PART 12

Disaster Medicine and Global Humanitarian Relief

CHAPTER 83

Natural Disaster Management

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The frequency of natural disasters appears to be increasing, as are the human health and economic consequences that follow them.[46] From 2000 to 2015, nearly twice as many natural disasters occurred annually as from 1980 to 1995[34] (Figure 83-1). From 2006 to 2015, natural disasters affected approximately 165 million people per year worldwide, at an average annual cost of approximately U.S. $128 billion.[34] The data suggest that economic impacts are increasing as the size of populations increase in hazard-prone areas; the average costs of damages per disaster (in U.S. dollars) were more than 75% higher in 2000 to 2015 than in 1980 to 1995.[15,34] In that same time period, natural disasters claimed more than 745,000 lives.[24] The 2010 earthquake in Haiti killed more than 230,000 people, injured more than 200,000, and displaced more than one million from their homes. The Japan earthquake and tsunami of 2011 killed at least 18,000 people, injured at least 27,000, and displaced more than 400,000. Critical examination of responses to these tragic events has improved proposed tactics for future disaster responses.[21]

In addition to advances in organizational systems and medical practices used in disaster responses worldwide in the past decades, new technologies are increasingly available to the public and to responders, and are having a significant impact on disaster responses. Because the public has greater access to real-time information using networked systems, communication and response strategies are changing. Social media (e.g., Facebook and Twitter) and newer crowdsourcing platforms (e.g., Ushahidi) can augment situational awareness of both professional responders and the general public by providing real-time data regarding the event, locations of victims, and many specific health needs[57] (Video 83-1).

There is significant potential overlap in the skills of providers trained in wilderness and disaster medicine, with both groups being adept at working in austere environments in often challenging conditions, providing clinical care with limited resources, and being able to improvise when needed in order to best support health.[58]

SCOPE OF THE PROBLEM

Many different definitions of *disaster* have been proposed, but a common theme among most definitions is that disasters create needs that outstrip the resources immediately available to respond. The Centre for Research on the Epidemiology of Disasters in Brussels describes a disaster as a "situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance."[25] Disasters can be natural or technological, and technological disasters can be accidental or intentional. Within the realm of natural disasters, the general categories are (1) biologic (transmissible pathogens, insect infestations, toxins), (2) geophysical (earthquakes/tsunamis, volcanoes, dry mass movements), (3) hydrologic (floods, wet mass movements), (4) meteorologic (storms), (5) climatologic (extreme temperatures, droughts, wildfires), and (6) extraterrestrial (meteorites/asteroids).[23] From 2000 to 2015, an average of 419 natural disasters was reported annually worldwide. These disasters occurred in more than 120 countries, but more than a third of all natural disasters occurred in just five countries (China, United States, Indonesia, the Philippines, and India). The most frequent types of disasters were hydrologic (50.9%), meteorologic (26.5%), climatologic (13.4%), and geophysical (9.4%). Disaster events may occur suddenly, with little to no warning, as is the case with earthquakes and volcanic eruptions; may occur with some warning, as is the case with hurricanes or cyclones and floods; or may evolve more slowly over time, as is the case with many transmissible pathogen outbreaks.

Taking a rational approach to preparing for all types of disasters requires using the disaster cycle (Figure 83-2), which traditionally has four phases: planning, mitigation, response, and recovery. In the planning phase, officials must first assess data available to them to examine the likelihood and potential severity of all of the hazards facing their region, as well as critically examine their current readiness for those hazards. This process is called a hazard vulnerability analysis; it serves to help planners logically prioritize planning efforts and use of resources as they prepare for potential emergencies.

Once emergency managers have completed and/or updated a hazard vulnerability analysis, they can examine their emergency response plans and systems to see how those plans and systems can best be improved for the known threats faced by the region. In the mitigation phase, emergency managers and other leaders take steps to limit the scope of damage for anticipated events they cannot fully prevent. Examples of effective mitigation activities include using improved building codes to help buildings withstand earthquakes, designing floodways to divert water away from population centers and other vital areas in the community, and building tornado safe rooms in highly vulnerable areas. Essential actions in the response and recovery phases are discussed.

HEALTH CONSEQUENCES OF DISASTERS

Disasters can produce a wide range of potential health effects on a population; many of these effects are predictable. Although categories and specific types of potential natural hazards may vary greatly, the potential public health and medical needs of at-risk populations generally do not vary.[27,44] Required public health and medical interventions following a disaster typically depend more on the severity of the disaster than on than on the specific event itself; some exceptions are related to the types of acute injuries sustained from different types of events.

In nearly all disasters, people, especially those displaced from their homes, require replacement of water, sanitation, shelter, and food. Inadequate access to water within a population can produce health consequences within days, as can inadequate access to shelter, depending on the weather conditions. Inadequate sanitation and lack of food produce more delayed, but no less profound, effects on the health of the community. Exacerbation of chronic illnesses is also a commonly observed health consequence following a disaster. This often arises from a combination of factors, including health stress from the event itself, disrupted access to usual medical care, and inadequate access to pharmaceutical supplies. Mental health concerns are also common following disasters, although the type and severity vary depending on the type and severity of the disaster, population affected, and other variables.

Outbreaks of infectious diseases following a natural disaster are often mentioned as a primary health concern; however, "the relationship between natural disasters and communicable diseases is frequently misconstrued."[79] In disasters with large numbers of fatalities, there is a common fear that dead bodies are a potential source of disease for the community. However, the evidence suggests that among those killed by the (noninfectious) natural

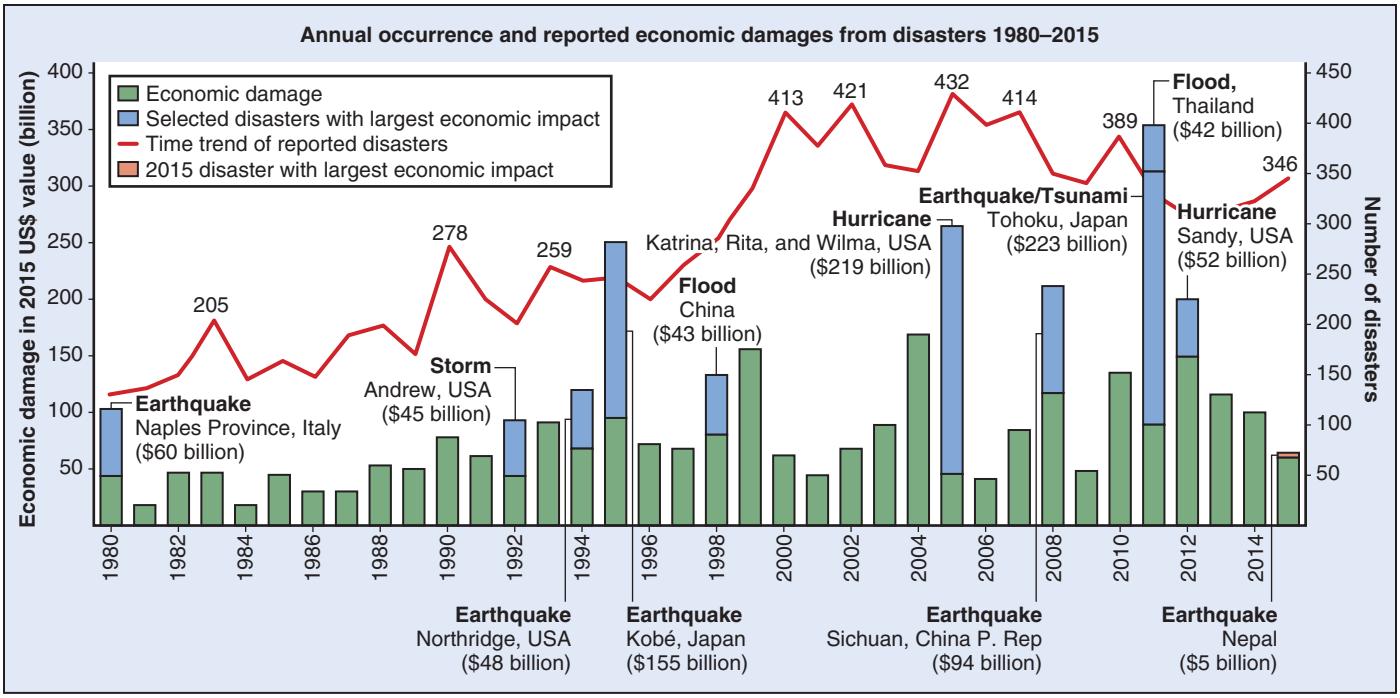

FIGURE 83-1 Annual occurrence and reported economic damages in disasters from 1980 to 2015. *(From Centre for Research on the Epidemiology of Disasters/United States Agency for International Development, CredCrunch 41 February 2016:* cred.be/publications*.)*

disaster itself, the risk of transmission of acute illness from the bodies of the deceased is extremely small.[52] In fact, the greatest risk factors for acute outbreaks of infectious disease depend on the characteristics of the displaced population and the care that they receive following the disaster. The key variables that influence the true likelihood of infectious disease outbreaks include the underlying immunization rates of the displaced population and their access to health care, as well as the degree of crowding in mass shelters and the distance of water supplies from shelters and latrines.[79] Diarrheal outbreak risks are highest when shelters are overcrowded, clean water is not available, and sanitation systems are inadequate and/or improperly located. Outbreaks of measles and other vaccine-preventable illness among displaced persons have been noted when vaccination rates are low. Malnutrition is also a risk factor for transmissible disease among displaced persons, although this is much more common following prolonged armed conflicts than after natural disasters.[62]

Acute injury and illness are the health consequences that most depend on the type of disaster. For example, earthquakes may produce more crush injuries, requiring greater attention to orthopedic and spinal care in the response, whereas floods may produce more near-drownings, hypothermia, and contaminated wounds among survivors.[3,60]

FIGURE 83-2 The disaster cycle. *(From Ciottone GR: Introduction to disaster medicine. In Ciottone GR, Biddinger PD, Darling RG, et al, editors:* Ciottone's disaster medicine*, 2nd ed, St Louis, 2016, Elsevier.)*

HEALTH AND THE MEDICAL RESPONSE TO NATURAL DISASTERS

A successful medical response to disasters requires meeting the health needs of the entire population affected by the disaster, not just the needs of those acutely injured by the event. Traditionally, much medical planning has focused on mass casualty planning and mass trauma care; however, the health consequences of disrupted access to primary care, poor sanitation, limited access to clean water and food, and crowding in shelters must also be considered.[79] The Sphere Project was established in 1997 as a voluntary initiative among humanitarian organizations to improve the quality of humanitarian assistance and response and to address the basic health concerns following disaster. The Sphere Handbook, *Humanitarian Charter and Minimum Standards in Humanitarian Response,* is one of the most internationally recognized and accepted documents delineating core principles and minimum standards in disaster health and humanitarian response.[64] Key minimum standards of note in the 2011 handbook that are relevant to health and medical disaster responders include[64]:

- Affected persons must be aware of key public health risks, and be able to adopt measures to prevent deterioration in hygienic conditions, as well as to use and maintain the provided facilities.
- All people must have safe and equitable access to sufficient water for drinking, cooking, and personal and domestic hygiene. Average water use for drinking, cooking, and personal hygiene in any household is at least 15 L per person per day; average drinking water needed for survival is 2.5 to 3 L per person per day.
- The habitat, food preparation and service areas, public centers, and areas around drinking water sources must be free from human fecal contamination. Latrines must be at least 30 m away from any groundwater source, and the

bottom of latrine pits must be at least 1.5 m above the groundwater table. A maximum of 20 people should use any single toilet.
- All disaster-affected people should have the knowledge and means to protect themselves from disease and nuisance vectors that are likely to cause significant risks to health or well-being.
- The environment should not be littered by solid waste, including medical waste. Affected persons should have the means to dispose of their domestic waste conveniently and effectively.
- People should have an environment in which health risks and other risks posed by water erosion and standing water, including storm water, flood water, domestic wastewater, and wastewater from medical facilities, are minimized.

In addition to ensuring provision of the affected population's basic health and hygiene needs, there are additional specific response considerations of which the medical professional must be aware.

SCENE SAFETY

A disaster scene may have numerous safety hazards for responders, including dangerous travel over a wide geographic region; injury from collapsed or unstable structures or falling debris; exposure to hazardous materials, smoke, or dust; excessive noise from machinery and other equipment; and exposure to adverse weather or unfamiliar and/or dangerous environments. Workers may suffer fatigue and dehydration.[31] There may be security concerns in conflict zones or if there is significant civil unrest. The phase of search and rescue of survivors is an especially dangerous phase of the response; Chapter 55 discusses this phase in detail. Medical responders must have access to appropriately trained personnel who are able to assess for the presence and significance of safety threats, so everyone is aware of risks and able to minimize them. Formal appointment of an appropriately trained safety officer at the disaster scene is a commonly recognized best practice. Responders must also have access to any necessary personal protective equipment for use in the response, provided that they are appropriately trained to wear the personal protective equipment and medically suited to use it.

PROVISION OF ACUTE CARE

It is commonly said that "all disasters are local," meaning that the initial medical care following any disaster will be provided by local emergency medical services, hospital, and community responders available in the area.[53] This can produce significant challenges for local medical and public health systems, because the majority of injuries and deaths occur at the time of the disaster event, generally before external assistance can be mobilized to deploy to the scene. Many of the acutely life-saving interventions needed after disasters must be performed quickly. For example, the demand for acute medical services is highest in the first 12 hours to 3 days following an earthquake.[3] Strategies that local systems may use to provide necessary care include a combination of working harder (e.g., calling in more staff, providing greater throughput, or working longer hours), simplifying care (using medical austerity), and/or adopting a triage ethic that potentially limits care. Depending on the degree of mismatch between resources and needs, the focus of postdisaster care may change from individual care to public health efforts, with an explicit goal of doing the greatest good for the greatest number of people. Debates continue regarding altering standards of care during disaster relief efforts. In the United States, concerns have been noted about provider credentialing, malpractice considerations and coverage, and changing standards of care in disaster or emergency situations.[4,5] A transparent, medically and ethically sound triage system is necessary to determine a victim's medical needs and to best match them with available resources. The level of austerity is determined by availability of health care personnel, supplies, and equipment at the disaster treatment site, and varies throughout the disaster as available resources and needs evolve.

As external responders deploy to the disaster scene, coordination among relief organizations and the remaining functional components of the local health infrastructure is essential. Many different types of field hospitals have been deployed to disaster situations, from improvised tents staffed with medical teams and limited equipment to highly functional modular systems with an operating room, intensive care unit, emergency department, and other dedicated facilities. Some internationally deployed field hospital facilities are owned and operated by national military services but are sometimes used in a humanitarian context. The intention is to use these facilities to assist with resuscitation and stabilization of acutely injured disaster victims, but recent studies have questioned whether they can be deployed quickly enough to effectively serve this purpose.[78]

PROVISION OF MENTAL HEALTH CARE

A growing body of evidence has shown that exposure to major disaster events is a risk factor for experiencing adverse mental health and substance abuse problems.[30,32,56] Unfortunately, however, medical planning for disasters often omits planning and/or training on how to respond to large-scale mental health needs of a population following major incidents.[35,63] Optimal support for victims' mental health needs requires deployment of appropriately trained psychiatrists, psychologists, and social workers; however, all disaster responders can provide psychological first aid to victims with a limited amount of additional training. Psychological first aid is a "humane, supportive response to a fellow human being who is suffering and who may need support,"[83] and is supported and recommended by the World Health Organization, the Sphere Project, and numerous other humanitarian organizations. Psychological first-aid action principles can be found in Figure 83-3 and involve the following themes:
- Providing practical care and support that does not intrude
- Assessing needs and concerns
- Helping people to address basic needs (e.g., food and water, information)
- Listening to people but not pressuring them to talk
- Comforting people and helping them to feel calm
- Helping people connect to information, services, and social supports
- Protecting people from further harm.

SUPPORT FOR PRIMARY CARE AND LONG-TERM CARE

Disasters can substantially limit an affected population's local medical care system through direct physical damage to medical facilities, equipment, and supplies; overload of facilities with acutely injured victims; and displacement of patients and medical

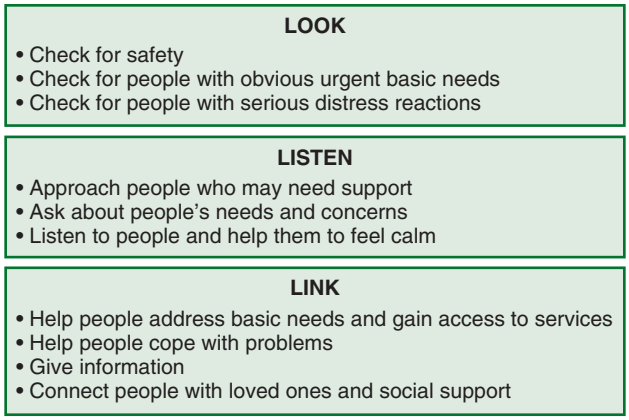

FIGURE 83-3 Psychological first-aid action principles. *(From World Health Organization, War Trauma Foundation and World Vision International:* Psychological first aid: guide for field workers, *Geneva, 2011, World Health Organization.)*

personnel away from their usual sites of medical care.[61] Disasters often disrupt the population's access to usual sites of primary care, as well as to specialty care sites, such as dialysis centers or substance abuse treatment clinics. This can produce adverse health outcomes, especially if patients cannot have access to care for diabetes, high blood pressure, heart failure, and other chronic disorders.[45,50,59] There is growing awareness that medical responders need to be able to support, but not replace, the local primary health care infrastructure while it is being reconstituted following a disaster. Although this function has traditionally received less attention than the function of providing acute trauma and injury care, the provision of primary care is very important to the overall success of a disaster response and is in need of further study and planning measures.

CARE OF THE DECEASED

As previously mentioned, rumors regarding the health threats caused by dead bodies are common following a disaster among both the general population and some responder groups. Inappropriate actions, such as creating mass graves for the deceased, have been observed in disasters as a response to such poor information. These actions can disrupt proper identification of victims and cause additional emotional trauma for survivors. As much as possible, bodies should be cared for with great respect, and care for the deceased should foster trust between the community and disaster responders. Burial is generally an appropriate method of disposal; deference should be given to local cultural customs whenever safely possible. The World Health Organization lists the following important principles when dealing with fatalities in a disaster situation[82]:

- Give priority to the living over the dead.
- Dispel myths about health risks posed by corpses.
- Identify and tag corpses.
- Provide appropriate mortuary services.
- Reject unceremonious and mass disposal of unidentified corpses.
- Respond to the wishes of the family.
- Respect cultural and religious observances.
- Protect communities from transmission of medical epidemics.

CARE FOR VULNERABLE POPULATIONS

Disasters disproportionately affect the world's poor, marginalized populations and nations, which bear the brunt of the health effects.[10,11,17,55] Any group or population considered to be at higher risk for poor outcomes in the wake of a disaster is considered vulnerable. Commonly, this includes households headed by women and children, older adults, the disabled, and persons with preexisting mental illness. Unfortunately, however, because of physical and social barriers, these populations are often excluded from the planning and preparation process before disasters strike, and they often cannot get critical goods and services following a disaster. Preventing exploitation of these groups (e.g., sexual and gender-based violence, human trafficking) requires security, active surveillance programs, responsive community services, and engaged authorities.

ORGANIZATIONAL SYSTEMS FOR DISASTER RESPONSE

THE INCIDENT COMMAND SYSTEM AND THE NATIONAL INCIDENT MANAGEMENT SYSTEM

The Incident Command System (ICS) is an incident management framework designed to support efficient and effective management of disaster and other emergency events that is now widely used by governmental, nongovernmental, and private organizations across the United States. The ICS originally arose in the 1970s after the U.S. Congress noted numerous systemic failures in a response to severe wildfires in southern California, including poor communication, incompatible leadership structures among organizations, and lack of coordination of response plans by similar agencies. To address these failures, Congress funded development of what is now the ICS, which allows more effective interagency communication, integration, and coordination.[28] Principal features of the ICS include use of common terms, a unity of command, management by objective, a manageable span of control, and flexible organizational structure to respond to any size or type of incident.[72] *Unity of command* means that in order to maintain clear authority and lines of communication, each individual participating in the response has only one supervisor. *Management by objective* means that the incident response objectives are clearly and explicitly identified by the command leadership, and are agreed upon and followed by all persons operating within the ICS for a fixed period of time (the operational period). The recommended *manageable span of control* means that any supervisor within the ICS organizational chart has three to seven subordinates.

The ICS became the national standard for public safety, emergency medical services, hospitals, and many other organizations in 2004 when it was included as a fundamental tenet of the National Incident Management System, and its use became a requirement of federal preparedness funding.[54] The ICS has been adapted for specific settings, such as hospitals and schools, and has been recommended as a global incident management system by the United Nations.[13,26,70]

The ICS uses a flexible, scalable organizational structure that includes a command team and four functional areas (Figure 83-4):

- Command: Responsible for overall management and direction of the incident; sets the response strategy

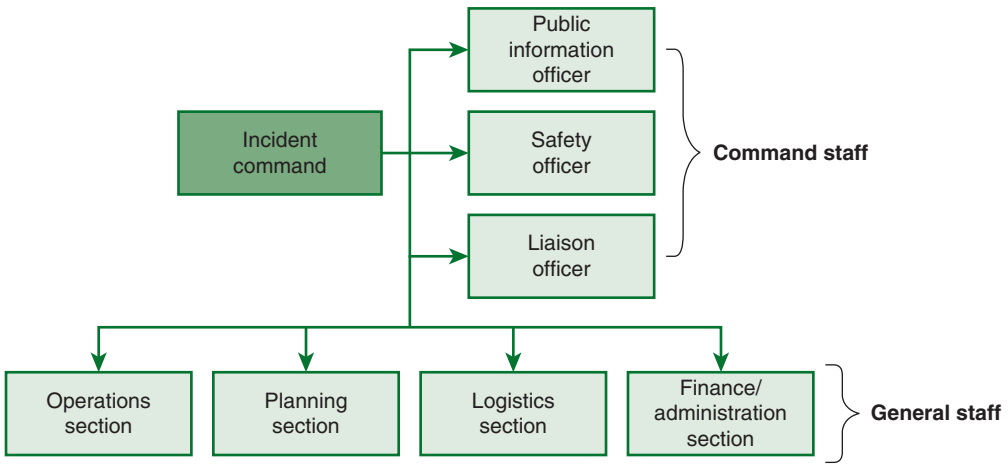

FIGURE 83-4 The incident command system. *(From Federal Emergency Management Agency: emilms.fema.gov/IS200b/ICS01summary.htm.)*

- Operations: Conducts tactical response activities, such as search and rescue, patient care, medical evacuation, or fire suppression
- Planning: Collects and evaluates response information; supports situational awareness throughout the entire ICS structure; is responsible for creating and updating an incident action plan that is followed by all personnel
- Logistics: Manages and procures supplies, facilities, transportation, and other needed resources to support the response tactics and responders
- Finance and Administration: Oversees financial management, timekeeping, and related administrative management functions; is typically activated for longer-term or complex incidents

When multiple organizations or jurisdictions have overlapping legal authority or jurisdiction for an event, a *unified command* is established. The unified command provides a mechanism for incident commanders representing multiple organizations to work within a single integrated command structure that shares a common set of incident objectives.[72] The unified command improves coordination and communication and allows organizations to work together without ceding individual "authority, responsibility, or accountability."[72] A unified command has been set up in many major domestic disasters, including the multistate responses to Hurricane Katrina and the *Deepwater Horizon* oil spill.[14,29]

As mentioned earlier, the ICS is just one part of the larger National Incident Management System in the United States, which provides a nationwide model for how all levels of government and the private sector can collaborate in all types of emergencies.[72] Such collaboration ideally starts long before any disaster event occurs. The preparedness cycle (Figure 83-5) illustrates that disaster preparedness is an iterative cycle in which response partners are continually planning, training, testing, and evaluating their systems so they can identify gaps and problems well in advance of the incident. Numerous after-action reports following successful responses to incidents have cited collaborative planning, training, and exercising as the building blocks that helped to forge relationships and build trust, improving overall management.[14,47]

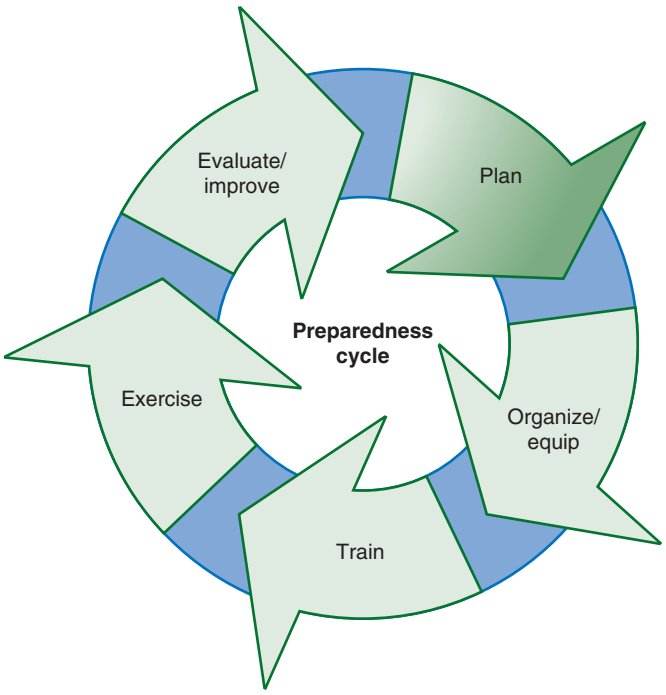

FIGURE 83-5 The preparedness cycle. *(From Federal Emergency Management Agency:* fema.gov.*)*

THE UNITED NATIONS CLUSTER APPROACH FOR GLOBAL HUMANITARIAN RESPONSE

The ICS is the standard incident management framework used in the United States, but different structures are often used in non-U.S. disasters, especially when responders from many countries combine in the response. Global and domestic disaster response systems share many goals, including improving multiagency coordination, forming flexible organizational structures to meet the needs of the incident, and reducing duplication of efforts. However, unlike a domestic incident management system, which can be mandated by national legislation, the multiple and diverse agencies that respond to a global disaster "cannot be forced to work within the parameters of a common plan—ultimately, [leaders] must persuade the majority of the value of a cohesive approach."[9] Global disaster response agencies and personnel must also respect the sovereignty of the nation affected by the disaster. Therefore, any global disaster response system must be respectful of the affected nation's people and government by being flexible enough to take a supporting or leading role, depending on the nation's coordination capacity and requests for assistance.[40,66]

The United Nations' cluster approach was formally adopted in 2005, and has served since then as the primary framework used in global humanitarian disaster responses, designed to promote preparedness, accountability, and predictability. Prior to its adoption, many global responses suffered from shortcomings in quality and timeliness of the response, isolation of planning and preparedness measures among key agencies, and lack of clarity about roles and responsibilities, among other challenges.[2]Essential humanitarian principles that accompany the cluster approach have also been developed. These are meant to guide all of the response systems and activities operating within the cluster system so they can be effective, regardless of the context in which they are applied.[41,68]

A *cluster* is a group of humanitarian organizations (that may or may not be associated with the United Nations) working in each major sector, such as shelter or health, of a humanitarian response. A designated agency leads the response for each cluster at the global level and at the country level (Figure 83-6). Each cluster lead agency has responsibility for coordinating activities before, during, and after a disaster to most effectively meet the needs of affected people. Clusters at the global level are involved in building preparedness and technical capacity through development of standards, tools, and protocols; providing training and technical assistance for all levels of responders; sharing best practices and lessons learned; and facilitating partnerships among the cluster's participating agencies.[37] When a disaster occurs, a cluster may be activated if the government of the affected nation is too overwhelmed or constrained to coordinate a response. Country-level clusters engage in collaborative planning, implementation, and monitoring of cluster strategies. They prepare needs assessments and suggest solutions and priorities to the humanitarian coordinator, to whom all cluster lead agencies are accountable. Using a flexible and modular approach, only those clusters that address an identified gap are activated during a disaster; they are deactivated when the need subsides and/or when the local government becomes able to address the need. Any humanitarian organization participating in a cluster shares the responsibility with the lead agency to meet the humanitarian needs of the affected nation and a responsibility to adhere to common standards. Some of these standards include commitment to humanitarian principles, capacity and willingness to contribute to the cluster's response plan, and commitment to participate in and work cooperatively with the cluster to ensure optimal use of available resources.[40]

Real-world disasters in which the cluster approach has been used since 2005, such as the Pakistan (2005) and Haiti (2010) earthquakes, have provided an opportunity to evaluate the approach. Involvement of local authorities and institutions in the cluster system was found to positively influence the short-term and long-term effects of the response, particularly when national agencies had sufficient capacity and were assigned to lead clusters. Early identification and involvement of local leaders also

FIGURE 83-6 The United Nations cluster system. *(From United Nations Office for the Coordination of Humanitarian Affairs:* unocha.org/what-we-do/coordination-tools/cluster-coordination.*)*

appeared to have a positive impact on the transition to recovery and reconstruction. However, noted challenges with local integration of the cluster system included exclusion of local agencies by not conducting meetings or sharing materials in the local language, as well as negative consequences of aid actions that, in some cases, ignored and/or competed with local efforts.[1,7,33] Evaluators also noted challenges with insufficient training and lack of support for cluster leaders, as well as high rate of turnover among participating nongovernmental organizations. They also noted that cluster meetings were too long and too frequent. In 2011, a set of improvements known as the transformative agenda included measures to strengthen leadership in the cluster approach, an emphasis on augmenting rather than replacing existing capacities, and attempts to simplify cluster processes.[38]

CORE ACTIVITIES OF THE DISASTER RESPONSE AND RECOVERY PHASES

Although they are often thought of as separate, the phases of disaster response and recovery are, in fact, overlapping and range from immediate life safety activities through actions to support long-term physical and social recovery of a community (Figure 83-7). Complexity and duration of each phase can vary substantially, depending on type and scope of event, resources available to respond, and overall resiliency of the community.[71,73]

When advance notice of a severe natural event is available, as may be the case with certain floods, wildland fires, and hurricanes, the disaster response can begin before the hazard arrives. Activities may include issuing public information and warnings, taking emergency protective measures, such as creating sandbag barriers, prepositioning critical supplies or personnel, and evacuation of personnel from vulnerable areas. Once the hazard impact occurs, immediate life safety priorities take precedence, including search and rescue operations and provision of first aid and emergency medical services. In many disasters, local organizations and civilian bystanders are often the initial responders called on to deliver most of the immediate life-saving care before outside resources can be mobilized. This underscores the need for local and personal preparedness, as well as for community-based disaster response training.[6,8,76]

Successful disaster responses are generally able to stabilize the situation following the initial event and prevent secondary disasters, such as spread of communicable diseases,[43] death or illness from exposure,[1] and other long-term negative health consequences.[81] This phase may be referred to as the short-term recovery or emergency relief phase and involves meeting the immediate needs for food, water, shelter, sanitation and hygiene, clothing, and medicine. Family reunification and fatalities management may also occur at this time. As short-term recovery efforts continue, planning begins for longer-term recovery efforts involving local and external agencies, and formal disaster assessments occur.[48] Formal disaster assessments are rigorous processes designed to support the best use of recovery resources and allow for coordinated recovery strategies to take shape across the community.[39] As early recovery progresses, subtle but

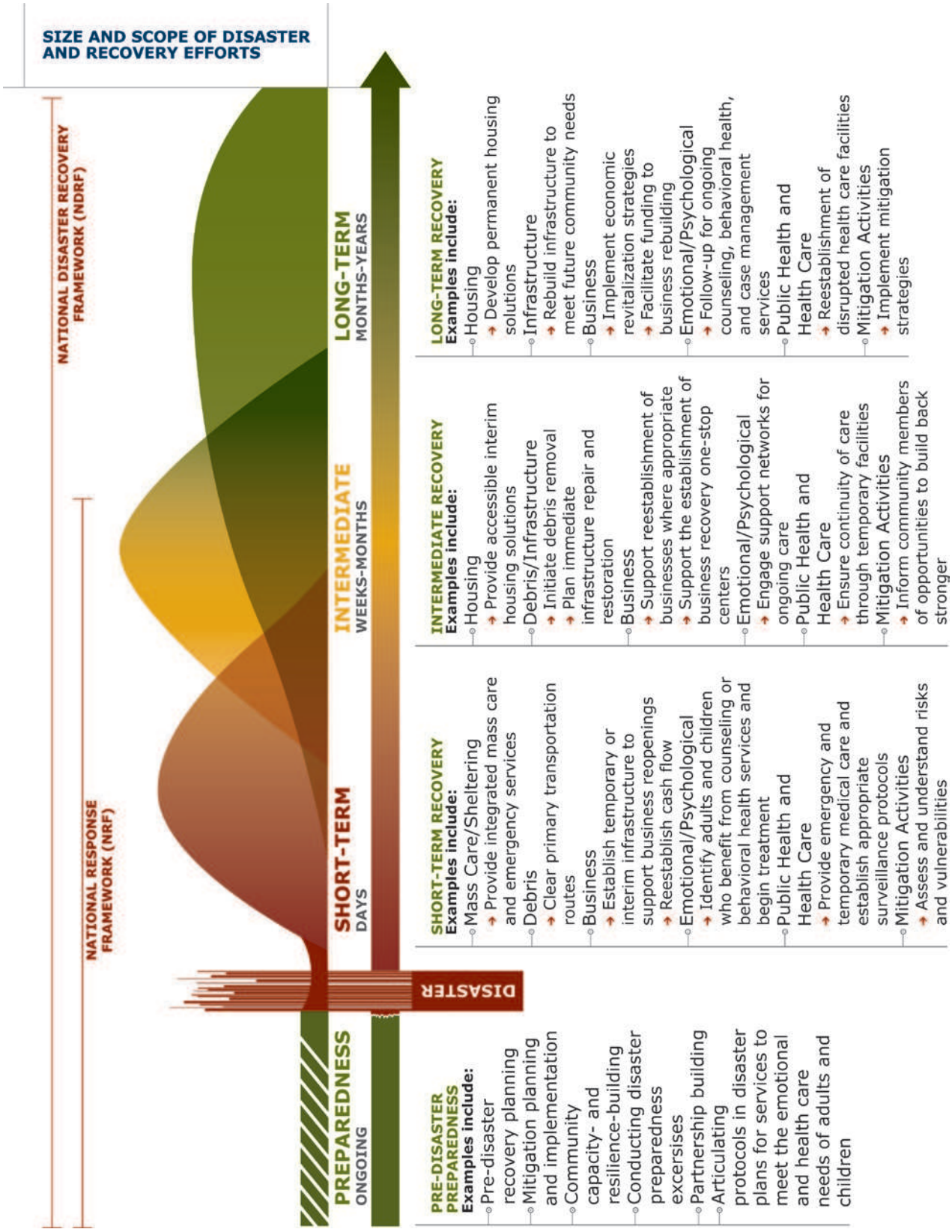

FIGURE 83-7 The disaster response and recovery continuum. *(From Federal Emergency Management Agency:* fema.gov/pdf/recoveryframework/ndrf.pdf*, 2011, p. 8.)*

significant changes occur. For example, moving persons from a temporary shelter to temporary housing allows individuals and communities to reestablish more normal predisaster routines.[48]

Medium-term to long-term recovery includes reconstruction of permanent physical structures. The purpose of this reconstruction is not simply to restore previous structures and systems, but to identify and implement lessons learned to mitigate against future hazards.[48] Support for local leadership and primacy, fostering inclusive partnerships, and informed decision making based on needs and vulnerability assessments are cross-cutting principles for U.S. domestic and international humanitarian recovery efforts.[18,71]

PROFESSIONALIZATION OF THE DISASTER RESPONSE

In the past several years, there has been growing recognition that disaster medical assistance personnel and the organizations sponsoring their deployment can cause harm to the affected population, even when intentions are good. Deployment of foreign personnel with improper training for the needed medical services, economic displacement of local medical providers and businesses by free international aid resources, and poor accountability of organizations to the crisis-affected state and local authorities have all been described in humanitarian medical responses to disasters. To acknowledge this, the Sphere Project has developed four protection principles for responding humanitarian agencies, the first of which is that they "should ensure that their actions do not bring further harm to affected people."[64] Additionally, the Sphere Handbook notes important trends in the professionalization of disaster response, including:

- A growing conceptual and operational focus on local and national responses with the awareness that affected populations must be consulted and the response capacities of the crisis-affected state and national agencies and institutions must be reinforced
- More proactive accountability of humanitarian action, in particular, accountability to affected populations, but also more proactive coordination, including within the humanitarian reform process (cluster approach), under the auspices of the interagency standing committee
- An increased focus on protection issues and responses
- Increasing awareness of potentially large-scale forced migration due to climate change–induced disasters and an awareness that environmental degradation increases vulnerability
- The recognition that poor urban populations are growing rapidly and that they have specific vulnerabilities, in particular, related to the money economy, social cohesion, and physical space
- New approaches to aid, such as cash and voucher transfers and local purchases, replacing in-kind shipments of humanitarian assistance
- An increased recognition of disaster risk reduction as both a sector and an approach
- An increased involvement of the military in humanitarian response, a set of actors not primarily driven by the humanitarian imperative, requiring the development of specific guidelines and coordination strategies for humanitarian civil–military dialogue
- An increased involvement of the private sector in humanitarian response requiring similar guidelines and strategies as the civil-military dialogue.[64]

SOCIAL MEDIA AND MOBILE TECHNOLOGY IN DISASTERS

Rapidly expanding global access to the Internet and social media platforms and widespread availability of mobile phones have had a remarkable effect on disaster response in the past decade. Online tools allow greater information sharing among affected populations and responders. This has significantly improved situational awareness, empowered community members, and given rise to a new type of emergency responder: the digital humanitarian. Researchers have recently categorized social media functions in disasters into 15 categories, such as providing and receiving disaster preparedness information, sending and receiving requests for help or assistance, raising awareness and donations, and implementing traditional crisis communication activities, providing a helpful framework to study and discuss this expanding topic.[36]

The 2010 Haiti earthquake was an early example of an evolving disaster response in the digital age. The Ushahidi open-source platform established a Haiti page just 2 hours after the earthquake occurred, and allowed thousands of online volunteers from around the world to monitor, categorize, and map

FIGURE 83-8 Disaster medical care in Kathmandu, Nepal. *(Courtesy Jon Brack.)*

information collected from survivors on the ground. This information was used by responding agencies to quickly match resources with needs.[57] Responses to subsequent natural disasters, including the earthquakes in Chile (2010) and Nepal (2015) (Figures 83-8 and 83-9) and Supertyphoon Yolanda (2013), have used digital humanitarians, and many of them are now part of formally activated networks to review, verify, and translate digital information into usable data.[20,22]

Governmental agencies have also increasingly embraced social media platforms, including Facebook, Twitter, and YouTube, and mobile devices to communicate about disasters before, during, and after they occur.[19,51] The Federal Emergency Management Agency, for example, has created a smartphone application that provides general disaster preparedness information, and real-time weather alerts, and allows individuals to find shelters, apply for aid, and submit disaster reports. Tools such as the Google Person Finder, Facebook Safety Check, and Red Cross Safe and Well allow individuals to report their status and reconnect with loved ones.

FIGURE 83-9 Nursing care in Dhading, Nepal. *(Courtesy Sheila Preece.)*

TABLE 83-1 Responder Self-Care

	Individual Actions*	Organizational Measures†
Predisaster care	Personal assessment of current physical and emotional health, training and competency for the job at hand, family preparedness and ability to cope with responder's absence and assignment, employer support and preparedness for responder's absence	Has written policy for staff stress management Conducts predeployment screening and assessments Conducts predeployment training and stress education
Care during disaster deployment	Self-monitor and maintain boundaries Maintain contact with friends, family, colleagues, as possible Work with partner or in teams Take breaks Avoid use of food and substances as a support	Monitors staff stress response Provides ongoing stress management training and support Provides crisis support for critical or unusual sources of severe stress Provides practical and emotional end-of-assignment support
Postdisaster care	Seek out and give social support Consider participating in an organized debriefing Maintain contact with colleagues from deployment Pay attention to health, nutrition, rekindling relationships Make time for sleep, exercise, and leisure activities	Has policies and capabilities to provide postassignment support to staff

*Data from National Child Traumatic Stress Network and National Center for PTSD. Psychological first aid field operations guide, 2nd ed, appendix 3: Provider care, 2006. http://www.ptsd.va.gov/professional/manuals/psych-first-aid.asp; and U.S. Department of Health and Human Services. A guide to managing stress in crisis response professions. DHHS pub no 4113. Rockville, MD, 2005, Center for Mental Health Services, Substance Abuse and Mental Health Services Administration.
†Data from Antares Foundation. Managing stress in humanitarian workers: guidelines for good practice, 3rd ed, 2012: www.antaresfoundation.org.

Nongovernmental relief organizations are using social media and mobile devices in new and effective ways to collect and manage donations to support their response efforts. The American Red Cross raised U.S. $32 million for Haiti relief efforts by inviting donors to text "Haiti" to their office and contribute $10 each, as compared with raising only $130,000 via mobile phone donations following Hurricane Katrina 5 years earlier.[84] Following Hurricane Sandy, an Amazon.com "wedding registry" was created, allowing individuals to donate specific items, such as flashlights and diapers, requested by a grassroots relief network.[42] The recovers.org platform, developed by residents of a Massachusetts community hit with an EF3 tornado, convenes government organizations, aid organizations, and individuals on a common platform to directly match needs and resources (https://www.ted.com/talks/caitria_and_morgan_o_neill_how_to_step_up_in_the_face_of_disaster).

However, with the many potential applications of social media in disasters, researchers and practitioners urge that advance planning is necessary to be most effective.[36,51] Organizations should strongly consider establishing a social media presence before a disaster, establishing training and staffing plans for social media use during a disaster, coordinating with partners for consistent messaging, and engaging with active social media discussions during the response and recovery phases, including correcting the spread of false rumors in real time.[74] The United Nations Office for the Coordination of Humanitarian Affairs has proposed hashtag standards for emergencies, in the hope of organizing information in a way that makes it easier for responders to find and act upon the information. This was inspired in part by the emergence of standardized hashtags during widespread floods in the Philippines in 2012. #RescuePH requested a rescue, #ReliefPH requested and shared relief resources and information, #FloodPH reported flooded locations, and #SAFENOW allowed users to update prior requests.[67]

RESPONDER SELF-CARE

Many health care workers responding to natural disasters will find the experience challenging and meaningful, but the reality of a disaster deployment can include exposure to trauma, violence, long hours, austere working and living conditions in an unfamiliar environment, and concern about family and work responsibilities at home. It is important that potential disaster responders understand, prepare for, and continuously manage the potential effects of stress during their response and afterward. Common stress reactions can be behavioral (e.g., irritability, hypervigilance), physical (e.g., chronic fatigue, weight loss or gain), psychological (e.g., feeling heroic, guilty, or grief-stricken), cognitive (e.g., memory problems, difficulty making decisions), and social (e.g., isolating, difficulty receiving or accepting support).[69] These are normal reactions to abnormal situations. Mild to moderate stress reactions can improve one's immediate performance, and most disaster workers recover from them in the months following deployment.[49,75] Posttraumatic growth is a long-term benefit some disaster workers experience following a deployment; this can manifest itself in an "increased sense of mastery, self-efficacy, control, [and a sense of truly making a difference]."[12,69] On the other hand, disaster responders returning from deployments can experience depression, burnout, anxiety, and posttraumatic stress disorder; the percentages of these reactions vary by event and individual background.[16,49,77] Factors such as prior mental health issues, lack of appreciation and recognition, poor team functioning, lack of social support, and being a volunteer, rather than a professional, responder are associated with negative postdisaster mental health effects.[49,65]

Ideally, responder self-care takes place before, during, and after a deployment and occurs on both the individual and organizational level. Examples of self-care activities at both levels are included in Table 83-1. Good self-care also protects the responder from becoming an additional disaster casualty and placing additional burdens on already-strained resources. Available programs and policies in place to support responder well-being are helpful references to include when a person is trying to decide whether to respond to a disaster and/or with which organization he or she may choose to deploy.[80]

REFERENCES

Complete references used in this text are available online at expertconsult.inkling.com.

