

## RECOVERY AND RECONSTRUCTION AFTER DISASTER

Michael K. Lindell  
Texas A&M University, College Station, TX, USA

### Definition

*Disaster recovery.* Disaster recovery has three distinct but interrelated meanings. First, it is a *goal* that involves the restoration of normal community activities that were disrupted by disaster impacts – in most people’s minds, exactly as they were before the disaster struck. Second, it is a *phase* in the emergency management cycle that begins with stabilization of the disaster conditions (the end of the emergency response phase) and ends when the community has returned to its normal routines. Third, it is a *process* by which the community achieves the goal of returning to normal routines. The recovery process involves both activities that were planned before disaster impact and those that were improvised after disaster impact.

*Disaster impacts.* These are the physical and social disturbances that a hazard agent inflicts when it strikes a community. Physical impacts comprise casualties (deaths, injuries, and illnesses) and damage to agriculture, structures, infrastructure, and the natural environment. Social impacts comprise psychological impacts, demographic impacts, economic impacts, and political impacts. *Incident stabilization.* This is the point in time at which the immediate threats to human safety and property resulting from the physical impacts of the hazard agents have been resolved and the community as a whole can focus on disaster recovery.

### Disaster impacts

As noted earlier, disaster impacts comprise both physical and social impacts. The physical impacts are casualties (deaths and injuries) and property damage, and both vary substantially across hazard agents. The physical impacts of a disaster are usually the most obvious, easily measured, and first reported by the news media. Social impacts include psychosocial, demographic, economic, and political impacts. A very important aspect of disaster impacts is their *impact ratio* – the amount of damage divided by the amount of community resources. Long-term social impacts tend to be minimal in the USA 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 disaster 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 NGOs (nongovernmental organizations such as the American

Red Cross) direct recovery resources to the affected area, thus preventing long-term impacts from occurring. For example, 1992 Hurricane Andrew inflicted \$26.5 billion in losses to the Miami Florida USA area, but this was only 0.4% of the US GDP (Charvériat, 2000). However, the fact that communities *as a whole* recover does not mean that specific neighborhoods or households within those neighborhoods recover at the same rate or even at all. Similarly, it does not mean specific economic sectors or individual businesses within those sectors will be able to maintain or even resume operations. Thus, it is important to anticipate which population segments and economic sectors will have the most difficulty in recovering. This will enable community authorities to intervene with technical and financial assistance when it is needed, monitor their recovery, and encourage them to adopt hazard mitigation measures to reduce their hazard vulnerability.

Disaster impacts vary among households and businesses because of preexisting variation in the vulnerability of social units within each of these categories. Specifically, social vulnerability is people’s “capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard” (Wisner et al., 2004, p. 11). Whereas people’s physical vulnerability refers to their susceptibility to biological changes (i.e., impacts on anatomical structures and physiological functioning), their social vulnerability refers to limitations in their physical assets (buildings, furnishings, vehicles) and psychological (knowledge, skills, and abilities), social (community integration), economic (financial savings), and political (public policy influence) resources. The central point of the social vulnerability perspective is that, just as people’s occupancy of hazard prone areas and the physical vulnerability of the structures in which they live and work are not randomly distributed, neither is social vulnerability randomly distributed – either geographically or demographically. Thus, just as variations in structural vulnerability can increase or decrease the effect of hazard exposure on physical impacts (property damage and casualties), so too can variations in social vulnerability (Bolin, 2006; Enarson et al., 2006). In particular, households that are elderly, female-headed, lower income, and ethnic minority are likely to have high vulnerability to disasters.

### Physical impacts

*Casualties.* According to the EM-DAT database ([www.emdat.be/database](http://www.emdat.be/database)), there were 25 geophysical, hydrological, or meteorological disasters that produced more than 50,000 deaths between 1900 and 2011. Of these, 12 were earthquakes (maximum = 242,000), seven were tropical cyclones (maximum = 300,000), and six were floods (maximum = 3,700,000). There is significant variation by region, with Asia experiencing 54% of the earthquakes but 71% of the casualties from these events, 41% of the floods but 98% of the casualties, and 41% of the storms but 92% of the casualties. By contrast, the Americans experienced 22% of the earthquakes but 17% of the

casualties from these events, 24% of the floods but less than 2% of the casualties, and 33% of the storms and 8% of the casualties. Berke (1995) found that developing countries in Asia, Africa, and South America accounted for approximately 3,000 deaths per disaster, whereas the corresponding figure for high-income countries was 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.

*Damage.* Losses of structures, animals, and crops also are important measures of physical impacts, and the EM-DAT database shows that these have been rising exponentially throughout the world since 1970. Moreover, Berke (1995) reported that the rate of increase is even greater in developing countries such as India and Kenya. Such losses usually result from physical damage or destruction of property, but they also can be caused by losses of land use to 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 (water, waste disposal, electric power, fuel, telecommunications, and transportation), or community services (public safety, health, education) 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 furniture inside the building). 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.

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 (USA) 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.

