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Impact webs: a novel approach for characterising and assessing multi-risk in complex systems

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Characterising and assessing multi-risk in complex systems is vital to realise the expected outcome of the Sendai Framework for Disaster Risk Reduction. As sectors and systems are increasingly interconnected, the space in which impacts cascade is expanding. This became apparent throughout the COVID-19 pandemic, but can also be seen in the compounding and cross-border effects of climate change and connected extreme events, or from global ripple effects of armed conflicts such as the aggression committed by Russia against Ukraine. Single-hazard and single-risk approaches, while useful in certain contexts, are becoming increasingly insufficient for comprehensively managing risk due to cross-sector and cross-system interactions. There is therefore a need to develop tools that can account for how multiple hazards interact with multiple vulnerabilities of interdependent systems and sectors, which requires a systemic perspective for assessing risks.

To this aim, we developed a novel analytical tool to characterise the interconnections between risks, their underlying hazards, risk drivers, root causes and responses to risks and impacts across different systems. The tool draws on the impact chains approach (i.e. conceptual models for climate risk assessment), expanding its linear and sectoral focus towards a system-oriented view. We follow the recommendation of Zebisch et al (2021) and name this tool ‘Impact Webs'.

We applied the tool to five case studies in Bangladesh, Ecuador, India, Indonesia and Togo to characterise and assess cascading risks linked to COVID-19, responses to it (e.g. restriction measures) and other hazards that co-occurred during the pandemic (e.g. hydrological, geophysical, climatological). The participatory co-development of the Impact Webs was led by local case study experts and involved desk research, stakeholder workshops and expert/community consultations.

These diverse applications at multiple scales showed that Impact Webs are useful to conceptualise and visualise networks of interconnected elements across sectors. Because of the tools suitability

to simultaneously analyse the interactions of multiple hazards with multiple pre-existing vulnerabilities, it provided a representation of the multi-risk space in the case studies. This is promising to identify critical elements for further investigation, such as feedback effects, trade-offs and key agents that can influence risks in systems. To this aim, the tool not only accounts for negative impacts, but also how policy responses and societal reactions to policies can lead to additional positive outcomes, as well as unintended consequences, i.e. risks arising from responses. However, given the complexity of systems and system boundaries, it is not possible to characterise all interconnections using Impact Webs. While this simplification of reality is useful for communication purposes, only the most prominent outcomes of the tool are derivable, and although the participatory approach aims to reduce this, results can be influenced by inherent biases. Despite these challenges, we find that Impact Webs are a promising new approach to characterise and assess multi-risk, thereby supporting comprehensive disaster risk management.