

# THE IMPACT OF SPATIALLY DISTRIBUTED EVACUATION FRACTIONS ON FLOOD SAFETY STANDARDS IN THE NETHERLANDS

Dike safety standards in the Netherlands are established through a risk-based approach. This study focuses on one particular risk aspect known as individual risk. Individual risk quantifies the risk an individual faces at any given time and location within a dike ring. It is influenced by various factors, including the evacuation fraction, which represents the proportion of individuals that can be pre-emptively evacuated in the event of a flood threat. In contrast to the current conservative methodology, primarily dependent on expert opinions and exclusion of spatial considerations and flooding arrival times, this study proposes a more refined approach. By spatially determining evacuation fractions and integrating arrival times, the study reveals substantial variations in dike safety determination compared to the current method. The inclusion of arrival times leads to a significant increase in the average evacuation fraction, challenging the current practice and suggesting potential unnecessary dike strengthening projects for certain dike sections. The case study, Dike Ring 48, yielded significant findings with implications for dike safety standards. The research results indicated a substantial increase in the average evacuation fraction, from 76% to 90%, challenging the conservative nature of the current methodology. Moreover, the spatial distribution revealed differences in evacuation fractions across neighbourhoods, depending on the location of a potential dike breach and the associated flood scenario. This study not only identified limitations in the current dike safety methodology, but also suggested possibilities for future investigations to enhance the accuracy of flood risk management strategies.

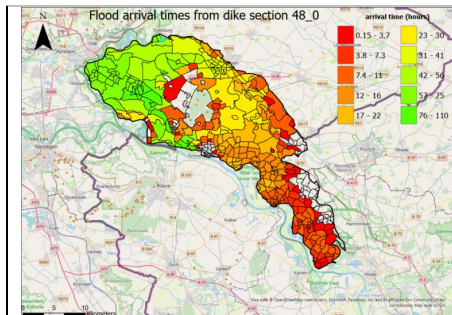
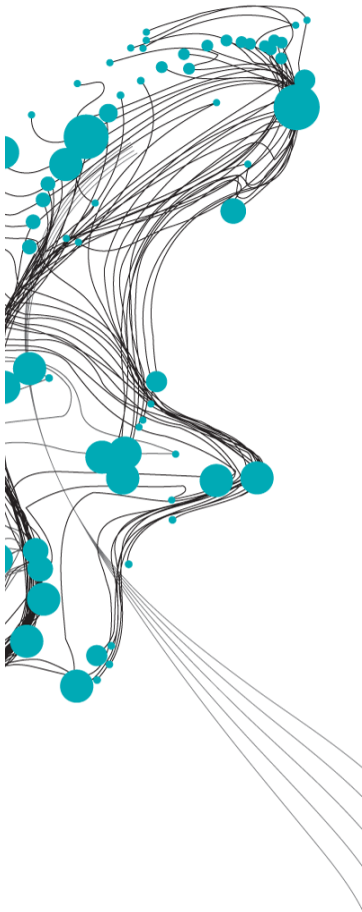


Figure 1. Flood arrival time per neighbourhood for dike section 48\_0.

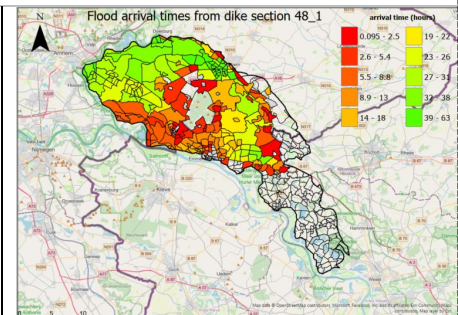


Figure 2. Flood arrival time per neighbourhood for dike section 48\_1.

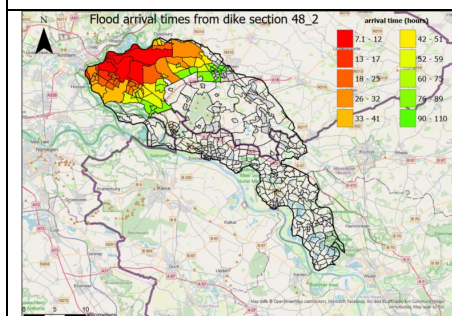


Figure 3. Flood arrival time per neighbourhood for dike section 48\_2.

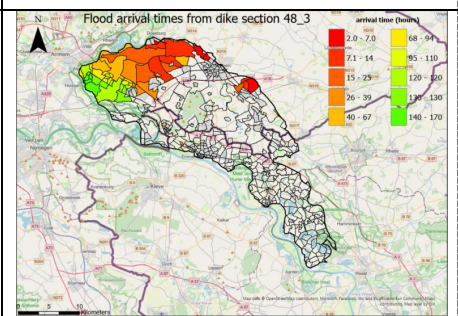


Figure 4. Flood arrival time per neighbourhood for dike section 48\_3.

**Loek Hahn**

**Graduation Date:**  
30 November 2023

**Graduation committee:**  
*University of Twente*  
Dr.Ir. M.J. Booij  
Dr.Ir. M.B. Ulak

*Royal HaskoningDHV*  
Ir. S.G. Westerhof  
Ir. R.J.M. Huting