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# Multi-hazard risk assessment of critical infrastructure at the global scale

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Critical infrastructures (CI) play an essential role in the day-to-day functioning of societies and economies. They refer to the array of physical assets required for the operation of the complex infrastructure network, which include energy grids, waste systems, and transportation networks. At the same time, impacts of natural hazards highlight the importance of improving our understanding on the natural hazard risk to these infrastructures. CI have evolved in large interconnected networks, whereby disruption of one asset may quickly propagate into widespread consequences – even outside an exposed area. The disruption of the services provided by CI have large potential to seriously hamper the daily activities of societies and economies that depend on them, as well as the recovery in the aftermath of an disruptive event.

To date, however, scientific literature on the potential global asset damages to CI induced by multi-hazards remain limited. Modelling assessments that combine information on hazard intensities and extents, exposure of infrastructure and the vulnerability of these exposed assets are crucial to improve our understanding of infrastructure that are directly at risk to multi-hazards. In this study, we provide first global estimates of multi-hazard risk to CI systems under current climate conditions. To this end, we assess: (1) the global exposure of CI to coastal and fluvial flooding, cyclones, earthquakes and landslides; and (2) quantify the potential asset damages as a consequence of these multi-hazards.

We represent the infrastructure network by seven overarching CI systems: energy, transportation, telecommunication, water, waste, education and health. A total of 42 infrastructure types (e.g. hospitals, power towers, wastewater treatment plants) are selected from OpenStreetMap (OSM) and categorized under these overarching CI systems. The high-detailed spatial data for infrastructure is combined with hazard data to derive the exposure of infrastructure to the various hazards. Moreover, we develop a vulnerability database for critical infrastructure based on the current body of literature to translate the exposure into asset damages.

It is urgently needed to build robust and resilient infrastructure, so that they are able to cope with current and future natural hazards. Therefore, risk information should systematically be included

for infrastructure planning, and the protection of the most vulnerable and critical assets needs to be improved. Limiting the direct impact of natural hazards on exposed assets will result in economic and social benefits that go beyond direct infrastructure damage.