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How are flood risk estimates affected by the choice of return periods?

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Introduction

Flood risk assessments are commonly carried out by estimating potential damage for floods of several exceedance probabilities (or return periods), plotting these on an exceedance probability-loss curve (risk curve), and estimating risk as the area under the curve. However, there is little insight into how the selection of the return-periods (which ones and how many) used actually affects the final risk calculation. Moreover, there are only few studies that assess the impacts of future changes in both land use and climate on flood risk.

In this paper we investigate:

(a) how this choice of return periods affects calculated flood risk;

(b) the sensitivity of flood risk to future changes in climate and land use.

Study area

The research was carried out for a case study section of the River Meuse in Dutch Limburg, southeastern Netherlands (see Fig. 1).

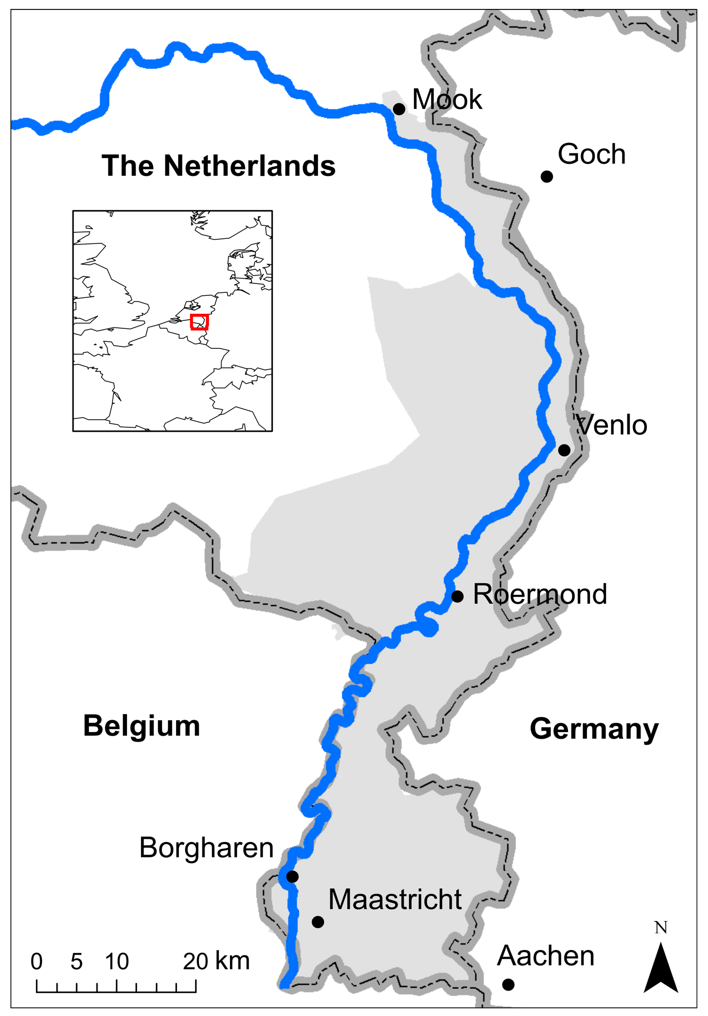

Fig. 1: Map showing the location of the study area. Dutch Limburg is shown in grey.

Methods

We coupled an inundation model (Floodscanner) with a flood damage model (Damagescanner), to estimate monetary damage for floods of different return periods, and then used these damage estimates to calculate risk as the area under a risk curve (Fig. 2).

In most studies, such a risk calculation is based on damage estimates for just a few return periods (in the EU flood directive, Member States are only obliged to create flood hazard maps for 3 return periods). Here, we first used all return periods between 2 and 10,000 years to give our most accurate estimate. We then assessed how the estimated risk changes if fewer return periods are used to construct the risk curve.

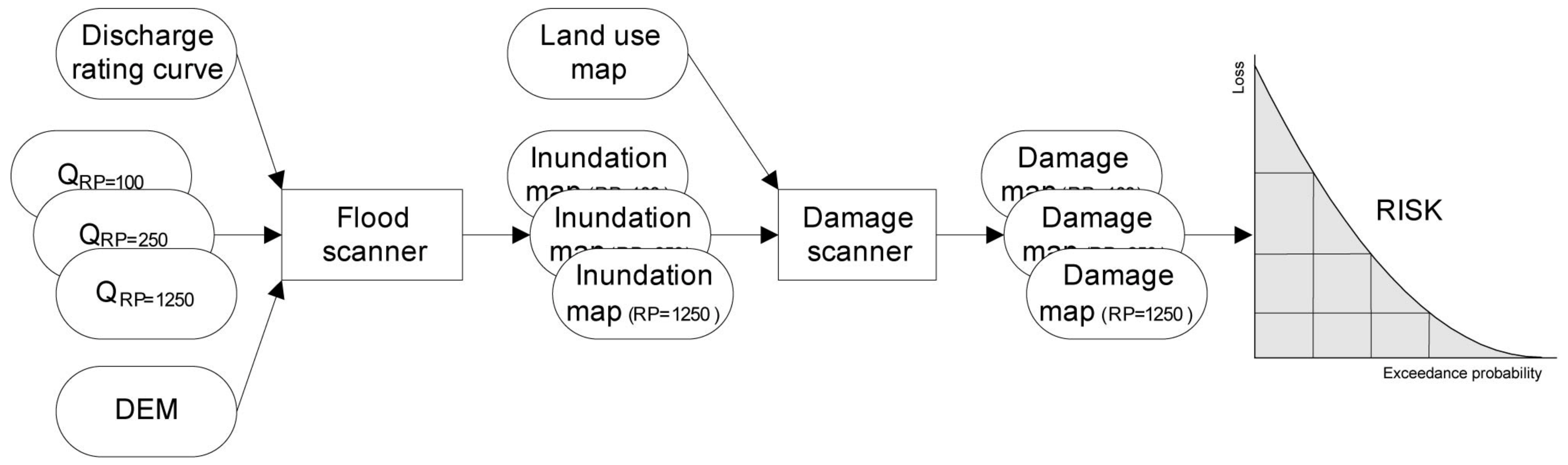

Fig. 2: Overview of the methods used. Floodscanner produces maps of inundation depth per grid-cell. Damagescanner estimates damage per grid-cell. Risk, in terms of expected annual damage, is calculated as the area under the resulting exceedance probability-loss curve.

