



From Disaster Risk Reduction to Policy Studies: Bridging Research Communities

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Abstract: Major conceptual and empirical advances over the past three decades have clarified how natural hazard events interact with community and human exposures and vulnerabilities to create risks that then become emergencies, disasters, or in the worst combinations, catastrophes. However, corresponding disaster risk reduction (DRR) knowledge and technology exist to significantly lessen the impacts of hazard events, but in many countries, including the United States, it requires major policy changes and implementation actions by public officials, particularly at local levels. With event losses continuing to mount, the DRR research community must demonstrate relevance and connections to the policy studies community in its most inclusive sense and draw in those scholars so that DRR research is more convergent and balanced and so that DRR advocacy is more informed and effective. To attract more policy studies scholars to DRR, and to disaster research more generally, a five-component bridge is offered based on the following equation: $EmR/DR/CatR = H + Ex \times V$, where the risk of an emergency (EmR), a disaster (DR), or a catastrophe (CatR) is a function of a community's hazard or hazards (H), its human and asset exposures (Ex) to those hazards, and the vulnerabilities (V) of those exposures. DOI: 10.1061/(ASCE)NH.1527-6996.0000365. This work is made available under the terms of the Creative Commons Attribution 4.0 International license, <http://creativecommons.org/licenses/by/4.0/>.

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Introduction

In 2016, the US National Science Foundation (NSF) announced Growing Convergence Research (CR) as a foundation-wide priority, defining it as a “means of solving vexing problems, in particular complex problems focusing on societal needs.” More specifically, NSF explained CR as having two major characteristics: (1) that it be “driven by a specific and compelling problem;” and (2) that it require “deep integration across disciplines” (NSF 2018). Although the 21st century is demonstrating many such compelling problems, disaster risk reduction (DRR) clearly qualifies as one such compelling problem that requires multiple disciplines in new collaborations to effectively understand and address.

The United Nations Office for Disaster Risk Reduction (UNISDR) has defined DRR as “preventing new and reducing existing disaster risk and managing residual risk, all of which

contributes to strengthening resilience and therefore to the achievement of sustainable development” (UNISDR 2016, p. 8). An important annotation then followed (*italics added*): “Disaster risk reduction is the *policy objective* of disaster risk management, and its *goals and objectives* are defined in disaster risk reduction *strategies and plans*.” That is, the international consensus definition emphasized that at its core, DRR is no longer so much about understanding the physical hazards themselves but rather about effective policymaking and implementation to deal with the risks associated with those hazards.

While publics around the world, as well as both traditional and social media, focus on high or shocking human casualty events (e.g., Hurricane Katrina's 2005 impacts in and around New Orleans and along the US Gulf Coast or the 2010 greater Port-au-Prince, Haiti, earthquake), most damaging hazard events are individually smaller but cumulatively much larger. From 1990 through 2018, 1.84 million people worldwide were killed by disasters, an annual average of 63,000-plus (CRED 2019). In 2016 alone, which was a year without a particularly high-profile event, Swiss Re (one of the leading global reinsurance firms) estimated total worldwide disaster losses at \$175 billion USD—up from \$94 billion in 2015 (Swiss Re 2017). The year 2017 then set a new global record, with Munich Re (another leading reinsurance firm) estimating total insured and uninsured losses at \$330 billion USD—half of which occurred in the United States (Munich Re 2018). For 2018, Munich Re estimated total insured and uninsured losses fortunately falling back to \$160 billion USD, but with the United States showing the largest single event losses at \$16.5 billion USD, which was a wildfire (the Camp Fire) in Northern California (Munich Re 2019).

From this perspective, the principal problem is not so much improving response to damaging hazard events, although that is still important, but rather attacking preevent the root causes of disasters (Blaikie et al. 1994; Wisner et al. 2004). More recently and in a broader context, Tierney (2014, p. 5) noted that “[b]ecause the roots of both risk and resilience exist within the social order itself,

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societies, communities, and organizations have the power to reduce risk and become more resilient.” Or as the UNISDR (2017) put it in the 2017 *Global Assessment of Risk [GAR] Atlas* (p. 12): “A change of focus [is needed] from managing disasters . . . to managing the underlying processes that create risk . . . , one that makes explicit and visible the hidden veins of disaster risk.”

To that conceptual shift from responding to events to managing risk must be added actually doing something about both ongoing risk creation and massive stocks of existing risk. Reflecting that challenge, the May 2017 United Nations Global Platform for Disaster Risk Reduction meetings in Cancún, Mexico, had as the conference subtitle “from commitment to action.” Or as one attendee put it, “We have talked it, [now] let’s see if we can walk it.”

However, “walking it” from rhetorical statements to action requires that the DRR research community (1) make new and strengthen existing conceptual connections with the policy studies community, which includes scholars studying policymaking processes, policy content, and policy evaluation, and (2) draw in that community to more fully involve itself in DRR issues, problems, and potential solutions. The underlying reason, in effect the convergence research challenge, is that the DRR community needs a stronger policy studies presence in its social science group to improve the DRR community’s team science (TS) balance with its natural science, engineering, technology, planning, and other groups. Although the TS approach developed separately from convergence research, particularly in medicine at the US National Institutes of Health, they are conceptually very close. In fact, from a DRR perspective, TS may be viewed as the operational expression of CR for “studies of complex social problems with multiple causes” (National Cancer Institute 2019; NRC 2015; Hall et al. 2017; Lanier et al. 2018).

The reality is that effective DRR in every country needs stronger policies and implementation regimes, which requires a combination of (1) much deeper research-based understandings of policymaking, particularly as it relates to DRR initiatives, and (2) significantly increased capacities for DRR communications and advocacy. In 2019, Ms. Mami Mizutori, the Special Representative of the U.N. Secretary-General for Disaster Risk Reduction, captured the task succinctly: “Scientists must speak in a compelling way to politicians and policymakers if an evidence-based approach is to inform national and local strategies for disaster reduction” (UNISDR 2019).

