Assessing Community Impacts of Natural Disasters

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Abstract: Research on the community impacts of natural disasters has yielded a wide variety of findings, but no coherent model of the process by which hazard agent characteristics produce physical and social impacts. This article summarizes the principal features of this process and describes the ways in which hazard mitigation and emergency preparedness practices can limit the physical impacts and the ways in which community recovery resources and extra-community assistance can reduce social impacts.

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Introduction

A natural disaster occurs when an extreme geological, meteorological, or hydrological event exceeds the ability of a community to cope with that event. Assessing the community impacts of natural disasters is important for three reasons. First, such information is useful to community leaders after a disaster strikes so they can determine if there is a need for external assistance and, if so, how much. Second, information about disaster impacts can be used to identify specific segments of the community that have been affected disproportionately (e.g., low-income households, ethnic minorities, or specific types of businesses) or might be affected in the future. Third, planners can develop disaster impact projections before disasters strike to assess potential consequences of alternative hazard adjustments. Unfortunately, it turns out that the assessment of disaster impacts is a complex process because, as Fig. 1 indicates, the effects of the *hazard agent characteristics* on the disaster's *physical impacts* depend upon the affected community's *hazard mitigation practices* and its *emergency preparedness practices* because both of these can reduce the physical impacts of the hazard agent. The physical impacts, in turn, cause the disaster's *social impacts* but these can be reduced by *community recovery resources* and *extra-community assistance*. The following sections describe the components of the model in greater detail.

Components of the Model

Hazard Agent Characteristics

There is a long history of interest in defining hazard agents such as hurricanes, earthquakes, and floods in terms of specific characteristics (for reviews, see Dynes 1970; Cvetkovich and Earle 1985; Lindell and Perry 1992). Hazard impacts often are difficult to characterize because a given hazard agent may initiate a number of different threats. For example, tropical cyclones (also known as hurricanes or typhoons) can cause casualties and damage through wind, rain, storm surge, and inland flooding (Bryant 1991). Volcanoes can impact human settlements through ash fall, explosive eruptions, lava flows, mudflows and floods, and forest fires (Warrick et al. 1981; Saarinen and Sell 1985; Perry and Lindell 1990). Nonetheless, the most significant characteristics for assessing a disaster's impacts are its speed of onset and availability of perceptual cues (such as wind, rain, or ground movement), the intensity, scope, and duration of impact, and the probability of occurrence. The speed of onset and availability of perceptual cues affect the amount of forewarning that affected populations will have to complete emergency response actions (Lindell 1994). In turn, these attributes determine the extent of casualties among the population and the degree of damage to structures in the affected area.

The impact intensity of a natural hazard generally can be defined in terms of the physical materials involved and the energy these materials impart. The physical materials involved in disasters differ in terms of their physical state—gas (or vapor), liquid, or solid (or particulate). In most cases, the hazard from a gas arises from its temperature or pressure. Examples include hurricane or tornado wind (recall that the atmosphere is a mixture of gases), which is hazardous because of overpressures that can inflict traumatic injuries directly on people. High wind also is hazardous because it can destroy structures and accelerate debris that can itself cause traumatic injuries. Alternatively, the hazard from a gas might arise from its toxicity, as is the case in some volcanic eruptions. Liquids also can be hazardous because of their toxicity but the most common liquid hazard is water, which is hazardous to structures because of the pressure it can exert and is hazardous to living things when it fills the lungs and prevents respiration. Lava is solid rock that has been liquefied by extreme heat and therefore is hazardous to people and structures because of its thermal energy. Solids also can be hazardous if they take the form of particulates such as airborne volcanic ash or floodborne mud. These are particularly significant because they can leave deposits that have impacts of long duration.

The scope of impact defines the number of affected social units (e.g., individuals, households, and businesses). The probability of occurrence (per unit of time) is another important char-

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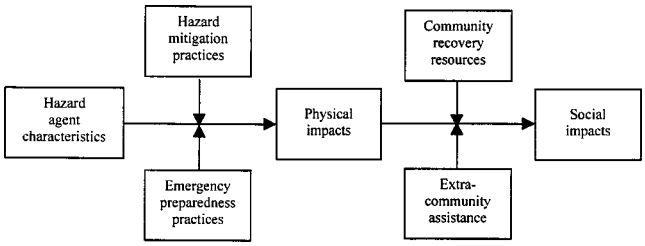


Fig. 1. Model of community disaster impacts

acteristic of natural hazards, but this affects disaster impacts indirectly because more probable hazards are likely to mobilize communities to engage in hazard mitigation and emergency preparedness measures to reduce their vulnerability (Prater and Lindell 2000).

Physical Impacts of Disasters

The physical impacts of disasters include casualties (deaths and injuries) and property damage, and both vary substantially across hazard agents. According to Noji (1997), hurricanes produced 16 of the 65 greatest disasters of the 20th Century (in terms of deaths) and the greatest number of deaths from 1947 to 1980 (499,000). Earthquakes produced 28 of the greatest disasters and 450,000 deaths, whereas floods produced four of the greatest disasters and 194,000 deaths. Other significant natural hazards include volcanic eruptions with nine of the greatest disasters and 9,000 deaths, landslides with four of the greatest disasters and 5,000 deaths, and tsunamis with three of the greatest disasters and 5,000 deaths. There is significant variation by country, with developing countries in Asia, Africa, and South America accounting for the top 20 positions in terms of number of deaths from 1966 to 1990. Low-income countries suffer approximately 3,000 deaths per disaster whereas the corresponding figure for high-income countries is approximately 500 deaths per disaster. Moreover, these disparities appear to be increasing because the average annual death toll in developed countries declined by at least 75% between 1960 and 1990, but the same time period saw increases of over 400% in developing countries (Berke 1995).

