Disaster Risk Reduction

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Summary and Keywords

Disaster risk reduction (DRR, or disaster reduction) is an umbrella term for processes of preparing for, responding to, recovering from, and managing the risk of disasters. It refers primarily to the acts of setting the policy and strategic agendas for these tasks. It reflects a long-standing need to reorientate priorities from merely responding to disasters once they have struck to reducing or avoiding their impacts. To be achieved, DRR requires a combination of physical and social measures, with full participation of affected populations and other stakeholders.

Academically, disasters have been studied systematically for more than 100 years. During this period, the emphasis has changed from analyzing natural hazards as the primary drivers of disaster to a more pluralistic approach in which vulnerability and exposure to hazards and threats are viewed as playing vitally important roles. Disasters can have natural, technological, social, or intentional (i.e., terrorism-related) causes, but they are increasingly composite events that involve combinations of factors. Hence there is now much emphasis on “natech” events, in which natural hazards affect technological systems, and cascading disasters, in which escalation points caused by interacting sources of vulnerability may have the power to make the secondary effects more important than the primary trigger. Root causes and contexts have assumed a greater salience in the explanation of disaster, which tends to involve complex interactions among social, economic, political, and physical factors. Resilience has come to the fore as a positive concept for organizing processes of DRR. It is usually defined as a mixture of adaptation to hazards and threats and the ability to resist or overcome the negative effects of disaster.

DRR concepts and strategies have been mainstreamed in modern society by international action under the auspices of the United Nations and the Sendai Framework for DRR, 2015–2030. The challenges of applying UN frameworks include uncertainty about whether the underlying concepts are durable, whether they can be applied rigorously, whether they have enough support among policy and decisionmakers, and whether they can acquire a sound practical basis. The future of DRR depends on humanity’s ability to implement solutions to conflict, migration, and environmental change, not merely the impact of disasters per se. In an era in which population is rising, wealth disparities and human mobility are increasing, and environmental change has begun to lead to major up-

heavals, DRR has gone from being a rather esoteric, specialized field to one that is central to the future of human existence.

Keywords: disaster risk reduction, disaster risk management, emergency response, emergency and crisis planning, risk mitigation, vulnerability, resilience, crisis analysis

What is Disaster Risk Reduction?

Disaster risk reduction (DRR, or disaster reduction) was defined by United Nations International Strategy for Disaster Reduction (UNISDR, 2004, p. 3) as "The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development." This widely used but awkwardly phrased definition conveys inclusiveness and spreads the process of DRR over all five phases of the "disaster cycle" (Richardson, 2005): mitigation, preparedness, emergency response, recovery, and reconstruction. It betokens a comprehensive approach to the problem of disasters in the modern world. In a later glossary (UNISDR, 2017), DRR was seen as the policy arm of disaster risk management, the set of decisions and actions that enable a situation to be managed. New risk must be prevented from emerging, existing risk must be reduced, and residual risk must be managed. This requires that warning systems be provided, awareness raised, indigenous and scientific knowledge be employed, and institutional arrangements be in place to provide adequate risk governance (Ahrens & Rudolph, 2006).

Activities designed to reduce the impact of disasters are often classified by type and scale. Mitigation is generally seen as structural, semistructural, and nonstructural. Structural solutions involve building things such as flood walls, strengthening houses (for example, against earthquake shaking or hurricane-force winds), and stabilizing slopes. An example of a semistructural measure is to designate a water meadow as a floodwater detention and storage area intended to reduce the volume of river discharge further downstream. A further example is applying floodproofing measures to a house. Nonstructural measures include emergency planning and interdiction of certain land uses in areas of high hazard. There is an emphasis on combining hazard-reduction measures with ecological approaches to create "green infrastructure," as in the Chinese concept of "sponge cities" that absorb and disperse flood runoff (Jiang et al., 2018).

The concept of DRR was first elaborated in the 1980s (Davis & Lohman, 1987; Kelman, 2018), but it came to prominence in the early 2000s from dissatisfaction with approaches to disaster mitigation that are too narrowly sectoral or that concentrate on putting right the damage after the event rather than tackling its root causes. The very existence of a 'disaster cycle' indicates how calamity is a repetitive process. Centuries of reconstituting vulnerabilities in the recovery process make it clear that, when they strike, disasters should point the way to a safer society, one that is insulated against any repeat of the damage, destruction, and casualties.

Academic Approaches: The Evolution of a Pro-to-Discipline

Serious scientific studies of large disasters have taken place ever since the Enlightenment. They include the studies of the 1783 Calabrian earthquakes (Royal Society, 1785), the 1858 Kingdom of Naples earthquake (Mallet, 1862), and the 1883 eruption of Krakatoa volcano (Symons, 1888). However, no such endeavor could be described as having established disasters as a field of study. Instead, the catalytic event was the explosion of a munitions ship in Halifax Sound, Nova Scotia, Canada, on December 6, 1917. The curate of St. Paul's Anglican church in Halifax was Samuel Henry Prince, a man of both academic and practical leanings. He survived the blast, which killed 1,963 people and injured 9,000, amounting to 22% of the city's population (Scanlon, 1988). Prince went on to write a doctoral thesis in sociology on the Halifax explosion, in which he reviewed systematically the social regularities that he had encountered in two and a half years of ministering to the survivors of the disaster. The thesis was published in New York by Columbia University (Prince, 1920). Although Prince did not return to the topic of disasters until many years later, his work came at a time when there was a burgeoning interest in the field.

