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Detection and attribution of extreme weather disasters

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Single disasters related to extreme weather events have caused loss and damage on the order of up to tens of billions US dollars over the past years. Recent disasters fueled the debate about whether and to what extent these events are related to climate change. In international climate negotiations disaster loss and damage is now high on the agenda, and related policy mechanisms have been discussed or are being implemented. In view of funding allocation and effective risk reduction strategies detection and attribution to climate change of extreme weather events and disasters is a key issue. Different avenues have so far been taken to address detection and attribution in this context. Physical climate sciences have developed approaches, among others, where variables that are reasonably sampled over climatically relevant time periods and related to the meteorological characteristics of the extreme event are examined. Trends in these variables (e.g. air or sea surface temperatures) are compared between observations and climate simulations with and without anthropogenic forcing. Generally, progress has been made in recent years in attribution of changes in the chance of some single extreme weather events to anthropogenic climate change but there remain important challenges.

A different line of research is primarily concerned with losses related to the extreme weather events over time, using disaster databases. A growing consensus is that the increase in asset values and in exposure are main drivers of the strong increase of economic losses over the past several decades, and only a limited number of studies have found trends consistent with expectations from climate change.

Here we propose a better integration of existing lines of research in detection and attribution of extreme weather events and disasters by applying a risk framework. Risk is thereby defined as a function of the probability of occurrence of an extreme weather event, and the associated consequences, with consequences being a function of the intensity of the physical weather event, the exposure and value of assets, and vulnerabilities. We have examined selected major extreme events and disasters, including superstorm Sandy in 2012, the Pakistan floods and the heat wave in Russia in 2010, the 2010 floods in Colombia and the 2011 floods in Australia. We systematically analyzed to what extent (anthropogenic) climate change may have contributed to intensity and frequency of the event, along with changes in the other risk variables, to eventually reach a more comprehensive understanding of the relative role of climate change in recent loss and damage of extreme weather events.