## Social impacts

*Psychosocial impacts.* Research reviews conducted over a period of 25 years have concluded that disasters can cause a wide range of negative psychological responses (Gerrity and Flynn, 1997; Norris et al., 2002a, b). In most cases, the observed effects are mild and transitory – the result of “normal people, responding normally, to a very abnormal situation” (Gerrity and Flynn, 1997, p. 108). The vast majority of disaster victims experience only mild psychological distress. For example, Bolin and Bolton (1986) found negative impacts such as upsets with storms (61%), time pressures (48%), lack of patience (38%), and strained family relationships (31%) after the 1982 Paris Texas USA tornado. However, victims also experienced positive impacts including strengthened family relationships (91%), decreased importance of material possessions (62%), and increased family happiness (23%). The data showed only minor differences between Blacks and Whites in the prevalence of psychosocial impacts.

Researchers have also examined public records in their search for psychological impacts of disasters. For example, Morrow's (1997) examination of vital statistics (births, marriages, deaths, and divorce applications) had no significant long-term trends due to Hurricane Andrew. However, domestic violence rates remained constant for about 6 months after the hurricane but increased about 50% for nearly 2 years after that. Nonetheless, there are especially vulnerable groups that might need extra attention if they show signs of long-standing problems due to the disaster. This includes youth, people with preexisting mental conditions, and victims who have witnessed the death or severe injury of loved ones. Single minority female heads of household who have limited psychosocial resources for coping with severe exposures and secondary stressors have the most adverse outcomes, especially in developing countries (Morrow, 1997; Norris et al., 2002a).

The negative psychological impacts described above, which Lazarus and Folkman (1984) call *emotion focused coping*, 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 (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 psychological impacts with long-term adaptive consequences, such as changes in risk perception (beliefs in the likelihood of the occurrence a disaster and its personal consequences for the individual) and increased hazard intrusiveness (frequency of thought and discussion 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, and Spittal et al., 2008, for literature on seismic hazard adjustment).

*Demographic impacts.* The demographic impact of a disaster can be assessed by adapting the *demographic balancing equation*,  $P_a - P_b = B - D + IM - OM$ , where  $P_a$  is the population size after the disaster,  $P_b$  is the population size before the disaster,  $B$  is the number of births,  $D$  is the number of deaths,  $IM$  is the number of immigrants, and  $OM$  is the number of emigrants (Smith et al., 2001). The magnitude of the disaster impact,  $P_a - P_b$ , is computed at two specific points in time for the population of a specific geographical area. The identification of the “impact area” is especially important in assessing demographic impacts because early US research (Friesma et al., 1979; Wright et al., 1979) suggested disasters have negligible demographic impacts. However, the highly aggregated level of analysis in these studies did not preclude the possibility of significant impacts at lower levels of aggregation (census tracts, block groups, or blocks). For example, casualties and emigration decreased the population of Lampuuk in the Aceh province of Indonesia to approximately 6% of its preimpact population immediately after the 2004 Indian Ocean tsunami (Fanany, 2010). Although there can be a major loss of life in some disasters, the most likely demographic impacts are the emigration of population segments that have lost housing and the (temporary) immigration of construction workers. In many cases, housing-related emigration is also temporary, but census data showed that the city of New Orleans dropped to 44% of its preimpact population in the year after Hurricane Katrina and only returned to 78% of its preimpact population 6 years later. Moreover, there are documented cases in which housing reconstruction has been delayed indefinitely – leading to “ghost towns” (Comerio, 1998). Other potential causes of emigration are psychological impacts (belief that the likelihood of disaster recurrence is unacceptably high), economic impacts (loss of jobs or community services), or political impacts (increased neighborhood or community conflict).

*Economic impacts.* The property damage caused by disaster impact creates losses in asset values that can be measured by the cost of repair or replacement (CACND, 1999). In most cases, disaster losses are initially borne by the affected households, businesses, and local government agencies whose property is damaged or destroyed. However, some of these losses are redistributed during the disaster recovery process through insurance and disaster relief. In addition to direct economic losses, there are indirect losses that arise from the interdependence of community subunits. Research on the economic impacts of disasters (Alesch et al., 1993; Rose and Limb, 2002; Tierney, 2006) suggests 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 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, 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.

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 tasks such as damage assessment, emergency demolition, debris removal, infrastructure restoration, and replanning stricken areas. In addition to these 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 a source of many victim grievances and this creates many opportunities for community conflict (Bates and Peacock, 1993; Bolin, 1982, 1993). Victims usually attempt to recreate preimpact housing patterns, which can thwart government attempts at relocation to less hazardous areas (Dove, 2008). Such attempts also can be problematic for their neighbors if victims attempt to site temporary housing, such as mobile homes, on their own lots while awaiting the reconstruction of permanent housing. Conflicts arise when such housing is considered to be a blight on the neighborhood and neighbors are afraid the “temporary” housing will become permanent. Neighbors also are pitted against each other when developers attempt to buy 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.

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. This is most likely when government agencies or NGOs relate to local communities through manipulation or consultation rather than partnership or ownership (Kenny, 2010). Consistent with Dynes’s (1970) typology of organizations, existing community groups with an explicit political agenda can *expand* their membership to increase their strength, whereas community groups without an explicit political agenda can *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, California following the 1989 Loma Prieta earthquake (Tierney et al., 2001). Usually, community action groups pressure government to provide 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; Prater and Lindell, 2000; Shefner, 1999). The point here is not that disasters produce political behavior that is different from that encountered in normal 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).

