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Uncertainty and extreme weather events in India

Abstract

Multiple extreme weather events claimed scores of lives, damaged property and brought public life to standstill over parts of India in May 2018. In their aftermath, a blame game ensued with some assigning responsibility to scientific and state agencies, to others calling for more research and accurate weather forecasts. However, could 'better' or 'more' science solve the problem? Uncertainties in meteorology and climate sciences are persistent and limit the extent to which early warning systems can accurately inform mitigation and actionable policy. Despite scientific advances, some uncertainties might never be resolved entirely. It is important to recognise these realities and embrace uncertainty instead. This will also help to channel resources appropriately, attribute causality, build public trust, and improve policy effectiveness.[i]

Keywords*:* uncertainty, natural disasters, science-policy, climate change, vulnerability, disaster management

A month of extreme weather

Dust storms, thunderstorms and lightning struck different parts of India (particularly the states of Rajasthan, Andhra Pradesh, Uttar Pradesh, Bihar and Delhi) throughout May. Though these events are not unusual in the peak summer months, their destructiveness caught authorities, the public and scientists by surprise. Cumulatively, more than a hundred people died in their immediate aftermath (BBC 2018; Jamwal 2018), in addition to extensive damage caused to property, crops, livestock and infrastructure. Questions cropped up immediately as to why the IMD (Indian Meteorological Department) failed to accurately provide forecasts and disseminate warnings in advance. How could such calamitous events pass by largely unnoticed? Politicians, such as the chief minister of India's largest state (Uttar Pradesh), accused the IMD of failing in one of its primary tasks – to inform the public of impending weather threats (Pandey 2018). In a defensive mode, scientists from the IMD and National Centre for Medium Range Weather Forecasting (NCMRWF) stated that they communicated probability forecasts well in advance and it was the responsibility of the state authorities to take it to the "last mile" and alert people (Ashok 2018). The scientists also re-affirmed that they were aware of conditions that could precipitate weather extremes (e.g western disturbances, summer heat wave) but that their localized impacts and timing over the mainland are difficult to predict within the existing state of knowledge (Jamwal 2018).

Calls and promises for more research in this area followed instantly. Part of the public's surprise and anxiety is informed by the perception that India's mainland has traditionally been less susceptible to devastating natural hazards compared to eastern India's vulnerable coastline. Here, advances in cyclone forecasts, together with improved routines and co-operation between scientific and civic agencies (i.e National Disaster Management Authority) have dramatically reduced death tolls and built trust in the meteorological services. The last major cyclone, Hudhud in 2014, caused 38 deaths in Orissa, down from an estimated 15,000 deaths from a similar cyclone in 1999.

As it turns out, in the weeks following the most intense storms, the same meteorological agency (IMD) was accused of "going overboard" in its severe storm weather warnings (Hindustan Times, 2018). Panic spread across the National Capital Region (NCR), with the IMD coming in for heavy criticism. What explains this confusion? Is it public anxiety, unclear communication, the apparent inability of scientists to provide accurate forecasts or the inability to embrace 'uncertainty'? We argue that the controversies and debates around these recent extreme events highlight the need to take seriously an overarching and often neglected aspect concerning meteorological forecasts and their dissemination – that of uncertainty.

Uncertainty is here to stay

In climate science, uncertainty refers to the inability to predict the scale, intensity, and impact of climate change on human and natural environments (Curry and Webster, 2011). As a result, uncertainty poses a "super wicked problem" (Curry and Webster, 2011) because it impedes the ability of local policymakers and governments to accurately predict or plan for future events and disasters. Climate studies are concerned with climatic patterns that span a long time horizon (30 years plus) and cover larger spatial scales, wherein weather refers to shorter-term phenomena occurring within hours, days or weeks. However, weather patterns are embedded in interactions within an evidently more erratic climatic system (IPCC, 2014). Local people are usually more concerned with immediate weather, whereas climate scientists are concerned with a different tempo-spatial scale. Scientific advances and the introduction of cutting-edge technology including satellites, radar systems, supercomputers, construction of historical data sets and fine-tuned models have helped to improve the reliability of weather forecasts and climate projections. For example, it is now possible to generate relatively confident weather forecasts over a 5-day period in India (Interview, NCMRWF 31 May 2017). Cyclone track projections - known to the public through cone shaped scenario maps - consistently improved and are immensely valuable for disaster management today. Nevertheless, forecasts, especially at the local level, often throw up unexpected 'surprises', as in the case of violent thunderstorms and lightning. Lead times to detect them can be extremely short, falling in the narrow range of hours to minutes. Even if identified, it is a challenge to precisely locate impacts, which explains why IMD bulletins describe likely affected areas, not villages or households where impacts ultimately materialise. Climate change also puts hitherto relatively 'safer' areas at risk from hazards for which they lack prior experience. Cyclone Ockhi provides a recent case in point (D'Monte 2017). It wreaked havoc over south India in 2017 killing scores of fishers, and caught authorities and scientists by utter surprise with a similar blame game ensuing in its aftermath as witnessed in northern India this year.

