ORIGINAL RESEARCH

Building Community Resilience: What Can the United States Learn From Experiences in Other Countries?

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ABSTRACT

Objectives: Community resilience (CR) is emerging as a major public policy priority within disaster management and is one of two key pillars of the December 2009 US National Health Security Strategy. However, there is no clear agreement on what key elements constitute CR. We examined exemplary practices from international disaster management to validate the elements of CR, as suggested by Homeland Security Presidential Directive 21 (HSPD-21), to potentially identify new elements and to identify practices that could be emulated or adapted to help build CR.

Methods: We extracted detailed information relevant to CR from unpublished case studies we had developed previously, describing exemplary practices from international natural disasters occurring between 1985 and 2005. We then mapped specific practices against the five elements of CR suggested by HSPD-21.

Results: We identified 49 relevant exemplary practices from 11 natural disasters in 10 countries (earthquakes in Mexico, India, and Iran; volcanic eruption in Philippines; hurricanes in Honduras and Cuba; floods in Bangladesh, Vietnam, and Mozambique; tsunami in Indian Ocean countries; and typhoon in Vietnam). Of these, 35 mapped well against the five elements of CR: community education, community empowerment, practice, social networks, and familiarity with local services; 15 additional practices were related to physical security and economic security. The five HSPD-21 CR elements and two additional ones we identified were closely related to one another; social networks were especially important to CR.

Conclusions: While each disaster is unique, the elements of CR appear to be broadly applicable across countries and disaster settings. Our descriptive study provides retrospective empirical evidence that helps validate, and adds to, the elements of CR suggested by HSPD-21. It also generates hypotheses about factors contributing to CR that can be tested in future analytic or experimental research. (*Disaster Med Public Health Preparedness*. 2013;7:292-301)

Key Words: community resilience, health security, disaster, disaster preparedness, disaster management, lessons learned, social networks, global disaster

Community resilience (CR) is emerging as a public policy priority within the context of disaster management. CR refers to the capacity of a human community, whether a city, a region, or some other collectivity, to sustain itself through crises that challenge its physical environment and social fabric.[1] This report focuses on CR as the ability of a community to fortify itself so that it is able to prevent, respond to, and recover from a natural or intentional public health disaster. Enhancing CR is essential for vulnerable communities whose economic and institutional constraints would otherwise limit their ability to withstand or recover from a disaster. Strengthening social networks and long-term economic and social redevelopment are key to attracting surviving and displaced community members back to their community following a disaster.[2-4]

CR is an important concept for strengthening the health security of a population, which the 2009 US National Health Security Strategy defines as being "prepared for, protected from, and resilient in the face of health threats or incidents with potentially negative health consequences"[5]; indeed, CR is one of two key pillars of the strategy. Homeland Security Presidential Directive 21 (HSPD-21), "National Strategy for Public Health and Medical Preparedness," provides further insights into the key components of CR (emphasis added):

Where local civic leaders, citizens, and families are *educated* regarding threats and are *empowered* to mitigate their own risk, where they are *practiced* in responding to events, where they have *social networks*

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to fall back upon, and where they have *familiarity* with local public health and medical systems, there will be *community resilience* that will significantly attenuate the requirement for additional assistance.[6]

HSPD-21 suggests a paradigm for building CR that includes the following key elements: education, empowerment, practice, social networks, and familiarity with local health service systems. Collectively, the elements of the CR paradigm should help communities enhance their self-sufficiency for disaster preparedness, response, and rehabilitation.

Notwithstanding HSPD-21, there is still no clear agreement on what key elements constitute CR within the context of natural disasters or health security more broadly. Without critical evidence from prospective testing of potential CR core components, one approach is to examine lessons from prior disasters to understand what characterized and distinguished communities in their ability to prepare for, respond to, and rebound from disaster. Therefore, we examined exemplary practices in international disaster management from the specific perspective of efforts relevant to CR. This retrospective review provides an opportunity to validate the components of a CR paradigm, as suggested by HSPD-21, potentially to identify new elements derived empirically, and to identify practices that could be emulated or adapted in the United States and elsewhere. Public policy attention to CR is particularly relevant as the United States plans to implement the December 2009 National Health Security Strategy and also as areas continue to recover from past disasters, such as the 2010 earthquakes in Haiti, Chile, and China, the disasters in Japan, and Hurricane Katrina.