### Disaster recovery goals

Most people's goal in disaster recovery is to restore household, business, and government activity to the "normal" patterns that existed before the disaster struck. To do this, they typically assume they must restore the buildings and infrastructure as they were before the disaster. However, it is increasingly understood that restoring the community to its previous condition will also reproduce its previous hazard vulnerability. When cities allow too much development in floodplains or allow substandard housing to be built that collapses in an earthquake, "normal" is an unsustainable condition. Consequently, a disaster resilient community learns from experience which areas of the community have excessive levels of hazard exposure. It also identifies the buildings and infrastructure that have inadequate designs, construction methods, and construction materials. In short, communities need to incorporate hazard mitigation into their disaster recovery. That is, they need to adopt hazard source control, community protection works, land-use practices, building construction practices, and building contents protection practices (Federal Emergency Management Agency, 1986; Lindell et al., 2006, Chapter 7). *Hazard source control* involves intervention at the point of hazard generation to reduce the probability or magnitude of an event. By contrast, *community protection works* attenuate disaster impact by altering the hazard transmission process, especially by confining or diverting materials flows to reduce the hazard exposure of target locations and populations. *Land-use practices* limit hazard exposure by minimizing development in areas where the likelihood of hazard impact is high. By contrast, *building construction practices* limit physical vulnerability by building structures whose resistance to hazard impact is high. Finally, *building contents protection* prevents furniture, equipment (e.g., furnaces, air conditioners, washers, dryers), and other building contents from being damaged or destroyed. In many cases, but not all, appropriate building construction practices protect building contents at the same time as they protect the

structure itself. For example, preventing wind damage to a structure will also prevent damage to its contents. However, seismic shaking can overturn water heaters and refrigerators without causing any damage to the building structure itself.

### Disaster recovery stages and functions

The identification of disaster recovery as an emergency management phase has led some authors to divide it into stages, but there has been little agreement on the number and definitions of recovery stages (Alexander, 1993; Kates and Pijawka, 1977; Sullivan, 2003; UNDRR, 1984; Schwab et al., 1998). It is now generally accepted that disaster recovery encompasses multiple activities, some implemented sequentially and others implemented simultaneously. At any one time, some households and businesses might be engaged in one set of recovery activities whereas others are engaged in other recovery activities. Indeed, some households and businesses might be fully recovered months or years after others and there might be others that never recover at all. Thus, it is more useful to think of disaster recovery in terms of four functions: disaster assessment, short-term recovery, long-term reconstruction, and recovery management (see Table 1). The recovery phase's *disaster assessment* function should be integrated with the emergency response phase's emergency assessment function in identifying the physical impacts of the disaster. *Short-term recovery* focuses on the immediate tasks of securing the impact area, housing victims, and establishing conditions under which households and businesses can begin the process of recovery.

Recovery and Reconstruction After Disaster, Table 1 Disaster recovery functions

<i>Disaster assessment</i>	
• Rapid assessment	• Victims' needs assessments
• Preliminary damage assessment	• "Lessons learned"
• Site assessment	
<i>Short-term recovery</i>	
• Impact area security	• Emergency demolition
• Temporary shelter/housing	• Repair permitting
• Infrastructure restoration	• Donations management
• Debris management	• Disaster assistance
<i>Long-term reconstruction</i>	
• Hazard source control and area protection	• Economic development
• Land-use practices	• Infrastructure resilience
• Building construction practices	• Historic preservation
• Public health/mental health recovery	• Environmental recovery
	• Disaster memorialization
<i>Recovery management</i>	
• Agency notification and mobilization	• Recovery legal authority and financing
• Mobilization of recovery facilities and equipment	• Administrative and logistical support
• Internal direction and control	• Documentation
• External coordination	
• Public information	

*Long-term reconstruction* actually implements the reconstruction of the disaster impact area and manages the disaster's psychological, demographic, economic, and political impacts. Finally, *recovery management* monitors the performance of the disaster assessment, short-term recovery, and long-term reconstruction functions. It also ensures they are coordinated and provides the resources needed to accomplish them.

### Disaster recovery processes

There are three relatively distinct types of social units that should be considered in disaster recovery: households, businesses, and government agencies. Households and businesses focus primarily on their own recovery but government agencies must address the recovery needs of the entire community.

### Household recovery

There are three basic components to household recovery. These are housing recovery, economic recovery, and psychological recovery (Bolin and Trainer, 1978). All three of these components require resources to recover, but households must invest time to obtain these resources. This includes time to find and purchase alternate shelter, clothing, food, furniture, and appliances to support daily living (Yelvington, 1997). Time is also needed to file insurance claims, apply for loans and grants, and search for jobs. The time required for these tasks is increased by multiple trips to obtain required documentation and understaffing of providers (Morrow, 1997). Finally, victims need skill and self confidence to cope with the disaster assistance bureaucracy (Morrow, 1997).

*Housing recovery.* Households typically use four types of housing recovery following a disaster (Quarantelli, 1982). The first type, *emergency shelter*, consists of unplanned and spontaneously sought locations that are intended only to provide protection from the elements, typically open yards and cars after earthquakes (Bolin and Stanford, 1991, 1998). The second type 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 type is *temporary housing*, which allows victims to reestablish household routines in nonpreferred locations or structures. The last type is *permanent housing*, which reestablishes household routines in preferred locations and structures. There is no single pattern of progression through the stages of housing because households vary in number and sequence of movements and the duration of their stays in each type of housing (Cole, 2003). Indeed, the transition from one stage to another can be delayed unpredictably, as when it took 9 days for shelter occupancy to peak after the 1987 Whittier Narrows California earthquake (Bolin, 1993). Yelvington (1997) reported that temporary shelters experienced increased demand as buildings were condemned by

authorities or landlords begin reconstruction on damaged structures.

