Role of mangroves and salt marshes for nature-based flood risk mitigation in major deltas of the world

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Coastal areas are facing several threats, on the one hand due to their population that is expected to increase considerably over the coming decades and on the other hand due to climate change, resulting in rising sea level and increasing cyclone intensity generating flooding risks by storm surges and coastal erosion by waves.

Over the past years and in some regions, it has been proposed to use preserved or restored coastal habitats, such as tidal wetlands, for protection of populations and economic assets from coastal hazards, often in addition to hard engineering structures as dikes or embankments. This approach defined as nature-based management, relies on the ability of the wetland vegetation to mitigate the impact of storm waves and surges, and to adapt by sedimentation to sea level rise, in addition to other valuable ecosystem services.

Our study investigates a specific aspect of the nature-based management approach, namely, the benefits in terms of storm surge mitigation of salt marshes and mangrove forests for low-lying areas and populations by comparing the consequences of their presence and absence during storm surge events in the world's most populated deltas. We investigate these consequences using a GIS model based on globally available data and relatively simple assumptions that assesses the relative magnitude of the nature-based flood risk mitigation by salt marshes or mangrove forests in large delta areas.

We applied our model to 11 deltas with a worldwide distribution. For every delta, the presence of tidal wetlands influenced the flood pathway, the storm surge passed through the tidal wetlands during the flooding, and then resulted in a benefit in terms of storm surge mitigation. Nevertheless, the results present a large diversity among the deltas in terms of the relative magnitude of storm surge mitigation. This diversity highlights the influence of the local characteristics of the deltas, such as effects of the channels structure, the location of the tidal wetlands in the delta or the topography of the low-lying areas.

Two main conclusions could be drawn from the results. There is no correlation between the total surface area of tidal wetlands in the delta and the land area benefiting from flood mitigation, however, the relative magnitude of flood risk mitigation is higher when tidal wetlands occupy a larger area of the delta.

A second concern in the study was the influence of the tidal wetlands on the mitigation of flood risks for the delta population. Results show some dissimilarity with the land area benefiting from flood risks mitigation. Those differences are reflecting the impact of the population distribution and density as well as the historic settlement and development of the population.

Despite the large variations in the magnitude of flood risk mitigation by tidal wetlands over our 11 deltas in terms of land area and delta population, we can affirm that at a delta scale tidal wetlands are providing flood risk mitigation.

Keywords: tidal wetlands; flood risk mitigation: delta: storm surge