In 1923, Harlan H. Barrows, Professor of Geography at the University of Chicago, gave his seminal presidential address to the Association of American Geographers entitled "Geography as human ecology." Using the language of the time, he observed that "Geography will aim to make clear the relationships existing between natural environments and the distribution and activities of man" (Barrows, 1923, p. 3). Under Barrows's tutelage, a new field of the human ecology of extreme events grew up. Some of its protagonists were anthropologists, but many were geographers, including Barrows's student Gilbert Fowler White. White's thesis on diversification of the response to flood hazards was completed in 1942 and published as a Chicago research paper in 1945 (White, 1945). It helped to revolutionize hazard management in the United States and eventually in other countries as well, thanks to White's own students and followers (Hinshaw, 2006).

Unwittingly, Samuel Henry Prince had set the ball rolling concerning the study of how human communities adapt to, and cope with, extreme events. Another strand of this endeavor was soon to emerge in Prince's own discipline, sociology. In the United States, Lowell Juilliard Carr (1932) formulated a social theory of disaster phases and in the Soviet Union Pitirim Alexandrovich Sorokin, who knew Prince's work, was interested in the impact of stressful situations, as in conflict and disaster, upon social relations. His theories did not reach an international audience until the Soviet Government exiled him and, in his new home at Harvard University, he began to write in English (Sorokin, 1942).

In geography, Gilbert White effectively created a school of thought based on Barrows's formulation of human ecology (White, 1974). This established natural hazards as a legitimate field of study and began a long drawn-out process of combining natural sciences, such as seismology, volcanology, geomorphology, climatology, and meteorology, with social studies of how communities and populations react to hazards. Books such as *The En-*

vironment as Hazard (Burton, Kates, & White, 1978; second edition, 1993) were enormously influential in promoting this approach.

In the 1950s, Chicago remained prominent, but in sociology rather than geography. The National Opinion Research Center (NORC), based at the University of Chicago, grew out of social attitudes surveys conducted in the United States and United Kingdom during World War II (Fritz & Marks, 1954). Along with the U.S. National Research Council (National Academy of Sciences), NORC had an intense interest in the destructive impact, in physical and social terms, of a possible nuclear war. Analogies were sought in the effects of tornadoes, hurricanes, earthquakes, and floods. Psychologists were involved as well as sociologists. The results included Charles Fritz's work on the convergence reaction after disaster (Fritz & Mathewson, 1957) and Anthony F. C. Wallace's formulation of a psychological disaster syndrome (Wallace, 1956). The relevance of this work to nuclear studies may have been questionable, but it significantly boosted understanding of natural hazards.

By the 1960s, there were two powerhouses of disaster studies, both in the United States. At the University of Ohio, sociologists Enrico L. ("Henry") Quarantelli and Russell R. Dynes established the Disaster Research Center, which in 1985 moved to the University of Delaware, where it remains. At the University of Colorado at Boulder, Gilbert F. White created the Natural Hazards Research and Applications Information Center, later renamed the Natural Hazards Center. By the mid-1970s, a loose association of development specialists in the United Kingdom had formed the London Technical Group, which had established the journal *Disasters*, one of the first in a field that subsequently came to include at least 85 international journals dedicated to the topic, and hundreds more that occasionally publish articles on disaster.

These various initiatives put disaster studies on the map as a proto-academic discipline. Emphasis was strongly placed on studying the conditions that caused disasters and the processes of responding to them. How to mitigate calamity was yet to be a major priority in the academic work. For such a change to occur, there needed to be a revolution in thinking. In fact, there were several, as the next section shows.

Academic Approaches: The Evolution of a Concept

The review of academic organization and schools of thought leads to the question of how the ideas evolved. The term *disaster risk reduction* is new enough, at least in terms of general circulation, to be almost a neologism, but it has roots that go back a century to the earliest recognition that disasters are a class of phenomena that deserves systematic study. For more than half of the elapsed time, the approach was a linear one: physical forces cause an impact on the socioeconomic system, leading to impact, consequences, and aftermath. This gives rise to the basic conceptual equation $H \times V = R \rightarrow D$ (hazard times vulnerability equals risk, leading sporadically to disaster). In the 1960s and 1970s,

much effort was dedicated to attempts to work out the magnitude–frequency relationships of hazard impacts (Hewitt, 1970), which, given the paucity of data, was often a serious challenge. Concepts such as exposure, dose rate (derived from radiation hazards), and coping capacity were later added to the conceptual equation.

In 1983, Kenneth Hewitt and colleagues published what came to be known as the "radical critique" (Hewitt, 1983). It had become increasingly clear that the emphasis on hazards was obscuring the fact that vulnerability is a better descriptor of susceptibility to disasters. The radical critique argued that hazards were often little more than a trigger and vulnerability moreor less defined disaster risk. This message was reinforced in powerful discussions such as that by O'Keefe, Westgate, & Wisner ("Taking the naturalness out of natural disasters," 1976). This culminated in a book that has proved to be the most popular in the field, namely *At Risk: Natural Hazards, People's Vulnerability and Disasters* (Blaikieet al., 1994; Wisner et al., 2004). The essence of this work is the "disaster crunch model," or "pressure and release" model. In this, disasters are seen to be a consequence of root causes, dynamic pressures, and unsafe conditions, which cumulate to interact with hazards, the triggers of impact (Twigg, 2015, pp. 6–13). Thus, the authors of *At Risk* gave the world a model in which, for the first time, the context of disasters was seen as an influence that included more than merely extreme hazardous events.