There often are difficulties in determining how many of the deaths and injuries are ''due to'' a disaster. In some cases it is impossible to determine how many persons are missing and, if so, whether this is due to death or unrecorded relocation. The size of the error in estimates of disaster death tolls can be seen in the fact that for many of the most catastrophic events the number of deaths is rounded to the nearest thousand and some even are rounded to the nearest ten thousand (Noji 1997). Estimates of injuries are similarly problematic [see Langness (1994); Peek-Asa et al. (1998); and Shoaf et al. (1998) regarding conflicting estimates of deaths and injuries attributable to the Northridge earthquake]. Even when bodies can be counted, there are problems because disaster impact may be only a contributing factor to casualties with preexisting health conditions. Moreover, some casualties are indirect consequences of the hazard agent as, for example, with casualties caused by structural fires following earthquakes (e.g., burns) and destruction of infrastructure (e.g., illnesses from contaminated water supplies).

Losses of structures, animals, and crops also are important measures of physical impacts, and these are rising exponentially in the United States (Mileti 1999), but the rate of increase is even greater in developing countries such as India and Kenya (Berke 1995). Such losses usually result from physical damage or destruction, but they also can be caused by other losses of use such as chemical or radiological contamination, or loss of the land itself to subsidence or erosion. Damage to the built environment can be classified broadly as affecting residential, commercial, industrial, infrastructure, or community services sectors. Moreover, damage within each of these sectors can be divided into damage to structures and damage to contents. It usually is the case that damage to contents results from collapsing structures (e.g., hurricane winds failing the building envelope and allowing rain to destroy the contents). Because collapsing buildings are a major cause of casualties as well, this suggests that strengthening the structure will protect the contents and occupants. However, some hazard agents can damage building contents without affecting the structure itself (e.g., earthquakes striking seismically resistant buildings whose contents are not securely fastened). Thus risk area residents may need to adopt additional hazard adjustments to protect contents and occupants even if they already have structural protection.

As is the case with estimates of casualties, estimates of losses to the built environment are prone to error. Damage estimates are most accurate when trained damage assessors enter each building to assess the percent of damage to each of the major structural systems (e.g., roof, walls, floors) and the percentage reduction in market valuation due to the damage. Early approximate estimates are obtained by conducting ''windshield surveys'' in which trained damage assessors drive through the impact area and estimate the extent of damage that is visible from the street, or by conducting computer analyses using *HAZUS* (National Institute of Building Sciences 1998). These early approximate estimates are especially important in major disasters because detailed assessments are not needed in the early stages of disaster recovery and the time required to conduct them on a large number of damaged structures using a limited number of qualified inspectors would unnecessarily delay the community recovery process.

Other important physical impacts include damage or contamination to cropland, rangeland, and woodlands. Such impacts may be well understood for some hazard agents but not others. For example, ashfall from the 1980 Mt. St. Helens eruption was initially expected to devastate crops and livestock in downwind areas but no significant losses materialized (Warrick et al. 1981). There also is concern about damage or contamination to the natural environment (wild lands) because these areas serve valuable functions such as damping the extremes of river discharge and providing habitat for wildlife. In part, concern arises from the potential for indirect consequences such as increased runoff and silting of downstream river beds, but many people also are concerned about the natural environment simply because they value it for its own sake.

Hazard Mitigation Practices

One way to reduce the physical impacts of disasters is to adopt hazard mitigation practices. These can be defined as preimpact actions that protect passively against casualties and damage at the time of hazard impact (as opposed to an active emergency response) and include community protection works, land use practices, and building construction practices (Lindell and Perry 2000). Community protection works, which limit the impact of a hazard agent on the entire community, include dams and levees that protect against floodwater and sea walls that protect against storm surge. Land use practices reduce hazard vulnerability by avoiding construction in areas that are susceptible to hazard im-

pact. Government agencies can encourage the adoption of appropriate land use practices by establishing regulations that prevent development in hazardous locations, providing incentives that encourage development in safe locations, or informing landowners about the risks and benefits of development in locations throughout the community. Finally, hazard mitigation can be achieved through building construction practices that make individual structures less vulnerable to natural hazards. Such construction practices include elevating structures out of flood plains, designing structures to respond more effectively to lateral stresses, and providing window shutters to protect against wind pressure and debris impacts.

Emergency Preparedness Practices

Another way to reduce a disaster's physical impacts is to adopt emergency preparedness practices, which can be defined as preimpact actions that provide the human and material resources needed to support active responses at the time of hazard impact (Lindell and Perry 2000). The first step in emergency preparedness is to identify the demands that a disaster of a given magnitude would place upon the community. These demands can be met by performing four basic emergency response functions: emergency assessment, expedient hazard mitigation, population protection, and incident management (Lindell and Perry 1992, 1996). Emergency assessment consists of those actions that define the potential scope of the disaster impacts (e.g., projecting hurricane wind speed), expedient hazard mitigation consists of short-term actions that protect property (e.g., sandbagging around structures), population protection actions protect people from impact (e.g., warning and evacuation), and incident management actions activate and coordinate the emergency response (e.g., communication among responding agencies). The next step is to determine which community organization will be responsible for accomplishing each function (Federal Emergency Management Agency 1996). Once functional responsibilities have been assigned, each organization must develop procedures for accomplishing those functions. Finally, the organizations must acquire response resources (personnel, facilities, and equipment) to implement their plans and they need to maintain preparedness for emergency response through continued planning, training, drills, and exercises (Daines 1991).