METHODS

As described previously, we specifically sought successful international experiences in the wake of the US response to Hurricane Katrina.[7] However, extensive searching of published and unpublished reports and disaster-related Web sites uncovered documentation of problems but relatively little on positive experiences. Therefore, we developed our own criteria for selection of "exemplary" practices. We captured information on international experiences that met one or more of the following criteria-practices: (1) related to problem areas identified in the Hurricane Katrina response; (2) innovative from national or international perspective; (3) with some evidence of favorable impact; and (4) validated by experts we interviewed after our literature review. We developed a case study for each relevant disaster; some disasters included several exemplary practices, while others included only one. From our (unpublished) case studies we extracted details of practices addressing various aspects of community involvement and mapped them onto the CR paradigm suggested by HSPD-21 to both identify and examine common threads across countries and validate the HSPD-21-based CR paradigm. We used this same empirical approach to identify further elements of relevance to a CR paradigm.

RESULTS

Selected Experiences From International Disasters

The exemplary practices described herein are drawn from 11 natural disasters that occurred outside the United States between 1985 and 2005 (Table 1). The descriptions are organized according to the elements of the CR paradigm

TABLE 1

Disasters Included in the Analysis (in Chronological Order)

Location	Type	Year(s)	Deaths	Persons Affected (1000s)
Mexico[8]	Earthquake	1985	9500	100 (displaced)
Philippines[9,10]	Volcanic eruption	1991	200-800	100
Bangladesh[11]	Flood	1998	918	31 000
Honduras[12]	Hurricane	1998	5757	441 (displaced)
Vietnam[13]	Floods	1998	397	Unknown
		1999	800	1700; 55 (displaced)
Mozambique[14,15]	Floods	2000	700	550 (displaced)
		2001	113	223 (displaced)
India[16]	Earthquake	2001	>20 000	Unknown
Iran[17]	Earthquake	2003	30 000	75-90 (displaced)
Indian Ocean countries[18,19]	Tsunami	2004	240 000	1768
Vietnam[20]	Typhoon	2005	68	>10 (displaced)
Cuba[21-23]	Hurricanes	1998	6	818 (evacuated)
		2001	5	712 (evacuated)
		2004	0	1300 (evacuated)
		2005	16	1500 (evacuated)
		2005	4	760 (evacuated)

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TABLE 2

Exemplary Practices Related to CR Elements Suggested in HSPD-21

Country, Disaster	Exemplary Practice	Phase
	Community Education	
Cuba, hurricanes	Public disaster education as part of routine education curricula	PR
	Effective early warning and public communications	PR
Philippines, volcano	Media partnerships for public education and risk communication	PR
Iran, earthquake	Communications with affected populations via newsletter	RR
	Community Empowerment	
Mozambique, floods	Community involvement in preparedness planning	PR
Honduras, hurricane	Building local capacity in risk management planning	PR
Cuba, hurricanes	Focus on community preparedness	PR, RE
Mozambique, floods	Local self-sufficiency and contributions to response efforts	RE
Mexico, earthquake	Supportive national leadership and policy	RR
	Participatory planning and feedback via community-based councils	RR
Honduras, hurricane	Decentralization of programming decisions	RR
	Direct community involvement in rebuilding homes	RR
	Close community consultation in recovery operations	RR
Vietnam, floods	Local design of disaster-resistant housing	RR
Cuba, hurricanes	Rebuilding by community members	RR
India, earthquake	Local labor and materials for housing reconstruction	RR
	Practice	
Honduras, hurricane	Building local capacity in risk management planning	PR
Indian Ocean countries, tsunami	Community training	PR
Mozambique, floods	Community training	PR
Cuba hurricanes	Community training	PR
Mozambique, floods	Community involvement in exercises	PR
Indian Ocean countries, tsunami	Community exercises	PR
Cuba, hurricanes	Community involvement in drills	PR
India, earthquake	Vocational training of community members	RR
Vietnam, floods	Local training and practical demonstration	RR
	Social Networks	
Indian Ocean countries, tsunami	Community disaster committees	PR
Mozambique, floods	Working through respected community leaders	PR
Cuba, hurricanes	Local monitoring of population needs including vulnerable populations	PR
Mozambique, floods	Evacuation and temporary sheltering of communities as a whole	RE
Cuba, hurricanes	Disaster sheltering based on local social networks	RE
India, earthquake	Local network of NGOs for coordination and data gathering	RE
Iran, earthquake	Central role of local leaders in coordination of response	RE
	Familiarity	
Philippines, volcano	Public familiarity with a new disaster alert system	PR
Cuba, hurricanes	Advance identification of safe refuge sites	PR
Iran, earthquake	Community newsletter	RE, RR