There are significant variations among households in their housing recovery and these are correlated with households' demographic characteristics (Peacock et al., 2006). Severity of damage and the availability of relatives nearby predict who stays with relatives, whereas income, homeownership, and availability of relatives nearby predict who accepts relatives (Morrow, 1997). Moreover, kin networks are likely to seek temporary shelter together, especially if all relatives became victims because they lived so close together (Yelvington, 1997). Households with higher incomes who lack nearby friends and relatives with undamaged homes seek commercial facilities, whereas lower-income households in such conditions are forced to accept mass care facilities.

Sites for temporary housing include homes of friends and relatives, commercial facilities such as rental houses and apartments, and mass facilities such as trailer parks. Some of these sites are in or near the stricken community, but others are hundreds or even thousands of kilometers away. Lack of alternative housing within an acceptable distance of jobs or peers led some households to leave the Miami area after Hurricane Andrew. The population loss was 18% in South Dade County, 33% in Florida City, and 31% in Homestead (Dash et al., 1997). Other households remained in severely damaged units – or even condemned units – without electric power or telephone service for months (Yelvington, 1997) or doubled up with relatives (Morrow, 1997).

Households encounter many problems during reconstruction, including high prices for repairs, poor quality work, and contract breaches (Bolin, 1993). The rebuilt structures do benefit from improved quality and hazard resistance (Bolin, 1993, indicates 50% of respondents reported this) and this is especially true for public housing (Morrow, 1997). However, few victims think the improvements are worth the inconvenience they experienced. Lower-income households tend to have higher hazard exposure because they often live in more hazard prone locations. They also have higher physical vulnerability because they live in structures that were built according to older, less stringent building codes, used lower quality construction materials and methods, and have been 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 return to permanent housing, sometimes remaining for extended periods of time in severely damaged homes (Girard and Peacock, 1997). Indeed, they sometimes are forced to accept as permanent what originally was intended as temporary housing (Peacock et al., 1987). Consequently, there might still be low-income households in temporary sheltering and temporary housing even after high-income households all have relocated to permanent housing (Berke et al., 1993; Rubin et al., 1985).

*Economic recovery.* Some households' economic recovery takes place quickly, but others' takes much

longer. For example, the percentage of households reporting complete economic recovery after the Whittier earthquake was 50% at the end of the first year but 21% reported little or no recovery even at the end of 4 years (Bolin, 1993). Economic recovery was positively related to household income and negatively related to structural damage, household size, and the total number of moves (Bolin, 1993). In some cases, this is due to the loss of permanent jobs that are replaced only by temporary jobs in temporary shelter management, debris cleanup, and construction – or are not replaced at all (Yelvington, 1997).

There are systematic differences in the rate of economic recovery among ethnic groups. For example, Bolin and Bolton (1986) found that Black households (30%) lagged behind Whites (51%) in their return to preimpact economic conditions 8 months after the Paris, Texas, tornado. However, the variables affecting economic recovery were relatively similar for Black and White families. In both ethnic groups, economic recovery was negatively related to family size (larger families had lower levels of recovery), but positively related to socioeconomic status (SES – education, profession, and income), use of disaster assistance, insurance adequacy, and aid adequacy. In addition, Black household recovery was negatively related to primary group aid and the number of household moves. The direct effect of family size and SES on economic recovery was compounded by the indirect effects of these variables via their impacts on the use of disaster assistance, insurance adequacy, aid adequacy, and household moves. The variables that had positive direct effects on economic recovery (use of disaster assistance, insurance adequacy, aid adequacy) were negatively related to family size and positively related to SES. That is, larger households were less likely – and higher SES households were more likely – to use disaster assistance, have adequate insurance, or receive adequate aid. Moreover, these variables were positively related to family size and negatively related to SES. That is, larger households made more moves and higher SES households made fewer moves. The overall effect of this complex pattern of relationships is for large poor households to be doubly handicapped in their economic recovery.

*Psychological recovery.* 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 requiring 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 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). Thus, professionals involved in particularly difficult search operations and medical

personnel who handle extraordinary workloads during disaster periods might also benefit from post-disaster counseling. However, there is little evidence of emergency workers needing directive therapies. In particular, there appears to be little scientific evidence that some widely used programs such as *Critical Incident Stress Debriefing* are effective (McNally et al., 2003).

In summary, the majority of victims and responders recover relatively quickly from the stress of disasters without psychological interventions. Those who suffer the greatest losses to their material resources (e.g., the destruction of their homes) and their social networks (e.g., spouses and other family members) are likely to experience the most psychological distress, but not necessarily an amount that is personally unmanageable. Thus, the appropriate strategy for psychological recovery by victims and first responders seems to be one of minimal intervention to provide information about sources of material support (for victims) and to facilitate optional involvement in social and emotional support groups (for victims and first responders).

### Business recovery

Several studies of the economic impacts of environmental disasters have examined the ways in which individual businesses prepare for, are disrupted by, and recover from these events (see Tierney, 2006 and Zhang et al., 2009 for reviews). These studies found older, larger (measured by the number of employees), and more financially stable businesses are more likely to adopt hazard adjustments, as are businesses in the manufacturing, professional services, finance, insurance, and real estate sectors. Small businesses are more physically vulnerable because they are more likely than large businesses to be located in nonengineered buildings and are less likely to have the capacity to design and implement hazard management programs to reduce this physical vulnerability. At the same time as they face increased costs to repair structures and replace contents, these businesses also face reduced patronage if they must move far from their previous locations. Ultimately, many small businesses have failed by the time the space is available for reoccupancy at their original locations.

