Vulnerability and Risk: Some Thoughts From A Political and Policy Perspective

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Introduction

In this essay we explore some distinctions between vulnerability-based and risk-based approaches to thinking about extreme events. We use the word "vulnerability" to describe inherent characteristics of a system that create the potential for harm but are independent of the probabilistic *risk of the occurrence* ("event risk") of any particular hazard or extreme event. We further distinguish between the "risk" of an event, say a Category 5 hurricane, and the *risk of a particular outcome* ("outcome risk"), say $10 billion in losses from a particular hurricane. The latter definition of "risk" integrates both the characteristics of a system and the chance of the occurrence of an event that jointly result in losses.[4] Our point in this essay is to consider separately vulnerability and risk, and the implications of such a distinction for thinking about the policy and politics of "risk management."

We believe that the distinction of vulnerability from risk carries with it a set of implications for the politics of and policies for dealing with extreme events. In this short essay, we explore these implications through a series of assertions designed to stimulate discussion and debate.

Assertion 1: Risk-based approaches to covering the costs of extreme events do not depend for their success on reduction of vulnerability.

Prior to September 11, the World Trade Center (WTC) was vulnerable to terrorist attack from hijacked civilian airliners, but the quantified risk of terrorist attacks on tall buildings was not well known (and was considered to be much lower than it actually turned out to be). There is a certain tautological element in this discussion, we realize, arising from two directions:

1. The vulnerability of the WTC only commands our attention now because of the occurrence of the attacks; and
2. Many extreme events are of interest precisely because they are so unexpected; i.e., prior risk calculations were grossly in error.

Yet there is something real here. In fact, the twin towers were designed to protect occupants from a range of possible yet unforeseeable disasters. Despite the horrendous loss of life, many

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[4] We are aware of the many differing definitions of "risk" and "vulnerability" (and related terms) in the academic literature, hence our beginning with the definitions used in this essay.

thousands more were able to escape after the attack due to the WTC's good design, which in turn was due to building codes, evolving engineering practice, and many other factors.

The primary insurer of the WTC, however, took a huge loss because premiums for terrorist attacks were low with respect to the event risk, now more tangible through hindsight. But here is the key point: if insurers had managed to more accurately quantify *event risk*, they could have raised premiums to reflect that risk, spread their own *outcome risk*, and covered their losses, *without requiring any reduction in vulnerability of the nation's air-travel infrastructure to terrorism*. Indeed, insurers and others who seek to "manage probabilistic risk" need nothing more than accurate information about incidence of extreme events to be successful; such information allows them to effectively manage outcome risks.

Assertion 2: Risk-based approaches to preparing for extreme events are focused on acquiring accurate probabilistic information about the events themselves.

Probabilistic risk assessment—the process of determining the probabilities of certain events—is prediction by a different name. The process of prediction for decision (as opposed to prediction for science) examines the likelihood of certain future events in order that decision makers might have a more informed basis for selecting one possible course of action over another. For many reasons, however, reliance on prediction as the basis for decision making is fraught with peril and can in fact introduce unhelpful pathologies to a decision process (see Sarewitz et al., 2000).

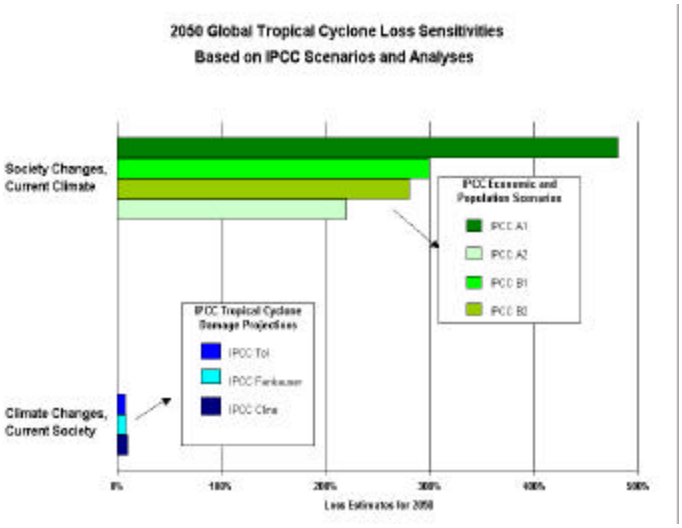
Consider the U.S. National Flood Insurance Program (NFIP). The NFIP is based on the assumption that the risk of a flood at a particular location exceeding a certain level (i.e., the "100-year" flood) can be quantified to allow for actuarially sound risk management practices. Since the NFIP has been in effect, the regime has arguably enhanced vulnerabilities to flood losses rather than reduced the outcome risk. One main reason for this perverse outcome is the assumption of climate stationarity that necessarily underlies the notion of a "100-year" flood. This assumption is fundamentally flawed because climate varies and changes on all time scales. Extrapolating from a finite record of past events to the immediate future does little more than guarantee that risk estimates for floods of particular magnitudes will be wrong. The situation is made worse by the fact that the risk management approach is not only used to manage risk, but also to estimate vulnerability. Based on predicted flood risk, construction zones are delineated. If event risks are underestimated in decision processes, then resulting policies can increase vulnerability and by extension the outcome risks.