Can early detection improve and solve such problems in future? According to interviews conducted by us with scientists at the NCMRWF, improvements are possible but take a long time. A significant improvement in forecasting quality of just one day might take more than a decade of research. Along the way, "*surprises can happen even with the best models, inputs and data…but not even in 200 years can all uncertainties be solved*" (Interview, NCMRWF 31 May 2017). Placing accurate probability forecasts for weather events that have a short onset period are daunting - if not impossible - be it for fog, lightning or violent storms. The downscaling from global, to regional and local scales poses challenges because of the dynamic and highly complex interactions of multiple variables that accumulate as one moves across the scales: Land use changes, availability of good quality observational data, in addition to interactions between atmospheric layers, terrain modulations, clouds or large-scale climate phenomena add to this complexity (Interview, Ministry of Earth Sciences (MOES) 29 May 2017; NCMRWF 31 May 2017). In short, there can be infinite permutations and combinations when aggregating data, calibrating models and deriving forecasts. Disagreements and disputes within the scientific community itself remains a cause for uncertainty. Some climate scientists draw a clear linkage to climate change in causing May's events, while others predict a decreasing trend of dust storms over India (Jamwal 2018; Aggarwal 2018).

Debates around the uncertainty riddle do not confine themselves to the Indian context. Even the premier international agency for collating scientific evidence on climate change, the Intergovernmental Panel on Climate Change, has gradually stepped away from the idea of solving uncertainties; towards managing them better (IPCC 2014). Uncertainty is here to stay. Dutch philosopher van der Sluijs (2005:89), in this context compares uncertainty to a 'monster' and pointedly states that '*for each head of the uncertainty monster that science chops off, several new monster heads tend to pop up due to unforeseen complexities'*. In other words, it is not possible to perfectly predict and control the climate, weather and uncertainty – tempting as that may be in light of scientific advances.

A way forward

Embracing uncertainty does not mean that there is no place for improvements in science and scientific modelling. However, our research has revealed that even the best models struggle with different kinds of uncertainties. Uncertainty can be instrumentalised as an argument to do nothing, which is dangerous. Similarly overplaying the role that science and technology can play to deal with uncertainty is also inappropriate. Politicians and the public often place undue expectation in the IMD, and are unwilling to accept the limitations and uncertainty within forecasts. As a senior scientists from the IMD put it "*communication on uncertainty is very important and probability forecasts are useless unless we make the public aware..however, decision makers want deterministic forecasts"* (Interview, IMD 2 June 2017). Therefore, a key challenge is to communicate uncertainty appropriately to a range of stakeholders, from politicians to the lay public. This could help diffuse political tension and public anxiety, as in the NCR's case. While scientists largely accept the presence of uncertainty, they struggle because decision maker's desire foolproof accuracy and this is unrealistic. Another problem concerns causality. Why are some people more vulnerable than others to natural disasters? It should not be forgotten that most of the victims of disasters and extreme events tend to be the poorer, marginalised and live in exposed locales with deficient infrastructure and housing. Many of them have been subjected to a long history of systematic neglect. That "there's no such thing as a natural disaster" (Smith 2006) should no longer come as a surprise. These linkages are socio-economic in nature and weather extremes are mere triggers that expose these vulnerabilities. Little wonder then that most of the casualties were in some of India's poorest and ill-governed states.

Thus, preparing for disasters has to go beyond improving forecasting accuracy alone. Responsive governance, co-ordination between civic agencies, public awareness and fair social policy are equally, if not more important. This also raises wider questions regarding the current development model in India with its unequal, rapacious and ecologically destructive practices. After all, these factors drive land use changes, atmospheric pollution and aggravate climate change. In combination, they heighten the risks and susceptibility of large groups of marginalized people with highly unequal impacts.

Conclusion

Fundamental scientific challenges remain when it comes to the accuracy of weather forecasts as well as climate projections. Fast-paced scientific progress should not mislead us into believing that all uncertainties can be eliminated – many never will be. While climate sciences and meteorology have undoubtedly made great strides with benefits for the economy and ordinary people, expecting these advances to provide insulation from damages associated with natural disasters is problematic. Extreme events and related uncertainties are likely to increase with climate change (IPCC 2014) and therefore we must focus on addressing disaster preparedness and pre-existing social vulnerabilities. Disproportionate attention on scientific solutions also tends to deflect attention from the unequal social distribution of disaster impacts and closes down avenues for alternative policy options. Many of these require structural and systemic changes in development policy and planning. It is reasonable to expect forecasting to improve and civil society and state agencies to coordinate and develop better routines, as well as inform the public in a language that they can understand. However, it is unrealistic to expect accurate and localized prediction of every extreme weather event in future. The best antidote to the present predicament is thus to *embrace uncertainty*, and manage it better, whilst advancing the rights, livelihoods and interests of those who are most affected.

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[i] This commentary draws on interviews and research conducted for a Research Council of Norway (RCN) funded project ‘Climate Change, Uncertainty and Transformation’ (Project number 235449). For more: https://www.nmbu.no/en/faculty/landsam/department/noragric/research/our_projects/projects/node/21234. We are grateful to the many scientists and experts in India and Europe who spent time sharing their views and experiences with us. For confidentiality purposes, we are not naming any of them. The usual disclaimers apply.