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Understanding and predicting riparian decline: ecohydrology and hydro-climatological change

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Background

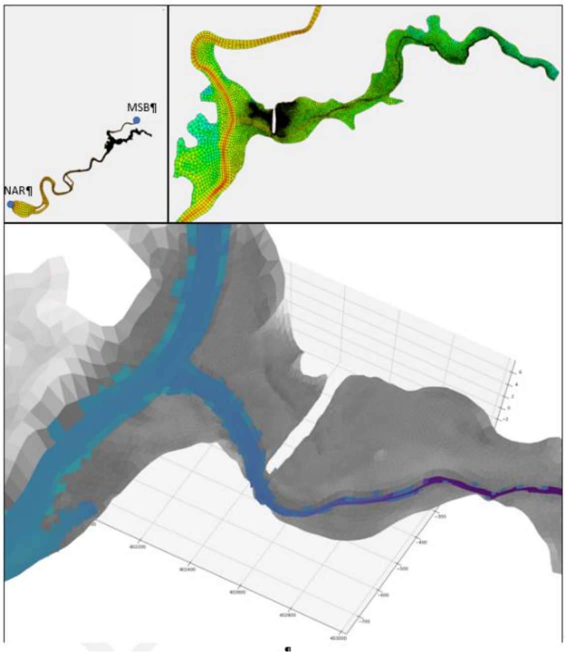

Figure 1: Overview of model mesh used for simulations. Full domain (top left); focus area at Helena confluence (top right) and zoomed in model domain showing zoomed in resolution of detail (bottom).

Since 2010, localised decline in riparian vegetation has been recorded at a number of sites in the Swan Canning Riverpark including Baigup, Ascot, Guildford and in Manning. At Guildford, vegetation die-off is particularly evident in *Eucalyptus rudis* along the Helena River and phytophthora pathogens are known to be present. However, dieback is a complex issue and there is evidence that a range of adverse environmental changes can leave trees vulnerable to biotic and/or abiotic disease. Waterlogging and salinity are amongst factors that may influence dieback.

In this study, field instrumentation, data analyses and modelling tools were applied to develop an understanding of the riparian salinity dynamics that may be influencing tree decline at the Helena River confluence with the Swan River. The Swan Canning Estuary Response Model (SCERM) was linked with lidar data to provide a model domain that extended into the riparian zone and enabled simulation of water levels, inundation and salinity (Figure 1). In addition to understanding local scale dynamics, the model was applied to understand regional scale risks of riparian decline in the upper Swan based on 2050 projections of a drier climate. A multi-criteria risk assessment approach was taken to develop a GIS-based predictive framework linked to the estuary response model (SCERM v3) and generate habitat salinity risk maps for the upper Swan.

Findings

The hydrogeology of the floodplain at the Helena confluence is complex, including low and high permeability layers that complicate the understanding of water and salt transport pathways. This is further complicated by drainage lines, depressions and roadways that create localised infiltration areas and alter the nature of the subterranean salt wedge.

Analyses of historic water levels using frequency distribution determined the 90^{th} percentile of river height at nearby Middle Swan Bridge to be 0.33m AHD. The Swan Coastal Plain digital elevation model showed that only rare high water / flood events (above 1m AHD) led to the connection of the river with the floodplain drainage lines and depressions (Figure 2). Where these events occur, it is hypothesised that surface water is left to evapo-concentrate and salt subsequently accumulates in the soil and leaches downward. Groundwater salinities were high (~1/3 seawater) driven in part by the accumulation of surface salts through those rare events, but also via the subterranean movement of river water (greater than 150m) into the floodplain aquifer, particularly during late summer / autumn.

Four factors were identified as contributing to increased root zone salinity and thereby increased stress for vegetation and tree risk: river salinity and associated subterranean salt-wedge; distance from the river

Figure 2: Land inundated at Helena River confluence at various water levels.

channel (salinity dilution distance); relief; and land cover type and the presence of vegetation. The four criteria were summed to provide an overall Habitat Salinity Risk score. This was computed for each 5x5m cell of the model domain to produce risk maps for the years 2008-2018. Unsurprisingly, highest risk areas are nearest river edges and in low-lying, poorly drained areas where evapo-concentration of salts would be greatest. Areas of greatest risk are Bayswater to Guildford.