Abbreviations: CR, community resilience; HSPD-21, Homeland Security Presidential Directive 21; PR, prevention/preparedness; RE, response; RR, recovery/redevelopment: NGOs, nongovernmental organizations.

suggested by HSPD-21 (Table 2). Additional activities relevant to CR are organized into new categories that suggest potential additions to this paradigm (Table 3).

Community Education

Observations from three international disasters illustrate different approaches to community education and public risk communications (Table 2). As part of Cuba's broader effort to create a culture of preparedness, all schools and many universities include disaster preparedness, prevention, and response as part of their curriculum, and workplaces provide routine training on risk reduction. Family physicians teach health risk reduction for disaster contexts, and a massive media campaign provides further information. In addition to general protective actions, citizens are told where to seek refuge.[24]

Effective public risk communications stem from community education. Cuba uses a multitiered system of mass media warnings to communicate information on a coming storm to the public, including preventive measures such as evacuation. In the Philippines, prior to the 1991 eruption of Mount Pinatubo, government authorities enlisted national and local media in distributing technical reports and a video from an earlier volcanic eruption elsewhere in the world to as many audiences as they could reach, including national and local

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TABLE 3

Exemplary Practices Related to Physical and Economic Security

Country, Disaster	Exemplary Practice	Phase
	Physical Security	
Mozambique, floods	Stockpiling and prepositioning of supplies	PR
Cuba, hurricanes	Prepositioning of supplies	PR
India, earthquake	Incorporation of earthquake-resistant building designs	RR
Vietnam, floods	Flood-resistant housing to reduce future vulnerability	RR
Vietnam, typhoon	Long-term approach to preparedness: mangrove forests to dampen storm surges	PR
Bangladesh, flood	Application of long-term development orientation to flood relief	PR
Honduras, hurricane	Integration of physical reconstruction into broader cultural and infrastructure development	RR
	Relocation of rebuilt structures to more secure (less vulnerable) sites	RR
Mozambique, floods	Recovery-to-development orientation to reduce physical vulnerability to future disasters	RR
	Economic Security	
Honduras, hurricane	Self-help approaches to provide income	RR
	Revitalization of agriculture on eroded hillsides	RR
Vietnam, typhoon	Mangrove forests as habitat to sea creatures important to the livelihoods of local populations	PR
Bangladesh, flood	Rice crop diversification and trade liberalization to reduce seasonal vulnerabilities, improve food security	PR
	In-kind aid rather than cash to help reestablish livelihoods	RR

Abbreviations: PR, prevention/preparedness; RE, response; RR, recovery/redevelopment.

government officials, students, community leaders, and community residents. The public education about potential impacts provided a strong base for the subsequent risk communications that in turn led to effective precautionary evacuations from the area before the volcanic eruption.

