RESILIENCE OF FISHERY PORTS AGAINST CLIMATE CHANGE: IMPACTS OF SEA LEVEL RISE AND STORM SURGES ON RUBBLE MOUND BREAKWATERS - A CASE STUDY IN SRI LANKA

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ABSTRACT

Small islands like Sri Lanka are believed to be at serious risk of being affected by the worst consequence of future climate change. As a result, economic activities around coastlines -such as fishing- will be disturbed, causing social and economic instabilities. These instabilities will be intensified due to some other factors inside society, such as the community's dependency on fish for nutrition needs. Climate change will result in higher sea levels and more intense tropical cyclones, which will eventually result in stronger wave climates and the intensification in coastal geomorphological processes, causing infrastructure in fishery harbours to underperform, especially towards the end of their design lives.

Fishery ports in Sri Lanka are typically shallow water harbours, with rock armoured rubble mound breakwaters being utilized in almost all locations to create safe landing areas for vessels. The number of harbours, and therefore the total length of rubble mound breakwaters in Sri Lanka, is increasing, and with stronger wave conditions in the future it is expected that maintenance costs will also significantly increase.

A shallow water harbour in the South of the country was selected for the first case study analyzed in the present research, and the stability of the breakwater to resist future wave climates was quantified by calculating the weight of armour units to resist six sea level scenarios and four storm surge scenarios, for 15 different wave conditions. Three cross sections were considered, located in three different locations with different water depths and bed slopes. The increase in armour unit weight, compared to the current requirements, in

order to resist future sea level rise and storm surges was about 27%-110%, depending on the sea level rise scenarios, for the breakwater section which is located in a mild slope ($\tan \theta = 0.0083$) sea bed, for an initial water depth of 7 meters. For the steeper slope ($\tan \theta = 0.0547$) with an initial water depth of 5 meters, the increase in armour unit weight was about 40%-140%, again, depending on the sea level rise scenarios considered. Thus, it is clear that the weight of the armour units required to resist future wave climate will significantly vary if the sea bed slope in front of the breakwater is altered, with this effect playing a more critical role in steeper sea beds, compared to the milder sea beds.

In order to shed further light on potential changes that sea level rise could cause on the bathymetry around a breakwater, a second case study was considered. Since Northern Sri Lanka is experiencing more frequent tropical cyclones than the South, a hypothetical layout for a new harbour in the North of Sri Lanka was selected for the second case study, and the impacts of climate change and sea level rise on morphology were evaluated by using an open source process based numerical model, Xbeach. 350 simulations were run for five sea level scenarios and five storm conditions, with 14 wave conditions for each sea-level-storm combination. For this specific case, it could be seen that the morphology in the front of the breakwater is not noticeably changed, and the increase in armour unit weight to resist the wave conditions brought about by an increasing sea bed slope will be insignificant compared to the armour unit weight increase to resist sea level rise.

Overall, increasing water levels will demand stronger and larger harbour structures, with improved foundations to resist future climate conditions. However, it is clear that more detailed studies are needed to ascertain the impact of waves and sea level rise on coastal morphology.

Key words: Fishery harbours, Fishing communities, Rubble mound breakwaters, Climate change, Morphology, Xbeach