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RISK ANALYSIS AND THE SOCIAL DIMENSIONS OF RISK

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Abstract: After briefly reviewing the historical and cultural trends that led to the development of contemporary risk analysis practices, I present a series of critiques of the methods and uses of risk analysis. The critiques are based on the following arguments, namely, that: (1) risk analysis is a social activity, rather than a scientific one; (2) risk analyses do not drive decision making with respect to risk, but rather serve to legitimize decisions that elites have already made; (3) the entities that employ risk professionals and set the parameters for analysis are frequently implicated in the production of risk, tend to be inherently incapable of grasping the potential for worst cases, and sometimes are actively involved in suppressing that knowledge; (4) risk analytic procedures differ significantly from socially-rational approaches to assessing risk, which are less concerned with probabilities than possibilities; and (5) risk professionals are incapable of making valid projections, because risk production is a dynamic process involving complex interactions among sets of social factors that cannot be measured or modeled on an a priori basis.

The field of probabilistic risk analysis offers tools for assessing and managing risk that are almost universally accepted. Risk analysis is viewed as a mature discipline that frames risk-related problems in appropriate ways and serves as a sound basis for judgments concerning risk. This paper questions these assumptions, arguing that risk analysis should instead by seen as a set of social activities dominated by the interests of elites. This is one reason why calculations conducted by risk professionals generate conclusions that are widely at variance with the social rationality that characterizes public perspectives on risk. Risk analysis itself is a rhetorical device that serves to distract attention away from two critical characteristics of risk: that risk is produced through social activity, and that, rather than being relatively stable and thus calculable features of systems, risk levels are continually in flux.

■ RISK FRAMES: RISK ANALYSIS AND MANAGEMENT IN HISTORICAL CONTEXT

For all of recorded history, societies have recognized risk and practiced various forms of risk analysis and management. In ancient societies, analytic insights were drawn from folklore and oral traditions. Roman and Greek mythology, the Bible, and other historical records chronicle the ways in which early societies attempted to identify the sources of human misfortunes such as plagues, floods, wars, and famine. Risk management strategies generally centered on rituals designed to propitiate angry, disappointed, and potentially vengeful

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gods. Judeo-Christian beliefs framed human suffering as divine retribution--a process that could be mitigated through prayer, fasting, mortification of the flesh, pilgrimages, and other religious rituals. Interestingly, these early conceptualizations of the origins of risk remain relevant for many societies and groups even in contemporary times, as indicated most recently in pronouncements by the U.S. evangelical activist Pat Robertson, who attributed the devastation of the January 2010 earthquake in Haiti to the notion that the earthquake occurred because Haitians had in the 18th century "made a pact with the devil" in order to secure their independence from France. The idea that death, disease, and disaster are the direct result of human failings and subsequent punishment still retains its hold, existing uncomfortably alongside more widely accepted approaches to analyzing and managing risk.

Persistent notions of divine intervention in human affairs aside, current conceptualizations of risk and its management have their roots in Enlightenment optimism concerning the ability of science to investigate and elucidate the laws and physical processes that govern the natural world. Western approaches to risk analysis and management can be traced to the aftermath of the Lisbon earthquake of 1755, which caused a tsunami and gave rise to hundreds of fires, killing more than 100,000 people. The earthquake, which was discussed extensively by Enlightenment philosophers, marked the point at which divine explanations of catastrophe began to be supplanted by secular ones. After the earthquake, hazards were framed as controllable through human action, as indicated by post-earthquake reconstruction efforts undertaken under the direction of the Marquis of Pombal, Portugal's prime minister (Dynes, 1998; 1999). Pombaline city planning and architectural design, which reflected 18th century scientific and engineering knowledge on seismic threats, foreshadowed contemporary risk management strategies.

In the18th and 19th centuries, Enlightenment principles also began increasingly to influence social-scientific theories and methods emphasizing the importance of discovering through empirical investigation the laws that govern societal processes and social behavior. Owing to the seminal work of French scholars such as Comte and Durkheim, positivism, the epistemological standpoint that posits the unity of the physical and social sciences within a common framework of empiricism and the use of the scientific method, became the dominant approach for investigating both nature and society. By the dawn of the 20th century, the positivist paradigm, which sought the capacity to understand, predict, and control both natural and societal processes and emphasized the need for systematic, data-driven analysis, was widely accepted throughout the Western world. Just as it influenced developments in virtually all realms of scholarly endeavor, positivism had a profound influence on the manner in which a range of disciplines approached the study of risk.

Risk analysis and management were influenced by other social changes associated with the rise of modernity. Gambling and wagering were pastimes enjoyed (and also denounced) by societies and social groups throughout recorded history, and ancient peoples doubtless possessed an intuitive understanding of the probabilities and risks associated with different types of wagers. However, the systematic study of probability, which formed the basis for the discipline of statistics, began in the 16th century. Such investigations were crucial for the development of contemporary risk analysis.

Similarly, various schemes for insuring both lives and property against potential future losses have existed for millennia, but Western concepts of insurance began in England in the 16th and 17th century, first as a way of managing the risks associated with shipping--Lloyd's of London developed as a marine insurer in the late 17th century-- and later as a hedge against losses from urban fires. Fire-related concerns also drove the development of the U.S. property casualty insurance industry. Around that same time, the provision of life insurance, which had been common throughout history, also became more empirically- and statistically-based, leading to the development of actuarial science. These trends, all based on Enlightenment and positivistic reasoning, formed the basis for the field of risk analysis.