The concept of resilience has a rich history that extends back more than two millennia (Alexander, 2013). The first systematic use of the term in the context of disasters occurred in 1984 (Timmerman, 1981), but it was not until the 2000s that it came into common currency in this field as a concept, an ideology, and a means of solving problems. The simplest way to explain resilience, or resiliency, is by analogy to the use of the term in mechanics in the 19th century. A material is resilient if, when a force is applied, it exhibits a good combination of resistance (i.e., strength) and ability to absorb the force (i.e. ductility). By analogy, society must show resistance and adaptability to hazards. A good alternative definition is that of the U.S. National Academies (2012, p. 16): "Resilience—the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events."

The concept of resilience arrived in disaster studies directly from the work of Crawford Stanley Holling in systems ecology (Holling, 1973). This is unfortunate, as it led to many misapplications of the term. Working at a time when island ecology provided environments that were closed systems for mass and open systems for energy, Holling was concerned to model homeostasis, in which once a shock had passed, the system would return to its original equilibrium (which could therefore be considered to be innate). As most physical and social phenomena in disasters do not have a stable equilibrium, this caused problems. The late Bernard Manyena was instrumental in promoting the idea of resilience not as "bounce back," but as "bounce forward," to a new and better state (Manyena, 2006; Manyena, O'Brien, O'Keefe, & Rose, 2011).

The "discovery" of resilience in disaster studies had a marked effect on the concept of DRR. The two terms came into use at a similar point in time. They stemmed from a grow-

ing impatience with the prevailing paradigm of “disaster management.” For decades, there had been a heavy emphasis on responding to disasters. This was embodied in Carr’s phase of “readjustment” (Carr, 1932) and in the subsequent, and intensely popular, disaster cycle model, it was the critical phase of emergency response (De Smet, Schreurs, & Leysen, 2015). In the United States, legislation in the 1990s endeavored to shift the policy emphasis from reacting to disaster to mitigating and preventing it. The problem here is that risk reduction involves capital expenditure that can often easily be deferred or deleted, whereas there is an absolute imperative to respond to disasters.

The concept of a disaster cycle (Richardson, 2005) has been one of the more enduring models used in this field. It probably stems from the work of the sociologist Lowell Juilliard Carr in the 1930s (Carr, 1932), and many different formulations have since been proposed. At its simplest, the cycle posits that disasters are repetitive phenomena in which there is a sequence of phases, including quiescence (dominated by mitigation activities), preparedness prior to an impending event (where premonitory phenomena allow warning and readying activities to take place), emergency response during the crisis phase, recovery of critical infrastructure and basic functions, and reconstruction. Kates and Pijawka (1977) divided the last of these phases into replacement and developmental reconstruction, in which the latter involved commemorative, often monumental, building processes and the relaunching of the affected area into a new phase of growth. Kates and Pijawka (1977) also showed that the speed and comprehensiveness of recovery, and thus the duration of the phases, had much to do with level of development and availability of resources, including those that support governance.

There are various motives for dissatisfaction with the disaster cycle model (Neal, 1997). To begin with, not all disasters are cyclical, and some are one-off events (for example, collapsing reservoir dams that cause outburst floods). The most cyclical extreme events are hydrometeorological ones that follow a pattern of seasonality, but even so, substantial irregularities are bound to occur. Secondly, the length of the phases is highly variable, both from one disaster to another and within the sequence of an individual event. In addition, the phases tend to overlap. Repetitive impacts can obscure or destroy the sequence. Thus, Hogg (1980) found that in Friuli, northern Italy, in 1976, two main earthquakes six months apart threw the cycle into reverse gear. Nevertheless, the cycle has proved to be a valuable means of organizing ideas and activities in emergency planning (Perry & Lindell, 2003) and emergency training (Alexander, 2000). Are scholars perhaps less comfortable with the concept of a disaster cycle than are practitioners? On behalf of anthropologists, Barrios (2017) saw the phases as expressions of longer-term cultural change, which is perhaps a good illustration of the search underway in DRR for an understanding of deeper root causes. In this, the cycle has a tendency tofocus attention on more superficial issues. This may trouble the scholars, although it may not matter to those practitioners who feel they are unable to change the root causes, the fundamental matrix in which disasters occur.

By the second decade of the new millennium, vulnerability and resilience studies were well established, with an emphasis on the local, or community, level (Djalante & Thomalla, 2011). However, hazards studies still dominated the scene. A movement had arisen against the use of the term *natural disaster*, with the intention of making it clear to all that disasters are not natural occurrences but are the result of vulnerability conditions that are eminently reducible if the right resources are applied (Cannon, 1994; Gaillard, 2019).

Disaster vulnerability must be seen as both specific and contextual. Specific vulnerability is that pertaining directly to future disaster impacts. For example, a house may be susceptible to collapse in a forthcoming earthquake. Contextual vulnerability encompasses all forms of vulnerability, such as poverty, unemployment, hunger, and susceptibility to disease, that are not a direct function of disaster risk but have a bearing in that it is not possible to make people resilient against disaster if they are not resilient against the depredations of normal life.

