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The potential of tidal barrages and lagoons to manage future coastal flood risk

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In the face of a changing climate, adaptation and mitigation measures are important for coastal communities that seek to maintain their resilience to extreme events. Measures that can be classed as being both adaptation and mitigation can doubly contribute to this. Tide barrages and lagoons have the capacity to generate electricity from the rise and fall of the tide, which over the assets lifetime would contribute significantly towards emission reduction targets and towards a low carbon economy. In addition to electricity generation, the barrage or lagoon can also act as a flood defence during extreme events. This means that coastal communities protected by the barrage will have adaptation benefits to the increasing frequency of storm surges that are a result of sea-level rise. Finally, the barrage also has the potential to act as a transport link with vehicles able to cross, reducing travel times and emissions.

The research project RISES-AM focuses on the implications of the higher end climate scenarios, particularly those with a global average warming that is greater than 2 ^{0}C with respect to pre-industrial temperatures. RISES-AM aims to produce a better quantification of the impacts and vulnerabilities associated with these high end climate scenarios, and show that adaptation to them is possible at an affordable cost when compared to the increase in risk resulting from them.

We investigated the physical and economic impact of extreme flood events of on the Mersey Estuary and surrounding areas. It is thought the Mersey Estuary is likely to be more sensitive to changes in forcing factors in the future than in the past where industrial impacts where the main drivers of change. Extreme events were simulated, for the present day and in 2100 where high impact emission scenarios have resulted in SLR ranging from 0.71 m to 1.80 m depending on the higher end emission scenario selected. If built, the barrage in the Estuary or lagoon in surrounding areas such as the Wirral peninsula will still be present in 2100. It is therefore important to consider long time horizons and the associated climate change.

Both business as usual i.e. no adaptation measures and the presence of a tidal barrage or lagoon at two locations were simulated. Three different representative concentration pathways were used to derive an increase of mean sea-level by 2100. To accurately assess the economic impact, a number of different extreme events with varying annual probabilities of occurrence were simulated, these range from 1 in 1 year to 1 in 1000 years probability of exceedance. The flood inundation model LISFLOOD-FP was used to simulate these extreme events and the economic impact resulting from any inundation in the flood plain was calculated and compared alongside the cost and revenue from projected electricity generation to see if the flood protection benefits would contribute positively to a cost benefit analysis, assessing the building of the barrage.

This preliminary study shows that tidal lagoons and barrages do have the potential to offer flood risk benefit and become part of integrated strategies to minimise flood risk in coastal areas, but this is site specific and detailed modelling studies are required. The benefits of these structures are dependent on their shape, size and location, and feasibility studies should consider impacts in the near and far-field.