Climate change: past, present or future?

Versteeg, R.P.[1],de Graaff, B.J.A.**

** HKV consultants*

[1] *Details for contact author (Botter 11-29, Lelystad, The Netherlands, +31320294214, versteeg@hkv.nl)*

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ABSTRACT

Objective

Probabilities of floods are often determined using extreme-value distributions of river discharges and hydraulic models representing river flow and flooding. The discharges are usually measured or simulated by hydrological models forced with historical meteorological input. However, historical data series are susceptible to already perceptible climate change and underestimate the probability of flooding in the current climate. This affects the planning and urgency of mitigation measures for flood prevention. This paper presents the approach used by Dutch Water Authorities to correct for already noticeable climate change effects, based on analyses of the Reusel catchment in the Netherlands.

Methods

Trends in meteorological data are identified using a season dependent Loess smoother (Cleveland, 1979) on precipitation and evaporation time series ranging from 1906 to 2015. Time series are subsequently detrended based on the Loess smooth, resulting in meteorological data representing the current climate (Beersma, 2015).

Changes in expected flood frequency are determined in a three step procedure. First, the detrended meteorological data are fed into the Wageningen rainfall-runoff model (Warmerdam, 1996) to simulate flows to the river. Second, using extreme-value distributions several synthetic flood waves are derived for return periods of 1 year up to 100 years. Third, hydraulic processes and flooding are simulated using a 1D2D-

Sobek hydraulic model.

Results

Applying the Loess smoother to the meteorological data showed an increase in precipitation in extreme events of 20% over the period 1906-2015. Subsequent analysis of flood frequency indicated that floods in the Reusel occur approximately three times more often when using the detrended meteorological data compared to using the original meteorological measurements. Other Dutch catchments also showed two to three times more frequent flooding. The impact for other catchments will vary depending on the already realised climate change and the catchment characteristics.

Conclusions

The Reusel case study indicates that climate change is already noticeable in historical time series of flow, precipitation and evaporation in the Netherlands. The Reusel case also clearly demonstrates the importance to detrend meteorological data to the current climate and adjust data to future climate projections, in order to maintain flood protection at the desired level. Therefore, the Dutch Water Authorities have made these time series and related statistics available to all water managers (www.meteobase.nl).

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