Some experts in both hydrology and flood insurance might take issue with the argument in the preceding paragraph. One way to adjucate disagreement about the role of prediction in decision making is to "verify" predictive claims against what actually occurs. This technique is one of the strengths of the weather prediction enterprise, where tens of millions of prediction are made each year. However, whether the subject is extreme flooding or terrorist attacks there is a class of phenomena for which lack of experience with making and using risk estimates makes it impossible to say anything meaningful about the accuracy of the prediction. The situation is made more complicated in cases where relationships that inform expert probabilities (such as the case of greenhouse gases and the climate) are themselves highly non-stationary and perhaps influenced by the predictions themselves.

Two conclusions follow from this discussion. There are numerous cases in which accurate assessment of risk (either type) is impossible. Further, while experts can certainly provide sophisticated and rigorous assessments of uncertainty surrounding risk assessments, lack of experience with many phenomena and outcomes means that *understanding the uncertainty of the uncertainty estimates is impossible*. A classic example is the 95 percent probability assigned to an earthquake prediction along the Parkfield segment of the San Andreas fault for the period 1985-1993. The event has still not occurred. In such cases, policies focused on risk management could very easily result in outcomes quite different than those intended. Distinguishing situations amenable to risk management from those that are not would thus seem to be a high priority for effective policy development, but has thus far not been explicitly integrated into the risk policy arena.

Assertion 3: Understanding and reducing vulnerability does not demand accurate predictions of the incidence of extreme events.

All decisions include some informal assessment of probabilities. If one lives on a flood plain it would probably be foolish to devote enormous resources to protecting against asteroid impacts. Thus, vulnerability management is implicitly underlain by some sense of what is reasonable and what is not. We might term this sense "naïve expectation," in that it is not informed by sophisticated quantitative predictions about specific risks. Rather, it may be informed by history, by general scientific insight (e.g., floods occur on flood plains), by judgment acquired through personal experience, or other means. So our point is not that vulnerability is divorced from probability, but that vulnerability management does not depend on precise predictive quantification of specific future events or classes of events.



To illustrate the importance of this argument, consider the following: research on sources of vulnerability to extreme weather events indicates that over the next 50 years, economic losses from socioeconomic and demographic changes (economic growth; population growth and migration) will be from 20 to 60 times greater than losses due to increased incidence of extreme weather [see Figure 1]. The three blue bars show three different calculations (named for their respective authors) used by Intergovernmental Panel on Climate Change (IPCC) in its Second Assessment Report for the increase in tropical cyclone-related damage in 2050 (relative to 2000) resulting from changes in the climate, independent of any changes in society. The four green bars show the sensitivity of tropical cyclone-related damage in 2050 (relative to 2000) resulting from changes in society based on four different IPCC population and wealth scenarios used in its Third Assessment Report, independent of any changes in climate.

At the heart of the problem of vulnerability lies the tension between individual action and collective consequence. Coastal migrations and urbanization are among the most conspicuous demographic trends of modernizing societies. Individuals are moving from inland to coastal locations, and from rural settings to cities, in search of economic opportunity, or perhaps better scenery, or even cultural opportunity. By moving to the coast, one is adding to one's individual vulnerability to extreme events in an incrementally tiny way. Given the increased opportunity for economic gain, it might be irrational not to move. But the collective impact of millions of such moves is the substantial augmentation of collective vulnerability to a wide variety of hazards. This is evidenced most conspicuously by the explosive growth of developing-world megacities, and seen as well in loss data from coastal disasters in the United States.[5]

Real events illustrate these issues more poignantly. Hurricane Mitch, which caused about 10,000 Nicaraguan and Honduran fatalities in October-November 1998, was proclaimed by environmentalists as a harbinger of what the world would be like under conditions of global warming. The world, however, is already like this. More to the point, the event was not unprecedented in Central America, and the losses were more-or-less in line with what would have been expected from a more holistic vision of increased population and development vulnerabilities in the region.

In July 2000, the flank of a giant garbage dump near Manila, Philippines, collapsed and killed over 200 people after becoming saturated from monsoon rains. The extreme event itself was unprecedented, which is to say that risk could not have been accurately quantified beforehand. Yet the fact that thousands of people made their living, and their homes, on this mountain of garbage could be interpreted as prima fascia evidence of vulnerability to all manner of disaster, from epidemic disease to the debris flow that actually did occur.