While there is some momentum in literature linking DRR and policy studies, it lacks coherency, thus limiting its cumulative impact. Some studies focus on international policy frameworks such as the *Hyogo Framework for Action: Building the Resilience of Nations and Communities to Disasters 2005–2015* and the follow-on *Sendai Framework for Disaster Risk Reduction 2015–2030* [(Zimmermann and Keiler 2015); on Sendai, specifically see Aitsi-Selmi et al. (2016)]. Others assess policies or programs or their components (e.g., public engagement) at the international (Chan et al. 2019), national (Ahmed 2013; Amri et al. 2017), or local level (Burnside-Lawry and Carvalho 2015; Garschagen et al. 2018).

The literature also includes studies of the effects of other frameworks or policies (e.g., decentralization) on DRR (Grady et al. 2016) or DRR aspects in planning (Crnčević and Lovren 2018). Other studies link DRR and policy evaluation via qualitative data collection methods, including document analysis, interviews, and focus-groups (e.g., Ahmed 2013; Burnside-Lawry and Carvalho 2015; Crnčević and Lovren 2018; Grady et al. 2016; Zimmermann and Keiler 2015) or mix some of these methods with surveys (e.g., Amri et al. 2017; Garschagen et al. 2018).

Studies employing quantitative decision support tools utilized in policy studies, such as benefit-cost analysis, remain rare in the DRR literature, in part due to “a lack of data and expertise and high

resource demands” (Kull et al. 2013, p. 378). Shreve and Kelman (2014) argue that studies that use benefit-cost analysis in DRR typically have significant limitations, such as, for example, failing to consider alternative climate change scenarios, durations of benefits, and sensitivity analyses, which examine how outcomes change with variations in assumptions, inputs (e.g., discount rates), or other analytic components. They further argue that these concerns need to be addressed “[t]o represent the potential benefits of DRR more comprehensively to decision makers” (p. 232).

Of particular relevance to this paper is how little is known about the ways in which DRR policies, particularly at the national to local levels, are developed and adopted. Kishore’s (2010, p. 6) point remains valid:

There is very limited literature on the process aspect of institutional and legislative systems. It is easy to find a compilation of recently enacted disaster risk reduction related legislations but extremely difficult to find documentation on the process that led to the formulation, enactment and implementation of the provisions of the new legislation.

With these needs in mind, this paper is intended to fill, or at least bridge across, three interrelated gaps between the DRR and policy studies communities. The first is an *accessibility* gap where because DRR is often framed in physical science, engineering, planning, or similar terms, the discourse appears densely technical and relatively closed. This paper will demonstrate that what are commonly thought of as technical issues (building codes are a prime example) are quite understandable when viewed from a political and policymaking perspective.

The second is a *relevance* or *connectedness* gap to principal questions in mainstream policy studies where DRR may appear at first glance to be unrelated to the field’s major theoretical concerns and frameworks. This paper will show that DRR, and what are called more generally disasters, have a centrally important but understudied place in the conceptual frameworks of the policymaking process.

The third gap between the DRR and policy studies communities is in *communications-advocacy*. As implied in the previous Mizutori quote, many physical and atmospheric scientists, engineers, or other geotechnical experts, and even social scientists, often find it difficult to understand and communicate with policymakers and, particularly, political leaders (the *we seem to be on different planets* syndrome). While policy studies scholars often face the same problems, they are much more familiar with the language and mores of the policymaking world and can and should play key roles in the understanding of, and then advocacy for, DRR.

Stronger links between DRR and policy studies will contribute to knowledge and practice advancements in six more specific ways. First, it will orient DRR scholars toward more in-depth understandings of how policy processes work and how and when some DRR issues are recognized as important and achieve agenda status, as expressed in Kingdon’s (1984, p. 1) classic question, “How does an idea’s time come?” Second, it will help scholars in both DRR and policy studies communities understand how, when, and why some disasters become focusing events [(Birkland 1997, 1998, 2006); see also the pathbreaking May (1992)] and lead to significant policy changes while other disasters do not. This is a critical theoretical and empirical issue because of the tendency, in Birkland’s (2016) words, to “select on dependent variable” (major policy change) and then track back to find a focusing event, which of course tilts the analysis toward finding one.

In line with Birkland’s challenge to be more discerning, O’Donovan (2017a, b) has researched policy failures revealed by

disasters and subsequent policy learning, and DeLeo (2018) has examined rapid versus slow indicator accumulations and their impacts on agenda-setting. However, much more focusing event research is required to fully answer why some major hazard events lead to changes in agendas and then policy while others do not.

In the wake of Hurricane Katrina in 2005, for example, the US Congress passed the (70-page) *Post-Katrina Emergency Management Reform Act of 2006* that made extensive changes in the roles and responsibilities of the US Federal Emergency Management Agency (FEMA) and very specifically “provided additional authorities to federal agencies to address the shortcomings from Katrina” [(GAO 2018, p. 3); see GAO (2008, 2013) for the development and implementation of this act]. In contrast, after 2017’s Hurricane Maria that devastated Puerto Rico, the US Congress largely left policy improvements to FEMA itself, which issued an afteraction report for the whole of the 2017 hurricane season and listed some internal corrective steps to be undertaken (FEMA 2018). The only FEMA-related legislation enacted after Hurricane Maria was the (one page) *FEMA Accountability, Modernization, and Transparency Act of 2017* calling for modernization of FEMA’s grant systems for disaster assistance (e.g., through an online interface) rather than addressing any specific Maria-related shortcomings, despite the storm’s high human death toll [“excess mortality,” see Milken Institute School of Health, the George Washington University (2018)] in Puerto Rico that settled officially, after much debate and litigation, at 2,975 souls.

Third, linking longer-term policy studies to DRR will inform both research communities on how DRR policies are generated but then challenged and revised by interest groups and by the judicial branch (e.g., in the US, *the Harvest Family Church v. Federal Emergency Management Agency*) even after they are being implemented by the executive branch.

Fourth, this paper hopes to attract or at least facilitate more policy studies scholars to (1) provide systematic feedback on adopted DRR policies and programs that would allow implementation modifications and, when indicated, strategic course changes, and (2) for lack of a better term, *watchdog* DRR initiatives to flag merely rhetorical or symbolic DRR initiatives by, for example, blue-ribbon commissions or special study reports that take months to complete and in the end yield little or no concrete outcomes.