Communication with the public is also relevant in the recovery/reconstruction phase following a disaster. In the aftermath of the 2003 earthquake in Bam, Iran, the United Nations Development Program began to publish and distribute a biweekly community newsletter that disseminated information to members of affected communities about the recovery and redevelopment processes, including critical information on job opportunities, shelter opportunities, victims' entitlements, recommended safety and risk reduction actions, and health care availability. The initiative also stimulated other organizations to start their own sector-specific newsletters to disseminate information on ongoing redevelopment efforts.[25]

Community Empowerment

The international disaster experiences offer numerous examples of community empowerment (Table 2). Mozambique's local governments and nongovernmental organizations have learned that involving the community can help improve disaster preparedness. In the district of Buzi, they worked through local leaders, created local community-based disaster risk management committees, supported participatory planning, trained communities in local languages, and conducted flood simulation exercises.[26] Similarly, local predisaster training in the La Masica district of Honduras before Hurricane Mitch in 1998 empowered local leaders to take effective action once the hurricane struck and resulted in no loss of life from the storm.[27]

Community preparedness is a centerpiece of natural disaster mitigation in Cuba, and significant efforts by the government have fostered a culture of preparedness. In interviews conducted in 2005, Cubans reported that they knew the stages of emergency warning, where to get information, how to secure their house, and where they would go for shelter if they needed to evacuate.[23] An international aid worker in Havana during Hurricane Georges (1998) described the level of community preparedness in greater detail:

As we were foreigners, people assumed we didn't know what to do so we had a steady stream of neighbors in and out of our apartment, counseling us to fill the bathtub with water, tape the windows, unplug all electrical items, get batteries or candles, and put the car in the garage. Everyone in the apartment building was out helping to tape up the windows in the entry way…. Everyone, even the children, knew what to do.[28]

Community empowerment is also relevant to disaster *response*. In the 2000 floods in Mozambique, before help from other countries arrived, local coordination was the key for a quick and effective response. The Mozambiquan Red Cross and local health workers set up emergency health posts. Local officials organized temporary accommodation centers, and local leaders took charge of distributing tents and food and constructing latrines and water tanks.[20] Search and rescue teams relied not only on national and international aid but also on local civilians and their canoes. Mozambique's own efforts were responsible for a disproportionate share of rescues in both 1990 and 1991.[29]

Community empowerment carries over to disaster *recovery* and reconstruction. Immediately following the 1985 earthquake in Mexico City, the president issued a decree

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establishing a time-limited agency called the Popular Housing Reconstruction (Spanish acronym, RHP), which had a two-year mandate to rebuild urban areas damaged by the earthquake, while preserving social integrity. RHP organized victims from each reconstruction site into a "renovation council." These councils held regular meetings to help maintain victims' social relations and support systems, review and revise RHP site plans and prototype apartment designs, and provide a forum for residents to voice their concerns about the recovery and reconstruction process. The input of community members was vital to the ultimate decision to rebuild housing on damaged sites rather than to build in new areas and relocate families. Toward the end of the reconstruction efforts, the RHP director general wrote, "We learned to listen with care and interest to the sentiments of those affected by reconstruction. Little by little – in stages – the attitudes of the program beneficiaries changed from hostility, uncertainty, incredulity, suspicion, and doubt to hope and confidence."[8]

Decentralization of disaster recovery and reconstruction can enable community empowerment, as illustrated in Honduras. As part of the immediate response and recovery following Hurricane Mitch, the Honduras Fund for Social Investment (Spanish acronym, FHIS) decentralized its operations and worked closely with communities in affected districts to assess immediate needs for shelter, clean drinking water, sanitation, and other infrastructure elements.[30,31] Teams were granted special authority to act on location, enhancing their capacity to work within affected communities. The World Bank commended the rapid physical reconstruction of infrastructure and housing in Honduras and attributed the success to a variety off actors, including self-help schemes that employed displaced persons in redeveloping their own communities and in some cases their own homes. In communities where residents were more involved in the design and even reconstruction of their homes, redevelopment efforts were completed more quickly, subject to fewer charges of corruption or profiteering, and praised more by community members as meeting their needs, with fewer undesirable social or economic impacts.[12]

