

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

A Discussion Paper prepared for Columbia-Wharton/Penn Roundtable on
"Risk Management Strategies in an Uncertain World"

Daniel Sarewitz¹ and Roger Pielke, Jr.²

4 April 2002

Introduction

In this essay we explore some distinctions between vulnerability-based and risk-based approaches to management of 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 of any particular hazard or extreme event. We distinguish between the "risk" of an event, say a Category 5 hurricane, and the "risk" of a particular outcome, 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.³ 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 and vulnerability management.

We assert 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 provoke 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 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.

¹ Center for Science, Policy and Outcomes, Columbia University

² Center for Science and Technology Policy Research, University of Colorado

³ 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.

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 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 risk, now more tangible through hindsight. But here is the key point: if insurers had managed to more accurately quantify risk, they could have raised premiums to reflect that risk, spread their own 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 risks.

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

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) seeks to foretell certain future events in order that decision makers might have a more informed basis for selecting one possible course of action over another. However for many reasons (see Sarewitz et al. *Prediction*, Island Press 2000), reliance on prediction as the basis for decision making is fraught with peril and can in fact introduce pathologies to a decision process .

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 accurately enough to allow for actuarially sound risk management practices. In fact, the NFIP has arguable enhanced vulnerabilities rather than reduced risk. One main reason for this is that the assumption of climate stationarity that must underlie the notion of a "100-year" flood is demonstrably false. Climate varies and changes on all time scales. Thus, extrapolating from a finite record of past events to the immediate future does little more than guarantee that risk estimates 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 shape vulnerability in that based on predicted flood risk areas are delineated that are appropriate for building and inhabiting. If risks are mis-estimated in decision processes related to vulnerability, then vulnerability can in fact be increased rather than reduced through resulting action.

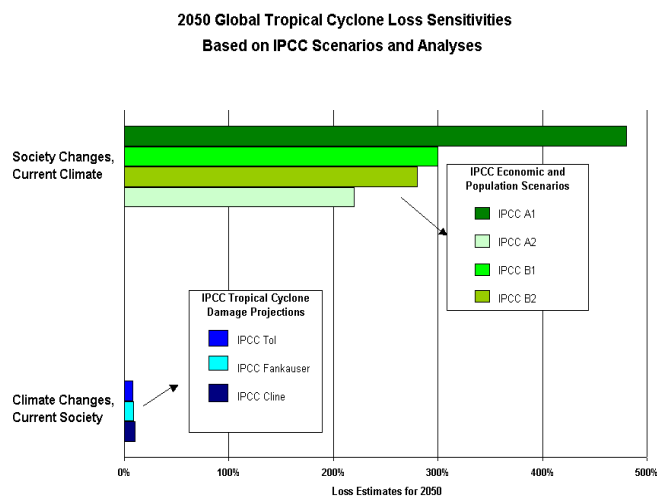
Some experts in both hydrology and flood insurance might take issue with many of the statements of the preceding paragraph. One way to adjudicate conflicting claims over the role of prediction in decision making is to "verify" predictive claims against what actually occurs. This technique is one of the 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 are a class of phenomena for

which the lack of experience with making and using risk estimates is simply insufficient to say anything meaningful about the accuracy of the prediction. The situation is made more complicated in cases where relationships that shape probabilities (such as greenhouse gases and climate) are themselves highly non-stationary and perhaps influenced by the predictions themselves.

Two conclusions follow from this discussion. In many cases accurate assessment of risk is impossible. Further, in many cases while experts can certainly provide sophisticated and rigorous assessments of uncertainty surrounding risk assessments, lack of experience with may phenomena means that understanding the uncertainty of the uncertainty estimates is impossible. In cases where the former conclusions hold, 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 responses.

Assertion 3: Risk-based approaches to preparing for extreme events are focused on understanding the behavior and probability of the events themselves.

Research on sources of vulnerability to extreme weather events suggests that over the next 50 years, economic losses from socioeconomic and demographic changes (economic growth; population growth and migration) will be many times greater than losses due to increased incidence of extreme weather [See Figure]. The three blue bars show three different calculations (named for their respective authors) used by 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. These changes are independent of any changes in climate.

Real events illustrate the argument more poignantly. Hurricane Mitch, which killed about 10,000 Nicaraguans and Hondurans in October-November 1998, was proclaimed by environmentalists as a harbinger of what the world would be like under conditions of global warming. Obviously, however, the world 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 population increase in the region.