Social Impacts of Disaster

Social impacts, which include psychosocial, sociodemographic, socioeconomic, and sociopolitical impacts, can develop over a long period of time and can be difficult to assess when they occur. Despite the difficulty in measuring these social impacts, it is nonetheless important to monitor them because they can cause significant problems for the long-term functioning of specific types of households and businesses in an affected community. A better understanding of disasters' social impacts can provide a basis for preimpact prediction and the development of contingency plans to prevent adverse consequences from occurring.

For many years, research on the social impacts of disasters consisted of an accumulation of case studies, but two research teams conducted comprehensive statistical analyses of extensive databases to assess the long-term effects of disasters on stricken communities (Friesma et al. 1979; Wright et al. 1979). The more comprehensive Wright et al. (1979) study used census data from the 1960 (preimpact) and 1970 (postimpact) censuses to assess the effects of all recorded disasters in the United States. The authors concurred with earlier findings by Friesma et al. (1979) in concluding that no long-term social impact of disasters could be detected at the community level. In discussing their findings, the authors acknowledged that their results were dominated by the types of disasters that occur most frequently in the United States: tornadoes, floods, and hurricanes. Moreover, most of the disasters they studied had a relatively small scope of impact and thus caused only minimal disruption to their communities even in the short term. Finally, they noted that their findings did not preclude the possibility of significant long-term impacts upon lower levels such as the neighborhood, business, and household.

Nonetheless, their findings called attention to the importance of the *impact ratio*—the amount of damage divided by the amount of community resources—in understanding disaster impacts. They hypothesized that long-term social impacts tend to be minimal because most hazard agents have a relatively small scope of impact and tend to strike undeveloped areas more frequently than intensely developed areas simply because there are more of the former than the latter. Thus the numerator of the impact ratio tends to be low and local resources are sufficient to prevent long-term effects from occurring. Even when a hazard agent has a large scope of impact and strikes a large developed area (causing a large impact ratio in the short term), state and federal agencies, and nongovernmental organizations (e.g., American Red Cross) direct recovery resources to the affected area, thus preventing long-term impacts from occurring. For example, Hurricane Andrew inflicted $26.5 billion in losses to the Miami area, but this was only 0.4% of the U.S. Gross Domestic Product (Charvériat 2000). The recovery problems described by Peacock et al. (1997) were determined more by organizational impediments than by the unavailability of resources.

The findings of Wright et al. (1979) and Friesma et al. (1979) made major contributions to theory and policy, but they left some important questions unanswered. First, are there long-term social impacts that are not measured by census data? Second, does the absence of net effects obscure the presence of significant distributive effects? That is, do ''winners'' such as construction contractors that profit from the reconstruction offset ''losers'' such as those who have suffered the devastation of their homes and personal belongings. Third, what are the implications for catastrophic disasters of findings derived from small-scale disasters? Fourth, to what extent can these findings be generalized from the United States to other countries having less wealth or smaller size? Many of these questions were addressed in subsequent studies described below.

Psychosocial Impacts

One type of social impact not measured by census data consists of psychosocial impacts and, indeed, research reviews conducted over a period of 25 years have concluded that disasters can cause a wide range of negative psychosocial responses (Perry and Lindell 1978; Bolin 1985; Houts et al. 1988; Gerrity and Flynn 1997). These include psychophysiological effects such as fatigue, gastrointestinal upset, and tics, as well as cognitive signs such as confusion, impaired concentration, and attention deficits. Psychosocial impacts include emotional signs such as anxiety, depression, and grief, as well as behavioral effects such as sleep and appetite changes, ritualistic behavior, and substance abuse. In most cases, the effects that are observed are mild and transitory—the result of ''normal people, responding normally, to a very abnormal situation'' (Gerrity and Flynn 1997, p. 108). Few disaster victims require psychiatric diagnosis and most benefit more from

a ''crisis counseling'' orientation than from a ''mental health treatment'' orientation, especially if their normal social support networks of friends, relatives, neighbors, and coworkers remain largely intact. However, there are population segments that require special attention and active outreach. These include children, frail elderly, people with preexisting mental illness, racial and ethnic minorities, and families of those who have died in the disaster. Emergency workers also need special attention because they often work long hours without rest, have witnessed horrific sights, and are members of organizations in which discussion of emotional issues may be regarded as a sign of weakness (Rubin 1991).

The negative psychosocial impacts described above, which Lazarus and Folkman (1984) call ''emotion-focused coping'' responses, generally disrupt the social functioning of only a very small portion of the victim population. Instead, the majority of disaster victims engage in adaptive ''problem-focused coping'' activities to save their own lives and those of their closest associates. Further, there is an increased incidence in prosocial behaviors such as donating material aid and a decreased incidence of antisocial behaviors such as crime (Mileti et al. 1975; Drabek 1986; Siegel et al. 1999). In some cases, people even engage in altruistic behaviors that risk their own lives to save the lives of others (Tierney et al. 2001).

