currently scattered across different sources including global databases (e.g. openstreetmap) and national-scale aggregated statistics (e.g. national census). The dataset developed here is inherently multi-hazards as it includes the characteristics that are deemed relevant for floods, earthquakes and landslides, and potentially useful to assess impact of other phenomena and/or cascading effects. To do that, we use a combination of existing approaches: we merge spatial data with country-based aggregated data to assess exposure of selected critical infrastructures and we subsequently harmonize the dataset at the regional scale. We collect exposure characteristics relevant for multiple hazards, collected by local representatives in the 5 countries of Central Asia establishing a dialogue between stakeholders at the regional scale. The process of data collection and sharing is supported by dedicated workshops (Peresan et al., this volume). Data are then structured according to a recognized taxonomy (GED4ALL, Silva et al., 2022), which is here used for the first time in Central Asia to encompass multiple building and infrastructure typologies in a multi-hazard context. In particular, we included commercial and industrial *buildings for which no information was priory available and gathered country-based reconstruction costs to support the assessment of financial consequences of disasters and increase financial resilience.*

The references contained herein have been also added to the manuscript.

- *Discussion: it is nice to see authors discuss some of their assumptions there. But these are learning points for other researchers that would want to put together similar databases somewhere else, and for these reasons, the discussion should explain how similar or different the authors' assumptions were from what is done for other exposure databases (and what are reasons that motivated different approaches). In other words: authors need to confront each point they make with the existing literature.*

The discussion was enhanced by including references to the state of the art and explaining how this work collects existing approaches and/or differs from them. The process of collecting the available information, which is scattered across sources, is particularly challenging for critical infrastructure exposure layers, as also pointed out by Batista e Silva, et al. (2019). Here, we tackled this problem by integrating country-based data into the global and regional datasets used to develop critical infrastructure exposure layers (e.g. OpenStreetMap, Nirandjan et al., 2022), We collected country-based data for each of the 5 Central Asia countries, thanks to a strong interaction with national research groups and stakeholders (Peresan et al., 2023).
The work is based on several assumptions which are required in order to assemble the first regional-scale layers of their kind. In particular, we assumed that the socio-economic data (e.g. percentage of employees in different sectors) to infer the number of commercial and industrial buildings, as also done by Crowley et al. (2020) for commercial buildings. In our case, due to the absence of specific data on the commercial, industrial and healthcare typologies, we used data from Europe or post-soviet countries assuming that they apply to Central Asia. However, the relative importance of retail and wholesale varies across EU Member States and might vary as well across Central Asia. Hence, further analysis might be required in the future in order to achieve a higher accuracy. Also, we defined broad typologies that comprise multiple building types (e.g. EMCA typologies), as previously done by other authors for residential buildings (e.g. Wieland et al,. 2015 and Pittore et al., 2020 for Central Asia; Calderon et al., 2021 for Central America; Yepes-Estrada et al., 2017 for South America). These typologies can be associated with multiple vulnerability or fragility curves, combined under general assumptions. For example, retail commercial buildings in Central Asia were assumed to be similar to residential buildings, as also confirmed by local partners during the interaction. Hence, the characteristics of retail buildings were defined based on each country's residential building stock. Different assumptions were performed by Crowley et al., (2020) who developed the first exposure dataset of non-residential buildings for Europe using multiple categories (e.g. wholesale, retail, offices, hotels and restaurants under commercial buildings). The different approaches are mostly due to the larger amount of information available in Europe at national scale. Finally, while some non-residential buildings have been mapped by global projects (e.g. schools), information on the spatial distribution of commercial and industrial buildings is scarce (as also underlined by Batista e Silva et al., 2019 for the European context), and does only support a simplified approach based on proxies (e.g. population or land-use), which is a common approach in data-scarce regions (De Bono and Mora, 2014; Gomez-Zapata et al., 2023).
Thanks to the high resolution of the population layer adopted in the analysis (Scaini et al., 2023), the exposure dataset for non-residential buildings and croplands was developed on a considerably high resolution (500 and 100m, respectively). This supports the assessment of risk related to floods and potentially landslides, for which a much higher resolution in order to provide reliable results with respect to earthquakes. Nonetheless, regional-scale datasets such as the one presented here can only support simplified damage/risk assessment that should be calibrated and validated carefully based on past events, when possible, and more specific information on the performance of building typologies considered. This is very relevant, in particular for earthquakes (Wald et al., 2023) to prevent over- or under-estimation of potential risks.

All these aspects were integrated into the discussion so that the reader can understand which are the strengths of the method, the assumptions taken, the novel aspects and the limitations to be fulfilled in future work.

- *Conclusions should summarise in a few sentences what the paper adds to the broader literature.*

This work contributes to tackling the issues related to exposure assessment of critical infrastructures at the regional scale, while promoting Disaster Risk Reduction in Central Asia by enhancing the availability and sharing of risk-related information. We combine existing global and regional datasets with local-scale data collected thanks to a strong interaction with stakeholders, and include country-based costs that allow for assessing financial risks. We also produce datasets at a high resolution, in particular for crops, which allows to assess risks related not only to earthquakes but also to floods and landslides, for which a higher spatial resolution is required. Conclusions were modified to highlight our contribution and the impact of the work for disaster risk reduction purposes.

After that, it could be relevant to spend a bit of time to see whether the new information added to the paper could improve the abstract.
The additional information collected during the review and integrated into the manuscript has been included in the abstract.

A few queries on data presentation / availability / access:

Section 2 text should comment on Table 1 in greater detail. This is true in particular for national and sub-national data. Personal communication sources (institution or public servants) should be mentioned, because local partners must be credited; alternatively, a clear explanation should be provided as to why they cannot be named. The number of oblasts per country should be given to give a better idea of the granularity of the data.
Thank you for the comment. The data collection was indeed a pivotal part in the project. Additional challenges were put by the COVID-19 pandemic that negatively conditioned the interactions, with only virtual meetings and no possibility to interact in person. The local research groups, for which the representatives are co-authoring the manuscript, were in charge of gathering reliable information at the country level. They provided it through official documents and/or information from various sources, sometimes collated into personal communications. Dedicated online meetings were periodically organized for each country to discuss specific issues and data requirements, and data were collected through shared folders and tables where each group of partners could contribute. The process was also supported by country-based workshops that provided participants with an overview of the exposure assessment methods to be applied. The process of assembling an exposure development layer was carried out for selected case-study and using data provided from local partners. This facilitated both data collection and the demonstration of the approaches in a context familiar for participants, More details are provided by Peresan et al. (2023). We included more detail on the data provided and the process of data collection. We modified table 1 including the institutions or the persons who provided the information. We also added the number of Oblasts per country to the table.

In Table 1, what is missing is a year tag for each data source.
We included a year tag to the data sources in Table 1. The year is relative to the last known update of the referenced dataset, as explained in the new table caption.

On a related note, it would be good to provide a map of the region including the countries and their names.
A map was added showing the Central Asia Region and including each country name.

Data availability: is there no way to make the resulting dataset available along with the publication of the paper (rather than to wait for publication by the World Bank)? As things stand, the paper discusses an unpublished database…
At the time of the submission, the datasets were in the process of being published. They are now available (since 01/09/2023) under the Creative Commons Attributions 4.0 license at the following link: https://datacatalog.worldbank.org/search/dataset/0064117/Central-Asia-Exposure-Data. The links to the databases and the official project reports were included to the Data availability section.