REFERENCES

1. ActionAid International. The evolving UN cluster approach in the aftermath of the Pakistan earthquake: an NGO perspective. <https://www.actionaid.org.uk/sites/default/files/doc_lib/234_1_un_cluster_approach.pdf>.
2. Adinolfi C, Bassiouni D, Lauritzsen HF, Williams HR. Humanitarian response review: an independent report commissioned by the United Nations Emergency Relief Coordinator and Under-Secretary-General for Humanitarian Affairs, Office for the Coordination of Humanitarian Affairs. New York and Geneva. 2005. <http://www.unicef.org/emerg/files/ocha_hrr.pdf>.
3. Al Khaldi KH. Earthquake. In: Ciottone GR, Biddinger PD, Darling RG, et al., editors. Ciottone's Disaster Medicine. Philadelphia: Elsevier; 2016. p. 572–4.
4. Altevogt BM, Stroud C, Hanson SL, et al., editors. Guidance for establishing crisis standards of care for use in disaster situations: a letter report. Washington, DC: Institute of Medicine; 2009.
5. Annas GJ. Standard of care—in sickness and in health and in emergencies. N Engl J Med 2010;362:2126.
6. Ashkenazi I, McNulty E, Marcus LJ, Dorn BC. The role of bystanders in mass casualty events: lessons from the 2010 Haiti earthquake. J Defense Studies Res Manage 2012;2:2324.
7. Binder A. Is the humanitarian failure in Haiti a system failure? International Development Policy. Articles and Debates 4.3. 2013, <https://poldev.revues.org/1625#ftn13>.
8. Brennan MA, Barnett RV, Flint CG. Community volunteers: the front line of disaster response. Int J Vol Admin 2007;XXIV:71–7.
9. Broughton B, Maguire S. Inter-agency real-time evaluation of the humanitarian response to the Darfur crisis. United Nations Office of the Coordination of Humanitarian Affairs, 2006. <https://docs.unocha.org/sites/dms/Documents/RTE_DARFUR_Final_Report_14_Mar.pdf>.
10. Brouwer R, Akter S, Brander L, et al. Socioeconomic vulnerability and adaptation to environmental risk: a case study of climate change and flooding in Bangladesh. Risk Anal 2007;27:313.
11. Burkle FM. Globalization and disasters: issues of public health, state capacity and political action. J Int Affairs 2006;59:241.
12. Calderon-Abbo J, Kronenberg M, Many M, et al. Fostering healthcare providers' post-traumatic growth in disaster areas: proposed additional core competencies in trauma-impact management. Am J Med Sci 2008;336:208–14.
13. California Emergency Medical Services Authority. Hospital Incident Command System. 2014. <http://www.emsa.ca.gov/disaster_medical_services_division_hospital_incident_command_system>.
14. Carwile W. Unified command and the state-federal response to Hurricane Katrina in Mississippi. Homeland Security Affairs 1, Article 6. 2006. <https://www.hsaj.org/articles/689#fn5>.
15. Centre for Research on the Epidemiology of Disasters. The human cost of natural disasters: a global perspective. Université Catholique de Louvain. Brussels, Belgium. 2015. <http://emdat.be/human_cost_natdis>.
16. Chang C, Lee L, Connor K, et al. Posttraumatic distress and coping strategies among rescue workers after an earthquake. J Nerv Ment Dis 2003;191:391–8.
17. Clack Z, Keim M, MacIntyre A, et al. Emergency health and risk management in sub-Saharan Africa: a lesson from the embassy bombings in Tanzania and Kenya. Prehosp Disaster Med 2002;17:59.
18. Cluster Working Group on Early Recovery. Guidance note on early recovery. 2008. <https://docs.unocha.org/sites/dms/Documents/Guidance%20note%20on%20Early%20Recovery.pdf>.
19. Cohen SE. Sandy marked a shift for social media use in disasters. Emerg Manage 2013. <http://www.emergencymgmt.com/disaster/Sandy-Social-Media-Use-in-Disasters.html?page=1>.
20. Corcoran L. How data gathering has helped in Nepal. The Irish Times. 2015. <http://www.irishtimes.com/business/technology/how-data-gathering-has-helped-in-nepal-1.2219588>.
21. Cranmer HH, Biddinger PD. Typhoon Haiyan and the professionalization of disaster response. N Engl J Med 2014;370:1185–7.
22. Digital Humanitarian Network. Activations. <http://digitalhumanitarians.com/active-activations>.
23. EM-DAT: The International Disaster Database. <http://www.emdat.be/classification>.
24. EM-DAT: The International Disaster Database. <http://www.emdat.be/disaster_trends/index.html>.
25. EM-DAT: The International Disaster Database. <http://www.emdat.be/glossary>.
26. FAO. Fire management: voluntary guidelines. Principles and strategic actions. Fire Management Working Paper 17. Rome. 2006. <http://www.fao.org/forestry/firemanagement/35853/en/>.
27. Federal Emergency Management Agency. CPG 101: Developing and Maintaining Emergency Operations Plans: Version 2.0, 2010, FEMA. <http://www.fema.gov/media-library-data/20130726-1828-25045-0014/cpg_101_comprehensive_preparedness_guide_developing_and_maintaining_emergency_operations_plans_2010.pdf>.
28. FIRESCOPE. Some highlights of the evolution of the Incident Command System. 2003. <http://www.firescope.org/firescope-history/firescope-historical-documents.htm>.
29. Florida Commission on Oil Spill Response Coordination. Report 2: An analysis of the effectiveness of the use of the Incident Command System in the Deepwater Horizon (DWH) Incident. 2012. <https://www.dep.state.fl.us/deepwaterhorizon/files2/corc/Incident_Command_System.pdf>.
30. Foa EB, Stein DJ, McFarlane AC. Symptomatology and psychopathology of mental health problems after disaster. J Clin Psychiatry 2006;67(Suppl. 2):15–25.
31. Freitas R. Scene safety and situational awareness in disaster response. In: Ciottone GR, Biddinger PD, Darling RG, et al., editors. Ciottone's Disaster Medicine. Philadelphia: Elsevier; 2016. p. 255–62.
32. Galea S, Nandi A, Vlahov D. The epidemiology of post-traumatic stress disorder after disasters. Epidemiol Rev 2005;27:78–91.
33. Grunewald F, Binder A. Inter-agency real-time evaluation in Haiti: 3 months after the earthquake. Groupe Urgence Rehabilitation Development and Global Public Policy Institute. 2010. <https://docs.unocha.org/sites/dms/Documents/Haiti_IA_RTE_1_final_report_en.pdf>.
34. Guha-Sapir D, Below R, Hoyois PH. EM-DAT: The CRED/OFDA international disaster database. Université Catholique de Louvain. Brussels, 2015, <http://emdat.be/database>.
35. Hawley SR, Hawley GC, St Romain T, Ablah E. Quantitative impact of mental health preparedness training for public health professionals. Biosecur Bioterror 2007;5:347–52.
36. Houston JB, Hawthorne J, Perreault MF, et al. Social media and disasters: a functional framework for social media use in disaster planning, response, and research. Disasters 2015;39:1–22.
37. Inter-Agency Standing Committee. Guidance note on using the cluster approach to strengthen humanitarian response. 2006. <https://interagencystandingcommittee.org/system/files/legacy_files/Cluster%20implementation%2C%20Guidance%20Note%2C%20WG66%2C%2020061115-.pdf>.
38. Inter-Agency Standing Committee. IASC Transformative Agenda. <https://interagencystandingcommittee.org/iasc-transformative-agenda>.
39. Inter-Agency Standing Committee. Operational guidance for coordinated assessments in humanitarian crisis. Geneva, Switzerland: UN Office for Coordination of Humanitarian Affairs, 2012.
40. Inter-Agency Standing Committee. Reference module for cluster coordination at country level. 2015. <https://interagencystandingcommittee.org/system/files/cluster_coordination_reference_module_2015_final.pdf>.
41. International Federation of Red Cross and Red Crescent Societies. Promoting the fundamental principles and humanitarian values. <http://www.ifrc.org/en/who-we-are/vision-and-mission/principles-and-values/>.
42. Islam M, Dolan K, et al. Who is responsible for the "second disaster?" An online registry for disaster relief has proved a successful model for avoiding nonproductive donations—when will we adopt it. Stanford Social Innovation Review 2013. <http://ssir.org/articles/entry/who_is_responsible_for_the_second_disaster>.
43. Jafari N, Shahsanai A, et al. Prevention of communicable diseases after disaster: a review. J Res Med Sci 2011;16:956–62.
44. Keim M. Disaster preparedness. In: Ciottone GR, Biddinger PD, Darling RG, et al., editors. Ciottone's Disaster Medicine. Philadelphia: Elsevier; 2016. p. 200–14.
45. Kenney RJ. Emergency preparedness concepts for dialysis facilities: reawakened after Hurricane Katrina. Clin J Am Soc Nephrol 2007;2:809–13.
46. Leaning J, Guha-Sapir D. Natural disasters, armed conflict, and public health. N Engl J Med 2013;369:1836–42.
47. Leonard HB, Cole CM, et al. Why was Boston strong? Lessons from the Boston Marathon bombing. Harvard Kennedy School Program on Crisis Leadership. 2014. <http://www.hks.harvard.edu/content/download/67366/1242274/version/1/file/WhyWasBostonStrong.pdf>.
48. Lindell MK. Recovery and reconstruction after disaster. In: Bobrowsky PT, editor. Encyclopedia of Natural Hazards. Dordrecht, Netherlands: Springer Science+Business Media; 2013. p. 812–24.
49. Lopes Cardozo B, Gotway Crawford C, Eriksson C, et al. Psychological distress, depression, anxiety, and burnout among international humanitarian aid workers: a longitudinal study. PLoS ONE 2012;7(9):e44948.
50. McClure B, Mendoza S, Duncan L, et al. Effects of regulation on methadone and buprenorphine provision in the wake of Hurricane Sandy. J Urban Health 2014;91:999–1008.
51. Merchant RM, Elmer S, Lurie N. Integrating social media into emergency-preparedness efforts. N Engl J Med 2011;365:289–91.
52. Morgan O. Infectious disease risks from dead bodies following natural disasters. Rev Panam Salud Publica 2004;15:307–11.

53. Mothershead JL. Local disaster response. In: Ciottone GR, Biddinger PD, Darling RG, et al., editors. Ciottone's Disaster Medicine. Philadelphia: Elsevier; 2016. p. 90–4.
54. National Incident Management System Implementation Guidance and Reporting. <https://www.fema.gov/implementation-guidance-and-reporting>.
55. National Science and Technology Council, Committee on the Environment and Natural Resources, Subcommittee on Natural Disaster Reduction. Natural disaster reduction: A plan for the nation. Washington, DC: U.S. Government Printing Office; 1996.
56. North CS, Pfefferbaum B. Mental health response to community disasters: a systematic review. JAMA 2013;310:507–18.
57. Ramirez J. "Ushahidi" technology saves lives in Haiti and Chile. Newsweek. March 3, 2010.
58. Salas RN. Humanity, teamwork, and art in post-earthquake Nepal. N Engl J Med 2015;373:205–7.
59. Sareen H, Shoaf KI. Impact of the 1994 Northridge earthquake on the utilization and difficulties associated with prescription medications and health aids. Prehosp Disaster Med 2000;15:173–80.
60. Sarin RR, Kim SH. Flood. In: Ciottone GR, Biddinger PD, Darling RG, et al., editors. Ciottone's Disaster Medicine. Philadelphia: Elsevier; 2016. p. 580–2.
61. Shoaf KI, Rothman SJ. Public health impact of disasters. Australian Emergency Management Institute Mar-May 2000, pp 58–63.
62. Spiegel PB. Differences in world responses to natural disasters and complex emergencies. JAMA 2005;293:1915–18.
63. Terhakopian A, Benedek DM. Hospital disaster preparedness: mental and behavioral health interventions for infectious disease outbreaks and bioterrorism incidents. Am J Disaster Med 2007;2:43–50.
64. The Sphere Project. 2011. <http://www.sphereproject.org/resources/sphere-essentials/>.
65. Thormar SB, Gersons BPR, et al. The mental health impact of volunteering in a disaster setting: a review. J Nervous Mental Dis 2010; 198:529–38.
66. United Nations. United Nations resolution 46/182: Strengthening of the coordination of humanitarian emergency assistance of the United Nations. 1991. <http://www.un.org/documents/ga/res/46/a46r182.htm>.
67. United Nations Office for the Coordination of Humanitarian Affairs. Hashtag standards for emergencies. 2014. <https://docs.unocha.org/sites/dms/Documents/TB%20012_Hashtag%20Standards.pdf>.
68. United Nations Office for the Coordination of Humanitarian Affairs. OCHA on message: Humanitarian principles. 2012. <https://docs.unocha.org/sites/dms/Documents/OOM-humanitarianprinciples_eng_June12.pdf>.
69. US Department of Health and Human Services. A guide to managing stress in crisis response professions. DHHS pub no 4113. Rockville, MD: Center for Mental Health Services, Substance Abuse and Mental Health Services Administration; 2005. p. 2–3.
70. US Department of Homeland Security. IS-100.Sca Introduction to the Incident Command System: For schools. <https://emilms.fema.gov/is100sca/index.htm>.
71. US Department of Homeland Security. National Disaster Recovery Framework. 2011. <http://www.fema.gov/pdf/recoveryframework/ndrf.pdf>.
72. US Department of Homeland Security. National Incident Management System. 2008. <https://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf>.
73. US Department of Homeland Security. National Response Framework. 2013. <https://www.fema.gov/media-library-data/20130726-1914-25045-1246/final_national_response_framework_20130501.pdf>.
74. US Department of Homeland Security, Science and Technology Directorate. Innovative uses of social media in emergency management. <http://www.firstresponder.gov/SAVER/Documents/Social-Media-EM_0913-508.pdf>; 2013 [accessed 10.03.2016].
75. US Department of Veteran Affairs National Center for PTSD. Effects of traumatic stress after mass violence, terror, or disaster. February 23, 2016. <http://www.ptsd.va.gov/professional/trauma/disaster-terrorism/stress-mv-t-dhtml.asp>.
76. Valentine PV, Smith TE. Finding something to do: the disaster continuity care model. Brief Treat Crisis Interv 2002;2:183–96.
77. Van de Velden P, van Loon P, et al. Mental health problems among search and rescue workers deployed in the Haiti earthquake 2010: a pre-post comparison. Psychiatry Res 2012;198:100–5.
78. Von Schreeb J, Riddez L, Samnegård H, Rosling H. Foreign field hospitals and the recent sudden-impact disasters in Iran, Haiti, Indonesia, and Pakistan. Prehosp Disaster Med 2008;23:144–51.
79. Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. Emerg Infect Dis 2007;13:1–5.
80. Wildes R, Kayden S, Goralnick E, et al. Sign me up: rules of the road for humanitarian volunteers during the Ebola outbreak. Disaster Med Public Health Prep 2015;9:88–9.
81. World Bank and The United Nations. Natural hazards, unnatural disasters: the economics of effective prevention. Washington, DC: The World Bank; 2010. p. 44–6.
82. World Health Organization/SEARO Technical Notes for Emergencies. Technical Note Number 8. Disposal of Dead Bodies in Emergency Conditions. <http://www.who.int/water_sanitation_health/hygiene/emergencies/deadbodies.pdf>.
83. World Health Organization, War Trauma Foundation, and World Vision International. Psychological first aid: guide for field workers. Geneva: WHO; 2011.
84. Woyke E. What the Red Cross learned from its Haiti mobile campaign. Forbes. Aug 26, 2010. <http://www.forbes.com/sites/elizabethwoyke/2010/08/26/what-the-red-cross-learned-from-its-haiti-mobile-campaign/#611b0f37333b>.

CHAPTER 84

Global Humanitarian Medicine and Disaster Relief

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Health care professionals engaging in wilderness medicine have many personal and professional qualities ideally suited for international humanitarian and disaster medicine. These individuals are able to cope with environmental extremes and rugged situations, and are by nature adaptable and practical (Figure 84-1). Such health care providers appreciate human diversity and thrive through altruism.

This chapter outlines many of the major medical and nonmedical issues pertaining to serving as an aid worker in humanitarian emergencies, disasters, and related crises. It is geared to medical providers from all related allied disciplines. This field is in constant evolution; readers are encouraged to consult the cited online references for up-to-date information.

The aid work community is rife with differing opinions and debate on critical issues. The concepts and opinions written in this chapter should serve to foster personal and professional reflections. The chapter is a framework for exploring humanitarian and disaster work. It is important to realize that comprehensive graduate studies are dedicated to this topic. It is our hope that this chapter will inspire readers to engage in aid work, which is a unique, important, and rewarding component of wilderness medicine.

SURVEY OF KEY EVENTS AND MEDICAL PROBLEMS

Events and disasters requiring humanitarian support have occurred throughout human history and will continue to occur. These events vary in location, impact, and responses. This section of the chapter provides an overview of some of the more notable types of events.

ARMED CONFLICT

The seeds of humanitarianism can be traced back to the social justice movements of the 19th century, such as abolitionism and missionary efforts. Many, however, place the origin of modern humanitarian action in 1859 with the Battle of Solferino in northern Italy.[4] Franco-Sardinian and Austrian forces engaged in combat, leaving 6000 persons dead and 35,000 wounded or missing. A young Swiss businessman, Henry Dunant, and the local population did their best to care for the injured in the Castiglione church. Dunant's experiences led him to create an organization called the International Committee of the Red Cross (ICRC), which would go on to protect and assist persons wounded in war. Dunant's work eventually led to the Red Cross and Red Crescent Movement, which is composed of the ICRC, the International Federation of the Red Cross and Red Crescent Societies (IFRC), and national societies from virtually every country in the world. The principles that governed these societies later became the basis of the Geneva Conventions,[18] which outline the protection and care needed for civilians and prisoners in times of armed conflict. The ICRC led the way for provision of humanitarian emergency aid in the 20th century, but did not remain the only leader for long.

In the wake of the First World War, Save the Children was created in the United Kingdom, to feed children starving throughout Europe. The International Rescue Committee had its roots in 1933, assisting Germans suffering under the Hitler regime. In 1942, the Oxford Committee for Famine Relief, later Oxfam, campaigned for food supplies to be sent through an allied naval blockade to starving women and children in enemy-occupied Greece during the Second World War. Following World War II, a number of American charities banded together to form the Cooperative for American Remittances to Europe (CARE) and sent small packages of food and relief to recipients in Europe. The United Nations (UN) was formed in 1945, and many of its humanitarian arms were set up soon after: UNICEF to assist children, the UN High Commissioner for Refugees, and the World Food Programme. In the late 1960s, a group of French physicians working for the ICRC in the Nigerian Biafra conflict became frustrated by the organization's confidential, reserved style of operations and its passivity in the face of mass starvation. In 1971 alongside some journalist colleagues, they formed Médecins Sans Frontières (MSF), or Doctors Without Borders.[27] Since Solferino, armed conflict has always played a central role in humanitarian actions, whether workers are responding to the consequences of conflict or being influenced by the logic and operations of conflict.

The Cold War had a major impact on humanitarian events because proxy wars were fought in such nations as Mozambique, Angola, Afghanistan, Ethiopia, and Somalia. These conflicts led to an explosion in the numbers of refugees crossing international borders. Refugee camps swelled in the 1980s and 1990s and still persist. Many aid organizations "cut their teeth" and matured serving these needy populations.

Numerous protracted conflicts continue to be foci for humanitarian organizations; some have been going on for years or decades. For example, South Sudan has been engulfed in a civil war since the 1980s, and the Democratic Republic of Congo is still suffering through a conflict, at one point labeled Africa's World War, that tragically began on the heels of the Rwandan genocide in 1994. Each of these conflicts takes up a major proportion of the human and financial resources of certain large international aid agencies; the inherent dangers are obvious. There are many other examples, such as conflicts in Afghanistan, Somalia, Colombia, and the Central African Republic.

At times, aid has not been easily rendered for reasons not immediately made public. In the 1984 famine in Ethiopia, during which one million people died, the Ethiopian government forcibly moved its people from drought-prone areas. Later, it was learned that this was done for political reasons, to suppress a rebel movement. In the catastrophic refugee camps of the eastern Democratic Republic of Congo, formed after genocide in Rwanda in 1994 (Figure 84-2), some humanitarian agencies came to believe that the aid provided was being manipulated by the same forces that had conducted the genocide. In these situations, aid agencies have withdrawn their services once workers are convinced that resources are being misused for political ends rather than to genuinely help those in greatest need. Strong-arm regimes persist to this day, forcing aid organizations to make difficult

FIGURE 84-1 Médecins Sans Frontières aid worker performing a minor surgical procedure in Ethiopia, 2008. *(Courtesy Damien Follet, Médecins Sans Frontières.)*

choices between reporting what workers see on the ground and obtaining government permission to continue providing aid to suffering populations.[27]

The notion of "military humanitarianism" grew from crises in which Western military forces became increasingly involved in providing humanitarian assistance. In 1991, following ousting of the Iraqi regime from Kuwait, the Kurdish exodus to the north of Iraq led to a massive relief operation involving foreign governments. In 1992, interclan warfare in Somalia led to an ill-fated operation led by the U.S. military to secure the region and deliver aid. The 1990s were marked by rupture of the former Yugoslavia, war in Bosnia, and war in the former Serbian province of Kosovo. Events included the July 1995 execution of 7000 persons in the UN "safe haven" of Srebrenica. Later, a "humanitarian war" consisting of aerial bombing was led by Western governments and the North Atlantic Treaty Organization (NATO) to aid the former Serbian territory of Kosovo; the war arguably contributed to displacement of more than one million Albanians. NATO's use of the word *humanitarian* to justify its actions has been disputed.[27] "If an appeal to humanitarian considerations can justify both a medical aid operation and a military campaign, doesn't that suggest that aid workers and international troops represent two sides of the same coin?"[36] The consequences of military humanitarianism for aid organizations became even clearer in Afghanistan following the U.S.-led invasion after 9/11 and subsequent occupation of the country by NATO. Stark examples involved deployment of special forces in civilian dress who claimed to be on a humanitarian mission and threatened to suspend aid to populations in southern Afghanistan if the people refused to provide information about the Taliban and al-Qaeda. Such actions led to a dangerous blurring of the lines of identities and intentions, leaving it difficult to distinguish aid efforts from political or military actions. The end results were loss of aid workers' lives and formation of a climate in which it was much more difficult to negotiate access to suspicious populations.

Beyond Afghanistan, recent conflicts in Iraq, Syria, and Somalia have been marked by extreme insecurity for aid workers. These crises also typify the polarized and growing anti-Western context in which Western coalition military forces are operating or seeking influence.[27] For MSF, the problems peaked in 2013 in Somalia, arguably the world's most failed state; after delivering humanitarian assistance there for 22 years, MSF finally had to withdraw completely from the country. Aid organizations have yet to find a way to minimize risks and provide safe access in such highly insecure places. Until they do, it is the populations left behind that suffer.

In response to armed conflicts over decades, specialized medical and surgical skills have been developed and refined. The importance of improved logistic abilities of aid organizations has had a significant impact on their effectiveness. Public health efforts, such as preemptive measles vaccinations, epidemiologic tools for detecting epidemics, and curative medical approaches, have evolved enough that significant problems of morbidity and mortality can be predicted and diseases prevented and treated. Medical care available in complex conflict settings has improved to the extent that human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) and tuberculosis have been successfully treated in areas such as the eastern Democratic Republic of Congo and south Sudan.[27]

POPULATION DISPLACEMENT

People may be forced to leave their homes due to violence or natural disasters. Once they have decided to do so and cross an international boundary, they officially become refugees and are guaranteed certain rights and protections under international law. Most, however, do not cross an international boundary, and they become internally displaced people within their home country. They remain under the protection of their own government, even though that government may have been the cause of their flight. Internally displaced people are among the world's most vulnerable people.

As of January 2014, the number of displaced persons due to conflict surpassed 50 million, with 16.7 million refugees, mostly from Palestine, Syria, Afghanistan, and Somalia, and 33.3 million internally displaced people, notably from Syria, Sudan, Iraq, Colombia, Democratic Republic of Congo, and South Sudan[15] (Figure 84-3). Another 22 million people were newly displaced

FIGURE 84-2 Massive exodus of refugees toward Goma, Zaïre, 1994. *(Courtesy B. Press, Médecins Sans Frontières.)*

FIGURE 84-3 Violence and targeted attacks by armed elements on civilians led to the displacement of hundreds of thousands in the Darfur region of Sudan, 2004. *(Courtesy Espen Rasmussen, Médecins Sans Frontières.)*

in 2013 as a result of natural disasters, mostly in the Philippines, China, and India.

The priorities in refugee emergencies are outlined in the section on Needs in Humanitarian Crises later in this chapter.[20]

NATURAL DISASTERS

Major natural disasters (see Chapter 86) have occurred throughout human history. International nongovernmental organizations (NGOs) previously played minor roles while military forces provided most of the aid. This scenario has changed dramatically in recent years.

The history of natural disasters is one of devastating losses of life. Floods in China in 1931 killed between 1 and 4 million persons. Severe storms also take their toll. The 2008 cyclone in Myanmar killed more than 80,000 and displaced more than 2 million inhabitants.[33] In November 2013, more than 6000 persons died and another 4 million were displaced as Typhoon Haiyan struck the coasts of the Philippines.[12]

Earthquakes have wreaked particular destruction. In December 2004, a major earthquake in the Indian Ocean caused a tsunami that affected numerous Asian countries and killed 230,000 persons. Although some national governments were able to care for their own populations, the international response was massive. It was also apparent that unless an organization was already present on the ground at the time of the disaster, the possibility that an organization could become operational within 24 to 48 hours was limited to a select few that had plans in place for a surge in need and logistic stockpiles of needed food and goods. Even with such a capacity for response, it can be challenging to determine which ports or airstrips are not damaged, especially because other first-response organizations are attempting to do the same. This was the case in Nepal following the earthquakes that occurred in close succession in April and May of 2015.

In January 2010 an earthquake devastated Haiti, a nation that was already perhaps the most desperate and neglected nation in the Americas (Figure 84-4). During the disaster, 60% of the country's existing health care facilities were destroyed and 10% of medical personnel either were killed or left the country. The human death toll was 220,000, and much of the infrastructure of the nation was lost. Although the immediate focus was on major surgical and intensive medical care, basic primary care was needed for thousands with minor injuries and chronic medical problems. The psychological trauma was widespread, especially due to aftershocks. Countless lives were saved by the efforts of the overall response. Lessons about coordination and leadership were still to be learned, however,[14] especially when hundreds of aid workers, many of whom did not have appropriate expertise or training, from many organizations were arriving. Haitians and state systems were excluded from decision making, and there was little understanding of how to provide acute care in the densely populated urban areas or, later on, care for the victims of a cholera epidemic.

FIGURE 84-4 An 8-year-old girl is transferred by MSF for specialized surgical care to Santo Domingo following initial surgical attention in Haiti following the 2010 earthquake. *(Courtesy Stefaan Maddens, Médecins Sans Frontières.)*

FIGURE 84-5 Malaria treatment of a child with antimalarials and blood transfusion in Ivory Coast, 2003. *(Courtesy Peter Casaer, Médecins Sans Frontières.)*

On March 2011, an earthquake occurred off the coast of Japan, triggering a tsunami and subsequent nuclear reactor meltdown. It is instructive to bear in mind that wealthy countries are not immune from crisis; a humanitarian response took place in that highly developed country.

DISEASE EPIDEMICS

By definition, disease epidemics occur when new or resurgent cases of a certain disease, in a given human population and during a given period, substantially exceed what is expected based on recent experience. Medieval history recounts epochs of plague killing millions of persons. Influenza in the early 1900s killed between 50 and 100 million persons; from 1956 to 1958, flu epidemics killed another 4 million. Smallpox swept across the world for centuries before vaccination resulted in its eradication. Measles continues to kill approximately 164,000 persons annually and remains a serious concern in regions with crowded and malnourished populations. In some refugee camps, measles vaccine is provided along with vitamin A, which reduces the impact of the infection. Malaria epidemics persist worldwide, particularly in sub-Saharan African. Rapid antigen detection tests and artemisinin-based antimalarial medications have improved diagnosis and disease management (Figure 84-5).

Numerous other disease epidemics have occurred and continue to occur. Global cholera pandemics have killed millions across all continents, despite the treatment, fluid replacement, being straightforward. Meningococcal meningitis can be epidemic in the "meningitis belt" of sub-Saharan Africa, from Senegal to Ethiopia. Mass treatment and vaccination campaigns are required once the disease burden hits epidemic proportions.

Currently, efforts are under way to vaccinate residents of the entire meningitis belt region in order to eradicate the illness. In March 2014, the largest epidemic ever seen of Ebola viral hemorrhagic fever occurred. It affected primarily Guinea, Liberia, and Sierra Leone; cases were found in Nigeria, Mali, Senegal, Spain, the United States, and the United Kingdom. After the onset of the epidemic, more than 25,000 people were infected, of whom more than 40% died. Whether because of lack of expertise or fear, and aside from a few notable exceptions, the international response to support West Africa during this outbreak was tragically too little, too late.

The current HIV/AIDS pandemic is certainly a global emergency, with at least 35 million infected persons.[39] Of infected persons worldwide, 71% are in sub-Saharan Africa. In 2013, more than 11 million HIV-positive people in low- and middle-income countries had access to antiretroviral treatment; this number represents only 36% of the total need. Global outrage about the high cost of HIV/AIDS treatment inspired a surge of concerted activism. Subsequently, the price of antiretroviral drugs has dropped from about $15,000 to $150 per year, significantly improving access to treatment. Unfortunately, because one-third of persons with HIV/AIDS are coinfected with tuberculosis; resurgence of that disease has also become a global problem.

SEXUAL VIOLENCE AND MENTAL ILLNESS

Victims of disasters and humanitarian crises around the world continue to endure sexual violence and mental illness (Figure 84-6). In settings where the rate of sexual violence is high, as in conflict zones and refugee camps, dedicated teams might be created to provide assistance, with staff working in the community to raise awareness of the problem of sexual violence and to promote social and legal support. In 2013, MSF treated more than 11,000 victims of rape; these statistics are likely incomplete because patients experience shame and fear about reporting rape, are stigmatized, and have logistic problems in seeking care.[21]

Due to armed conflict, displacement, neglect, and disaster, persons in crisis are increasingly recognized to suffer mental health consequences. Providing psychosocial support to victims of trauma may help reduce the incidence of long-term psychological problems. Psychosocial care focuses on supporting a community to develop its own culturally appropriate coping strategies after trauma. In some instances, psychiatric care for select individuals may also be needed.

FIGURE 84-6 Mental health assistance is provided to victim of tropical storm Stan in Guatemala, 2005. *(Courtesy Marco Baroncini, Médecins Sans Frontières.)*

FIGURE 84-7 3-year-old girl receiving treatment for kala azar and malnutrition in Somalia, 2004. Bandages on the hands and face are in place to prevent the child from removing the nasogastric tube. *(Courtesy Espen Rasmussen, Médecins Sans Frontières.)*

FAMINE AND MALNUTRITION

Famines continue to cause significant rates of morbidity and mortality (Figure 84-7). Malnutrition is involved in nearly half of all deaths of children under 5 years of age, or almost 3 million per year.[34] Although it is easy to think of famine as a result of lack of food, it is rarely that simple. Factors such as conflict, resource scarcity, climate change, and governmental policies play significant roles. One of the major developments from the 2005 famine in Niger was implementation of ready-to-use therapeutic foods such as Plumpy'Nut (a peanut-butter—like food requiring no water), which became available on an outpatient basis (Figure 84-8). This intervention became a substitute for admitting patients to traditional therapeutic feeding centers, where they would have obtained a watery milk-based refeeding treatment.

NEGLECTED DISEASES

Rare and/or neglected diseases cause serious crises in various parts of the globe. Because these diseases are not well known and receive less media attention, they often do not represent an enticing or lucrative market for commercial drug companies. Hence, there are often few options available for treating victims of such diseases, such as human African trypanosomiasis (African sleeping sickness), Chagas' disease, and leishmaniasis.

EMERGING URBAN CONTEXTS

New contexts requiring humanitarian assistance will continue to arise. Rapid urbanization has led to increased violent conflict in

FIGURE 84-8 MSF aid worker examines a child with severe malnutrition in Ethiopia, 2008. Children without medical complications are treated on an ambulatory basis. *(Courtesy Francesco Zizola, Médecins Sans Frontières.)*

the vast slums of cities such as Port-au-Prince in Haiti, Rio de Janeiro in Brazil, and Tegucigalpa in Honduras. Street children and marginalized populations are victims of such settings. These contexts are in part driven by criminal violence. However, in some countries, such as Colombia, urbanization and slum growth are driven as much by political conflict as by criminal elements; both lead to indigenous people leaving rural areas for cities.

Responding to natural disasters and epidemics in urban settings is more difficult than in rural or lightly populated settings. Not only is there a higher impact purely because of the numbers of people involved, but gaining a solid understanding of stakeholders and power dynamics is more complicated. The 2010 Haiti earthquake and the cholera outbreak that followed were excellent examples of how much aid organizations still need to learn (Figure 84-9).

ACTORS DURING EVENTS: THEIR CAPABILITIES, LIMITATIONS, AND USUAL ROLES

The number of agencies responding to humanitarian crises has greatly increased in the last three decades. However, it is common to see a "standard" set of organizations and actors in a crisis zone. These include the affected population, national government and local groups, UN, armed actors, foreign governments, Red Cross, NGOs, religious or faith-based organizations, private corporations, donor agencies, and academic institutions. Each organization has specific capabilities, limitations, and niches. The usual agencies responding to medical needs include a state ministry of health, the World Health Organization (WHO), and medical NGOs.

First and foremost, it is the ministry of health that is officially responsible for health care of the population. If humanitarian medical agencies are operating, it must be assumed that the ministry of health has been overwhelmed in one or more of its capacities. In certain cases, ministry of health staff may be unable, uninterested, or unwilling to work in the affected area because of the level of violence or the presence of hostile antigovernment forces. In other circumstances, the ministry of health may have been virtually nonfunctional before the crisis. This is most often true for provision of accessible, quality primary health care. The ministry of health may not have the level of expertise or the required human, financial, and material resources to provide medical care required to adequately respond to the crisis.

The WHO is often present in the affected country before a crisis. This organization provides technical advice and supports training. It sometimes provides administrative capacity or medical and logistic resources to the ministry of health. During a crisis, the WHO continues in this advisory role while taking on other responsibilities. Most prominently, it works with the ministry of health to coordinate the emergency response. At times, the WHO takes the lead on the coordination role, especially in the first phases of an emergency or in nations where the ministry of health lacks the capacity or interest.

Medical NGOs, such as MSF, Medical Emergency Relief International, the International Rescue Committee, the International Medical Corps, and Médecins du Monde, usually focus on patient treatment during a crisis. These organizations have well-developed logistic supply systems for drugs and medical materials managed by staff knowledgeable in logistics and pharmacists. NGOs have pools of international medical staff, including nurses, general physicians, and specialists such as epidemiologists, psychologists, and surgeons. Activities are coordinated by experienced operations staff that oversee the assignments and manage relations with other actors (Figure 84-10). When possible, the majority of NGO workers, medical or nonmedical, are nationals from the affected country, and they often work in ministry of health hospitals and clinics (Figure 84-11). NGOs frequently pay stipends to ministry of health staff in these facilities. This compensation provides extra motivation to support the increased workload and to enable quality control and greater efficiency; it also runs the risk of creating a "brain drain" from local health systems. NGOs ensure a constant supply of essential medical materials and

FIGURE 84-9 Many lost their homes and were displaced following the 2010 Haiti earthquake. Shelter construction was a major problem. *(Courtesy Paul Cabrera, Médecins Sans Frontières.)*

FIGURE 84-10 Aid workers brought rice, water, and essential supplies to isolated areas affected by the 2004 Indian Ocean tsunami, and then returned to the base station with patients requiring treatment (Indonesia, 2005). *(Courtesy Francesco Zizola, Médecins Sans Frontières.)*

FIGURE 84-11 NGO workers caring for a patient with cholera in collaboration with the national ministry of health in Lusaka, Zambia, 2010. *(Courtesy Robin Meldrum, Médecins Sans Frontières.)*

drugs, and help to improve water and sanitation systems of health care facilities. They seek to maintain a constant power supply and work in other essential sectors necessary to ensure safe and quality health care management within the facility. In many cases, the NGO essentially takes over management of the hospital, although striving to be tactful and to respect preexisting management structures.

In cases in which a ministry of health hospital has been abandoned or destroyed, medical NGOs will usually either take over the abandoned facility until the ministry of health can return or will convert existing suitable buildings into temporary health structures. In some cases, NGOs set up full medical services in an inflatable or container-based hospital. In some settings, as during cholera outbreaks, NGOs set up separate medical structures outside the hospital to ensure proper disease containment.

In certain circumstances, medical NGOs provide primary health care through mobile clinics (Figure 84-12). This is essentially outpatient care for people spread out in smaller groups within the affected region. Mobile clinic teams can be converted into mass vaccination teams when there are outbreaks of contagious diseases, such as yellow fever, measles, or meningitis.

FIGURE 84-12 MSF sexual and reproductive mobile health care outreach team in Colombia, 2007. *(Courtesy Francesco Zizola, Médecins Sans Frontières.)*

NGOs provide more than curative care. Depending on their mandate, they may be equipped for preventing deterioration of the overall health condition of the population. They do this by providing shelter, water, sanitation, food and nutrition, nonfood items (e.g., soap, sanitary napkins, buckets, blankets), education, and protection. Improving palliative care is also a growing concern.

Humanitarian UN organizations specialize in specific types of essential services and populations. The UN Children's Fund, or UNICEF, supports activities such as the provision of vaccines to the ministry of health for access by NGOs. UNICEF also provides medications to health care facilities and increasingly supports therapeutic treatment of acutely undernourished children.

The UN High Commission for Refugees coordinates relief activities and provision of essential services to refugees and internally displaced populations. As much as possible, it funds NGOs to provide basic services to the refugee population. The commission also supplies shelter support, such as tents and other essential material, and often offers expert advice. It negotiates living space for refugees, protects refugee rights in the host country, and undertakes assessments when new displacements occur.

The World Food Programme provides foods, such as maize, oil, sugar, and pulse (food crops harvested for their dry seeds), to populations in crisis. Most of these foods are donated by donor countries, but increasingly, food is purchased locally or regionally. The World Food Programme normally oversees food transport from its source to the disaster zone. In line with this often massive network involving logistics, the World Food Programme can take the lead in providing air transport for UN and NGO aid workers to areas that are difficult or hazardous to reach by road.

The UN Population Fund is involved in reproductive health, gender equality, and strategies to promote healthy population growth. It specifically supports the ministry of health and other government sectors in providing safe maternal care. The International Organization for Migration assists displaced people, often through provision of shelter and the orderly and humane migration of persons in transit.

To varying degrees, all UN agencies limit the scope of their direct implementation of field operations because of high personnel costs, high levels of bureaucracy, and security restrictions. NGOs are therefore seen as essential service providers that take contacts from UN agencies to implement and provide basic services to populations in need.

Certain NGOs have developed specializations in certain sectors. Action Contre la Faim, or Action Against Hunger, specializes in food distribution and nutrition activities. CARE has developed expertise in camp management, food and nonfood item distributions, and shelter provision. Save the Children and Plan International focus on education, child protection, and primary health care services. The German government organization Gesellschaft für Technische Zusammenarbeit is often involved in logistics and mechanical support for UN and NGO vehicle fleets.

Many religious or faith-based NGOs, such as World Vision, Catholic Relief Services, Adventist Development and Relief Agency, Lutheran World Relief, and the Mennonite Committee, are active during the crisis phase of emergencies. These organizations tend to have a longer-term, developmental approach to their interventions and are well suited to carry on a project once the work is handed over by the more immediately responsive humanitarian medical agencies that focus on the emergency phase of a crisis.

During a crisis, the Red Cross can often mobilize volunteers to assist with the response. National Red Cross or Red Crescent Society members are involved in many sectors and phases of emergency response, including distribution of food, nonfood items, and water and the provision of primary health care, shelter, and sanitation. The IFRC specializes in a rapid response to natural disasters. In conflict zones, the ICRC is also involved in a variety of activities. Most notably, these include emergency surgical response for war wounded, reuniting separated families, and monitoring conditions of prisoners of war and prisons. The ICRC is not an NGO, but rather, a charter organization with a special

FIGURE 84-13 Sudanese Janjaweed fighter poses in a small village in Darfur, Sudan, at the border with Chad, 2004. *(Courtesy Espen Rasmussen, Médecins Sans Frontières.)*

international mandate to monitor the respect of international humanitarian law in armed conflict.

Other organizations focus on advocacy and human rights protection. Oxfam International (originally, the Oxford Committee for Famine Relief) increasingly specializes in advocacy and in-depth analysis of the vulnerability of affected populations. Organizations such as Human Rights Watch and Amnesty International collect testimony and do research on the plight of persons affected by crises, especially in cases where abuse occurs. The International Crisis Group provides detailed analysis of a given crisis situation and the factors that contribute to its deterioration or improvement.

Foreign governments provide funding for many of the activities mentioned. Most NGOs and all UN organizations rely on this funding. A few organizations, such as MSF, are (at least for the most part) financially independent and do not rely on government-sourced funds.

Armed groups can figure prominently in a crisis zone (Figure 84-13). These can include UN or other foreign forces, domestic military forces, and domestic or foreign police forces. Also present may be nonstate actors, such as antigovernment forces or forces involved in armed actions in many states. For the most part, armed groups allow relief agencies to operate unobstructed. Police and military forces, whether foreign or domestic, can play an important role in providing stability to the affected region. At the same, time, armed elements can also destabilize any context and create fear and suffering in the host population, especially if they rob, rape, steal, and kill, as has occurred in eastern Congo. Foreign troops, including UN forces, have an interest in facilitating and sometimes even undertaking, relief activities. Aid agencies often appreciate the remarkable logistic capabilities of these forces, but are also often reticent to collaborate too closely with an armed group.