International disaster experiences offer additional examples of *direct community involvement in the design and/or physical rebuilding of infrastructure* damaged or destroyed by natural disaster. In 2000 the Vietnamese Red Cross and its international counterpart agency sponsored a national housing competition to identify the best locally developed designs for disaster-resistant housing. The winning design combined steel frames and concrete foundations, providing high quality disaster-resistant housing that could be built quickly and easily by community members themselves.[13] In the aftermath of hurricanes Lili and Isodore in Cuba in 2002, reconstruction began immediately, with community members working together to rebuild their communities, supported by construction and specialized brigades.[32] With 344 000 houses destroyed and over 888 000 damaged following the 2001 earthquake in Gujarat, India, authorities drew from lessons learned after the 1993 earthquake and allowed families affected by the 2001 earthquake to reconstruct housing on the site of their original homes rather than requiring them to relocate to other villages, as was done in 1993. Reconstruction drew on local labor and material. Such an approach made economic sense: following the 1993 earthquake, the unit cost of homes combining owner construction and onsite reconstruction was far less compared to relocated homes constructed by the owner (3.7 times higher) or a contractor (13.6 times higher).[16]

Practice

In disaster risk management, "practice" is operationalized through training and simulation exercises (Table 2). In Honduras, the predisaster training in the La Masica district provides a rare example of documented impact of community-level training and practiced response. The ability of trained local leaders to quickly assess the risk of flooding associated with the storm and trigger implementation of the flood mitigation plan that the community had developed before Hurricane Mitch struck in 1998 resulted in no loss of lives in the district. In comparison, hundreds of lives were lost in similarly populated and geographically situated communities around the country.[27] Similarly, beginning in 2003, the Indian national government participated in a disaster risk management program, sponsored by the United Nations Development Program, to increase disaster preparedness capabilities in local communities. In Samiyarpettai, India, a community that had recently received training and developed a local disaster management plan, only 24 lives were lost in the tsunami, compared to nearly four times this number of deaths in nearby Pudupettai, which had not yet received the training.[33]

Even in instances in which the impact is not documented, community training can enable concerted disaster response. Several months before each of the Mozambiquan floods (2000 and 2001), meteorologists predicted heavy rainfall. After receiving predictions in 1999, the Mozambiquan Red Cross began to retrain its volunteers in basic health care in areas likely to be affected. The government's National Disaster Management Institute (Portuguese acronym, INGC) sent out teams to prepare people in vulnerable areas with education and training in local languages.[26] During the 2001 floods, a Mozambiquan Red Cross official found a group of volunteers trained in the drought of 1992-1993 who were working in the relief effort. Their training had been simple but included instruction in critical tasks such as how to erect tents, organize a camp, register the displaced, assess needs, chlorinate water, build latrines, and perform first aid and boat rescues. As one report notes, the advantage of such broad community-based disaster preparedness training is that it can be applied to a range of different disasters.[20] Finally, in Cuba, disaster preparedness is built into the country's legal

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framework. All adult citizens must receive civil defense training, and a legal decree specifically details the role of ministries, social organizations, and public entities in emergency situations.

Experiences from three countries illustrate practice through disaster preparedness exercises. In Mozambique, the less severe floods in 1999 gave the INGC the opportunity to conduct a large training exercise that involved simulations of rescue and relief operations.[34] The simulations included the police, the Mozambiquan Red Cross, the Mozambique Flying Club, fire brigade, and scouts. Well-established roles and the practice afforded by the exercises prepared response agencies to face the 2000 and 2001 floods.[20] In India and Sri Lanka, the national governments had worked with the United Nations Development Program before the 2004 tsunami on community-level training and mock disaster drills to illustrate and teach basic survival skills and promote low cost and safe housing techniques. These initiatives are credited with enabling the governments and relief organizations to rapidly mobilize the local responses to the tsunami, and the United Nations documented the favorable impact of the efforts.[33] Finally, Cuba holds an annual two-day drill on hurricane risk reduction at the start of each hurricane season. Such efforts, which include simulation exercises, are conducted nationwide in ministries, schools, hospitals, and factories. The drills help prepare for response and also contribute to assuring that the physical infrastructure can withstand upcoming hurricanes.[35]

Practical community training can also be relevant during *disaster recovery*. The reconstruction of the houses in Gujarat, India, following the 2001 earthquake necessitated the training of local residents in engineering and construction methods.