There also are psychosocial impacts with long-term adaptive consequences, such as changes in risk perception (beliefs in the likelihood of the occurrence of a disaster and its personal consequences for the individual) and increased hazard intrusiveness (frequency of thought, discussion, and information receipt about a hazard). In turn, these beliefs can affect risk area residents' adoption of household hazard adjustments that reduce their vulnerability to future disasters. However, these cognitive impacts of disaster experience do not appear to be large in aggregate—resulting in modest effects on household hazard adjustment [see Lindell and Perry (2000) for a review of the literature on seismic hazard adjustment, and Lindell and Prater (2000) and Lindell and Whitney (2000) for more recent empirical research].

Sociodemographic Impacts

Perhaps the most significant sociodemographic impact of a disaster on a stricken community is the destruction of households' dwellings. Such an event initiates what can be a very long process of disaster recovery for some population segments. According to Quarantelli (1982), people typically pass through four stages of housing recovery following a disaster. The first stage is emergency shelter, which consists of unplanned and spontaneously sought locations that are intended only to provide protection from the elements. The next step is temporary shelter, which includes food preparation and sleeping facilities that usually are sought from friends and relatives or are found in commercial lodging, although ''mass care'' facilities in school gymnasiums or church auditoriums are acceptable as a last resort. The third step is temporary housing, which allows victims to reestablish household routines in nonpreferred locations or structures. The last step is permanent housing, which reestablishes household routines in preferred locations and structures. Households vary in the progression and duration of each type of housing and the transition from one stage to another can be delayed unpredictably, as when it took 9 days for shelter occupancy to peak after the Whittier Narrows earthquake (Bolin 1993). Particularly significant are the problems faced by lower income households, which tend to be headed disproportionately by females and racial/ethnic minorities. Such households are more likely to experience destruction of their homes because of preimpact locational vulnerability. This is especially true in developing countries such as Guatemala (Bates and Peacock 1987; Peacock et al. 1987), but also has been reported in the U.S. (Peacock and Girard 1997). The homes of these households also are more likely to be destroyed because the structures were built according to older, less stringent building codes, used lower quality construction materials and methods, and were less well maintained (Bolin and Bolton 1986). Because lower income households have fewer resources on which to draw for recovery, they also take longer to transition through the stages of housing, sometimes remaining for extended periods of time in severely damaged homes (Girard and Peacock 1997). In other cases, they are forced to accept as permanent what originally was intended as temporary housing (Peacock et al. 1987). Consequently, there may still be low-income households in temporary sheltering and temporary housing even after high-income households all have relocated to permanent housing (Rubin et al. 1985; Berke et al. 1993).

Socioeconomic Impacts

The property damage caused by disaster impact causes direct economic losses that can be thought of as a loss in asset value (Committee on Assessing the Costs of Natural Disasters 1999) and this can be measured by the cost of repair or replacement. Disaster losses in the United States are initially borne by the affected households, businesses, and local government agencies whose property is damaged or destroyed but some of these losses are redistributed during the disaster recovery process. There have been many attempts to estimate the magnitude of direct losses from individual disasters and the annual average losses from particular types of hazards (e.g., Mileti 1999). Unfortunately, these losses are difficult to determine precisely because there is no organization that tracks all of the relevant data and some data are not recorded at all (Charvériat 2000; Committee on Assessing the Costs of Natural Disasters 1999). For insured property, the insurers record the amount of the deductible and the reimbursed loss, but uninsured losses are not recorded so they must be estimated—often with questionable accuracy.

The ultimate economic impact of a disaster depends upon the disposition of the damaged assets. Some of these assets are not replaced and so their loss causes a reduction in consumption (and, thus, a decrease in the quality of life) or a reduction in investment (and, thus, a decrease in economic productivity). Other assets are replaced—either through in-kind donations (e.g., food and clothing) or commercial purchases. In the latter case, the cost of replacement must come from some source of recovery funding, which generally can be characterized as either intertemporal transfers (to the present time from past savings or future loan payments) or interpersonal transfers (from one group to another at a given time). Some of the specific mechanisms for financing recovery include obtaining tax deductions or deferrals, unemployment benefits, loans (paying back the principal at low- or no-interest), grants (requiring no return of principal), insurance payoffs, or additional employment. Other sources include depleting cash financial assets (e.g., savings accounts), selling tangible assets, or migrating to an area with available housing, employment, or less risk (in some cases this is done by the principal wage earner only).

In addition to direct economic losses, there are indirect losses that arise from the interdependence of community subunits. Research on the socioeconomic impacts of disasters (Alesch et al.

1993; Dacy and Kunreuther 1969; Dalhamer and D'Sousa 1997; Durkin 1984; Gordon et al. 1995; Kroll 1991; Lindell and Perry 1998; Nigg 1995; Tierney 1997) suggests that the relationships among the social units within a community can be described as a state of dynamic equilibrium involving a steady flow of resources, especially money. Specifically, a household's linkages with the community are defined by the money that it must pay for products, services, and infrastructure support. This money is obtained from the wages that employers pay for the household's labor. Similarly, the linkages that a business has with the community are defined by the money it provides to its employees, suppliers, and infrastructure in exchange for inputs such as labor, materials and services, and electric power, fuel, water/wastewater, telecommunications, and transportation. Conversely, it provides products or services to customers in exchange for the money it uses to pay for its inputs.