Undisciplined armed groups, or armed actors hostile to the objectives of the aid agency or the aid agency donors, can hinder the provision of aid. The threat of armed robbery, extortion, or physical violence from such groups imposes security risks that restrict the movement of aid workers and the procurement and provision of essential supplies and materials.

MOTIVATING FACTORS FOR ORGANIZATIONAL INVOLVEMENT

Motivations for involvement during crises and disasters influence theoretical and practical objectives. The overall vision of an organization dictates how it will prioritize precious resources and time. It influences interactions with the affected population and other actors. It affects how and from whom organizations raise funds. For example, some aid organizations have few reservations about using full-page, "flies in the eyes" advertisements to portray starving children to aggressively raise money. Other organizations depict beneficiaries with greater dignity and strive to raise only the funds they can immediately spend. Both approaches have merits and challenges. An organization's goals influence the type of field in which it wants to operate (e.g., strictly in an emergency situation or later, in a developmental context or during the transition between the two) and with whom the organization affiliates or partners. Goals influence public positioning, as well as how and with whom organizations conduct advocacy.

A variety of motivating factors stimulate organizational involvement in crises (Figure 84-14). As with any organization, there are sometimes detailed objectives and operational priorities that may work at cross-purposes. For example, agencies involved in medical assistance or public health in a crisis share a common purpose: to save lives through provision of essential health care services. However, interpretation of this purpose is rarely straightforward because it is influenced by the traditions, culture, and motivation of the agency. For example, some NGOs strongly believe in hands-on provision of medical care to individual patients. In contrast, other NGOs would rather build their capacity or train operators, leaving the day-to-day medical care to local actors. Both approaches have legitimacy; prospective aid workers should align themselves with an approach they prefer. Another type of tension occurs between curative care and public health approaches. For example, some aid organizations believe that the best way to address the HIV pandemic is to directly treat infected persons, whereas others place more emphasis on public education and prevention efforts.

Some medical aid actors, for example, Médecins du Monde (Doctors of the World), are motivated to raise public awareness of the plight of the population. This is equal in importance to and sometimes has an even greater impact than provision of medical care, depending on the context. This tension poses a dilemma for most medical relief personnel. Should the organization undertake advocacy and public condemnation of abuses and gross neglect? Doing so could compromise the agency's neutrality in the face of armed actors that control violence, making it more

FIGURE 84-14 MSF aid worker with a child with severe malnutrition in Ethiopia, 2008. *(Courtesy Francesco Zizola, Médecins Sans Frontières.)*

difficult to safely provide medical services. Speaking out can result in the organization being expelled by a government not wanting to face criticism.

Other NGOs, such as the Save the Children Fund, are rights-based organizations, that is, they are motivated to uphold human rights. These organizations view the provision of their services as meeting the basic rights of the affected population and affording some protection against abuse to the population.

The ICRC was founded on international humanitarian law. Members are the primary defenders of the laws of war and proactively promote respect for these laws among armed groups. They favor neutrality and thus do not take sides in a conflict. Although this affords them unparalleled access, it limits their public advocacy.

Other organizations are motivated by religious beliefs and principles. Christian Aid, World Vision, Catholic Relief Services, and Islamic Relief are examples. By and large, these agencies do not have the objective to proselytize, other than by example.

Foreign governments are motivated by a combination of "enlightened self-interest," public pressure, and quasi-humanitarian motivations. In a major natural disaster, the citizens of a nation may desire to see their government doing something to help. In other cases, the foreign government may be expressing a humanitarian ideal they feel is intrinsic to their culture and society; however, if the stakes are high, self-interest will always prevail. The notion of enlightened self-interest simply means, "by helping others, we help ourselves." For example, military medical personnel may be required to provide services to a population located in a strategic region or area. In this case, the primary motivation to provide the service may be to gather intelligence and to garner the sympathy of the population (to win "hearts and minds"). In this way, foreign governments can also isolate insurgents trying to use the population as cover, as well as fulfilling other strategic purposes.

The UN can follow a similar logic, although its motivation is one of collective security, well-being, and stability. Depending on the circumstances, the UN may proactively align its agencies and (as much as possible) the NGOs, so that all efforts contribute to the desired end. This integration of efforts and conditioning of aid on strategic objectives, rather than on existing needs of the population, may be criticized by more independent NGOs.

NEEDS IN HUMANITARIAN CRISES

Humanitarian crises most often happen in the countries least able or least willing to deal with them, because of underlying poverty, lack of resources and infrastructure, or political instability. Thus the needs in a crisis situation go well beyond medical care. The following is an outline of needs commonly seen during disasters and crises, including displaced populations in camp settings.[20,26]

INITIAL ASSESSMENT

Prior to undertaking any humanitarian intervention, a thorough, rapid assessment must be conducted. This initial assessment addresses each of the sectors listed below and identifies the current situation, existing and necessary resources, interventions needed, and possibilities for specific interventions. The first phase of an initial assessment occurs within a matter of days and includes collection of both quantitative and qualitative data. Further details on how to conduct an initial assessment follows later.

Water and Sanitation

Depending on the ambient conditions, human beings without water to drink will die from dehydration in a matter of hours to days. Consumption of contaminated water leads to transmission of pathogens, often leading to fatal diarrhea and other infectious diseases. Transmission of disease most often occurs from drinking water contaminated by human feces; thus water and sanitation are intimately linked. The Sphere Project (described in more detail later) sets out the following guidelines for water and sanitation.[30]

FIGURE 84-15 Internally displaced Sudanese women and girls wait a long time at a water tap stand to collect clean water in Sudan, 2004. *(Courtesy Stefan Pleger, Médecins Sans Frontières.)*

Water. Each individual should have, on average, 15 L/day of clean water for drinking, cooking, and personal hygiene (Figure 84-15). In an emergency situation, one may start by providing 5 L/day, making provisions to supply more water as soon as possible. In a stabilized setting, the goal is to supply each individual with 20 L/day. Water-gathering points must be within 500 m (1640 feet) of each household, with individuals queuing no longer than 15 minutes and able to fill their 20-L containers in 3 minutes or less. Taste and cultural acceptability of the water source must be taken into consideration.

Sanitation. A maximum of 20 people should use each toilet. Toilets, generally latrines, should ideally be provided for each household and segregated by sex (Figure 84-16). In an acute emergency, it may be necessary to build large pit latrines until more private, permanent structures can be built. Toilets should be no more than 50 m (164 feet) from homes, and they should be clean and well maintained.

Cultural acceptability is crucial when constructing latrines. If men, women, and children do not feel comfortable using the toilets provided, they will defecate elsewhere, near homes and water sources, leading to the spread of disease. Additionally, security concerns must be taken into account when latrines are constructed. In multiple-refugee settings, women have been sexually assaulted while using poorly lit, insecure public latrines.[28]

Food and Nutrition

Food shortages and acute malnutrition are common in humanitarian crises. Often, crises occur in areas with a high baseline prevalence of malnutrition prior to the emergency. Providing adequate, culturally appropriate nutrition is a key part of any humanitarian response. This includes not only providing an adequate supply of food (estimated to be approximately 2100 Kcal/day by Sphere guidelines)[30] but also identifying those

FIGURE 84-16 Logistics staff build latrines in Muzaffarabad, Pakistan, where thousands of displaced people had arrived following an earthquake in northern Pakistan, 2005. *(Courtesy Stephan Grosse Rueschkamp, Médecins Sans Frontières.)*

populations suffering from acute micronutrient or macronutrient malnutrition and designing programs to address the needs of these populations.

The initial assessment should identify the global acute malnutrition rate, in order to determine what sort of supplementation programs are needed and to identify populations at risk (e.g., children under 5 years of age, pregnant and nursing mothers, the chronically ill). Micronutrients, such as vitamin A, should be provided to populations exhibiting symptoms or at risk for deficiency. Whenever possible, local food sources should be used to provide nutrition to the population in crisis. The ICRC's *Nutrition Manual for Humanitarian Action* provides an excellent reference for provision of nutrition and treatment of malnutrition.[24]

Shelter, Security, and Site Planning

Hundreds, if not thousands, of people can be displaced by conflict or natural disaster. One of the first priorities of any humanitarian response is to provide adequate shelter, essential nonfood items, and adequate security to the displaced population. Sphere standards suggest that temporary shelters provide a minimum of 3.5 m^2 of covered space per person, ensure adequate access to essential needs, such as water, toilets, and health care facilities, and keep families and social networks intact whenever possible.

Provision of culturally acceptable nonfood items, including clothing, bedding, pots, plates, utensils, soap, and burial materials, is required where appropriate. Adequate lighting, gender-separated latrines, and adequate camp security are essential (Figure 84-17). Camps must be protected from invading forces and on-site crime. The site on which the camp will be built must also meet specific criteria, including a gradient of no more than 6% and proximity to a water supply and a transport route.[30]

FIGURE 84-17 Nonfood items are distributed by NGOs to people fleeing violence in an isolated region in northern Pakistan, 2010. *(Courtesy Médecins Sans Frontières-France.)*

HEALTH CARE IN THE EMERGENCY PHASE

Health care needs in a crisis can result from epidemic, acute, and chronic medical illness, malnutrition, and traumatic injuries resulting from a natural disaster or conflict (Figure 84-18). MSF suggests a health care system be constructed to provide necessary curative treatment, reduce suffering from disease, and be capable of carrying out case findings. The health care system should have the ability to treat a large number of patients, provide access to various levels of care, and contribute to public health surveillance. Finally, it should provide both preventive and curative services and be flexible enough to adapt quickly to a highly dynamic situation.[20] Health care facilities should be equipped to care for various types of disease, including surgical disease, mental health disorders, obstetric conditions, and chronic diseases such as HIV and tuberculosis. Staff members should have a working knowledge of diseases commonly seen in refugee and crisis settings.

Control of Communicable Diseases and Epidemics

The MSF's *Refugee Health: An Approach to Emergency Situations* estimates that up to 95% of deaths among refugees in crisis are due to preventable diseases such as measles, diarrhea, respiratory illnesses, and malnutrition.[20] Epidemics can be caused by these diseases, as well as by malaria, meningococcal meningitis, typhus, hepatitis, encephalitis, and hemorrhagic fevers such as yellow fever and dengue. These communicable diseases may arrive in the camp with the host population, or they may be new to the

FIGURE 84-18 18-year-old Darfur refugee who has been shot in the hand is prepared for surgery in Chad, 2004. *(Courtesy Espen Rasmussen, Médecins Sans Frontières.)*

displaced persons and endemic to the area of the encampment. Overcrowding, malnutrition, and poor sanitation lead to increased transmission, which can have devastating consequences.

In order to prevent epidemics, mass vaccination campaigns, particularly for measles, must be carried out early in the crisis. Robust and sensitive surveillance systems must be implemented, and protocols for prevention, diagnosis, and treatment of potentially epidemic disease must be widely available. Laboratories to identify potentially epidemic disease must be identified early, and adequate medications and medical supplies must be readily available. Refer to *Communicable Disease Control in Emergencies: A Field Manual* by the WHO for further guidance.[8]

Public Health Surveillance

According to the U.S. Centers for Disease Control (CDC), "Public health surveillance refers to the collection, analysis, and use of data to target public health prevention. It is the foundation of public health practice."[7]

A public health surveillance system should collect demographic, mortality, morbidity, needs, and program activity data.[20] The system should be as simple as possible and allow for rapid identification of threats to public health. Additionally, this system should assist in the planning of the intervention, including what populations are most at risk, what areas to target, the size of the impending threat, and other factors. A robust public health surveillance system should allow for ongoing monitoring and evaluation of the program at the field level, and all information gleaned from the system should be easily and rapidly used at the program level. Most often, data will be collected at health centers and selected community centers. For a detailed discussion of public health surveillance systems, refer to the "Surveillance" section in *Communicable Disease Control in Emergencies: A Field Manual* by the WHO.[8]

HUMAN RESOURCES AND TRAINING

Adequate numbers of trained staff are crucial for a successful response to a humanitarian crisis. Unfortunately, in the acute phase, adequate staff is often lacking. Generally, a mixture of national and expatriate personnel will work together during a given response, with the assistance of selected staff from the refugee/displaced population. This draws from MSF's *Refugee Health: An Approach to Emergency Situations*.[20]

As with any sector, the first step is to perform an assessment to determine needs, based on planned interventions. For example, staff will likely be needed for each of the sectors mentioned in this section, including for health centers, feeding centers, security, surveillance, and community outreach. The recently displaced will often include many potentially qualified staff. However, it is important to seek proof of qualifications whenever possible and to respect local employment laws when hiring refugee/displaced staff. The recently displaced may, quite understandably, be tempted to overstate qualifications in order to obtain more resources.

Once appropriate staff members have been recruited, assessment of needed training is the next step. For example, training on mass vaccination campaigns for measles can be implemented. Training can take on the form of formal classes or apprenticeships as necessary. It is important to clearly outline the salary, hours of work, days off each week, vacation time, and so forth in a contract for each employee, in accordance with national/local laws.

Coordination and Logistic Support

Almost all modern humanitarian operations will have a field logistician to manage a refugee/displaced camp's needs. The number of staff members on the logistics team can equal or exceed that of the medical staff. Logistics is defined as the science of organization, planning, and implementation. Logisticians are responsible for keeping medical and nonmedical inventories stocked, ensuring the function of camp facilities, coordinating transportation of materials and staff, and providing security. Without adequate logistic support, a program is doomed to fail (Figure 84-19). The importance of the work of the logistics team, which often takes place behind the scenes, cannot be overstated. Courses on logistics in emergencies are provided by many organizations, including MSF, ICRC, RedR UK, Massachusetts Institute of Technology, and a number of other universities and NGOs.

FIGURE 84-19 Following the outbreak of cholera in Zimbabwe, NGO logisticians constructed "elephant" pumps near Harare that operated 24 hours per day, providing water for up to 5000 persons, 2009. *(Courtesy Joanna Stavropoulou, Médecins Sans Frontières.)*

IDENTIFYING HEALTH CARE NEEDS FOLLOWING A DISASTER AND SETTING UP A HUMANITARIAN INTERVENTION

BACKGROUND

Information gathering is recognized as the crucial first step in assessing the needs of a population affected by a disaster.[6] Initially, a limited amount of information obtained on site will suffice to guide relief efforts.[32] This information must be obtained quickly and must include health indicators. The art and science of this public health intelligence is the disaster application of *rapid epidemiologic assessment (REA),* which, when related specifically to health, is termed the *rapid health assessment (RHA).*

Over the last two decades, REA protocols have been standardized and specialized for use in natural disasters and complex humanitarian emergencies and are now incorporated into all major humanitarian organizations' field manuals (Box 84-1). In addition to collecting information on disaster impact, displaced persons, health care facilities, and entire health sectors, REAs provide estimates of population size and composition, mortality rates, nutrition and health status, and environmental risks that may affect health in the future.[6] By assessing the impact of disasters on health, REA information enables the mapping of affected communities, examining the public health impact of the emergency, and reviewing availability of local resources.[6] These data serve as the initial step in development of an ongoing health

BOX 84-1 List of Organizations with Rapid Health Assessment Protocols*

Rapid Health Assessment Protocols for Emergencies (WHO)
Handbook for Emergencies (UNHCR)
Assisting in Emergencies (UNICEF)
Handbook for Delegates (FRC)
Humanitarian Charter and Minimum Standards in Disaster Response (Sphere)
Refugee Health (MSF)
Rapid Health Assessment of Refugees or Displaced Populations (Epicentre)
Field Operations Guide (OFDA)
Famine-Affected, Refugee, and Displaced Populations: Recommendations for Public Health Issues (CDC)

Additional References Consulted

War and Public Health (ICRC)
A Framework for Survival (Center for International Health and Cooperation)

*See Internet Resources for online locations of each organization's RHA protocol. From Bradt DA, Drummond CM: Rapid epidemiological assessment of health status in displaced populations: an evolution toward standard minimum essential data sets, *Prehosp Disast Med* 17:178, 2003.
CDC, Centers for Disease Control and Prevention; ICRC, International Committee for the Red Cross; IFRC, International Federation of the Red Cross and Red Crescent Societies; Sphere, Sphere Project; MSF, Medécins Sans Frontières; OsFDA, Office of U.S. Foreign Disasters Assistance; UNHCR, United Nations High Commissioner for Refugees; UNICEF, United Nations Children's Fund; WHO, World Health Organization.

information system and in design of targeted and appropriate health interventions. Additionally, the data collected in ongoing REA assessments permit humanitarian organizations to evaluate and monitor programs, and to advocate and build the capacity for affected populations.

PRINCIPLES FOR HEALTH ASSESSMENT IN DISASTERS AND CRISES

The objective of a health-related humanitarian intervention during the acute phase of an emergency is to reduce the numbers of deaths and to stabilize the population's health situation. In order to do this, data must be rapidly collected. Exacerbation of baseline health needs, additional health needs, and emerging health needs (Figure 84-20) must be differentiated. Health indicators, such as mortality and malnutrition rates, must be determined in the early stages of the emergency. The RHA is a key instrument in all these processes. It is a collection of subjective and objective information that measures the damage and identifies the needs and the level and type of response.[29] The RHA is based more on qualitative than quantitative data and thus can be subject to biases, as well as measurement and sampling errors.[29] However, it is the first step in a continuous process and provides the basis for comprehensive follow-up assessment missions.

The main methods employed in any RHA are:[29]
- Review of existing information
- Interviews
- Observation
- Rapid surveys

Several key questions must be answered by the RHA:[29]
- Is there an emergency or not?
- What are the type, impact, and possible evolution of the emergency?
- What is the most severely affected geographic area and catchment population?
- What is the main health problem?
- What is the existing response capacity?
- What are critical information gaps for follow-up assessments?
- What are recommended priority actions for immediate response?
- What are the resources needed to implement those priority actions?

The type of disaster and its context both affect the assessment. Because each type of disaster is associated with different consequences (e.g., floods are often associated with food shortages that can affect baseline malnutrition rates), the RHA should be tailored to the disaster. According to the UN Global Health Cluster, there are six categories of disaster and complex humanitarian emergencies that have a far-reaching negative impact:[29]
- Rapid-onset natural disasters (e.g., floods, earthquakes, tropical storms, volcanic eruptions)
- Slow-onset (natural) disasters (e.g., drought, famine, desertification)
- Technologic disasters (e.g., pollution, spillage, explosion, fire)
- Complex humanitarian emergencies (e.g., armed conflict)
- Epidemics (e.g., cholera, meningitis, measles, hemorrhagic fever)
- Sudden, large population movements

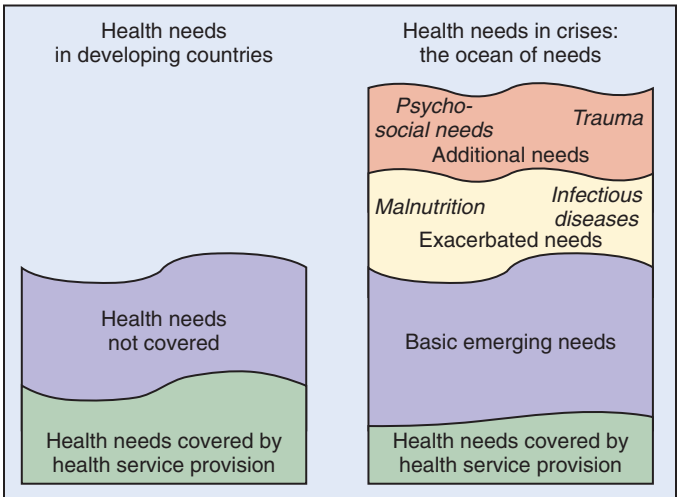
After the assessment is completed, results are compiled and analyzed, and a report drafted that includes recommendations for action. A summary of key activities for the assessment is:
- Planning the mission
- Field visits
- Analysis
- Report writing
- Dissemination

Given the dynamic nature of the disaster or complex humanitarian emergency, the results of the RHA are only valid for a limited period, so results should be disseminated within 2 weeks after the start of the emergency.[29]

The Assessment Process

Planning. To undertake an RHA, four main basic preconditions must be fulfilled that affect all frameworks for humanitarian action.[29] These preconditions are unimpeded access, security, relevant expertise, and availability of funding for the intervention(s).

Visas and security clearance must be obtained for both national and international staff. Local customs must be respected and local authorities contacted for permission to conduct the assessment. Teams must be briefed on security protocols and provided with evacuation plans and maps with global positioning



A disaster has three effects on the baseline situation on the left:
1. Additional health needs arise, such as mass trauma (earthquake) or weapon injuries (armed conflict).
2. Health needs that were already present (e.g., malnutrition, infectious diseases) are exacerbated owing to new exposure and/or lack of prevention.
3. Basic needs emerge, owing to the shinking capacity of health services. This results in lack of both prevention and early treatment.

FIGURE 84-20 The "Ocean of Needs" in a humanitarian emergency. *(From Michael M:* Global health cluster rapid health assessment guidelines, 2007: *2.* wpro.who.int/internet/files/eha/toolkit/web/health-cluster-approach.html.*)*

system coordinates if possible. Site visits may be day trips or longer, according to the number of sites and distances, and transportation, including drivers and fuel, may need to be arranged.

Team. The assessment team should be a multifunctional, multidisciplinary group whose members have various areas of expertise and organizational representation. The group should include a mix of genders, nationals/internationals, and insiders/outsiders.[23,29] The team should be deployed to perform the assessment within hours to days after the alert. Sufficient time must be reserved for in-country briefing of the whole team and familiarization with the RHA tools. This is especially important if the team includes translators. In most cases, team members should be properly identified with badges from their organization and should travel in vehicles marked with the organization's logo; however, for security reasons, this is not always the case. Gender issues may need to be considered; female team members may be required to interview female respondents. Teams must be briefed on local customs and clothing. Women may be required to cover their heads, and clothing must always be modest.

Tools. The RHA consists of data gathered from a number of sources. In this way, information can be triangulated, which helps to minimize the potential for bias and measurement error. The RHA framework includes reviewing existing information, interviewing, observation, and rapid health surveys.[29]

Existing information includes reports by the UN agency, NGO, and other groups; maps; demographic statistics from census data; and administrative data (e.g., ministry of health data, clinical records, and health indicators gathered by health services and programs).[29]

Interviews are semistructured and normally held with key informants, selected because they possess specific information or are representative of a category of the affected population.[29] Focus group interviews may also be conducted. These provide a large body of information in a relatively short period of time.

Observation is also called direct observation and entails examining the environment, infrastructure, events, relationships, and people in order to produce information on the general status of the population and to provide context.[29] A useful form of direct observation is a *transect walk,* which is a relaxed stroll with key informants through an area of interest. This provides an opportunity for observation and discussion.[29]

Surveys are crucial for developing figures that inform the report. They are used to inquire into morbidity and mortality rates, the case fatality ratio, and nutritional status.[29] Crude mortality rate and nutritional status of children under 5 years of age are the recognized basic indicators to be measured in emergencies.

Methods

Initial Assessment. Data collection starts before the team arrives at the site of the emergency. Initial assessment involves gathering cross-sectional, qualitative data to provide a snapshot of the affected population. It uses information assembled from the Internet, government agencies, UN agencies, and NGOs. Once the team is on the ground, information on the affected population is acquired using other qualitative methods, including participant observation, informant style interviews, and focus groups. Available materials from the local government ministries, international agencies, and community-based organizations are still sought. Information gathered according to a predetermined checklist includes population density and composition, family size, environmental conditions such as vector breeding sites, food availability, and types of disease.[6]

Surveys and Sampling Methods. Cross-sectional household surveys are a key component of REAs (Table 84-1). Survey questions are based on the objectives and outcomes that need to be measured, including mortality and malnutrition rates.

Sampling methods include probability and nonprobability sampling. The two most common categories of nonprobability sampling are convenience sampling and purposive sampling. Convenience sampling relies on sampling the respondents most easy to assess. Consequently, this is the type most often used in emergency situations.[29]

TABLE 84-1 Characteristics of Rapid Health Assessments, Cross-Sectional Household Surveys, and Surveillance Methods Used to Assess Populations Affected by Humanitarian Emergencies

	Assessment	Survey	Surveillance
Objective	Rapid appraisal	Medium-term appraisal	Analytic appraisal
Data type	Qualitative	Quantitative	Quantitative
Units	Community	Household	Community
Method	Observation, interviews, focus groups	Sample with survey	Periodic, standardized

Courtesy Kirsten Johnson, MD, McGill University.

Probability sampling methods are simple random sampling, systematic random sampling, stratified random sampling, and cluster sampling. The first three methods require lists of individuals, households, or the population at hand. These lists are often difficult to obtain in a complex emergency because of the high level of disorder and movement of people. The fourth method, cluster sampling, only requires a map of the area with approximate estimates of the relative sizes of the population units. This method of sampling is also valued for its simplicity, reasonable validity, and precision. For these reasons, cluster sampling is the most commonly used method of probability sampling in humanitarian emergencies.[38]

Cluster sampling methods require estimation of the population. This can be obtained from census data, maps, aerial photographs, or satellite imagery. For example, using aerial photographs to map a refugee camp provides a visual layout of the entire area. This area is then divided into smaller sections. The density is determined by counting the number of people populating one of the smaller segments. The total population is then determined by multiplying the number of sections in the total area by the number of people counted in the first segment. This method has been found to have reasonable accuracy and is commonly used in the field by MSF and other major NGOs.

Cluster sampling that has been validated for immunization and nutrition studies uses the 30 × 30, two-stage sampling methodology, or some derivative of this method.[38] The first stage requires grouping the population into smaller geographic units, such as villages, and then choosing these units, or clusters, proportional to the population size (the recommended number of clusters is at least 30, but this can be increased if subgroup analysis is intended). The second stage requires selection of households and then individuals, who are asked to participate in the survey within each cluster; the recommended number is at least 30. The choice of 30 clusters is based on statistical considerations for stability and distribution of means and proportion, whereas the choice of 30 individuals per cluster is based on the number of individuals necessary to have sufficient precision and who can be reasonably measured in a single day.[38]

Data Analysis. The RHA should use standards against which needs can be measured in order to define aid priorities calculated on the basis of need alone. There is widespread agreement to use crude mortality rate and the nutritional status of under-5s as common indicators, to which the under-5 mortality rate is often added.[38] Additional key basic indicators are shown in Table 84-2.

Acute malnutrition is estimated by the weight-for-height index or the mid–upper arm circumference. When using the weight-for-height index, children with an index of less than 80% of the median are considered moderately malnourished and children with index scores of less than 70% are severely malnourished.[31] A global acute malnutrition rate of more than 10% is considered critical; if it reaches 20%, immediate humanitarian intervention is needed.[29]

The estimate of population size can be used to establish mortality rates. The most specific indicator of the health status

TABLE 84-2 Common Indicators of Population Mortality in Emergencies

Indicator	Simplified Formula	Common Application
Crude MR	Deaths ÷ (population at risk × period of time)	Always presented
Age-specific MR	Deaths in age group ÷ (population in age group at risk × period of time for those within the age range)	Under-5 mortality rate (U5MR)
Group-specific MR	Deaths in subgroup ÷ (subgroup populations at risk × period of time)	MR among males/females; among unaccompanied children; among displaced persons vs. residents; in a special ethnic group
Period-specific MR	Deaths during subperiod ÷ (population at risk during subperiod × duration of subperiod)	Monthly MR; MR during epidemic period; MR before/after displacement
Cause-specific MR	Deaths due to given cause ÷ (population at risk × period of time)	MR due to violence; MR due to disease causing epidemic
Proportionate mortality	Deaths due to given cause ÷ total deaths (*not* a rate)	Proportion of deaths due to violence; proportion due to disease causing epidemic
Case-fatality ratio (CFR [or rate])	Deaths due to given cause (disease) ÷ total cases of given disease	CFR of cholera, measles, severe malaria; important during epidemic
Excess MR (total number of excess deaths)	Observed MR – expected noncrisis MR (× population at risk × period of time)	

From Checchi F, Roberts L: Interpreting and using mortality data in humanitarian emergencies: A primer for nonepidemiologists, Humanitarian Practice Network No. 52, September 2005, p 5. MR, mortality rate.

of the affected population is the crude mortality rate, which is typically expressed as deaths per day per 10,000 persons.

A rule of thumb for the emergency threshold is a doubling of the norm of the mortality rate. However, the baseline crude mortality rate varies by location and may not be readily available. In developing countries, the baseline crude mortality rate is normally between 0.4 and 0.6 per 10,000 persons per day.[30,31] The crude mortality rate is considered elevated if it is higher than 1 death per 10,000 per day; it is deemed critical when deaths exceed 2 per 10,000 per day.[31] This number is doubled for all children under 5 years of age. Therefore, the under-5 crude mortality rate is considered elevated at more than 2 deaths per 10,000 per day and severe if there are more than 4 deaths per 10,000 per day. Age-specific mortality rates should be obtained as soon as possible and disaggregated into age-groups of less than 12 months, 1 to 5 years, 6 to 14 years, 15 to 45 years, and over 45 years, thus allowing for better targeted programs.

Knowing the cause-specific mortality rates is paramount for effective planning of interventions. Standard case definitions of communicable and noncommunicable diseases common to complex emergencies should be used in order to identify the immediate health problems. Part of the purpose of the RHA is to identify risk factors for, and outbreaks of, disease, in addition to other factors that will result in high death rates. Determining the cause of death not only helps to prioritize and establish appropriate interventions, but also enhances accuracy of monitoring these programs over time. Baseline disease surveillance systems need to be established as early as possible, along with a system to promote communication of data between agencies and the local government.

Reporting

The RHA report must be clear, standardized, action oriented, timely, and widely distributed. A model outline might include the following headings:[29]

Executive summary
Assessment
Background
Affected population
Needs and resources
Capacities
Current responses
Conclusions
Recommendations
Budget required and international aid needed
Forthcoming reports
Annexes (maps, health facility description, narratives)

Program Development: the Logical Framework

RHAs are designed to be the initial phase of a continuum that informs humanitarian action. Usually, donors are prepared to allocate resources on the basis of the limited information that the RHA provides. Consequently, programs must be constructed that follow the recommendations put forward in the RHA report but also with the flexibility to change based on ongoing surveillance, monitoring, and evaluation measures.

Initial programs should focus on the most significant causes of illness and death. In complex humanitarian emergencies, these normally are diarrheal disease, acute respiratory tract infections, measles, malaria, and trauma (Figure 84-21).

Many strategies can be used to approach program design. The logical framework (log frame) is commonly employed in humanitarian emergencies because it breaks down a complex set of activities and enables a snapshot view of the goals a project or program aims to accomplish.[19] This approach requires thought about objectives and encourages identification and use of measurable indicators.[19] It provides a focus for people involved in different activities to see how their roles and actions fit into a bigger picture.[19]

FIGURE 84-21 Relief workers prepare for a measles vaccination campaign in Darfur, Sudan, 2004. *(Courtesy Kris Torgeson, Médecins Sans Frontières.)*

TABLE 84-3 Logical Framework Matrix*

Objective (Narrative Summary)	Indicators	Sources of Verification	Assumption
Goal (overall objective)			
Purpose (outcome)			
Outputs (results)			
Activities			

*See text for an explanation of the "log frame" matrix, shown here.
From Grove N, Zwi AB: Beyond the log frame: a new tool for examining health and peace-building initiatives, *Dev Pract* 18:66, 2008.

The log frame is described as a "matrix which summarizes the main elements of a program and connects them to one another."[11] The log frame in its most basic form consists of a matrix, with the rows corresponding to a hierarchy of project objectives (goal, purpose, output, activities) and the columns used to describe the objective (narrative summary), indicators, sources of verification, and critical assumptions (Table 84-3).[19]

The matrix is intended to reflect a "vertical logic." The first column, starting from the bottom, should tell a "feasible means-to-ends narrative" about a project or program.[19] It describes how a set of activities (such as training technicians and building wells) produces an output (increased quantity of water) that is related to a defined purpose (providing access to more clean drinking water for a village) that in turn contributes to a goal (reduced morbidity and mortality from water-related diseases).[19] At the same time, the log frame provides a "horizontal logic" that outlines how progress toward each objective can be measured and verified; it also identifies any external factors that may affect or impede the ability of the project to reach its objectives[19] (Figure 84-22).

As a program is being designed and implemented, coordination and communication between relief organizations and the local population are critical. Responding organizations too often create programmatic plans without involving the host population. Assistance programs should be assessed for suitability, both to the population and context of the emergency.

Surveillance, Monitoring, and Evaluation

Data collection employing standardized surveys should be continued periodically in order to create an effective surveillance system. Specific information in the context of a complex emergency that must be assessed on a regular basis includes, but is not limited to, population demographics, mortality rates, nutritional status, identification of vulnerable groups, and review of all the external interventions that are being implemented. Surveillance systems should be monitored for trends. Spikes in rates of disease, malnutrition, or death indicate the need for program changes or shifting of resources to meet changing needs. Increases can also be used to advocate for additional resources. Decreases in rates are measures of a program's success.

PUTTING SERVICES IN PLACE AND MOBILIZING RESOURCES

Effective coordination of humanitarian assistance is crucial for saving lives, helping victims, and encouraging local coping mechanisms. Humanitarian emergency situations are characterized by widespread and urgent needs, competing priorities, destroyed or damaged infrastructure, rapid influx of relief workers and

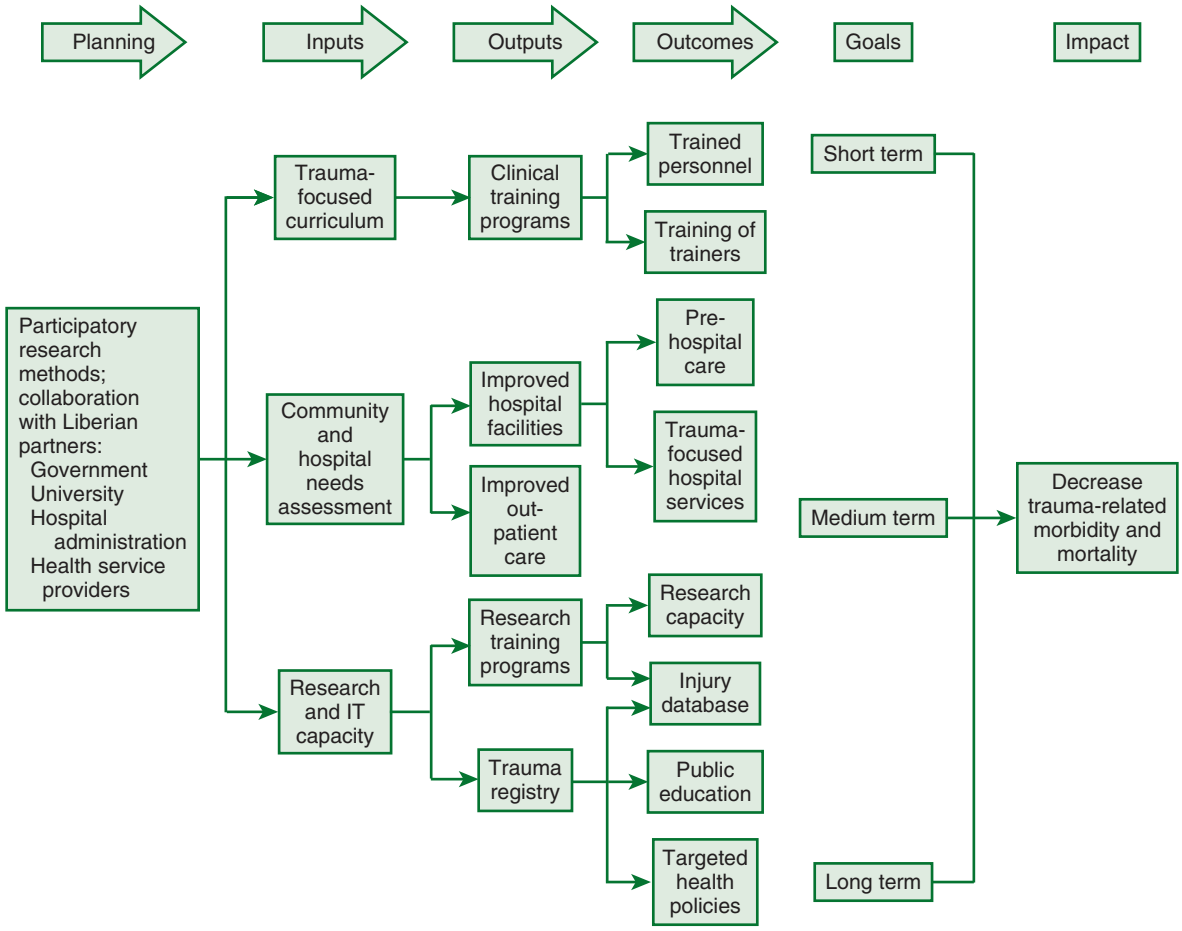


FIGURE 84-22 An example of a logic model for a proposed trauma system in Liberia. *(Courtesy Kirsten Johnson, MD, McGill University.)*

humanitarian aid, and great pressure on national authorities and civic institutions.[3] An emergency situation frequently risks slipping into chaos.

Weak or absent coordination in humanitarian crises could result in gaps in services for affected populations, duplication of efforts, inefficient use of resources, political and other impediments, and slow reactions to changing conditions. By contrast, effective coordination allows entities to harmonize their responses. When coordination works, humanitarian aid efforts become greater than the sum of their parts.

Other than coordination, mechanisms that should be in place to facilitate the humanitarian response include:

- Rapid deployment of qualified personnel
- Stand-by logistic support, including telecommunications equipment, specially equipped field vehicles, medical supplies and drugs, cold chain and personal support kits
- Funding

THE AID WORKER IN THE HUMANITARIAN CRISIS

MOTIVATING FACTORS FOR PERSONAL INVOLVEMENT IN HUMANITARIAN EVENTS AND DISASTERS

It is worth asking why a health care professional who is capable, respected, and experienced would leave his or her home, job, and loved ones to work in a challenging, exhausting, and possibly dangerous destination. And why do it for months to years with little or no salary? Hardened aid workers would joke that they are crazy. Generally, this is only a little bit true.

There are many reasons to depart for the field; for most persons, there is a combination of factors. Though these motivations are usually intense and well-intentioned, there can be contradictory effects. For example, committing to work for the benefit of those in need overseas can develop strong field skills and experience, but can contribute, at least temporarily, to becoming out of date or less well adapted to the medical skills and knowledge required for work at home. Volunteerism is often commended and comes with considerable rewards, but lack of anticipation and preparation can result in financial and career difficulties. Personal discoveries are made and deep personal connections are forged while working in such challenging contexts, but friendships and relationships at home can be affected. Providing medical relief to persons in profound need is the primary motivation for most health care professionals (Figure 84-23). The medical act can be understood to exist in two interconnected parts: The first part is the concrete action, such as a consultation or surgical procedure, and the second part is being with patients, accompanying them physically and emotionally. Both parts are challenged in the field when resources are limited, time is short, and the number of patients and complexity of context become overwhelming. Aid workers practice "bearing witness" in their own ways; in doing this work, they recognize what James Orbinski, the former International President of MSF, wrote in *An Imperfect Offering*, "Humanitarianism is about more than medical efficiency or technical competence. In its first moment, in its sacred present, humanitarianism seeks to relieve the immediacy of suffering and most especially of suffering alone."[25]

Humanitarian principles are touchstones for many who go into the field. These include independence, neutrality, impartiality, humanism, compassion, empathy, and solidarity (Table 84-4). Individuals differ in the emphasis they place on each of these ideals, and their understanding and practice evolves over the course of many deployments. Personal and organizational experiences can and should lead to their being discussed, debated, and questioned regarding how we understand and apply the various principles, adapt them, and even sometimes contradict them.

A sense of responsibility to fellow human beings or commitment to social justice often contributes to an individual's decision to deploy, and may be based on personal philosophy, or moral, religious, or spiritual grounds (Figure 84-24). When medical

FIGURE 84-23 MSF aid worker with a child with severe malnutrition in a rewarming survival blanket in Ethiopia, 2008. *(Courtesy Francesco Zizola, Médecins Sans Frontières.)*

action and associated services alone are unable to meet needs; when patients, health care workers, and facilities are specifically targeted; or when the aid worker or NGO perceives that the conditions of a population would benefit if shared with a larger audience, then these convictions, in relation to humanitarian

TABLE 84-4 Fundamental Humanitarian Principles

Humanity	Humanitarian assistance is provided without discrimination to prevent and alleviate suffering wherever it may be found. Its purpose is to protect life and health, and to ensure respect for the human being.
Impartiality	Humanitarian assistance makes no discrimination as to nationality, race, religious beliefs, class, or political opinions. It endeavors to relieve the suffering of individuals, being guided solely by their needs, and to give priority to the most urgent cases of distress.
Neutrality	In order to continue to enjoy the confidence of all, humanitarian assistance may not take sides in hostilities or engage at any time in controversies of a political, racial, religious, or ideologic nature.
Independence	Humanitarian assistance must always maintain its autonomy by resisting any interference, whether political, ideologic, or economic, capable of diverting it from the course of action laid down by the requirements of humanity, impartiality, and neutrality.
Voluntary	Humanitarian assistance is not prompted in any manner by desire for personal, political, or financial gain.

Excerpted from International Committee of the Red Cross: The Fundamental Principles of the Red Cross and Red Crescent, ICRC publication 1996 ref. 0513: icrc.org/eng/assets/files/other/icrc_002_0513.pdf.

FIGURE 84-24 Aid worker examines a child in the midst of a nutritional crisis in the southeastern region of the Central African Republic, 2009. *(Courtesy Jaume Codina, Médecins Sans Frontières.)*

principles, may justify a more concerted advocacy, and sometimes speaking out publicly on behalf of patients.

Although most contexts allow considerable local, personal, or private advocacy, public speaking out must be carefully considered if carried out. There are many competing interests and ulterior motives in the field, and various actors may perceive the situation differently. The local community and local authorities, government representatives, nonstate actors, and one's own patients and staff can have strong reactions to public speech and action, with potential repercussions for the safety of patients and health care workers, and even (though rarely) for the ability to continue providing assistance at all.

It is important for persons considering aid work to realize that any conditions placed on victims can limit delivery and effectiveness of care. Aid work is compromised if made conditional on political support, military cooperation, or religious affiliation. This can subvert assistance and negate the humanitarian nature of action, leading to increased danger for patients and workers, and diminished ability to help those most in need. The personal motivations of aid workers may vary greatly, but the strategy and practice of assistance should be unconditional and based on need alone.

Despite popular media representations and some public perceptions, aid workers do not aim to be, and fortunately are not, saints, angels, or heroes. Humanitarian aid workers are of course very much human and, as such, are flawed, complicated, and have mixed or ambivalent feelings about what they do and how they do it. During their time in the field, they will undoubtedly experience joy and fulfillment, but also boredom, frustration, and even personal crises.

Certain personal motivations can be limiting or even harmful. Some aid workers view going to the field as a type of medical tourism or adventurism. Undoubtedly, medical skills can enable one to travel widely and have a "cross-cultural experience," but this attitude toward aid work tends to voyeurism, trivializing patients and their situation. Other aid workers seek the "helper's high," the positive feeling that comes from doing something "good." Others have "check-mark syndrome"; for them, working in an emergency situation is just one more box to tick off on their list for doing it all. Both of these attitudes are inherently self-serving, and treat patients as a means to a personal end.

