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ENSO impacts on flood risk at the global scale

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We present the impacts of El Niño Southern Oscillation (ENSO) on society and the economy, via relationships between ENSO and the hydrological cycle. We also discuss ways in which this knowledge can be used in disaster risk management and risk reduction. This contribution provides the most recent results of an ongoing 4-year collaborative research initiative to assess and map the impacts of large scale interannual climate variability on flood hazard and risk at the global scale.

We have examined anomalies in flood risk between ENSO phases, whereby flood risk is expressed in terms of indicators such as: annual expected damage; annual expected affected population; annual expected affected Gross Domestic Product (GDP). We show that large anomalies in flood risk occur during El Niño or La Niña years in basins covering large parts of the Earth's surface. These anomalies reach statistical significance river basins covering almost two-thirds of the Earth's surface. Particularly strong anomalies exist in southern Africa, parts of western Africa, Australia, parts of Central Eurasia (especially for El Niño), the western USA (especially La Niña anomalies), and parts of South America. We relate these anomalies to possible causal relationships between ENSO and flood hazard, using both modelled and observed data on flood occurrence and extremity.

The implications for flood risk management are many-fold. In those regions where disaster risk is strongly influenced by ENSO, the potential predictably of ENSO could be used to develop probabilistic flood risk projections with lead times up to several seasons. Such data could be used by the insurance industry in managing risk portfolios and by multinational companies for assessing the robustness of their supply chains to potential flood-related interruptions. Seasonal forecasts of ENSO influence of peak flows could also allow for improved flood early warning and regulation by dam operators, which could also reduce overall risks (and by extension insured losses).

We carried out the research by simulating daily river discharges using a global hydrological model (PCR-GLOBWB), forced with gridded climate reanalysis time-series (EU-WATCH). From this, we derived peak annual flood volumes for large-scale river basins globally. These were used to force a global inundation model (dynRout) to map inundation extent and depth for return periods between 2 and 1000 years, under El Niño conditions, neutral conditions, and La Niña conditions. Theses flood hazard maps were combined with global datasets on socioeconomic variables such as population and income to represent the socioeconomic exposure to flooding, and depth-damage curves to represent vulnerability.