About 1270 model houses were built in 90 villages throughout the state. Village members were selected for training in retrofitting techniques, earthquake-resistant designs, and seismic safety design features required for government certification and financial compensation. In Vietnam, a locally-based nongovernmental organization offered training to communities in disaster-resistant housing construction and assisted inhabitants of communities affected by the 1998 and 1999 floods in strengthening their houses. They combined practical demonstrations with activities to promote greater local awareness of the importance of considering disaster-readiness when building homes.

Social Networks

Observations from the international disaster experiences strongly validate the importance of social networks to community resilience (Table 2). Many nations, such as India, Sri Lanka, and Mozambique had relied on networks led by respected local leaders to develop community disaster plans and rapidly mobilize responses.[26,36] In Cuba, local divisions of the Committee for the Defense of the Revolution maintain neighborhood information that includes disaster preparedness assets, houses that are vulnerable to hurricanes or that can serve as shelters, the location of community members during evacuations, and individuals with special needs. For example, in advance of Hurricane Michelle in 2001, neighborhood representatives from the Federation of Cuban Women monitored their vulnerable population while the community doctors surveyed patients in the neighborhood to see if anyone needed to be moved to the hospital before the storm hit.

Preservation of social networks is also critical in disaster response. Although warned several months in advance of floods in Mozambique, residents underestimated the devastating effect of the flooding, and few families willingly evacuated their homes sufficiently early. However, those who were evacuated were organized into predetermined groups identified by local leaders. Temporary accommodation was established on high ground, with people from particular neighborhoods all living together. The administration of Chokwe, the largest city that was totally evacuated, moved as a group and continued to administer the new accommodation.[34] After the initial mortality resulting directly from the flood, death and malnutrition were low in the temporary high-ground accommodations. During Hurricane Wilma in Cuba in 2005, the Cuban government reported that 80% of evacuees stayed in others' homes rather than in government shelters.[37] Indeed, many Cubans often seek refuge in the homes of neighbors, relatives, and friends when natural disasters strike. This practice is integrated into the national emergency response plan. Houses that are certified as hurricane safe are designated and used as places of refuge for other community members during an evacuation. Updated lists maintained by government officials during disaster response include information about who has received food and needs medicines in the shelters.[38]

Local social networks can also facilitate effective coordination of disaster response. In the heavily affected district of Kutch following the 2001 earthquake in Gujarat, India, a district-wide network of relief organizations was responsible for establishing 33 community subcenters to coordinate relief and a surveillance system and electronic data network to quickly access village-level data about health, housing, schools, infrastructure, and livelihood. While initially established to collect and disseminate information, these centers were later designated as rehabilitation support centers and became places for community residents to voice their concerns about the relief efforts and help influence government policy.[16] In Iran, the Iranian Red Crescent Society coordinated local response efforts with local leaders so as not to alienate the population, and drew on local "notables" or "white beards" to help serve as a liaison between the relief workers and the community members and survivors.[17]

Familiarity

Public education and communications enhance familiarity with early warning and postdisaster services (Table 2).

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As regular monitoring was established on Mount Pinatubo in the Philippines two months before the June 1991 eruption, seismologists developed a five-tiered alert system to define danger zones before and after the disaster struck. Information from this system was broadcast widely and regularly to the public to familiarize them with the potential threat and appropriate actions to take in response. The effective precautionary evacuations of the area around Pinatubo are credited in large part to these communications efforts.[39] In Cuba, a country constantly battered by hurricanes, particular houses throughout the country are chosen ahead of time as places of safe refuge so that vulnerable individuals can familiarize themselves in advance with potential evacuation sites.[24] Finally, the biweekly community newsletter established in the aftermath of the 2003 earthquake in Bam, Iran (described earlier), is another example of communications with affected populations to enhance their familiarity with relief and recovery services and opportunities.[25]

Additional Exemplary Practices

Thorough examination of the unpublished international case studies from the perspective of building CR uncovered additional examples that do not fit neatly within the elements of CR suggested by HSPD-21. These include physical security and economic security, as described in the following sections and summarized in Table 3.

