Response to Topic Editor and reviewers' comments

Public justification:

It is a tough decision. Reviewers have raised serious concerns regarding the robustness of the methodology, the accuracy of the dataset, and the usefulness of the dataset. The authors have made a strong effort during the revision process and have addressed many of the reviewers' comments. The authors emphasize the robustness of the methodology by citing several previous studies (e.g., Watson et al., 2023). However, the existence of approaches in the literature does not necessarily guarantee that the methodology is sufficiently robust for reliable ecological assessment in this specific context. The authors should further discuss possible pathways for the improvement of these indices and more convincingly demonstrate the accuracy of the dataset to a broad audience.

We thank the Topic Editor for the careful evaluation and appreciate the opportunity to provide clarification. We also note that both reviewers in this second round recommended acceptance as is, describing the revised manuscript as clear and substantially strengthened. In their formal assessments, both reviewers rated the dataset's "usefulness" as excellent and "data quality" as good (the available categories being Excellent, Good, Fair, Poor).

The concerns raised regarding methodological robustness, dataset accuracy, and practical usefulness were central to the first round of review, and we addressed them extensively throughout the revised manuscript. Based on the reviewers' very positive comments in this round, we understand these concerns to have been satisfactorily resolved. These issues are explicitly covered in the Methods (Sections 2.1–2.2), the validation and uncertainty analysis (Sections 2.3, 3.2-3.3), and the Discussion. Together, these sections demonstrate the transparency, reproducibility, and methodological grounding expected for an ESSD data description paper, which aims to document high-quality datasets rather than introduce new methodological frameworks.

Regarding the robustness and accuracy of the dataset, we respectfully clarify that our validation approach (visual interpretation of high-resolution imagery combined with stratified random sampling) is the standard method used in Human Footprint mapping and in many land use/land cover mapping accuracy assessments (e.g., Olofsson et al., 2013, 2014; Venter et al., 2016), including those that have been published in ESSD (Theobald et al., 2020). This approach provides a direct and transparent measure of agreement between mapped pressures and actual on-the-ground conditions. Accuracy in this context of cumulative pressure maps is therefore demonstrated through these established spatial validation protocols, which, for our study, shows to be high. Moreover, we emphasise that the HIF represents potential human influence rather than realised ecological condition, which we clearly state in the manuscript.

More broadly, as outlined in the revised manuscript and our past response to reviewer 2 (which is publicly available from the first round of reviews), the Human Footprint framework and the pressure–response approach underpinning our work have been widely adopted across ecology, conservation planning, and global environmental reporting. The methods and resulting datasets have been used in hundreds of peer-reviewed studies and in major assessments such as IPBES and the Global Biodiversity Framework. New national-scale implementations continue to be produced and used by conservation scientists (e.g., Canassa et al., 2025; Forti et al., 2025; Presotto et al., 2025; Torres-Romero et al., 2025). The high citation rates of these papers reflect scientific acceptance of the approach as sufficiently robust for ecological assessment across diverse contexts, and we see no methodological reason why an Australian application would be an exception. We have also outlined a clear justification of the approach in the Introduction, referencing numerous scientifically reviewed papers that showcase the utility of the approach in various ecological settings (see paragraph three of the Introduction). For these reasons, and because ESSD's emphasis is on transparent documentation of datasets, we believe the current level of methodological justification is appropriate.

In response to the Editor's suggestion, we have briefly expanded the Discussion (lines 606-614) to more explicitly outline pathways for future improvement, such as the integration of fire-regime data, invasive-species layers, livestock-intensity information, friction-surface accessibility models, and structured or data-driven score calibration. We also highlight that cumulative-pressure methods continue to support contemporary ecological research and biodiversity reporting, adding further evidence of the approach's practical reliability and relevance.

The new paragraph added to the discussion (lines 606-614) reads as follows:

"*Although cumulative pressure maps necessarily simplify complex human-environment interactions, the framework applied here is grounded in more than two decades of peer-reviewed development and remains widely used across ecological science and environmental decision-making (Watson et al., 2023b). As outlined above, future national assessments will be strengthened through integration of fire-regime metrics, invasive-species layers, and livestock-intensity data as they become available. These improvements will become increasingly feasible as higher-resolution national datasets continue to emerge. Importantly, pressure and ecological intactness layers derived from cumulative pressure maps continue to support contemporary applications in biodiversity risk assessment, conservation priority-setting, and protected-area evaluation (Canassa et al., 2025; Forti et al., 2025; Presotto et al., 2025; Ramírez-Delgado et al., 2025; Torres-Romero et al., 2025), emphasizing both the practical reliability and ongoing relevance of the approach*."

