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Dependence of high sea water level and river discharge at the global scale

Philip Ward (1), Anaïs Couasnon (1), Ivan Haigh (2), Sanne Muis (1,3), Ted Veldkamp (1), Hessel Winsemius (1,3), and Thomas Wahl (4)

(1) VU University Amsterdam, Institute for Environmental Studies, Amsterdam, Netherlands (philip.ward@ivm.vu.nl), (2) University of Southampton, Southampton, UK, (3) Deltares, Delft, The Netherlands, (4) University of Central Florida, Orlando, USA

It is widely recognized that floods cause huge socioeconomic impacts. From 1980-2013, global flood losses exceeded $1 trillion, with ~220,000 fatalities. These impacts are particularly hard felt in low-lying densely populated deltas and estuaries, whose location at the coast-land interface makes them naturally prone to flooding. When river and coastal floods coincide, their impacts in these deltas and estuaries are often worse than when they occur in isolation. Such floods are examples of so-called 'compound events'.

In order to better understand the impacts of these compound events, we require an improved understanding of the dependence between coastal and river flooding. In this contribution, we provide the first global mapping of the dependence between high sea levels and enhanced river discharge for deltas and estuaries worldwide, based on observed data. We find significant dependence for sea levels conditional on high discharge at 56% of the stations studied, and for discharge conditional on high sea levels at 55% of the stations studied. Therefore, the dependence is of broad importance geographically, rather than being constrained to a few locations. We also show that the joint exceedance probability of events in which both the design discharge and sea level are exceeded can be several magnitudes higher when the dependence is considered than when it is not. This has large implications for the ways in which flood risk is assessed in deltas and estuarine regions that are under the influence of both coastal and riverine processes. When carrying out flood risk assessments in these regions, these joint exceedance probabilities should be correctly accounted for.

The research was carried out by analysing the statistical dependency between observed sea levels (and the storm surge component) from GESLA-2 and river discharge using gauged data from GRDC stations all around the world. The dependence structure was examined using copula functions.