A look at future flood risk prospects
ideas of All-Risk researchers

Kok, M.

Publication date
2022

Document Version
Final published version

Published in
Towards Improved Flood Defences

Citation (APA)
Kok, M. (2022). A look at future flood risk prospects: ideas of All-Risk researchers. In M. Kok, J. Cortes Arevalo, & M. Vos (Eds.), *Towards Improved Flood Defences: Five Years of All-Risk Research into the New Safety Standards* (pp. 28-31). TU Delft OPEN Publishing.

A look at future flood risk prospects: ideas of All-Risk researchers

By Matthijs Kok
Professor of Flood Risk at Delft University of Technology

Over the last five years (starting from 2017), the All-Risk research programme has investigated many topics to support the implementation of dike reinforcement projects. But, what are the All-Risk researchers' ideas and directions about future research? On 4 November 2021, almost all All-Risk researchers gathered in one of the forts of the 'Dutch Waterline' to discuss these ideas (**Figure 1**). This reflection is the author's subjective view, inspired by the research ideas pitched during the meeting (**Figure 2**).

Flood risk is a key concept that concerns the possible consequences of flooding and the probability of a flood. The risk approach is more than that, however. Flood risk can also be expressed in many risk measures, such as societal risk (the probability that a large group of people will lose their lives) and individual risk (the probability that an individual will die). Indeed, the Dutch flood safety standards set a basic level of protection for each dike segment, considering that the yearly probability of a person dying because of flooding may not exceed 1/100,000. An extra level of protection is added per dike segment the more serious the consequences of a flood are. For example, the increased disturbance to social and critical infrastructure. However, the added value of the risk approach lies not in the statistics concerning probabilities and consequences but in the ability to generate the impact and efficiency of measures to reduce flood risk.

The Dutch Flood Protection Programme reinforces almost 2/3 of the primary flood defences to maintain safety standards over the next three decades. In light of the new Environment and Planning Act, these reinforcement projects should improve to some extent the landscape quality through collaborative and innovative efforts between flood risk and other sectors. The All-Risk researchers think that more effort is needed to obtain more insight into failure events of flood defences, to make the utmost of current efforts to strengthen the flood defences and reduce the consequences of floods. Therefore, the Netherlands may also consider the spatial demands, population and economic growth to improve the preparation of possible floods. All-Risk researchers suggested starting by taking the utmost advantage of the ongoing efforts for reducing the probability of flood and reducing in an effective way the potential consequences. This way, the flood defence system and the surrounding landscape might be designed for the remaining - even if small - probability of failure. Such a 'design for the extreme events' emerged from the All-Risk researcher ideas during this event and is further elaborated into the following research categories:

1. Long-term integrated strategies

An important question is whether every area below sea level needs to be protected. From historical evidence, one can see that mankind like to live on dry land instead of living in floating houses. Also, voluntary moving away from these areas is not attractive. For the longer term, different strategies for different climate scenarios (for example, 1-5 m sea-level rise) need to be developed in an interdisciplinary design effort, not only using models, since the physical reality is much more complicated than a model can indicate. Next to spatial planning, technical issues need to be addressed: is there a limit in raising the dikes, and what about the financial issues? As flood defences, are constructions like sheet piles more sustainable than earthen dikes? How much space do earthen dikes need? It is sometimes suggested that flood defences cannot be heightened anymore. Still, this suggestion can certainly be discussed while also considering the impacts on the river behaviour and the future requirements for new climate development (**Figure 3**). Therefore, an integrated strategy is required to address the extreme events, the impacts on the river ecosystem and the built landscape from the proposed flood defence interventions.

2. Nature-Based Solutions

The main challenge is to assess the contribution of "nature-based solutions" to flood protection of society. For example, explore actions to increase the tidal flats to attenuate waves, promote marsh expansion and

Figure 1: Participants of the meeting held 4 November 2021 are presenting and discussing each other's ideas. Photo by Martijn Vos.

