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## A Framework for Multi- and Systemic-Risk Analysis: Focusing on Indirect Risks Based on Dependencies

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Despite the rising importance of both systemic and multi-risks caused by interrelated natural hazards (e.g., compound, cascading, consecutive), there is still an apparent lack of unifying frameworks that allow for harmonized assessment and management of these risks. This paper presents a six-step framework developed as part of the HORIZON 2020 MYRIAD-EU project, with the framework flexible enough to cover single, multi- and systemic risk analysis, including measurement, modelling and management dimensions. The six steps are: i) finding a system's definition, ii) characterization of direct risk, iii) characterization of indirect risk, iv) evaluation of direct and indirect risk, v) defining risk management options, and vi) accounting for future systems state. The framework is developed based on systemic risk ideas, drawing a need to delineate clear system boundaries and identify interdependencies of system elements, ultimately enabling system of systems approach that can incorporate complexities in a manageable level for a diverse set of risk bearers. As done traditionally, in the process of risk assessment, we first propose an assessment of direct risks, emerging due to direct contact of system elements with a hazard(s). However, we suggest to move forward and then focus on indirect risks emerging due to interdependencies in the system and in response to direct risk realization, especially within a co-produced selection of indirect risk metrics with relevant stakeholders. Risk management options, including indirect risk management, are then considered, with a special emphasis on synergies and asynergies of risk management options between hazards, sectors, and impact types and between top down and bottom-up related risk management instruments. While the paper is focused on a detailed presentation and discussion of the conceptual framework, given that the framework is currently applied in five pilots across Europe (Danube, Canary Islands, Scandinavia, North Sea, and Veneto Region), it also brings initial results from practical implementation, including initial tools and methods, challenges, and opportunities.