Businesses' operational vulnerability arises from their proximity to the point of maximum impact and the structural vulnerability of the buildings in which they are located (Tierney 1997; Lindell and Perry 1998). Other sources of operational vulnerability arise from dependency upon inputs as well as those who purchase its outputs—distributors and customers. Evidence of businesses' operational vulnerability to input disruptions can be seen in data provided by Nigg (1995), who reported that business managers' median estimate of the amount of time that they could continue to operate without infrastructure was 0 h for electric power, 4 h for telephones, 48 h for water/sewer, and 120 h for fuel. If this infrastructure support is unavailable for time periods longer than these, the businesses must suspend operations even if they have suffered no damage to their structures or contents.

It also is important to recognize the financial impacts of recovery (in addition to the financial impacts of emergency response) on local government. Costs must be incurred for damage assessment, emergency demolition, debris removal, infrastructure restoration, and replanning stricken areas. In addition to these additional costs, there are decreased revenues due to loss or deferral of sales taxes, business taxes, property taxes, personal income taxes, and user fees.

Political Impacts

There is substantial evidence that disaster impacts can cause social activism resulting in political disruption, especially during the seemingly interminable period of disaster recovery. The disaster recovery period is the source of many victim grievances and this creates many opportunities for community conflict, both in the U.S. (Bolin 1982, 1993) and abroad (Bates and Peacock 1987). Victims usually attempt to recreate preimpact housing patterns, but it can be problematic for their neighbors if victims attempt to site mobile homes on their own lots while awaiting the reconstruction of permanent housing. Conflicts arise because such housing usually is considered to be a blight on the neighborhood and neighbors are afraid that the ''temporary'' housing will become permanent. Neighbors also are pitted against each other when developers attempt to buy up damaged or destroyed properties and build multifamily units on lots previously zoned for single family dwellings. Such rezoning attempts are a major threat to the market value of owner-occupied homes but tend to have less impact on renters because they have less incentive to remain in the neighborhood. There are exceptions to this generalization because some ethnic groups have very close ties to their neighborhoods, even if they rent rather than own.

Victims often experience a decrease in the quality of life associated with their housing, with the following complaints being most frequent. First, availability is a problem because there are inadequate numbers of housing units and delays in movement from temporary shelter to temporary housing and on to permanent housing. Second, site characteristics are a problem because temporary shelter and temporary housing often are far from work, school, shopping, and preferred neighbors. Third, building characteristics are a problem because of lack of affordability, inadequate size, poor quality, and designs that are incompatible with personal or cultural preferences. Fourth, conditions of allocation are a problem because recovery agencies impose financial conditions, reporting requirements, and onsite inspections. All of these complaints can cause political impacts by mobilizing victim groups, especially if victims with grievances have a shared identity (e.g., age or ethnicity) or a history of past activism (Tierney et al. 2001). These researchers have contended that the situation is especially problematic when cultural conflicts emerge from the beliefs, values, artifacts, and behavior shared by members of a subgroup differ from those of other groups, especially the majority. These components of culture usually differ systematically across demographic categories of victims and include acceptable shelter and housing arrangements, sources and types of recovery resources, and acceptable processes for distributing recovery assistance. One particularly potent area of cultural conflict arises from differences in people's beliefs about the *goals* of recovery, which involve people's ultimate values regarding ''what kind of community we want to live in.'' Many members of a community seek to reestablish conditions just as they were before the disaster while others envision the disaster as ''instant urban renewal'' that provides an opportunity to achieve a radically different community (Rubin 1991; Dash et al. 1997).

Another source of conflict is the contrast between a personalistic culture in many victim communities, which is based upon bonds of affection, and the universalistic culture of the alien relief bureaucracy, which values rationality and efficiency over personal loyalty even when engaged in humanitarian activity (Bolin 1982; Tierney et al. 2001). This conflict typically manifests itself in differences in emphasis regarding a task (material/economic) versus social-emotional (interpersonal relationships/emotional well-being) orientation toward recovery activities. In many cases, recovery is facilitated when outside recovery organizations hire local ''boundary spanners'' to provide a link between these two disparate cultures (Berke et al. 1993).

Attempts to change prevailing patterns of civil governance can arise when individuals sharing a grievance about the handling of the recovery process seek to redress that grievance through collective action. Consistent with Dynes's (1970) typology of organizations, existing community groups with an explicit political agenda may *expand* their membership to increase their strength, whereas community groups without an explicit political agenda may *extend* their domains to include disaster-related grievances. Alternatively, new groups can *emerge* to influence local, state, or federal government agencies and legislators to take actions that they support and to terminate actions that they disapprove. Indeed, such was the case for Latinos in Watsonville following the Loma Prieta earthquake (Tierney et al. 2001). Usually, community action groups pressure government to provide them with additional resources for recovering from disaster impact, but may oppose candidates' reelections or even seek to recall some politicians from office (Olson and Drury 1997; Shefner 1999; Prater and Lindell 2000). The point here is not that disasters produce political behavior that is different from that encountered in nor-

mal life. Rather, disaster impacts might only produce a different set of victims and grievances and, therefore, a minor variation on the prevailing political agenda (Morrow and Peacock 1997).

