Climate change impacts of saline intrusion in a subtropical estuary

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Abstract: Climate change is expected to significantly alter hydrological regimes throughout the world, affecting water resources and the frequency of floods and droughts. While these factors have been widely studied throughout the literature there have been relatively few studies that have evaluated the impacts of climate change on saline intrusion. This study aimed to assess how climate change coupled with sea level rise would impact on saline intrusion along the Logan-Albert estuary in Southeast Queensland.

The one-dimensional MIKE HYDRO model was applied with the advection dispersion model for this purpose. Observed streamflow and modelled tides were applied as boundary conditions to drive the model, which was calibrated against monthly observed salinity concentrations obtained from Healthy Land and Water along the length of the Logan and Albert estuaries. Tidal boundaries were assumed to have a salinity concentration of 35 PSU, while the upstream inflows were assumed to have a salinity concentration of 0.1 PSU.

The impacts of climate change and sea level rise on saline intrusion were investigated. An ensemble of 11 high-resolution climate models forced under high (Representative Concentration Pathway 8.5 - RCP8.5) were obtained from the Queensland Department of Environment and Science (Syktus et al., 2020). These models were applied to simulate the catchments hydrological response to climate change. Three future periods were evaluated (2020s, 2050s, and 2080s), which were assessed against a model baseline (1980-2010). The simulated hydrologic response from the ensemble of climate models were applied as upstream boundary conditions to the hydrodynamic salinity model. The impacts of sea level rise were considered under the RCP8.5 scenario by altering the modelled tides, which were adopted as downstream boundaries.

Hydrological modelling results showed that high and mean flows were projected to decrease significantly in the future under RCP8.5 and that these decreases would become largest by the end of the century. By the 2050s and 2080s a majority of the climate models indicated decreased streamflow, whereas for the 2020s there was no clear indication on the sign of change. This decrease in freshwater inflows when combined with elevated sea levels due to sea level rise led to significant increases in salinity concentrations along the estuary, particularly along the mid estuaries. These increases were most substantial by the end of the century, when streamflow inputs were lowest and sea level rise (and therefore tidal intrusion) was highest. These changes could have a range of implications for agriculture and the environment. For instance, sugarcane is the primary industry located along the lower Logan-Albert floodplain and may be impacted by this increased saline intrusion, through changes in groundwater levels and salinity concentrations. This study provides a useful framework for assess saline intrusions changes as a result of climate change, which may be readily applied to estuaries elsewhere in Australia.

REFERENCES

Syktus, J., Toombs, N., Wong, K., Trancoso, R., Ahrens, D., 2020. Queensland Future Climate Dataset – Downscaled CMIP5 climate projections for RCP8.5 and RCP4.5, Version 1.0.2. ed. Terrestrial Ecosystem Research Network (TERN). DOI:https://doi.org/10.25901/5e3ba30f141b7

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