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The 2012 and 2023 Mw 7.6 tsunamigenic earthquakes at the Philippine trench and tsunami hazard implications

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On 2nd December 2023, the eastern coasts of Philippines were struck by an M7.6 earthquake followed by a moderate tsunami measuring 0.5 m in height. The earthquake was the result of thrust faulting in the Philippine Trench (subduction zone) at the depth of 32.8 km according to the United States Geological Survey. Philippine Trench is the result of tectonic convergence between the Philippine Sea and Sunda plates. The December 2023 earthquake resulted in three deaths; however, no death or casualty was reported due to the tsunami. This event reminds another M7.6 tsunamigenic earthquake on 31st August 2012 in the outer-rise region of the Philippine Trench that occurred approximately 300 km from the 2023 epicenter causing one death (https://doi.org/10.1007/s00024-014-0790-2).

From historical records, two prominent events in the region are an M 8.0 – 8.3 tsunamigenic earthquakes in 1918, and an M 7.9 earthquake in August 1976. The latter event generated a locally destructive tsunami that killed 5,000 people. It appears the largest recorded event in the region is the 1918 earthquake with a magnitude in the range of M 8.0 – 8.3. Considering the relatively short span of recorded earthquake history, the 1918 event cannot conclusively be regarded as the largest possible event from the Philippine Trench. Recent insights from global earthquakes in various subduction zones suggest that the occurrence of M9 earthquakes is feasible in any subduction zone, provided that the zone's length is sufficient to accommodate such events. Therefore, it is important to study the hazards from M9 earthquakes and potential tsunamis in the Philippine Trench and investigate the risks to infrastructure.

The purpose of this research is to study the tsunamigenic potential of the Philippine Trench by modeling the 2012 and 2023 events and comparing them, modelling potential worst-case tsunamigenic earthquakes in the region and investigating their hazards and risks to infrastructure. The methodology used in this research are waveform analyses, spectral and wavelet analysis, numerical modelling, and fault tree analysis (FTA). We develop a cascading risk model based on FTA for critical infrastructure in the region.