Community Recovery Resources

Community recovery resources can come from a variety of individuals and organizations. The victims themselves might have financial (e.g., savings and insurance) as well as tangible assets (e.g., property) that are undamaged by hazard impact. As one might expect, low-income victims tend to have lower levels of savings, but they also are more likely to be victims of insurance redlining and, thus, have been forced into contracts with insurance companies that go bankrupt after the disaster. Thus even those who plan ahead for disaster recovery can find themselves without the financial resources they need (Peacock and Girard 1997). Alternatively, the victims can promote their recovery by bringing in additional funds through overtime employment or by freeing up the needed funds by reducing their consumption below preimpact levels. Friends, relatives, neighbors, and coworkers can assist recovery through financial and inkind contributions, as can community based organizations (CBOs) and local government. In addition, the latter also can provide assistance by means of tax deductions or deferrals.

The impact of a disaster on the housing recovery of affected households depends upon a number of community characteristics. One of these is the availability of housing vacancies, which vary by size, quality, and price, as well as location. As indicated by Bolin's (1993) analysis of likely housing problems after a major earthquake in the New Madrid Seismic Zone, the magnitude of the housing shortage will depend upon the number of units lost in relation to the number of vacancies existing before disaster impact. In turn, the number of units lost will be determined by the type of hazard agent and its magnitude and scope of impact. Another factor is the proximity of friends and relatives with whom to stay, but this generally is a short-term solution because the relationship between victim and host families often becomes strained after a month (Bolin 1993). Moreover, extended families sometimes cannot help because they also are victims (Morrow and Peacock 1997). This is a problem in areas with low mobility where most of the extended family lives in the affected community and tends to be most prevalent in lower income groups that have few alternative resources. Temporary shelter in school gymnasiums and church auditoriums also is limited in duration because these facilities need to revert to their primary functions as soon as possible. Indeed, these facilities may be in short supply because their long-span roofs make them especially vulnerable to hazard impact (e.g., earthquake shaking and hurricane wind forces).

Availability of temporary (mobile homes or substandard housing) and permanent housing generally is limited by their preimpact supply in the housing market. In the United States, the Federal Emergency Management Agency (FEMA) arranges to have mobile homes brought in if necessary, but even this expedient method of expanding the housing stock takes time. Even when houses are only moderately damaged, loss of housing functionality may be a problem if there is massive disruption of infrastructure. In such cases, tent cities may be necessary if undamaged housing is beyond commuting range [e.g., Homestead, Florida after Hurricane Andrew (Peacock and Girard 1997)]. Mass relocation has been attempted in the past, but it usually is undesirable because it creates social and psychological disruption and delays physical reconstruction and economic recovery [e.g., Darwin, Australia after Cyclone Tracy, see Britton and Wettenhall (1990)].

Another major factor affecting household recovery is the nature of a community's private and public housing support programs. Some of this assistance comes from primary groups (i.e., the resources of friends, relatives, and coworkers), but other assistance comes from charitable organizations at the local, regional, national, and international levels (e.g., American Red Cross). The impacts of a disaster on household functioning can be reduced by financial assistance from government agencies such as FEMA and the Small Business Administration (SBA), but this form of aid typically has potentially unpopular conditions. Ability to repay is an issue because SBA loan criteria favor those with a greater ability to recover on their own. Low interest SBA loans go to those who would have qualified for commercial loans, not those who are in the greatest need (Tierney 1997). It is not clear how SBA can overcome this problem because the loan criteria are designed to screen out those who are likely to default. If the criteria were relaxed, the program would continue to be a loan program for those who repaid, but would be converted to a grant program for those who default. Other unpopular conditions have been reported in FEMA's temporary housing assistance program where homeowners receive three months of support whereas renters receive only two months. Moreover, the criteria require applicants to demonstrate need in order to receive assistance, but this creates antagonism toward ''government intrusiveness'' (Bolin 1982).

Recovery resources can be administrative as well as financial. For example, disaster-induced discontinuities in economic functioning can sharply increase the demand for specific types of products such as flashlights, batteries, electric generators, and ice. There also is a significant increase in demand for services such as construction. In most cases, the increase in demand has precisely the effect that would be predicted by economic theory—prices tend to rise substantially [however, see Dacy and Kunreuther (1969) for a counterexample]. Instead of providing funds for victims to pay higher prices, many disaster-stricken jurisdictions enact ordinances preventing ''price gouging'' and requiring licensing of out-of-town contractors (Rubin 1991). They also create consumer information programs to inform residents about selecting a reliable contractor, to advise them of their contractual rights in construction projects, and to provide telephone hotlines to report violators (Schwab et al. 1998).

Some of the needed financial resources come from the households themselves, but kin networks are another major source of assistance. Financial assistance is available from CBOs such as local churches, but is limited in amounts. It also is available from commercial banks and from local government agencies, but most of this assistance is in the form of loans that must be repaid. Lower income groups have difficulty obtaining assistance from these sources because they frequently do not meet the criteria for obtaining a loan.

Extra-Community Assistance

Extra-community assistance can be obtained from a variety of sources. One major source is nongovernmental organizations' (NGOs') in-kind contributions of goods (food, medicine, and shelter) and services (e.g., medical support). NGOs such as the Red Cross, regional governments, and national governments also can provide financial assistance through grants that do not need to be repaid by the victims or loans that might be offered at below-market interest rates. Government at all levels also can provide unemployment benefits and tax deductions or deferrals. Of

course, the significance of tax deductions or deferrals declines with income and the very poorest are unlikely to benefit from these mechanisms. The amount and timeliness of extra-community assistance depends upon the resources that remain undamaged in the remainder of the country, which is a function of the disaster's impact ratio. Another important factor is the degree to which a community is vertically integrated with higher levels of government and horizontally integrated with other jurisdictions at the same level of government (Berke et al. 1993). Communities that are more strongly integrated are more likely to receive the resources they need to recover.