Some persons perform aid work to "find themselves." This can be part of forming an identity, finding a cause in which to believe, or finding a raison d'être into which to channel one's time, skills, and passion. This can resonate constructively for persons who have long trained and worked in a rigid and rigorous medical environment, where they question their contribution. For others, humanitarian work is about "testing oneself" by engaging in self-sacrifice and seeking a challenge. In aid work this is often possible because one must often depend on clinical skills over technology, and workers are required to deliver effective care with limited resources.

For some, aid work serves as a flight from a negative situation. There may be professional frustration with medical practice in a developed country with a burdensome or wasteful health system. Some may be disillusioned with the values and way of life in their home society, and seek something more meaningful personally and professionally. Persons who deploy to leave behind personal problems or conflicts should be aware that "wherever you go, there you are."

Many workers find that when they are in the field with patients, they find a better understanding of the human condition. To do this work is to enter into the possible beauty and brutality of the lives of others. Aid work allows discovery of important differences, and challenges a person's ideas about the world. Workers discover what people have in common and what may transcend distance, language, and culture.

PROFESSIONAL CHARACTERISTICS OF THE AID WORKER

Qualities that support field work include professional preparation, understanding the project context, and teamwork and management skills. These characteristics are enhanced by a clear mission purpose and the desire to provide the best medical assistance.

A key foundation for effectiveness in the field is the highest possible level of clinical skills, which is even more relevant in places with the fewest resources. There is no substitute for superb medical practice, because humanitarian assistance aims to provide the best possible care, not a "better than nothing" approach. Although work in the field is growing more technical and more specialized over time, aid workers should ideally have well-rounded medical skills and be capable of managing patients with a poor premorbid state who are decompensating. Patients often present at or near the point of death, so procedural and resuscitation skills are essential. Relevant capacities derive from the fields of pediatrics, infectious diseases, emergency medicine, obstetrics and gynecology, surgery including trauma care, family and community medicine, wilderness medicine, and mental health (Figure 84-25). Tropical medicine training is recommended. Medical knowledge is not often the major limiting factor in aid work, although it is perhaps what most providers worry about, particularly on their first mission. Colleagues from the area or region can be an invaluable resource, providing the aid worker is respectful and able to listen. There are increasingly available in-field resources, and technical assistance is commonly available from the capital city coordinating team or from headquarters via

FIGURE 84-25 Victim of a land mine at the Chad-Sudan border is prepared for surgery by a multidisciplinary international team in 2004. *(Courtesy Francesco Zizola, Médecins Sans Frontières.)*

FIGURE 84-26 Aid workers meet with village elders to explain the importance of mothers bringing malnourished children to medical attention in Djibouti, 2010. *(Courtesy Claude Mahoudeau, Médecins Sans Frontières.)*

the Internet, email, mobile phone, or satellite phone. Prior professional experience in resource-poor settings is valuable, including in an underserved or isolated location in one's home country.

Communication skills are vital. French, English, Spanish, and, increasingly, Arabic are commonly used languages. Improving language skills before deploying helps aid workers function as part of a team and understand subtleties missed in translation. In many projects, communication with patients requires less common local languages and dialects. There may be multiple languages spoken in the same location, especially among displaced populations. At the very least, it is useful to learn key phrases, such as greetings, expressions of gratitude, and simple medical questions, in the local dialect. This fosters good will and creates the precious moments when one can speak directly to patients. A key skill is knowing how to best work in translation (Figure 84-26). One model, based on the Refugee Medical Clinic at the San Francisco General Hospital, includes these guidelines: forming an alliance with one's interpreter and positioning that person to allow the aid worker to remain face to face with the patient; asking the interpreter to provide the aid worker with culturally relevant information; and making best efforts to keep eye contact with the patient in order to address him or her directly. Ask the interpreter to speak in the first person, translate literally, and use short, simple sentences that minimize addition of jargon and metaphors.[9]

Having a professional approach to field placement begins with keeping one's availability up to date. Prospective aid workers should also allow a reasonable time frame for an assignment and "down time" both before and after the deployment to deal with the unexpected. The human resources officer has the primary responsibility for matching the right person to the right position, but aid workers should ask questions and carefully review background papers and the job description while remaining adaptable to the reality that is met on arrival in the field. There should be congruence between the phase of the project and how the aid worker fits into it. It is important to realize that there is no obligation to accept the mission offered if you perceive that you are not a good fit for the position or cannot accept the conditions and/or overall security situation. Aid workers should clearly communicate with human resources personnel, ask questions and raise concerns where pertinent, and remain flexible.

Clinical, leadership, and management capacities evolve over multiple field assignments, as the aid worker may take on higher levels of responsibility. All of these qualities may be required during a single mission and even on a first mission. It is not uncommon to be in a position of authority, although this is shifting somewhat as national or local staff have risen in responsibility within some organizations.

Appropriate behavior, given the local context, is important in patient care, staff interactions, and relations with the community. For example, modest dress including specific local dictates, or wearing a laboratory coat may be expected and necessary. One should strive always to be respectful and courteous. The qualities of listening before speaking and understanding before acting, although not always possible, are part of establishing good relations. It may take a long time to firmly grasp one's role in a project, and it is often worth being patient as the process unfolds.

Comprehending the local context is crucial. This includes spending time with local authorities and the community. One should become familiar with the medical and social hierarchy and the relationship between traditional leaders and government officials. There are benefits to getting to know diverse members of the community. For example, when the single ancient electric generator at the camp breaks down, it is invaluable to know the person who can fix it. Knowing the traditional midwife who delivered half the children in the town may be a path to understanding causes and solutions to poor maternal outcomes.

A respectful bedside manner is important, despite possible chaos or lack of medical facilities and equipment. Even in capable, well-intentioned hands, preserving patient dignity can be challenging when medical services are overwhelmed (Figure 84-27). Proactively seek the ideas of locally based staff and beneficiaries. They know the population best, have been there before, and will continue to manage care after you leave. Avoid any condescending or patronizing behavior because it can feed thorny political and social issues, including past experiences with colonization, military occupation, and regional tensions.

The ability to work cooperatively with others is crucial. The team will cross nationalities and languages, medical specialties, and nonmedical backgrounds. Individuals should recognize the value of different perspectives and support them. Effective teams invest in team building and collaboration, and conduct regular meetings. Informal meetings can sometimes take the form of having tea, a warm beer, or a meal together at a staff member's home or in a neutral location. This informality helps set aside personal and political differences and deepens interpersonal links. Teaching one's responsibilities to others also helps develop a beneficial redundancy within the project. This is especially useful when workers are away on a break or leave the project. It is always best that no single person become indispensable.

Management skills are required of those in leadership positions, which is commonplace even among inexperienced first-mission aid workers. However, these skills are not often well developed among medical providers. Ideally, projects should have dedicated "project coordinators," who lead the team overall

FIGURE 84-27 Jude Anne Hospital, Port-au-Prince, Haiti. In the absence of affordable maternity care elsewhere, six women safely deliver at the same time at this NGO hospital. Unfortunately, women in labor must sometimes wait on the floor for an empty bed. Those who have just delivered have no choice but to pack and leave minutes after delivering, 2007. *(Courtesy Julie Remy, Médecins Sans Frontières.)*

with more formal management skills. However, all health staffers need to work in a systematic and deliberate way, set priorities, and ensure timely follow-through on tasks. In our home societies, most clinicians rely on support staff, administrators, and managers to plan, organize, and ensure a smoothly functioning medical system. In the field, these responsibilities may likely fall on the shoulders of medical aid workers; not being prepared for this is commonly cited as a deficit among expatriates. Health care professionals should have basic management skills, including being able to anticipate human resources and material needs for the project based on the medical goals. They should be able to develop job descriptions, hire and fire staff, schedule staff, and supervise and evaluate team members. Aid workers need to enforce best practices based on evidence-based medicine when available, while individualizing care and looking for improvements to better outcomes, teaching, and learning from colleagues. They should mediate staff and patient concerns in a fair and transparent manner, acknowledging that optimal working conditions will likely never occur. Aid workers should treat all staff equally and fairly and always avoid playing favorites.

Leadership skills are relevant not only for heads of mission or project coordinators. At all levels, there is a need for self-reliance and initiative. Aid workers need to look ahead, assess risk, and anticipate changes in the context so as to best adapt interventions to what is needed. This follows from observing, drawing from past experience, asking questions and listening, collecting information widely, making time for analysis and reflection, and capturing and putting together the best ideas. In aid work, with its difficult contexts and many challenges, building strategic vision and carrying it out will require all of this and more of you and your team.

TYPICAL DAILY FIELD RESPONSIBILITIES OF HEALTH CARE WORKERS

The heavy workload of medical staff during aid missions is a reality; however, intense periods of work are sometimes punctuated by inactivity or even boredom. The field activities of medical staff are diverse, so being flexible is paramount. A useful attitude is to have one's sleeves rolled up and be ready to do whatever it takes to attend to the needs of the victims of a crisis. For example, if the logistics team is working around the clock to process a massive international shipment of aid goods, it engenders goodwill and teamwork for the medical staff to also help move boxes (Figure 84-28).

The expatriate staff can set the tone for the work environment. Nonetheless, the vast majority of medical and nonmedical work in disasters is done by national staffers who are hired from the affected population. It is critical to create a collaborative working environment where national staffers and beneficiaries of aid are treated with dignity and respect by expatriate staff. It is also important for expatriates to promote a positive work-life balance. This may be impossible during the acute phase of an emergency, such as an earthquake, tsunami, or cholera outbreak, where every moment of action can equate to lives saved. Outside of such situations, however, working at a breakneck speed, taking no breaks, and burning out prematurely are best avoided. Setting realistic goals, realizing that you cannot "save the world," and taking care of yourself are often not accomplished by overzealous but well-intentioned aid workers. Inability to follow a reasonable pace can lead to premature burnout, rapid turnover of staff, disruption of the medical program, and unnecessary stress within the team. If one aid worker cannot rest, it makes it harder for others to rest. The realistic aid worker knows that no one can do it all and derives satisfaction from small daily achievements in a chaotic work environment (Figure 84-29).

Field duties vary depending on the qualifications, job description, and local situation. Among physicians, a key factor determining one's role is the ability to perform surgery. Nonsurgical physicians typically lead the care of pediatric and adult patients with nonsurgical conditions and ambulatory services for specific conditions, such as tuberculosis, HIV, and sexual violence. Nurses serve in various settings, including hospitals, operating theaters, mobile clinics, specialized clinics for conditions such as tuberculosis and HIV, and primary health centers. In some aid organizations, expatriate physicians play a largely clinical role and expatriate nurses play a more managerial role.

FIGURE 84-28 Aid workers unload supplies from a helicopter following the 2010 earthquake in Haiti. *(Courtesy Julie Remy, Médecins Sans Frontières.)*

Expatriate medical staffs have hands-on medical and paramedical duties. A key role is attending to the sickest patients requiring the most acute medical care, using what is available and realistic in the particular disaster setting. Expatriate staff should be present for patients requiring resuscitation or a high level of medical care. However, this category of patients should not necessarily be given undue attention at the expense of usually high numbers of ambulatory patients. In all cases, it is important to work alongside the local staff to make the best

FIGURE 84-29 Patients with cholera receiving intravenous hydration in a makeshift treatment center in Kadoma, Zimbabwe, 2009. *(Courtesy Médecins Sans Frontières Germany.)*

FIGURE 84-30 MSF mobile health team negotiates access with military officers in Colombia, 2007. *(Courtesy Juan Carlos Tomasi, Médecins Sans Frontières.)*

diagnosis possible and provide the highest level of care, while balancing cost, feasibility, sustainability, and other considerations, such as security. For example, urgently transferring a patient with a surgical abdomen to a higher level of care on insecure roads at night may not be possible. Should an untoward event, such as a kidnapping, carjacking, or armed attack on patients, families, or staff occur, an attempted patient transfer may jeopardize the overall humanitarian intervention. An untoward security event can shut down an entire project, depriving hundreds or thousands of patients of needed care. Security often supersedes medical considerations. Therefore security-sensitive final decisions such as patient transfers are often made with nonmedical project coordinators and coordination staff in the capital city (Figure 84-30).

Medical care begins with a decision about the goals of the medical program. In most cases, everything cannot be done, and difficult choices have to be made. Goals can include provision of basic ambulatory medical care at the expense of not aiding the sickest, or offering a secondary or tertiary level of care, leaving primary care to other actors. These decisions are not always easy and may require negotiation with the affected population, MOH, stakeholders, and other NGOs. However, in many "silent" disaster settings in remote locales, there are few other actors, in which case the medical priorities come down to undertaking a needs assessment, making difficult decisions, and doing the best one can with available resources. Compromises are common, but they should be minimized as much as possible.

Patient triage is required during an acute disaster. Medical staff must decide which patients are candidates for immediate medical aid, which can wait, which should be directed to other aid providers, and which should be palliated. The healthy, loud, and influential will often jump to the front of a queue of patients waiting to be seen in an outpatient clinic at the expense of children, older adults, women, and the marginalized. Instituting triage based on sound criteria ensures that the sickest are aided first and those that are turned away are not the most vulnerable. Such tools include the WHO integrated approach to childhood illnesses[37] and pediatric emergency triage and treatment guidelines currently being implemented. A healthy skepticism about seemingly well patients should exist. Foreign aid organizations that distribute free medications become an attractive target for malingering individuals hoping to obtain pills that can be later sold in the market.

Medical care of admitted and ambulatory patients can be conducted by both expatriate and national staff (Figure 84-31). These activities can be conducted by different types of medical providers. The exact delegation of medical duties will depend on the skills and availability of medical providers, as well as local custom and program design. Expatriate doctors often supervise ward rounds. An early morning ward round with discharges makes room for new admissions that will flow from primary health clinics during the day. During ward rounds, there optimally should be some clinical teaching. National staff have often worked independently for a number of years and may have advanced medical and surgical skills and be more knowledgeable on certain topics than are expatriates, so knowledge sharing is important.

All aspects of the medical program require expatriate supervision and involvement in order to ensure quality, appropriateness, and impartiality of the aid provided. Ambulatory outpatient care should not be minimized in priority. The outpatient department often sees hundreds of patients per day, so small changes in protocol or policy can significantly change the quality of care and costs incurred. A priority should be standardization of medical care; a number of guidebooks exist that have been translated into multiple languages and are available for free on the Internet (refbooks.msf.org/). Medical staff hired in the affected country may have had limited formal medical or nursing education, so a priority for expatriate staff should be to ensure a consistent level of knowledge and skill among the national staff, as well as enforcement of the use of standard medical protocols and pharmacopeia that meet international standards.

Evacuating the critically ill or those requiring specialized services creates difficult decisions that should involve the expatriate medical staff. These decisions often require significant input from nonmedical staff who best understand logistic and security situations. Evacuation is often not possible, so aid workers must be prepared to improvise care with available resources (Figure 84-32). Consultation via email, satellite phone, and radio may be available to gain advice from colleagues with more experience.

Provision of medical care to expatriate and national staff themselves is often done by the expatriate "medic" (physician or nurse). Aid workers often become ill, and protecting their health is a priority. Infectious diseases, such as diarrhea, cellulitis, and malaria, are common, as are symptoms related to stress and

FIGURE 84-31 Expatriate medic conducts ward rounds at an MSF medical facility in southwestern Somalia, 2006. *(Courtesy Espen Rasmussen, Médecins Sans Frontières.)*

FIGURE 84-32 A premature newborn is cared for in an improvised incubator made from a styrofoam box in the Central African Republic, 2009. *(Courtesy Raghu Venugopal, Médecins Sans Frontières.)*

overwork. Certain medical duties, such as the care of victims of sexual assault, may emotionally overwhelm aid staff, so preventive counseling for aid workers may be required. Medics need to monitor the work and nonwork environments in order to safeguard team health. Although the set-up and maintenance of housing, eating, and cooking areas often falls to the logistics staff, medics should keep an eye out for problems in these areas because they can seriously affect team health and the ability to retain staff. Use of illicit drugs or excessive alcohol drinking is not uncommon in a stressful environment. These may violate national laws and result in jailing or expelling of aid staff. Persons not coping well who turn to substance abuse may require counseling and support, time off, disciplinary action, or removal from the field.

Daily activities include management of staff employed from the affected country. During design of the medical program, a list of required human resources is developed. Medical workers to be hired include physicians, nurses, nurse's aides, orderlies, pharmacists, and hygiene staff. Job descriptions and contracts need to be formulated with the aid of human resources officers. Often, prospective medical staff need to be quickly screened, interviewed, and hired. Aid workers should be cognizant of the impact their employment practices may have on the local economy and health worker market. Often, local employers and the Ministry of Health cannot "compete" with the salaries offered by international aid organizations. This can result in an exodus from local organizations. However, it may result in improved use of underutilized or undersupported medical providers.

National staff may possess extensive medical knowledge and skills. Others require education about standardized medical practices. Coaching and mentoring of staff into positions of increasing responsibility is typical. A careful balance of delegation of medical tasks to national staff followed by supervision is necessary. Staff require evaluations; in some cases, change of position, warning, or dismissal may be necessary if performance is not adequate. In a community with rebels, warlords, fighting clans, and lawlessness, such employment decisions can be a tricky situation because employees may be related to belligerents of conflict. Any termination of an employee's contract should be done with prudence and consultation with human resources to prevent retaliation.

All staff must strive to ensure that theft of resources be minimized, because this is a common and serious problem in aid work. The work of pharmacists, stock-keepers, and guards must be scrutinized fairly and carefully to guard against the reality of theft, corruption, and misdirection of aid. Local staff may face pressure from gangs and other armed elements to steal.

Nonclinical duties include generation of information systems and data evaluation. Key data points include number of daily consultations and daily rates of morbidity and mortality. Also monitored are syndromes suggestive of emergence of epidemic disease (e.g., cases of watery diarrhea that may suggest a cholera outbreak). Most NGOs have a standard format of recording and list of data points for which they require monthly record keeping. Data packages exist for management of specific conditions, such as HIV (e.g., the Follow-up and Care of HIV Infection and AIDS in MSF). Deaths should be reviewed by the responsible medical officers and means sought to improve quality of medical care where appropriate.

Organizing daily medical care involves scheduling staff, including at night and on weekends. Where there is no preexisting medical facility, aid workers may have to physically set up wards. Other services and structures that require set up and scheduling include the operating theater, pharmacy, laboratory, and medical storeroom. Isolation space needs to be set aside for patients with communicable diseases such as gastroenteritis, cholera, dysentery, TB, or hemorrhagic fever. The logistics staff most likely will set up ancillary services, including a place for patients and their families to toilet, bathe, dispose of waste, cook food, obtain clean water, and wash clothes.

Advocacy on behalf of the affected population facing the crisis is a key role of aid workers. Medics are in close daily contact with patients and families. This places them in a unique position to learn about their struggles and needs. Aid workers should take time to speak to beneficiaries about nonmedical issues and understand their realities. Advocacy can take the form of requesting more services from one's own organization, the host government, or other aid agencies. It can include speaking out in one's home society about the crisis in order to bring attention to the situation. Speaking out can take the form of a press release, news conference, presentation to peers or government officials, or written communication in the medical or lay press. Some aid workers maintain a blog during their overseas service (msf.ca/en/staff-and-patients-blogs). Blogs can generate awareness, but should be conducted with attention to security considerations and in consultation with coordination staff within one's organization.

Aid workers should continuously reanalyze the relevance of their presence and intervention. It should be asked whether the resources spent in one's project could be better spent elsewhere. This is often not easy or comfortable, and it raises concerns among the beneficiaries of aid and national staff, who often do not want to see resources diverted elsewhere. However, just as every project opens, it also must eventually close. Aid workers should thus keep in mind possible exit strategies and opportunities to transition to appropriate partners. Finally, aid workers should always strive to find the neediest population. This may require conducting outreach and assessments of neighboring communities and maintaining good communication links with local actors, other aid agencies, the government, and the host population.

HOW TO BECOME INVOLVED AND STAY INVOLVED

Once the health care worker is interested in aid work, there are several steps that can lead to becoming involved and remaining committed to a unique and demanding endeavor. Becoming involved should first include analyzing one's own motivations for being an aid worker. Ideally, motivations should be altruistic and driven solely by a desire to aid the victims of a crisis. Financial, personal, professional, community, and academic rewards can be part of and follow aid work, but these should be secondary motivating factors. Aid work attracts all kinds of people—a common caricature is of "misfits, mercenaries, and missionaries." Try not to be one of these.

Networking with colleagues and experienced aid workers is useful. These contacts often have pearls of wisdom that can apply to an intended clinical practice setting, including how to plan time away from one's usual employment and information on aid organizations seeking particular medical skills.

Internet-based research on aid organizations is essential. Inevitably, there will be advantages and drawbacks to each aid organization. No aid organization is perfect, and few can do everything for everyone. It is key to contact human resources

BOX 84-2 Select Humanitarian Organizations Involved in Health Care Delivery

Action Contre la Faim (Action Against Hunger)
ACF, a global humanitarian organization committed to ending world hunger, works to save the lives of malnourished children while providing communities with access to safe water and sustainable solutions to hunger: actionagainsthunger.org

Alliance for International Medical Action
ALIMA operates a new model for responding to humanitarian crises. It brings together the medical expertise of international humanitarian aid workers with that of national medical organizations and global research institutions to provide quality medical care to people in need: alima_ong.org/en/

International Committee of the Red Cross
The ICRC is an impartial, neutral, and independent organization with an exclusively humanitarian mission to protect the lives and dignity of victims of armed conflict and other situations of violence and to provide them with assistance: icrc.org/en

International Federation of the Red Cross and Red Crescent Societies
The world's largest humanitarian organization, the IFRC carries out relief operations to assist victims of disasters, and combines this with development work to strengthen the capacities of its member National Societies: ifrc.org/en

International Medical Corps
The IMC works to relieve the suffering of those affected by war, natural disaster, and disease by delivering vital health care services that focus on training and helping devastated populations return to self-reliance: internationalmedicalcorps.org

International Rescue Committee
The IRC helps people whose lives and livelihoods are shattered by conflict and disaster, through provision of health care, infrastructure, learning, and economic support: rescue.org

Médecins Sans Frontières (Doctors Without Borders)
MSF is an international, independent, medical humanitarian organization that delivers emergency aid to people affected by armed conflict, epidemics, natural disasters, and exclusion from health care: msf.org

Partners in Health
PIH strives to achieve two overarching goals: to bring the benefits of modern medical science to those most in need of them and to serve as an antidote to despair: pih.org

Save the Children
Save the Children ensures that children affected by floods, famines, earthquakes, and armed conflict get life-saving medical aid, shelter, food, and water: savethechildren.org

World Vision International
WVI is a global Christian relief, development, and advocacy organization dedicated to working with children, families, and communities to overcome poverty and injustice, through transformational development, emergency relief, justice promotion, partnerships, and public awareness: wvi.org

officers in different organizations to learn more about the nature of the group's objectives and operations, as well as how one might fit with that group. A list of international humanitarian organizations is found in Box 84-2. Some organizations offer seminars, webinars, and informal presentations about their work. A useful opportunity is to attend a presentation from a returned field worker. Experienced field workers can relate "the good, the bad, and the ugly" of the organization one aims to join, with specific examples from their missions.

Some aid organizations have local fundraisers and events to raise the level of public awareness about aid work. These events will often be staffed by ex–field volunteers and office staff and are forums to learn more about the aid organization.

Getting involved should include assessment of one's medical skills. It may be important to gain additional skills before deployment. Relevant skills include trauma and wound care, pediatrics, obstetrics and gynecology, tropical medicine, HIV/AIDS and tuberculosis care, mental health, public health, dermatology, and dentistry. Additional assets include basic skills in biostatistics, epidemiology, and use of common spreadsheet and database programs. Enrolling in language courses and gaining language proficiency increases the likelihood of being deployed.

Exposure to austere, impoverished environments is an important preparatory consideration. Aid work is often in rural environments with limited or no access to telecommunications, modern comforts, and the company of friends and family. Spending time in such an environment can be helpful in determining whether one will be comfortable and thrive in a similar setting.

Redeploying can be challenging and is ideally driven by an ongoing humanitarian concern to serve those in need. Persons who redeploy are often those who had a satisfying initial experience and were able to meet the personal and professional challenges they encountered. In other cases, priorities such as being close to one's family, having children, financial considerations, maintaining relationships with loved ones, and occupational decisions take precedence over another deployment. Some find repetitive aid missions financially difficult or even impossible, because many charitable organizations do not provide compensation or only a limited stipend.

Continuing involvement in aid work should include reassessment of one's knowledge base, skills, and attitudes. A mission often highlights potential areas for personal and professional development. For example, strategies to cope with boredom and stress can be fine-tuned during a return home. An aid worker may wish to gain more surgical skills, or expertise in relevant fields such as vaccination and nutrition. A number of aid organizations offer courses to returned staff. Some of these courses are linked to a return of service in the future. An aid worker may wish to pursue additional training through university-based courses in areas such as tropical medicine, pediatrics, or other topics.

HOW TO PREPARE FOR A MISSION

Preparing for a humanitarian mission can be daunting. One is expected to perform in an austere, high-stress environment with limited resources. Each humanitarian worker's abilities and limits are different based on his or her training, personality, and experiences. Before signing up, it is crucial that each individual determine whether he or she will be able to function adequately in the setting of a crisis. It is best for all involved if any hesitations are dealt with *before* the mission begins.

Preparing to Deliver Medical Care in a Crisis

A medical provider in a humanitarian crisis will likely be responsible for the care of hundreds, or even thousands, of patients. Whether responding to the needs of a population affected by armed conflict or to a disaster in the days and weeks following an earthquake, one will encounter patients with acute traumatic injuries. Poor roads and lack of public safety further generate trauma. Sooner or later, an even larger burden of medical disease will surface, including infectious diseases, common pediatric illnesses, chronic disease that has worsened in the context of the emergency, and obstetric and gynecologic diseases. Ideally, the aid worker's skill set is suited to dealing with such a broad range of medical problems.

It is crucial to remember, however, that public health needs are often greatest immediately following a humanitarian crisis. Diseases not often encountered in one's normal practice can cause large epidemics that lead to a high level of death and disability (Figure 84-33). Before deployment, try to learn about prevention, diagnosis, and treatment of diseases that may cause epidemics during acute crises (Box 84-3). In addition to these diseases, common illnesses include HIV/AIDS, tuberculosis, and malaria. Clinical guidelines can be very useful. The deploying NGO will often provide clinical guidelines tailored to its own formulary and the setting. If this is not available, the MSF *Clinical Guidelines* are useful (refbooks.msf.org/). In addition, some smaller textbooks with information on tropical diseases are available (Box 84-4).

FIGURE 84-33 Logistics staff members prepare cool boxes filled with vaccines to respond to a meningitis outbreak in Dosso, Niger, 2009. *(Courtesy Olivier Asselin, Médecins Sans Frontières.)*

Medical professionals may be asked to implement basic public health interventions, such as vaccination campaigns. They may also give input on construction of latrines and water distribution points. These activities require significant support from logistics experts. International guidelines for these basic needs are outlined in the Sphere standards.[30]

BOX 84-3 Causes of Epidemic Disease in Acute Crises

Measles
Typhus
Cholera and other bacterial and nonbacterial infectious diarrheal diseases
Meningococcal meningitis
Relapsing fever
Typhoid fever
Respiratory illnesses, viral and bacterial
Influenza
Hepatitis A and E
Leishmaniasis
Malaria
Scabies
Hemorrhagic fevers (Ebola fever, yellow fever, dengue fever)
Plague
Japanese encephalitis
Whooping cough
Tetanus
Poliomyelitis
Conjunctivitis
Guinea worm

From Médecins Sans Frontières: *Refugee health: an approach to emergency situations*, Oxford, England, 1997, Macmillan Education, pp 145-152.

BOX 84-4 Suggested Readings in Tropical Medicine and Public Health in Crises

Brent A, Davidson R, Seale A: *Oxford Handbook of Tropical Medicine,* Oxford, England, 2014, Oxford University Press.
Beeching NJ, Gill GV: *Lecture Notes on Tropical Medicine,* Oxford, England, 2014, Blackwell Publishing Ltd.
Médecins Sans Frontières Reference Books (various): refbooks.msf.org.
Perrin P: *H.E.L.P. Public Health Course in the Management of Humanitarian Aid,* Geneva, Switzerland, 2001, International Committee of the Red Cross.
Connolly MA, editor: *Communicable Disease Control in Emergencies: A Field Manual,* Geneva, Switzerland, 2005, World Health Organization: who.int/iris/bitstream/10665/96340/1/9241546166_eng.pdf.
WHO Technical Report Series 985: *The Selection and Use of Essential Medicines: Report of the WHO Expert Committee, 2013,* Geneva, Switzerland, 2014, World Health Organization: who.int/iris/bitstream/10665/112729/1/WHO_TRS_985_eng.pdfs/.

FIGURE 84-34 National and expatriate aid workers perform surgery following the 2010 Haitian earthquake. *(Courtesy Richard Accidat, Médecins Sans Frontières.)*

Because there is often a lack of ancillary and support staff, it can be helpful to know how to perform basic nursing and laboratory duties, such as starting intravenous lines, mixing an oral rehydration solution, examining blood smears for malaria, or using a hematocrit machine. It is critical to be flexible, eager to learn, and willing to assist any and all members of the team when necessary.

Working Outside One's Skill Set

In crisis settings, aid workers are sometimes asked to provide care for which they are not fully trained. For example, one may be asked to perform a dental or surgical procedure for the first time. In these situations, it is necessary to use good judgment, follow standard medical ethics, and "first, do no harm." Whenever possible, the most experienced and highly trained practitioner should provide the relevant care at all times. If possible, arrange for the patient to be transferred to a trained provider. It is not ethical for an inexperienced practitioner to perform a surgical procedure when a general surgeon is available within a reasonable distance (Figure 84-34). The crisis setting is not an excuse for an inexperienced or untrained provider to learn or perform procedures for "practice." Bad outcomes that could have been prevented or dealt with in other ways do not escape observation in the field. Local hostility, lawsuits, and expulsion of the aid worker by the NGO—or expulsion of the NGO itself from the country—are all possible consequences of reckless medical misadventures and unnecessary risk taking. For example, allowing a logistician to do a lumbar puncture is not acceptable. When faced with a surgical emergency such as a perforated viscus, it is better for someone who is not a surgeon to begin administering antibiotics and fluids, place a nasogastric tube, and arrange urgent transfer to an operating theater. Performing a laparotomy for the first time in the field when there are other options is simply not acceptable.

However, on occasion one must attempt to provide aggressive and invasive care in order to save a life or limb. For example, this might be massive debridement for necrotizing fasciitis or amputation for a severely traumatized or infected limb with bony involvement and necrosis. In these rare cases, several texts are available that may help guide these procedures (Box 84-5). As would be appropriate in any setting, be sure to have a conversation with the patient and, if present, the patient's family, clearly explaining your abilities and limitations, as well as the reasons you will be performing this procedure, although it is out of the scope of your normal practice.

Dealing With Death

In crisis settings, patients can be extremely ill, and treatment options are often limited. Unfortunately, not everyone can be

BOX 84-5 Guides to Performing Emergency Surgery and Procedures in Crisis Settings

David Werner, Carol Thurman, and Jane Maxwell: *Where There Is No Doctor: A Village Health Care Handbook,* 2013, Hesperian Foundation: hesperian.org.
Murray Dickson: *Where There Is No Dentist,* 2012, Hesperian Foundation: hesperian.org.
Maurice King: *Primary Surgery, Volumes I, II, III,* Oxford Medical Publication: primary-surgery.org/start.html.
Surgical Care at the District Hospital: The WHO Manual: who.int/surgery/publications/imeesc/en/index.html.
Giannou C, Baldan M, *War Surgery,* May 2010, ICRC: icrc.org/eng/assets/files/other/icrc-002-0973.pdf.
Michael B. Dobson: *Anesthesia at the District Hospital,* World Health Organization: who.int/iris/handle/10665/42193.pdf.

saved. Despite heroic efforts, many patients die. Be prepared for this before you arrive, and take the time to debrief and check in with members of your team when there is time.

Behavior and Expectations

Having appropriate expectations before deployment can help reduce stress and improve one's ability to function. It is important to be able to live, work, and thrive in austere conditions. Food may run out, bathing may consist of no more than dousing from a bucket of cold water, and the toilet may be a hole in the ground. Resources for clinical and personal needs are often extremely limited in a crisis setting. Expect very little to be available and for systems and roles to break down.

Health professionals need to be watchful for signs that they are beginning to present with stress; then, techniques that have helped them manage stress in the past must be implemented. Before deployment, identify the healthy ways in which you can deal with stress. Exercise, walking, meditation, reading, and keeping a journal are examples. Remember that often it is unsafe to exercise outside, so consider indoor exercises, such as yoga, tai chi, stretching, or skipping. Humanitarian staff must prepare for isolation. It is often extremely difficult to communicate with family or friends. Bring along good books, a deck of cards, movies, and seasons of your favorite TV series to watch on your laptop. With the isolation comes cramped living and working conditions. Find ways to be with yourself when you need solitude. Close the door, put on headphones, use earplugs, or go for a long walk (if it is safe). It is best to avoid smoking, excessive drinking, and unsafe sex, and it is usually forbidden to use illicit drugs or engage with sex trade workers. Many organizations require humanitarian staff to sign a code of conduct before deployment.[17]

Emotions, such as frustration and anger, are normal responses to poorly functioning systems, poor resources, and an extreme level of human suffering; however, this anger is counterproductive. Try to function as professionally as possible, particularly with national staff and those from other regions, who may be accustomed to a different work ethic and pace when delivering medical care.

Adequate sleep, nutrition, hygiene, and hydration go a long way in reducing stress and improving the ability to function in a difficult setting. Whenever possible, attend to your own needs while caring for others. Most humanitarian organizations have publications on managing stress in crises.[2,16] Keep these references stowed away in your computer or bag, because you will likely find them useful.

PRACTICAL CONSIDERATIONS

Getting Oriented

Before deployment, it is important to understand the local situation, conflict, and culture as completely as possible. Humanitarian staff should contact others who have served in the region in similar roles. Seek out reports from missions carried out in the region by relevant international organizations. Several online resources, such as the British Broadcasting Company country profiles (news.bbc.co.uk/2/hi/country_profiles/default.stm) and the CDC's travelers' health website (nc.cdc.gov/travel/), can provide political, cultural, and health information. Travel guidebooks often provide concise, readable summaries of a country's history and cultural norms, and relevant chapters can often be downloaded inexpensively online.

Deploying organizations will often provide a formal orientation and security briefing. Following the agency and team security protocols is a nonnegotiable absolute must. Not following security protocols is the surest way to be disciplined, fired, or sent home. By endangering one's own safety by not following guidelines, one jeopardizes the team, patients, and mission itself. The UN Office for Project Services provides a useful online training in UN security protocols, which are often in effect in crisis settings (training.dss.un.org/courses/login/index.php). Staff should understand security and evacuation protocols before deployment. For example, UN evacuation flights allow only one bag weighing 12 kg or less if a person is evacuated emergently.

Several books document the experiences of medical and nonmedical staff in humanitarian crises; these books help give a sense of what to expect in this unique setting (Box 84-6).

How to Pack

Pack light, but be sure to take essential items that will not be available in the destination country. The packing list in Appendix A serves as a guide. Consult with staff on the ground to complement this list. Key items include personal medications (e.g., malaria prophylaxis, daily medications, pain relievers, and sleeping pills), personal documents with additional photocopies, proof of evacuation and medical insurance, and proof of vaccination. Many countries will not allow entry without proof of updated yellow fever vaccination. Consult a travel clinic and the CDC website for necessary vaccinations several weeks before deployment. During the intervals between deployments, keep immunizations up to date.

Additional Training

Several courses offered internationally can help physicians and other health care workers to work in a humanitarian emergency (Tables 84-5 and 84-6). Consult the deploying NGO for additional recommended courses. Several universities offer courses in global public health, humanitarian aid, and tropical diseases. A master of public health degree can often be helpful in these settings. Short courses in tropical diseases are available at the Gorgas Memorial Institute of Tropical Medicine in Peru (gorgas.dom.uab.edu/), the Burnet Institute in Australia (burnet.edu.au/home), and the London School of Hygiene and Tropical Medicine (lshtm.ac.uk/). Emergency physicians may pursue a fellowship in International Emergency Medicine (see iemfellowships.com). Courses in relevant languages can also be helpful and are widely available.

Practical Tips on How to Have a Good Mission

It is important to realize that no matter what the length or intensity of the predeparture briefing, one will only really know about the conditions when on the ground at the scene. If it is a first mission, it is better to do more rather than less preparation.

Personal Matters. Embarking on a field mission is the start of a very intense journey (Figure 84-35). The personal impact is

BOX 84-6 Select Experiences of Aid Workers

James Maskalyk: *A Young Doctor in a War-Torn Village,* New York, 2009, Spiegel and Grau.
Dan Bortolotti: *Hope in Hell: Inside the World of Doctors Without Borders,* Buffalo, New York, 2004, Firefly Ltd.
Sheri Fink: *War Hospital: A True Story of Surgery and Survival,* Cambridge, Massachusetts, 2003, Perseus Books Group.
James Orbinski: *An Imperfect Offering: Humanitarian Action in the Twenty-First Century,* Toronto, Ontario, Canada, 2008, Random House.

TABLE 84-5 Select North American Master's Degree and Certificate Programs in Humanitarian Assistance

School	Location	Degrees Offered	Website
American Public	Charles Town, WV	Master of Arts (MA) in Emergency and Disaster Management	apu.apus.edu/academic/programs/degree/1200/master-of-arts-in-emergency-and-disaster-management-capstone-option
Andrews	Berrien Springs, MI	Master of Science in Administration (MSA) in Community and International Development with an emphasis in Disaster Preparedness Master of Social Work (MSW) with a Certificate in Emergency Preparedness	andrews.edu/grad/programs/
Benedictine	Lisle, IL	Certificate in Emergency Preparedness	online.ben.edu/online-graduate-certificates/emergency-preparedness
Boston	Boston, MA	Master of Public Health (MPH) with an emphasis in Managing Disasters and Complex Humanitarian Emergencies Certificate in Managing Disasters and Complex Humanitarian Emergencies	bu.edu/sph/students/resources/guides/2014-2015-concentrators-guides/global-health-concentrators-guide-2014-15/mph-degree-requirements/concentration-courses/emphasis-areas/managing-disasters-and-complex-humanitarian-emergencies/
California State	Vallejo, CA	Master of Science (MSc) in Transportation and Engineering Management with a concentration in Humanitarian Disaster Management	csum.edu/web/industry/graduate-studies/mste
Columbia	New York, NY	Certificate in Public Health and Humanitarian Assistance	mailman.columbia.edu/academics/degree-offerings/mph/full-time-mph/certificates/public-health-and-humanitarian-assistance
Fordham	New York, NY	MA in International Humanitarian Action International Diploma in Humanitarian Assistance International Diploma in Operational Humanitarian Assistance International Diploma in the Management of Humanitarian Action International Diploma in Humanitarian Leadership	legacy.fordham.edu/academics/programs_at_fordham_/international_humani/graduate_program/
George Brown College	Toronto, ON, Canada	Certificate in Emergency Management	coned.georgebrown.ca/owa_prod/cewskcrss.P_ProgArea?area_code=PA0046
Georgetown	Washington, DC	Certificate in Refugees and Humanitarian Emergencies	isim.georgetown.edu/academics/refugees
George Washington	Washington, DC	MA in International Development Studies with a specialization in Humanitarian Assistance	elliott.gwu.edu/international-development-studies/humanitarian-assistance
Georgia State	Atlanta, GA	Graduate Certificate in Disaster Management	pmap.gsu.edu/programs/graduate/certificates/graduate-certificate-in-disaster-management/
Harvard	Cambridge, MA	MPH with a concentration in Humanitarian Studies, Ethics, and Human Rights Humanitarian Studies: Theory and Practice Program	humanitarianacademy.harvard.edu/about-you/students/hsph-graduate-concentration-certificate-program hhi.harvard.edu/graduate
Johns Hopkins	Washington, DC	MPH with a concentration in Humanitarian Assistance and Health and Human Rights Certificate in Humanitarian Assistance Certificate in Health Emergencies in Large Populations	jhsph.edu/research/centers-and-institutes/center-for-refugee-and-disaster-response/education_training/degrees/
Justice Institute of British Columbia	New Westminster, BC, Canada	Emergency Management Certificate	jibc.ca/programs-courses/schools-departments/school-public-safety/emergency-management-division/academic-programs/emergency-management-certificate
Massachusetts Institute of Technology	Cambridge, MA	Master of Engineering (MEng) in Logistics	scm.mit.edu/program
Royal Roads	Victoria, BC, Canada	MA in Conflict Analysis and Management MA in Disaster and Emergency Management MA in Human Security and Peace-building	royalroads.ca/prospective-students/programs/humanitarian-studies
Ryerson	Toronto, ON, Canada	Certificate in Disaster and Emergency Management	ce-online.ryerson.ca/ce/calendar/default.aspx?section=program&sub=cert&cert=DISMAN00&mode=program

TABLE 84-5 Select North American Master's Degree and Certificate Programs in Humanitarian Assistance—cont'd

School	Location	Degrees Offered	Website
Tufts	Medford, MA	MA in Humanitarian Assistance MSc in Food Policy and Applied Nutrition in the Humanitarian Assistance specialization at the Friedman School of Nutrition Science and Policy	fic.tufts.edu/education/maha/ nutrition.tufts.edu/academics/fpan
Tulane	New Orleans, LA	MPH in Disaster Management Certificate in Disaster Management and Resilience	tulane.edu/publichealth/ehs/mph.cfm tulane.edu/publichealth/academics/disaster-management-and-resilience-certificate.cfm
Uniformed Services University of the Health Sciences	Bethesda, MD	Disaster Preparedness Program	cdham.org/disaster-preparedness-program-dpp
University of British Columbia	Vancouver, BC, Canada	Master of Arts in Planning (MAP) or Master of Science in Planning (MScP) with focus area on Disaster and Risk Management Planning	scarp.ubc.ca/focus-area-disaster-and-risk-management-planning
University of Connecticut	Storrs, CT	Online Master of Professional Studies in Humanitarian Services Administration	hrm.business.uconn.edu
University of Denver	Denver, CO	MA in International Studies with a graduate certificate in Humanitarian Assistance	du.edu/korbel/humanitarian-assistance/index.html
University of Hawaii	Honolulu, HI	Certificate in Disaster Management and Humanitarian Assistance	durp.hawaii.edu/Disaster%20Management.html
University of Massachusetts Boston	Boston, MA	Online certificate program in Global Post-Disaster Reconstruction and Management Online Graduate Certificate in Global Post-Disaster Studies	umb.edu/academics/caps/corporate/disaster-reconstruction umb.edu/academics/caps/certificates/global-post-disaster
University of South Florida	Tampa, FL	MPH in Disaster Management and Humanitarian Relief Graduate Certificate in Disaster Management Graduate Certificate in Humanitarian Assistance	health.usf.edu/publichealth/onlineprograms/omph_gdmhr.htm usf.edu/innovative-education/programs/graduate-certificates/fully-online.aspx
University of Wisconsin	Madison, WI	Disaster Management Diploma	dmc.engr.wisc.edu/Diploma/index.lasso
York	Toronto, ON, Canada	Master of Disaster and Emergency Management	dem.gradstudies.yorku.ca

From Walker P, Russ C: Professionalising the humanitarian sector: a scoping study, Enhancing Learning and Research for Humanitarian Assistance (ELRHA), April 2010: elrha.org/uploads/Professionalising_the_humanitarian_sector.pdf.

immense, particularly if the destination is a war zone or other type of humanitarian crisis. Experiencing grinding poverty in an isolated region facing chronic neglect can be difficult as well. With that in mind, when deploying, it is important that any matters at home, including family and interpersonal relationships, are resolved so that they do not generate added stress while in the field. Organizing home-related affairs before departing will better allow the aid worker to use what little personal time exists in the field in a relaxing way that will feed positively into meeting the demands of the assignment. Ensure that all financial obligations (e.g., bills) are paid or otherwise resolved before departure. These matters should be settled in a way that does not require your input while on assignment.

