Geophysical Research Abstracts
Vol. 19, EGU2017-2723, 2017
EGU General Assembly 2017

Dependency of high coastal water level and river discharge at the global scale

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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 this paper, we present the first global scale analysis of the statistical dependency of high coastal water levels (and the storm surge component alone) and river discharge. This is essential for understanding the likelihood of compound flood events occurring at locations around the world as well as for accurate flood risk assessments and effective flood risk management. To date, most flood risk assessments at the large scale assume statistical independence between coastal and river flooding. However, several local and continental studies in recent years have shown that this is not the case.

We analysed the statistical dependency between observed coastal water levels (and the storm surge component) and river discharge using gauged data from stations all around the world. We show that the relationship is strong over large regions of the world. We use copula functions to show how the likelihood of design events is strongly influenced by this dependency; when the dependency is included, the likelihood of flood defence failure is higher than when statistical independence is assumed. Nevertheless, the gauged data used in this study provide an incomplete picture, since there are large parts of the world for which no data are available. We therefore discuss our ongoing modelling approaches to more thoroughly assess the dependency of coastal and river floods, and to carry out risk assessments that account for this dependency.