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Incorporating the correlation between upstream inland, downstream coastal and surface boundary conditions into climate scenarios for flood impact analysis along the river Scheldt

Victor Ntegeka, Patrick Willems, and Jaak Monbaliu

Katholieke Universiteit Leuven, Department of Civil Engineering, Heverlee, Belgium (victor.ntegeka@bwk.kuleuven.be, + 32 16 32 19 89)

Climate change scenarios have been developed that are useful for flood impact studies along the river Scheldt in Belgium. They consist of scenarios for the downstream coastal boundary (sea level rise, storm surges), the upstream inland boundary (rainfall and related runoff discharges) and the surface boundary along the Scheldt reaches (wind speed and direction). Correlations between the climatic changes at the three boundaries have been considered.

For each of the boundaries, the climate change scenarios are based on statistical analysis of an ensemble set of (at least 20) simulation results with regional climate models (RCMs). The RCM results are provided by several databases, including the CERA database (2 CLM runs), the EU-FP5 PRUDENCE database (31 runs with 12 RCMs) and the EU-FP6 ENSEMBLES database (18 RCM runs). RCM results of precipitation, temperature, potential evapotranspiration, wind speed, wind direction and sea level pressure (SLP) have been validated for historical periods (e.g. 1961-1990, 1981-2000) and analyzed for future changes till 2100 (e.g. for the near future, 2011-2040 or 2016-2035, the not so near future, 2041-2070 or 2046-2065, and the longer term future, 2071-2100 or 2076-2095). The validation is done for daily and monthly mean values, and daily extremes in different seasons. Future changes take the form of change factors, dependent on season, return period (for the extremes) and time scale. Based on the ensemble set of change factors, tailored climate scenarios (tailored for the specific application of flood impact analysis along the Scheldt) have been developed. After statistical analysis of the whole range of change factors, a reduced set of climate scenarios ("high", "mean" and "low") was derived for each boundary (upstream, downstream and surface). Smart combinations of these scenarios account for the correlations between the boundary changes.

Changes in SLP were transferred to changes in storm surges at the Scheldt mouth (at Vlissingen) based on a correlation model between the SLP at the Baltic Sea and the storm surge level. This model was derived after analysis of SLP composite maps and SLP-surge correlation maps for days where the surge exceeds given thresholds (for different return periods).

Changes in inland precipitation and evapotranspiration were transferred to corresponding changes in runoff discharges (upstream along the Scheldt) based on simulations in rainfall-runoff models of the upstream river basins. After calibration of the rainfall-runoff models to historical series, the precipitation and evapotranspiration input series were stochastically perturbed to account for the changes in the number of rain storms, the rain storm intensities and the correlated changes in evapotranspiration. This was done for each of the tailored climate scenarios. Extreme value analysis on the rainfall-runoff model results allowed assessment of the changes in runoff discharges at the upstream Scheldt boundaries, in relation to the return period of the runoff event.