FIGURE 84-35 Aid workers provide mental health services following the 2010 earthquake in Haiti. *(Courtesy Richard Accidat, Médecins Sans Frontières.)*

It is wise to consider taking a vacation before deployment. This can minimize the pressures that go along with preparing for the field mission, while building energy for what lies ahead. Being well rested for the nonstop orientation and work will go a long way toward creating the possibility for a positive experience.

Before leaving, speak with others currently working in the field or with those who have worked there previously. If the organization does not mention this possibility, be sure to ask about it, because it is possible. This is an important way to find out about the living and working conditions, the people you will meet, and the work itself.

It is essential to have a positive attitude, because stress, ill will, and cynicism are common in emergencies. Try to maintain a genuine sense of optimism and healthy sense of humor. A positive attitude rubs off on teammates. Persons who are negative can drag down a team.

Be respectful of others. No matter where someone is from and no matter how you feel about their beliefs, religion, ethnicity, or nationality, do your best to keep an open mind and be supportive.

Remember that you are a guest in a foreign land. A courteous and considerate approach to local traditions, customs, and laws is central not only to showing respect but to creating the basis for open and meaningful relationships. Meeting others from different cultures is truly a privilege. Although people in distant

lands may not have the same luxuries, technical gadgets, or formal education, they usually possess more in other areas of life and on other levels. The key to success is being open to this and discovering the beauty and wisdom of different cultures. Although aid workers may see the worst in humankind while working in a crisis, they will also see and experience the best (Figure 84-36). Appreciating the best is an important key to navigating through what will be a very difficult and challenging, but extremely rewarding mission.

Perhaps the most difficult challenge will be working and living as a team. Aid workers do not have the luxury of choosing their team, and organizations do not have the luxury of matching personalities. Team tensions are inevitable and the greater your emotional maturity, the better off you and your team will be.

In a war zone, external checks and balances around what is morally correct are minimal. Due process is replaced by atrocities and human rights violations. Aid workers must rely on their own internal moral compasses in these environments. Awareness of this can assist in reinforcing good decisions around one's behavior and interactions with others. Linked to this, it is important to appreciate the power balance that exists between expatriates and others. Individuals who work for aid organizations represent wealth from the perspective of most beneficiaries and community members. Although aid workers may feel that they are "roughing

TABLE 84-6 Humanitarian Training Centers, Organizations, and Resources

Sector	Name of Organization	Comments	Location	Website
Professional associations	Professionals in Humanitarian Assistance and Protection	Professional association of humanitarian workers with focus on policy and international humanitarian law	Geneva	phap.org/
	Global Humanitarian Health Association	Professional association of humanitarian health workers	Canada	Coming soon; in the meantime, go to humanitarianstudies initiative.org or humanitarianu.com
	Humanitarian Logistics Association	Professional association of logisticians	UK	humanitarianlogistics.org/
	The International Society of Physical and Rehabilitation Medicine	Global agency for physical and rehabilitation medicine	Switzerland	isprm.org
	World Association for Disaster and Emergency Medicine	Professional association for the global improvement of prehospital and emergency health care, public health, and disaster health and preparedness	USA	wadem.org
	World Public Health Nutrition Association	Professional association for public health nutritionists		wphna.org
General information on humanitarian aid and relief and training	AlertNet	News and training information		alertnet.org/theevents/training/
	ReliefWeb	News and training information		reliefweb.int
	IRIN	Regional news		irinnews.org
	People in Aid	Resources, information, and links	UK	peopleinaid.org
	Humanitarian Practice Network (HPN)	Research and articles pertaining to the humanitarian sector	UK	odihpn.org
	OSCAR (UK information service for World Mission)	Resources, training, and links	UK	oscar.org.uk
	UN Office for the Coordination of Humanitarian Affairs(OCHA)	News and resources		unocha.org/
	Inter-Agency Standing Committee (IASC)	Standards, policy papers, news, and resources		humanitarianinfo.org/iasc/
Security and safety	RedR	Security short courses	London, UK	redr.org
	Bioforce	Security courses (French)	Vénissieux, France	bioforce.asso.fr
	Centre for Safety	Mine awareness	Nieuwegein, The Netherlands	centreforsafety.org
	Centurion Risk Assessment Services	Hostile environment and first aid (NGO and diplomats)	Hants, UK	centurionsafety.net
	OnCourse	Security, driving courses	Uganda, Kenya	oncourse4wd.com
	Essential Field Training	Security courses (French)	Switzerland	essential-field-training.org
	Merlin	Security short courses	UK	merlin.org.uk

TABLE 84-6 Humanitarian Training Centers, Organizations, and Resources—cont'd

Sector	Name of Organization	Comments	Location	Website
Medical	International Health Exchange (IHE) (often in partnership with RedR)	Link for short courses	London, UK	ihe.org.uk
	Centre for International Child Health	MSc and short courses	Melbourne, Australia	rch.org.au/cich
	Liverpool School of Tropical Medicine	Postgraduate, short courses, MSc	Liverpool, UK	lstmed.ac.uk
	Leeds Beckett University	MSc Public Health, Health Promotion	Leeds, UK	leedsbeckett.ac.uk
	Christian Medical Fellowship	Short courses, preparation for field work	London, UK	cmf.org.uk
	London School of Hygiene and Tropical Medicine	Short courses, MSc	London, UK	lshtm.ac.uk
	Institute of Tropical Medicine	Short courses, MSc	Antwerp, Belgium	itg.be
	Queen Margaret University College	Postgraduate, short courses, MSc	Edinburgh, UK	qmu.ac.uk
	Swiss Tropical and Public Health Institute	Postgraduate, short courses, MSc	Basel, Switzerland	sti.ch
	Deutsches Institut für Ärztliche Mission	Short courses, preparation for field work, German only	Tübingen, Germany	difaem.de
	Uppsala University	Short courses	Uppsala, Sweden	kbh.uu.se/imch
	Universitätsklinikum und Medizinische Fakultät Heidelberg	Short courses	Heidelberg, Germany	hyg.uni-heidelberg.de/ithoeg/teaching/short/short.htm
	InterHealth	Services	London, UK	interhealth.org.uk
	International Rescue Committee (IRC)	Short courses	New York	theirc.org/phce
	International Committee of the Red Cross (ICRC), HELP Courses	Short courses	Geneva, Switzerland	icrc.org
	Teaching-aids at Low Cost (TALC)	Teaching resources	Harpenden, Hertfordshire, UK	talcuk.org/
	Merlin	Same courses as IHE	London, UK and Washington, DC	merlin.org.uk
Nutrition	Action Against Hunger		Multinational	acf-international.org
	The Emergency Nutrition Network		Dublin, Ireland	ennonline.net
Water and sanitation	RedR Training Department	Short courses, onsite courses, resources	London, UK	redr.org
	Loughborough University	MSc	Loughborough, UK	lboro.ac.uk
	International Water and Sanitation Center (IRC)	Short courses and resources	The Netherlands	irc.nl
	NETWAS	Short courses, onsite courses	Nairobi, Kenya	netwas.org
	SKAT	Resources		skat.ch
	Department of Water and Sanitation in Developing Countries (SANDEC)	Short courses (English and German)	Switzerland	sandec.ch
	UN World Bank, WatSan Programme	Resources, short courses	Nairobi, Kenya	wsp.org
	Kenya Water for Health Organisation	Resources, short courses	Nairobi, Kenya	kwaho.org
	Water Supply and Sanitation Collaborative Council	Resources		wsscc.org
	Cranfield University		Cranfield and Shrivenham, UK	cranfield.ac.uk
Logistics	RedR Training Department	Short courses, onsite courses, resources	London, UK	redr.org
	Merlin	Short courses, onsite courses, resources		merlin.org.uk
	Bioforce	Short courses, logistics studies (French)	Vénissieux, France	bioforce.asso.fr

Continued

TABLE 84-6 Humanitarian Training Centers, Organizations, and Resources—cont'd

Sector	Name of Organization	Comments	Location	Website
Management and leadership	Centre for Health Planning and Management			keele.ac.uk
Humanitarian aid, relief, and development	University of Wolverhampton, Centre for Rural Development and Training (CRDT)	Program management and development	UK	wlv.ac.uk/crdt
	Sphere Project	Standards, resources, trainings	Geneva, Switzerland	sphereproject.org/
	Humanitarian U	Online certificate-based professional courses	Canada	humanitarianu.com
	Canadian Consortium for Humanitarian Training (CCHT)	2-week intensive competency-based entry-level certification course annually in May	Canada	humanitarianstudies initiative.org
	Leadership Academy	Training courses and resources	London, UK	humanitarianleader shipacademy.org
	Disasterready.org	Online training courses	USA	Disasterready.org
	Enhancing Learning and Research for Humanitarian Assistance (ELRHA)	Training courses and resources	UK	elrha.org
	Brunel University		Uxbridge, Middlesex, UK	brunel.ac.uk
	Centre for Development and Emergency Practice (CENDEP), Oxford Brookes University		Oxford, UK	brookes.ac.uk
	NOHA, Joint European Master's in International Humanitarian Action		Present in France, Germany, Ireland, Belgium, The Netherlands, Spain, and Sweden	nohanet.org
	University of Geneva, MS in Humanitarian Action		Programme Plurifacultaire Action Humanitaire (ppAH), Geneva, Switzerland	
	CIHC International Diploma in Humanitarian Assistance (IDHA)		Michel Veuthey, Academic Director, Geneva, Switzerland	cihc.org
	Centre for Development Studies (CDS)		Swansea, UK	swansea.ac.uk
	Centre for Health Economics		York, UK	york.ac.uk
	Christian Community Development		Korntal-München, Germany	aem.de
	International Disaster and Relief Training (IDART)	Customized trainings	Austin, TX	training2go.org/
	University of Liverpool	Diploma in Humanitarian Assistance	Liverpool, UK	liverpool.ac.uk
	Humanitarian Academy at Harvard	Short Courses	Cambridge, MA	humanitarianacademy .harvard.edu
	Global Human Rights Education and Training Centre	Online courses in human rights education		hrea.org/learn/ humanitarian-action -and-disaster-relief/
	Advanced Training Program on Humanitarian Action (ATHA)	Online and face-to-face trainings and webinars	Boston, MA	atha.se
	Imara International Humanitarian Group	Online and face-to-face trainings	Argentina	fundacion-imara.org
Monitoring and evaluation	International Institute of Rural Reconstruction		Philippines, Kenya, USA	iirr.org/
	RedR		London, UK	redr.org
	Overseas Development Group		Norwich, UK	uea.ac.uk/dev/

From Walker P, Russ C: Professionalising the humanitarian sector: a scoping study, Enhancing Learning and Research for Humanitarian Assistance (ELRHA), April 2010: elrha.org/uploads/Professionalising_the_humanitarian_sector.pdf.

FIGURE 84-36 Payasos Sin Fronteras (Clowns Without Borders) working alongside Médecins Sans Frontières in Ampara, Sri Lanka. Performances and spectacles were organized in camps and schools to help children and youngsters overcome the trauma following the 2004 Indian Ocean tsunami, 2005. *(Courtesy Médecins Sans Frontières Spain.)*

it" in the field, whatever they have represents more wealth than most local peoples can hope to amass in a lifetime. This affects the dynamic of the relationship and needs to be carefully examined and understood in order to avoid inadvertently abusing one's position.

Professional Matters. Much of an aid worker's success will be based on the relationships forged while on a mission (Figure 84-37). Handling this well from the start is extremely important. Persons from Western countries often have the misconception that they possess superior knowledge and that they will be imparting their wisdom to others. Although job titles may indicate something of this nature, do not be fooled. Expatriates do most of the learning, particularly on first missions.

It is important to remember that most of the local staff have been doing their work for years, and have seen expatriates come and go. It is always a good starting point in a conversation to ask local staff members how long they have worked for the organization, because this will acknowledge the desire to learn from their experience and knowledge, while also offering one's own services. It is crucial to understand what is already in place and why it has been put in place. New international staff usually

FIGURE 84-37 A field coordinator meets with members of the local community following the opening of a mother-child health care unit in the Bakool region, Somalia, 2006. *(Courtesy Espen Rasmussen, Médecins Sans Frontières.)*

FIGURE 84-38 MSF doctor examines a patient with drug-resistant tuberculosis in Abovian, Armenia, 2010. Many patients are unable to complete the grueling therapy. *(Courtesy Bruno De Cock, Médecins Sans Frontières.)*

come into a project with great motivation and ambition. This can be misguided into changing work processes too quickly and without sufficient thought about what has been done before. Talking to staff and finding out the background will save much effort by zeroing in on what really needs input in a way that is effective and sustainable.

One of the most difficult aspects will be the seemingly impossible choices to face on an almost daily basis. There will be too many patients and not enough time or resources to meet all medical needs. The tragedies will be enormous and emotionally intense (Figure 84-38). It will not be possible to do everything, or to do everything well. Although aspirations will be high, expectations need to be realistic. One's well-being and capacity to sustain effort depend on this realization. Know your limits, and know that whatever you accomplish is more than if you were not there at all. Aid workers can only do their best, and whatever that is, it makes a difference for those treated. Somehow, one needs to let go of the rest without giving up hope. The aim is to be realistic, appreciate the successes, learn from the failures, and keep advancing in a way that can be sustained.

CONSIDERATIONS WHEN RETURNING HOME

The challenges involved in returning home from a mission need to be taken seriously in order to work through the experience to a positive conclusion. In the process of responding to a humanitarian crisis, aid workers often are changed, whereas persons at home have, for the most part, continued on common, everyday paths. There will be genuine and polite curiosity about one's experience, but often the experience will be too foreign for most nonparticipants to relate, in particular on a level that is sufficiently supportive (Figure 84-39).

Support that comes from family and friends will be limited in time and understanding. Do not expect too much. They remember you from before, and they will give support based on their prior experiences. Family and friends are only parts of the reentry process. Being able to tell your stories, both pleasant and unpleasant, freely and in detail will allow you to process the experience. This requires reaching out to like-minded field workers. Seeking out others who have done similar work is helpful in reflecting on experiences and working through them in a healthy way. Relying on professional psychosocial support is wise, because it is not possible to work in a war zone or humanitarian crisis and not face traumatic stress at some level. Ideally, the mental health professional with whom you consult will have experience in posttraumatic stress disorder. Some aid workers develop anxiety and depression and need assistance from a physician, psychologist, or psychiatrist. Alternative healing arts should be considered.

FIGURE 84-39 Haitian, German, and British physicians attend to patients in an outdoor makeshift ward following the 2010 Haitian earthquake. *(Courtesy Julie Remy, Médecins Sans Frontières.)*

After returning, reverse culture shock may occur. One may see his or her home society, culture, and relative wealth from a different perspective. One may question societal values. Over time, as one readjusts to being home, this feeling usually eases. When aid workers are engaged in relief work over a number of years, reverse culture shock will lessen because their thinking evolves around the relativity of pain and suffering and they come to accept the fact that they cannot personally take responsibility for global wrongs. Some aid workers quickly learn that although they cannot change the world, they *can* change lives, and that fact alone is settling. Some experienced aid workers simply quit comparing the perplexing and stark differences between justice and reality in the field and at home. Others use it as a basis for continued motivation to contribute to aid work.

Planning "down time" after returning home is important to recover physically, mentally, and psychologically. As tempting as it may to be to jump into another mission, it is better in the long run to take time between missions and become rooted again in one's home society. Some experienced aid workers believe it is helpful to have something or someone important "to return home to." Too many consecutive aid trips can lead to burnout and a loss of "anchors" in life. Staying involved in relief work over many years is possible, but requires pacing and keeping a strong support network at home. This can only be accomplished by taking time off between field assignments.

Whenever possible, it is important not to become financially dependent on humanitarian work. Financial dependence may mean not being able to take sufficient time off at home in between assignments.

Even if one is a medical professional, it is important to seek medical care for posttravel illnesses rather than self-diagnosing or self-treating. For example, if fever develops within the first months after returning, make sure to seek medical attention and give an accurate travel history. Tropical diseases can manifest weeks or months after returning home. It is easy to disconnect the disease from travel. Even if one only suffers what would normally be considered a viral upper respiratory tract infection, it is not worth taking the risk of ignoring it, because it could be malaria. Some aid workers routinely schedule a medical check-up with blood and stool sample analysis upon their return home.

Activities After Returning From a Mission

Aid workers find themselves with numerous choices of activities in which to engage after a mission. Some choose to present their experience to schools, universities, and government officials. Trainees in the health professions are particularly keen to learn from persons who have recently been on a mission. Colleagues at work may appreciate a presentation, and sharing one's hard work in a disaster setting can provide realistic inspiration for others wanting to go on a future mission.

Aid organizations often ask returned workers to meet with prospective donors and the general public. Workers back from the field are natural spokespersons for the organization and its work. Aid organizations often receive numerous requests for speakers from conferences and community groups. An organization may involve returnees in their recruiting efforts by having them speak with prospective future aid workers. Aid organizations also require boards of trustees or directors. Although governance may not be as exciting as is field work, it is a key part of running a charitable organization.

Some aid organizations try to promote a vibrant culture of debate and discussion within home society associations. These groups can also serve as social and professional networking opportunities to share experiences and cope with stress and isolation upon returning home. Remaining involved can strengthen a connection with an aid organization, and for some, increase the likelihood that they again work overseas.

Because returning home after a mission is not easy, some NGOs host peer support groups, which can be a rewarding way for former field workers to remain involved by helping colleagues who have had difficult field experiences. A few returned workers seek full-time or part-time employment within the organization in a head office, or seek employment with another aid organization or government bureau. Experienced workers may seek more senior voluntary positions in which they are coordinating or providing technical advice to less experienced aid workers. Many returned aid workers take courses in areas in which they would like to improve their skills.

Some returned aid workers remain engaged by writing about their work in the medical or lay press, others display photos of their mission, and a few even create art using material from their mission. The majority of aid workers enjoy coming home. Still, many have difficulty making sense of the vast disparity between the brutal reality and difficulties of their field experience and the relative prosperity, security, and comfort of life in their home society.

EVOLUTION OF THE HUMANITARIAN SYSTEM

The world is facing increased natural disasters and complex emergencies with an increase in the severity of impact on populations in terms of morbidity and mortality, forced migration, and competition for resources (Figure 84-40). This will, in turn, create increased demand for humanitarian responses; there is already unprecedented growth in this sector. In 2014, funding for international humanitarian responses totaled more than U.S. $22 billion, of which one-quarter came from private donors and the remainder from governments.[10] On average, humanitarian NGOs

FIGURE 84-40 MSF nurse examines a child suffering severe malnutrition in the Zinder Region of Niger, 2007. *(Courtesy Karine Klein, Médecins Sans Frontières.)*

account for roughly one-third of this expenditure, and are thus major players in terms of volume of aid.[1] More than 4000 humanitarian NGOs exist worldwide, but 40% of the spending is carried out by only five (MSF, Catholic Relief Services, Oxfam, Save the Children, and World Vision International). It is estimated that in 2010, there were well over 200,000 humanitarian aid workers globally.[1] This workforce is believed to be growing at an annual rate of 6%.[35] The humanitarian sector "supply" numbers are clearly significant.

EFFORTS TOWARD IMPROVING RESPONSES TO NEEDS IN THE FIELD

Meeting the demand for humanitarian response requires careful application of lessons learned, strengthening of standards for responses, and increased attention to current training courses, certification programs, and professionalization. As the numbers of disasters and complex humanitarian emergencies increase, there needs to be a focus on enhancing quality and accountability in terms of service delivery in the field. One of the ways to do this is to ensure that humanitarians are properly trained before they provide assistance. A long-term vision is to create a professional body that accredits standardized training programs and oversees individual practice. Some efforts aimed at improving responses are already in place; a few of these are outlined in the following sections.

The Sphere Project

The Sphere Project, which has been running in various forms since 1997,[30] is an initiative to define and uphold the standards by which the global community responds to the plight of people affected by disasters. Sphere does this through a set of guidelines that are set out in the *Humanitarian Charter and Minimum Standards in Humanitarian Response* (universally known as the Sphere Handbook). Its rights-based approach outlines minimum standards that apply to each of the main sectors of response: water, sanitation, and hygiene promotion; food security and nutrition; shelter, settlement, and nonfood items; and health action. The Sphere Handbook also includes core standards and protection, the Humanitarian Charter, and references to all the contributing documents and texts.

United Nations Reform: The Cluster Approach

The response that followed the 2004 Indian Ocean tsunami was uncoordinated, duplicative, and competitive, and resulted in haphazard distribution of resources and provision of unneeded goods and services.[5] It became evident that a major problem in provision of relief and recovery was lack of coordination (Figure 84-41). As a result of this lesson, the Interagency Standing Committee of the UN Office for the Coordination of Humanitarian Affairs formed a series of clusters that encouraged operational agencies involved in international disaster responses to plan and operate together. The Department of Health Actions in Crises of the WHO was assigned as the lead of the Global Health Cluster; the Global Health Cluster brings many of the humanitarian and UN agencies that relate to health care to the table to identify how they can better coordinate their activities. A similar cluster organizational structure has been implemented in many countries. Some aid agencies have chosen to have selective involvement in the clusters approach and also continue with bilateral relationships with other actors, citing that accountability to the UN can, in selective contexts, lead to a loss of independent humanitarian action and access.

FIGURE 84-41 A relief worker assesses medical needs following the Indian Ocean tsunami, 250 km (155 miles) from Banda Aceh, an area accessible only by boat or helicopter (Indonesia, 2005). *(Courtesy Francesco Zizola, Médecins Sans Frontières.)*

Humanitarian NGO Professionalization

The NGO community has improved its effectiveness in a number of ways, including interorganization coordination and training programs for staff. It also engages in research to inform programs (e.g., MSF's operational research center, Epicentre). Recent developments also include generation of the Code of Conduct for Health Systems Strengthening.

The NGO Code of Conduct for Health Systems Strengthening is in response to recent growth in the number of international NGOs associated with the increase in aid flows to the health sector.[13] This Code is intended as a tool for service organizations and eventually, for funders and host governments. The Code serves as a guide to encourage NGO practices that contribute to building public health systems and to discourage those that are harmful.[13] The document was drafted by a group of activist and service delivery organizations, including Health Alliance International (the convening organization), ActionAid International USA, African Medical and Research Foundation, Equinet, Health Global Access Project, Oxfam Great Britain, Partners in Health, People's Health Movement, and Physicians for Human Rights.

The articles of the Code of Conduct are as follows:[13]

- NGOs will engage in hiring practices that ensure long-term health system sustainability.
- NGOs will enact employee compensation practices that strengthen the public sector.
- NGOs pledge to create and maintain human resources training and support systems that are good for the countries where they work.
- NGOs will minimize the NGO management burden for ministries.
- NGOs will support Ministries of Health as they engage with communities.
- NGOs will advocate for policies that promote and support the public sector.

TRAINING AND CERTIFICATION

Several groups have attempted to define disaster medicine competencies, but few have been based on the science of disaster medicine. Currently, not even the actual domain of disaster medicine is clear, which makes it virtually impossible to reach agreement on who needs to know what in order to function during a disaster or to develop practical response plans.[5] Many organizations operate independently, which has led to inconsistency and confusion. Thus far, no international consensus has been reached about which competencies are required in order to receive credentials to work at some specific level in disaster medicine. Currently, there is no mechanism to accredit organizations to do what they say they can do.[5] There are no internationally accepted guidelines and no standards have been agreed on; hence, no competencies based on science and supposed best practices are available for dissemination and implementation.[5]

There are many NGO and academic training programs worldwide. Within the WHO Department of Health Actions in Crises, organizations and institutions that offer training programs are identifying core competencies for humanitarian workers. These must incorporate not only the minimum knowledge and skills required but also the behavior and the moral and ethical motivations that should be present for an individual to be considered

competent to work in the humanitarian sector.[35] These academic and operational stakeholders plan that a certification process will be developed that will create a scale of recognized professional qualifications. Finally, in order for humanitarian aid to be truly professionalized, it is necessary to create a professional association for humanitarian workers, an academic studies association, and an association of humanitarian organizations that could institutionally support and legitimize the professional accreditation.[35]

CURRENT CHALLENGES, CONTROVERSIES AND KEY FUTURE ISSUES

By their nature, aid workers tend to respond immediately and reactively, placing themselves where need is great and working in the present moment of that need. For individuals and the organizations aiming to provide humanitarian and emergency medical assistance, and for those who support them and others who receive their assistance, waiting for the next crisis to occur is getting behind the curve. Both leaders and workers on the ground have to review and question past experience and decisions, critically analyze current situations and trends, and refuse to accept the status quo. Looking ahead, the challenges and difficulties are many, but it is in confronting them that we may improve our medical actions and have greater impact in the field.

GROWTH AND ITS EFFECTS

The number of actors in the humanitarian sector and size of aid organizations have grown tremendously, as have the financial resources used and the ambitions for goals to be achieved. Public awareness of humanitarian efforts has increased greatly as well. Through modern communication systems, media giants, and power of social networks in information sharing and advocacy, there is increasing awareness of growing needs around the globe, even during small distant crises.

Growth of the sector is frequently regarded as a good thing. The supposition is that the bigger an organization is and the more personnel it has, the more that can be done. Although this is often true, questions are asked about the effects and implications of that growth and the reality of what is actually being accomplished on the ground. In the 2010 earthquake disaster in Haiti, there was massive disorganization as hundreds of aid organizations arrived to create what has been called an aid circus (Figure 84-42). The various agencies jostled each other and "planted their flags" for a piece of the action; the result was what some have dubbed a "second disaster." Some, but not all, of the organizations were "start-ups," and their activities were not well coordinated. Many groups with good intentions lack the funding, technical expertise, and on-the-ground capacity to deliver timely and sustainable results.

FIGURE 84-42 Aid workers in Jacmel, Haiti, following the earthquake discuss who will do what function, 2010. *(Courtesy Julie Remy, Médecins Sans Frontières.)*

FIGURE 84-43 A health promotion and outreach team performs a street play that informs the public about what can be done following sexual assault in Liberia in 2009. *(Courtesy Alessandra Vilas Boas, Médecins Sans Frontières.)*

Growth of an organization usually causes the headquarters to enlarge and the administration to increase, which can raise overhead costs and reduce the proportion of funds going to the field. More levels of hierarchy are introduced, and leaders are more removed from the field. Large organizations may be able to provide a robust response, but not always swiftly or with the ability to adapt quickly. The necessary professionalization of aid work has resulted in an increased organizational structure and more regulations. Although the priority of the individual medical act still exists, it must compete with many complex business issues, such as taxes, lawsuits, employment contracts, and labor disputes.

Financial, human, and intellectual resources are required to support the growth of professional agencies. More money is needed annually, more resources are needed to raise it, and more money is kept in reserve for future crises. The pool of human resources can be stretched, especially at coordinator levels that require more capability and experience. Medical leadership is hard to nurture, requiring retention over years and willingness to take on management, administrative, and planning roles.

Aid organizations can change or lose focus as they grow, shifting toward mid-term and long-term projects, public health or development-type programs, and advocacy-only work because these orientations seem to have the benefit of increased program stability and less security risk. The humanitarian sector as a whole has demonstrated more conservative decision making, and its coordination efforts are seen as sometimes slow and poorly effective. The result, as described in the 2014 MSF study "Where Is Everyone: Responding to Emergencies in the Most Difficult Places,"[22] is that in acute emergencies, and in places with challenges affecting security and logistics, there can be a near absence of both UN agencies and international NGOs. The 2014 Ebola epidemic, notwithstanding the degree of technical expertise required for a response, was a clear example of this trend of inadequate international response. The response arrived, but it was exceedingly late.

LOCAL PEOPLE AND LOCAL CAPACITY

Relief work on the ground is primarily carried out by staff from the country facing the crisis (Figure 84-43). In some instances, they are autonomous local implementing partners; at other times, local staff are hired directly by the international organization. In the latter instance, competition for the best local staff is

common, with "international" salaries sometimes distorting the local economy, attracting talented staff away from the Ministry of Health or local organizations. Working relationships between international and local staff are often collegial and highly positive. However, a frequent complaint from local staff is the "revolving door" of expatriates who come and go on short missions, changing the medical program immediately upon arrival, sometimes with little experience or knowledge of how the current situation came into existence. Expatriates with little experience can be put in positions of maximal medical authority and then exercise it poorly, despite local staff having more experience and relevant skills to lead the medical team. Aid agencies have slowly evolved to elevate these local colleagues into supervisory positions, acknowledging their expertise and capacity. These "national staff workers" are increasingly being expatriated to work in other countries in need. This may benefit the organization as well as the destination country. Although it can temporarily be a drain on the home nation, the investment can return the staff member with valuable experience and increased skills and knowledge.

Local relief organizations have expanded. Some provide an excellent standard of care, and continue to work when international NGO access is limited or cut off. Others have lacked the skill and experience for implementation of programs, or do not have the impartiality and neutrality to work in a conflict or politically contested area.

The local or host community can often provide critical services to the population in danger. This adds up to a greatly increased domestic capacity to deal with the crisis. Depending on the country and context, this could be a high technical level of medical personnel, families who extend their homes and food, or community workers who help build and maintain such interventions as water and sanitation systems. Increasingly, lack of skilled medical workers in many of these contexts is met by task shifting or training lay personnel to provide health services and resources. Examples are peer groups for HIV medication adherence and initiation of treatment, community-based malaria diagnosis and treatment programs, and community management of malnutrition through locally produced supplemental food products. Even in emergency situations, it behooves the aid organization to spend sufficient time getting to know the local community, in order to capitalize on the local capacity, refine program choices based on local needs, and maximize local acceptance of the organization's presence. Avoiding paternalistic interactions with the community requires careful attention and ongoing discourse. In the end, developing a meaningful level of accountability to the beneficiaries and communities would benefit all involved.[4]

MEDICAL QUALITY AND ACCESS TO CARE

Improving the quality of medical interventions is a constant discussion in humanitarian assistance. Manuals have been refined and international standards established. These are of practical help in the field, but do not define the ultimate goals of medical care. One end of the spectrum is broad-based basic care that treats the most people at the least cost. Emphasis is placed on prevention and simple treatments of basic illnesses. Such cost-effective measures include distributing oral rehydration solution packets to treat children with diarrhea. At the other end of the spectrum is managing the most challenging clinical problems and pushing the limits of the field (Figure 84-44). Examples include using internal fixation for fractures; treating infections such as HIV in unstable conflict settings; improving therapy for multidrug-resistant TB, human African trypanosomiasis, and Chagas' disease; treating noncommunicable diseases such as hypertension and diabetes; and transporting inflatable hospitals, surgeons, and anesthetists to the field in the urgent hours after a natural disaster.

Amidst the interest in medical advances and running large programs, some basic yet vital contributors to quality can be overlooked. Examples include the quality of nursing assessments and patient surveillance, staff hand washing, sterile dressing changes, hospital hygiene, skillful triage, patient education, follow-up, and adherence counseling (Figure 84-45). There is little quality of care without these simple interventions. Improving adherence to evidence-based best practices in the fields of global health and disaster medicine can go some distance to reducing rates of morbidity and mortality in humanitarian projects. However, dissemination of such information to medical staff remains scattered and inconsistent.

FIGURE 84-44 Water pump and water bladder equipment used for kidney dialysis at Port-au-Prince General Hospital following the 2010 earthquake in Haiti. *(Courtesy Julie Remy, Médecins Sans Frontières.)*

A major barrier to medical care is access to essential medicines, biologics, and diagnostics adapted to low-income settings. Players in this arena include the pharmaceutical industry, patient rights groups, universities and other research institutions, the World Trade Organization, the WHO, and governments with variable policies that sometimes prioritize patients and the public health benefit while at other times favor protecting intellectual property and private business interests. Approaches and proposals to improve access to life-saving medications include policies allowing compulsory licenses for drug production, public campaigns to influence government and company policies, public-private partnerships for drug development, patent pools for therapeutic molecules, and a foreign currency exchange tax to be used for global health.

Problematically, medical data are often restricted from broad use by researchers or the public. Medical research in low-income

FIGURE 84-45 An aid worker inserts an intravenous line to care for a 13-year-old patient in Darfur, Sudan, 2004. *(Courtesy Stephan Grosse Rueschkamp, Médecins Sans Frontières.)*

FIGURE 84-46 A doctor talks with an armed guard during a nutritional screening in Somalia in 2004. *(Courtesy Espen Rasmussen, Médecins Sans Frontières.)*

countries and from relief work is still published predominantly in proprietary journals, which own and charge for information. Nonetheless, there has been some change among private and public institutions toward collaboration and sharing of drugs and data, and proliferation of online, open-access journals is an encouraging trend.

SECURITY, INSECURITY, AND POWER IN THE FIELD

By its very nature, relief work involves an element of danger, and in some contexts that risk is considerable (Figure 84-46). The number of serious incidents continues to rise each year, with few exceptions. Causative factors include the violence inherent in conflict, societal breakdown, and criminal activity. Other reasons are political manipulation, terrorization as a tool of war, direct targeting for personal or strategic reasons, anti-Western or anti-foreigner sentiment, and an unsafe infrastructure, such as roads and buildings. Other factors at play may be underdeveloped contacts and local relations; vastly differing perceptions of the context among aid workers, belligerents, community residents, and authorities; inexperience on the part of field workers to deal with critical incidents or threats; lack of information; and the extent of personal exposure in the field.

In the past few years, there have been increasing incidents of direct targeting of patients, health care facilities, and health care personnel by militant groups. In response, the ICRC has formed the Health Care in Danger project. Some argue that the targeting represents a breakdown of respect for international humanitarian law by state and nonstate actors, specifically in regard to provisions for protection of noncombatants and civilians. Others note that throughout the long history of war, there has usually been little acceptance of neutral parties by belligerents in a conflict, and that the ability to provide relief or assistance in such settings has always been a matter of negotiation. In the field, NGOs have no choice but to believe in and endeavor to negotiate the "humanitarian space" in which to work, whether based on international law, humanitarian principles, or the measured compromise of those principles in the realpolitik that recognizes the motivations and self-interests of warring parties.

HUMANITARIANISM AND ENVIRONMENTALISM

There is near universal agreement that global climate change is an important issue, although there is variability in predictions of how soon and to what degree it might occur. If global climate change occurs, it is predicted to exacerbate flooding and drought, contribute to shortages of food and drinking water, and cause migration of populations and violent conflicts over limited resources. A more immediate concern is environmental degradation, such as poisoning of land by oil or mineral extraction companies, diversion or consumption of water and pollution of air by manufacturing industries, and destruction of natural resources by belligerents or depletion of them by populations themselves. Some argue that environmentalism encompasses humanitarianism. If a person is going to be able to deliver assistance to another person, the planet Earth must be able to house and sustain its population. Developing effective stewardship of the environment is necessary for continuing humanitarianism and responding to disasters. However, there is a natural tension between environmentalism and emergency humanitarian relief. Aid to populations in distress is necessarily focused on immediate and short-term protection of a highly vulnerable population, and its tools and actions may directly contrast with environmentalism's broader target population and longer-term goals. Environmental protection, taken to an extreme, could mean seriously limiting aid work. Aid work is messy. Airplane flights need to occur, all-terrain vehicles to run, and generators to spew out smoke. If a million people are displaced from their homes and they cut down a forest for shelter and fuel, is such an act justified so that the million can survive?

Although the priority of humanitarian relief must be saving lives, there are ways to carry out its actions that are environmentally friendly. Transportation costs are reduced if workers are deployed for longer times and plans are made for supplies needed. Hybrid car fleets and solar-powered energy reduce fossil fuel use and waste production. Lighter weight, recycled, or prefabricated building materials can spare critical local resources. The greening of humanitarianism can lead to immediate and long-term improvements, depending on how we answer the questions it raises for us. How do we minimize the impact on the environment by a displaced population and our aid efforts, thereby helping those suffering from contamination or lack of these resources? How can large relief organizations, in headquarters and in the field, reduce their own waste and production of carbon? Can we connect the principles and practice of humanitarian assistance to the preservation and regeneration of that which supports all of us?

HUMANITARIAN ETHICS AND MORALS

Although medical humanitarian workers perpetually act by definition, an ongoing debate and ever-evolving understanding of their ethics and morals must remain a critical component of these actions. What is right and wrong in a particular emergency or critical context? What can and what must we do to respond? In trying to answer these questions, we root ourselves in the person-to-person individual medical act, attempting to care for and bear witness to the other. We practice an ethic of refusal–refusal to accept the lack of humanity, refusal to accept unnatural and untimely deaths, and refusal to remain silent when speaking out may be the best way to save lives. We act, as James Orbinski said in his MSF Nobel Prize acceptance speech, "in the hope that the cycles of violence and destruction will not continue endlessly."

APPENDIX

A Suggested Packing List

DOCUMENTS

Passport* (plus copy)
Visa* (plus copy)
Immunization card* (plus copy)
Air ticket* (plus copy)
Letter of invitation by NGO*
Medical evacuation insurance card* (plus copy)
Health insurance card*
Trip cancellation insurance*
International calling card*
Driver's license (consider an international driver's license)*
ATM/credit cards (may not work)*
Cash (generally U.S. currency, but check with contacts)*
Copy of medical school diploma
Copy of medical license
Curriculum vitae and/or resume
Hospital identification badge
Business cards
Extra passport photos
Address/contact list* (see below)

GIFTS TO BRING YOUR TEAM

Chocolate
Cheese
Newspapers
Movies
Comfort foods (relevant to the cultures of teammates)
Coffee
Gift packages for your teammates from their families sent to you before departure

ADDRESS OR CONTACT LIST*

Field supervisor and local contacts
Arrival and airport contacts
Local embassy
Family and friends
Lost ATM or credit card reporting
Medical evacuation company
Health insurance company
Local airline office
Travel agent

GEAR

Money belt*
Day pack
Alarm clock (that runs on batteries)
Headlamps or flashlights*
Mosquito net
Sunglasses
Sleep sack
Rain protection
Duct tape
Swiss Army knife (not for carry-on)
Sewing kit
Earplugs
Pocket tissues (toilet paper)*
Baby wipes
Luggage locks (for hotel, not flight)
Quick-dry travel towel
Flip-flops or shower sandals
Bandana or scarf
Travel clothesline
Laundry detergent
Sink stopper
Zip-lock bags
Water purifier or disinfection tablets
Phrasebook
Travel guide*
Stethoscope
White coat, surgical scrubs (where applicable)
Pocket medical references

ELECTRONICS

Laptop and power cord*
Electrical adapters and converter*
Surge protector
Flash drive*
Unlocked cell phone and charger*
Music player and charger*
Camera and memory cards*
Other cables and adapters
Handheld calculator
Extra batteries

FIRST-AID KIT

Sunscreen
Insect repellent
Antimalarial prophylaxis
HIV postexposure prophylaxis
Alcohol-based hand sanitizer
Traveler's diarrhea antibiotic(s)
Antidiarrheal
Laxative
Acetaminophen or ibuprofen
Decongestant
Antihistamine
Albuterol inhaler
Prednisone
Fluconazole
Bacitracin ointment
Antiemetic
Vitamins
Oral contraceptive and emergency contraceptive
Condoms
Adhesive bandages
Blister dressings
Alcohol wipes
Cloth tape
Wound closure strips
Safety pins
Tweezers
Spare eyeglasses or contact lenses
Sunglasses
Sutures and needle driver
Nitrile gloves

*These items should be packed in your carry-on bag.

TOILETRIES

Toothbrush and toothpaste
Dental floss
Shampoo and soap
Comb and brush
Razor and shaving cream
Deodorant
Contact lens kit
Eyeglasses (and spare)
Sunscreen
Makeup
Mirror
Lotions and creams
Lip balm
Tampons
Facecloth
Prescription medicines*

EXTRAS

Notebook, journal, and pens
Photos from home
Gum, candy, and protein bars
Instant coffee packages and teabags
Magazines and novels
Playing cards and games
Textbooks and equipment donations

REFERENCES

Complete references used in this text are available online at expertconsult.inkling.com.

CHAPTER 85

Natural and Human-Made Hazards: Disaster Risk Management Issues

SHEILA B. REED

The term *hazard* is usually applied to a rare or extreme event in the natural or human-made environment. Hazards can include latent conditions representing future threats that can adversely affect human life or property to the extent of causing a disaster or major disruptive situation. Natural hazards are caused by biologic, geologic, seismic, hydrologic, or meteorologic processes in the natural environment and include drought, flood, earthquake, volcanic eruption, and severe storms. When natural hazards affect vulnerable human settlements, structures, and economic assets, they can be disastrous, disrupting the normal functioning of a society and necessitating extraordinary emergency interventions to save lives and the environment.

Human-made hazards are derived from human interactions with the environment, human relationships and attitudes, and the use of technology. For example, transportation accidents, petrochemical explosions, mine fires, building collapses, oil spills, hazardous waste leaks, and nuclear power plant failures are disasters in which the principal and direct causes are human actions. Many hazards have both natural and human components. Desertification results from arid conditions, erosion, and overgrazing; landslides may occur from poorly planned construction on unstable hillsides; and flooding may be caused by dam failures.

The distinction between many natural causes of hazards and the contributions of humans to disastrous situations is becoming increasingly blurred. As populations grow and expand, pressure on land resources may force settlement in vulnerable areas, where hazards such as volcanic eruptions, earthquakes, or floods can become major disasters. When disasters strike major population areas or where disaster-affected people must gather in camps or other common areas to receive relief services, incidences of disease have the potential of becoming epidemics because of overcrowding. Drought may contribute to famine in areas where food shortages result from combinations of lack of rainfall, displacement of people, and lack of access to food supplies. The widely publicized focus on the impacts of climate change emanates from studies of the effects of climatic conditions and environmental pollution. Variables in studies of global warming form such complex interactions that even computerized models have difficulty predicting the outcomes, lending possible substantiation for delays in addressing the causes. Hazards with a combination of causes result in complex disasters and often in complex emergencies. Conflicts, for example, in Syria, Iraq, and Afghanistan, create environmental disasters as well as disastrous consequences for the population in terms of death and displacement.

Whatever their causes, disasters have serious political, economic, social, and environmental implications. In less developed areas, disasters can severely set back or reverse developmental efforts. Disasters generally cause greater rates of mortality and morbidity among women and children, who are 14 times more likely than men to die during a disaster.

