Flow deficits in northern Australian estuaries: Implications for water extraction

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Abstract: Water development in river systems with highly variable interannual flow can significantly impact downstream and estuarine ecosystems by altering nutrient delivery. Highly variable systems, such as those in the wet-dry tropics in northern Australia, may be particularly susceptible to disruption, because the downstream ecosystems are highly adapted to a specific flow regime.

Australia's wet-dry tropical rivers are some of the world's last remaining unregulated rivers, but predicting the impact of future water extraction from an increasing number of infrastructure projects is hampered by lack of knowledge on the impact of flow and associated nutrient loads. Ironically, the lack of information arises from the very reasons that these rivers have not yet been developed: the physical remoteness of these river systems and the difficulty of collecting data during flood periods. An additional challenge for water development in highly episodic river systems is the scale of water infrastructure interception, e.g. dams, required to ensure water security across interannually variable flow conditions. Thus, establishing baseline conditions based on long-term flow information before substantial water extraction occurs is critical when considering the feasibility of such projects.

Here we analysed 119 years of modelled end-of-system flows for the Flinders, Gilbert, and Mitchell rivers in Northern Australia, quantified the interannual variability to establish baseline conditions, and characterized the nutrient loads to the estuary, with calibration from collected data. The end-of-system flows were modelled using an eWater Source model, calibrated to gauging stations in the respective catchments with high Nash-Sutcliffe efficiency values (> 0.9). The timescales of flow and nutrient delivery to the end-of-system were used to discuss how altered timescales due to water extraction impact the productivity of the estuarine ecosystem. Our results show multi-decadal periods of below-average flow in all three rivers with interdispersed highly episodic flow events, indicating periods of prolonged flow deficit. Flow and nutrient load were found to be correlated, suggesting that nutrient delivery mostly occurred during the sporadic flow events. From this, our key finding was that estuarine ecosystems of the rivers in question were only received sporadic supply of nutrients which may be exacerbated by upstream water extraction. We discuss the implications of sporadic flow and nutrient delivery on the estuarine ecosystem and assess risks of potential water development in wet-dry tropical river systems.

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