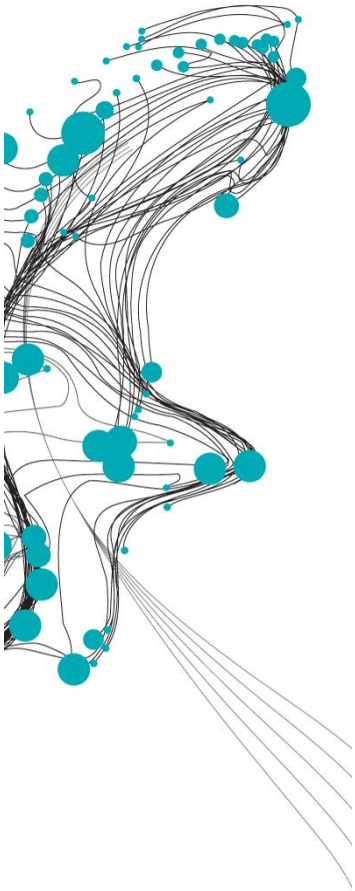

SHIFTING DISCHARGE, ALTERING RISK

AN EXPLORATORY STUDY ABOUT THE IMPACT OF THE DISCHARGE DISTRIBUTIONS UPON THE FLOOD RISK OF THE UPPER-RHINE AREA OF THE NETHERLANDS

The largest river in the Netherlands, the Rhine, bifurcates in several branches. The distribution of discharge amongst these branches is fixed by policy. As these distributions directly determine the water levels along the downstream river branches of the Rhine, they are expected to be an important factor in the risk of flooding during high water events. In this study, the impact of changing discharge distributions amongst the branches of the Rhine is investigated. The impact is measured in terms of risk; expressed in the expected damage in Euros per year.

A literature study revealed that the current distributions originate from the 18th century, when they were established through constructions at the bifurcation points. The agreement upon the discharge distribution originates in water scarcity rather than safety. Since then, little changes have been made to these agreements and bifurcation points.

Focusing on the upper part of the river Rhine, the risk of the current situation was calculated using a numerical tool that was developed for this purpose. The definition used for risk was: risk = probability * consequences. This tool calculated the probability of failure, based on the water load and the strength of the dikes along the different branches. The water load was derived from the discharge statistics of GRADE2015 and the strength of the dikes was calculated based on fragility curves, only taking the failure mechanisms overflow/overtopping, macro-stability, and piping into account when available. The data for the consequences was derived from the Flood Risk study of The Netherlands of 2006 (VNK).

Starting from the current situation, the distribution of discharges was changed, calculating the flood risk for various distributions. This analysis showed that the total risk could be reduced by 35% when the distribution at the IJsselkop is diverted more towards the Nederrijn-Lek, and 10% when changing the distribution at the Pannerdensche Kop more towards the Waal (Figure 2). Although the accuracy of the tool is limited, mainly due to incomplete data, the results of this study show that it is worthwhile to investigate this further, as it is likely that the total risk will change for a different discharge distribution.

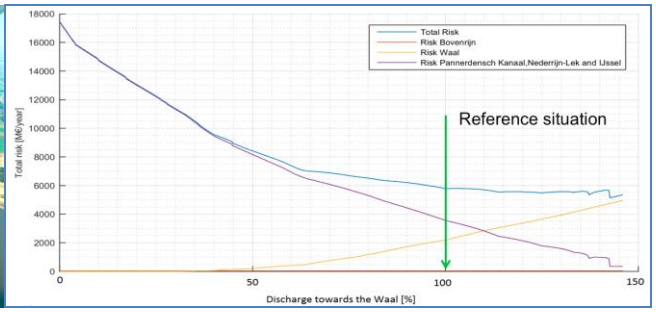

Figure 1 (left): Bifurcation point Pannerdensche Kop and a visualization of the discharge distribution towards the Pannerdensch Kanaal and Waal as a fraction of the discharge in the Bovenrijn.

Figure 2 (right): Flood risk of the upper-Rhine area for the Pannerdensche Kop as a function of the discharge towards the River Waal.

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