DISASTER RISK REDUCTION AND MANAGEMENT

This chapter covers 12 hazards, each with significant geophysical components, and discusses their causes, characteristics, predictability, adverse effects, and risk reduction measures. Hazards are viewed from a perspective of seeking means to reduce risks to vulnerable people and societies. The disaster risk reduction approach highlights causes of vulnerability and relates them closely to risk factors in society, such as poverty and economic development. The socioeconomic forces that make people vulnerable to disasters are likely to result from long-term trends. The study of disaster risk management, which formerly focused on natural hazards, now encompasses a range of slow-onset and rapid-onset disasters and their natural and human causes.

Activities associated with the conceptual framework of disaster risk reduction have gained wide usage by governments since

REFERENCES

1. Active Learning Network for Accountability and Performance in Humanitarian Action. The State of the Humanitarian System, 2012: <alnap.org/resource/6565>.
2. Antares Foundation. Managing stress in humanitarian workers: Guidelines for good practice, 3rd ed, March 2012: <antaresfoundation.org/search/?query=1.%09Antares%20Foundation%3A%20Managing%20stress%20in%20humanitarian%20workers%3A%20Guidelines%20for%20good%20practice%2C%202006.%20#.VRsLXkshe2Q>.
3. Bakewell O, Garbutt A. The use and abuse of the logical framework approach. Stockholm: SIDA; 2005.
4. Barnett M. Empire of Humanity: A History of Humanitarianism, Ithaca. New York: Cornell University Press; 2013.
5. Birnbaum ML. The times they are a-changin'—quickly. Prehosp Disaster Med 2009;24:79.
6. Bradt DA, Drummond CM. Rapid epidemiological assessment of health status in displaced populations: An evolution toward standard minimum essential data sets. Prehosp Disaster Med 2003;17:178.
7. Centers for Disease Control and Prevention. Surveillance Resource Centre: <cdc.gov/surveillancepractice/>.
8. Connolly MA, editor. Communicable disease control in emergencies: A field manual. Geneva: World Health Organization; 2005.
9. Faust S, Drickey R. Working with interpreters. J Fam Pract 1988;22:131.
10. Global Humanitarian Assistance: Report 2014: <globalhumanitarianassistance.org/report/gha-report-2014>.
11. Grove N, Zwi AB. Beyond the log frame: A new tool for examining health and peace-building initiatives. Dev Pract 2008;18:66.
12. Hanley T, Binas R, Murray J, Tribunalo B. IASC Inter-agency Humanitarian Evaluation of the Typhoon Haiyan Response, October 2014, United Nations Office for Coordination of Humanitarian Affairs: <humanitarianresponse.info/programme-cycle/space/document/iasc-inter-agency-humanitarian-evaluation-typhoon-haiyan-response>.
13. Health Alliance International. NGO Code of Conduct for Health Systems Strengthening:<ngocodeofconduct.org>.
14. Holmes J. Learning the Lessons of Haiti. Humanitarian Exchange. Number 48, October 2010: <odihpn.org/humanitarian-exchange-magazine/issue-48/lessons-learned-from-the-haiti-earthquake-response>.
15. Internal Displacement Monitoring Centre. <internal-displacement.org/global-figures>.
16. International Committee of the Red Cross. Humanitarian action and armed conflict: coping with stress, ICRC, 2001: <icrc.org/eng/resources/documents/publication/p0576.htm>.
17. International Committee of the Red Cross. The code of conduct: humanitarian principles in practice, ICRC, 2004: <icrc.org/eng/resources/documents/misc/64zahh.htm>.
18. Kellenberger J. Sixty years of the Geneva Conventions: learning from the past to better face the future. Ceremonial Address by the President of the International Committee of the Red Cross at the 60th Anniversary of the Geneva Conventions, August 12, 2009, Geneva, Switzerland: <icrc.org/eng/assets/files/other/irrc-875-60years-geneva-convention.pdf>.
19. Leaning J, Briggs SM, Chen LC. Humanitarian crises and the medical and public health response. Cambridge, Massachusetts: Harvard University Press; 1999.
20. Médecins San Frontières. Refugee health: an approach to emergency situations. Oxford, England: Macmillan Education; 1997 <refbooks.msf.org/msf_docs/en/Refugee_Health/RH.pdf>.
21. Médecins Sans Frontières. International Activity Report 2013: <msf.org/international-activity-report-2013>.
22. Médecins Sans Frontières. Where is Everyone? Responding to Emergencies in the Most Difficult Places, July 2014: <msf.org/article/msf-report-where-everyone>.
23. Michael M. Global health cluster rapid health assessment guidelines, 2007, WHO Health Cluster Approach/Resources and Tools: <2.wpro.who.int/internet/files/eha/toolkit/web/health-cluster-approach.html>.
24. Mourey A. Nutrition manual for humanitarian action, 2008, International Committee of the Red Cross: <icrc.org/eng/assets/files/other/icrc_002_0820.pdf>.
25. Orbinski J. An imperfect offering: humanitarian action in the twenty-first century. Toronto, Ontario, Canada: Random House Canada; 2008. p. 7.
26. Perrin P. H.E.L.P. Public Health Course in the Management of Humanitarian Aid. Geneva, Switzerland: ICRC; 2001.
27. Phelan KPQ. From an idea to action: the evolution of Médecins Sans Frontières. In: Stout CE, editor. The new humanitarians. London: Praeger; 2008.
28. Shanks L, Schull MJ. Rape in war: the humanitarian response. CMAJ 2000;163:1152.
29. Smith G. Development of rapid epidemiologic assessment methods to evaluate health status and delivery of health services. Int J Epidemiol 1989;18(Suppl. 2):1.
30. Sphere Project. Humanitarian Charter and Minimum Standards in Disaster Response: <sphereproject.org/>.
31. Spiegel PB, Salama P, Maloney S, et al. Quality of malnutrition assessment surveys conducted during famine in Ethiopia. JAMA 2004;292:613.
32. Tailhades M, Toole MJ. Disasters: What are the needs? How can they be assessed? Trop Doct 1991;21:18.
33. Turner R, Baker J, Oo ZM, Aye NS. Inter-Agency Real Time Evaluation of the Response to Cyclone Nargis, 17 December 2008, United Nations Office for Coordination of Humanitarian Affairs: <alnap.org/resource/8296>.
34. UNICEF data. <data.unicef.org/nutrition/malnutrition>.
35. Walker P, Russ C. Professionalising the humanitarian sector: a scoping study, Enhancing Learning and Research for Humanitarian Assistance (ELRHA), April 2010: <elrha.org/hp/scoping-study/>.
36. Weissman F. Military humanitarianism: a deadly confusion, MSF Activity Report 2003/04, p 8: <msf.org/international-activity-report-2003 2004>.
37. World Health Organization. Integrated Management of Childhood Illness (IMCI): <who.int/maternal_child_adolescent/topics/child/imci/en/>.
38. World Health Organization (Western Pacific Region). Hanoi School of Public Health: Regional Training Course on Rapid Health Assessment, November 2007, Hanoi, Vietnam: <wpro.who.int/internet/files/eha/dir/Regional%20Training%20Course%20on%20Rapid%20Health%20Assessment/RHA%20global%20health%20cluster.pdf>.
39. World Health Organization. Global Health Observatory Data: <who.int/gho/hiv/en/>.

the World Conference on Disaster Reduction in Kobe, Japan, in 2005 and have been strengthened in the follow-on World Conference on Disaster Risk Reduction in 2015 in Sendai, Japan. Disaster risk reduction aims to reduce the probability of disasters by using methods that are financially, environmentally, and culturally sensitive and by using mitigation methods that are agreed on through public consultation. The practice of disaster risk reduction encompasses all aspects of preventing, planning for, responding to, and recovering from disasters, including predisaster and postdisaster activities. A critical feature is training communities to allow them more direct responsibility for disaster reduction and creating resilience that allows societies and systems to effectively and efficiently resist, accommodate, and recover from the effects of disasters. Another key component is improving on unsustainable predisaster conditions through well-planned disaster recovery programs. The essential components of a disaster risk reduction framework are:

- Risk awareness and assessment, including hazard analysis and vulnerability and capacity analysis, including analysis of possible impacts related to gender and age
- Knowledge development, including education, training, research, and information
- Public commitment and institutional frameworks, including organizational, policy, legislational, and community actions
- Application of measures, including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments
- Early warning systems, including forecasting, dissemination of warnings, preparedness measures, and reaction capacities

Selection of management options depends on the type of hazard and its characteristics. Box 85-1 lists the elements usually found in a disaster preparedness plan for sudden-onset hazards, such as earthquakes, tsunamis, volcanic eruptions, tropical cyclones, and floods. Preparedness measures for slow-onset disasters, such as drought, include early warning systems that alert authorities to precursory conditions and allow preparations to avert food and water shortages.

SLOW-ONSET VERSUS RAPID-ONSET HAZARDS

The distinction between slow-onset and rapid-onset hazards is useful because the methods to deal with them often differ. Rapid-onset hazards often occur with violent intensity and have profound effects on the surrounding environment, resulting in measurable numbers of casualties and damage. Slow-onset climatic changes brought on by deforestation, drought, desertification, or environmental pollution change the suitability of different parts of the world for human habitation, and affect agriculture and flora and fauna. The effects of slow-onset disasters are often insidious. Their impact can be measured only through environmental studies and in terms of reduction in quality of life and productivity for the affected population. Variables include levels of public attention to the hazards and the ability of the government to deal with them. Typically, threats become mitigated by slow movement away from hazards; for example, many of the 11,000 residents of the Pacific island nation of Tuvalu have left the country because the island is being "swallowed" by rising sea levels.

Between 1994 and 2013, 6873 natural disasters were recorded worldwide. They claimed 1.35 million lives (average 68,000 per year) and affected 218 million people. Earthquakes (and their associated tsunamis) killed more people than did all other types of disasters combined. Other primary killers were tropical cyclones and floods. Most deaths have been concentrated in a relatively small number of communities, predominantly in poorer nations of Africa, Asia, Latin America, and Oceania. In comparison, North America, Europe, Japan, and Australia have long-term average annual death tolls due to disasters that rarely exceed a few hundred persons. Although comprehensive data for economic losses from rapid-onset hazards are difficult to obtain, a few examples illustrate the scale of the problem. Annual worldwide losses from tropical cyclones are estimated at between $6 billion and $7 billion. For landslides, the comparable figure exceeds $1 billion. These figures only hint at the impact of such disasters on the affected human population. The eruption of Colombia's Nevado del Ruiz volcano in 1985 killed approximately 22,000 people and left 10,000 more homeless. An earthquake in Bam, Iran, in December of 2003 claimed at least 30,000 lives and destroyed 80% of the city. The 2005 Atlantic hurricane season caused record damages of $100 billion. Hurricane Katrina alone, in August of 2005, killed 1417 people in three U.S. states, displaced 1.5 million, and caused $75 billion in damages.

The relative human, economic, and social impacts of rapid-onset disasters are usually greatest in smaller, poorer nations. The 1985 earthquake in Mexico City caused economic losses equivalent to about 3.5% of Mexico's gross national product. Hurricane Allen in 1980 caused losses in St Lucia equivalent to 89% of the island nation's gross national product and destroyed 90% of its banana crop, which normally accounts for 80% of the country's agricultural output. One of the strongest storms in recent history, Hurricane Mitch in 1998, devastated the economies and infrastructures of Honduras and Nicaragua. From 1994 to 2013, high- and upper-income countries experienced 56% of global disasters but lost 32% of lives, whereas low- and lower-income countries experienced 44% of global disasters but suffered 68% of deaths. The disparity is further illustrated by average death rates, with more than three times the number dying in lower-income countries: 332 deaths for poor countries versus 105 for the richer countries. Economic losses from rapid-onset hazards are increasing at a fast pace. In the United States, damage to buildings from earthquakes, tropical cyclones, and floods was estimated to increase from approximately $6 billion in 1978 to more than $11 billion in 2000 without additional loss reduction measures. At this same time, it was estimated that a major earthquake in Tokyo would probably kill more than 30,000 people, cause the collapse of 60,000 houses, and set fire to more than 400,000 homes.

Slow-onset disasters take an even greater toll, but precise figures are difficult to establish. Drought currently affects more people than does any other disaster. Droughts affected more than 1 billion people, or 25% of the global total of persons affected by disasters, between 1994 and 2013, but represented only 5% of disaster events. Approximately 41% of drought disasters were in Africa, indicating that low-income countries are overwhelmed even though drought early warning systems are in place. In the United States, drought leads in economic impact, causing losses of $6 billion to $8 billion per year. Worldwide, droughts have led to famines, resulting in large numbers of deaths and displacements. Increasing desertification in arid areas may be contributing to droughts. Desertification, or decline in biologic productivity, extends to 70% of total productive arid lands (3.6 billion acres worldwide) and may adversely affect the quality of life for 10% of the world's population, including urban dwellers.

BOX 85-1 Essentials of a Preparedness Plan for Rapid-Onset Disasters

1. Identification and mapping of the hazard zones; registration of valuable and movable property
2. Identification of safe refuge zones to which the population and critical movable assets will be evacuated in case of danger
3. Identification and maintenance of evacuation routes
4. Identification of assembly points for persons awaiting transport for evacuation
5. Means of transport and traffic control
6. Shelter and accommodation in the refuge zone
7. Inventory of personnel and equipment for search and rescue
8. Hospital and medical services for treatment of injured persons
9. Security in evacuated areas
10. Formulation and communication of public warnings and procedures for communication in emergencies
11. Longer-term recovery plans (e.g., social services for trauma victims)
12. Provisions for revising and updating the plan

Climate change associated with global warming is predicted to occur over the next 100 years as a result of increased atmospheric carbon dioxide (CO_2) caused by the burning of fossil fuels, deforestation, and generation of methane. Ultimately, sea levels will rise and coastal cities worldwide will be inundated. A rise of 1 m (3.3 feet) in sea levels could flood 15% of the arable land in Egypt's Nile Delta and completely submerge the tiny islands of the Maldives, currently inhabited by 200,000. Hundreds of millions of people will also be affected if increased ultraviolet radiation is delivered to Earth's surface as a result of stratospheric ozone depletion caused by continued release of chlorofluorocarbons (CFCs).

Although global warming and ozone depletion are threats that may become more evident in the future, other forms of environmental pollution, such as water and air pollution, have immediate effects on life today. Massive oil spills, such as the 2010 leakages in the Gulf of Mexico, make headlines, and adverse health effects are seen from contamination and smog. Deforestation, particularly in the tropical rainforests, is highly significant. In addition to its contribution to possible global warming, loss of forested land increases vulnerability to droughts, landslides, and floods.

ASSESSING VULNERABILITY AND RISK

Not all hazards become disasters. Whether or not a disaster occurs depends on the magnitude, intensity, and duration of the event and vulnerability of the community. For example, a severe earthquake is not a disaster unless it significantly disrupts a community by creating large numbers of casualties and substantial destruction. Effective disaster risk management requires information about magnitude of the risk faced and how much importance society places on reduction of that risk. Risks are often quantified in aggregated ways (e.g., a probability of 1 in 23,000 per year of dying in an earthquake in Iran). The importance placed on the risk for a hazard is likely to be influenced by the nature of the risks faced on a daily basis. For instance, in Pakistan, where communities are regularly affected by floods, earthquakes, and landslides, people use their meager resources to protect against what they perceive to be the greater risks, such as disease and irrigation failure. In California, where the risk for disease is low, communities choose to initiate programs against natural disasters.

Vulnerability is defined as the conditions determined by the physical, social, economic, and environmental factors that increase the susceptibility of communities to the impact of hazards. Roles of men and women in society are also determinants of how each will be affected by different hazards, and how they will cope and recover from disasters. Many aspects of vulnerability cannot be described in monetary terms and should not be overlooked. These include personal loss of family, home, and income, along with related human suffering and psychosocial problems. Although communities in developed nations may be as prone to hazards as those living in poorer nations, wealthier communities are often less vulnerable to damage. For example, although both southern California and Managua, Nicaragua, are prone to earthquakes, California is less vulnerable to damage because of strictly enforced building codes, zoning regulations, earthquake preparedness training, and sophisticated communications systems. In 1971, the San Fernando earthquake in California measured 6.4 on the Richter scale but caused minor damage and 58 deaths, whereas an earthquake of similar magnitude that struck Managua 2 years later reduced the center of the city to rubble, killing approximately 6000 people. Similarly, in wealthy countries, drought and resulting loss of food production and groundwater are managed by use of food surpluses and treated water, but drought in poor nations often leads to deaths from famine, as well as sickness and death from contaminated water supplies.

DISASTER MITIGATION STRATEGIES

Mitigation is the effort to reduce loss of life and property from the impact of a disaster by taking action before the next disaster. Mitigation measures are most effective when all citizens understand local risks and make choices to support investments in long-term community and personal well-being. Where resources for mitigation are limited, they should be directed toward protecting the most vulnerable elements. Vulnerability also implies a lack of resources for rapid recovery.

For most risks associated with natural geophysical hazards, such as volcanic eruptions, tsunamis, and tropical cyclones, little or no opportunity is available to reduce the hazard itself. In these cases, emphasis must be placed on reducing the vulnerability of the elements at risk. However, for technologic and human-made hazards or slow-onset hazards, such as environmental pollution and desertification, reducing the hazard is likely to be the most effective mitigation strategy.

Two key aspects of mitigation are risk analysis and risk reduction. Risk analysis may include hazard mapping and multihazard mitigation planning. Risk reduction measures include floodplain management, safety programs, and hazard reduction programs. Mitigation actions by planning authorities and communities to reduce vulnerability can be active, in which desired actions are promoted through incentives, or passive, in which undesired actions are prevented by use of controls and penalties. Discussion of mitigation options follows.

ENGINEERING AND CONSTRUCTION

Engineering measures range from large-scale engineering works to strengthening individual buildings and implementing small-scale community-based projects to incorporate better protection into traditional structures, such as buildings, roads, and embankments.

PHYSICAL PLANNING MEASURES

Careful placement of new facilities, particularly community facilities such as schools, hospitals, and infrastructure elements, plays an important role in reducing the settlement vulnerability. In urban areas, deconcentration of elements especially at risk is an important principle. Specific procedures include hazard mapping and development of a master plan containing land use control guidelines. Hazard occurrence probabilities can be extrapolated from historical data and used to create hazard maps to show regional variation. Hazard mapping can be detailed by an inventory of people or things that are exposed or vulnerable to the hazard. In France, a plan called the Zones Exposed to Risks of Movements of the Soil and Subsoil produces landslide hazard maps at scales of 1:25,000 or larger that are used as tools for mitigation planning. The maps portray degrees of risk for various types of landslides, including activity, rate, and potential consequences.

ECONOMIC MEASURES

The linkages among different sectors of the economy may be more severely disrupted than the physical infrastructure. Diversifying and strengthening the economy are important ways to reduce risks. Within a strong economy, governments can use economic incentives to encourage individuals or institutions to take disaster mitigation actions. Increasing emphasis is being placed on securing contributions from the private sector to disaster risk reduction. Following the Indian Ocean tsunami of 2004, many beachside hotels in Thailand augmented awareness programs for clients and local communities and contributed to strengthening warning systems.

LEGISLATION, MANAGEMENT, AND INSTITUTIONAL MEASURES

The countries most affected by the 2004 Indian Ocean tsunami (Indonesia, Sri Lanka, Thailand, and the Maldives) have passed new disaster legislation that sets out general parameters for preparedness, response, and recovery. The resulting laws stipulate roles and responsibilities for members of government disaster systems, such as ministries and municipalities. These governments have also elaborated standard operating procedures and

initiated drills. Myanmar (Burma) enacted a Natural Disaster Management Law in July 2013 and approved establishment of a Disaster Management Training Center in the Ayeyarwady Region, hardest hit by Cyclone Nargis in 2009. Creating disaster protection takes time and requires support from programs of education, training, and institution building to provide the required professional knowledge and competence. Improved forecasting and development of warning systems are critical protective measures.

SOCIETAL MEASURES

Mitigation planning should aim to develop a "safety culture" in which all members of society are aware of the hazards they face, know how to protect themselves, and support the protection efforts of others and the community as a whole. Specifically, these societal measures include conducting community education programs and planning and practicing evacuation procedures.

THE NATURE OF HAZARDS

Some hazards exist naturally, and others are partially rooted in natural systems. Many of these occur infrequently or affect only small populations. One example is the eruption of toxic gases from several volcanic lakes in Cameroon that killed 2000 people in 1984 and 1986. Other rare events, such as meteor impacts, may occur only once every few centuries. Additional widespread but minor phenomena that damage property but do not generally cause loss of life include land subsidence and sinkholes. Some hazards, such as snowstorms, often occur in areas that are prepared to deal with them, and thus they rarely become disasters.

This chapter discusses hazards that affect large populations and that can be categorized as follows:

- Geologic hazards—earthquakes, tsunamis, volcanic eruptions, landslides
- Climatic hazards—tropical cyclones, tornadoes, floods, drought, winter storms
- Environmental hazards—environmental pollution, deforestation, desertification

To plan appropriate responses to implement emergency medical care and other measures to save or restore the physical and mental health of affected populations, governments and communities first need to understand the causal phenomena, characteristics, predictability of the hazards, and factors that contribute to vulnerability. Examination of the hazard's effects on humans, property, and the environment can promote measures to prevent or lessen casualties and destruction.

GEOLOGIC HAZARDS

EARTHQUAKES

Earthquakes are among the most destructive and feared of natural hazards. They may occur at any time of year, day or night, with sudden impact and little warning. They can destroy buildings in seconds, killing or injuring the inhabitants. Earthquakes not only destroy entire cities but may destabilize the government, economy, and social structure of a country.

Causal Phenomena

Earth's crust is a rock layer varying in thickness from a depth of about 5 to 10 km (3.1 to 6.2 miles) under the oceans to 70 km (43.5 miles) under the continents. The theory of plate tectonics holds that seven or eight major and many minor crustal plates, varying in size from a few hundred to many thousands of kilometers, "ride" on Earth's mobile mantle. When the plates contact each other, stresses arise in the crust. Stresses occur along the plate boundaries by pulling away from, sliding alongside, and pushing against one another. All these movements are associated with earthquakes.

Faults are areas of stress at plate boundaries that release accumulated energy by slipping or rupturing. Elastic rebound occurs when the maximum point of supportable strain is reached and a rupture occurs, allowing the rock to rebound until the strain is relieved (Figure 85-1). Usually, the rock rebounds on both sides of the fault in opposite directions. The point of rupture is called the *focus* and may be located near the surface or deep below it. The point on the surface directly above the focus is termed the *epicenter* (Figure 85-2).

The energy generated by an earthquake is not always released violently and can be small or gradual. Minor Earth tremors are recorded daily in the United States, but whether these are caused by the same processes that can level a city is not known. Most damaging earthquakes are associated with sudden ruptures of the crust.

Characteristics

The actual rupture process may last from a fraction of a second to a few minutes for a major earthquake. Seismic (from the Greek *seismos,* meaning "shock" or "earthquake") waves are generated. These last from less than one-tenth of a second to a few minutes and cause ground shaking. The seismic waves propagate in all directions, causing vibrations that damage vulnerable structures and infrastructure elements.

There are three main types of seismic waves. The body waves (P, or primary, and S, or secondary) penetrate the body of Earth, vibrating quickly (Figure 85-3). P waves travel at an average of about 6 km per second (kps) (3.7 miles per second [mps]) and provide the initial jolt that causes buildings to vibrate up and down. S waves travel about 4 kps (2.5 mps) in a movement similar to the snap of a whip, causing a sharper jolt that vibrates structures from side to side and usually results in the most destruction. Surface waves (L waves) vibrate the ground horizontally and vertically and cause swaying of tall buildings, even at great distances from the epicenter.

The earthquake focus depth is an important factor in determining the characteristics of the waves. The focus depth can be deep (from 300 to 700 km [186 to 435 miles]) or shallow (< 70 km [43 miles]). Shallow-focus earthquakes are extremely damaging because of their proximity to the surface. The earthquake may be preceded by preliminary tremors and followed by aftershocks of decreasing intensity.

Earthquake Scales

Earthquakes can be described by using two distinctly different scales of measurement demonstrating magnitude and intensity. The earthquake magnitude, or amount of energy released, is determined by using a seismograph, which records ground vibrations. The Richter scale mathematically adjusts the readings for distance of the instrument from the epicenter. The Richter scale is logarithmic; an increase of one magnitude signifies a 10-fold increase in ground motion, or about 30 times the energy. Thus, an earthquake with a Richter magnitude of 7.5 releases 30 times more energy than one with a 6.5 Richter magnitude. The smallest quake to be felt by humans was of magnitude 3.0. The largest earthquakes that have been recorded under this system are 9.5 (Chile, 1960) and 9.25 (Alaska, 1969).

The *moment magnitude scale* is a successor to the Richter scale and is most often used to estimate large earthquake magnitudes. Theoretically, all magnitude scales should yield approximately the same value for any given earthquake. However, measurement of the great Indian Ocean earthquake that occurred on December 26, 2004, generating a tsunami that killed more than 280,000 people, produced estimates by various institutions using different scales. The current official magnitude is generally considered to be 9.1 to 9.3. It was the third-largest earthquake ever recorded on a seismograph, with the longest duration of faulting between 8.3 and 10 minutes.

The earthquake intensity scale measures the effects of an earthquake where it occurs. The most widely used scale of this type is the Modified Mercalli Intensity Scale, which expresses the intensity of earthquake effects on people, structures, and Earth's surface in values from I to XII (Table 85-1). Another, more explicit, scale used in Europe is the Medvedev-Sponheuer-Karnik scale.

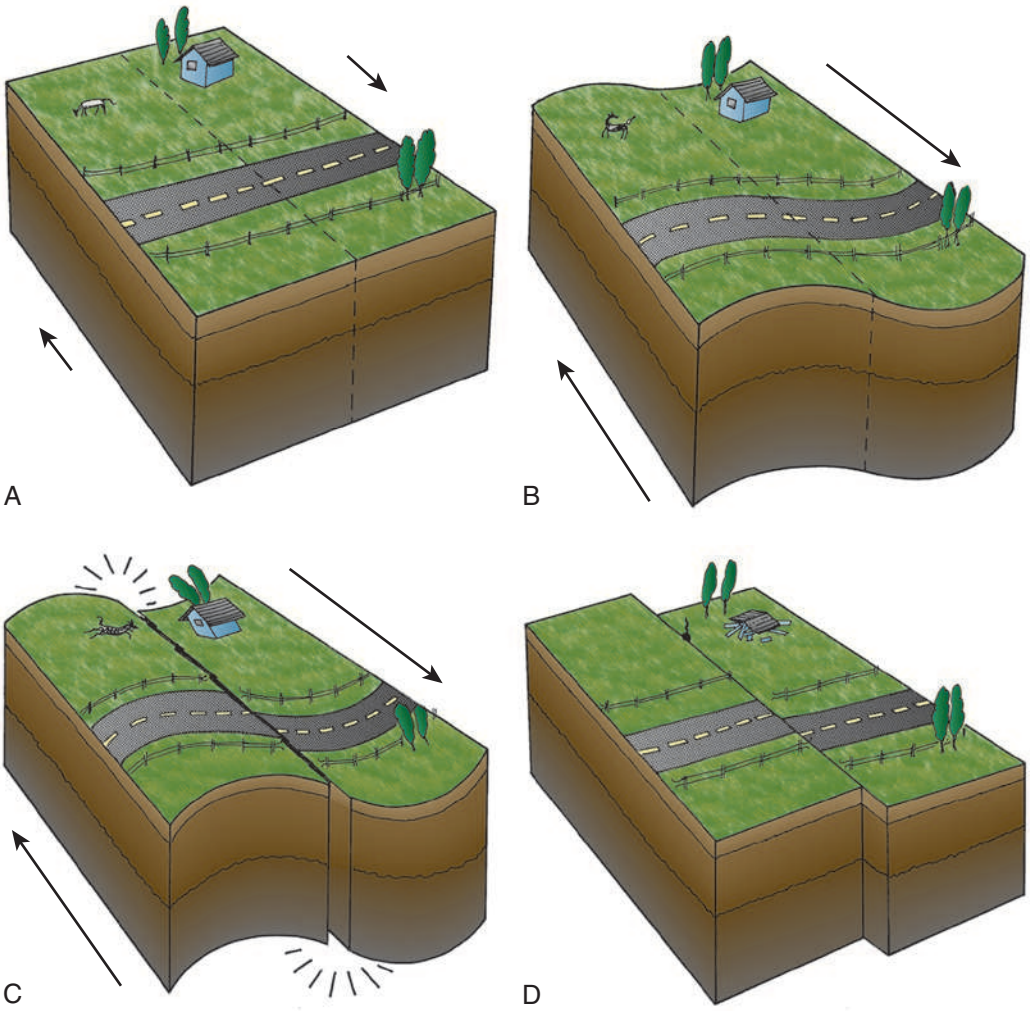


FIGURE 85-1 Elastic rebound in earthquake. **A,** Forces build up over time. **B,** Crust deforms. **C,** Crust snaps. **D,** Plates slide.

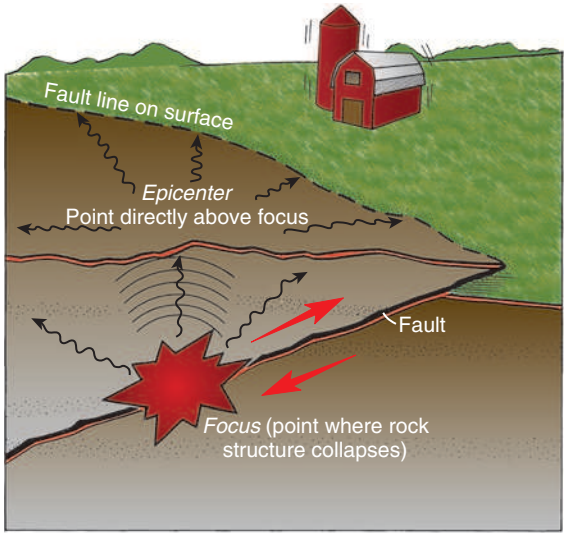


FIGURE 85-2 Motion of Earth's plates causes increased pressure at faults where the plates meet. Eventually, the rock structure collapses, and movement occurs along the fault. Energy is propagated to the surface above and radiates outward. Waves of motion in Earth's crust shake landforms and buildings, causing damage. *(Courtesy Disaster Management Center, University of Wisconsin–Madison.)*

Location and Predictability

Most earthquakes (95%) occur in well-defined zones near the boundaries of the tectonic plates. These areas bordering the Pacific Ocean are called the circum-Pacific belt. Areas traversing the East Indies, the Himalayas, Iran, Turkey, and the Balkans are called the Alpide belt. Earthquakes also occur along the ocean trenches, such as those around the Aleutian Islands, Tonga, Japan, and Chile and within the eastern Caribbean. Some earthquakes occur in the middle of the plates, possibly indicating where earlier plate boundaries might have been. These have included the New Madrid earthquake in 1811 and the Charleston earthquake in 1816 in the United States, the Agadir earthquake in 1960 in Morocco, and the Koyna earthquake in 1967 in India.

Earthquake prediction was a constant preoccupation for early astrologers and prophets. Some signs of earthquake noted by observers were buildings gently trembling, animals and birds becoming excited, and well water turning cloudy and smelling bad. Although some modern scientists claim the ability to predict earthquakes, the methods are still controversial. In fact, no earthquake has ever been precisely predicted. Rather, probabilities are calculated. For example, over the next 30 years, there is a 67% chance of an earthquake in the San Francisco Bay area. Earthquakes that have not been predicted include the 1995 earthquake in Kobe, Japan, which killed more than 5000 people, and the 2011 Tohoku earthquake. The high probability of a devastating earthquake in the Kathmandu Valley had long been discussed. The Gorkha earthquake (7.8 magnitude) in Nepal of April 2015 released some of the tectonic strain; nevertheless, considerable seismic pressure still exists in the region.

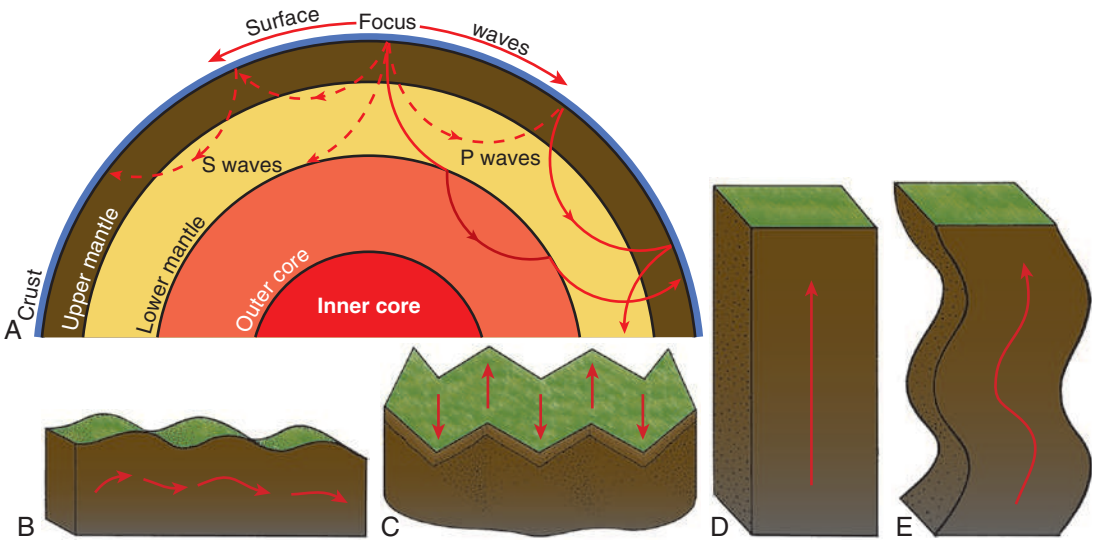


FIGURE 85-3 **A,** Propagation of seismic waves in an earthquake. Surface waves vibrate the ground horizontally **(B** and **C)** and vertically **(D** and **E).**

Fortunately, mechanical observation systems make it possible to issue warnings to nearby populations immediately after detection of an earthquake. Reasonable risk assessments of potential earthquake activity can be made with confidence based on the following:

- Knowledge of seismic zones or areas most at risk, gained through study of historical incidence and plate tectonics
- Monitoring of seismic activity by use of seismographs and other instruments (the U.S. Geological Survey monitors global seismic activity through 2150 seismic stations)
- Use of community-based, scientifically sound observations, such as elevation and turbidity of water in wells and radon gas escape into well water

The island of Hispaniola, shared by Haiti and the Dominican Republic, has a history of destructive earthquakes. In January 2010, a magnitude 7.0 earthquake occurred approximately 25 km (16 miles) west-southwest from the capital city Port-au-Prince at a depth of 13 km (8.1 miles). Two years before this, scientists had detected signs of growing stresses in the fault that forms a boundary between the Gonave microplate and the Caribbean plate to the south, specifically the Enriquillo-Plantain Garden fault system, which includes much of Haiti. They warned Haitian officials that the fault was capable of causing a 7.2 magnitude earthquake, only slightly stronger than the actual 7.0 earthquake that eventually occurred. Unfortunately, 2 years is little time to prepare for such an event in a country like Haiti, which endures

TABLE 85-1 Modified Mercalli Intensity Scale of 1931

Scale	Description
I	Not felt except by very few persons under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor vehicles may rock slightly. Vibration similar to passing of truck. Duration estimated.
IV	During the day felt indoors by many but outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation resembles heavy truck striking building. Standing motor vehicles rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken. A few instances of cracked plaster. Unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, considerable in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motor vehicles.
VIII	Damage slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, and walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor vehicles disturbed.
IX	Damage considerable in specially designed structures. Well-designed structures thrown out of plumb, greatly in substantial buildings with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed. Most masonry and frame structures with foundations destroyed; ground severely cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.

widespread poverty and lacks resources for preparedness and mitigation. A legacy of poor building standards has increased vulnerability and cannot be easily remedied.

Earthquake Hazards

Earthquakes produce many direct, and sometimes indirect, effects. Landslides, flooding, and tsunamis are considered secondary hazards and are discussed later in this chapter.

Fault Displacement and Ground Shaking. Fault displacement, either rapid or gradual, may damage foundations of buildings on or near the fault area or may displace the land, creating troughs and ridges. The March 2011 Tohoku earthquake off the coast of Japan was the fifth strongest on record (9.0) and moved the entire island of Honshu 8 feet eastward. Ground shaking causes more widespread damage, particularly to the built environment. The extent of the damage is related to the size of the earthquake, closeness of the focus to the surface, buffering power of the area's rocks and soil, and type of buildings being shaken. The Northridge, California, quake in 1994 was one of the most costly, producing $44 billion in damage, due to the position of the event directly below a population center.

Aftershocks may cause further damage and may recur for weeks or even years after the initial event. The Kashmir earthquake (also known as the Northern Pakistan earthquake) occurred on October 8, 2005, and registered 7.6 on the moment magnitude scale. Affecting three countries, this earthquake killed more than 90,000 people. Between October 2005 and February 2006, there were more than 978 aftershocks of magnitude 4.0 or above.

Ground Failure and Soil Liquefaction. Seismic vibrations may cause settlement beneath buildings when soils consolidate or compact. Certain types of soil, such as alluvial and sandy soils, are more vulnerable to failure. Liquefaction is a type of ground failure that occurs when saturated soils lose strength and collapse or become liquefied. During the 1964 earthquake in Nigata, Japan, the ground beneath earthquake-resistant buildings became liquefied, causing the buildings to lean up to 45 degrees from vertical. Most of these buildings were later jacked upright and reoccupied. In the 2001 earthquake in the Bhuj area of Gudjarat, western India, many reservoir dams were damaged because of water-saturated alluvial foundations.

Lateral Spreads and Flow Failure. Lateral spreads involve the lateral movement of large blocks of soil as a result of liquefaction in a subsurface layer. During the 1964 Alaska earthquake, more than 200 bridges were damaged or destroyed by lateral spreading of flood plain deposits toward river channels. In the 1906 San Francisco earthquake, major pipelines were broken by lateral spreading, hampering efforts to fight fires. In 1989, the Marina District in San Francisco, built on soft landfill, was damaged by lateral spreading from the Loma Prieta earthquake.

Flow failure, in which either a layer of liquefied soil rides on top of another layer or blocks of intact material ride on top of liquefied soil, can be catastrophic. Some of the most damaging flow failures have occurred underwater in coastal areas, carrying away large sections of port facilities and generating large sea waves. Some flow failures on land have been as much as a mile in length and breadth, such as those induced by the 1920 earthquake in Gansu, China, which killed 200,000 people.

Landslides and Avalanches. Slope instability may cause landslides and snow avalanches during an earthquake. Steepness, weak soils, and the presence of water may contribute to vulnerability from landslides. Liquefaction of soils on slopes may lead to disastrous slides. The most abundant types of earthquake-induced landslides are rockfalls and rockslides, usually originating on steep slopes. The Kashmir earthquake of 2005 was characterized by numerous landslides that blocked access by assistance organizations to people in high mountain areas. The Nepal earthquake of April 2015 triggered avalanches on Mt Everest, killing 19 members of various climbing expeditions at the south base camp, the highest death toll in 1 day related to Everest climbing.

Tsunamis. Tsunamis may be generated by undersea or near-shore earthquakes and may break over the coastline with great destructive force. The Indian Ocean tsunami of December 2004 that devastated Banda Aceh, Indonesia, was generated by an earthquake occurring 240 km (149 miles) off the coast of Sumatra at the boundary between the Indian and Burmese tectonic plates in the Sumatra-Andaman subduction zone. A second earthquake of 8.7 magnitude occurred along the same fault in March 2005, but this event produced a much smaller tsunami (4 m [13 feet] versus 9 m [30 feet] in height). The December 2004 earthquake ruptured a longer segment of the fault and occurred in much deeper water, creating a larger movement of the sea floor.

Fires. One of the most destructive consequences of an earthquake is fire, particularly in urban centers. Great postearthquake fires played a major role in the destruction of Lisbon, Portugal, in 1755 and San Francisco in 1906, and caused considerable damage in Kobe, Japan, in 1995. The million wooden buildings in Tokyo pose a major risk of fire if an earthquake strikes, as is predicted to occur in the next few decades.

Typical Adverse Effects

Ground shaking can damage human settlements, buildings, infrastructure elements (particularly bridges), elevated roads, railways, water towers, water treatment facilities, utility lines, pipelines, electricity-generating facilities, and transformer stations. Aftershocks can do great damage to already weakened structures. Significant secondary effects include fires, dam failures, and landslides, which may block waterways and cause flooding. Flooding may also be caused by seiches (back-and-forth wave actions in bays) or by failures in dams and levees. Damage may occur to facilities that use or manufacture dangerous materials, resulting in chemical spills. Communications facilities may break down. Destruction of property may have a serious impact on shelter needs, economic production, and living standards of the affected community. Depending on their level of vulnerability, many people may be homeless in the aftermath of an earthquake.

The casualty rate is often high, especially when earthquakes occur in areas of high population density, particularly when streets between buildings are narrow, buildings are not earthquake resistant, the ground is sloping and unstable, or adobe or dry stone construction is used, with heavy upper floors and roofs.

Casualty rates may be high when quakes occur at night because the preliminary tremors are not felt during sleep and people are not tuned in to receive media warnings. In the daytime, people are particularly vulnerable in large unsafe structures such as schools and offices. Casualties generally decrease with distance from the epicenter. As a rule of thumb, quakes result in three times as many injured survivors as persons killed. The proportion of dead may be higher with major landslides and other secondary hazards. In areas where houses are of lightweight construction, especially with wood frames, casualties are generally much fewer, and earthquakes may occur regularly with no serious, direct effects on human populations.

The most widespread acute, serious medical problems are broken bones. Other health threats may occur with secondary flooding, when water supplies are disrupted (earthquakes can change levels in the water table) and contaminated water is used or water shortages exist, and when people are living in high-density relief camps, where epidemics may develop or food shortages exist.

In the aftermath of the Colombia earthquake of January 1999, which most heavily affected the city of Armenia, the death toll was 1185 and 160,000 people were left homeless, most in urban areas. In Armenia, where 60% to 70% of homes had been destroyed, movement was restricted by fallen debris and unemployment rose from 12% to 35%. People were living in unsatisfactory shelters made with plastic sheeting. Many migrated from the area to other places that could not absorb them. Although the international response to aid Colombia was strong, the overwhelming need continued to pose problems. Five weeks after the earthquake, supplies of food, clean drinking water, and shelter materials were still urgently required. Hygiene and sanitation services and essential medicines were desperately needed. Social services were required to work toward normalizing the lives of victims, especially children. In Gujarat, India, where

FIGURE 85-4 Nurse attending earthquake casualties in Haiti. *(Courtesy Pan America Health Organization.)*

30,000 people died in 2001, assistance agencies struggled for years to help rebuild the more than 300,000 houses that were lost. In the Kashmir earthquake of 2005, 3.3 million persons were left homeless in Pakistan, and many of them were at risk of dying from the winter cold and spread of disease.