In as much as it is useful to make a distinction, disasters can be divided into five categories: those caused by natural hazards, technological failures, social issues (riots, strikes, crowd crushes, etc.), intentional acts, and composite events. The last of these includes both “natech” events, in which natural hazards cause adverse impacts upon technological systems (Krausmann, Girgin, & Necci, 2019), and cascading disasters (Pescaroli & Alexander, 2018). *Intentional disasters* is an umbrella term for terrorist incidents, including hostage taking, deliberate contamination, sabotage, shootings, hijackings, and bombings. Since the events of September 11, 2001, in the United States, much research has been conducted on the motivations, mechanisms, trends, and effects of terrorism, especially in the United States (Suskind, 2006). Terrorist acts can have profound enough consequences to be considered disasters, and they have been analyzed as such (Waugh, 2007). Waugh argued that terrorism has evolved over time toward a predilection for mass-casualty attacks, which often include the suicide of the perpetrator. He concluded, “The potential lethality and destructiveness of terrorism today make it a hazard that cannot be ignored” (Waugh, 2007, p. 388).

From the point of view of anticipating terrorism and combatting the threat of attacks, one of the main problems is the extreme mutability of terrorist strategies. Whereas natural hazards tend to follow predictable patterns of magnitude and frequency, terrorist incidents vary widely in their power, location around the world, and mode of operation. Thus they pose a serious problem of predictability, scenario building, and foresight-based planning (Coaffee, 2009; Kaplan, 2005). Essentially, civil defense has mutated from defending noncombatant citizens against aggression by foreign powers, or perpetrators of civil war, to counterterrorism (Alexander, 2002). Civil protection, by contrast, is the process of preparing for, responding to, and recovering from most other kinds of disaster or major incident. It has only a limited role in counterterrorism. It is not involved in the gathering and interpretation of intelligence, in surveillance, in forensic work, or in crime-scene in-

vestigation, but it is involved in bringing rescue and care to victims and survivors (Alexander, 2016, p. 165).

In the context of this article, several questions about terrorist acts need to be answered. Is terrorism a disaster? If so, is it exceptional in relation to other forms of disaster? Can it be managed using DRR measures that apply to other forms of calamity? Terrorist incidents have a proven capability to kill thousands of people, create massive destruction, and, crucially, cause huge disruption and widespread, persistent anxiety. In this respect, they have major disaster potential. Their ability to interfere with the normal workings of society and the difficulties of predicting them make terrorist incidents somewhat exceptional. However, the latter should not be overstated, as there are trends and consistencies in the progress of terrorism at the scale of countries, continents, and global developments (Kluch & Vaux, 2016). In terms of preparedness and response, counterterrorism must either coexist with, or be incorporated into, plenary DRR. As a result, there tend to be two strands in this, based upon the concepts of security and safety. The former involves surveillance and related procedures; the latter deals with structural and nonstructural measures of reducing vulnerability and exposure to extreme events of various kinds. Clearly, there is overlap. Counterterrorism is thus part of, or at least strongly alliedto, DRR.

The United Nations and Disaster Risk Reduction

Until the 1990s, there was little in the way of a global strategy for reducing the risks and impacts of disasters. However, the relentless rise of losses made it imperative for such to be derived. In 1984, Dr. Frank Press, President of the U.S. National Academy of Sciences, had called for an international decade for seismic monitoring. Seismometer networks were fragmented at the time, even though major earthquakes had global resonances. When UN sponsorship and recognition were sought for the decade, delegates from developing countries tended to see the proposal as something that would exclusively benefit technologically advanced countries. Moreover, those who represented areas of the world that do not have significant seismic hazards were lukewarm about the project. Hence, it was changed into a decade for the reduction of disasters caused by natural hazards more generally. The UN International Decade for Natural Disaster Reduction (IDNDR) ran from 1990 until 2000. In 1994, the UN organized the Yokohama world conference, which resulted in the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and a plan of action.

Although 140 countries organized national committees for disaster reduction, the effect of the decade on the toll of disasters was muted. A preparatory publication by the U.S. National Research Council (1987) mentioned the goal of halving the effects of disaster in a decade. This was patently impossible, but it could be regarded as an achievement that the relentless rise in casualties was held down by improved mitigation. The greatest effect of the Decade was to increase international collaboration in DRR. Knowledge was

shared more readily, cooperative agreements were signed, and the requirements for reducing disaster risk were studied in a more concerted way. Such was the momentum that, when the Decade ended, its secretariat was rapidly transformed into a small, permanent office of the UN, the UN International Strategy for Disaster Reduction (UNISDR).

After five years of work, UNISDR launched the Hyogo Framework for Action, 2005–2015, a global strategy designed to ensure that member countries took disaster risk seriously and did something about it (UNISDR, 2005). The emphasis was on creating or strengthening institutions for better preparedness. The main weakness of the framework is that it was nonbinding and could not be enforced. In May 2008, when Cyclone Nargis struck Myanmar and killed 140,000 people, it was all too evident that preparedness, even response, could be ignored (Seekins, 2009). Nevertheless, other countries, notably India and Bangladesh, were more assiduous in preparing for disaster, and in some cases there were spectacular reductions in impacts—for example, as a result of mass evacuations in Cyclone Phailin in October 2013 (Pal, Ghosh, & Ghosh, 2017).