Physical Security: Supplies, Structures, and Longer-Term Approaches

Mozambique and Cuba offer examples of *stockpiling and prepositioning supplies* as a means to provide the physical security needed by populations in the immediate aftermath of a disaster. In Mozambique, as part of the flood contingency preparedness, the government stockpiled 5100 tons of fuel, food, water and sanitation, education, and health supplies; rubber boats were prepositioned; and warnings were broadcast in local languages in communities judged to be at risk of flooding.[40,41] Two days before Hurricane Michelle hit Cubain 2001, shelters were stocked with food and medical supplies, people and animals living in possible flood areas were evacuated, and materials located in stockrooms were transferred. An international aid expert working in Cuba during the storms reported on additional physical security measures each household took to minimize damage— taping windows, unplugging electrical items, and stockpiling batteries and candles.

Disaster-resistant housing is another physical security measure to mitigate against future natural disasters. The extensive reconstruction of homes in Gujarat, India, following the 2001 earthquake and in Vietnam following the 1998 and 1999 floods was based on disaster-resistant housing designs, whether for retrofitting or new construction. Houses constructed in Vietnam following the 1998 floods were dubbed "little mountains" when all but one of 2450 such houses withstood the 1999 flood. By August 2000, a total of 7400 little mountain houses had been built at a cost of only $500 each.[13]

Long-term approaches to providing physical security as protection against natural disasters are additional enablers of CR. Beginning in 1994, the Vietnamese Red Cross planted mangrove forests along the coast to protect the sea dike system. These mangroves can dampen a 1.5-m wave into just ripples by the time it reaches the coast and in fact have reduced sea dike maintenance costs by an estimated $7.3 million per year. They also provide a habitat for sea creatures that are staples to the Vietnamese diet and essential to the livelihoods of an estimated 7750 families. This proved to be an effective intervention. For example, protected dikes were not damaged by Typhoon Wukong in October 2000 or Typhoon Damrey in 2005,[42] and inhabitants of areas protected by the mangrove forests reported a reduced sense of vulnerability and greater sense of physical security vis-à-vis potentially dangerous storms.[43] Experiences from Bangladesh, Honduras, and Mozambique demonstrate an underlying philosophy that postdisaster reconstruction should not only restore predisaster level of development but also improve the population's ability to resist future disasters. The largest nongovernmental organization in Bangladesh applied its long-term development orientation to flood relief following the 1998 flood,[11] and Honduras included relocation of some schools to less flood-vulnerable sites as part of a broad approach to reconstruction following Hurricane Mitch in 1998.[31] After the 2000 floods in Mozambique, 43 400 families were resettled to areas less vulnerable to floods. Mozambique's government saw the process of resettling the population displaced by the floods as an opportunity to improve the living conditions of people in flood-affected zones, where the level of poverty is extremely high, and to have disaster recovery act also as an engine for development.[41,44]

Economic Security: Preservation of Livelihoods

For the rapid physical reconstruction of infrastructure and housing in Honduras following Hurricane Mitch in 1998, local persons displaced by the storm were employed to help redevelop the affected communities. This arrangement provided community members with needed income in the short run.[12] Also in Honduras, the United Nations Food and Agriculture Organization credited efforts of the Lempira district for establishing agricultural practices such as productive revitalization of eroded hillsides as contributing to the economic and structural resilience of the community that allowed the communities in the district to recover more quickly from the 1998 hurricane.[45] In Vietnam, the mangrove forests described provided not only physical protection against storm surges but also habitat for sea creatures important to the diet and livelihoods of local populations. In Bangladesh, social and economic development between the severe floods of 1988 and 1998 included diversification of the local rice crops to both fall and winter harvest crops, which reduced communities' vulnerability to

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seasonal flood disasters and thereby bolstered their resilience by protecting them against debilitating food shortage. Bangladesh's liberalization of trade in rice in 1994 also provided the country with a distinct advantage in recovering from the 1998 flood, as compared to the floods a decade earlier.[11] The largest nongovernmental organization in Bangladesh was already working on long-term development projects when the 1998 flood hit. The organization played an important role in helping persons affected by the floods get back into their homes and return to their regular income-generating activities as quickly as possible. Its strategy of providing postdisaster aid in kind rather than in cash enabled recipients to immediately begin to reestablish their livelihoods (for example, the provision of seeds allowed farmers to begin planting grains and vegetables rather than requiring them to purchase supplies in a disrupted and inflationary market).

