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Combining regional climate and national human development scenarios to estimate future vulnerability to extreme climate and weather events

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Extreme climate and weather events such as droughts, floods, and tropical cyclones account for over 60% of the loss of life, and over 90% of total impacts, from natural disasters. Both observed trends and global climate models (GCMs) suggest that the frequency and intensity of extreme events is increasing, and will continue to increase as a result of climate change. Among planners and policy-makers at both national and international levels there is thus concern that this rise in extreme events will lead to greater losses in the future. Since low levels of development are associated with greater numbers of people killed and needing emergency assistance from natural disasters, the concern is most pronounced for least developed countries. If, however, these countries make substantial improvements in their levels of human development, as leading forecasters suggest may be the case over the coming decades, then their vulnerability to extreme events may fall. In this study, we examine the potential combined effects of increased extreme event frequency and improved levels of human development, to generate scenarios of risk levels into the second half of the century. It is the African continent for which these results may be the most relevant, since it is widely viewed as most vulnerable to increased risks from climate change; we focus on the particular country of Mozambique, which has experienced high losses from droughts, floods, and tropical cyclones in recent decades, and stands out as being among the most vulnerable in Africa.

To assess the change in risk levels from the present until 2060, we pull together three pieces of analysis. The first is a statistical analysis of the losses from 1990-2007 from climate-related disasters, using national level data from the Centre for Research on the Epidemiology of Disasters (CRED) and the United Nations. From this analysis, we establish statistical relationships between several drivers of vulnerability—including country size, frequency of disasters in a country, urbanization, and the level of human development (capturing income, life expectancy, and education)—and the numbers of people killed or in need of assistance at the country level. We replicate results from past studies in showing that human development, perhaps surprisingly, shows a strong non-linear relationship with risk (with countries of intermediate levels of development showing the highest risk levels), although we extend these results through the controlling for other variables. Second, we downscale a suite of GCMs using national meteorological data, in order to generate ranges of estimates for changes in the frequency of each of the climate hazards. Supplementing this, we consider a climate scenario that sees a linear extrapolation of current trends in hazard frequency. Third, we construct scenarios for each of the socio-economic vulnerability drivers, consistent with IPCC SRES A2 and B1 scenarios for population and income changes, and UN estimates for other demographic changes. Pulling the three pieces of analysis together, we are able to construct risk scenarios until 2060.

Our results are interesting in several respects. They show socio-economic development fully compensating for climate change in the impact on risk levels, within the range of estimated changes suggested by the suite of climate models. Recognizing the limits of models to predicting changed frequency of extreme events, there is also reason to believe that the current trend in increased hazard frequency may continue; for this latter scenario, risk levels rise substantially. Finally, given the observed non-linear relationship between development and risk, we observe in the B1 scenario risk levels at their highest level between 2030 and 2040, and then declining thereafter, as Mozambique passes the point of medium development. In the A2 scenario, by contrast, risk levels rise through mid-century, as development proceeds more slowly.