Discussion and Conclusions

Natural disasters have been found to have no measurable long-term impacts on the overall viability of communities in the United States. This appears to be because even the largest disasters in the United States have small impact ratios (geographic, demographic, and economic). Thus there are considerable resources in the remainder of the country to support the recovery of households and businesses that lack the economic assets to finance their own recovery. Recovery resources flow to affected communities that are strongly linked vertically and horizontally to resources in the remainder of the country (Berke et al. 1993). Nonetheless, some segments of these communities are either disproportionately affected by disaster impacts or poorly integrated into the recovery networks, or (frequently) both.

The proposition, illustrated in Fig. 1, that the magnitude of the physical impacts can be reduced by investments in hazard mitigation and emergency preparedness practices has become a basic premise of FEMA's National Mitigation Plan (e.g., Federal Emergency Management Agency 1995). One goal of hazard mitigation is to promote the adoption of land use practices that minimize unnecessary exposures of population and structures in high-risk areas. In places where the economic advantages of the location outweigh its potential losses due to disaster impact, building construction practices should be adopted that minimize the danger to the contents and occupants of structures. These hazard mitigation practices should be supplemented by emergency preparedness practices such as evacuation to avoid casualties in structures whose resistance to extreme environmental events cannot be assured.

A major challenge for future research is to identify ways in which hazard-prone communities can be induced to reduce their vulnerability. According to economic theory, excessive hazard exposure and structural vulnerability arise from systemic complexities that can be characterized as *market failures* such as inadequate information, barriers to market entry and exit, and capital flow restrictions (Lindell et al. 1997; Kunreuther 1998). An ideal pattern of socioeconomic development would be one in which risk area occupants purchase property on the basis of adequate information about hazard vulnerability. Moreover, they would locate only where it was economically advantageous in the long term as well as in the short term, and would diversify their assets over other locations and other forms of financial (e.g., savings accounts, insurance, stocks/bonds) and social (e.g., extended family) recovery assistance. Finally, risk area occupants would adopt hazard adjustments to limit their losses if a disaster were to strike. These adjustments would include hazard mitigation (e.g., land use practices and building construction practices) and emergency preparedness practices (e.g., detection and warning systems) to avoid casualties and property damage.

Actual patterns of development are significantly different from the ideal. In many cases, there is migration to hazard-prone areas because of beneficial land uses for agriculture, transportation, and recreation [i.e., people are ''pulled in,'' Bolin and Bolton (1986)]. This is compounded by a lack of accountability for investment decisions. Developers are at risk for only a short period of time before they pass an investment on to others (homeowners, insurers, mortgage holders) who ultimately will experience hazard impact. Such transactions can occur because many risk area residents are new arrivals who are unaware of the hazard. Even long-term residents of risk areas sometimes have little or no information about hazards and adjustments to those hazards because such information is suppressed by those with a major stake in the community's economic development (Meltsner 1979). Even when there is local knowledge about hazards, there often is a lack of hazard intrusiveness because events that are not recent or frequent tend not to be thought about or discussed (Lindell and Prater 2000). Moreover, people have an ''optimistic bias'' and tend to ignore low probability events or think of them as occurring far in the future. In particular, politicians tend to ignore consequences that they expect to occur only after their term of office is over, so only frequent, recent, or major impacts lead to increased adoption of community-wide hazard adjustments such as land use controls or more stringent building codes. Even then, the ''window of opportunity'' for the adoption of these adjustments is open only temporarily (Birkland 1998; Prater and Lindell 2000).

Increased hazard exposure also is caused by displacement from safer areas due to population pressures (i.e., people are ''pushed in''). When this occurs, the demographic distribution of risk tends to be inequitable because geographical locations often are systematically related to their residents' demographic characteristics—especially their (lack of) economic and political power to decrease hazard vulnerability. This pattern is very common in developing countries such as Brazil, where *favelas* are located in flood plains and on landslideprone slopes because the residents cannot afford to purchase homes in safer areas.

There also are problems in the adoption of effective hazard adjustments. One of these arises from households' and businesses' concentration of hazard exposure (i.e., having physical and financial assets located *only* in the risk area). Diversification is an effective way of avoiding concentration of hazard exposure, but low-income households and small businesses often have so few physical or financial assets that they cannot afford to locate some of them in safer areas. Hazard insurance is problematic because it tends to suffer from adverse selection, which means that only those who are at the greatest risk are likely to purchase it (Kunreuther 1998). Moreover, externalities arise when system dynamics cause the actions of one party to increase the vulnerability of another. In floodplains, upstream deforestation and urbanization increase the speed of rainfall runoff and, thus, increase downstream vulnerability. Technological protection works such as dams and levees can reduce such increases in hazard vulnerability, but many risk area occupants overestimate the effectiveness of such hazard adjustments (Harding and Parker 1974). This can cause further development of floodplains and, thus, increased hazard exposure that exceeds the risk reduction provided by the adjustment that was adopted.

