Reply to the comments by Referee #2

In this document, the review comments are in black, our responses are in blue.

Referee #2

This manuscript develops a sectoral GDP map (for service, industry, and agriculture) at 30 arcsec resolution and explores its application in disaster risk analysis. The authors generate land-use data and population data to downscale national-level GDP to derive spatial distribution results. By providing high-resolution global sectoral GDP maps, this dataset offers more detailed geospatial information to support disaster risk analysis and economic loss assessments.

The methodology and limitations in the manuscript are clearly discussed. However, the validation and analysis of the data itself need to be strengthened. Additionally, the Discussion section should be reconsidered in terms of its length and content.

> Thank you very much for your constructive comments which are very helpful for improving the manuscript. We made a plan for modifying the manuscript with additional background information. These are to be included in the revised version of the manuscript.

Specific Comments:

1. The Introduction section should include a discussion of other existing GDP spatial datasets, covering their methodologies, spatial resolutions, and the challenges in existing GDP mapping processes.

> Thank you for your feedback. In the revised manuscript, we will include additional details about the dataset, such as its spatiotemporal resolution, and provide a more comprehensive comparison with other existing datasets.

2. The study assumes that service-sector GDP is primarily distributed in high-population-density areas, but certain economic activities—such as high-end financial services and tourism—do not necessarily follow this pattern. For example, the financial district in Manhattan has an extremely high GDP density despite relatively low residential population density. Have the authors considered such spatial distribution patterns of economic activities?

> Thank you for your insightful comment regarding the handling of service GDP. We appreciate your attention to this detail.

As you pointed out, using fine-grained municipal-level population density could indeed lead to issues. However, our approach leverages the GRUMP dataset, which defines urban polygons based on nighttime light data, effectively capturing spatially contiguous urban areas. This means that large metropolitan areas, such as the area encompassing Manhattan, are treated as a single urban entity. Therefore, while Manhattan itself may have a high concentration of service sector activity, the GRUMP polygon for this area also includes surrounding residential areas, resulting in a high overall population density for the urban entity. This, in turn, leads to a correspondingly high allocation of service sector GDP within that defined urban area. We believe this approach provides a reasonable representation of the spatial distribution of service sector GDP at the scale of analysis used in this study.

3. Why did the authors choose the GRUMP dataset to account for urban effects instead of other datasets? A brief explanation for this choice would strengthen the methodology section.

> Thank you for your question regarding the choice of urban polygon dataset. We considered several options, including:

1. GRUMP
2. GHS-Urban
3. World Urban Areas (available in Esri ArcGIS)

We ultimately selected GRUMP for the following reasons. The GHS-Urban dataset, while comprehensive, delineates urban areas at a very fine-grained level. This resulted in the splitting of what are generally considered single urban agglomerations into multiple, separate urban polygons. This fragmentation led to unrealistically high population densities in some polygons when implementing the city-effect, which in turn skewed our service GDP estimates. Therefore, we deemed GHS-Urban unsuitable for our specific application.

The World Urban Areas dataset offered polygons that were very similar to those in GRUMP. However, as it is not openly accessible, we opted for the open-source GRUMP dataset to maintain transparency and reproducibility in our research.

4. The validation was conducted in only seven regions of Thailand, but Thailand's economic structure may not be representative at a global scale. For example, Western economies are more dependent on the service sector, while industrial and agricultural distributions vary significantly across different regions. Have the authors considered additional validation in countries with different economic structures, such as the United States, China, or Germany?

> We appreciate your observation regarding the limited scope of our current validation, which is confined to Thailand. We recognize that this raises questions about the broader applicability of our results. In the revised manuscript, we will address this by extending our validation to include other key regions, notably the United States. This expanded analysis, using sub-national statistical data, will bolster the reliability of our dataset and offer a more comprehensive evaluation of its performance across diverse economic settings.

5. A comparison with other existing GDP products or remote sensing proxies should be included to better highlight this dataset's advantages.

> Thank you for your comment regarding the comparison with existing GDP products and remote sensing proxies. We understand your question and would like to clarify our approach.

As you mentioned, GDP distribution has traditionally been conducted at scales ranging from national to municipal levels, based on statistical information. Studies that generate GDP maps at the grid scale, as we do in this paper, are limited to those mentioned in the Introduction.

Regarding remote sensing proxies, existing research generally falls into two categories: land cover or population distribution. Previous studies have primarily focused on population distribution. Our work represents, to the best of our knowledge, the first attempt to utilize land cover as a primary proxy for generating a global, high-resolution GDP map.

Therefore, when comparing our work to existing GDP products and remote sensing proxies, the most relevant comparison is indeed the one we already provide in the manuscript with our population-based map. This comparison serves to highlight the key differences and potential advantages of using land cover as a proxy, as opposed to the more traditional approach based on population distribution. We believe this comparison effectively addresses the spirit of your question regarding comparison with existing products and proxies.

6. Since the study aims to provide a globally applicable dataset, the Thailand case study in Section 4.1 should be presented as a supporting example rather than the main focus. It is recommended that the authors strengthen the discussion of the dataset itself, particularly regarding accuracy assessment, comparisons with existing datasets, spatial details, and temporal variation analysis. Additionally, by reducing the emphasis on the Thailand case study and discussing broader disaster analysis applications, the authors can better highlight the dataset's global applicability.

> Thank you for your helpful feedback. As mentioned in our response to another comment, we are planning to add validation for regions beyond Thailand in the revised manuscript. To accommodate this and maintain a balanced focus, we will reduce or remove the content related to the flood damage analysis in Thailand. This will allow us to shift the emphasis of the manuscript towards the broader validation efforts, including the comparison with population-based maps, and provide a more comprehensive assessment of the dataset's global applicability.