In spite of these well-documented cases, the focus in the climate change debate seeks ever more accurate quantification of unverifiable greenhouse risks through predictive science. As we have argued elsewhere, such an approach likely fosters gridlock and inaction; meanwhile, climate-related losses mount around the world (Sarewitz and Pielke, 2000).

Assertion 4: Extreme events are created by context.

The character of an extreme event is determined not simply by some set of characteristics inherent in the physical phenomena (e.g., a hurricane, monsoon rains), but by the interaction of those characteristics with other systems (e.g., impoverished communities living on denuded mountain slopes in Nicaragua, or on huge garbage dumps in the Philippines). Decision making might focus as easily on identifying and characterizing vulnerabilities as on identifying and focusing on risk.

[5] Such trends not only increase vulnerability, but also can create new risks, by creating new contexts for extreme events (e.g., the garbage dump in Manila), or even by creating new types of extreme events (e.g., technological disasters). Governing the collective action that can create such trends is also the responsibility of the state, although our stance here is different that that proposed by Ulrich Beck's *Risk Society*.

For flood policy, building on the bluff does nothing to change the risk of an extreme flood (event risk), but it does reduce vulnerability to flooding impacts to about zero. For the barge company facing no choice but to locate in the floodplain, a calculus must be made between managing company risk (e.g., purchasing insurance) and reducing vulnerability (e.g., better building practices). In the face of irreducible uncertainty about risk, such a calculus may instead depend on creative approaches to vulnerability management (such as by reinforcing a particular structure or enhancing company resiliency by locating several structures along the river in locations of differing vulnerability.). For still others, there may be no option other than risk management, but such alternatives should be reached after consideration of trade-offs with options for vulnerability management.

Consider another case. As the 1997-1998 El Niño developed in Southern Africa, scientists and aid agencies warned farmers of the increased risk of drought in coming seasons and offered strategies such as early planting of crops. But in this instance no drought materialized and much of Southern Africa received plentiful rains. At the end of the agricultural season, much of Southern Africa faced a grain deficit – not because of El Niño, but (at least in part) because of the seasonal forecast! Why? As one newspaper reported, the "smart farmers" – those who listened to the forecasters and altered their planting routine – were the ones who lost out.

Before the 1997/1998 event, scientists documented a clear relationship between ENSO and grain production in Southern Africa. Now that relationship has become much more complex due to the creation of a second, but much less clear, relationship between the ENSO *forecast* and grain production. For example, depending on how farmers respond to what some perceive as a "bad quality" forecast in 1997/1998, grain production may oscillate wildly between correlating positively and negatively with the forecast. Advancements in the science of seasonal forecasting seem to have outpaced advancements in the effective use of those forecasts. Strategies focused on reducing farmer vulnerability might have led to improved outcomes. (Pielke, 2000)

Assertion 5: It is politically difficult to justify vulnerability reduction on economic grounds.

The previous arguments suggest that risks can be reduced by reducing vulnerability. But this approach often runs afoul of policy, politics, and economics. When the insurance industry came to Congress in the aftermath of the 1989 Loma Prieta Earthquake and asked for legislation to protect them from catastrophic losses from future earthquakes, their lobbyists were adamantly opposed to linking this protection to a hazard reduction mandate (i.e., vulnerability reduction as used in this paper). Hazard reduction requires up-front costs and reeks of heavy-handed government intervention; it is a tough political sell that offers no benefit to the insurance industry, so long as the industry either a) understands the earthquake risk (which it didn't) or b) has a deep pocket to fall back on (which it wanted). The insurance industry believed that an unfunded mandate to cover catastrophic losses in the future—i.e., hypothetical losses—was more politically palatable than a mandate to pay real dollars, in the present, to reduce those hypothetical losses.

The insurers have a point, of course. While the costs of vulnerability management can be readily calculated, the benefit derived from such approaches is counterfactual and can only be surmised. Careful historical comparisons can give a range of cost-benefit relations, but the contextual

nature of extreme events renders such calculations only weakly applicable to the real problem at hand.

The relation between vulnerability and risk is not commutative: *reduced vulnerability always means reduced outcome risk, but reducing the outcome risk does not always reduce vulnerability.* This irony ought to create a policy incentive to focus on vulnerability reduction, since it leverages more than outcome risk reduction. But, as the case of climate change demonstrates all too clearly, when thinking about the future, risk turns more heads and grabs more headlines than vulnerability.

Nevertheless, after just about any major disaster, Congress holds hearings and introduces legislation aimed at containing future losses from the relevant hazard within acceptable bounds. Mounting flood losses motivated the creation of the National Flood Insurance Program in 1968, and repetitive losses have stimulated the demand for stronger links between insurance coverage and hazard reduction activities. The San Fernando earthquake of 1971 catalyzed the creation of the National Earthquake Hazards Reduction Program. The need to prevent future economic losses is always part of the political discourse in such cases. But this need tends to dissipate as the recovery process proceeds. Indeed, when thinking about the present, one might also suggest, without venturing too deeply into cynicism, that the political benefits of reducing vulnerability are considerably more difficult to capture than the benefits of responding efficaciously after disaster has struck—for example, by distributing disaster relief funds.

