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Quantifying and attributing uncertainty in flood damage estimates

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It is clear that the flood risk of river floods is growing because of continuous developments in flood-prone areas, anthropogenic interference in the drainage system and other changing environmental conditions. Economic developments and climate change are likely to continue to increase flood risks in the future. A transition from protective flood management to a more integrated risk management approach can be observed in many European countries, in order to cope with these projected changes and its associated uncertainties

Flood risk assessments are of key importance in flood risk management in order to make well considered decisions. Direct monetary damage that could potentially result from a flood is a key figure in flood risk assessments and can be used in cost-benefit analyses to facilitate decision making regarding risk-reducing measures. However, many uncertainties surround such flood damage estimates as uncertainties in the data underlying flood damage calculations propagate through the calculation and accumulate in the final damage estimate. Uncertainty exists in all components of flood damage models because of generalizations or aggregation of information. This is acknowledged by various studies but mainly uncertainty from a single source (e.g. water depth) is analyzed. A comprehensive study into how uncertainty from different sources compare to one another is currently lacking.

This research addresses this caveat and makes an effort to assess the variation in final flood damage estimates resulting from assumptions and uncertainties in land use data, water depth data, and stage-damage curves (and their associated maximum damage). The input data for the flood damage assessment from these three sources was varied in order to assess the sensitivity of the damage estimate for uncertainty in each component. The data was varied by taking different sources of land use information, introducing water depth errors manually, and by using different sets of stage-damage curves. All possible combinations of input data were used to calculate flood damages in order to present the full range of possible flood damage estimates. The approach is applied to a case study area in the south of the Netherlands on the south bank of the Meuse river: Land van Heusden/Maaskant (dikering 36).

It is found that variation in land use data has comparatively the smallest effect ($\sim$factor 1.2) on the resulting flood damage estimate, having a similar effect of a water depth error of about 25 cm. The flood damage estimate is most sensitive to the shape of the stage-damage curve and the maximum damage assumed for the different land use classes. Both can easily result in a factor 2 change in flood damage estimate, similar to an error in water depth of around 1.1 m. In total, absolute damage estimates can easily vary up to a factor 5 or 6 as a result from different assumptions and errors in the underlying data. Relative changes in flood damage (as a percentage of a reference situation), on the other hand, are surrounded by a much lower uncertainty, around a factor 1.3. Given these results, it is clear that choosing stage-damage functions and their respective maximum damages should receive much attention and that the use of absolute numbers of (avoided) damage, in for instance cost-benefit analyses, can be misleading.