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A Global Assessment of Potential Defence Costs for Coastal Areas Through the 21st Century

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Sea-level rise threatens low-lying coastal areas with increased coastal flooding during storms. One adaptation response to this challenge is to build or upgrade coastal flood defences as exemplified by the Netherlands, New Orleans or much of the Chinese coast. Using the DIVA framework, we examine the potential investment costs of such an adaptation strategy applied globally over the 21st Century. We consider sea-level rise scenarios consistent with the RCP2.6 and RCP8.5 emissions and the SSP2 socioeconomic scenarios. Existing defences are modelled based on rules similar to earlier global assessments. Maintenance costs are also considered and grow with the stock of defences over time. Three defence technologies are considered: (1) sea dikes for the open coast; (2) river dikes for the coastal reaches of rivers which are influenced by sea level; and (3) storm surge barriers. This is the first time that surge barriers have been considered in such an analysis. Two adaptation approaches are followed using these technologies: (1) dike only protection which is based on sea dikes and river dikes; and (2) dike and barrier protection which is based on sea dikes, surge barriers and river dikes where surge barriers are not appropriate. These adaptation approaches are employed following four adaptation strategies (or scenarios) on how protection might be implemented across the world. Note that these are not economic optimisation approaches and rather ask what would the costs be if we followed a defined defence strategy everywhere. These strategies include (1) Constant Protection Levels – maintain current protection levels (raising defences with sea level); and (2) Risk Intolerance – keep relative average annual losses below 0.01% percent of local GDP. Adaptation Strategy 2 takes a normative approach and assumes the world protects like the Netherlands. This allows us to consider the potential scale of the adaptation deficit compared to the other adaptation strategies if such an approach was followed.
These results provide improved estimates of potential protection costs given sea-level rise compared to earlier estimates. Considering the Constant Protection Level Strategy from 2015 to 2100, the total accumulated defence costs are up to US$8 and US$10 trillion for the RCP2.6 and RCP8.5 scenarios, respectively. These new defence costs are higher than earlier estimates. This reflects the higher and more realistic range of unit defence costs that are used compared to earlier studies. Further we consider the costs of maintenance of all the existing dike stock, which is a substantial cost and was ignored or not fully considered in earlier analyses. Maintenance is found to be the largest component of the protection costs with important implications for future funding needs. Lastly, earlier studies focused on sea dikes, while this study also includes river dikes and surge barriers where appropriate. Regionally, most investment is in High Income OECD countries and Upper Middle Income Countries, especially before 2050. After 2050, investment in Lower Middle Income Countries becomes more significant, but the relative ranking remains the same.