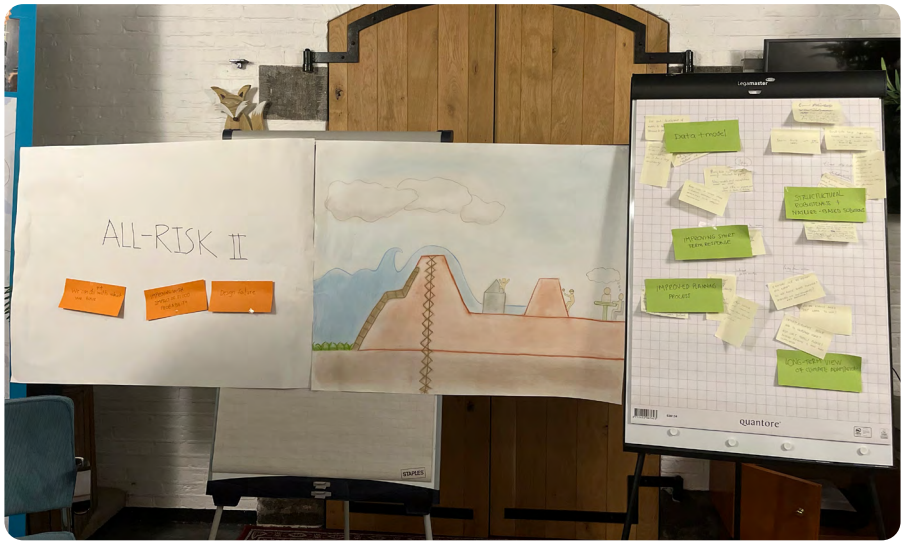

Figure 2: Wall with the summary of the researcher's sticky notes with future research ideas along the dike scheme that was used to illustrate the All-Risk research topics. This central scheme now depicts a dike that fails partly and gradually while the inland area is somehow prepared to outstand the flood. Photo by Martijn Vos.