UN actions on disaster have emanated from Japanese cities that have had major disasters. Hence, Kobe in Hyogo Prefecture was the site of the Hyogo Framework. Sendai, city of the devastating March 2011 tsunami, is the home of UNISDR's Sendai Framework for Disaster Risk Reduction, 2015–2030 (UNISDR, 2015A). This is a more modern, forward-looking instrument than the Hyogo Framework. It refers to many of the issues that the latter left out, such as gender, human rights, animals in disaster, and people with disabilities. It discusses targets, although it does not set them. It simplifies the priorities for action from five to four, and it sets out the actions needed, at the policy level, to make DRR happen. Like its predecessor, the Sendai Framework is nonbinding and cannot be enforced.

An early criticism of the Hyogo Framework was that it is a top-down instrument that is remote when it comes to the reality on the ground. No matter how large they are, disasters are always local affairs, as the theatre of operations is always local. Two reports on this were produced by a consortium of nongovernmental humanitarian organizations, the Global Network of Civil Society Organisations for Disaster Reduction (GNCSODR, 2009, 2011). The first was entitled "Clouds but little rain...," in the words of a bishop from the East African drought areas. The reports concluded that the Hyogo Framework had had little impact at the local level. All things considered, national strategies for DRR are needed, but without a local agenda, there is no guarantee that they will translate into action on the ground where it is needed.

UNISDR's reaction to this was to found the Safe Cities initiative. This started with a declaration, made at Incheon near Seoul in South Korea in 2009, which involves a strategy with a ten-point plan (UNISDR, 2013). Although several thousand towns and cities have signed up to this initiative, they still only represent about one per cent of all urban settlements, and signing the declaration does not necessarily translate into effective disaster mitigation. Like the Sendai Framework, the Safe Cities initiative places emphasis on *governance*. Although for centuries since its inception in 1330 this word has been nothing

more than a synonym for government, it has come to assume overtones of transparency, responsiveness, and democracy. Disaster risk governance requires public administrations to consider the views of stakeholders and constituencies , to safeguard critical infrastructure , to monitor, measure, and assess risks . and to fund the work of reducing impacts.

The Sendai and Hyogo Frameworks are intended to be compatible with other UN instruments, such as the Framework Convention on Climate Change and the Sustainable Development Goals. These two are particularly important because the former deals with limiting hydrometeorological extremes of the kind that cause many of the world's flood, storm, and drought disasters, while the latter confronts the general vulnerability of the world's poorest people, who are also those most profoundly affected by disaster.

Practical Strategies: Getting Disaster Under Control

The guiding purpose of the UN frameworks is to ensure that DRR is "mainstreamed" and is an enduring part of the agenda, particularly for the making of governmental policy. However, this begs the question of at what geographical scale is DRR most effective? When large disasters strike poor developing countries, the result is often a relief appeal, managed by the United Nations and announced through the country's embassies abroad. Search-and-rescue teams will travel around the world, although they do so at very high cost and with minimal benefits in terms of numbers of lives saved. Typically, a major earthquake may see the convergence of 1,200 to 2,000 foreign rescuers. In the Haiti seismic disaster of January 2010, despite a death toll estimated at between 70,000 and 300,000, only 139 people were rescued, only nine of whom were brought out of the rubble after the fourth day of the aftermath (Benjamin, Bassily Marcus, Babu, Silver, & Martin, 2011). Like international shelter provision, search and rescue tends to be an inefficient, often ineffective, process. Nevertheless, it is part of a humanitarian response that the Dutch journalist Linda Polman dubbed the "crisis caravan" (Polman, 2010).

International disaster response is at best unwieldy and at worst inappropriate. It is also in crisis, as a result of the complexity of moral judgments that must be made when a simple assumption of neutrality when supplying aid is not sufficient (Ramalingam, 2013). The "aid industry" has learned to make needs assessment, but some commentators have detected a state of "assessment fatigue," born of skepticism about the effectiveness of needs assessment and lack of collaboration between humanitarian organizations that are effectively competing in the field (Olin & von Schreeb, 2014). Aid remains poorly tied to development assistance, and the agenda for the latter changes at intervals with the varying dictates of a donor country's ways of projecting its "soft power."

In an age of identity politics and renewed "tribalism," there has been something of a retreat from globalism into more limited forms of nationalism. The international arena remains one in which expertise will continue to be shared and common aims pursued, for example, in applying the benefits of science to DRR (UNISDR, 2015B). But is the national

level the right one for mitigation and preparedness? As countries tend to have distinctive legal and administrative systems, the answer is usually Yes, but there are problems with "top-down" policies which either never materialize on the ground or are not appreciated when they do so. Disasters, of course, do not respect administrative boundaries. Hence, some degree of harmonization and interchange is needed, especially at the national level, or even above that at the regional level. To face up to disaster risk, countries need to start by passing a basic law that creates a statutory system for managing hazards, vulnerabilities, and impacts.

By promoting a common modus operandi, a country can ensure that its provinces and municipalities work together and assist each other both to tackle disaster risk and to respond to impacts. In fact, the municipality can be considered the "bedrock" unit of risk and emergency management planning (Alexander, 2016). However, there are problems with such a conception. First, municipalities can vary enormously in size and composition, from extensive conurbations to small rural villages. Their requirements in terms of hazard abatement, threat control, vulnerability reduction, safety, and security may vary widely. Secondly, although the concept of a municipality—local government—may be convenient in terms of public administration, it may be lacking in other areas. These include the private sector, which operates at a wide variety of scales, and the presence of community.