There also is variation among business sectors in their patterns of recovery. Whereas wholesale and retail businesses generally report experiencing significant sales losses, manufacturing and construction companies often show gains following a disaster (Webb et al., 2000). Moreover, businesses that serve a large (e.g., regional or international) market tend to recover more rapidly than those that only serve local markets (Webb et al., 2002). Small businesses, in particular, have been found to experience more obstacles than large firms and chains in their attempts to regain their predisaster levels of operations. Compared to their large counterparts, small firms are more likely to depend primarily on neighborhood customers, lack the financial resources needed for recovery, and lack

access to governmental recovery programs (Alesch et al., 2001; Tierney, 2006). Thus, business sector and business size can be seen as indicators of operational vulnerability that are equivalent to the demographic indicators of social vulnerability in households.

### Sources of recovery assistance

There are three fundamental patterns of household recovery that are defined by the three corresponding sources of assistance (Bolin and Trainer, 1978). These are autonomous (own resources), kinship (extended family resources), or institutional (governmental) – although few households actually rely on only one source.

Autonomous recovery depends on the household's available human, material, and financial resources. Human resources are available to the extent household members can continue to derive generate income from employment, rental of physical assets, or interest/dividends from financial assets. Moreover, household recovery depends on the degree to which material resources are available. This includes the extent to which its possessions – land, buildings, equipment, furniture, clothes, vehicles, crops, and animals – are undamaged or can be restored at reasonable expense. A household's recovery also depends on the degree to which its financial resources are available. This includes an ability to withdraw savings quickly from banks, to quickly liquidate stocks and bonds at a fair price, and to receive adequate compensation from its insurer. In some cases, household recovery also depends on the degree to which creditors will accept delayed payments on financial liabilities such as loans, mortgages, and credit card debt. Finally, household recovery depends on the degree to which members can reduce consumption such as purchases of shelter, food, clothing, medical care, entertainment, and other goods and services. Kinship recovery depends on the physical proximity of other nuclear families in the kin network, the closeness of the psychological ties within the network, the assets of the other families and, of course, the extent to which those families also suffered losses. Institutional recovery depends on whether victims meet the qualification standards, usually documented residence in the impact area and proof of loss.

Some aspects of household recovery are relatively similar across ethnic groups, but others reveal distinct differences. After Hurricane Andrew, Anglos, Blacks, and Hispanics experienced similar levels of frustration in coping with the challenges of living in damaged homes, job relocation, dealing with agencies, behavioral problems with children, and loss of household members (Morrow, 1997). However, there were significant differences in the experience of other problems. For example, Blacks reported the greatest frequency of frustration about living in temporary quarters, whereas Hispanics experienced the greatest frustrations in dealing with building inspectors.

### Hazard insurance

Hazard insurance is important because it decreases government workload and expense after disasters by shifting part of the administrative burden for evaluating damage to insurance companies in the private sector. Moreover, hazard insurance defines the terms of coverage in advance, thus reducing opportunities for politicians to increase benefits after disaster. Unfortunately, the potential contribution of hazard insurance remains to be fully realized. There are many difficulties in developing and maintaining an actuarially sound hazard insurance program, so hazard insurance varies significantly in its availability and cost – flood, hurricane, and earthquake insurance being particularly problematic (Kunreuther and Roth, 1998). In particular, the National Flood Insurance Program has made significant strides over the past 30 years, but it continues to require operational subsidies.

One of the basic problems is that those who are most likely to purchase flood insurance are, in fact, those who are most likely to file claims (Kunreuther, 1998). This problem of *adverse selection* makes it impossible to sustain a market in private flood insurance. In some cases, the homeowners are underinsured or lack any insurance because they cannot afford quality insurance or were denied access to it (Peacock and Girard, 1997). In addition, there are cognitive obstacles to developing a comprehensive hazard insurance program. Building on earlier hazards research (see Burton et al., 1993, for a summary) and psychological research on judgment and decision making (see Slovic et al., 1974, for an early statement and Baron, 2000, for a more recent summary), researchers have identified numerous logical deficiencies in the ways people process information in laboratory studies of risk. One important issue concerns what economists call *moral hazard* and psychologists refer to as a *lack of perceived personal responsibility for protection*. The concept of moral hazard has important policy implications because the Interagency Floodplain Review Committee (1994) report concluded federal disaster relief policy creates this condition by relieving households of the responsibility for providing their own disaster recovery resources.

Hazard insurance can make a significant contribution to household recovery but coverage varies by hazard agent, with Bolin and Bolton (1986) reporting 86% coverage for a tornado and Bolin (1993) reporting 25% for an earthquake. Risk area residents are particularly likely to forego earthquake insurance because they consider premiums to be too high and deductibles too large (Palm et al., 1990). Income, education, and occupational status all correlate with earthquake insurance purchase (Bolin, 1993). Strategies for coping with uninsured losses include obtaining government or commercial loans, obtaining government or nongovernmental organization (NGO) grants, withdrawing savings, and deciding not to replace damaged items (Bolin, 1993). Loans can be problematic because they involve long-term debt that takes many years to repay (Bolin, 1993). Government grants require households to

meet specific standards, including proof that they are indeed residents of the disaster impact area. However, there can be problems in registering people who evacuated or were rescued without identification (Yelvington, 1997). Relaxed standards seem humane but can allow the chronically homeless and out of area construction workers to obtain access to services intended only for disaster victims. In turn, resentment toward “freeloaders” can curtail services to victims.