Along many dimensions, risk analysis is a mature discipline. Methods of risk analysis are well established and taught in colleges and universities. Many books and articles have been written on methods for conceptualizing and measuring risk, and there are journals and professional societies devoted to the topic. The use of risk analytic methods serve as a basis for decision making in numerous areas, including construction standards for facilities and infrastructure, public risk communication campaigns, government regulatory activities, insurance premiums, and investments in safety and security measures. Current risk

analytic methodologies have their origins in post-World War II activities surrounding the development of nuclear power, as exemplified by WASH-1400, also known as the Reactor Safety Study or the Rasmussen Report, which was published by the Nuclear Regulatory Commission in 1975. This long-discredited report was superceded in 1991 by NUREG-1150, "Severe Accident Risks: An Assessment of Five U.S. Nuclear Power Plants," and later by a new suite of PRA techniques (see, for example, Kafka 2008).

Initial risk-analytic methods came under significant criticism for failing to take into account "human factors" that can affect the probability and consequences of hazard events. These concerns led to the development of methods for incorporating human behavior into risk calculations. The concept of "operator error" subsequently loomed large in discourses on the causes of technological disasters.

The validity of probabilistic risk analysis (PRA) as a means for understanding both the likelihood of negative events of all types and the consequences of such events is now so widely accepted that it is taken for granted. However, the cultural mainstreaming of PRA and related methods, combined with evidence of their efficacy, have themselves had perverse effects, among which are the uncritical acceptance of risk projections and a reluctance to question the premises upon which such projections are based. In the sections that follow, I take up these issues in more detail, starting first with cultural blind spots that prevent the appropriate framing of risk analysis as a social process, and moving to the notion that such methods fail to take into account that risk itself is socially produced.

■ SOCIAL DIMENSIONS OF RISK ANALYSIS

The widespread acceptance of positivism and the scientific world view is an unacknowledged force that lends credence to the claims of PRA and to contemporary risk management practices. Since PRA represents a scientific approach to estimating the probabilities and consequences of failure in complex systems, its underlying assumptions remain largely unquestioned, and its social dimensions remain unexplored. In this section, I discuss risk analysis as social behavior that is subject to the same influences and constraints as any other form of social behavior. More specifically, I focus on risk analysis as an elite-driven activity, in that the interests of elites shape both the practices and the conclusions of risk analysis. I also note that, because of the field's status as an elite-driven form of social behavior, the findings that flow from risk-analytic efforts frequently conflict with broader societal framings of risk and its management.

As indicated above, the field of risk analysis has its roots in Cold War concerns with the uses of nuclear technology. The 1950s concept of "atoms for peace"[1] promised that scientific accomplishments associated with the development of nuclear weapons would in short order be transferred to the civilian sector in the form of inexpensive electric power, new medical technologies, and other technological breakthroughs. PRA ostensibly arose out of efforts to ensure that plans for the development of nuclear power as an industry would incorporate systematic safety assessments. Missing from such narratives is the fact that PRA originally arose as a consequence of governmental and (later) industry claims about the extremely low costs associated with nuclear energy generation, as well as their wholly untested arguments regarding its safety. Lee Clarke (1985) has described the aggressive stance taken by the U.S. government in promoting nuclear power, which at times extended to more or less demanding that a reluctant electrical power industry adopt nuclear technologies. Critical here is the point that PRA was employed to assess the safety of nuclear power plants only after political elites had already decided to build them.

Elsewhere I have made the point that viewed in historical context "political power, organizational agendas, and economic interests drive the science of risk assessment" (Tierney 1999: 223). Social studies of science in general, as well as research on the application of risk analytic procedures, highlight the many ways

[1] The concept takes its name from a speech made by then-U.S. president Dwight Eisenhower to the UN General Assembly on Dec. 8, 1953, which argued for peaceful civilian applications of nuclear science. The worldwide transfer of nuclear technology and weapons were an unforeseen consequence of the "atoms for peace" strategy--and an illustration of the human inability fully to grasp the forces that produce future risks.

in which putatively "scientific" calculations are shaped at the macro level by broader societal forces, as the meso level by organizational and institutional interests, and at the micro level by processes that take place in groups engaged in deliberations over such calculations.

All these forces came into play in the analysis of the risks associated with nuclear power, and their influences are evident in a host of other risk-analytic projects. For example, Clarke (1999) has documented how decisions about the transportation of oil through the trans-Alaska pipeline and in supertankers like the *Exxon Valdez* were made on economic grounds and then later justified through the use of risk analysis methods. He has also shown that risk management plans for large-scale oil spills like the *Exxon Valdez* event and cataclysms like nuclear war are in essence "fantasy documents" that perform the rhetorical function of reducing doubts about the safety of inherently risky activities (Clarke 1999). Additionally, he has demonstrated that a key element in risk analysis and management strategies is the use of the "disqualification heuristic" (Clarke 1993), which cognitively eliminates from consideration through risk analysis particular sources of risk.

Disqualification is also widely used in considering the consequences of risky activities. Analyses of facilities using high-risk technologies may thus be confined to on-site, as opposed to off-site effects of failures, for example, or certain costs may be eliminated from cost-benefit analyses in the interest of "bounding" and making more manageable risk-related problems. Risks left unanalyzed are by definition left unmanaged. For example, in an earlier publication (Tierney 1999) I noted that in 1986, when a commercial airliner experienced a complete hydraulic failure that led to a deadly crash, the plane's safety manual contained no instructions for what pilots should do under such circumstances, nor had the pilots been trained on how to respond. Such a failure was seen by the plane's manufacturer and the airline as impossible, so such measures were defined as unneeded.