One of the most important practical lessons to be learned about disaster impact assessment is that local planners should know their communities' economic base (e.g., types of commercial, industrial, and agricultural businesses) and types of employment (professional, skilled, unskilled) within areas prone to major hazards. They should prepare for disaster recovery by identifying

vulnerable community subunits and developing recovery plans before disaster strikes. They also should anticipate the ways in which their communities' housing construction programs (e.g., zoning, subdivision regulations, building codes) could affect vulnerable segments of the community by developing preimpact disaster recovery plans that define processes for expedited review of building designs and building inspections (Schwab et al. 1998).

Another lesson for local planners is that low-income workers are likely to have a more difficult time finding temporary and permanent housing. This can be a severe problem for some businesses, such as restaurants, hotels, and other tourist oriented businesses, that are dependent upon low-skill, low-income employees (Drabek 1994). After a disaster, local planners and CBOs should monitor and address the unmet needs of different geographic areas, economic sectors, and demographic groups. They also should anticipate the emergence of political conflicts about recovery goals, the orientations of extra-community organizations, and frustration over the pace of recovery. One way of mitigating these political impacts is to anticipate the conditions that cause them and to prepare disaster recovery plans before disaster strikes.

Another important implication of the research on disaster impacts is that the reduction of hazard vulnerability must be a community effort, not an individual one. A home or business that is designed and constructed to withstand extreme environmental forces will not necessarily protect against the disruption of critical linkages to other parts of the community. For businesses, this is because disruption of *any one* of the four linkages—to suppliers, workers, infrastructure, or customers—can cause a business to fail. Thus a business can experience disaster-induced losses, including bankruptcy, even if it has successfully mitigated the threats to the building in which it is housed and the contents of that building (i.e., personnel, equipment, materials, and supplies). Alternatively, a business can fail if there is a major shift in the demand for its products and services that has been induced by the disaster. For example, customers' demand for discretionary products such as sporting goods may decline significantly if they are spending all of their money on construction materials. Such a reduction in demand might not materialize immediately and, indeed, could occur in businesses that are not even located within the disaster impact area. Thus businesses engaged in hazard mitigation must not stop when they have achieved protection for their own buildings and contents. A business's survival is assured only if those upon whom it depends also protect themselves.

A similar principle applies to local governments; they should expect a continuation of demands for routine services and provision of disaster-related services even if they also have suffered damage to their facilities and casualties to their employees. Moreover, these demands will come during a time at which decreased solvency of households and businesses jeopardizes local government revenues derived from taxes on property and sales, user fees, and licenses. Thus local government agencies must adopt hazard mitigation measures to ensure their ability to provide services during the recovery period (Perry and Lindell 1997).

In summary, it is clear that there has been significant progress over that past 25 years in developing an understanding of the complexities involved in avoiding and recovering from the community impacts of disasters. Many studies have addressed the psychosocial, sociodemographic, socioeconomic, and sociopolitical impacts of disasters, but there have been few attempts to synthesize this work. Differential impacts of disasters on community subgroups have been addressed extensively in the psychosocial domain, and the ways in which differentials in sociodemographic impacts produce sociopolitical consequences has begun to attract significant attention. However, documentation of systematic differences in socioeconomic impacts remains sparse.

In addition to developing greater integration among areas of research (which typically follow disciplinary lines), future research must also address some other deficiencies. First, this article addressed only natural hazards, but technological hazards also should be addressed because contamination by some toxic chemicals or radiological materials can produce impacts that are more persistent than physical destruction. For example, areas around the Chernobyl nuclear power plant must be isolated for many years to come. By contrast, toxic gases affect people without harming property (e.g., the release of methyl isocyanate near Bhopal India). These differences in physical impacts would be expected to produce corresponding differences in social impacts.

Second, there is only a limited understanding of the ways in which conclusions based upon research in the United States apply to other countries. One major variable is the nature of the hazards that different countries face. Flooding is a worldwide concern, but hurricanes and earthquakes affect only certain areas of the globe. These differences in hazard exposure have a significant effect on the observed levels of disaster impacts and need to be accounted for in future research. A second variable, the physical size of an affected country, is important because the geographic impact ratio (the size of the impact area in relation to the size of the country) is another potential confounding variable in understanding disaster impacts. Related variables include the demographic impact ratio, which measures disaster casualties in terms of a country's total population, and the economic impact ratio, which measures disaster losses in relation to a country's annual Gross Domestic Product. The latter is influenced by a country's level of economic development, with industrialized economies appearing to be more resilient to disasters than developing economies, which are characterized by subsistence-level agriculture that relies on little infrastructure support, and has few exchanges of money for products, services, and labor.

Other important factors include similarity in the levels of hazard mitigation, emergency preparedness, community recovery resources, and access to extra-community assistance. These variables are confounded to some extent with the nature of countries' political structures, especially the degree to which power is centralized and the degree to which local government is horizontally and vertically integrated. In many respects, these variables raise questions about the degree to which the experience in the United States is relevant to many developing countries. If future research can identify the factors that affect the generalizability of the United States' experience, this will clarify the ways in which other countries can reduce their vulnerability to disaster impacts and promote recovery when disaster does strike. It will be particularly important to examine the ways in which these variables influence the dynamics of hazard vulnerability, as well as the processes of adopting and implementing effective hazard mitigation, emergency preparedness, and recovery assistance practices.

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