Mangroves facing climate change: landward migration potential in response to projected scenarios of sea level rise

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Adaptation of species and populations to environmental change on a shorter than evolutionary time scales can be viewed as a balance between range shifts and biological exploitation of a species' or an individual's flexibility. In this contribution we present two specific research programmes of our team which deal with both separately. Regarding range shifts the most immediate impact is local appearance and disappearance of potential or actual habitat because of sea level rise. Mangrove forests prominently occupy an intertidal boundary position where the effects of sea level rise will be fast and well visible. This study in East Africa (Gazi Bay, Kenya) addresses the question whether or not mangroves can be resilient to a rise in sea level by focusing on their potential to migrate towards landward areas. The combinatory analysis between remote sensing, DGPS-based ground truth and digital terrain models (DTM) unveils how real vegetation assemblages can shift under different projected (minimum (+9cm), relative (+20cm), average (+48cm) and maximum (+88cm)) scenarios of sea level rise (SLR). Under SLR scenarios up to 48cm by the year 2100, the landward extension remarkably implies an area increase for each of the dominant mangrove assemblages except for *Avicennia marina* and *Ceriops tagal*, both on the landward side. On the one hand, the increase in most species in the first three scenarios, including the socio-economically most important species in this area, *Rhizophora mucronata* and *C. tagal* on the seaward side, strongly depends on the colonisation rate of these species. On the other hand, a SLR scenario of +88cm by the year 2100 indicates that the area flooded only by equinoctial tides strongly decreases due to the topographical settings at the edge of the inhabited area. Consequently, the landward *Avicennia*-dominated assemblages will further decrease as a formation if they fail to adapt to a more frequent inundation. Whether species will dynamically adapt to local climatic and environmental conditions we investigated the behaviour of their water transport tissues (as key to their ecological success) upon such changes both in their natural environment and experimentally. Vascular traits, shrinkage and swelling patterns (because of water status) through automatic point dendrometers on the trunks of adult *Avicennia marina* trees *in situ* and on seedling leaves and stems of *Bruguiera gymnorrhiza* and *Rhizophora mucronata ex situ* are used to understand a tree's behaviour. Our findings suggest that freshwater availability (rather than tidal inundation) affected radial increment, either in a concentric or patchy pattern in *Avicennia*, and that shrinking and swelling followed but shortly after the onset of changes in salinity in the other two species. Such findings are indicative of rapid changes in mangrove individuals in the highly dynamic environment that mangrove forests are, but demand integration in order to understand eventual success or failure to survive.