Elite interests and associated frames are so pervasive that they not only influence the content of risk analytic activities but even shape the cognitions and actions of actual and potential victims of risky activities, who are often the very people in the best position to provide risk-relevant information. This pattern is well documented with respect to a wide range of risky technologies. A case in point is Sherry Cable and Thomas Shriver's extensive research on the social dynamics of the Oak Ridge, Tennessee Nuclear Reservation, one of three U.S. communities established for the purpose of developing the atomic bomb.[2] Despite clear indications of toxic exposure and lapses in safety in this "atomic city," many nuclear workers consider their work to be safe and indeed patriotic. Like many other workers who actively side with the employers on which their livelihoods depend, weapons plant employees and other Oak Ridge residents have developed various mechanisms of social control that they employ against whistle-blowers, as well as ways of ignoring or countering claims about the need for more stringent safety procedures (Mix, Cable, and Shriver 2009; Cable, Shriver, and Mix 2008; Shriver et al. 2000). Such practices both originate from and reinforce the interests of the owners and operators of the Oak Ridge Reservation, which prefer to operate their facilities in an atmosphere of secrecy and which have developed their own methods for dealing with those who question the safety of nuclear weapon production.[3]

Through her analyses of the social dimensions of risk analysis and management, most notably in her highly influential study of the *Challenger* accident, Diane Vaughan (1989; 1996; 1999) provides extensive documentation on the manner in which institutional, organizational, and group-level factors influence both "scientific" assessments of risk and risk-management decision making. Within organizations that manage risky activities such as the launching of space shuttles, ways of thinking about and handling risks become so highly routinized that signals suggesting things may be about to go horribly wrong are quite often simply discounted. Social norms surrounding safety and risk, including norms concerning which signals matter and

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2 The other two communities were Los Alamos, New Mexico and Hanford, Washington.

3 The Oak Ridge weapons facilities have a long record of accidents and safety violations that have resulted in fines and other sanctions. Oak Ridge has recently come under extensive scrutiny and criticism for its activism in promoting the use of nuclear energy through the Global Nuclear Energy Partnership. Among other risks, initial Oak Ridge plans for the further global diffusion of nuclear technologies failed to take into account the risks associated with the proliferation of weapons-grade nuclear material.

which can be safely ignored, can be a major source of accidents and disasters, yet organizational and group norms are not taken into account in formal risk analyses.

The idea that risk analysis is fundamentally a social, as opposed to a scientific, activity is best exemplified by the behavior of the global financial sector in the years preceding the financial collapse of 2008. Buoyed by the putative accomplishments of "financial engineering" and armed with esoteric mathematical models that inspired a near-religious confidence in investors and regulators alike, financial elites set the stage for one of the most abrupt systemic financial collapses in modern history. Here again, risk modeling played an essentially rhetorical role in the activities of investment banks, mortgage lenders, and the insurance industry during the financial bubble--activities that more closely resembled a vast Ponzi scheme than sound financial management. Even as evidence of their faulty reasoning continued to mount, elites and their hired experts continued to extol their superior ability to understand the behavior of markets and the analysis and management of financial risks. The bubble itself could not have been sustained without extensive collusion among multifarious institutional and organizational actors, including various kinds of banks and lenders, rating agencies, insurers, regulators, government officials. It was the activities of these entities, rather than the analyses they produced that should have been the focus of inquiries into the soundness of the world's financial system.

Elite hubris in the years leading up to the financial meltdown of 2008 had its roots not in the systematic study of risk but rather in ideologies that touted the omniscience and adaptive capacities of so-called free markets. The fundamentally ideological nature of the belief in the forces of the free market was given a scholarly veneer by the work of numerous economists, most notably those of the Chicago School and its founder, Milton Friedman. Free-market economics meshed nicely with and in fact enabled the broader projects of political and financial elites within the world financial system--so much so that it became nothing less than an article of faith within elite circles. The fields of financial risk analysis and management proceeded apace, offering a growing array of analytic technologies, techniques, and instruments whose own risks were poorly understood outside a very small circle of knowledgeable users. A broad consensus developed regarding the value of such instruments, effectively blocking critical consideration of what should have been seen as essential questions about the risks associated with the use of risk-analytic methods and products themselves. And like whistle-blowers everywhere, those who questioned the validity of the "trees-grow-to-the-sky" reasoning that fueled the financial bubble, or the idea that bundling together and dispersing inherently risky loans made those loans less risky were quickly labeled "irrational" by the bubble's elite champions.

The fact that fundamentally flawed risk-analytic procedures are so firmly institutionalized within the political economy of the global system is one reason why elites charged with managing risks find it virtually impossible to engage in self-reflection regarding their methods and assumptions. However, another more important reason is that the beliefs of elites do not derive from analysis and reflection at all. Rather, as noted above, and not surprisingly from the point of view of social science, their beliefs are ideological in origin. This point was unintentionally made clear in testimony before the U.S. Congress by former U.S. Federal Reserve chairman Alan Greenspan, concerning the 2008 financial crash. Under questioning, Greenspan calmly expressed his personal disappointment that his faith in free markets, which he freely admitted amounted to an ideology, had proved to be misplaced.[4] Again not surprisingly, Greenspan's wistful musings on the god that failed have gone unheeded within the world financial sector and its institutions, which learned little from the crash--except that governments would continue to underwrite their risky activities--and are busy engineering the financial catastrophes of the future, assisted, as always, by the profession of risk analysis.

