

Nat. Hazards Earth Syst. Sci. Discuss., referee comment RC2  
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## Comment on nhess-2022-139

Anonymous Referee #2

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Referee comment on "Multi-hazard Tropical Cyclone Risk Assessment for Australia" by  
Cameron Do and Yuriy Kuleshov, Nat. Hazards Earth Syst. Sci. Discuss.,  
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- The manuscript provides a framework for comparing TC-related risk across Australia, incorporating multiple hazards, multiple exposure elements and multiple indicators of vulnerability.
- The framework described is a relative risk rating, based on a limited view of the probability of events (i.e. a 1% AEP level of hazard) in combination with national-scale indicators of exposure and vulnerability.
- Similar efforts have been undertaken within government in recent times, but are as yet unpublished. This manuscript provides a stimulating discussion on the complexity of evaluating multi-hazard risk in a nationally-consistent framework.
- Properly undertaken, the resulting information from this analysis could be valuable for prioritising interventions across the country.
- The derivation of some metrics warrants further discussion - the range of spatial scales presents unique challenges to developing representative rankings of hazards, especially with relatively coarse information. Flood and storm surge inundation are highly sensitive to spatial resolution, and will be challenging to represent at LGA resolution.
- The elements of exposure and vulnerability must be linked - using social vulnerability indicators in combination with physical asset exposure will not produce a valid evaluation of risk (either physical or social).
- We have concerns over the evaluation of risk, showing highest risk in northern NSW, including some LGAs well inland where wind hazard will be declining, there is no surge hazard and flood hazard is evaluated to be in the lowest quintile.

### Specific comments and questions for the authors:

- Line 78: Only one ARI is used - the relative impact may change for different return levels due to the different spatial pattern in hazard and/or vulnerability. Do the authors have any comments on this?
- Line 79: It is not appropriate to say this is representative of the hazards in the near future. The 100-year ARI hazard level is an indication of the long term probability in that it occurs - on average - once in every 100 years. There is a possibility of such an

event occurring in any given year (approximately a 1% probability), with no inference about the near future likelihood. Further, the 100-year return period level may well change over the next 100 years. Knutson et al (2020) report the most confident TC-related projection is increased storm surge levels, with medium to high confidence that TC-related precipitation will increase at the global scale.

- Section 2.1: There is not sufficient discussion on the metrics used for the hazard indices. No references are provided for flood or landslide hazard information in the main part of the manuscript (a table is presented in the appendix, but it is not referenced, and the links in the table are not accessible); the reference provided for Storm Surge does not describe that hazard ("For this global study, the effects are only related to the wind speed at a global scale." Cardona *et al.*, 2014). This is a major concern to the core objectives of the manuscript.
- Line 80: There are more up-to-date sources of information for storm tide hazard - e.g. the Canute 3.0 data available through the NESP Climate Hub ([https://shiny.csiro.au/Canute3\\_0/](https://shiny.csiro.au/Canute3_0/))
- Line 81: Mean values of hazard may not be appropriate for some LGAs. This is an issue the authors note (in reference to East Pilbara). However, the hazard needs to be evaluated in the context of exposed assets. In the case of East Pilbara, the majority of exposed assets (primarily population) are close to the coastline, where wind hazard (and flood hazard) will be higher. In our comparative rankings, we have used a 90th percentile of the hazard level, reflecting the general proximity of population to the coastline.
- Line 89: No reference to the table of data sources is provided.
- Line 89: Power line and electrical substations will be highly correlated, so using both as input to the exposure definition will be unduly weighted to that infrastructure element.
- Line 89: What power line information was used - distribution lines or transmission lines? In some urban LGAs, there may be limited transmission network coverage, with power supplied through lower voltage feeder networks that may lead to biased estimates of exposure. The data table provided does not contain working links, so readers are not able to inspect those sources.
- Overall losses will be impacted by the value of lost income to businesses. With no business information included, this may lead to an underestimate of exposure in some areas.
- Line 103: The choice of vulnerability indexes is not clearly linked to the choice of exposure indexes. In the Hazard-Exposure-Vulnerability framework, the vulnerability is directly related to the exposed assets. Using social vulnerability indicators and physical assets presents a logical mismatch between the two risk factors. Ideally, physical vulnerability indicators should be used that link the hazard to the exposed physical assets.
- The "no vehicle homes" is duplicated in the contributing indicators in the IRSD indicators, so places undue weighting on this indicator. Additionally, the claim of "no vehicle homes" indicator being particularly relevant should be justified - what evidence is there to support the assertion they are more susceptible to loss of life, especially given the very limited fatalities attributable to TCs in Australia? Further, evacuation is only a consideration in storm tide prone areas. Otherwise, the emergency services advice is to shelter in place (i.e. at dwellings that are built to modern codes). A better indicator of vulnerability would therefore be the proportion of houses that are not constructed to modern wind loading standards.
- Line 274: The use of data with null values for some LGAs suggests additional effort is required to ensure consistent coverage - either through alternate indexes or suitable estimations from other sources.
- Line 307: Correct "main coastland"
- Line 377: ABS data would typically be well validated. Engagement with the ABS may have addressed the authors concerns over validation of the (vulnerability) indicators.
- Several of the references are incomplete or inaccessible e.g. Scawthorn et al., 2006, Do and Kuleshov, 2022, Burston et al. (missing journal name)

- Appendix: None of the links in the table are accessible - appears the links have not been properly included in conversion to PDF. "Geosciences Australia" should be "Geoscience Australia"