Choice of return periods

The calculated risk is greatly affected by the return periods used. For example, using all return periods between 2 and 10,000 years returns a risk of €34 million p.a. If only 3 return periods are used, whereby one is of high probability (2-25 years), one of medium probability (250 years), and one of low probability (500-10,000 years), the calculated risk is in the range €44-67 million p.a.

Table 1: Examples of the effects of the choice of return periods on calculated risk

Description	Risk (€ m p.a.)
All return periods from 2 to 10,000 years	34
All return periods from 10 to 10,000 years	23
3 return periods	44-67

Future scenarios

We then estimated the percentage change in risk between current conditions and 2030, assuming two scenarios of climate and land use change (low and high), as shown in Fig. 3.

The results show significant increases in risk as a result of both climate and land use change, with stronger increases as a result of the latter.

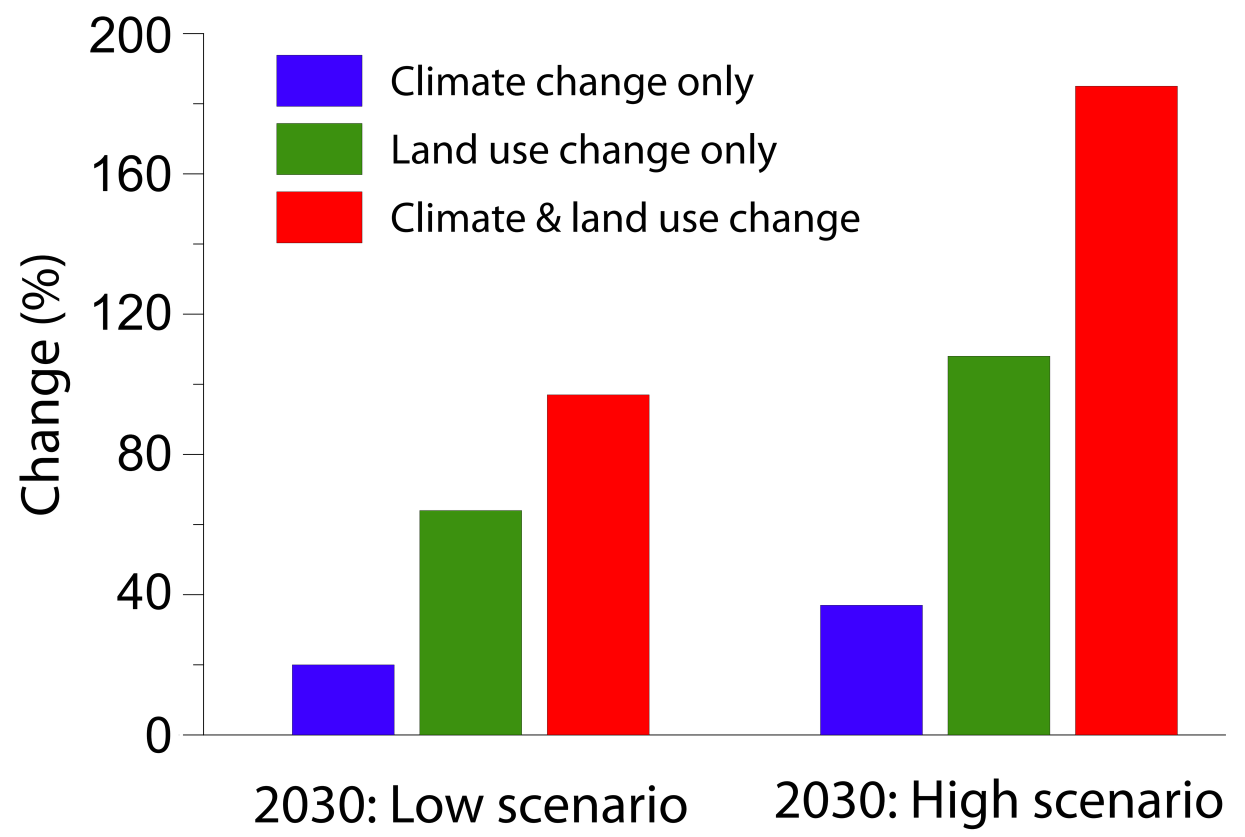

Fig. 3: Change in risk (%) between reference scenario (2010) and 2030 for low (left) and high (right) scenarios

Conclusions

- Estimated flood risk is very strongly influenced by the choice of return periods (which ones and how many) used to construct the risk curve.
- In the case study region, simulated climate and land use change both lead to projected significant increases in flood risk by 2030, with a greater influence for land use change.

Full reference

Ward, P.J., De Moel, H., Aerts, J.C.J.H., 2011. How are flood risk estimates affected by the choice of return periods? Natural Hazards and Earth System Sciences, 11, doi:10.5194/nhess-11-3181-2011

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