Reviewer 1 – Additional minor suggestions

We thank the reviewer for these thoughtful optional suggestions and for the very positive assessment of the revised manuscript. We address each point below.

- **It is interesting that the highest uncertainty is where multiple pressures co-occur – might this also occur because of the nature of additive pressures (though you have adapted the overlaps using some hierarchical calculations – would it be simpler or the same if you simply used the maximum value of any pressure rather than the summation?)**

We agree with the reviewer's observation. As noted in Section 3.2, higher uncertainty in areas where multiple pressures co-occur likely reflects the accumulation of positional and classification errors from overlapping layers, combined with the additive nature of cumulative pressure models. These areas also typically contain higher-scoring pressures, for which we simulated relatively large variations (±50%), further amplifying variability.

We have retained the additive approach to maintain consistency with past Human Footprint applications and to preserve comparability across studies. This approach has also been shown to exhibit robust correspondence with alternative cumulative-pressure formulations (Arias-Patino et al., 2024),including antagonist models (Kennedy et al., 2019; Theobald, 2013; Theobald et al., 2020). However, we agree that future studies could explicitly compare additive formulations with maximum-pressure or alternative aggregation approaches, as suggested by the reviewer.

• Glad to see the histogram of values – is part of the very long tail related to the "stretching" caused by the additive combination of pressures?
The long tail indeed reflects the combination of multiple pressures, and this is consistent with prior Human Footprint studies. As this behaviour is inherent to the method and already briefly described in Section 3, we have not added further explanation.

• Regarding the alignment of pressures with the IUCN threat taxonomy – I think the power of a taxonomy is that each pressure can be in one and only one threat class (perhaps analogous to a binomial nomenclature, a la Linnaeus).

Regarding the alignment with the IUCN-CMP taxonomy, we clarify that the taxonomy is used as a conceptual reference framework, rather than as a strict one-to-one mapping between pressures and threat classes. In practice, some IUCN threat classes are represented by multiple spatial pressure layers that capture different aspects of the same underlying threat (for example, agricultural land use versus associated infrastructure). We have added a clarifying footnote to Table S1 to make this distinction explicit; the footnote reads:

"Note: This IUCN-CMP classification of the pressures considered in this study is provided as a conceptual crosswalk. Some IUCN-CMP threat classes correspond to more than one pressure in this study. This reflects differences in how similar threats manifest across landscapes. For example, 'terrestrial animal farming' (IUCN-CMP Level 2.3) is represented in both intensive land uses (areas dominated by agricultural infrastructure, such as feedlots, piggeries, and glasshouses) and pastureland (extensive grazing areas without major built infrastructure) pressure layers. These pressures are treated separately to distinguish between different types and intensities of land-use modification, while remaining conceptually consistent with the broader IUCN-CMP framework."

• Regarding population density maps as a surrogate for accessibility – it seems this is a scale (resolution) dependent situation. As the resolution of maps increases (e.g., from 1 km to 0.1 km) and the dasymetric allocation of the population tightens to where buildings are located (at least for night-time population density), then is there less "spill-over" into adjacent (presumably accessible) areas?
We agree that the behaviour of dasymetric population layers is scale dependent. In our framework, accessibility is mainly represented by roads and infrastructure, whereas population density serves as a proxy for the intensity of human presence rather than access itself. The use of a 100 m dasymetrically allocated population dataset greatly reduces the spill-over effects observed at coarser resolutions (e.g. 1 km). While exploring population-based proxies across multiple spatial resolutions would be valuable, this lies beyond the scope of the present data paper.

• I appreciate your point about timing of publication for Theobald 2025 and powerlines/pipelines. I should have said Theobald et al. 2020 which contained powerlines as well.

We appreciate the clarification regarding Theobald et al. (2020), which we have indeed cited in the manuscript.

• Thanks for providing the validation plot dataset.

We appreciate the reviewer for the reminder to include the validation plot dataset, which we hope can be useful to others.

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