Fifth, linking policy studies to DRR will show the latter community of scholars how problem definitions shape DRR solutions, as noted by Stone (2002, p. 133) in general terms:

Problem definition is never simply a matter of defining goals and measuring our distance from them Problem definition is a matter of representation because every description of a situation is a portrayal from only one of many points of view. Problem definition is strategic because groups, individuals, and government agencies deliberately and consciously fashion portrayals as to promote their favored course of action

Sixth and finally, closer ties between the DRR and policy studies communities will further familiarize DRR scholars with such policy analysis tools as the following: (1) stakeholder mapping to identify key stakeholders with an interest in such public policy problems as a community’s hazards and risks; (2) forecasting or estimating trends (e.g., increasing populations of the physically and socially vulnerable); (3) deflating, to control for inflation, DRR program costs; (4) improving benefit-cost analyses so that alternative policies are more comparable, particularly for the crucial issue of DRR outcomes; and (5) depicting decision trees and choice points and their possible consequences. Although these tools have been criticized for presenting “an appearance of objectivity and neutrality on issues

that are instead value-laden and political” (Clemons and McBeth 2017, p. 58), they will help the DRR research community sharpen its arguments and increase its effectiveness in policy advocacy.

Disasters in Major Conceptual Frameworks of the Policymaking Process

As noted above, a DRR reach out to the policy studies community is easier than it might appear because although framed within broader conceptual terms, what are commonly called disasters already have a place in major analytic approaches to understanding the policy process. In the foundational multiple streams approach (MSA) to explain policymaking, Kingdon in his original work [(Kingdon 1984); see also the subsequent editions (Kingdon 1995, 2011), and for fuller MSA development see Zahariadis (1999, 2003, 2007, 2014) and Herweg et al. (2017)] posited that major policy changes come about when three streams converge: (1) a problem stream, (2) a solution(s) stream, and (3) a political stream, when decision-makers are willing, or feel compelled, to suddenly address a problem that has previously not been on the agenda, or very high on it, with one or more of the proposed solutions. Kingdon was explicit in noting the importance of a “focusing event like a crisis or disaster” (Kingdon 1995, pp. 94–100) as often required to open *policy windows* [pp. 168–170; see also Keeler (1993) on macrowindows] and push a problem onto the policymaking agenda, including through changes or shifts in the “national mood” (pp. 146–149).

The importance of the MSA to the history and development of policy studies cannot be overstated, including for comparative analytic purposes, because it has been so widely used or at least invoked. At the time of their writing, Cairney and Jones (2016, p. 37) noted that it had been cited over 12,000 times and continued to have great appeal as a “Universal Theory” [but see also Béland and Howlett (2016) for a critique].

Although not as explicitly, disasters also figure in two other major analytic frameworks for understanding the policy process. In the revised version of their advocacy coalition framework (ACF), Sabatier and Jenkins-Smith [(1993, pp. 220–222); for a more general ACF update, see Jenkins-Smith et al. (2014)] added the concept of an “exogenous shock” (similar to Kingdon’s focusing event) that affects public opinion (similar to Kingdon’s national mood) and thereby policymaking systems by facilitating the development or strengthening of coalitions that push for policy change.

In the third major analytic framework, punctuated equilibrium theory (PET), Baumgartner and Jones [(1993); see also Baumgartner et al. (2014)] argued that the US policymaking system is characterized by illusions of stability whereby issue-based policymaking monopolies dominate, seemingly permanently. However, they argued that such policymaking monopolies are more fragile than is commonly perceived and that policymaking in fact lurches from attending to one problem or issue to another. Part of that lurching process are triggering devices, or at least attributed triggers (Baumgartner and Jones 1993, pp. 129–130), that change how a problem is perceived, defined or redefined, rises, or is forced onto a suddenly unsettled agenda and how that leads to at least potentially challenging which institutions are perceived as the most appropriate for dealing with a problem and, consequently, the policy solutions advanced to address it.

In sum, while the multiple streams approach is the most explicit about how disasters as *potential* focusing events [again see Birkland (2016) for that important italics] may affect agenda-setting and open windows of opportunity for policy change, disasters also logically qualify as exogenous shocks in the ACF and as triggering devices or attributed triggers in the PET. Seen from that

perspective, the DRR research community can directly strengthen its connections—its bridging or reach out—to the policy studies community. However, it will take special effort from the DRR side because of the way that research communities, particularly but not exclusively in the US, have developed over time.

It is now common to characterize scholarly research communities as isolated silos with little interaction, but a better metaphor would be islands of different sizes, shapes, and distances from each other. While conventionally defined as a subdiscipline of political science, policy studies is complex and can even be extended to include scholars in public administration and evaluation research, so this paper will use a *one bridge with five components* approach to strengthen and provide more coherency to the connections between DRR and policy studies in the latter's most inclusive sense.

The five components will flow from an elaboration of an early equation that has been fundamental to DRR and to disaster research generally. Each of the equation components will demonstrate the relevance of, and relatively easy connectedness between, DRR/disaster research and policy studies and thus facilitate greater research coherency.

The conclusion will then reprise the argued place of hazard events, or more precisely their societal impacts, in the three major policy studies analytic frameworks discussed above (MSA, ACF, and PET), highlighting their conceptual roles in, or connections to, those frameworks. Finally, it will address three possible motivations for policy studies in its most inclusive sense to engage with the DRR research community, ranging from research opportunities and the increasing emphases on convergence research and team science, particularly from funding sources, to a fundamental 21st-century moral imperative.

Bridge Component One: From R to $EmR/DR/CatR$

In the aftermath of most major damaging hazard events, except where fatalism reigns and disasters are still seen as acts of God, the public, traditional media, and now social media invariably ask some version of the question, *what just happened, and why?* Not to put too fine a point on it, that question—particularly the why part—is what makes disasters, and therefore disaster risk reduction, essentially public policy and/or policy implementation issues. After all, if communities are destined to periodically suffer from the effects of earthquakes, floods, cyclones/hurricanes, wildfires, or other hazard events, then nothing needs to be done in the secular realm. On the other hand, if disasters are seen as resulting from decisions about where to build, what to build, which standards to follow, and what populations are put (differentially) in harm's way, then disasters and disaster risk reduction are intrinsically policy (and political-economic, of course) issues.