The 2010s saw a strengthening of interest in the idea of community-level DRR (Arbon, 2014). Many researchers saw community as a force for good and a way in which people could identify with something that bound them together and united them against disaster risk. In fact, the concept of community was intimately bound up with that of social capital, the latent resources inherent in society (Aldrich, 2012). Although this approach may be valid in certain well-defined circumstances, it suffers from four problems. The first is that the scale of a community may be hard to define. Internet users may form a community of like-minded people with a common agenda but be located in different countries and time zones. Even in a single urban place, does community operate at a citywide level or at the scale of neighborhoods? Second, communities are often neither socially homogeneous nor united in their aims and objectives. They can be fragmented and composed of disparate elements. Third, it is a mistake to assume that communities are therapeutic social organisms. They may be riven by factionalism, strife, and competition. Communities generally have leaders, but whether such people truly represent the will and aspirations of those they lead is an open question. Fourth and finally, social capital has been criticized (Haynes, 2009) as being a misleading concept that is neither capital nor necessarily a force for good. Despite these caveats, if DRR is practiced by local people, working in concert, it is more likely to succeed because they are more likely to feel that they have a stake in its outcome.

At its best, community DRR can safeguard the integrity of local social, economic, and cultural relationships. If these are sound, the social fabric is likely to survive the depredations of disaster and renew itself afterwards. Local know-how, combined with scientific

knowledge, can provide the answers to the dilemmas and challenges of mitigation. Hence the popularity of community-based approaches.

A related question concerns whether DRR is culturally conditioned, or at least to what extent it responds to cultural imperatives. J-C. Gaillard (2019) has provided a compelling critique of Western models of science and how they have tended to crowd out alternative narratives and explanations. He would argue that community-based DRR is unlikely to work if no one listens to what the community has to say. Through religion, belief systems, and social mores, people have many different ways of rationalizing disaster risk. A common one is cognitive dissonance (Cooper, 2007), meaning belief in two incompatible things simultaneously. A typical example might be, “earthquakes are a problem here; I live here, but I am not at risk of earthquakes” (Hansen & Condon, 1989). The tendency to invoke the “syndrome of personal invulnerability” is reinforced by Kates’s “prison of experience” (Kates, 1962, p. 132), in which people cannot extend their perception beyond what they have experienced, whether or not that is a guide to future impacts. Nonetheless, indigenous knowledge is not to be sneered at, especially when it embodies tried and tested coping mechanisms.

To activate DRR, first both the hazards (or threats) and vulnerabilities must be known. This involves compiling magnitude–frequency relationships for known and tractable hazards. These are often limited by short runs of data and by the tendency of mean values to shift over time as dynamic changes occur in the environment, for example, global warming. This can amount to a problem of “fat-tailed distributions,” or negative skewness, meaning that very large events are more probable than a simple Gaussian distribution would suggest. Meanwhile, vulnerabilities are also dynamic and must be seen as a coupled system of specific and general susceptibilities, representing the negative side of people’s abilities to resist harm.

Foresight involves knowing what to expect and preparing to confront the impacts. Planning should be based on scenarios. These should provide a range of mechanisms whereby hazards can strike (for example, at different times of day, with differing severities, in different combinations) and should investigate the potential consequences. Preparations should be made on the basis of known hazards, assessed vulnerabilities, and likely outcomes. Strictly speaking, “black swans” (Taleb, 2008) will not occur. These are events or phenomena whose occurrence is totally outside the realm of experience and which cannot be foreseen. As virtually all natural and anthropogenic hazards have some form of knowable antecedent, we can surmise that the black swan is extinct and its ecological niche has been occupied by the red herring!

Some of the most difficult and intractable elements of DRR are the root causes. In order to focus attention on these, experts have proposed that disasters be investigated by forensic methods (FORIN Project, 2011). These should be able to separate the more superficial triggers of events from the underlying factors that make them chronic or serious. Poverty, disability, marginalization, and deprivation are often present in the root causes of disaster vulnerability.

Lastly, in the practical sense, there is the question of welfare. This could be defined as "the provision of care to a minimum acceptable standard to people who are unable adequately to look after themselves." The definition is the author's own, as the literature is remarkably short of working definitions of the term, perhaps because it is not politically expedient to be too precise about what it means. The rationale of welfare stems from the moral observation that all people and groups should be able to lead lives to whatever minimum standard of safety and well-being that society is able to guarantee. Kinship groups, nongovernmental organizations, and governments are all involved in the provision of welfare. Failure to provide it means that disaster will selectively "pick off" the weakest in society, something that unfortunately is all too common.

Welfare comes into sharp relief during disasters, but to define it adequately requires a consideration of what it is not. For instance, "forgiveness money" involves compensating people for taking unnecessary risks, which forms part of the insurers' moral hazard, whereby risk-takers are subsidized by non-risk-takers (Trainer & Bolin, 1977). One of the most common distortions of welfare is political largesse. Disaster survivors are also voters. Whereas the political value of, for example, flood defenses is likely to be relatively low, the value of making people feel that they are looked after may well influence their voting patterns, however inefficient the disbursement and however it eschews the problem of getting people to take responsibility for their own risks.