DISCUSSION

The disaster experiences described here were not undertaken within an explicit framework of building CR, yet they provide numerous illustrations of the various components of CR as actually applied across disaster preparedness, response, and recovery. They support a contemporary (and evolving) paradigm for CR that includes all of the elements described in HSPD-21 plus two new ones:

- education and public risk communications of impending threats (eg, hurricane, volcanic eruption) and education regarding services and other opportunities following a disaster;
- empowerment—leadership and supportive national policies and direct community involvement in disaster planning, response and reconstruction;
- practice—community training and simulation exercises;
- social networks—working through respected community leaders and maintaining the integrity of the community even when they are displaced as a result of a disaster;
- familiarity via education and communications to enhance the public's understanding of (and familiarity with), predisaster early warning systems, appropriate disaster responses, and post-disaster services and opportunities;
- physical security—prepositioning of disaster supplies and construction of disaster-resistant housing; and
- economic security to support and preserve livelihoods.

These elements of CR are not mutually exclusive but rather are intertwined with one another. For example, community education and practice both contribute to familiarity (perhaps all three could be combined into a single element); these in turn contribute to community empowerment. Moreover, and to paraphrase George Orwell's *Animal Farm*, all elements of CR are equal, but some are more equal than others. Social networks are at the heart of CR. They contribute to community empowerment and practice of disaster management skills, facilitate community education and training, and serve as a foundation for community familiarity with local health services both before and after a disaster. Local rebuilding efforts relied on education and training but also on community networks to coordinate these efforts. The international disaster experiences illustrate how preserving and fostering social networks during all phases of the disaster cycle helped communities quickly regain livelihood and a means to survive. Social networks, often led by respected community leaders or pre-established community disaster committees, allowed response and recovery efforts to be coordinated efficiently at the local level.

Our descriptive study has generated promising ideas for strengthening CR, but several important questions remain unanswered. Our findings are largely retrospective in nature. Only limited data are available from real-time disaster response and recovery, but these data are critical to help minimize recall bias. Further, we extracted exemplary practices across a number of countries, but sufficient data to conduct *within-country* comparative analysis are desirable to help elucidate why some communities rebound more quickly than others experiencing the same event. We are starting to isolate the critical components of community resilience. However, we have few validated measures to assess community resilience before an event. These data are needed to ensure that preparedness plans appropriately account for preexisting vulnerabilities.

Our findings suggest implications for public policy and appropriate next steps. The broad policy recommendations espoused previously[7] remain pertinent: given the dearth of publicly available documentation of success stories, we urge greater collection and better archiving of exemplary practices in international disaster management so that the United States and other countries can leverage lessons learned from these experiences, that is, institutionalize a process to share and learn lessons across countries and consider adopting or adapting relevant practices reported here early in preparedness and recovery planning. For CR in particular, we urge the following:

- Systematically document disaster experiences related to the seven CR elements described here.
- Collect sufficient data to allow comparative analysis of factors (eg, structural, policy, governance) contributing to or impeding successful outcomes *within a country* and, to the extent possible, document *over time*—changes in CR-building activities following one disaster and their impact in a subsequent disaster.

CONCLUSIONS

While each disaster and disaster setting is unique, it is already well accepted that common disaster management principles apply anywhere in the world. The international disaster experiences described here support a conclusion that the principles underlying CR are probably also universal, despite the vast differences in cultural and economic context of the

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international disasters from which our examples are drawn. Our findings validate the elements of CR as described in HSPD-21 and suggest modifications to an evolving CR paradigm within the context of disaster management and health security more broadly. We suggest actions to improve our understanding of CR and identify promising approaches to build CR, which need to be more rigorously tested. The United States, as all countries, can and should draw on concrete experiences and lessons from other countries in their efforts to build CR within their own borders. This is particularly timely as the United States begins to implement its new National Health Security Strategy and areas such as New Orleans and Haiti, among others, continue to recover from natural disaster.

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