Future risk was simulated using a 2050 simulation of the SCERM, assuming a reduction in freshwater inflow, increase in the average sea level and increase in air temperature. These were compared to the 2008 reference simulation and showed that the 2050 changes would effect a doubling of salinity at Middle Swan Bridge. The simulation results were re-input into the multi-criteria assessment algorithm to generate a 2050 map of risk, which demonstrated the extent of salinity risk further upstream (Figure 3). The relative change between 2008 and 2050 was also mapped to demonstrate how a drying climate and rising sea level intensifies the risk of salinity at already susceptible locations.

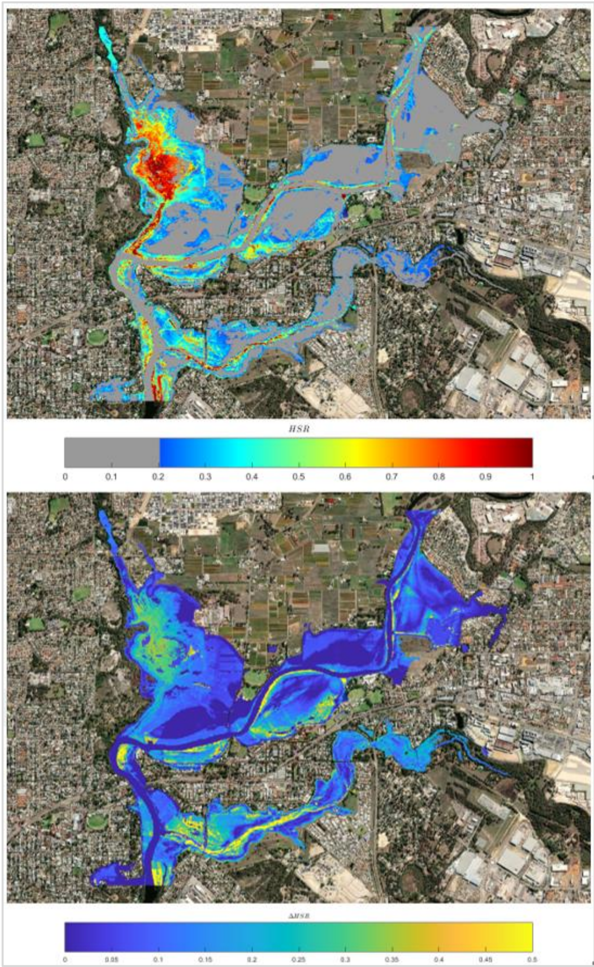

Figure 3: Habitat salinity risk (HSR) map for 2050 (top) and change in HSR between 2008 and 2050.

Management implications

While there is some uncertainty and potential oversimplification in the model approaches and habitat salinity risk assessment, these analyses highlight the impacts of climate change and need for adaptation management if present day biodiversity values are to be maintained. Accordingly, a range of approaches could be considered to mitigate risk including:

- revising environmental flow provisions to take account of flow for salinity mitigation
- revegetation of flooded gum to focus on low to moderate salt risk areas and the selection of more salt tolerant species for high risk areas
- site scale reassessment of local surface water and urban stormwater drainage to identify opportunities to enhance freshwater flushing in high risk areas
- groundwater freshening.

Further information

Hipsey MR, Alilou H, Bourke S, Bunting C, Busch BD, Job M, Whitwell C and Zhai S (2020) Understanding and predicting riparian decline: Ecohydrology and hydro-climatological change in the Upper Swan estuary. AED Report, The University of Western Australia, Perth, Australia. 51pp.

Huntley B and van Dongen R (2017) Remote Sensing Pre-field Analysis – Helena River. Technical Report Department of Biodiversity, Conservation and Attractions.