The emptiness of PRA's claims is perhaps most evident when worst cases are taken into account. Low-probability-high-consequence events have always presented problems for the field of risk analysis, but generally those problems have been framed in terms of risk perception and risk communication challenges, not challenges to the claims of PRA itself. Yet now there is a growing body of knowledge that does challenge

[4] Showing his lack of familiarity with social science concepts, financial wizard Greenspan confused the concepts of ideology and cognitive frame, while at the same time inadvertently revealing the basis in ideology of his own free-market beliefs.

those claims. Students of risk are increasingly concerned with the tails of distributions (commonly referred to as "long" or "fat" tails), as opposed to the areas under risk curves, and with "black swans" (Taleb 2007). Long before the occurrence of the paradigmatic long tail event, the financial collapse of 2008, social scientists were conducting research on the handling of worst cases by organizations and elites. For example, in *Never Saw It Coming: Cultural Challenges in Envisioning the Worst* (2006) Karen Cerulo brings together a large body of research to support the notion that human beings and societies find it extremely difficult to envision worse cases, and that this difficulty is cultural as well as cognitive in nature. Cerulo argues that both individuals, organizations, and groups show a marked tendency toward what she terms "positive asymmetry," meaning, in simple terms, that they are cognitively and culturally much more comfortable with upside than with downside thinking. Focusing on organizations, for example, she locates blindness to worst cases in cultural practices and institutional logics that lull members into ignoring the potential for catastrophic failures. Perhaps more important, however, she highlights the practices societies, institutions, and organizations employ both with worst cases and those who raise questions about worst cases, which she terms eclipsing, clouding, and recasting practices. These practices, which are designed to render the worst invisible, include banishment; shunning; shadowing, or emphasizing high points so low points become less visible in the process; and rhetorical recasting, a practice in which negative events are reinterpreted in a positive light. But even more succinctly, and tellingly for this argument, Cerulo makes the case that it is elites that have the ultimate say in what constitutes the worst, in that they have the power to define the parameters of which risks warrant consideration and which should be discounted.

Lee Clarke points to similar limitations in the ability to envision the worst, including other cognitive habits that blind us to worst cases. Most relevant to the current discussion is the socialized and trained capacity to think primarily in probabilistic, rather than "possibilistic" terms. While the probabilistic reasoning on which PRA is based focuses understandably on failure probabilities, possibilistic reasoning is concerned with the impacts that could occur as a consequence of disaster events and the use of risky technologies (Clarke 2006; 2008). In other words, it focuses on worst cases, not the most probable or credible ones, as defined by elites and experts. Clarke argues, for example, that the inability to think in possibilistic terms was behind the federal government's flat-footed response to Hurricane Katrina (Clarke, 2005). As Katrina approached, government officials felt quite confident that everything that could be done to prepare for a major hurricane was being done; the fact that Katrina was not just a major hurricane but a near-worst-case was not considered by those in charge, despite the fact that a Category 3 event had been identified as such by many scientists, journalists, and other observers (see discussion below).[5]

The 1992 Los Angeles civil unrest is another example of the inability of organizations and institutions to think about worst cases. The precipitating event for the uprising occurred when four police officers accused in the beating of African American motorist Rodney King[6] were acquitted of all charges against them. Police chief Darryl Gates had indicated during the jury deliberations[7] that the city was ready should problems develop when the verdict was issued. For example, he noted that the city had sufficient resources to pay overtime for police officers. Just after the verdict was issued, restive crowds began to form in African American neighborhoods in Los Angeles. Confident of the ability of the Los Angeles Police Department to manage any crises that might develop, the police chief left headquarters to attend a fundraiser for his own mayoral bid in the upscale Bel Air neighborhood of Los Angeles. The uprising that ensued was the most damaging episode of civil unrest to occur in the U.S. since the tumultuous 1960s era, and among the most

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5 Also significant is the fact that even though Katrina was in the range of a Category 3 hurricane when it made landfall in the Gulf region, Katrina has been a Category 5 event when it moved ominously over the waters of the Gulf of Mexico. Thus the storm surge generated by Katrina was that of a Category 5, not a Category 3. Such an idea does not seem particularly difficult to grasp. Despite that fact, early government and media reports framed Katrina as "not as bad as expected" and as a "near miss." Were government officials ill-advised by those who warned of catastrophic impacts, or were they focused, as officials often are, on upside projections?

6 The beating was among the first episodes of police violence to be captured on video tape by a bystander. For those living in an era of citizen journalism, it is difficult to imagine the interest and indignation generated by that tape.

7 The trial had been moved from Los Angeles to the suburban community of Simi Valley, ostensibly to access a more objective jury pool. Simi Valley was a largely Caucasian community that was home to many retired Los Angeles police officers.

costly riots in U.S. history, as judged by property damage, the costs associated with the use of state National Guard and federal troops in response to the unrest, and U. S. government disaster relief payouts.[8]

Prior to the insurrection, the police department considered any outbreaks of violence that might emerge to be manageable—a wholly unwarranted view, given its lack of personnel and other needed resources, expertise in crowd management, and poor relations with minority communities in Los Angeles. Additionally, despite what they may have been hoping, police officials had not actually expected an acquittal in the case, given the video evidence of police brutality. Here again, probabilistic reasoning dominated, when the appropriate stance should have been possibilistic. Rather than being planned for as a potential worst case, a possible riot was framed as a routine organizational problem involving how LAPD officers would be paid if they had to work overtime.