In the end, efforts to enhance vulnerability management will always confront the question of "Who Pays?" In the absence of vulnerability management, reassignment of liability occurs with each new extreme event (try buying terrorism insurance on your skyscraper today). There are of course many approaches to reducing and redistributing these unpredictable future costs, but, as we have noted, they entail may entail additional current costs, and political tradeoffs. For example, those living in vulnerable areas could be taxed more, unless state or local government reduce identified vulnerabilities to extreme events. Long-term liability for vulnerability management could be legislatively assigned to developers, contractors and builders. FEMA, the Institute for Business and Home Safety and the insurance industry could work together to reduce contractor liability by presenting an integrated hazards geography approach to siting decisions. Such a public-private partnership would probably be necessary to overcome predictable political opposition .

Assertion 6: Vulnerability reduction is a human rights issue. Risk reduction is not.

Even more important than the economic rationale is the human one, exemplified by the images of human suffering and social disruption that proliferate in the immediate aftermath of a catastrophe. Extreme events have precisely the sort of narrative power that fuels political action. Basic human needs--water, food, shelter, and security--are suddenly forfeit; lives are lost; families are sundered. Indeed, emphasis on the economic aspects of disasters can appear insensitive to the real human issues in disaster management.

William Hooke of the American Meteorological Society has suggested that vulnerability reduction can be framed in terms of fundamental human rights—that modern society has an

obligation to ensure that all citizens live in homes and communities that provide a basic level of protection from the threat of disasters. As simple as this type of rhetorical prescription may seem, it has really never played much of a role in public discourse over risk management and vulnerability reduction. Yet assertion of fundamental human rights has often been a highly potent political strategy, dating back to the debates surround the founding of the nation. In a human rights context, issues of cost/benefit and debates over uncertainty not only lose their centrality, but they are rendered inappropriate. Protection and enforcement of human rights is a core responsibility of the state.

Consider the Americans with Disabilities Act, which was opposed on grounds that were largely economic. Cost-benefit analyses showed, for example, that fitting public buses with wheelchair access devices would be more expensive than simply providing, at public expense, taxi service for people with disabilities who did not have their own means of transportation. Yet the point of ADA was that people with disabilities deserved, as humans and citizens, to be fully integrated into our society, not marginalized from it. This meant that they needed the same access to resources that non-disabled people enjoyed. The economic arguments failed; the law passed.

The fact that risk management strategies are more subject to rigorous (even if unverifiable) quantification than vulnerability management should not in itself be an obstacle to the creation of better policies for preparing for extreme events. Indeed, by privileging risk management over vulnerability management, quantification becomes a value in itself that constricts both policy options and the potential for achieving public benefits through diverse means. We would observe that significant policy change is almost always driven by value-based politics, and reduction of vulnerability to extreme events at the national and global level strikes as us a formidable basis for such a value-based political approach.

Conclusion

In this essay we have sought to distinguish vulnerability from risk, and to discuss some of the implications of this distinction for vulnerability management in the face uncertainty. We assert here that vulnerability management deserves a place in discussion of alternative policies for addressing the prospect of disasters. Too often vulnerability lies in the shadow of risk, or worse still, the concepts are integrated with a net result of losing focus on vulnerability as a distinct contributor to outcomes that we observe but seek to avoid. A focus on vulnerability management would require a clear-eyed view of the limits of predictive science for guiding the way to an uncertain future. It would focus on the design of healthy decision processes that are sufficiently flexible and reflexive to adapt to uncertainty, improve with experience, and continually assess alternative approaches to vulnerability management.

We do not view vulnerability management to be in conflict with strategies of risk assessment. Rather, we believe that in some decision contexts one approach is likely to be more effective than another, or that a combination of both may also be appropriate. But decision makers rarely seek to distinguish such circumstances, so that risk assessment is haphazardly applied in most every context. In our view, this uncritical approach has contributed to such negative outcomes such as political gridlock in the climate change debate, an (arguable) increase in vulnerability from the nation's flood policies, and increased human suffering from the misapplication of risk

management strategies in the case of seasonal forecasting in Southern Africa during the 1997/1998 El Niño.

Effective planning for and response to hazards and other extreme events requires that the vulnerability associated with specific social and decision processes be understood in parallel with understandings of processes and probabilities of risk, so that judgments can be made about the appropriate balance between risk-based and vulnerability-based approaches to management. A myopic focus on risk to the exclusion of vulnerability can easily enhance rather than reduce the prospects for negative outcomes.

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