### Higher levels of government

Countries across the world vary in the relative roles of local, state (provincial), and federal (national) levels of government. In some cases, the entire burden of government assistance falls on the federal/national government whereas, in others, responsibility is distributed across multiple levels of government. Because of this diversity, this section focuses on the system in the United States because it illustrates types of complexities that arise in a federal system of distributed responsibility.

In the USA, state and federal agencies can play significant roles in disaster recovery, but the burden most frequently falls on local governments because only about 19% of all disasters receive state disaster declarations and 1% qualifies for Presidential Disaster Declarations (PDDs). Thus, local governments should prepare to undertake a variety of functions during a disaster recovery process, understanding that they might not receive any aid from higher levels of government for minor disasters. The main factor affecting the level of involvement of state and federal government is the scope of the event. After a major disaster, a PDD opens a broad range of programs for relief and reconstruction. In such cases, the state plays a coordinating role, working with both federal and local governments.

The lead agency at the federal level is FEMA, but other federal agencies might be called upon when a PDD is granted, including the Small Business Administration, the US Army Corps of Engineers, the Department of Housing and Urban Development, the National Oceanographic and Atmospheric Administration, and the Economic Development Administration, among others. Each of these agencies funds specific disaster recovery programs. According to the National Response Framework, these agencies can be housed in Disaster Field Offices (DFOs) in the vicinity of the disaster. Emergency Response Teams (ERTs) are located in the DFOs. These include an Operations Section that coordinates federal, state, and voluntary efforts, and an Infrastructure Support Branch to facilitate restoration of public utilities and other infrastructure services.

The main types of programs providing recovery assistance are Individual Assistance, Infrastructure Support (formerly Public Assistance), and Hazard Mitigation Grant Program. Individual Assistance is available to households through the Temporary Housing Assistance program, Individual and Family Grants, Disaster Unemployment assistance, legal services, special tax considerations, and crisis

counseling programs. Individuals and businesses can receive aid through the Small Business Administration Disaster Loans program, which can provide loans for repairs to housing and businesses, and also for operating expenses. In the past, many loan programs have been inaccessible to low-income households, which tend to rent rather than own their housing. Thus, they failed to qualify for loans because of their low incomes and lack of collateral. The Individual and Family Grant Program was intended to fill the need for a program targeting those whose needs were not being met by the SBA loan program, private insurance, or NGO assistance. However, the amounts awarded tend to be small.

Assistance provided under the Hazard Mitigation Grant Program has increased in importance since the passage of the Disaster Mitigation Act of 2000. This legislation requires local governments to identify potential mitigation measures that could be incorporated into the repair of damaged facilities in order to be eligible for pre- and post-disaster funding. These activities include hazard mapping, mitigation planning, development of building codes, development of training and public education programs, establishing Reconstruction Information Centers, and assisting communities to promote sustainable development. In addition, there may be state programs that also provide assistance to households and local governments for recovery from disasters that do not receive a PDD.

### Nongovernmental organizations and community-based organizations

The role of NGOs such as the American Red Cross, Salvation Army, and Mennonite Disaster Service is widely publicized and the role of community-based organizations (CBOs) such as local churches and service organizations is increasingly recognized. Such organizations provide housing, food, clothing, medicine, and financial assistance to disaster victims. In most cases, the *existing* government social service agencies are supplemented by NGOs that *expand* their membership to perform the tasks they are expected to perform during disaster recovery (Dynes, 1970). By contrast, existing CBOs typically *extend* themselves beyond their normal tasks to perform novel activities. In addition, there are situations in which existing, expanding, and extending organizations cannot successfully meet the recovery needs of disaster victims. In such cases, government agencies, NGOs, and CBOs form an *Unmet Needs Committee*, which is an *emergent* organization that is designed to serve those whose needs are not being addressed by existing programs. In some cases, the need for such emergent organizations arises from political organization and activism by population segments that believe they are being neglected (Morrow and Peacock, 1997; Phillips, 1993).

### Local government recovery functions

Rubin (1991) accounted for community recovery in terms of six variables – *federal influences and conditions, state*

*influences and conditions, community-based needs and demands for action, personal leadership, ability to act, and knowing what to do.* One important commonality among the 14 cases Rubin et al. (1985) studied is that the speed, efficiency, and equity of community recovery depended significantly upon local government's ability to improvise effective recovery strategies. That is, communities recovered more quickly and effectively if they could identify and respond to the specific problems that arose from its unique circumstances. More recently, practitioners and researchers have begun to agree that community disaster recovery is even faster and more effective if it is based on a recovery plan that has been developed prior to disaster impact (Olson et al., 1998; Schwab et al., 1998; Wilson, 1991; Wu and Lindell, 2004). The recovery plan needs to establish clear goals and an implementation strategy (Smith and Wenger, 2006), preferably one that does not reproduce the community's preimpact hazard vulnerability.