Although he is concerned with ways of thinking that create blind spots regarding risk, Clarke places more emphasis than does Cerulo on the non-cognitive factors that lead to the inability to take worst cases into account. Having studied organizations and their responses to risk and disaster for three decades, Clarke emphasizes instead why organizations and institutions such as the Department of Homeland Security, FEMA, Exxon, and the LAPD need to present themselves as both knowledgeable about worst cases and able to control them—even if the worst cases they envision are not actually the worst that could happen. Such positions are key elements in organizations' claims regarding their own legitimacy and trustworthiness. Such properties in turn constitute critical resources upon which organizations can draw in a variety of ways: to protect themselves against regulation and other external efforts to intervene in their internal affairs; as rhetorical aids in damage control campaigns, should such campaigns become necessary; and as post-hoc justifications when things do go wrong.

This line of research poses some intriguing questions: What does it mean for conventional risk analysis if, as increasingly appears to be the case, the consequences of hazard events, such as deaths, economic losses, and environmental catastrophes, are driven not by likely or probable cases, but by worst cases? And what does it mean in turn if worst cases are consistently disqualified when institutions, organizations, and groups think about risk?

The emphasis on risk analysis and management as "legitimacy work" helps explain why the pronouncements of elites and the organizations and institutions they represent are given such wide credence during normal times, as well as why their claims are so often accepted when things go wrong. Credibility, believability, and trustworthiness are resources that are jealously guarded by organizations precisely because they may have to be drawn upon during crises. Institutional credibility also provides insights into why members of society, who are acutely aware that they themselves quite often act untruthfully when their own interests are at stake, find it so difficult to believe that elites also lie, and why they so willingly embrace glaring untruths, so long as they emanate from their leaders.

By virtue of their positions in society, elites and their representatives are surrounded by an aura of credibility that ordinary members of society lack. Their institutionalized positions of authority, bolstered by their enormous power, enable them to convey even risible untruths with impunity. Following the 2005 Hurricane Katrina catastrophe, for example, then-president Bush made the authoritative pronouncement that "nobody expected the levees to fail" in that event--a statement that was widely accepted but clearly false, given research and prior press coverage indicating the likelihood of such an occurrence should the Gulf Region experience a Category 3 hurricane.[9] This was the same president who, with the collusion of other seats of power and influence, including the U. S. press and friendly governments, was able to lead not only his own nation, but also international allies, into a ill-considered strategy of war without end against enemies without end. The processes involved in the application of hegemonic power, including the ability to lie without accountability, constitute yet another set of socially-organized activities that lie outside the realm of

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8 The Los Angeles unrest, like most of what are termed commodity riots, was not particularly deadly; such uprisings focus much more on attacking and damaging property.

9 The fascinating story of the "Hurricane Pam" disaster exercise, which preceded Katrina by just one year, has yet to be fully told. Suffice it to say that true worst-case scenarios were not used in the Pam exercise.

conventional risk analysis and management, but that at the same time contribute in significant ways to the risks societies face.

Like the recognition that everyone finds it necessary to lie from time to time, the idea that employees seek to please their employers makes intuitive sense. Who among us wants to fail repeatedly to live up to our employers' expectations? Who would wish to be the lone dissenter in a group seeking to garner the approval of the person or entity that pays for its services? Who seeks to be marginalized for interfering with group schedules and productivity, or for jeopardizing the bonuses group members seek to obtain? Seen from this perspective, it is logical that these very same social incentives and pressures operate within the risk professions. Yet here again, the products of risk-analytic efforts are quite often accepted merely because they emanate from sources that are assumed to be authoritative. Insiders and others who are familiar the work environments in which risk analysts toil know better. For example, prominent risk scholar Baruch Fischhoff, observing more than a decade ago that "inevitably a field is shaped by those who pay its bills" (1996:76), cited various ways in which the sponsors of risk-analytic activities shape professional practices in subtle and not-so-subtle ways, for example by specifying the manner in which issues will be examined and cutting support for researchers who fail to produce findings that are consistent with sponsor interests.

Similarly, if production pressures cause other types of workers to cut corners in answering the demands of their superiors, why wouldn't such pressures be felt by risk analysts as well? As Fischhoff recently noted "risk analysts are people, too" (2006: 80), and as people they are subject to the same social and organizational pressures that affect non-experts. Analyses conducted under the sponsorship of the U.S. Department of Homeland Security (DHS) are a case in point.[10] Faced with the requirement that it develop risk estimates for an incredibly wide range of perils, the agency dutifully provides the required projections, regardless of their empirical soundness and credibility. Those charged with producing risk analyses do so whether the phenomena in question are relatively well-understood and based on reasonably sound actuarial evidence (e.g., losses from flooding) or poorly understood and without precedent (e.g. large-scale bioterrorism, dirty bomb attacks upon U.S. cities). The paramount requirement is that the work be done, and done in a timely fashion. With respect to risk management, DHS is also required by presidential order to mandate state and local government preparedness activities for a range of scenarios, including highly unlikely ones (e.g., community-scale attacks using blister agents) that evidently were identified through non-transparent governmental and agency decision processes. The initial list of scenarios included mainly terrorism-related attacks, but as a consequence of pushback by bureaucratic actors concerned with the seemingly more prosaic threats posed by natural hazards, DHS officials added major earthquakes and hurricanes to its scenario list. Not long afterwards, the Katrina catastrophe occurred.[11]

Just as the tail never wags the dog, risk analysis never determines what risks are selected for modeling and assumed by or imposed upon societies and communities. Analytic procedures merely add the veneer of science to what are essentially political and economic decisions. To believe otherwise is to reject an overwhelming body of historical and social-scientific evidence.