In what became a classic, Blaikie et al. (1994, pp. 21–22) offered a remarkably succinct answer to the why question about disasters, and they modestly called it a pseudo-equation: $R = H \times V$, where risk (R) was a multiplicative function not only of a hazard (H) but also of the vulnerability (V) of the impact area, with vulnerability importantly understood as not only physical but also socio-economic. As Wisner et al. later explained with the slightly modified formulation $DR = H \times V$ (where R became DR for disaster risk specifically), the equation was intended as a “*reminder to enquire about both vulnerability (V) and hazard (H)—correcting a long-standing bias toward physicalist or hazard-focused research and policy*” (Wisner et al. 2012, p. 24, italics added). The $DR = H \times V$ equation remains widely used (Etkin 2016; Frigerio and De Amicis 2016; Ranke 2016; Nirupama 2012; USAID 2011).

It should be noted that Wisner et al. (2004) subsequently offered a more elaborated discussion of the vulnerability component that Wisner, with other authors, later expressed as $DR = H[(V/C) - M]$ where “. . . C represents capacity for personal protection and M symbolizes larger-scale risk mitigation by preventive action and social protection” [(Wisner et al. 2012, pp. 23–24); see also Flanagan et al. (2011); for a widely cited but somewhat different perspective see Adger (2006)]. To social protection as vulnerability reduction must now be added enhanced social capital in affected or at-risk communities, because bonding, bridging, connecting, and linking with others is increasingly understood as contributing to disaster resilience, including from the effects of climate change (Aldrich et al. 2016), where adaptation must be multidimensional (IPCC 2014).

But why did Wisner et al. feel so strongly about correcting that original long-standing bias toward physicalist or hazard-focused research and policy? The answer is that the bias had helped generate a most unfortunate term: natural disaster. O’Keefe et al. mounted an early (1976) challenge to that term, but it was Hewitt (1983) who fully developed the need for a corrected, or at least a more balanced, usage, including an early highlighting of the importance of public policy:

In the dominant view . . . disaster itself is attributed to nature. However, there is an equally strong conviction that something can be done about disaster by society. But that something is viewed as strictly a matter of public policy backed up by the most advanced geophysical, geotechnical and managerial capability [(Hewitt 1983, p. 6); for further reflections see Hewitt (1995)].

After Hurricane Katrina, Smith (2006) reiterated that argument, as have Bankoff (2010) and from a more political perspective Olson (2018). Smith was particularly emphatic:

There are no such things as “natural disasters.” Hazards events may be natural, occurring more or less frequently and of greater or lesser magnitude, but disasters are not. What makes a hazard event into a disaster depends primarily on the way a society is ordered. Human systems place some people more at risk than others, creating relationships best understood by an individual’s, household’s, community’s, or society’s vulnerability.

However, even without the misleading word “natural,” the term disaster has a rich history of discourse (Quarantelli 1998; Oliver-Smith 1999; Perry and Quarantelli 2005). In a 1986 presidential address to the International Sociological Association, Quarantelli (1987), one of the founders of disaster research, argued that the hazards and disaster research field needed to not only better define its core terms but also more systematically address the differences between *accidents*, *emergencies*, *disasters*, and *catastrophes* by defining each event level’s characteristics and establishing *threshold indicators*, particularly response requirements.

Quarantelli (2000, pp. 1–2) subsequently refined his argument by positing that organizational roles in disasters are very different from organizational roles in more everyday emergencies. Later, and clearly affected by observing the US experience with Hurricane Katrina, Quarantelli (2006) sharpened the next level distinction, between disasters and catastrophes, which was then further refined by Wachtendorf et al.:

The magnitude and scope of Hurricane Katrina facilitated the emergence of social conditions consistent with the characteristics of catastrophe, including those identified by Quarantelli as well as the characteristic newly-identified in this study

(mass and extended out-migration of residents) [(Wachtendorf et al. 2010; p. 8); see also Fussell et al. (2010); Gutmann and Field (2010); and Holguín-Veras et al. (2014); for a longer perspective on disasters and migration see Boustan et al. (2012) and Smith (2006)].

To streamline the argument for present purposes, *accidents* (which will be set aside for the remainder of this paper) may be understood as requiring only on-duty first responders and their standard resources. However, *emergencies* are more complex and require back-up and off-duty response personnel and the deployment of supplemental or warehouse resources. *Disasters* then require assistance external to the affected community or communities and the activation of latent response (e.g., the Red Cross) and extending organizations (e.g., utility companies and such key private sector suppliers as Home Depot or Walmart). However, *catastrophes* generate (1) new and/or fundamentally changed response organizations, (2) new and/or fundamentally changed social movements or combinations/alliances, (3) altered long-term demographics associated with push-pull migration patterns, (4) repurposed land (where some areas are never rebuilt or repopulated), and (5) in some cases, international assistance.

To clarify, the three thresholds are not equidistant points along a continuum, nor are they equally spaced steps up a ladder. The reality is that emergencies are relatively frequent, disasters less so, but, fortunately, catastrophes are still rare. From this three-level perspective and as part of the DRR reach out to the policy studies community, disaster risk reduction can thus be framed as decisions taken, policies developed, and programs implemented in a community that increase the probability that a major hazard event will result only in an emergency rather than a disaster or worst case, a catastrophe. But as will be developed further subsequently, all too often the problem is in the negative: decisions not taken, policy choices not made, and programs not implemented, which are precisely the areas where the policy studies community could be of crucial and specific analytic help to the DRR research community.

Two problems exist within the emergency/disaster/catastrophe threshold criteria. The first is temporal because while it is relatively easy in almost real time to distinguish between an emergency and a disaster, distinguishing if a hazard event's outcomes qualify as a catastrophe requires a much longer retrospective. Although with notable exceptions (Bolin 1985; Elliot and Howell 2017; Peacock et al. 2015), long-term recovery and longitudinal analyses are still too rare in disaster research and thus inhibit using past cases to exemplify the disaster versus catastrophe distinction.

