SEA LEVEL RISE IMPLICATIONS FOR ESTUARINE MODELLING AND MANAGEMENT

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INTRODUCTION

Estuaries provide a wide range of environmental, cultural, social, and economic services. These include primary production, water purification, recreational opportunities, navigational routes, and nurseries for aquatic species. However, a growing body of literature indicates that sea level rise (SLR) is increasingly threatening these services in estuaries due to their low-lying topography and proximity to the open ocean. As such, sustainable management of estuaries, adjacent low-lying areas, and associated ecosystems requires a thorough and evidence-based understanding of how different estuaries may respond to SLR over time and space (Khojasteh et al. (2021)) (Figure 1). This, in turn, would help policymakers manage the far-reaching impacts and prioritise funds-based adaptation and mitigation strategies.

METHODOLOGY

Assessing SLR impacts in estuaries can either be undertaken on an individual site basis or via broader approaches that may be relevant to many estuaries. This study utilises the latter approach and, to this aim, a large ensemble of idealised prismatic and converging estuarine hydrodynamic simulations were conducted. Several parameters were varied throughout the simulations, including tidal range at the mouth, estuary length, estuary depth, bed roughness, bed slope, river inflow, and SLR scenarios. The results were then analysed. (i) to present a systematic hydrodynamic understanding of different estuary types in present-day and future conditions, (ii) to detail the influence of SLR on tidal energy dynamics, (iii) to establish a framework for assessing SLR impacts on estuaries worldwide, and (iv) to guide decision-makers in establishing holistic, evidence-based management plans for estuaries. This is of significance as the current knowledge about SLR and estuarine management is primarily focused on individual case studies, potentially due to the absence of adequate resources available to develop detailed hydrodynamic models for every estuary worldwide.

RESULTS & DISCUSSION

Over 2000 idealised estuary models were simulated to determine how SLR influences the hydrodynamics of various systems with different boundary conditions. These results indicate that SLR can lead to tidal range amplification in some estuaries, although entrance restriction effects may offset this phenomenon. Further, SLR is likely to alter the distributions and magnitudes of tidal currents, tidal prism, tidal asymmetry, sediments, tidal energy, and the location of priority tidal energy harvesting sites.

To link the idealised findings with real-world estuaries. 26 real-world sites were simulated and analysed under present-day and future SLR conditions. This information was used to identify estuaries that are most vulnerable to SLR-induced tidal variations around the world. These results were consistent with the idealised findings and highlighted their transferability to certain estuaries (e.g., sites with less complex geometries) worldwide without an existing, detailed hydrodynamic model. Long, weakly convergent estuaries with higher friction, river inflows and shallower water depths will likely experience significant changes in tidal dynamics due to SLR. The numerical approach and learnings of this research can be used to assess and predict cumulative SLR impacts on estuaries and help develop catchment-wide management strategies for these valuable environments globally.



Figure 1 - An estuarine system in pristine historic condition (top panel) and under present-day condition with impacts from climate change and anthropogenic activities (bottom panel) (after Khojasteh et al. (2022)).

REFERENCES

Khojasteh et al., (2021): Sea level rise impacts on estuarine dynamics: A review, Science of The Total Environment, ELSEVIER, vol. 780, p. 146470.

Khojasteh et al., (2022): Sea level rise will change estuarine tidal energy: A review, Renewable and Sustainable Energy Reviews, ELSEVIER, vol. 156, p. 111855.