Discussions so far may seem to suggest that the risks associated with the various courses of action societies and communities adopt in managing their affairs are knowable, and that elite interests are the primary barrier standing in the way of achieving that knowledge. That is far from the case. As I discuss in more detail in the section that follows, the goal of PRA is a chimera. This is the case not only because conventional risk analysis excludes the risks that concern societies most but more importantly because, as the product of social activities and processes, risk itself is an ever-moving target.

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[10] DHS generally outsources its risk-analysis activities to contracting organizations, owing in part to its lack of in-house expertise. Problems that could arise from this arrangement and from the agency's own relatively anemic analytic capabilities are apparently not a matter of concern.

[11] The ten planning scenarios, which were mandated by Homeland Security Presidential Directive 8, were: the detonation of a 10 kiloton improvised nuclear device; a biological attack using aerosolized anthrax; pandemic influenza; a biological attack using plague; chemical attacks using blister agents, toxic industrial chemicals, nerve agents, and chlorine gas; a major earthquake; and a major hurricane.

■ RISK ANALYSIS VERSUS SOCIAL RATIONALITY

The history PRA has been a contentious one. Its initial stages were marked by experts' concerns about discrepancies that existed between their own risk calculations and those of ordinary members of society, whose views were promptly framed as irrational. Risk-related discourses centered on why the general public held such distorted views of the hazards associated with various technologies and activities and on how "true risks" could be communicated in ways that the public could better understand. Different risks were framed as comparable and then compared with one another, leading experts to question why some people were so fearful of air travel, when they were much more at risk from traffic accidents, or why people feared some other form of risk, when they were actually much more likely to die in a lightning strike. Seen from this standpoint, the task of risk analysts was to clarify and communicate to putatively irrational publics exactly what the actual risks were, if for no other reasons than to allay public concerns. This expert-centric perspective remains a cornerstone of current risk-analytic methods, even as experts have grudgingly given ground over time to more society-centric considerations. (For additional discussion, see Fischhoff 1995; 2006: Fischhoff, Slovic, and Lichtenstein 1982).

The initial pushback against the expert-centric perspective came from social scientists interested in better understanding the factors that influenced public judgments concerning different kinds of risks. Early analyses showed that such judgments were rooted in perfectly understandable societal concerns about issues such as whether risks were assumed voluntarily or involuntarily and whether different types of risks were prosaic or exotic or highly dreaded. Further investigations revealed the social importance of questions such as whether risks were equitably or inequitably distributed across different groups, whether damage was reversible or irreversible, and whether certain risky activities imposed costs on future generations. Additional research insights revealed that perspectives on risk were also shaped by public trust in the institutions charged with managing risk, as well as by social factors such as race, class, and gender. Long after fields such as sociology had re-discovered the obvious connections that exist between emotions and social life, risk-related scholarship also began to examine how emotions such as fear influence risk-related behavior. With the rise of the environmental justice movement and research on risk disparities, new questions arose regarding the systematic imposition of unwanted risks on different racial and ethnic groups as well as groups lacking political power and influence. The net outcome of these investigations was to provide a much fuller understanding of how societies and social groups think about risk and react when faced with decisions regarding various "risk objects." (For examples of these findings, see Perrow 1984; Bullard, 1990; Capek 1993; Freudenburg 1993; Slovic 1999; Slovic et al. 2004.)

Complex societal and group perspectives on risk reflect a deep form of social rationality that stands in sharp contrast with the mechanistic assumptions of conventional PRA. As demonstrated in numerous empirical studies, public analyses of risk depart radically from expert-based methods concerned mainly with such factors as the probabilities associated with the failure system components and subsystems in nuclear reactors as a function of earthquake magnitude and ground motion, the likelihood of hazardous materials releases from a particular facility, or the number of cancers produced as a consequence of exposure to toxic materials. Instead, concerned publics might reasonably ask why nuclear reactors were built in earthquake-prone areas in the first place, whether particular hazardous materials might be replaced by safer ones or placed in facilities located away from population centers, or whether more research is needed to determine links between toxic materials and cancer. However, as noted in the section above, questions like these would concern activities on which elites have already made decisions, and thus would fall outside the purview of putatively scientific and objective discourses on risk.

The idea that ordinary members of society might possess a more grounded and nuanced understanding of the risks they wish to accept than designated experts clearly conflicts with contemporary ideas about the role of experts in advanced technological societies. More important for this discussion, however, it also conflicts with the interests of elite groups that dominate political discourse and decision making in those societies. However, even if it remains beyond the ken of many groups within the public, the recognition of this critical linkage serves as a mobilizing force in the activities of social movements concerned with risks and their

management. Here again, the rationality of such movements is invariably called into question by elites and their supporters in the risk professions.