A Critique of the Concept of Disaster Risk Reduction

As the second half of the 20th century progressed, it became clear that merely responding to disasters would not see improvements in the ability to reduce future impacts. Preparedness means being ready to respond rapidly, efficiently, and effectively when the next impact occurs, whether it is rapid or slow in onset, whether it is soon or distant in time, and whether it is large or small. However, it also means preparing to reduce the impact by putting in place measures to mitigate it, whether these be structural (such as flood defenses or anti-seismic construction) or nonstructural, such as emergency plans, recovery plans, controls on the use of hazard-plagued land, or insurance schemes. The transition from the catch-all term *disaster management* to *resilience* and *disaster risk reduction* betokened both a desire to see a real reordering of priorities and a recognition that the age of mitigation is here.

In 1962, Thomas Kuhn published his ground-breaking book *The Structure of Scientific Revolutions*, which described the paradigm model of consensus in science (Kuhn, 1970). Mounting evidence that the prevailing paradigm is wrong, inefficient, or inadequate to explain phenomena and causal relationships until a new consensus is built around another, more appropriate model, and this is the scientific revolution. What evidence do we have that DRR is a paradigm? Indeed, what evidence is there that science, or anything else, proceeds by the Kuhnian model? Critics of Kuhn's theory have argued that multiple paradigms can exist simultaneously, or, in other words, that science is more diverse than

Kuhn's model allows (Scheffler, 1967). DRR is not necessarily science, but it either possesses or needs a scientific basis if it is to provide answers to pressing issues of how to cope with disasters (UNISDR, 2015B). Among the communities that deal with threats, hazards, vulnerabilities, and responses, resilience has become such an accepted term that it probably merits the title of "paradigm." There is a distinct risk here that it will suffer the Kuhnian fate of paradigms, that users will become disenchanted with the idea. In 2005, in the aftermath of Hurricane Katrina in New Orleans, some groups of displaced citizens opposed the concept of resilience because they saw it as a means by which outsiders imposed unwanted solutions on them and ignored their real needs. In the scientific community, there is sometimes a sense that researchers are attributing powers to the concept of resilience that, through its innate simplicity, it manifestly lacks (Tierney, 2015). There is thus a risk that both resilience and DRR could become mere fads, rather than enduring concepts, although at present it is difficult to see what can replace them.

The Future of Disaster Risk Reduction

Despite archaeological and architectural evidence of an urge to count the effect of disasters, such as flood markers in ancient cities, systematic records of the impact of disasters have only been kept since the early 1970s. What they reveal is that impacts are "spiky," in that an uneven sequence with a gradual upward trend is punctuated by occasional events that are excessively large, the "spikes." To some extent, this is to be expected, as world population has tripled in 70 years and continues to rise. Thus, to maintain the same death toll (in raw numbers) in those parts of Africa where there is a population doubling time of 20 years, such as Burkina Faso, death tolls per 100,000 of the population would have to halve every two decades.

A greater issue may be the proliferation of vulnerability. This takes two main forms. The first is a function of the widening wealth gap, which means that a handful of people control half of the world's disposable wealth, and, if present trends continue, by 2030 they will control two thirds. This reduces the resources available to reduce both general and disaster-related vulnerability. Globally, wealth disparities began to emerge as a major trend in the period from 1970 to 1973. Although scholars have devoted much attention to the relationship between poverty and vulnerability (which is substantial and direct, but not absolute), there have been few analyses of how the great wealth divide affects the susceptibility of ordinary people to disaster (cf. Howell & Elliott, 2018). The second form of vulnerability is related to the interconnectedness of society, and its increasing dependency upon critical infrastructure and information and communications technology. Infrastructure failure can propagate disaster through a series of linked vulnerability states and thus greatly amplify the primary impact, especially at escalation points where vulnerabilities interact.

In studying DRR, there is increasing interest in root causes. Many of these, including the great wealth differential, have to do with society's power structures. In diverse kinds of society, it is not uncommon to encounter elite capture, in which those who hold the reins

of power capture the agenda and divert or subvert it to their own benefit. In this respect, good governance and democracy are fundamental aspects of DRR as it is practiced. The lack of either can limit citizens' access to the information they need to reduce the risks they face and can further constrain their options for doing so. One important factor in this is corruption, which is extremely widespread and deeply rooted in the modern world. Indeed, research suggests that corruption may be the leading factor in determining the gravity of earthquake disasters (Ambraseys & Bilham, 2011; Escaleras, Anbarci, & Register, 2007). This is because of its effect on weakening building regulations. In Chile, where corruption has been held in check, massive earthquakes have more limited effects than they do in places where the building codes have been ignored by corrupt planners, builders, investors, and inspectors.

Researchers have begun to make serious studies of the relationship between disasters, or DRR, and conflict. Warfare is, of course, a disaster in its own right, but by convention it is not included in the portfolio of events that are studied as part of DRR. There is, of course, overlap, for example in planning postdisaster and postconflict reconstruction. However, there is increasing interest in the prospects for DRR in areas of the world that are perennially unstable. DRR does exist in war-torn Syria and Afghanistan. It is an issue in the disputed, militarized territory of Kashmir and on the Bangladesh–Myanmar border where persecuted Rohingya refugees have arrived. Obviously, DRR is more difficult in areas of conflict and instability, but it is still needed and must be practiced, whatever the state of governance and whatever the limitations (Kelman, 2011).