The second problem with the thresholds should be familiar to virtually all research communities: the appropriate unit of analysis. To illustrate, the outcomes of a one-car automobile crash can be catastrophic for a family, and the use of community as the unit of analysis may mean anything from a neighborhood to a city, so it becomes very difficult without specified parameters to compare cases, especially cross-nationally. It is therefore incumbent upon the disaster research and policy studies communities to work together to define—and delimit—the postimpact unit of analysis, particularly because that will be a major analytic step toward establishing what might be called first-order accountability for the losses.

Establishing an agreed-upon unit of analysis between research communities is particularly important in comparative studies because hazard events are too often referred to by the media in simplistic national terms. Although there will be exceptions with small nation-states where a hazard event may indeed have direct country-wide impacts, the fact is that in most cases, human losses in a hazard event are subnational and geographically concentrated. To illustrate, on February 27, 2010, Chile experienced a magnitude 8.8

offshore earthquake and resulting tsunami, but in human casualty terms, it seriously affected only two of the country's 15 political-administrative jurisdictions (*Regiones*) in the south-central part of the country: Maule (*Región 7*) and Bio-Bio (*Región 8*), more than 400 kilometers from the seat of national government in Santiago. Although the event's shaking was felt over at least half the country, the Maule and Bio-Bio regions accounted for 69% of the reported fatalities: 379 combined of the total of 547 fatalities, according to medical records reviewed by forensic researchers Nahuelpan López and Varas Insunza (2013, p. 113). While other data sources show 521 fatalities for the 2010 event in Chile, they are much less detailed and specific than the forensic results.

The 2010 event in Chile brings up a collateral issue: how to define the unit(s) of analysis for direct economic damage and, therefore, first order accountability for those types of losses. Human losses are often more concentrated in political-administrative terms than economic damage, which can be quite widespread, particularly for infrastructure systems. Again, to illustrate with the 2010 event in Chile, the principal economic damage was to the transportation sector (ports, roads, bridges, and overpasses in particular) and extended well outside of Maule and Bio-Bio to several other *regiones*, including north of Santiago. A full picture of a major hazard event's impacts, and therefore the associated accountabilities, thus requires selecting appropriate units of analysis for both human and economic losses.

Bridge Component Two: From $H \times V$ to $H + Ex \times V$

The right side of the original $DR = H \times V$ equation obviously begins with a community's H , its hazard profile, or in Cutter's (2002) enduring term, its hazardscape. The last century and especially the last 50 years have seen unprecedented knowledge increases on the distribution, relative frequencies or recurrence intervals, and causal mechanisms of various hazard events. Plate boundaries, earthquake patterns, and subduction zones are well delineated, at least globally; tsunami-prone areas are well identified because of high-resolution geographical information systems (GIS); and tropical cyclone gestation and development models and track patterns are well established—although forecasting rapid storm intensification remains a major challenge. That is, for most communities, a specific hazard and its estimated parameters are, or can be, established, with one major exception: for communities facing primarily hydro-meteorological or related hazards (e.g., storms, rainfall, floods, droughts, and/or wildfires), climate change dynamics are destabilizing their hazard calculations, meaning that projections based on historical records are increasingly unreliable. While known more popularly as the 100-years flood every 10 years problem, the water management community is increasingly calling it a paradigm shift from reasonably stable climate regimes to nonstationarity (Milly et al. 2008).

From the viewpoint of the equation, change or at least instability in a community's hydrometeorological hazard calculations then has ripple effects across the remainder of our equation. In the US, the *Fourth National Climate Assessment (USGCR 2018a, b)*, by the multiagency federal US Global Change Research Program (USGCR), was explicit in describing the mounting effects of changing climate on the nation's hazardscape, from increasing storm intensities to longer and drier summers that increase wildfire potentials.

Based on early work (UNDRO 1992) that was not fully appreciated at the time but subsequently recaptured by Carreño et al. (2007) [see also Birkmann and von Teichman (2010)], there is a need to modify the right or action side of the original equation by

adding an *Ex* (exposures) to better capture the stunning increases in human population, infrastructure, and economic assets put in harm's way over the last century. The global picture is well known: human population in the year 1900 was approximately two billion but reached seven billion in 2012 and is estimated to reach well over nine billion by 2050. All of those people have had (or will have) to find at least minimal housing and employment somewhere, mostly in cities, where, in 2009 and for the first time in human history, more than half of the world's population was urban—with the pace of urbanization continuing to accelerate.

A quite vivid example of this exposure explosion to a major hazard is the state of Florida in the US, which in 1950 had a population of less than three million. However, according to the US Census Bureau (2018), the Florida population now exceeds 21 million. The vast majority of that population increase has occurred in coastal or near-coastal areas, greatly exacerbating both human and economic exposures in the most hurricane-prone of all US states. It should be noted that this type of exposure explosion is hardly confined to Florida. It is a global and continuing phenomenon (GFDRR 2016, see particularly Part 3).

However, exposures and exposure increases of various sizes and densities can have greater or lesser vulnerability problems depending upon how those exposures are chosen (or allowed), sited, and designed, and then constructed and maintained. To illustrate this point with a well-remembered DRR comparison, on February 9, 1971, a magnitude 6.5 earthquake reaching Modified Mercalli Intensity XI (extreme felt and observed shaking) occurred in the San Fernando Valley of southern California and killed 64 people (Bartholomew 2016). Less than 2 years later, on December 23, 1972, a magnitude 6.2 earthquake (no official MMI data are available for this event) destroyed approximately 90% of central Managua, Nicaragua's capital, and killed approximately 10,000 people (the exact number will never be known). The stark difference was due to the much greater population size and density in Managua, the city's building types, weak codes, and "lack of an effective building regulatory system for code enforcement" (Wright and Kramer 1973, p. 35). That is, a substantial portion of the Managua losses was attributable to classic policy failures: inadequate codes for its known risk and poor implementation of even the inadequate codes.

More recently in 2017, when Hurricane Irma passed through the central Florida Keys, the damage was relatively mild to newly-built structures that were elevated (to accommodate storm surge) and constructed to current building code (to withstand at least Category 3 winds). Even if elevated, structures built under previous, relatively weak codes were in many cases effectively destroyed. As an example, Fig. 1 captures the stark post-Irma differences between three structures with the same exposure. The one in the middle was built under 2014 building code requirements, with the ones on either side dating from the much less rigorous 1980s.