At the same time, social rationality in the face of risk and uncertainty forms the basis for the precautionary principle, which is sometimes applied in cases involving environmental and other hazards. On the one hand, while elites may wish to move forward with potentially risky technologies even in the absence of evidence on their associated risks, publics may decide collectively to slow such "progress" as a precaution against unforeseen negative consequences. On the other, non-elites may also opt to move forward on strategies for managing future risks in the absence of consensus on the part of key political actors, or even in opposition to political forces, as evidenced by actions taken by U.S. communities and other sub-national entities in the face of climate change. (For discussions on the precautionary principle as a form of possibilistic reasoning, see Clarke 2006; for a critique of what he terms "precautionary culture," see Furedi 2009.)

■ RISK ANALYSIS AND THE SOCIAL PRODUCTION OF RISK

Reprising a point made earlier, the field of risk analysis developed during a period in history that was marked by unquestioning acceptance of the notion that problems contemporary societies faced were amenable to solution through the application of scientific knowledge. The use of atomic weapons had enabled the Allies to win the Second World War, cures for devastating illnesses like polio were discovered, and human beings were beginning to explore space. Even if issues of great societal import, such as the causes of and appropriate cures for cancer, were still unknown, there was little doubt that they were knowable. When the Soviet Union detonated its first nuclear device, and later when it launched the first-ever satellite, the U. S. and other industrial societies followed suit by stepping up significantly their investments in scientific research and development. The profession of risk analysis thus emerged in an era of high optimism with respect to the achievements and promise of science as an engine of societal progress.

Within this context, it is understandable that PRA and related methodologies followed scientific conventions for the conduct of empirical research, including in particular the tenets of scientific realism. Like other physical phenomena, risk was framed as a property that existed "out there" in the physical world of plate tectonics, atmospheric disturbances, and the design and construction specifications of critical facilities such as nuclear power plants. Consistent with positivistic assumptions about the unity of science, social phenomena, such as the group dynamics involved in crisis decision making and the behavior of communities and groups under extreme situations, were also seen as understandable, explainable, predictable, and controllable through social scientific research.

Scientific realism, the fundamental assumptions of the positivist paradigm, and mid-20th-century optimism regarding the role of science in solving social problems subsequently became targets of major critiques. Advances in social constructionism posed significant challenges to scientific realism, especially with respect to phenomena of importance to the social sciences. Critical theory, post-structuralism, postmodernism, and other post-positivist theoretical developments also challenged the mid-20th-century paradigm of a realist, empiricist, and value-free science.

Even in the face of such critiques, and even in the face of ongoing research showing that it is social rationality and not formal risk calculations that drives societal (as opposed to elite) judgments on the severity and acceptability of different risks and on ways of managing risks, risk-analytic procedures continue to be used because of their importance for modern technological societies. In the remainder of the paper I show that this is the case despite the fact that both elites and members of society in general have erred significantly in the manner in which they have framed the concept of risk. More specifically, whether intentionally or unintentionally, their ways of conceptualizing risk fail to take into account the notion that, far from being some measurable quantity of potential negative impacts that exists "out there," risk itself is both highly dynamic and socially produced, which means in essence that at any given point or points in time, significant dimensions of risk are unknowable and unmeasurable. This idea is a radical challenge to the field of risk

analysis. The discussions that follow take up these issues, with a particular emphasis on PRA's often-unstated assumptions about the quiddity, or "thingness" of risk itself.

PRA and related analytic methods are premised on the notion that risk is a property, entity, or quality of physical and human systems that can be discerned *a priori*, operationalized, and measured. Of course, this premise does not assume that the "things" or outcomes that constitute the subject matter of risk analysis are fully predictable; indeed, the notion of uncertainty is an essential element in risk-analytic approaches. Rather, even given the large amount of attention it devotes to understanding and quantifying uncertainty, risk analysis ignores the fact that risk *cannot be measured*, except in hindsight. Risk cannot be measured, either at a given point of time or over time, because it is continually in flux. In other words, rather than being seen as a "thing" or property of systems, risk is better framed as a *dynamic process*. This is not to say that it is impossible for analysts, groups, and societies to determine to tell whether certain trends, such as global climate change, or certain decisions, such as deciding to do nothing to stem the buildup of greenhouse gases, will have consequences at some point in the future. Rather, it is to argue instead that it is virtually impossible to know in advance what those consequences will be.

The reason that future risks cannot be known lies in the fact that risk is continually generated and modified through human activity—activity that is far less predictable than the behavior of the natural and technological systems on which risk experts focus their attention. Risk is and always will remain a moving target because it is societies, institutions, organizations, groups, and individuals that produce risk. Indeed, human beings and societies have proven quite inept in forecasting future risks, and even in recognizing them when they appear. This is partly because elites inevitably seek to hide the risks they produce, but also because of the cognitive limits to thinking about future risks that were discussed above. But even more important, risk is unknowable because it is the product of the actions and interactions of complex sets of factors that themselves cannot be known in advance. Conventional risk analysis proceeds in ways that break down presumably closed systems into their component parts, which are then analyzed in turn for their potential contributions to failures and negative consequences within the systems of which they are a part. Yet the systems that produce risk are not closed systems, because they are social systems, and understanding and explaining risk is a synthetic process, not a reductionistic one.

Put another way, even taking into account uncertainty, risk analysis cannot produce representations of risk because it is based on sets of assumptions that ignore the underlying processes that generate risk. For example, life cycle analysis can yield data on how long particular infrastructure systems or facility components will continue to perform, but it provides no information on whether owners and operators will replace those systems and components when their potential for performance deteriorates. That information can only be obtained from other sources, such as information on how particular organizations tend to behave, or the knowledge that owners generally want to avoid regulation and extract all the productivity they can out of existing systems.