After a disaster, local government needs to perform many tasks very quickly, and many of these must be performed simultaneously. It is therefore critical to plan for disaster recovery, as well as for disaster response (Schwab et al., 1998). The line between emergency response and disaster recovery is not clear because some sectors of the community might be in response mode whereas others are moving into recovery, and some organizations will be carrying on both types of activity at the same time. This means that there will be little time to plan for disaster recovery once the emergency response has begun. By planning for recovery before disaster strikes, resources can be allocated more effectively and efficiently, increasing the probability of a rapid and full recovery.

Local government agencies will frequently find during disaster recovery that some households and businesses fail to perform the tasks that are required to recover from the disaster. Whether households and businesses lack the knowledge of how to recover or the resources needed to recover, government can provide assistance. Local government must also perform specific tasks during disaster recovery, some of which involve restoring services it performed before the disaster (e.g., providing functioning roads, street lights and signs, and traffic control devices). In addition, local government must rebuild any critical facilities (e.g., police and fire stations) that were damaged or destroyed. Finally, local government has a heightened need to perform its regulatory functions regarding land-use and building construction. These two functions require rapid action under conditions of a greatly multiplied workload, so special provisions are required to expedite the procedures for reviewing and approving the (re)development of private property.

In approaching the task of preimpact recovery planning, a community must overcome three major misconceptions about disaster recovery. The first misconception is that the entire recovery effort can be improvised after the emergency response is complete. In fact, a timely and effective disaster recovery requires a significant

amount of data collection and planning that will delay the recovery if they are postponed until after the emergency response is over. It is important to recognize that the disaster response phase's uncertainty and urgency about human safety has been replaced by households' and businesses' urgency to return to normal patterns of functioning and government agencies' uncertainty about how to organize the community to accomplish this.

The second misconception is that there will be ample time to collect data and plan the recovery during the emergency response. It is true that some recovery relevant data must be collected during the emergency response. However, an assessment of "lessons learned" from the disaster impact should be used to make final adjustments to a recovery process that has been designed before the disaster strikes. Finally, the third misconception is that the objective of disaster recovery should be to restore the community to the conditions that existed before the disaster. As noted earlier, this will simply reproduce the community's existing disaster vulnerability.

In many ways, the process of preparedness for disaster recovery is quite similar to the process of preparedness for emergency response. Thus, the community should establish a Recovery/Mitigation Committee before disaster strikes that will establish a vision of community disaster recovery and articulate the basic strategies that will be implemented before and after disaster impact. In addition, the committee should assign each recovery function to a specific organization, develop a Recovery Operations Plan, and acquire any necessary resources to implement it. Finally, the committee should conduct the training and tabletop exercises needed to ensure the ROP can be implemented effectively.

### The recovery/mitigation committee

The Recovery/Mitigation Committee can be an important part of an effective, rapid disaster recovery process. This committee should be established before a disaster during the preimpact recovery planning process. The Recovery/Mitigation Committee should examine the findings from the community hazard/vulnerability analysis to identify the locations having the highest levels of hazard exposure, physical vulnerability, and social vulnerability. The committee should begin to work with the rest of the community, and especially with those at greatest risk, to formulate a vision of the disaster recovery it intends to implement.

The Recovery/Mitigation Committee needs to work with the community before and after a disaster to articulate a vision of community disaster recovery. The recovery process needs to strike a balance between corporate centered and community-based economic development (Blair and Bingham, 2000). According to a *corporate centered economic development*, usually advocated by the local business community, government provides resources such as land and money to the private sector to invest without any restrictions. This market-based strategy

tends to produce results that are good in aggregate but produces an inequitable recovery. By contrast, *community-based economic development* involves active participation by government to ensure that the benefits of recovery will also be shared by economically disadvantaged segments of the community.

The short-term recovery following a major disaster can generate an economic boom as state and federal money flows into the community to reconstruct damaged buildings and infrastructure. These funds are used to pay for construction materials and the construction workforce and, to the extent that the materials and labor are acquired locally, they generate local revenues. In addition, the building suppliers hire additional workers and these, along with the construction workers, spend their wages on places to live, food to eat, and entertainment. Unless there are undamaged communities within commuting distance that can compete for this money, it will all be spent within the community.

Communities must also consider the long-term economic consequences of disaster recovery. What will happen after the reconstruction boom is over? They can attract new businesses if they have a skilled labor pool and good schools – especially colleges whose faculty and students can support knowledge-based industries. Other assets include low crime rates, low cost of living, good housing, and environmental amenities such as mountains, rivers, or lakes (Blakely, 2000). A community can also enhance its economic base if it can attract businesses that are compatible with the ones that are already there. Such firms can be identified by asking existing firms to identify their suppliers and distributors. These new firms might be attracted by the newer buildings and enhanced infrastructure that has been produced during disaster reconstruction.

If a disaster stricken community does not already have such assets, they can invest in four fundamental components of economic development – locality development, business development, human resources development, and community development. *Locality development* enhances a community's existing physical assets by improving roads or establishing parks on river and lake-fronts. *Business development* involves efforts to retain existing businesses or attract new ones. Although it is not easy, this can be accomplished working with businesses to identify their critical needs. In some cases, this might involve establishing a business incubator that allows startup companies to obtain low cost space and share meetings rooms. *Human resources development* expands the skilled workforce, possibly through customized worker training. Finally, *community development* utilizes NGOs, CBOs, and local firms that will hire current residents of the community whose household incomes are below the poverty level. For example, a comprehensive program for developing small businesses, affordable housing, community health clinics, and inexpensive child care can help to eliminate some of what new businesses might consider to be one of the risks of relocating to the community.

