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Exploring high-end climate change scenarios for flood protection of the Netherlands

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Sea level rise, changing storm frequency and intensity, and increased river discharge resulting from climate change pose a particular threat to low-lying countries like the Netherlands and create many new challenges for them. With these threats and challenges in mind, the Dutch cabinet established a special committee, the Delta Committee, charged with the development of effective planning-, management- and adaptation strategies for climate proofing the Netherlands. At the request of the Dutch Delta Committee, an international scientific assessment has been carried out to explore high-end climate change scenarios for flood protection of the Netherlands. Upper-bound values and longer-term projections (up to 2200) of climate-induced sea level rise, changing storm surge conditions, and peak discharge of the river Rhine have been considered. The assessment builds on a review of recent studies, model projections and expert opinions.

For the scenarios for sea level rise, thermal expansion of the ocean, the shrinking of small glaciers, the Greenland and the Antarctic Ice Sheets, and changes in terrestrial water storage are considered separately, along with their uncertainties. Except for the contribution of the Antarctic Ice Sheet all contributions are assumed to depend (at least in part) on the rise in global mean atmospheric temperature rise. To arrive at a projection for local sea level, elastic and gravity effects of elastic deformation of the Earth's crust arising from mass redistribution due to the melting of land-based ice masses, local expansion differences with respect to the global mean (dominated by ocean circulation changes) and local land movement were accounted for. Depending on the adopted impact of the elastic and gravity effects, a high-end projection for local sea level rise of 0.50 - 1.15 m and 0.05 - 1.25 m is projected for the Dutch coast for 2100. For 2200 these ranges are 1.5 - 4 m and 0.5 - 4.0 m.

Besides sea level rise, the height of storm surges and wind waves is extremely important for a low-lying country like the Netherlands. By law, coastal defense has to withstand a water level that occurs only once every 10,000 years. In the assessment for the Delta Committee, this aspect has been addressed by first investigating projected changes in the wind climate on the North Sea from global and regional climate model simulations. In a second step these winds are used to drive storm surge and wind wave models. The results point to changes being small compared to the uncertainty in present-day 10,000 year return values.

Finally, the effects of climate change on the discharge of the river Rhine were considered using hydrological models. It was found that average winter flow will increase while summer flows will be reduced to a magnitude depending on the assumed climate change scenario. Peak discharges that are currently being considered very high will become normal. Finally, it was concluded that the current hydraulic properties of the Rhine limit the potential increase of the design discharge substantially.