The U. S. inventory of nuclear power plans is a case in point. Nuclear facilities were originally licensed to operate for forty years. However, that time has now passed, and the owners of many facilities have obtained license extensions to operate for an additional twenty years. Components within nuclear facilities can be expected to fail more often as they age, and that has in fact been the pattern. The problem is further complicated by lax inspection by plant owners and insufficient oversight by regulators. Moreover, steps that are taken to monitor the safety of aging plants do not seem to work. Focusing on inspections of plants and their components, for example, the Union of Concerned Scientists faulted nuclear plant "aging management" programs for "looking in the wrong spots with the right inspection techniques…and…looking in the right spots with the wrong inspection techniques" (Union of Concerned Scientists 2005: 20)—processes that failed to detect accidents in the making. At the same time, plant owners and operators have assured regulators, investors, and the general public that they have safety problems well in hand, behavior that itself contributes to future nuclear plant risks in ways that are not measurable through conventional PRA. Additionally, nuclear power is now being framed as providing part of the solution for problems generated by the risk of climate change, suggesting that owners will try even harder in the future to keep their plants operating, even as they begin planning to construct new facilities which will in turn affect future risk levels for power plants.

The notion that the processes underlying risk production are social in nature leads logically to the question of what drives those processes. A general macro-level explanation is that risk is produced through the operation of the political economy of the world system. More recently, however, this "undifferentiated" approach to explaining risk (Freudenburg et al. 2008) has given way to finer-grained analyses of how societal, regional, and localized economic and political activities produce risk. For example, Mileti (1999) has argued that communities "design" the disasters of the future through the decisions they make (or fail to make), concerning issues such as land use, levees and other flood protection projection projects, and building codes. I have argued elsewhere (Tierney 1999) that hazards are created through the operation of growth machine politics (Molotch 1976; Molotch and Logan 1987) that invariably reflects the preferences of real estate and development interests. Freudenburg et al. (2008) similarly attribute disasters to "rent-seeking" by political and economic elites, by which they mean activities associated with making various kinds of projects more profitable for themselves while externalizing losses to others. Flood plain (mis) management is one such set of activities. Citing Gilbert White's influential scholarship on the "levee effect," Freudenburg et al. discuss how the development of flood plains continues unabated despite—or, more accurately, because of—regulations seeking to reduce flood losses. Levees and other flood protections encourage development while at the same time virtually guaranteeing even larger flood losses in the future. Freudenburg et al. also discuss the role of a prototypical "water pork" project, a navigation channel called the Mississippi River Gulf Outlet (MR-GO), in the devastation caused by Hurricane Katrina. Among their conclusions is that the common use of the term *disaster* masks the fact that disasters like Katrina are actually *tragedies* in the sense the term was used in ancient Greece: events that are caused by the hubristic acts of the powerful.

Hurricane Katrina constitutes an immensely tragic example of the social production of risk. Actors in that tragedy include the oil industry, whose drilling activities over time destroyed on a massive scale protective wetlands that could have served as a buffer against hurricane storm surges; the U. S. Army Corps of Engineers, which was responsible for the maintenance of many of the levees and channels in the Greater New Orleans region and which is now being sued by families who lost their homes in Katrina[12]; local growth promoters who pressured for the construction of MR-GO—also known locally as the "hurricane highway"—with the support of the Corps of Engineers; and government entities at the local, state, and federal levels that refused to invest either in more potentially effective levels of hurricane hazard mitigation or in adequate emergency preparedness planning. White flight from the city of New Orleans, wages lowered through the expansion of the service sector, lack of employment alternatives, and a legacy of inadequate public provision also played their own roles in leaving the mostly poor and mostly black city of New Orleans highly vulnerable (Cutter and Emrich 2006). And in the days leading up to the storm's landfall on the Gulf Coast, those socially-produced patterns of vulnerability also determined in large measure which residents would be able to evacuate and which would be forced to remain in Katrina's deadly path.

■ CONCLUSION

Despite their widespread use, conventional risk analytic methods are incapable of providing guidance on current and future risks. Risk analysis itself is social behavior that like all social behavior is influenced by social and cultural norms and expectations. These social pressures shape analytic activities in predictable ways. While risk professionals believe that their understanding of risk is superior to that of non-experts, the views on risk held by non-experts reflect a socially rational perspective that takes into account both the many facets of risks and their consequences and the possibility of worst cases. In contrast, its emphasis on probabilities blinds risk analysis to the possibility of worst-case events—a pattern that is amplified by organizations and institutions that in some cases are also blind to the potential for such events, but in others knowingly deny that potential.

More important, however, is that risk analysis misperceives the origins of risk, which are inherent in the social order itself, not in systems and their components. Considerations of "human factors" notwithstanding,

[12] The case in question is Robinson v. United States.

the discipline of risk analysis is incapable of identifying and analyzing the social factors that produce and continually modify risk potentials. At base, risk is the consequence of the actions of powerful entities as they go about the exercise of their power, whether the entities in question are economic or political elites, governments or corporations, admittedly capitalist enterprises or ostensibly socialist ones. As social science research increasingly shows, risk accrues as the inevitable result of the operation of the political economy at global, national, regional, and local scales, as actors pursue profit and other benefits while imposing risks on the less powerful. This is the fundamental point that is missed in contemporary narratives on risk and its management, and the fundamental reason why societies continue to experience ever-growing losses from ever more extreme events.

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