As Fig. 1 illustrates, a community's exposure factor in our equation might stay the same or even increase with further economic development but see its overall risk go down (from catastrophe to disaster and perhaps even to emergency) if hazard-aware DRR policies are adopted and implemented. Practically as well as conceptually, that type of DRR can be accomplished if the vulnerabilities of a community's exposures decrease or, more precisely with a policy-relevant transitive verb, are decreased. To illustrate, in the 1970s through the 1990s, various California cities (including Long Beach, Los Angeles, and San Francisco) enacted and implemented a set of retrofit programs for literally tens of thousands of unreinforced masonry (old brick) buildings, a type that had proven notoriously vulnerable to earthquakes [(FEMA 2009); see also the ahead-of-its-time Alesch and Petak (1986) article]. The outcome



Fig. 1. (Color) Hurricane Irma (2017), differential impacts in the mid-Florida Keys. (Image courtesy of Andy Newman/Florida Keys News Bureau.)

has been that an earthquake of a specific magnitude at its focus and locally high shaking intensities is now more likely to be a disaster than a catastrophe for those cities.

It must be pointed out that certain mitigation policies and programs can have the opposite effect if the magnitude or severity of a hazard event exceeds its expected range. For example, retrofitting and government-subsidized insurance programs may, in fact, set up communities for catastrophe because the measures may attract people and investment to hazard-prone areas (increasing their exposures) and create a false sense of security (Burby 2006). A catastrophe then eventuates if the hazard event exceeds DRR and preparedness measures designed for a normal range event.

While floods are the most common exemplar of that problem, the March 11, 2011 earthquake offshore the northeast coast of Japan that became a catastrophe for Fukushima Prefecture exemplifies this normal range problem. As a type of natural-natural-technological cascade event, a magnitude 9.0–9.1 earthquake triggered a tsunami that overwhelmed a protective wall at the Fukushima Daiichi nuclear power plant (sited at the coast for easy access to water) and shut down the energy supply for the cooling systems, which then led to reactor meltdowns, explosions, and the worst radiologic event in the world since Chernobyl. That is, given the coastal exposure of the Fukushima plant, its vulnerability was a protective wall designed for a normal range tsunami at the site—not one 10 m high.

A particularly poignant example of the exposure-vulnerability combination revolves around the poor, who are regularly highlighted as the most at-risk and/or suffering disproportionately from damaging hazard events (O'Keefe et al. 1976; Cuny 1985; Lewis 1999; Wisner 2001; Twigg 2004; UNISDR 2009; Cadag 2017). Kim (2012) found the poor to be approximately twice as likely to experience disasters as the nonpoor, even if they live in approximately the same geographic area. Simply put, better-off individuals and families live in better structures and possess greater resources to deal with event impacts: "Poor people are exposed . . . not only due to the increase in the probability of being hit by one, but also because of greater concentration in risky areas due to migration, higher population growth, or less propoor growth" (p. 209). In contrast, the wealthier strata recover more rapidly and may even become more advantaged as economic opportunities appear during recovery, mostly for them (Mutter 2015).

Exacerbating the general poverty = vulnerability socioeconomic problem is a specific component: gender. Poor women tend to live and concentrate in more precarious situations and are thereby more

exposed to hazards (Denton 2002; Kahn 2005; Neumayer and Plümper 2007; Juneja 2008; World Bank 2010; Ganapati 2012).

Bridge Component Three: The Equation, Crosslinks, Nondecision-making, Symbolic Politics, and Windows of Opportunity

Summing up for relevance to the policy studies community the previous two DRR bridge or conceptual reach out components, modifications to both sides of the original $D = H \times V$ equation yield the following: $EmR/DR/CatR = H + Ex \times V$, where the risk of an emergency (EmR), a disaster (DR), or a catastrophe ($CatR$) is a function of a community's hazard or hazards (H) of course, but crucially its human and asset exposures (Ex) crossed with the vulnerabilities (V) or susceptibilities to harm of those exposures.

Conceptually, the expanded formulation is intended to highlight the value of DRR as not only exposure reduction or better exposure management, but also and most notably, vulnerability reduction. Too often, the public and the media focus on postimpact response and pigeonhole major damaging events as singular or one-off occurrences, not the result of often decades of patterned, cumulative, but largely invisible exposure- and differentially vulnerability-creating (Cutter 2016) policy decisions and nondecisions.

Long familiar to the policy studies community, the term *nondecisions* in this study derives from the original work by Bachrach and Baratz (1962, 1963, 1970) and conforms to the explanation by Jordan-Zachery (2008):

Nondecision-making involves suppressing challenges to the status quo and suppressing the addition of new issues to an agenda. Issues are excluded from an agenda because they are threatening in some direct way, or because of the competition for the limited space for agenda items.

In many communities where DRR challenges the status quo (and often specifically, what to do about potentially massive stocks of existing risk as well as ongoing processes of risk creation), it is a likely candidate for issue suppression. Moreover, even when DRR can escape nondecision-making, a second trap often awaits: symbolic action, a term made famous originally by Edelman (1964, 1971), which Tenschler (1998) described as a bedrock in the study of political communication:

Edelman's approach assumes a doubling of the political reality. He assumes that all political actions and events are characterized by a division into an instrumental dimension, that is, a principal value—which represents the actual effect of a political action—and an expressive dimension, that is, a dramaturgical symbolic value—which represents the presentation of the action for the public. According to Edelman, political players subconsciously and based on their own roles produce a make-believe political world for the electorate using political symbols and rituals for and by the mass media; this process is increasingly being superimposed upon the principal value of political actions.

To recall, Kingdon argued originally that a focusing event like a crisis or disaster opens windows of opportunity to join a problem stream with solution and political streams to generate major policy change. Even then in the case of postimpact DRR policy initiatives specifically, policy changes often face uphill battles and symbolic treatment. The difficulty is that once the immediate response to a damaging event winds down, those opportunity windows for fundamental DRR policy and program changes tend to close very

quickly because a push to return to normalcy begins. However, normalcy often means reverting to the very risk creation policies and practices that set up a community for the event losses in the first place. It is even possible that a return to normalcy will entail risk recreation, as when floodplains are reoccupied or previous (and weak) building standards are retained or reinstated to speed so-called recovery.

