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# Mangrove vulnerability to sea-level rise under varying environmental conditions: A bio-morphodynamic modelling study involving vegetation dynamics and coastal profile change

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### Abstract

Regional variations in coastal environmental conditions (such as sediment supply, tides and waves) lead to different coverages and behaviours of mangrove forests. Yet it remains highly uncertain how mangroves in various environmental settings will respond to accelerating sea-level rise. Existing projections primarily focus on vertical accretion to offset sea-level rise impacts and on opportunities for lateral migration. However, the mechanisms controlling sediment transport and accretion across mangrove forests and how this links to coastal profile change and mangrove survival still need to be further investigated. Here we use a bio-morphodynamic model that couples mangrove dynamics, hydro-sedimentary processes and morphological change to systematically explore mangrove vulnerability under a wide range of environmental conditions based on mangrove ecosystems around the world. We first investigate coastal profile evolution and mangrove forest dynamics under a stable mean water level and then implement sea-level rise based scenarios following IPCC predictions. We show that tidal range and sediment supply play a key role in determining coastal profile evolution and mangrove characteristics. A larger tidal range increases landward sediment supply and raises sediment concentration across the whole tidal area. Spring-neap tidal cycles create a larger mangrove zone and cause faster coastal progradation; this is due to an extensive flooding area during spring periods and a calm hydrodynamic environment during neap periods. Moreover, results show that small waves enhance profile propagation but may also limit mangrove seaward expansion due to a higher bed shear stress at the seaward fringe of the mangrove forest. At last, we show how different rates of sea-level rise can further drive mangrove dynamics and morphological evolution in different environmental conditions. Our study provides in-depth insights into future mangrove development, which will help to manage the coastal environment in the face of global change.

### Keywords

bio-morphodynamic modelling, mangrove vulnerability, sea-level rise