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Multi-hazard risk and the asynergies of disaster risk reduction measures

The need for an integrated approach

Many countries face the risk of multiple hazards. Nonetheless, most Disaster Risk Reduction (DRR) measures are aimed at one hazard type. However, while positively influencing the risk of one hazard, DRR measures can have adverse effects on the risk of another hazard type.

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A need for comprehensive measures

- **Traditionally, Disaster Risk Reduction (DRR) measures are aimed at decreasing the risk of a single hazard.** However, in many countries the society faces the threat of multiple hazards (Cutter et al., 2015; De Ruiter et al., 2020).
- The **need for a shift from single to multi-risk assessments has been widely recognized** in international agreements, such as the Sendai Framework for Disaster Risk Reduction (UNDRR, 2015) and it was high on the agenda of the UNDRR Global Platform 2019 (UNDRR, 2019).
- **The effectiveness of DRR measures could benefit from a comprehensive systemic risk approach** (Cutter et al., 2015; Scolobig et al., 2017; UNDRR, 2020). This includes: (1) accounting for the different types of hazards that threaten an area, and (2) the interactions and dynamics between different hazards and their DRR measures.

Asynergies of DRR measures

We define asynergies of DRR measures as: **DRR measures that are aimed at reducing the risk of one hazard, but that can have opposing or conflicting effects on the risk of another hazard** (Figure 1).

The introduction of asynergies between DRR measures in risk analyses allows policy-makers to spatially differentiate building codes and other building-level DRR measures to address the most prevalent risk while not compromising the risk resulting from other hazards.

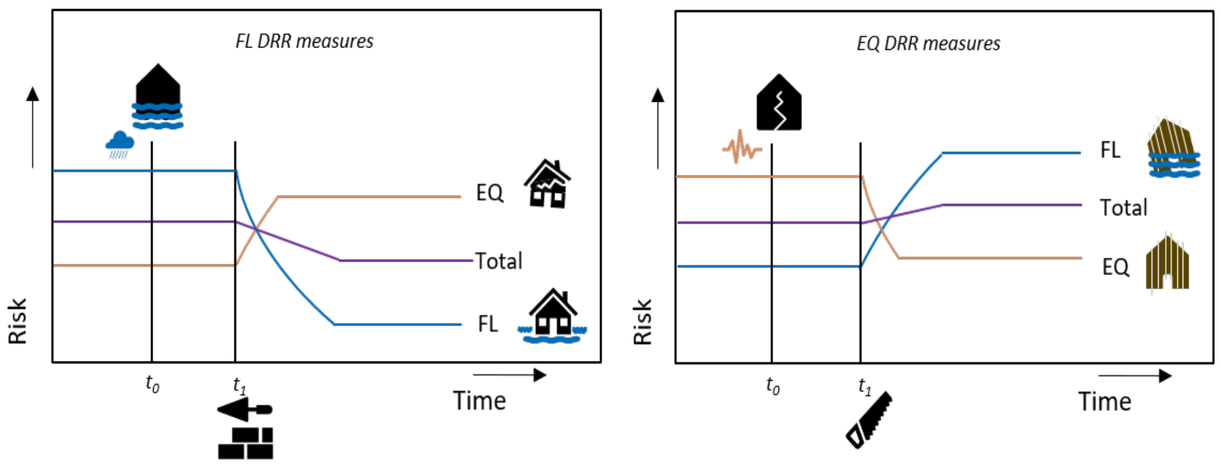

Figure 1. Schematic repersentation of asynergies between flood and earthquake measures for floods (left) and earthquakes (right)

Main aims

This poster shows two different studies on the asynergies of DRR measures:

- In a case study of Afghanistan, we assess the **(a)synergies of flood and earthquake DRR measures.** (1) We first calculate the risk of floods and earthquakes, in terms of average annual losses (AAL), in the current situation. (2) Next, we develop two DRR scenarios, where building-level measures to reduce flood and earthquake risk are implemented. We use this to identify districts for which DRR measures of one hazard increase the risk of another hazard. (3) We then also calculate the optimal situation between the two scenarios by, for each district, selecting the DRR scenario for which the AAL as a ratio of the total exposure is lowest.
- Based on a comprehensive literature review of **(a)synergies of flood and drought DRR measures**, We identify key knowledge gaps and show examples of: (a) how flood or drought DRR measures can have (unintended) positive or negative impacts on risk of the opposite hazard; and (b) how flood or drought DRR measures can be negatively impacted by the opposite hazard.