Bridge Component Four: The (Unavoidable) Political Dimension and the DRR Hard Nut

Alfred E. Alquist (1908–2006), who served as a California state senator for 30 years (1966–1996) and led California's rise to national and global prominence in earthquake safety legislation, regularly admonished geotechnical, engineering, policy, and planning experts (including one of the authors in this study who served as the first executive director of the California Seismic Safety Commission) with variants of the following: "Remember, at the end of the day, you still need the votes." Senator A. E. Alquist (personal communication, 1973) knew that "doing the right thing" was seldom sufficient to achieve a bill's passage through the state legislature, in which many other factors and influences—some not so altruistic—came into play.

Senator Alquist's reminder remains highly relevant and can be extended globally because, as noted previously, the principal DRR challenge is no longer purely the scientific understanding of hazards (although that remains admittedly incomplete, particularly with climate change affecting hydrometeorological and related hazards), nor is it so much the planning, architecture, engineering, or even the social science knowledge required to reduce or at least better manage risk. The principal DRR challenge now falls primarily in the policy and implementation realms and frankly in building increased public support for decision-makers and political leaders to champion stronger and more consistently applied DRR policies and programs. At this point in time, strong DRR policies and coherent implementation programs are still more the exception than the rule in many places (Neumayer et al. 2014; Keefer et al. 2011; UNISDR 2013, 2015a, b). It is especially true for the DRR hard nut: hazard-aware land use and building standards.

To illustrate, an old axiom in earthquake engineering is that *earthquakes don't kill people, buildings do*, and the public especially is regularly shocked by postimpact revelations that land use (zoning) policies and building standards (codes) were nonexistent, ignored, diluted, or not properly enforced. The result is often hundreds if not thousands of deaths and injuries. Indeed, for earthquakes specifically, Ambraseys and Bilham (2011) estimate that fully 83% of all fatalities worldwide can be attributed to corruption in code enforcement, and that the entire system in many places is a "process of concealment" (p. 153).

In a 2011 meeting at the *Facultad Latinoamericana de Ciencias Sociales* (FLACSO) in Costa Rica, and focusing on land use and building standards in Latin America and the Caribbean (LAC) specifically, Allan Lavell (the 2015 recipient of the United Nations Sasakawa Award for Disaster Risk Reduction, a biennial global competition) expressed frustration to the group, which included the senior author in this study, about well-designed laws and regulations that existed only on paper: "We don't need more legislation, we just need actual enforcement of what's already on the books" (A. Lavell, personal communication, 2011). That is, much of the appropriate legislation to assure more careful land use and better construction in the LAC region "was all there" in his words, but it was only symbolic (in the Edelman sense) and gave the public the illusion of safer communities—but little or none of the reality. This is

especially the case where national or state level legislation for DRR exists but must be implemented/enforced by local governments, which is the norm in most countries.

Capturing in late 2013 this painful distinction between building regulations in theory and building practices in reality is a quote from field supervisor María Fernanda Boidi to Elizabeth J. Zechmeister, director of Vanderbilt University's Latin American Public Opinion Project (LAPOP). As part of a survey instrument pretest in one of the most hazard-prone countries in the region, Boidi "asked the local team about construction rules and practices." That team then informally interviewed locally knowledgeable sources in the capital city's construction sector. The report was revealing:

Construction and major renovations need to get a permit from the *Alcaldía* [the municipal government]. And if they don't get the permit, it is highly likely the *Alcaldía* will catch you and you will have to pay a fee (or a bribe) . . .

Now, the *Alcaldía* only worries about getting paid the construction/renovation fee. They will not inspect the floor plans or the quality of the materials. This means that you can get all the permits and everything and still have a very unsafe house.

The local team tells me that if you want to build following all the standards (especially the antiseismic ones, which are the ones that matter!), it can cost you up to three times the price for a basic construction. But the price difference obeys to the difference in the price of the materials, not the permits. I am told that even big construction firms avoid the standards in order to save costs (Personal Communication from LAPOP Internal Memo, November 29, 2013, Vanderbilt University, Nashville, TN).

Three major points stand out from these passages. First, while a formal permit policy obviously exists in this city, it clearly has no siting and design review components, and no onsite materials or construction inspections. That is, the permit process is symbolic at best and has no substantive impact on the quality of construction. Second, the process is also easily and apparently inexpensively corrupted.

Third and perhaps most worrisome, the entire construction sector in this city, from the most informal to the largest companies, seems to be caught in a *lowest bidder syndrome* in which, because everyone knows that hazard-sensitive siting, design, building, and materials standards will not be enforced, bidders are competitively driven to risk-creating practices with little or no regard for land use regulations or building standards. Unfortunately, this means that the entire building stock of this at-risk city, from the humblest to the largest structures, is questionable, and only neighborhood-by-neighborhood, site-by-site, and building-by-building evaluations could determine actual structural safety levels across the city.

It is likely that such evaluations would show a *compliance deficit* where buildings bear little relationship to the codes in place at the time of their siting, design, and construction. Ronald Jackson, Executive Director of the Caribbean Disaster Emergency Management Agency (CDEMA 2017) put this problem in a larger urban risk Regional Roadmap for his home region by noting as concerns "poor risk governance, insufficient preparedness . . . , ineffective building regulation . . . [and] limited enforcement of building codes/standards . . ."

The policy problem of appropriate land use and building standards, in urban areas particularly, is exacerbated by the fact that in many countries, informal or extralegal (unofficial, unplanned, unregulated, unserved, and often called slum) settlements are still such a large part of the urban landscape. At an October 2016

UN HABITAT III conference in Quito, Ecuador, it was noted from an earlier issue paper that while gains had been made in regularizing slums, "one quarter of the world's population continues to live in [them]" (United Nations 2015, p. 3). In many countries, these informal settlements pose an especially deadly exposure-vulnerability combination because they often (1) do not even appear on official city maps, at least initially, (2) appear quite suddenly on lands that belong to others and/or to which title is ambiguous, (3) are generally self-built, virtually guaranteeing low quality construction, and (4) are almost exclusively composed of the poor and very poor.