### Developing a recovery operations plan

There are six important features of a preimpact recovery operations plan. First, it should define a disaster recovery organization. Second, it should identify the location of temporary housing because resolving this issue can cause conflicts that delay consideration of longer-term issues of permanent housing and distract policymakers altogether from hazard mitigation (Bolin and Trainer, 1978; Bolin, 1982). Third, the plan should indicate how to accomplish essential tasks such as damage assessment, condemnation, debris removal and disposal, rezoning, infrastructure restoration, temporary repair permits, development moratoria, and permit processing because all of these tasks must be addressed before the reconstruction of permanent housing can begin (Schwab et al., 1998).

Fourth, preimpact recovery plans also should address the licensing and monitoring of contractors and retail price controls to ensure victims are not exploited and also should address the jurisdiction's administrative powers and resources, especially the level of staffing that is available. It is almost inevitable that local government will have insufficient staff to perform critical recovery tasks such as damage assessment and building permit processing, so arrangements should be made to borrow staff from other jurisdictions (via preexisting Memoranda of Agreement) and to use trained volunteers such as local engineers, architects, and planners. Fifth, these plans also need to address the ways in which recovery tasks will be implemented at historical sites (Spennemann and Look, 1998). Finally, preimpact recovery plans should recognize the recovery period as a unique time to enact policies for hazard mitigation and make provision for incorporating this objective into the recovery planning process.

Communities that develop recovery plans addressing these functions will be better positioned to move promptly from emergency response into disaster recovery and, in turn, from disaster recovery to normal social and economic functioning. Not only will housing recovery be accelerated, but there is a greater likelihood that hazard mitigation will be integrated into the recovery process. The inclusion of hazard mitigation means that homes, businesses, and critical facilities such as schools and hospitals can be moved out of hazard prone areas. Moreover, any residential, commercial, or industrial structures that remain in hazard prone areas can be retrofitted to higher standards of hazard resistance. Thus, a preimpact plan can not only accelerate recovery but also decrease the community's vulnerability to future disasters.

### Summary

Disaster recovery is a *phase* in the emergency management cycle that frequently overlaps with the emergency response. Its *goal* is to restore normal community activities that were disrupted by disaster impacts through a *process* involving both activities that were planned before disaster impact and those that were improvised after disaster impact. Disaster recovery is most rapidly

and effectively achieved when communities engage in a preimpact planning process that addresses the major recovery functions and incorporates hazard mitigation and hazard insurance into a recovery operations plan.

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### Cross-references

Civil Protection and Crisis Management  
 Coastal Zone, Risk Management  
 Community Management of Hazards  
 Critical Incident Stress Syndrome  
 Cultural Heritage and Natural Hazards  
 Disaster Relief  
 Disaster Risk Reduction (DRR)  
 Disease Epidemiology of Natural Disasters  
 Economics of Disasters  
 Emergency Management  
 Emergency Planning  
 Emergency Shelter  
 Insurance  
 Integrated Emergency Management System  
 Mitigation  
 Mortality and Injury in Natural Disasters  
 Natural Hazard in Developing Countries  
 Post-Traumatic Stress Disorder (PTSD)  
 Psychological Impacts of Natural Disasters  
 Risk Assessment  
 Vulnerability  
 World-Wide Trends in Disasters Caused by Natural Hazards

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## RECURRENCE INTERVAL

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Glenn Biasi  
 University of Nevada Reno, Reno, NV, USA

### Synonyms

Earthquake period; Recurrence period

### Definition

Recurrence interval is the expected length of time between occurrences of a geologic event.

### Discussion

Usage of the term recurrence interval varies somewhat among geoscience disciplines. In paleoseismology,

recurrence interval refers to the time between ground-rupturing events at a point on a fault. Strong ground shaking is presumed, but in most cases, the magnitude of the earthquake is poorly known. For instrumentally measured earthquakes, the recurrence interval may be more precisely applied, such as with the specification of both the earthquake size and location. When applied to hydrological events, the recurrence interval refers to the average period between floods of a given size or greater. The distinction leads to some difference in statistical definition. Because usage of the term varies, the definition of the recurring event should be provided with the estimate itself.

*Estimation:* The most common estimator of the recurrence interval is the mean recurrence time based on a record over which detection of the events is considered certain. A useful estimate of the uncertainty of the recurrence interval is given by the standard error of the mean (the standard deviation divided by the square root of the number of intervals). If the number of intervals is small, an adjustment may be made for the distinction between sample and population statistics. The estimate may also be adjusted if it is known that no events occurred for a significant period before the first or after the last event in the sequence.

*Application to hazard estimation:* The recurrence interval estimate by itself implies nothing about the probability of an event in any particular period of time. Conditional probabilities of occurrence of the event depend on the probability distribution of the intervals themselves. Only when the events are random in time and thus modeled as a Poisson distribution can the reciprocal of the recurrence interval in years be interpreted as the annual probability of an event. If it is known that the process is clustered or quasi-periodic, the distribution model for intervals will affect the conditional probability of a future event. The term “return period” is sometimes used interchangeably with recurrence interval, but this should be done with care. In seismic engineering, return period can refer to the return of some level of ground motion, but when more than one fault contributes to the hazard, the return period may not match the recurrence interval on any contributing faults.

### Bibliography

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### Cross-references

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 Earthquake  
 Earthquake Prediction and Forecasting  
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