The January 2010 Haiti earthquake affected an estimated 3 million people. It killed approximately 100,000 persons and injured approximately 300,000, although estimates of casualties widely vary. More than 1 million Haitians were left homeless. Vital elements of the infrastructure that were necessary for responding to the disaster, including air, sea, and land transport facilities and communication systems, were severely damaged or destroyed. Treatment of the injured was hampered by the lack of hospitals and morgue facilities; bodies were left to decay on the streets for many days. International assistance was offered in abundance, but the logistic capabilities in Haiti for receiving emergency aid were limited. Doubtless, more lives were lost as a result of this vulnerability (Figures 85-4 and 85-5).

Earthquake Risk Reduction Measures

Earthquake warning systems currently in use warn of an earthquake that has already occurred. Examples include those that notify the high-speed trains in Japan, which if derailed would cause hundreds of deaths. One minute before the 2011 Tohoku earthquake was felt in Tokyo, 1000 seismometers sent out warnings that saved many lives. In California, it is technically feasible to develop a system that could warn Los Angeles up to a minute before the arrival of the seismic waves, allowing certain preventive actions, such as taking cover, to occur. However, because predicting the location, time, and magnitude of earthquakes is still likely many years away, warning systems and earthquake prevention measures are currently not reliable alternatives to preparedness. Preparedness actions include the following:

- Locating critical facilities such as hospitals and communications systems in safe locations, as through microzonation.
- Creating and enforcing building codes, building earthquake-resistant structures, and retrofitting older buildings: In Afghanistan, many new mud brick homes built by assistance organizations for returnees after 2003 were fitted with economical and relatively simple corner wall and ceiling braces and window lintels that reduced their vulnerability to ground shaking and collapsing roofs (Figure 85-6).
- Providing public education about the earthquake risk and ways of personally adjusting to it: Education in the form of drills in schools and government buildings helps to spread the preparedness attitude. People may choose to buy insurance, although it is likely to be expensive due to the high risks. Probably the most effective measures are personal and family plans for protecting lives and property, including exactly what to do when ground shaking begins.

Risk Reduction in China. The 2008 Sichuan earthquake in China, also known as the Great Wenchuan earthquake, resulted in more than 88,000 dead and missing persons, with 4.8 million persons left homeless. The epicenter was near Chengdu city in central China; however, most casualties were in rural towns and villages. Thousands of schoolchildren died due to shoddy school construction, and the giant panda habitat was threatened. Rescue efforts were hindered by high terrains and rainstorms.

The China Earthquake Administration and the other disaster management bodies in China documented lessons with international support in joint publications. These lessons have been incorporated into intensive mitigation measures undertaken by the government nationwide in the aftermath of the earthquake. An example is the European Union–China Disaster Risk Management cooperation, which supports joint training for search and rescue and establishment of protocols and coordination mechanisms.

FIGURE 85-5 Makeshift hospital in Haiti. *(Courtesy Pan America Health Organization.)*

FIGURE 85-6 Earthquake-resistant lintels in Afghanistan. *(Courtesy Sheila B. Reed.)*

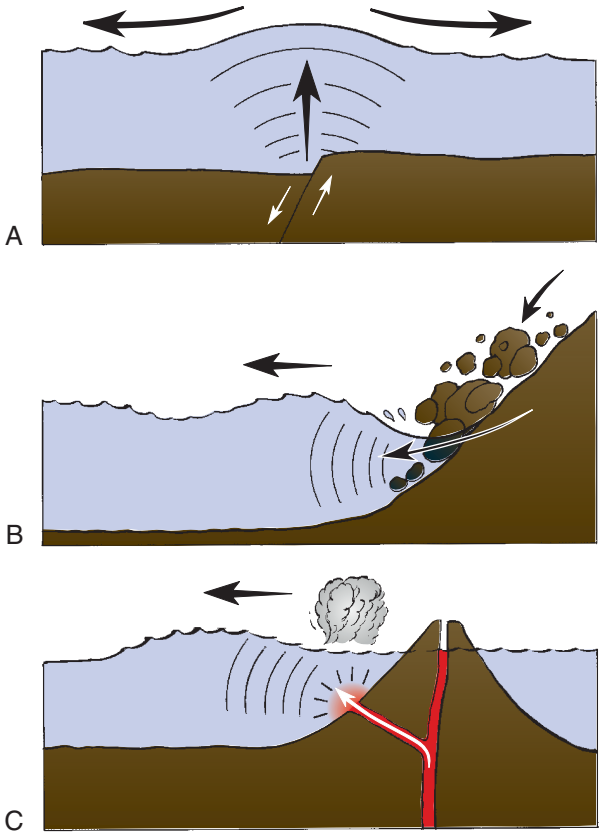


FIGURE 85-7 Tsunamis are produced in three ways. **A,** Fault movement on the sea floor. **B,** Landslide. **C,** Submarine explosion from volcanic eruption.

TSUNAMIS

Tsunami is a Japanese word meaning "harbor wave." Although tsunamis are sometimes called "tidal waves," they are unrelated to the tides. The waves originate from undersea or coastal seismic activity, landslides, and volcanic eruptions. They ultimately encroach over land with great destructive power, often affecting distant shores.

Causal Phenomena and Characteristics

The geologic movements that cause a tsunami are produced in three major ways (Figure 85-7). The foremost cause is fault movement on the sea floor, accompanied by an earthquake. The second most common cause is a landslide occurring underwater or originating above the sea and then plunging into the water. The highest tsunamis ever reported were produced by a landslide at Lituya Bay, Alaska, in 1958. A massive rockslide produced a wave that reached a high-water mark of 530 m (1740 feet) above the shoreline. A third cause of a tsunami is volcanic activity, which may uplift the flank of the volcano or cause an explosion.

Tsunamis differ from ordinary deep ocean waves, which are produced by wind blowing over water. Normal waves are rarely longer than 300 m (984 feet) from crest to crest. Tsunamis, however, may measure 150 km (90 miles) between successive wave crests. Tsunamis also travel much faster than ordinary waves. Compared with the normal wave speed of around 100 km/hr (62 mph), tsunamis in the deep water of the ocean may travel at the speed of a jet airplane—800 km/hr (497 mph). Despite their speed, tsunamis increase the water height only 30 to 45 cm (12 to 18 inches) and often pass unnoticed beneath ships at sea. In 1946, a ship's captain on a vessel lying offshore near Hilo, Hawaii, claimed he could feel no unusual waves beneath him, although he saw them crashing on the shore.

Contrary to popular belief, a tsunami is not a single giant wave. A tsunami can consist of 10 or more waves, termed a *tsunami wave train*. The waves follow each other in 5- to 90-minute intervals. As tsunamis approach the shore, they travel progressively slower. The final wave speed depends on the water depth. Waves in 18 m (59 feet) of water travel about 50 km/hr (31 mph). The shape of the near-shore sea floor influences how tsunami waves behave. Where the shore drops off quickly into deep water, the waves are smaller. Areas with long shallow shelves, such as the major Hawaiian Islands, allow formation of very high waves. In the bays and estuaries, seiches, in which the water sloshes back and forth, can amplify waves to some of the greatest heights ever observed.

On shore, the initial sign of a tsunami depends on what part of the wave first reaches land; a wave crest causes a rise in the water level, and a wave trough causes a recession. The rise may not be significant enough to be noticed by the general public. Observers are more likely to notice the withdrawal of water, which may leave fish floundering on the exposed sea floor. A tsunami does not always appear as a vertical wall of water, known as a *bore,* as is typically portrayed in drawings. More often, the effect is that of an incoming tide that floods the land. Normal waves and swells may ride on top of the tsunami wave, or the tsunami may roll across relatively calm inland waters.

The flooding produced by a tsunami may vary greatly from place to place over a short distance, depending on the submarine topography, shape of the shoreline, reflected waves, and modification of waves by seiches and tides. The Hilo, Hawaii, tsunami of 1946, originating in the Aleutian Trench, produced 18-m (59-foot) waves in one location and waves of only half that height a few miles away. The sequence of the largest wave in the tsunami wave train also varies, and the destructiveness is not always predictable. In 1960 in Hilo, many people returned to their homes after two waves had passed, only to be swallowed up in a giant bore that, in this case, was the third wave.

Predictability

Tsunamis have occurred in all oceans and in the Mediterranean Sea, but the majority of them occur in the Pacific Ocean. The zones stretching from New Zealand through East Asia, the Aleutians, and the western coasts of the Americas all the way to the South Shetland Islands are characterized by deep ocean trenches, explosive volcanic islands, and dynamic mountain ranges.

Prior to 1946, the recorded effects of tsunamis included only local casualties and significant damage. The Tsunami Warning System (TWS) was developed in Hawaii shortly after the 1946 Hilo tsunami and is headquartered in the Pacific Tsunami Warning Center in Honolulu. There are 26 member countries in the Pacific basin. The TWS works by monitoring seismic activity from a network of seismic stations. A tsunami is almost always generated by an undersea earthquake of magnitude 7.0 or greater. Therefore, special warning alarms sound when a quake measuring 6.5 or more occurs anywhere near the Pacific. A tsunami watch is declared if the epicenter is close enough to the ocean to be of concern. Government and voluntary agencies are alerted, and local media are activated to broadcast information. The five nearest tide stations monitor their gauges, and trained observers watch the waves. With positive indicators, a tsunami warning is issued.

The TWS met with general success in saving lives during the tsunamis of 1952 and 1957 in Hawaii. In 1960, however, two major earthquakes occurring a day apart rocked the coast of Chile in South America. The first registered 7.5 on the Richter scale and produced a small but noticeable wave in Hilo Bay. The second registered a stunning 8.5, more than 30 times the energy of the first, and authorities predicted generation of a large, destructive tsunami. When the waves hit Hilo, 15 hours after the earthquake, not all the public had taken the warnings seriously, and 61 people were killed. About 7 hours later, the tsunami struck Japan, killing 180. By the time that information of conditions in Chile reached the TWS, three giant waves had already destroyed villages along an 805-km (500-mile) stretch of coastal South America, arriving only 15 minutes after the earthquake.

Lack of an effective warning system has been blamed for the extensive loss of life from the tsunami generated in the Indian Ocean in December 2004. Over 290,000 people are estimated to

have died in 11 countries, and thousands more remain missing. Tsunamis have been relatively rare in the Indian Ocean, and the area has no international warning system. The first tsunami-generated wave crashed into Sumatra only 30 minutes after shaking from the earthquake had subsided. The tsunami ultimately traveled nearly 5000 km (3107 miles) to Africa. In contrast to stronger preparedness levels in the Pacific countries, citizens and tourists were not fully aware of the dangers and many watched from the beach with catastrophic results. In Kobe, Japan, the World Conference on Disaster Reduction in January of 2005 laid the groundwork for the first tsunami warning system in the Indian Ocean, much of which was positioned in recent years. Indonesia has set up costly and sophisticated tsunami warning systems and carried out numerous drills. However, 400 people were killed in an October 2010 tsunami on the Mentawai Islands, indicating that those most at risk are not able to receive warnings through communications systems or cannot flee from a tsunami generated close to shore.

FIGURE 85-9 Boat perched on a house near Banda Aceh, Indonesia, following the December 2004 tsunami. *(Courtesy Sheila B. Reed.)*

Vulnerability

The following major factors contribute to vulnerability to tsunamis:

- A growing world population, increasing urban concentration, and larger investments in the infrastructure, particularly in coastal regions, with some settlements and economic assets in low-lying coastal areas
- Lack of tsunami-resistant buildings and site planning
- Lack of a warning system or lack of sufficient education for the public to create awareness of the effects of a tsunami
- Unpredictable intensity of tsunamis

Typical Adverse Effects

The force of water in a bore, with pressures up to 10,000 kg/m^2, can raze everything in its path. The flooding from a tsunami, however, affects human settlements most, by water damage to homes, businesses, roads, and infrastructure elements. Withdrawal of the tsunami also causes significant damage. As the water is dragged back toward the sea, bottom sediments are scoured out, causing piers and port facilities to collapse and sweeping out the foundations of buildings. Entire beaches have disappeared, and houses have been carried out to sea. Water levels and currents may change unpredictably, and boats of all sizes may be swamped, sunk, or battered (Figures 85-8 to 85-10). The 2011 Tohoku earthquake generated a major tsunami that struck Sendai, Japan, traveling 10 km (6 miles) inland and precipitating nuclear accidents in the Fukushima Daiichi Nuclear Power Plant. Level-seven meltdowns occurred in three reactors. More than 100,000 persons were evacuated and not able to return to their homes due to continuously leaking radiation. Due to rapid evacuation and quarantine of the meltdown area, no deaths have yet been attributed to this nuclear accident, which was the second most serious on record (after Chernobyl in 1986). The earthquake and tsunami resulted in 15,900 deaths, with 2500 persons still missing. Most deaths were from drowning due to the tsunami, and very few from the earth shaking. Japan's stringent building codes and early warning system effectively stopped high-speed trains and factories; residents received cell phone warning texts.

Casualties and Public Health. Deaths occur principally from drowning as water inundates homes or neighborhoods. Many people may be washed out to sea or crushed by the giant waves. Injuries occur from battering by debris. Little evidence exists of tsunami flooding directly causing large-scale health problems. Rapid effective assistance to the Banda Aceh (Indonesia) area in early 2005 prevented widespread outbreaks of disease in displacement camps (Figure 85-11). Malaria mosquitoes may increase because of water trapped in pools. Open wells and other groundwater may be contaminated by saltwater and debris or sewage. Normal water supplies may be inaccessible for days because of broken water mains.

Crops and Food Supplies. Flooding and damage by tsunami waves may result in the following:

- Harvests may be lost, depending on the time of year
- Land may be rendered infertile from saltwater incursion from the sea
- Food stocks not moved to high ground are damaged
- Animals not moved to high ground may perish

FIGURE 85-8 Ship washed ashore in tsunami, December 2004, in Ko Lanta, Thailand. *(Courtesy Sheila B. Reed.)*

FIGURE 85-10 Generator ship washed ashore 2.3 miles inland, near Banda Aceh, Indonesia. *(Courtesy Sheila B. Reed.)*

FIGURE 85-11 Displaced people in temporary settlements in Aceh Province, Indonesia. *(Courtesy Sheila B. Reed.)*

Farm implements may be lost, hindering tillage
Boats and fishing nets may be lost

In July 1998, an earthquake of magnitude 7.0 occurred close to the northwest coast of Papua New Guinea. Although the tremor was felt over a large area, no earthquake damage was reported. Only 10 minutes after the quake, however, the first of three 7- to 10-m (23- to 33-foot) waves came ashore in Sandaun Province. The tsunamis struck at high speed after dark and penetrated up to 1 km (over half a mile) inland, totally destroying villages and vegetation along 50 km (31 miles) of the coast. Of the 9000 people affected, more than 2000 died, mainly as a result of being battered by debris as they were swept away by the water.

Tsunami Risk Reduction Measures

Strategies to reduce vulnerability to tsunamis include warning systems, structural design, mapping and land use, and education.

Warning Systems. Tsunami warning systems generally include a network of seismographs to determine the depth and magnitude of submarine and coastal earthquakes, tidal gauges to measure unusual rises and falls in sea level, and a network of sensors connected to floating buoys. The Tsunami Early Warning System (TEWS) in the Indian Ocean and Southeast Asia aims for a comprehensive end-to-end warning system encompassing all aspects of disaster risk reduction.

Structural Design. Tsunamis that are only 1 m high on land can exert physical pressures that cannot be withstood by structures and buildings. Improved design is needed that will allow incursion of water with minimal impact to buildings. In Thailand, new homes for persons displaced in the 2004 Indian Ocean tsunami were designed so that living quarters are on the second floor and the ground floor consists mainly of supporting pillars that allow water to pass through.

Mapping and Land Use. Tsunami run-up maps indicate the possible levels at which a tsunami can travel inland, allowing people to take precautions when they are in a potential run-up area, such as while visiting a beach. Mapping exercises also serve to show the actual damage from a past tsunami, contributing to the understanding of what allowed protection of certain shorelines, such as coastal mangroves or plantation trees. This information contributes to land use planning. Tsunami inundation maps take into consideration potential earthquake sources, factors that will speed or reduce the tsunami, and the probability of a tsunami occurring.

Education. Public education is a major saver of lives because misconceptions regarding tsunamis are likely to place people at greater risk. Lives were saved in Thailand and Indonesia in the 2004 Indian Ocean tsunami because some people recognized that the receding seawater was a warning and urged people to flee rather than stay and watch the waves. Indonesia installed broadcast tower warning systems in Aceh province in 2005 and 2006. Residents in Banda Aceh initially panicked when the alarms sounded, causing chaos on the roadways; some towers were destroyed by angry residents in reaction to false alarms. However, after some practice, families are now more aware of how to act when a tsunami watch or warning is issued. In Japan, warnings for earthquakes and tsunamis are routine and people react appropriately because they know that even false alarms are meant to save lives. The large loss of life in the 2011 Sendai, Japan, tsunami is attributed to the unanticipated power of the earthquake and tsunami, as well as residents having no memory of such a large tsunami. The seawalls in Sendai were only approximately 3 m (9.85 feet) high, but the tsunami rose to more than 40 m (131 feet) in some areas; the presence of the seawalls may have provided a false sense of security such that residents did not see the need to move farther inland.

VOLCANIC ERUPTIONS

A volcano is a vent or chimney to Earth's surface from a reservoir of molten rock, called magma, deep in Earth's crust (see Chapter 17). Approximately 500 volcanoes are active (have erupted in recorded history), and many thousands are dormant (could become active again) or extinct (are not expected to erupt again). On average, about 50 to 60 volcanoes erupt every year; only about 150 are routinely monitored. Since 1000 AD, more than 300,000 people have been killed directly or indirectly by volcanic eruptions, and currently about 10% of the world's population lives on or near potentially dangerous volcanoes. Japan's Mt Fuji and Italy's Mt Vesuvius each pose a threat to well over a million people.

Volcanology, the study of volcanoes, has experienced a period of intensified interest after five major eruptions in the 1980s and early 1990s: Mt St Helens in Washington state in the United States (1980), El Chichón in Mexico (1982), Galunggung in Indonesia (1982), Nevado del Ruiz in Colombia (1985), and Mt Pinatubo in the Philippines (1991). Although the Mt St Helens eruptions were predicted with remarkable accuracy, predictive capability on a worldwide basis for more explosive eruptions has not been achieved. No recognized immediate precursors to the eruption of El Chichón were known. It caused the worst volcanic disaster in Mexico's history and killed approximately 2000 people. In Colombia, despite sufficient warnings, ineffective implementation and evacuation measures resulted in more than 22,000 deaths from the eruption of Nevado del Ruiz. Galunggung erupted for 9 months, disrupting the lives of 600,000 people. Despite a major evacuation effort from Mt Pinatubo, 320 people died, mainly from collapse of ash-covered roofs. A study of these eruptions underscores the importance of predisaster geoscience studies, volcanic hazard assessments, volcano monitoring, contingency planning, and enhanced communications between scientists and authorities. The world's most dangerous volcanoes are in densely populated countries where only limited resources exist to monitor them, such as Mt Nyiragongo in the Democratic Republic of the Congo.

Causal Phenomena

The basic ingredients for a volcanic eruption are magma and an accumulation of gases beneath an active volcanic vent, which may be either on land or below the sea. Magma is composed of silicates containing dissolved gases and sometimes crystallized minerals in a liquid-like suspension. Driven by buoyancy and gas pressure, magma, which is lighter than surrounding rock, forces its way upward. As it reaches the surface, the pressures decrease, enabling the dissolved gases to effervesce, pushing the magma through the volcanic vent as the gases are released.

The chemical and physical composition of magma determines the amount of force with which a volcano erupts. Magmas that are less viscous allow gas to be released more easily. More viscous magma, perhaps containing a greater concentration of solid particles, may confine these gases longer, allowing greater pressures to build up. This greater pressure may lead to more violent eruptions. The structure of the volcano is also a

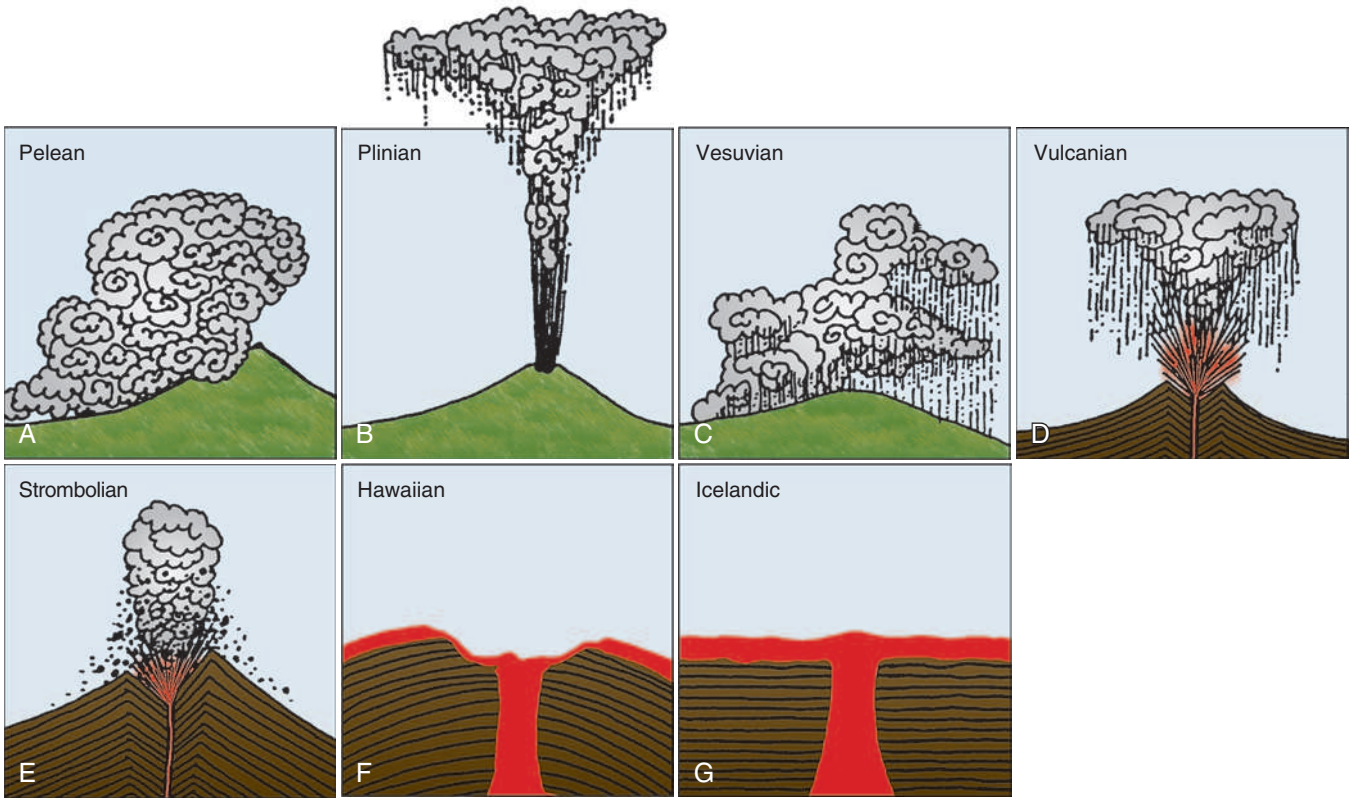


FIGURE 85-12 Eruption types. **A,** Pelean. **B,** Plinian. **C,** Vesuvian. **D,** Vulcanian. **E,** Strombolian. **F,** Hawaiian. **G,** Icelandic. *(Modified from United Nations Development Programme:* Introduction to hazards, *ed 3, New York, 1997, Disaster Management Training Programme, UN Office for the Coordination of Humanitarian Assistance.)*

determinant of its explosivity. Mt Calbuco in Chile is a stratovolcano that is built up of many layers of lava, and it is also an andesite rock volcano, with lavas containing 50% to 60% silicon dioxide. Calbuco erupted in April 2015 after more than 40 years of dormancy and sent a plume of volcanic ash 10 km (6.2 miles) into the sky. Volcanic eruptions may be described as follows in descending order of intensity (Figure 85-12).

Pelean Eruptions. This is the most disastrous type of eruption. The hardened plug at the volcano's throat forces the magma to blast out through a weak spot in the volcanic flank. The great force of the blast devastates most objects in its path, as occurred in the Mt St Helens eruption of 1980.

Plinian Eruptions. As the pressure on the magma is released, a violent upward expulsion of gas can extend far into the atmosphere. In 1991, Mt Pinatubo sent a plume of tephra 30 km (19 miles) above the surface.

Vesuvian Eruptions. As in the eruption of Mt Vesuvius in Italy in 79 AD, this type is very explosive and occurs infrequently. The explosion of built-up magma discharges a cloud of ash over a wide area.

Vulcanian Eruptions. Lava forms a crust over the volcanic vents between eruptions, building up the volcano. Subsequent eruptions are more violent and eject dense clouds of material. The Paricutin, Mexico, volcano originated in a cornfield in 1943 and eventually covered 260 km^2 (162 miles). A major eruption occurred in 1947.

Strombolian Eruptions. Gases escape through slow-moving lava in moderate explosions that may be continuous. Volcanic "bombs" of clotted lava may be ejected into the sky, as occurred in the 1965 eruption of Irazu in Costa Rica. Mt Yasur, a Strombolian volcano in Vanuatu, has erupted many times an hour for 800 years and is a major tourist attraction.

Hawaiian Eruptions. The lava is mobile and flows freely. Gases are released quietly, as in the Kilauea, Hawaii, volcano, which has continued to erupt since 1983.

Icelandic Eruptions. Similar to the Hawaiian type, lava flows from deep fissures and forms sheets spreading out in all directions, as in the Laki, Iceland, eruption of 1783.

Characteristics

No international scale exists to measure the size of volcanic eruptions. The volcanic explosivity index estimates the energy released in a volcanic eruption, based on measurements of the ejected matter, height of the eruption cloud, and other observations. The volcanic explosivity index scale ranges from 0 to 8. The largest eruption recorded was the Tambora volcano in Indonesia in 1815, which had a volcanic explosivity index of 7.

The primary volcanic hazards are associated with products of the eruption: pyroclastic flows, air-fall tephra, lava flows, and volcanic gases. The most destructive secondary hazards include lahars, landslides, and tsunamis.

Pyroclastic Flows. Pyroclastic (meaning "fire-broken" in Greek) flows are the most dangerous of all volcanic phenomena because there is virtually no defense against them. They are horizontally directed explosions or blasts of gas containing ash and larger fragments in suspension. They travel at great speed and burn everything in their path. The flows move like a snow or rock avalanche because they contain a heavy load of dust and lava fragments that are denser than the surrounding air. Gas continues to be released as they travel, creating a continuously expanding cloud.

Pyroclastic flows are responsible for the majority of deaths associated with volcanic eruptions. The pyroclastic flows from the Mt St Helens eruption in 1980 moved at rates up to 870 km/hr (541 mph), and pyroclastic deposits found 2 days after the blast at the foot of the mountain registered temperatures of more than 700°C (1292°F). The greatest distance recorded of such flows in historical times is 35 km (22 miles).

Air-Fall Tephra. Tephra smaller than 2 mm is classified as ash. Almost all volcanoes emit ash, but emissions vary widely in

volume and intensity. Heavy ashfalls can cause complete darkness or drastically reduce visibility. Fine material from great eruptions may travel around the world and affect the world climate. Clouds of dust and ash can remain in the air for days or weeks and spread over large distances, causing difficulty in driving and breathing as well as contributing to building collapse and air traffic disruption. The largest tephra are rocks or blocks, sometimes called "bombs," which have been known to travel more than 4 km (2.5 miles). Tephra may be hot enough to start fires when it lands on structures or vegetation.

Lava Flows. Lava flows are formed by hot, molten lava flowing from a volcano and spreading over the surrounding countryside. Depending on the viscosity, a flow may move a few meters per hour. It is usually slow enough that living creatures can move to safety. Sometimes the edges break off, causing small, hot avalanches.

Volcanic Gases. Gas is a product of every eruption and may also be emitted by the volcano during periods of inactivity, either intermittently or continually. Volcanic gas is composed mostly of steam. Often present are large amounts of toxic sulfur dioxide and hydrogen sulfide and smaller but measurable amounts of toxic hydrochloric and hydrofluoric acid gases. CO_2 is often a major component of volcanic gas and is an asphyxiant because it is much denser than air and tends to travel to and through low-lying areas and valleys. Several mountain climbers and skiers in Japan were overcome by hydrogen sulfide fumes in a valley near the Kusatsu-Shirane volcano, and eventually an alarm system was installed. In 1986, approximately 1800 people were asphyxiated by gas bursts from crater lakes in Cameroon.

Lahars and Landslides. Enormous quantities of ash and larger fragments (tephra) accumulate after an eruption on the steep slopes of a volcano, sometimes to a depth of several meters. When mixed with water, the volcanic debris is transformed into a material resembling wet concrete that flows easily downhill. *Lahar* is an Indonesian word for debris flows or mudflows. A primary debris flow is caused by eruptive activity, such as melting of snow and ice by hot volcanic materials, and a secondary debris flow results when heavy rainfall saturates the deposits.

The rate of flow is affected by its viscosity, volume of mud and debris, and slope and character of the terrain. The velocity may reach 100 km/hr (62 mph), and distance traveled may exceed 100 km (62 miles). Mudflows and debris flows can be very destructive. They have buried entire towns, such as Armero, Colombia. They can silt up waterways, causing floods and changing river courses.

Landslides and debris avalanches are common where stress from intruding magma causes fractures along cracks in the volcano. Ground deformation from swelling and hardening of volcanic material can produce landslides.

Tsunamis. Tsunamis, described previously, are generated by movement of the ocean floor, possibly caused by a volcano. In a study of volcanic eruptions in the past 1000 years, human fatalities resulting from indirect tsunami wave hazards were as significant as those from pyroclastic flows and primary mudflows.

Location

The distribution of volcanoes, as with earthquakes, is determined by the location of geologic forces involving the tectonic or crustal plates. About 80% of the active volcanoes are located near subduction boundaries. Subduction volcanoes occur where denser crustal plates are shoved beneath less dense continental plates, which occurs in most of the Pacific Ocean, especially in the area along the rim, known as the Pacific Ring of Fire. Subduction volcanoes are found in the United States in the Cascade Range of the Pacific Northwest and further north in the Aleutian Islands off Alaska. The ring of subduction volcanoes continues along the Aleutian Trench to Japan, stretching south to the Philippines and Indonesia. Many volcanoes are located beneath the ocean, and submarine eruptions may cause tsunamis and other effects.

Rift volcanoes occur at divergent zones where two distinct plates are slowly being separated, in areas such as Iceland and East Africa; they account for about 15% of active volcanoes. Hot spot volcanoes are located where crustal weaknesses allow molten material to penetrate, but not necessarily on the plate boundaries. These isolated regions of volcanic activity exist in about 100 places in the world. The Hawaiian Islands, in the middle of the Pacific plate, and Yellowstone Park, within the North American plate, are good examples.

Predictability

Systematic surveillance of volcanoes, begun early in the 20th century at the Hawaiian Volcano Observatory, indicates that most eruptions are preceded by measurable geophysical and geochemical changes. Short-term forecasts of future volcanic activity in hours or months may be made through volcano monitoring techniques that include seismic monitoring, ground deformation studies, and observations and recordings of hydrothermal, geochemical, and geoelectric changes. By carefully monitoring these factors, scientists were able to issue a high-confidence forecast of the 1991 Mt Pinatubo eruption, allowing a largely successful evacuation. The best basis for long-term forecasting (a year or longer) of a possible eruption is through geologic studies of the past history of each volcano. Each past eruption has left records in the form of lava beds. Deposits and layers of ash and tephra can be studied to determine the extent of the flows and length of time between eruptions.

Problems in Eruption Forecast and Prediction. Although significant progress has been made in long-term forecasting of volcanic eruptions, monitoring techniques have not progressed to the point of yielding precise predictions. For the purposes of warning the public and avoiding false alarms that create distrust and chaos, ideal predictions should provide precise information concerning the place, time, type, and magnitude of the eruption. The importance of enhanced communications between scientists and authorities is also emphasized. Despite sufficient warning, evacuation orders were not issued by local authorities, which resulted in more than 22,000 deaths from lahars produced by Nevado del Ruiz. The eruption of Mt St Helens was adequately monitored and forecasted, but the main explosion still surprised authorities because the volcano did not exhibit expected signs before eruption and because the blast was lateral rather than vertical; 57 people who remained in the danger area were killed. In the past decade, Iceland, which is home to 35 active volcanoes, has been able to successfully forecast approximately two-thirds of eruptions.

The greatest constraint to predictability is lack of baseline monitoring studies, which depict the full range of characteristics of the volcano. Accumulating baseline data may require study of the volcanic activity over thousands of years. Interpretation of baseline data enables differentiation of the precursory pattern of an actual eruption from other volcanic activity, such as intrusion of magma under the surface, which is sometimes termed an *aborted eruption*. Before the 1982 eruption of El Chichón, virtually nothing was known of its history of frequent and violent eruptions. No monitoring was conducted before or during the brief eruption.

Developing countries suffer the greatest economic losses from volcanic eruptions. More than 99% of deaths caused by an eruption since 1900 have been in developing countries. Because of shortages of funds and trained personnel, monitoring is also poorest in these countries.

Vulnerability

Rich volcanic soils and scenic terrains attract people to settle on the flanks of volcanoes. These people are more vulnerable if they live downwind from the volcano, in the path of historical channels for mudflows or lava flows, or close to waterways likely to flood because of silting. Structures with roof designs that do not resist ash accumulation are vulnerable even miles from a volcano. All combustible materials are at risk.

Typical Adverse Effects

Casualties and Health. Deaths can be expected from pyroclastic flows and mudflows and to a much lesser extent from lava flows and toxic gases. Injuries may occur from the impact of falling rock fragments and from being buried in mud. Burns

to the skin, breathing passages, and lungs may result from exposure to steam and hot dust clouds. Ashfall and toxic gases may cause respiratory difficulties for people and animals. Nontoxic gases of densities greater than air, such as CO_2, can be dangerous when they collect in low-lying areas. Water supplies contaminated with ash may contain toxic chemicals and cause illness. Deaths have also occurred indirectly from starvation and from tsunamis.

Settlements, Infrastructure, and Agriculture. Complete destruction of everything in the path of pyroclastic or lava flows should be expected, including vegetation, agricultural land, human settlements, structures, and bridges, roads, and other elements of infrastructure. Structures may collapse under the weight of ash, particularly if the ash is wet. Falling ash may be hot enough to cause fires. Flooding may result from waterways filling up with volcanic deposits or from melting of large amounts of snow or glacial ice. Rivers may change course because of oversilting. Ashfall can destroy mechanical systems by clogging openings, such as those in irrigation systems and airplane and other engines. Communication systems could be disrupted by electrical storms developing in the ash clouds. Transportation by air, land, and sea may be affected. Disruption in air traffic from large ash eruptions can have serious effects on an emergency response.

Crops in the path of flows are destroyed, and ashfall may render agricultural land temporarily unusable. Heavy ash loads may break the branches of fruit or nut trees. Livestock may inhale toxic gases or ash. Ash containing toxic chemicals, such as fluorine, may contaminate grazing lands.

The Caribbean island of Montserrat has undergone volcanic activity for years. In June 1997, the famous Soufrière Hills volcano erupted, causing at least nine deaths. The resulting pyroclastic flows buried and destroyed seven villages. Only one-third of the island is now considered relatively safe. In 2002, in the Democratic Republic of the Congo, lava poured from the Nyiragongo volcano, devastating the city of Goma and forcing 300,000 to flee, some crossing the border into Rwanda. A multidonor funded observatory was ultimately established to monitor the volcano, which emits 12,000 to 50,000 metric tons of sulfur dioxide each day.

Volcanic Eruption Risk Reduction Measures

Strengthening forecasting, initiation or expansion of volcanic monitoring, creation of emergency response plans, and establishment of effective communications and warning systems are the most effective measures to reduce the risk from volcanic hazards. As the description in the next section indicates, people may not fully accept the validity of warnings because of their own perceptions of the likelihood of hazards and adverse effects. Even those who accept the warnings may be willing to take risks to guard their livelihoods, homes, and possessions.

Despite Precautions, People Took High Risks in the Mt Merapi Eruption. The greatest population densities in Indonesia occur in the region south and east of Mt Merapi in central Java, where the soil is enriched by volcanic ash and debris. Institutionalized monitoring of volcanic activity has been ongoing since 1920. Evacuation alerts can be issued when telemetered rain gauges and radar installations at Merapi show that rainfall intensity and duration have reached a critical threshold known to trigger lahars. Preparedness measures for the Mt Merapi volcanic area have been cited as examples of good practice. These include evacuation maps, provincial and district disaster management teams (including subdistrict military units and police units), and other response organizations such as nongovernmental organizations. Evacuation routes to shelters in safe areas are clearly marked, and global positioning system coordinates are available for the evacuation area, health facilities, and warning towers. In 2006, as a response to the escalating alert levels for volcanic activity on Mt Merapi, local authorities in Yogyakarta and Central Java took steps to prepare the people at risk, warned vulnerable families to be vigilant, and asked some to move to safer areas; 20,000 people were evacuated. However, there was reluctance on the parts of some to leave their homes until the Alert 4, Code Red (signifying compulsory evacuation) was issued, because they feared losing livestock and belongings.

Beginning in mid-September of 2010, seismic activity increased, culminating in repeated outbursts of lava and ashes. In late October, eruptions became increasingly violent and continued into November. Large eruption columns formed, causing numerous pyroclastic flows down the heavily populated slopes of the volcano. Merapi's eruption was said by authorities to be the largest since the 1870s. More than 350,000 people were evacuated from the affected area. However, many persons remained behind or returned to their homes while the eruptions were continuing; 353 people were killed during the eruptions, many as a result of pyroclastic flows. The mountain continued to erupt until November 30, 2010. On December 3, 2010, the official alert status was reduced from Alert 4 to Alert 3 because the eruptive activity had subsided.

LANDSLIDES

Landslides are a major threat each year to human settlements and infrastructure elements. *Landslide* is a general term covering a wide variety of landforms and processes involving the downslope movement of soil and rock. Although landslides may occur with earthquakes, floods, and volcanoes, they are much more widespread and over time cause more property loss than any other geologic event.

Causal Phenomena

Landslides result from sudden or gradual changes in the composition, structure, hydrology, or vegetation of a slope. These changes may be natural or caused by humans, and they disturb the equilibrium of the slope's materials. A landslide occurs when the strength of the material in the slope is exceeded by the downslope stress. The resistance in a slope may be reduced by the following:

- Increase in water content, caused by heavy rainfall or rising groundwater
- Increase in slope angle, for new construction or by stream erosion
- Breakdown or alteration of slope materials, from weathering and other natural processes, placement of underground piping for utilities, or use of landfill

Downslope stress may be caused by the following:

- Vibrations from earthquakes (triggering some of the most disastrous landslides), blasting, machinery, traffic, or thunder
- Removal of lateral support by previous slope failure, construction, or excavation
- Removal of vegetation by fires, logging, overgrazing, or deforestation that causes loosening of soil particles and erosion
- Loading with weight from rain, hail, snow, accumulation of loose rock or volcanic material, weight of buildings, or seepage from irrigation and sewage systems

Characteristics

Landslides usually occur as secondary effects of heavy storms, earthquakes, and volcanic eruptions. However, mining caused the largest nonvolcanic landslide in North American history at the Bingham Canyon Mine in Utah in 2013. The materials involved in landslides are divided into two classes: bedrock and soil (earth and organic matter debris). A landslide may be classified by its type of movement (Figure 85-13).

Falls. A fall is a mass of rock or other material that moves downward by falling or bouncing through the air. These are most common along steep road or railroad embankments, steep escarpments, or steeply undercut cliffs, especially in coastal areas. Large individual boulders can cause significant damage.

Slides. Resulting from shear failure (slippage) along one or several surfaces, the slide material may remain intact or break up. In 2010, a mudslide caused by heavy rains in Gansu, China, resulted in more than 1400 deaths.

Topples. A topple is caused by overturning forces that rotate a rock out of its original position. The rock section may have settled at a precarious angle, balancing itself on a pivotal point from which it tilts or rotates forward. A topple may not

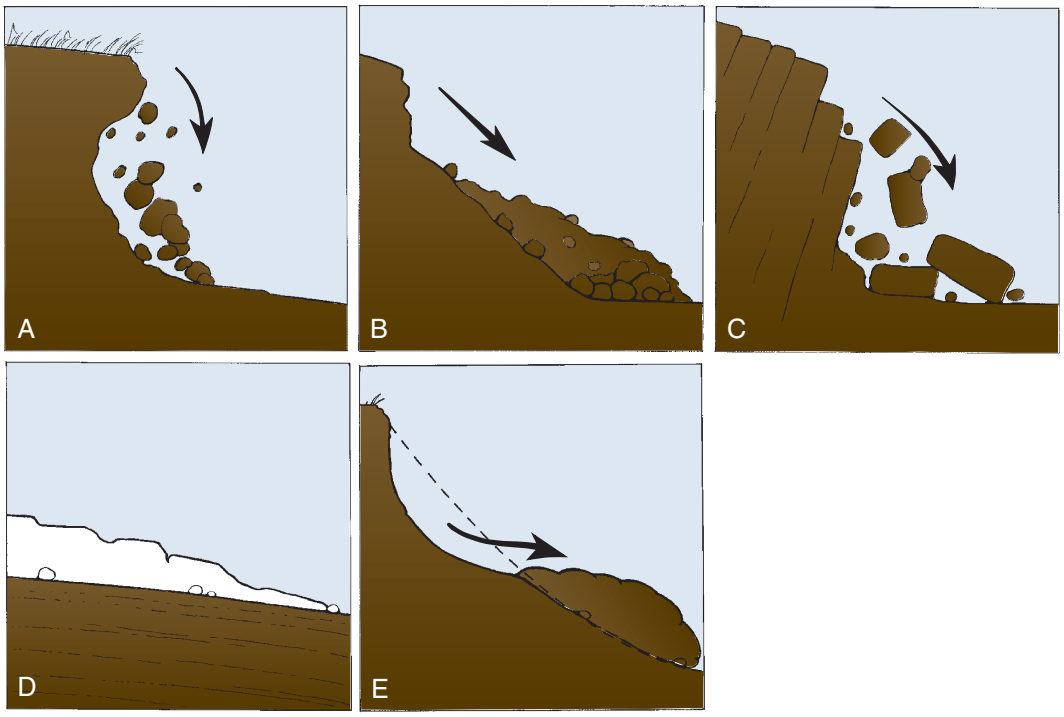


FIGURE 85-13 Landslides classified by type of movement. **A,** Fall. **B,** Slide. **C,** Topple. **D,** Lateral spread. **E,** Flow.

involve much movement, and it does not necessarily trigger a rockfall or rockslide.

Lateral Spreads. Large blocks of soil spread out horizontally by fracturing off the original base. Lateral spreads generally occur on gentle slopes, usually less than 6%, and typically spread 3 to 5 m (10 to 16 feet), but may move from 30 to 50 m (100 to 160 feet) where conditions are favorable. Lateral spreads usually break up internally and form numerous fissures and scarps. The process can be caused by liquefaction, in which saturated loose sands or silts assume a liquefied state. A lateral spread is usually triggered by ground shaking (as with an earthquake). During the 1964 Alaskan earthquake, more than 200 bridges were damaged or destroyed by lateral spreading of floodplain deposits near river channels.