Bridge Component Five: The Three Rs (Resilience, Response, Recovery)

Despite the fact that the term resilience has a long and relatively specific etymological history (Alexander 2013), it has recently become such a catchword that it is now used in all sorts of contexts and for all sorts of purposes—resulting in a myriad of definitions. Leichenko (2011, p. 166) has called the term "quite plastic," and Cutter (2016, p. 110) has noted that "even within academia there is a certain muddiness to the concept." For that reason, it seems prudent to stay with the UNISDR (2016, p. 13) definition in which resilience is:

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

The concepts of response and recovery as they relate to hazard events derive separately from resilience and are adapted from various and much earlier formulations of the disaster management cycle, including the work of Baird et al. (1975). In 1992, the United Nations Disaster Relief Organization (UNDRO, now defunct) proposed that the disaster management cycle comprised seven phases (prevention, mitigation, preparedness, impact, response, recovery, and development), a set that was adopted, in both senses of the word, by the United Nations Development Program (UNDP). For its part, the US National Governors Association established four stages: mitigation, preparedness, response, and recovery.

Given this thicket of stage conceptualizations (and definitions), it seems best to stay with the UNISDR (2016) terminology in which response is:

Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected (p. 22).

And recovery is:

The restoring or improving of livelihoods, health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and 'build back better,' to avoid or reduce future disaster risk (p. 21).

To recall, and as discussed early in this paper, response requirements are the lead determinant of the left side categories (risk of an emergency, a disaster, or a catastrophe) in the equation as a hazard event's impact characteristics become more acute and increasingly complex. However, recall that response requirements are driven primarily by the interaction of a community's hazard(s) with who,

what, and how much that community has put in harm's way (exposures) crossed with the vulnerabilities of those exposures. Logically then, the more effective a community's DRR policies and programs have been in managing its exposures and reducing their vulnerabilities over the years before a hazard event, the more effective will be the response to that event.

This DRR-response requirements relationship was captured well at the field level during the early 2001 response to a pair of destructive earthquakes that affected the greater metropolitan area of San Salvador (the capital of El Salvador) by Paul C. Bell, at the time the USAID Office of US Foreign Disaster Assistance (OFDA) Senior Regional Advisor for Latin America and the Caribbean. Bell was reflecting on 10 years of capacity-building in the LAC region and offered to the senior author in this study while in the field (paraphrasing, but very close), "Show me 10 killed and 30 injured, with 100 or fewer homeless, and I'll show you a pretty good response [now] in most places. If it's 500 or more killed, hundreds [more] injured, and 5,000 homeless, I'll show you a response that everybody will criticize" (P. C. Bell, personal communication, 2001). Bell's point was that the response capacities in the LAC region were inherently limited by budget, personnel, and equipment realities and that the only long-term solution was to bring more event impacts down to levels reasonably close to response capacities. Although Bell did not use the emergency/disaster/catastrophe distinctions to explain the value of DRR, the logic was there.

Finally, and to close this particular circle, resilience is also a relational concept because it is much easier to bounce back from an emergency than from a disaster or worst case, a catastrophe. Understood from that perspective, effective DRR policies and programs increase a community's resilience by limiting the losses and damages from which a community has to bounce back. In fact, Platt et al. (2016) have argued that the 3Rs in this study should actually be seen as a *system* in which preexisting resilience contributes to the quality of the short-term response, and the quality of that response then has a significant effect on long-term recovery. Indeed, their formula was resilience \times response = recovery.

Conclusion

This paper has argued that the DRR community needs broader, deeper, and more consistent engagement by and with the policy studies community and has made an equation-based bridging effort to facilitate more coherent and increased involvement: $EmR/DR/CatR = H + Ex \times V$, where the risk of an emergency (EmR), a disaster (DR), or a catastrophe ($CatR$) is a function of a community's hazard or hazards (H), its human and asset exposures (Ex) to those hazards, and the vulnerabilities (V) of those exposures. But from the policy studies perspective, why should scholars engage more fully with the DRR community? Where are the motivations? As this paper has hopefully demonstrated, the answer comes on three levels or dimensions, the first of which is an underappreciated congeniality at the conceptual or framework level.

With disasters, let alone catastrophes, clearly qualifying as *crises* or *focusing events* in the multiple streams approach, as *exogenous shocks* in the advocacy coalition framework, and as *lurch-inducing triggers* or *attributed triggers* in punctuated equilibrium theory, the conceptual and empirical bridges already exist for enhanced engagement in DRR research, and disaster research more broadly, by the policy studies community. These various conceptual roles offer powerful analytic points of entry and rich research opportunities for scholars in the policy studies community who study agenda control and policymaking processes, for those who emphasize policy content, and after policies are adopted, for those who study their

administration and/or who are involved in designing and evaluating the implementing programs.

The second dimension derives from the increasing emphases on convergence research and team science, particularly by funding agencies. As the 20th century waned and societies moved into the 21st century, it was increasingly recognized that many problems and challenges required research (and practice) communities to engage in team science and cross traditional disciplines, fields, and other divides. In the case of DRR specifically, as the physicalist approach to understanding DRR and disasters was slowly overturned—or at least balanced—by understanding them as socially, economically, and politically constructed human exposure and vulnerability problems, DRR became—in NSF convergence research terminology—one of those quintessentially complex problems for communities and even entire societies that requires new collaborations that can generate multiple solutions.

The third and final dimension is simply moral. As hazard event losses mount around the world, sometimes horrifically, the need to bring events down from catastrophes and disasters to less damaging and more manageable emergencies is literally a life and death issue, and the key to that deescalation of event impacts is more effective DRR. Simply put, with the good to excellent 21st-century knowledge of hazard patterns and mechanisms and knowing what can be done with DRR to lessen event impacts, it is morally offensive to see tens to hundreds of thousands of people dying annually in agony, terror, and despair. And despite the attacks on, and depreciation of, science and scientists in some countries, the key to accomplishing more effective DRR is to build and sustain a broad front of researchers equipped—and emboldened—to speak truth to power, a front that must include significantly more policy studies scholars to give DRR advocacy a harder, sharper, and more practiced edge.

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