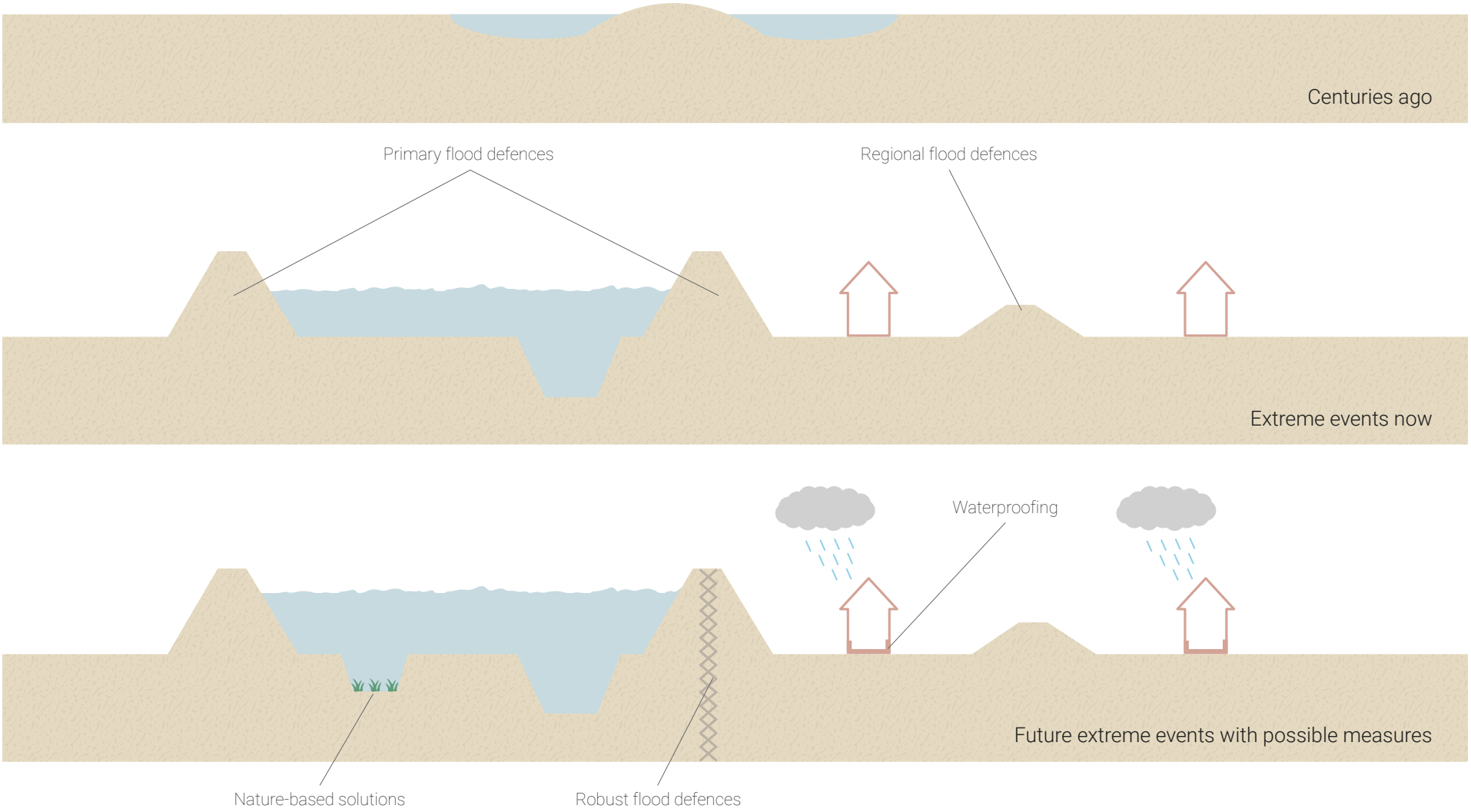

Figure 3: Compared to the rivers before human intervention (top), the flood defence system has provided flood safety and allowed us to benefit from the river, even under extreme conditions. However, the frequency and impact of extreme events may exacerbate in the future. Therefore, integrated flood defence interventions are required to address the extreme events, the consequences on the river ecosystem and on the built landscape (bottom). Based on Verhaal van de rivier, (Klijn et al. 2015, p. 14-15). Illustration by Pien Buters and Martijn Vos.

prevent erosion. Marshes reduce run-up and wave loadings on the dike. Moreover, marshes store carbon, purify the water, support fisheries and many more ecosystem services. Typical measures to maintain and expand marshes include: ensuring sediment supply, restoring shellfish reefs (trap sediment) and seagrass.

3. Impact reduction of floods

Flood risk can be reduced by reducing flood impact. Worldwide, we have seen increased economic damages and a decrease in loss of life by natural floods in the last decades. An explanation for this is that is on one hand the substantial growth of the economy in vulnerable areas, and on the other hand the improvement of flood forecasting methods. But is it enough? So, future research may also be aimed at the short-term response by, for example, improving early warning applications for floods to make them more effective and to reach vulnerable groups better.

4. Flood defences structural robustness

Structural robustness means that the structure itself (for example, earthen structure with clay core) does not fail completely and suddenly, but partly and gradually. The consequences of a flood can also reduce if a structure shows more ductile behaviour. Also, more predictable dike failure leads to less uncertainty, and a better failure process understanding needs further lab and field tests. Therefore, another research topic is to connect type of flooding or dike failure to safety standards.

5. Learning from data in combination with models

From a data point of view, many suggestions can be made to improve the quality of assessment and design of flood defences. There are better ways to estimate relevant subsurface parameters such as permeability from geological characteristics. Also, the connection with models is important, for example, the development and use of models to better predict the actual dike behaviour and performance. Furthermore, the triaxial test interpretation can be improved as it has a large uncertainty. Finally, river model calibration for a large area and a large range of conditions can be improved for a “robust model calibration”.