Flood and earthquake DRR measures

To simulate the implementation of flood and earthquake DRR measures in Afghanistan, we designed two DRR scenarios:

1. In the flood DRR scenario, we upgrade all residential, adobe buildings to brick buildings. Brick masonry buildings perform well during floods but are more likely to collapse during an earthquake).
2. In the earthquake DRR scenario, we upgrade all residential, adobe buildings to masonry buildings. Wood-frame buildings tend to perform well under ground shaking but are likely to sustain higher flood damages.

The optimal measures differ spatially throughout Afghanistan, but in most districts it is more beneficial to take flood DRR measures (Figure 2). However, in the districts where it is more beneficial to take earthquake measures (e.g. Bak and Khost wa Firing) the difference is considerable: up to 40%, whilst flood measures are only up to 16% better in individual districts (e.g. Kahmard and Shibkoh).

Floods and Earthquakes

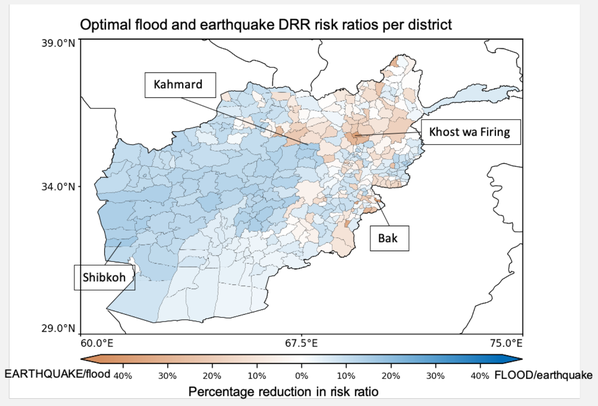

Figure 2. Optimal flood (blue) and earthquake (red) risk ratios per district and the sensitivity of the DRR measures in percentage reduction of the risk ratios (De Ruiter et al., 2021). In the districts where it is more beneficial to take earthquake measures (e.g., Bak and Khost wa Firing) the difference is considerable: up to 40%, whilst flood measures are only up to 16% better in individual districts (e.g. Kahmard and Shibkoh).

Floods and Droughts

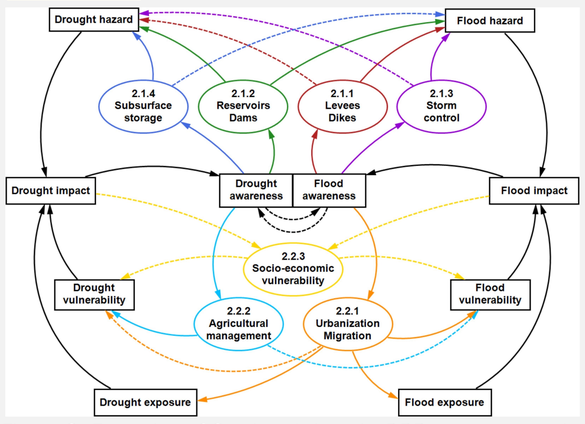

Figure 3. Examples of flood and drought DRR measures and their interactions with hazard, exposure, and vulnerability. Solid/dotted lines show possible examples of primary/secondary interactions. Numbering refers to the sections in which the measures are addressed in Ward et al., (2020).

Flood and drought DRR measures

Most research on hydrological risks focuses either on flood risk or drought risk, whilst floods and droughts are two extremes of the same hydrological cycle. Figure 3 demonstrates the complexity of the flood and drought spectrum, showing examples of flood and drought DRR measures, their interactions, and close linkages. For example, the construction of dikes and levees can lead to increased development in the areas protected by dikes, and thereby increase flood risk known as the levee effect (di Baldassarre et al., 2018). The increased exposure and socioeconomic activity can also place stress on available water resources, increasing drought risk.

Conclusions

A more comprehensive risk (reduction) management approach that addresses all relevant hazard types, would allow us to better address trade-offs and synergies between hazards, their DRR and adaptation measures across different temporal and spatial scales.

An improved capability of understanding risk and interactions between disaster risk reduction measures more comprehensively would strongly benefit first responders, aid organizations, urban planners and decision makers in designing sustainable DRR measures.

Further reading

- De Ruiter, M. C., De Bruijn, J. A., Englhardt, J., Daniell, J. E., de Moel, H., & Ward, P. J. (2021). The asynergies of structural disaster risk reduction measures: Comparing floods and earthquakes. Earth's Future, 9(1), e2020EF001531.
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