In July 2000, the flank of a giant garbage dump near Manila, Philippines, collapsed after becoming saturated from monsoon rains and killed over 200 people. 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 facie evidence of vulnerability to all manner of disaster, from epidemic disease to the debris flow that actually did occur.

Yet, in spite of these well-documented relationships, the global approach to climate change focuses on seeking to better quantify the risks of greenhouse gas emissions through predictive science. As we have argued elsewhere, such an approach likely fosters gridlock and inaction, meanwhile climate related losses mount around the world.

Assertion 4: Understanding and reducing vulnerability does not demand accurate predictions of the incidence of extreme events.

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 mountains slopes in Nicaragua, or on huge garbage dumps in the Philippines). Decision making might focus as easily on vulnerability management as on risk management.

For flood policy, building on the bluff does nothing to change the risk of an extreme flood, but it does reduce vulnerability to about zero. For the barge company facing no choice but to locate in the floodplain, a calculus must be made between managing risk (e.g., insurance) and reducing vulnerability (e.g., 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 Nino 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 was in a grain deficit – not because of El Nino, 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 in Southern Africa a clear relationship between ENSO and grain production. Now that relationship is no more, having been supplanted by a relationship between the ENSO *forecast* and grain production. And

depending on how farmers respond to what some perceive as a “bad” 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. Many strategies focused on reducing farmer’s vulnerability might have led to improved outcomes.

Assertion 5: Extreme events are created by context.

The chances for negative outcomes 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 in the jargon 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.

They have a point, of course. While the costs of vulnerability management can be readily calculated, the benefit derived from such approaches is counterfactual and cannot be verified. Careful historical comparisons can give a flavor of cost-benefit relations, but the contextual nature of extreme events renders such calculations suspect.

The relation between vulnerability and risk is not commutative: reduced vulnerability always means reduced risk of a negative outcome, but not vice versa. This asymmetry ought to create a policy incentive to focus on vulnerability reduction, since it leverages more than risk reduction. But, as the case of climate change demonstrates all too clearly, when thinking about the future, risk is sexier than vulnerability.

And, 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.

Assertion 6: It is politically difficult to justify vulnerability reduction on economic grounds.

It is difficult but not impossible. After just about any major disaster, Congress holds hearings and introduces legislation aimed at reducing the relevant hazard. 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.

Yet even more important than the economic rationale is the human one, 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, too much emphasis on the economic aspects of disasters can look callous and almost besides the point.

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 surrounding 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 the 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.

Assertion 7: Vulnerability reduction is a human rights issue. Risk reduction is not.

A focus on vulnerability also highlights the tension between individual action and collective consequence. Coastal migrations and urbanization are among the most conspicuous demographic trends of modernizing societies. Individuals are rationally deciding to move 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 at most 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, as evidenced most conspicuously by the explosive growth of developing-world megacities, and seen as well in loss data from coastal disasters in the U.S.

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.

Conclusion

In this essay we have sought to distinguish vulnerability from risk and some of the implications for management in the face uncertainty. We assert here that vulnerability management deserves a place in discussion of alternative policies in the face of the possibility of disasters. Too often vulnerability lies in the shadow of risk, or worse 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 to guide the way to an uncertain future and instead focus on the design of healthy decision processes flexible enough to learn from experience and intelligent enough to assess alternative approaches to vulnerability management.

We do not view vulnerability management to be in conflict with strategies of risk management. Rather, we believe that in some decision contexts one approach is likely to be more effective than another (or even some combination). But decision making rarely seeks to distinguish such circumstances with a net result being that risk management is haphazardly applied in most every context. When done improperly we see negative outcomes such as political gridlock in the climate change debate, an increase in vulnerability such as arguably has resulted from the nation's flood policies, and increased human suffering as resulted from the misapplication of risk management strategies in the case of seasonal forecasting in Southern Africa during the 1997/1998 El Nino.

Effective responses require that the vulnerability associated with specific social and decision processes be understood in parallel with understandings of processes of risk, such that determinations can be made as to the appropriate balance of risk and vulnerability management. In some situations, a myopic focus on risk to the exclusion of vulnerability can easily enhance rather than reduce the prospects for negative outcomes.