Global instability has produced a record number of international refugees and internally displaced persons. At the same time, massive shifts in the global economy are stimulating migration on a scale never before seen. If instability proliferates, and when artificial intelligence begins to bite into the employment market, then migration will become even more of an issue. The same will be the effect of climate change, in which parts of the globe may become virtually uninhabitable. In the period since World War II, capital has become more and more mobile, but labor has not been able to keep up. With somewhere between 55 and 67 tax havens and few controls on the movement of financial resources, the flight of capital is assured. Belatedly, migration is trying to catch up, but with many more restrictions on movement than those that apply to capital.

Refugees are not only at the bottom of the social scale, they are usually bereft of personal resources and shorn of the ability to cope. In the future, major unplanned mass migrations could easily coincide not only with military instability, but also with disasters caused by natural hazards. At present there is debate about the extent to which climate change will induce mass migration, about which some commentators are skeptical (Perch-Nielsen, Bättig, & Imboden, 2008), but it is nevertheless clear that the age of geographical inertia is ending. Disasters and migration will converge. Currently, the overlap between the two fields is limited to phenomena such as evacuation and shelter, but it is also frequently characterized by crises of leadership and precariousness of livelihoods. In the

future, the coincidence of natural hazard impacts and migration emergencies will become more common and potentially more serious.

Conclusions

DRR is a modern perspective on an idea that has ancient roots and is supported by a century of progressive academic study. It aims to put the human response to disaster risk on the mainstream policy agenda. While this has mainly taken place at the national level, it has been supported by international initiatives and has had some effect on local, municipal preparedness. It has long been clear that a reorientation of policy is needed from merely responding to disasters when they occur to preventing and mitigating them and managing and reducing the risk. DRR closely allies with the concept of resilience, in which people and organizations are encouraged to become resistant to disaster impacts and also to adapt to the risks. However, for many governments faced with the need to reduce expenditures, DRR can become a soft option for which support is liable to be cut. This is a form of institutionalized gambling with the probabilities of major disaster, that it will not happen during the—usually short—lifetime of a particular legislation.

For DRR to work well, it needs to take place in a context of transparent, responsive, and democratic governance. When human rights are restricted, information flows are distorted, the opportunity to act is reduced, and disparities proliferate. DRR presupposes a fair and equitable society. For example, in the context of disasters and risk, there should be no gender victimization (Enarson & Fordham, 2001) or discrimination against people with disabilities (Kelman & Stough, 2015). Clearly, rights come with responsibilities, and good governance should emphasize both.

Momentous changes are at work in the modern world. Human mobility is increasing with respect to all categories: forced, induced, and voluntary migration. Environmental change is accelerating. Hydrometeorological extreme events are likely to become bigger and more frequent as time passes. World population is multiplying. Economic inequality is intensifying. Dependency on complex networks of critical infrastructure is increasing. These factors represent exceptional challenges for DRR, which must reduce the threat of cascading events in which there are “consequences of consequences” (Pescaroli & Alexander, 2018). Scientific findings need to be applied, and linkages need to be investigated. Fortunately, there is a formidable international collaboration designed to promote such efforts (UNISDR, 2015B). However, much needs to be done. One of the biggest challenges is to get populations, communities, organizations, businesses, and governments to take disaster risk seriously and to play mature roles in the process of reducing risk. This requires transparency, collaboration, the assertion of both rights and responsibilities, and the allocation of resources. Foresight must be funded, but it must also be recognized as a necessary component of human life in the 21st century.

Under the duress of environmental change, population increase, economic and political polarization, and technological development, society is changing at such a rate that it is difficult to predict the future of DRR. For example, mass usage of social media in emer-

gency response only began in 2009, but in the subsequent decade it proliferated and began to change its character profoundly as different factions and groups learned to exploit the media (Palen & Hughes, 2018; Zhang, Fan, Yao, Hu, & Mostafavi, 2019).

There is a pressing need to understand the root causes of disaster (Bankoff, 2019). Many of these are political in nature and it is important not to shy away from political analysis and discussion. The prevailing ethos that "science is apolitical" is not only untrue, it is profoundly misleading, but science must be harnessed in the service of progressive, democratic forces that genuinely work to reduce disaster risk. Both migration (human mobility) and environmental change (global warming, mass extinction, sea-level rise, and extreme weather) will be important influences on the frequency and magnitude of disasters. They will mobilize new and challenging forms of human vulnerability (Otto et al., 2017). Given the risks of violent conflict associated with the disruptions caused by these phenomena, and the increasingly polarized political situation, then disasters will need to be studied together with conflict. Hitherto, the two fields have largely been isolated from one another. That position is looking increasingly unsustainable. In the end, it may all boil down to a single observation: that in seeking an explanation, the context may become more important than the event itself.

For the student of DRR, there is a need to define a core curriculum. In the modern day, too much research repeats the work of the more distant past. As a distinct field, disaster studies have a history that stretches back more than a century. It is important that the landmark papers and books are not forgotten. To illustrate the point, two important texts are mentioned here, both of which offer perceptive insights into the human condition in disaster—Sorokin (1942) and Hewitt (1983)—but it is possible to compile a list of at least 50 landmark scholarly works in disaster studies (Alexander, 2017). The majority of these are available in digital form.

DRR is a lively field in both the practical and academic fields. It brings the imperative to safeguard life, property, and livelihoods and it confronts formidable challenges. Disaster often lays bare the inner functions of society. Disaster reduction must ensure that they remain healthy and provide the safety and protection that citizens everywhere need.

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