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Stresstest scenarios as a useful addition to a risk approach

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ABSTRACT

Flood-prone areas are home to societies who developed the areas, used them for agriculture, built cities and prospered. Over time, these societies have developed strategies to cope with flood hazards. Recently, however, floods seem to happen more frequently and cause more severe impacts. In recent years, floods caused by climate extremes and outliers have surprised the inhabitants of flood-prone areas, also in developed areas like western Europe. The strategies who protect them seem not adequate anymore. Whether this results from climate change, or a short memory of the citizens in the flood-prone areas, or due to land use changes is not completely clear and probably differs per case. However, it indicates that more attention for those outliers or extremes is needed (Merz, 2015).

An important trigger for more attention for outliers in the Netherlands was the 2021 flood event caused by severe long-duration rainfall in summer in the Netherlands, Belgium and the Netherlands. The event was caused by unusual large-scale weather pattern which created a lot of moisture flowing in from a very large area (Kreienkamp, 2021). In the Netherlands, the consequences in the affected area were severe, but luckily no fatalities occurred. In Belgium and Germany more than 200 people were killed and many houses and infrastructure networks were damaged (ENW, 2021). This event came as a surprise: this type of large-scale rainfall event was in the Netherlands not considered in any risk approach, nor was it included in the 10.000 years of generated weather series for the Meuse River, the main river in the area, or included in procedures for response or crisis management (Asselman, 2022; ENW, 2021). In fact, the high-water/flood risk season is the winter and usually summer is used for repairs, maintenance and the warning and emergency services are then not alert. Therefore, water authorities were not well-prepared and had to challenge their experts to cope as well as possible and reduce impacts and rescue inhabitants.

The event is also considered a wake-up call for other areas in the country (De Bruijn & Slager, 2022). Policy makers and other have started taking actions to improve the resilience of the Netherlands for such large-scale rainfall event by improving awareness, better preparation, land use adaptation, increasing the sponge behaviour of areas, adaptation of critical infrastructure and improving crisis management procedures (Min, I&W, 2022).

To cope with flood risks the Netherlands has adopted a risk approach in which all potential events should be considered and weighed according to their probability of exceedance. However, this risk approach had a very strong focus on selecting the economic optimal design standard for water systems. Beyond-design events, with smaller probabilities, received little attention. Measures not related to adapting the water system were often found inefficient and therefore, not selected. As a consequence, strategies for adaptation of land use, or flood impact mitigation in general and for enhancing recovery are rarely implemented. This makes the country less resilient to extreme events that go beyond design standards of water systems.

Understanding of what may happen if beyond-design events occur, the potential flood extent and resulting water depths and flood durations, the impacts on the functioning of critical infrastructure, on agriculture and on cities is lacking. In December 2022, the government published recommendations stating that because prevention of flooding may not always be possible, preparation and adaptation must be better taken care of.

The risk information available was found not sufficient for preparing and implementing flood preparation and adaptation measures. It was found too complex for non-experts. It often consists of aggregate numbers and maps resulting from technical analyses of many model runs with a lot of assumptions and has little meaning to the common practice of local and regional authorities and stakeholders. This hampers them to discuss the link to their procedures and makes it difficult to discuss the need for adaptation or preparation measures.

Therefore, another additional approach was adopted called "stress testing". In this approach only one or a few scenarios are analysed in depth and the probability is only provided as a very wide range ("beyond design but feasible"). The consequences both direct and indirect, are analysed and discussed with many different relevant stakeholders such as local governments, provinces, water authorities, emergency management organisations, spatial planners, critical infrastructure operators, and also shared with the public.

In this approach the scenarios or events are stepped through and paused at various moments in time starting by the first signs and warning, then during the actual rainfall or flooding itself, next at the process of getting the water out the flooded areas and finally during the recovery phase. Those scenarios are not forecasts, but they help to discuss what can and should be done, increase understanding of the responsibilities and roles of different organisations and also reveal the questions and information needs they have. Those scenarios or stresstests are "just" selections out of a set of all potential events considered in the risk approach, but by focusing on just them, they serve as a communication vehicle (De Bruijn & Maas, in prep.).

The stresstests cannot be used for cost-benefit analyses, or to evaluate the embankments or water systems. They are not replacing but adding to more common approaches. For beyond-design events (which are also included in risk approaches but with a small weight) measures are needed which reduce impacts and enhance recovery and for those type of measures typically other institutes and citizens are needed and not water authorities. For such measures a storyline which enhances understanding and communication is thereofore crucial (De Bruijn et al., 2017).

In this research a method has been developed to explore vulnerable areas and to do stresstests. The first stresstests have been carried out for the urban areas in South Holland and explorations were carried out for the urbanized area along the Amsterdam-Rhine canal area (which includes amongst others Amsterdam, Utrecht and Leiden, and Amsterdam Airport) (De Bruijn, 2022). The resulting flood and impact maps and discussions on actions resulted in significant increase in understanding of potential consequences and in follow-up actions to improve crisis management and recommendations for spatial planning and design recommendations for new critical infrastructure objects.

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