Flows. Flows move as a viscous fluid, sometimes very rapidly, and can cover several miles. Water is not essential for flows to occur; however, most flows form after periods of heavy rainfall. A *mudflow* contains at least 50% sand, silt, and clay particles. A *lahar* is a mudflow that originates on the slope of a volcano and may be triggered by rainfall, sudden melting of snow or glaciers, or water flowing from crater lakes. A *debris flow* is a slurry of soils, rocks, and organic matter combined with air and water. Debris flows usually occur on steep gullies. Very slow, almost imperceptible flows of soil and bedrock are called *creeps*. Over long periods, creeps may cause telephone poles or other objects to tilt downhill.

Casualties. Catastrophic landslides have killed many thousands of persons, such as the debris slide on the slopes of Huascaran in Peru triggered by an earthquake in 1970, which killed more than 18,000 people. In January 1989, only 6 weeks after an earthquake killed 25,000 people in Armenia, another quake struck the Republic of Tajikistan, 50 km (31 miles) southwest of the capital city of Dushanbe. This quake registered 5.8 on the Richter scale. The earthquake triggered a landslide of hillside soils that had become wet with melted snow. The liquefied soil spilled downhill and eventually covered an area about 8 km (5 miles) long and 1 km (0.6 of a mile) wide. The total volume of mud was more than 10 million m^3. The epicenter of the earthquake was located in the village of Sharora. This village and several others were engulfed with mud that killed 200 persons and left 30,000 homeless. Mud deposits reached a height of 25 m (82 feet) in Sharora, causing rescue efforts to be abandoned. The area was later declared a national monument. The world's largest historic landslide occurred during the 1980 volcanic eruption of Mt St Helens. The volume of material was 2.8 km^3.

Recent large-scale landslides (and their causes and characteristics) have included Leyte, Philippines, in 2006 (rockslide and debris avalanche from heavy rains; 1100 deaths); Sichuan, China, in 2008 (Wenchuan earthquake, magnitude 8.0; 15,000 landslides and 20,000 deaths from landslides); East Cairo, Egypt, al-Duwayqa rockslide in 2008 (destabilization due to human-made construction and temperature regime changes; 107 deaths and 400 persons missing); Bududa, Uganda, in 2010 (debris flows after heavy rains: more than 400 deaths and 200,000 displaced persons); and Rio de Janeiro, Brazil, in 2010 (debris flows from heavy rainfall; 350 deaths). A tragic outcome occurred when the 2013 North India floods resulted in massive debris flow landslides that killed people trapped in houses by flood waters. Entire villages disappeared and more than 5000 people perished, mainly in Uttarakhand. Heavy rains in 2014 in Hiroshima prefecture caused the deadliest landslides in 42 years in Japan . In these two cases, the public did not receive timely warnings to avert casualties.

Predictability

The velocity of landslides varies from extremely slow (< 0.06 m/year) to extremely fast (> 3 m/sec), which might imply a similar variation in predictability. In absolute terms, however, predicting the actual occurrence of a landslide is extremely difficult, although situations of high risk, such as forecasted heavy rainfall or seismic activity combined with landslide susceptibility, may lead to estimation of a time frame and possible consequences.

Estimation of landslide hazard potential includes historical information on the geology, geomorphology (study of landforms), hydrology, and vegetation of a specific area. Structural features that may affect stability include sequence and type of layering, lithologic changes, planes, joints, faults, and folds. The most important geomorphologic consideration in prediction of landslides is the history of landslides in a given area.

The source, movement, amount of water, and water pressure must be studied. Climatic patterns combined with soil type may cause different types of landslides. For example, when monsoons occur in tropical regions, large debris slides of soils, rocks, and

FIGURE 85-14 Former hospital in Santiago Atitlán, Guatemala, buried during mudslide. *(Courtesy Paul S. Auerbach, MD.)*

organic matter may occur. Plant cover on slopes may have either a positive or negative stabilizing effect. Roots may decrease water runoff and increase soil cohesion; conversely, they may widen fractures in rock surfaces and promote infiltration. In Nepal in 2002, a heavy monsoon season caused flooding and landslides, killing 500 people. The vulnerability to landslides was increased by the proximity of most communities to slopes and the poor quality of housing. A tragic slide in Santiago Atitlán, Guatemala, which partially buried its hospital and killed hundreds of people, on October 5, 2005 (Figure 85-14) was caused by torrential rains from Hurricane Stan combined with vulnerability of the location on the slopes of a volcano. Landslides may be expected to increase in number with other impacts of climate change. Along with more intense and extreme rainfall, the growth in population in many developing countries may increase the numbers of casualties related to landslides.

Vulnerability

Settlements built on steep slopes, in weak soils, on cliff tops, at the base of steep slopes, on alluvial outwash fans, or at the mouth of streams emerging from mountain valleys are all vulnerable. Roads and communication lines through mountainous areas are in danger. In most types of landslides, damage may occur to buildings even if foundations have been strengthened. Infrastructural elements, such as buried utility lines or brittle pipes, are vulnerable. The province of Badakhshan in Afghanistan is becoming more vulnerable to landslides and mudslides, especially during the winter snowmelts, due to increasing deforestation. Impoverished communities suffered deadly mudslides in 2014 and 2015.

Typical Adverse Effects

Anything on top of or in the path of a landslide will be severely damaged or destroyed. In addition, rubble may damage lines of communication or block roadways. Waterways may be blocked, creating a flood risk. Casualties may not be widespread, except in the case of massive movements caused by major hazards such as earthquakes and volcanoes.

In addition to direct damage from a landslide, indirect effects include loss of productivity of agricultural or forestlands (if buried), reduced real estate values in high-risk areas and lost tax revenues from these devaluations, adverse effects on water quality in streams and irrigation facilities, and secondary physical effects, such as flooding.

Fatalities have resulted from slope failure in cases where population pressure has prompted settlement in areas vulnerable to landslides. Casualties may be caused by collapse of buildings or burial by landslide debris. Worldwide, approximately 600 deaths occur per year, mainly in the circum-Pacific region. The estimate for loss of life in the United States is 25 to 50 lives per year, greater than the average loss from earthquakes.

Landslide Risk Reduction Measures

Landslide management is a well-developed science in many countries. Landslides can be mitigated where sufficient resources are available. Basic reduction measures include terrain mapping, susceptibility analysis, stability analysis, and monitoring and warning systems. Warning systems include (1) sensors placed on a possible landslide path, (2) calculation of the stability of a slope and monitoring of the groundwater level, and (3) detection of early stages of landslide movement using sensors and inclinometers that generate detailed data sets. One major challenge is finding effective ways to manage landslides in developing countries. A further challenge centers on the fact that landslide risk mitigation may need to take into consideration changing environmental conditions, for example, looking more critically at areas underfilled with potentially degrading permafrost and the possibility of increased sediment loads and channel instability in rivers.

CLIMATIC HAZARDS

TROPICAL CYCLONES

The World Meteorological Organization (WMO) uses the generic term *tropical cyclone* to cover weather systems in which winds exceed gale force (minimum of 34 knots or 63 km/hr). Tropical cyclones are rotating, organized systems of clouds and thunderstorms with intense low-pressure circulation, originating over tropical or subtropical waters. Winds of hurricane force (63 knots or 117 km/hr) mark the most severe type. They are called hurricanes in the Caribbean region, the United States, Central America, and parts of the Pacific; typhoons in the northwestern Pacific and eastern Asia; severe cyclonic storms in the Bay of Bengal; and severe tropical cyclones in southern Indian, South Pacific, and Australian waters. For easy identification and tracking, the storms are generally given alternating masculine and feminine names or numbers that identify the year and annual sequence.

Tropical cyclones are the most devastating of seasonally recurring rapid-onset natural hazards. Between 80 and 100 tropical cyclones occur around the world each year. Devastation by violent winds, torrential rainfall, and accompanying phenomena, including storm surges and floods, can lead to massive community disruption. Official death and damage records for tropical cyclones include thousands of individual events. In Bangladesh alone, the deadliest tropical cyclone on record, Cyclone Bhola in 1970, killed between 300,000 and 500,000 people, although the exact death toll will never be known. Also in Bangladesh, deaths were recorded at 140,000 persons near Chittagong in 1991, and 3500 persons died in Cyclone Sidr in 2007. In the United States, damages approached $10 billion from Hurricane Gilbert (1988) and Hurricane Hugo (1989). Damages from Hurricane Andrew in Florida and Louisiana in 1992 totaled $16 billion. Hurricane Katrina, in August 2005, killed 1417 people in three states and caused $75 billion in damages.

In 2008, Cyclone Nargis struck Burma (Myanmar), killing more than 145,000 people, devastated the delta, which is the "rice basket" of the country, and destroyed the country's former capital and largest city, Yangon. Cyclone Nargis set several records: deadliest natural disaster in Burmese history, costliest cyclone originating in the north Indian Ocean on record, and second-deadliest northern Indian Ocean cyclone in recorded history.

Causal Phenomena

The development cycle of tropical cyclones may be divided into three stages: formation and initial development, full maturity, and modification or decay. Depending on their tracks over the warm tropical seas and proximity to land, tropical cyclones may last from less than 24 hours to more than 3 weeks (the average duration is about 6 days). Their tracks are naturally erratic but initially move generally westward and then progressively poleward into higher latitudes, where they may make landfall, or into an easterly direction as they lose their cyclonic structure.

Formation and Initial Development Stage. Four atmospheric and oceanic conditions are necessary for development of a cyclonic storm (Figure 85-15):

- A warm sea temperature (> 26° C [78.8° F] to a depth of 60 m [197 feet]) provides abundant water vapor in the air by evaporation.
- High relative humidity (degree to which the air is saturated by water vapor) of the atmosphere to a height of about

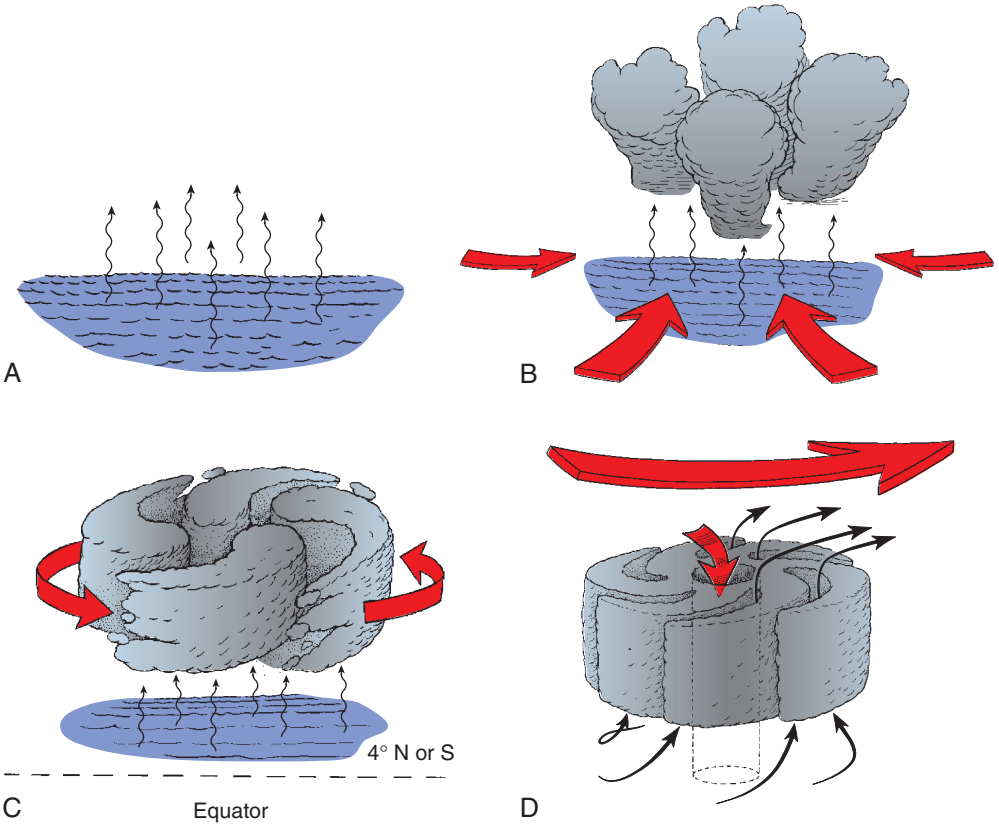


FIGURE 85-15 Cyclone formation. **A,** Warm seas (> 26° C [78.8° F]) cause rising humid air. **B,** Cooler high-altitude temperatures cause formation of cumulonimbus clouds. The surrounding air moves toward the central low-pressure area. **C,** Cumulonimbus clouds form into spiraling bands. The Coriolis effect causes winds to swirl around the central low-pressure area. **D,** High altitude dispels the top of the cyclonic air system. Dry high-altitude air flows down the "eye." Hurricane force winds circle around the eye.

7000 m (23,000 feet) facilitates condensation of water vapor into water droplets and clouds, releases heat energy, and induces a drop in barometric pressure.

Atmospheric instability (an above-average decrease of temperature with altitude) encourages considerable vertical cumulus cloud convection when condensation of rising air occurs.

A location of at least 4 to 5 latitude degrees from the equator allows the influence of Earth's rotational force to take effect (Coriolis effect) and induces cyclonic wind circulation around a low-pressure center.

The atmosphere can usually organize itself into a tropical cyclone in 2 to 4 days. This process is characterized by increasing thunderstorms and rain squalls at sea. Meteorologists can monitor these processes with weather satellites and radar from as far as 645 m (400 miles) away from the storm. The existence of favorable conditions for cyclone development determines the cyclone season for each monitoring center. In the Indian and south Asian region, the season is divided into two periods, from April to early June and from October to early December. In the Caribbean region and United States, tropical storms and hurricanes reach their peak strengths in middle to late summer. In the Southern Hemisphere, the cyclone season extends from November to April or May, but occasionally cyclones occur in other months in lower latitudes.

Maturity Stage. As viewed by weather satellites and radar imagery, the main physical feature of a mature tropical cyclone is a spiral pattern of highly turbulent, giant cumulus thundercloud bands. These bands spiral inward and form a dense, highly active central cloud core that wraps around a relatively calm and cloud-free "eye." The eye, where light winds occur, typically has a diameter of 20 to 60 km (12 to 37 miles) and appears as a black hole or dot surrounded by white clouds.

In contrast to the light wind conditions in the eye, the turbulent cloud formations extending outward from the eye accompany winds of up to 250 km/hr (155 mph), sufficient to destroy or severely damage most nonengineered structures in the affected communities. These strong winds are caused by a horizontal temperature gradient that exists between the warm core of the cyclone (up to 10° C [18° F] higher than the external environment) and the surrounding areas, resulting in a correspondingly high gradient of pressure.

Decay Stage. A tropical cyclone begins to weaken, in terms of its central low pressure, internal warm core, and extremely high winds, as soon as its sources of warm moist air begin to ebb or are abruptly cut off. This would occur during landfall, by movement into higher latitudes, or through influence of another low-pressure system. The weakening of a cyclone does not mean that danger to life and property is over. When the cyclone hits land, especially over mountainous or hilly terrain, widespread riverine and flash flooding may last for weeks. The energy from a weakening tropical cyclone may be reorganized into a less concentrated but more extensive storm system, causing widespread violent weather.

Characteristics

Tropical cyclones are characterized by their destructive winds, storm surges, and exceptional level of rainfall, which may cause flooding.

Destructive Winds. The strong winds generated by a tropical cyclone circulate clockwise in the Southern Hemisphere and counterclockwise in the Northern Hemisphere, while spiraling inward and increasing toward the cyclone center. In the Northern Hemisphere, the storms are classified as tropical depressions (maximum sustained winds of 61 km [38 miles] per hour); tropical storms (63 to 117 km [39 to 73 miles] per hour); hurricanes

(119 km [74 miles] per hour or higher); and major hurricanes (179 km [111 miles] per hour or higher).

Wind speeds progressively increase toward the core as follows:

- 150 to 300 km (93 to 186 miles) from the center of a typical mature cyclone, winds of 63 to 88 km/hr (39 to 54.7 mph)
- 100 to 150 km (62 to 93 miles) from the center, storm force winds of 89 to 117 km/hr (55 to 73 mph)
- 50 to 100 km (31 to 62 miles) from the center, winds in excess of hurricane force, 117 km/hr (73 mph) or greater
- 20 to 50 km (12 to 31 miles) from the center, the edge of the inner core containing winds 250 km/hr (155 mph) or greater

As the eye arrives, winds fall off to become almost calm, but they rise again just as quickly as the eye passes and are replaced by hurricane force winds from a direction nearly the reverse of those previously blowing.

The Beaufort scale is used to classify the intensity of the storms. It estimates the wind velocity by observations of the effects of winds on the ocean surface and familiar objects. Both the United States (Saffir-Simpson Hurricane Scale; Box 85-2) and Australia (Cyclone Severity Categories) use country-specific scales that estimate potential property damage in five categories. The Philippines has increased its typhoon warning signal numbers from three ranges of wind speeds to four in order to take into account the lower standards of building structures and regional variations. Typhoon Haiyan, known in the Philippines as Typhoon Yolanda, was one of the strongest tropical cyclones ever recorded, killing at least 6300 persons in November 2013; it was the strongest at landfall and in terms of 1-minute sustained wind speed. It was assessed as a Category 5 Super Typhoon on the Saffir-Simpson scale, making six landfalls in the Philippines before exiting into the South China Sea. It subsequently struck Vietnam as a severe tropical storm.

Storm Surges. The *storm surge,* defined as the rise in sea level above the normally predicted astronomic tide, is frequently a key or overriding factor in a tropical storm disaster. As the cyclone approaches the coast, the friction of strong onshore winds on the sea surface, in combination with the "suction effect" of reduced atmospheric pressure, can pile up seawater along a coastline near a cyclone's landfall well above the predicted tide level for that time. In cyclones of moderate intensity, the effect is generally limited to several meters, but exceptionally intense cyclones can cause storm surges up to 8 m (26 feet).

Of the countries experiencing cyclonic storms, those most vulnerable to storm surges are characterized by low-lying land along the closed and semienclosed bays facing the ocean. These countries include Bangladesh, China, India, Japan, Mexico, the United States, and Australia. Most of the casualties from the 1970 Bhola cyclone occurred from drowning in the storm surge. Prevailing onshore winds and low pressures from winter depressions in nontropical latitudes, as in countries bordering the North Sea, are also subject to storm surges that require substantial mitigation measures, such as dikes.

Rainfall Events. The world's highest rainfall totals over 1 to 2 days have occurred during tropical cyclones. The highest 12- and 24-hour totals, 135 cm (53 inches) and 188 cm (74 inches), respectively, both occurred during cyclones at La Réunion, an island in the southwestern Indian Ocean. The very high specific humidity condenses into exceptionally large raindrops and giant cumulus clouds, resulting in high precipitation rates. When a cyclone makes landfall, the rain rapidly saturates even dry catchment areas, and rapid runoff may explosively flood the usual water courses as it creates new ones.

The relationship between rainfall and wind speed is not always proportional. For instance, if the atmosphere over land is already saturated with moisture, rainfall will be strongly enhanced, and the cyclone will weaken slowly. If the atmosphere is dry, the rainfall will be greatly reduced, and the cyclone will decay faster. Thus landfall of even a relatively weak tropical cyclone may result in extensive flooding, as occurred in 2004 with Hurricane Jeanne, which had weakened to a tropical storm and dumped torrential rain on Haiti, killing 3000 people.

BOX 85-2 Saffir-Simpson Potential Hurricane Damage Scale

The Saffir-Simpson Hurricane Scale is a 1 to 5 rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, because storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region. Note that all winds are using the U.S. 1-minute average.

Category 1 Hurricane

Winds 64 to 82 knots or 119 to 153 km/hr (74 to 95 mph). Storm surge generally 1.2 to 1.5 m (4 to 5 feet) above normal. No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage.

Category 2 Hurricane

Winds 83 to 95 knots or 154 to 177 km/hr (96 to 110 mph). Storm surge generally 1.8 to 2.4 m (6 to 8 feet) above normal. Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers. Coastal and low-lying escape routes flood 2 to 4 hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings.

Category 3 Hurricane

Winds 96 to 113 knots or 178 to 209 km/hr (111 to 130 mph). Storm surge generally 2.7 to 3.7 m (9 to 12 feet) above normal. Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut by rising water 3 to 5 hours before arrival of the center of the hurricane. Flooding near the coast destroys smaller structures, with larger structures damaged by battering from floating debris. Terrain continuously lower than 1.5 m (5 feet) above mean sea level may be flooded inland 13 km (8 miles) or more. Evacuation of low-lying residences with several blocks of the shoreline may be required.

Category 4 Hurricane

Winds 114 to 135 knots or 210 to 249 km/hr (131 to 155 mph). Storm surge generally 4 to 5.5 m (13 to 18 feet) above normal. More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut by rising water 3 to 5 hours before arrival of the center of the hurricane. Major damage to lower floors of structures near the shore. Terrain lower than 3 m (10 feet) above sea level may be flooded requiring massive evacuation of residential areas as far inland as 10 km (6 miles).

Category 5 Hurricane

Winds greater than 135 knots or 249 km/hr (155 mph). Storm surge generally greater than 5.5 m (18 feet) above normal. Complete roof failure on many residences and industrial buildings. Some complete building failures, with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut by rising water 3 to 5 hours before arrival of the center of the hurricane. Major damage to lower floors of all structures located less than 4.5 m (15 feet) above sea level and within 450 m (500 yards) of the shoreline. Massive evacuation of residential areas on low ground within 8 to 16 km (5 to 10 miles) of the shoreline may be required. Only three category 5 hurricanes have made landfall in the United States since records began: the Labor Day Hurricane of 1935, Hurricane Camille in 1969, and Hurricane Andrew in 1992.

From The National Oceanic and Atmospheric Administration—National Weather Service, National Hurricane Center, Tropical Prediction Center, Miami, Florida, 2006: nhc.noaa.gov/aboutsshs.shtml.

FIGURE 85-16 Aftermath of Hurricane Mitch in Honduras in 1998. *(Courtesy Paul Thompson, InterWorks.)*

Deadly Hurricanes

The 1998 Atlantic hurricane season, from June 1 to November 30, was one of the deadliest in 200 years, killing more than 10,000 people in eight countries and causing billions of dollars in damage. Fourteen named storms, four more than average, formed in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. Of these, 10 became hurricanes. Hurricane Georges followed a path across the U.S. Virgin Islands, Puerto Rico, the Dominican Republic, Haiti, and Cuba, killing more than 500 persons and causing $5 billion in damages. Hurricane Mitch moved across Central America, killing an estimated 10,000 persons in Honduras and wiping out the country's infrastructure (Figure 85-16). Mitch regenerated as a tropical storm and then passed over south Florida.

The 2005 Atlantic hurricane season, however, was the most active season on record, lasting into January 2006. Twenty-seven tropical storms formed, of which 15 became hurricanes. Of these, seven were major hurricanes, five becoming Category 4 and three reaching Category 5. Hurricane Wilma was the most intense ever recorded in the Atlantic. It caused at least 1918 deaths and record damages of over $100 billion. Hurricanes Dennis, Emily, Katrina, Rita, and Wilma struck Mexico, Cuba, and the United States (Florida, Alabama, Louisiana, Texas, and Mississippi). The most catastrophic effects of the season were felt in New Orleans, where hurricane Katrina caused a storm surge that breached levees and flooded most of the city. Katrina started as an extremely powerful Category 5 storm off the coast but weakened to Category 4 when it hit New Orleans. Because it dropped rapidly in intensity, New Orleans experienced significantly less wind damage than might have been expected from a Category 5 storm.

Hurricane Sandy was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season. After Katrina, it was the second most costly in U.S. history and the largest in diameter. In the United States, Hurricane Sandy affected 24 states, including the entire Eastern Seaboard; its effects were felt westward to the Appalachian Mountains and even into Michigan and Wisconsin. Before its landfall in the United States, Sandy first hit Jamaica, followed by Cuba and the Bahamas; it also affected Haiti, the Dominican Republic, and Puerto Rico. Flooding in Haiti killed at least 54 persons and made 200,000 others homeless. Jamaica suffered loss of electricity for 70% of its residents and $100 million in damages.

Predictability

Tropical cyclones form in all oceans of the world except the South Atlantic and South Pacific east of 140 degrees W longitude. Nearly one-quarter form between 5 and 10 degrees latitude from the equator and two-thirds between 10 and 20 degrees latitude. It is rare for tropical cyclones to form south of 20 to 22 degrees latitude in the Southern Hemisphere; however, they occasionally form as far north as 30 to 32 degrees in the more extensive warmer waters of the Northern Hemisphere. They are mainly confined to the warmer 6 months of the year but have occurred in every month of the year in the western North Pacific. Of concern is the influence that climate change might have on the frequency and severity of tropical cyclones by virtue of raising sea surface temperatures and contributing to rising sea levels. Warm sea surface temperatures influence cyclone development, and warmer ocean waters increase hurricane intensity.

The locations, frequencies, and intensities of tropical cyclones are well known from historical observations and, more recently, from routine satellite monitoring. Tropical cyclones do not follow the same track, except coincidentally over short distances. Some follow linear paths, others recurve in a symmetric manner, and still others accelerate or slow down and seem stationary for a time. For this reason, predicting when, where, and if a storm will hit land is often difficult, especially with islands. Typhoon Parma in the Philippines in 2009 made three consecutive landfalls in the same area, which experienced winds of typhoon strength for 15 consecutive hours. In general, the difficulty in forecasting increases from lower to higher latitudes, whereas the margin of error in determining the cyclone center decreases as landfall approaches.

Special warning and preparedness strategies for evacuation from offshore facilities or closure of industrial plants must relate the costs and benefits of those strategies against the uncertainties of precision in the forecasts. For general community purposes that require a minimum 12 hours of preparedness time, the imprecision in forecasting the location of landfall within 24 hours should be generally tolerable, bearing in mind that highly adverse cyclonic weather usually commences about 6 hours before landfall of the cyclone. In the United States, a *hurricane watch* is issued when a hurricane is likely to strike within 36 hours, and a *hurricane warning* notifies of possible landfall within 24 hours. In September 2004, a Category 4 hurricane, Ivan, caused heavy damage to Jamaica, Grand Cayman, and the western tip of Cuba, and directly hit the Caribbean island of Grenada, home to 90,000 people. The island had not experienced a major hurricane in 40 years. Citizens received warnings in advance but generally did not have adequate preparedness measures in place. Remarkably few (39) died, but 90% of housing was damaged or destroyed (Figures 85-17 and 85-18).

Regrettably, progress in reducing forecasting errors has remained slow in the last two decades despite huge investments in monitoring systems. However, substantial progress has been made in the organization of warning and dissemination systems, particularly through regional cooperation. The activities of national meteorologic services are coordinated at the international level by the WMO. Forecasts and warnings are prepared within the framework of the WMO's World Weather Watch program. Under this program, meteorologic observational data

FIGURE 85-17 Damage in Grenada from Hurricane Ivan, September 2004. *(Courtesy Sheila B. Reed.)*

FIGURE 85-18 A man standing on the site of his house in Jamaica, destroyed by Hurricane Ivan, September 2004. *(Courtesy Sheila B. Reed.)*

are provided nationally, and data from satellites and information provided by the regional centers are exchanged around the world. The World Weather Watch system includes 8500 land stations, 5500 merchant ships, aircraft, special ocean weather ships, automatic weather stations, and meteorologic satellites. A tropical cyclone is first identified and then followed from satellite pictures. A global telecommunications system relays the observations.

Ultimately, however, national services are responsible for providing forecasts and warnings to the local population regarding tropical cyclones and the associated winds, rains, and storm surges. Unfortunately, many of the less developed countries, where most deaths from tropical cyclones occur, do not possess state-of-the-art warning systems.

Vulnerability

Human settlements located in exposed, low-lying coastal areas are vulnerable to the direct effects of a cyclone, such as wind, rain, and storm surges. Settlements in adjacent areas are vulnerable to floods, mudslides, or landslides from the resultant heavy rains. The death rate is higher where communications systems are poor and warning systems are inadequate.

The quality of structures determines resistance to the effects of the cyclone. Those most vulnerable are lightweight structures with wood frames, older buildings with weakened walls, and houses made of unreinforced concrete block (Figure 85-19). Infrastructural elements particularly at risk are telephone and telegraph poles and fishing boats and other maritime industries. Hospitals may be damaged, reducing access to health care and essential drugs.

Typical Adverse Effects

Structures are damaged and destroyed by wind force, through collapse from pressure differentials, and by flooding, storm surges, and landslides. Severe damage can occur to overhead power lines, bridges, embankments, nonweatherproofed buildings, and roofs of most structures. Falling trees, wind-driven rain, and flying debris cause considerable damage.

Casualties and Public Health. Relatively few fatalities occur because of the high winds in cyclonic storms, but many people may be injured and require hospitalization. Storm surges may cause many deaths but usually cause few injuries among survivors. Because of flooding and possible contamination of water supplies, malaria organisms and viruses may be prevalent several weeks after the flooding.

Water Supplies. Open wells and other groundwater supplies may be temporarily contaminated by flood waters and storm surges. They are considered contaminated by pathogenic organisms only if dead people or animals are lying in the sources or if sewage is present. Normal water sources may be unavailable for several days.

Crops and Food Supplies. The combination of high winds and heavy rains, even without flooding, can ruin standing crops and tree plantations. Food stocks may be lost or contaminated if the structures in which they were held have been destroyed or inundated. Salt from storm surges may also be deposited on agricultural lands and increase groundwater salinity. Fruit, nut, and lumber trees may be damaged or destroyed by winds, flooding, and storm surges. Plantation-type crops, such as bananas, are extremely vulnerable. Erosion can occur from flooding and storm surges. Food shortages may occur until the next harvest. Tree and food crops may be blown down or damaged and must be harvested prematurely.

Communications and Logistics. Communications may be severely disrupted as telephone lines, radio antennas, and satellite dishes are brought down, usually by wind. Roads and railroad lines may be blocked by fallen trees or debris, and aircraft movements may be curtailed for at least 12 to 24 hours after the storm. Modes of transportation, such as trucks, carts, and small boats, may be damaged by wind or flooding. The cumulative effect of all damage is to impede information gathering and transport networks.

Preparedness Measures Take Root After Cyclone Nargis in Burma (Myanmar)

Cyclone Nargis, a Category 4 cyclone, struck Burma in May 2008, killing 145,000 and severely affecting 2.4 million people. Wind speeds reached 200 km/hr. More than 750,000 houses, 4000

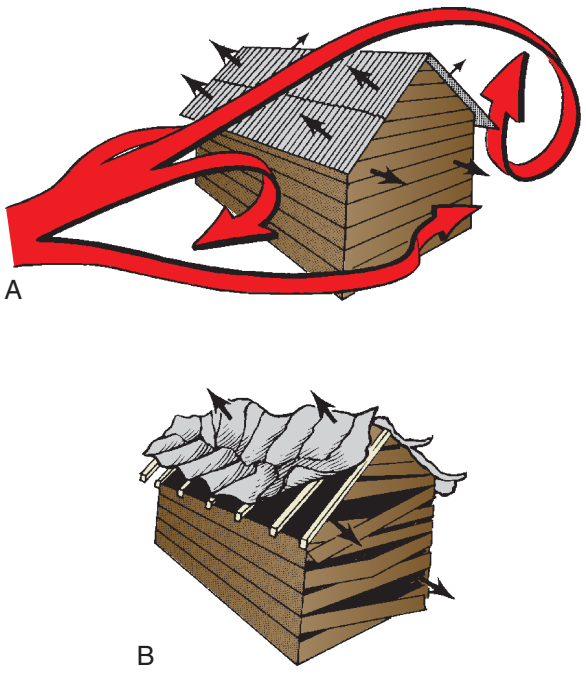


FIGURE 85-19 How high winds damage buildings. **A,** Wind blowing into a building is slowed at the windward face, creating high pressure. The airflow separates as it spills around the building, creating low pressure or suction at the end walls, roof, and leeward walls. **B,** The roof may lift off and the walls blow out if the structure is not specially reinforced. *(Courtesy Disaster Management Center, University of Wisconsin–Madison.)*

FIGURE 85-20 Plastic sheeting repair to houses after Cyclone Nargis in Burma (Myanmar). *(Courtesy Sheila B. Reed.)*

schools, and 630 health facilities were destroyed or badly damaged. More than 60% of the total rice paddy fields were submerged; millions of livestock animals were killed; and stored food, seed stocks, boats, and equipment were destroyed. The cyclone, and the flooding that followed, damaged close to 13% of ponds used for drinking and household water in Yangon and up to 43% of ponds in Ayeyarwady Division. The damage caused by Cyclone Nargis was found to be on a scale nearly equivalent to that suffered by Aceh in Indonesia, one of the most affected areas hit by the 2004 Indian Ocean tsunami.

Recovery efforts in the 2 years following Cyclone Nargis helped to restore a large percentage of agricultural productivity in Burma, although rebuilding of houses (Figure 85-20) and infrastructure elements was notably slower due to insufficient resources to implement the national recovery plan. Extensive environmental damage from the cyclone was also weakly addressed. However, disaster risk reduction measures were augmented by communities with the support of the government and assistance organizations. Many communities formed disaster management committees, promoted raising awareness, and developed evacuation plans for families and livestock (Figure 85-21). Committees and programs were established to replant mangroves and tree plantation barriers. Steps are being taken to strengthen hazard risk mapping, early warning systems, and scientific research to underpin national disaster risk reduction policies.

FIGURE 85-21 Women's group for disaster risk reduction in Burma. *(Courtesy Sheila B. Reed.)*

Cyclone Risk Reduction Measures

The primary ways to reduce property damage from cyclones are accurate forecasting, sufficient warning, and establishment of evacuation procedures and building codes. As described earlier, significant challenges exist in forecasting the behavior of cyclones and other severe wind storms. Another major challenge is altering the perception of people who live in coastal areas regarding the danger from cyclonic activity. People may ignore the dangers for various reasons: lack of experience in hurricanes and cyclones, insufficient understanding of the hazard, repeated false alarms, or incorrect landfall predictions that breed complacency.

TORNADOES

A tornado is the most dramatic example of a class of storms that includes thunderstorms and hailstorms; collectively, this class is often known simply as severe local storms. Tornadoes are sometimes referred to as "twisters" in the United States. Severe local storms, which may be a few miles to a few tens of miles in diameter, are often accompanied by unusually strong, gusty winds that can cause severe damage, by heavy local rain that can cause flash floods, and by lightning, hail, and sometimes tornadoes. These intense vortices may be only a few hundred feet in diameter but can contain winds in excess of 483 km/hr (300 mph), capable of tearing roofs off houses and lifting houses, trees, and vehicles hundreds of feet through the air. Tornadoes have been known to occur in swarms, with as many as several dozen affecting an area of hundreds of thousands of square miles in a single day. A new 1-day record was set in the United States on January 21, 1999, when 38 tornadoes were hatched in Arkansas, surpassing the previous record of 20 statewide. Before early September 2015, 29 tornadoes had already occurred in the Chicago area, setting a record for the most tornadoes in 1 year in the warning area.

Causal Phenomena

Tornadoes and other severe local storms result from intense, local atmospheric instability, usually caused by solar heating of Earth's surface, which causes intense convective columns. A tornado is a vortex in which air spirals inward and upward. It is frequently, but not always, visible as a funnel cloud hanging part or all of the way from the generating storm to the ground. The upper portion of the funnel consists of water droplets, and the lower portion usually consists of dust and soil being sucked up from the ground. The funnel size may range from a few meters to a few hundred meters in diameter and from 10 m (33 feet) to several kilometers high. The funnel may undergo changes in appearance during the tornado's lifetime. There may be a single well-defined funnel, multiple funnels, or funnels that appear to consist of several ropelike strands. Tornadoes may be as loud as the roar of a freight train. For a vortex to be classified as a tornado, it must be in contact with both the ground and the cloud base. Scientists have not yet created a complete definition of the word; for example, there is disagreement about whether separate touchdowns of the same funnel constitute separate tornadoes.

Tornadoes are the most violent events associated with thunderstorms. They have been observed on every continent except Antarctica but are most frequent and fierce in the United States. As many as 1200 tornadoes may strike the United States each year, mostly in the central plains (sometimes called Tornado Alley) and southeastern states, although they have occurred in every state, mostly in the spring and summer. Of all the natural hazards in the United States, thunderstorms with associated winds, rain, hail, and lightning rank first in number of deaths, second in number of injuries, and third in property damage. The Netherlands, followed by the UK, has the highest average number of tornadoes per area of any country, but most are small and cause only minor damage.

Various types of tornadoes include the landspout, multiple vortex, and waterspout. The most common type of tornado is small and lasts only a minute or two, causing minor damage over

a track often less than 90 m (300 feet) wide and 1.6 to 3.2 m (1 to 2 miles) long. Most tornado-related deaths, injuries, and property damage are caused by relatively infrequent, large, and long-lasting tornadoes with paths more than 1 mile wide and more than 100 miles long over several hours. There are several different scales for rating the strength of tornadoes. The Fujita (F) scale rates tornadoes by damage caused, but this has been replaced in some countries by the updated Enhanced Fujita (EF) scale. An F0 or EF0 tornado, the weakest category, damages trees, but not substantial structures. An F5 or EF5 tornado, the strongest category, rips buildings off their foundations and can deform large skyscrapers. The similar TORRO (T) scale ranges from a T0 for extremely weak tornadoes to T11 for the most powerful known tornadoes.

Predictability

Although conditions favorable to tornado formation can often be predicted a number of hours in advance, the areas in which these conditions are found may cover hundreds of thousands of square miles. It is impossible to predict where individual tornadoes will occur. When a warning is issued, a tornado has already formed, and the threatened population may have only a few minutes to take cover. In the United States, when tornadoes are considered likely within a well-defined region, a *tornado watch* is issued. When a tornado is actually detected, either visually or on radar, a *tornado warning* is issued. The U.S. National Weather Service has trained more than 290,000 Skywarn severe weather spotters across the United States; Canada has a similar program. When severe weather is anticipated, local weather service offices request that these spotters look out for severe weather and report any tornadoes immediately, so that the office can warn of the hazard. Storm spotters are needed because radar systems such as NEXRAD do not detect tornadoes. The radar systems merely detect "signatures" that hint at the presence of tornadoes. Radar may give a warning before there is any visual evidence of a tornado or imminent tornado, but ground truth from an observer can either verify the threat or determine that a tornado is not imminent. The spotter's ability to see what cannot be detected by radar is especially important as distance from the radar site increases, because the radar beam becomes progressively higher in altitude further away from the radar, chiefly a result of Earth's curvature, and the beam also spreads out.

Vulnerability

Most injuries from tornadoes are caused by flying or falling debris, usually from destroyed structures. The quality of structures will determine resistance to the effects of the tornado. Those most vulnerable are lightweight structures with wood frames, older buildings with weakened walls, mobile homes, and houses made of unreinforced concrete blocks. Thorough education regarding taking shelter from flying debris is essential to reduce deaths and injuries. Public education regarding the hazard is important to dispel myths. For example, opening house windows has not been shown to reduce damage even though this is a widespread belief; taking shelter under highway overpasses is not a safe way to wait out a tornado, contrary to some beliefs. On the other hand, taking shelter in a basement, under a staircase, or under a sturdy piece of furniture has been shown to increase chances of survival. Tornadoes have been known to cross major rivers, ascend mountains, affect valleys, and damage city centers. As a general rule, no area is safe from tornadoes, though some areas are less susceptible than others.

Examples of Tornado Outbreaks

The most extreme tornado in recorded history was the Tri-State Tornado, which roared through parts of Missouri, Illinois, and Indiana on March 18, 1925. It was likely an F5, although tornadoes were not ranked on any scale during that era. It holds records for longest path length (352 km [219 miles]), longest duration (about 3.5 hours), and fastest forward speed (117 km/hr [73 mph]) for a significant tornado anywhere on Earth. In addition, it is the deadliest (695 persons killed) single tornado in U.S. history. A tornado that struck Joplin, Missouri, in May 2011 killed 158 people and injured more than 1000 others, packed winds in excess of 200 mph, and stayed on the ground for more than 22 miles. The deadliest tornado in world history was the Daulatpur-Saturia tornado in Bangladesh on April 26, 1989, which killed approximately 1300 people. In Bangladesh, at least 19 tornadoes in its history have killed more than 100 people per event, almost one-half of the total deaths in the rest of the world.

The most extensive tornado outbreak on record was the Super Outbreak, on April 3 and 4, 1974, when 147 tornadoes struck Illinois, Indiana, Michigan, Ohio, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, and Alabama, killing 335 people, injuring more than 5500, affecting more than 27,000 households, and causing more than $600 million in damage. More than one-half the deaths were caused by fewer than 5% of the tornadoes. The worst of these struck Xenia, Ohio. It cut a swath of destruction one-half mile wide and 16 miles long, killed 34 people, injured 1150, and damaged or destroyed 2400 homes.

The year 2008 overtook the year 1998 as the deadliest tornado season in the United States, with 2192 tornadoes reported, 1691 confirmed (the most being in Kansas at 187), and 125 associated fatalities. Nine other tornado-related fatalities were reported elsewhere in the world: three in France, two each in Bangladesh and Poland, and one each in Russia and China. After a long lull in activity, a series of intense storms and associated cold fronts tracked across the Midwest, starting late on December 30, with most of the activity on December 31, New Year's Eve, 2010. Early that morning, an EF3 tornado touched down in Washington County, Arkansas, destroying houses and killing at least four people. In nearby Benton County, Arkansas, another tornado caused significant damage and injuries.

Tornado Risk Reduction Measures

The main means to prevent damage and casualties from tornadoes remains forecasting and warnings to urge the public to take protective measures. Scientists still do not know the exact mechanisms by which most tornadoes form, and occasional tornadoes still strike without a tornado warning being issued. More research is needed to refine existing knowledge. In the United States, many universities and government agencies, such as the National Severe Storms Laboratory, private-sector meteorologists, and National Center for Atmospheric Research, are actively seeking answers using various sources of funding, both private and public.

FLOODS

Throughout history, people have been attracted to the fertile lands of the floodplains, where their lives have been made easier by proximity to sources of food and water. Ironically, the same river or stream that provides sustenance to the surrounding population also renders humans vulnerable to disaster by periodic flooding. Flooding occurs when surface water covers land that is normally dry or when water overflows normal confinements. The most widespread of any hazard, floods can arise from abnormally heavy precipitation, dam failures, rapid snowmelts, river blockages, or even burst water mains. However, floods can provide benefits without creating disaster and are necessary to maintain most river ecosystems. They replenish soil fertility, provide water for crop irrigation and fisheries, and contribute seasonal water supplies to support life in arid lands.

Every year in Bangladesh, large tracts of land are submerged during the monsoon season, a normally beneficial process that deposits a rich layer of alluvial soil. The floods originate from three great river systems in the Himalayan mountains: the Ganges, Brahmaputra, and Meghna. In Bangladesh, the flood of 1974 affected 50% of the land; 27,500 persons perished from subsequent disease and starvation. Fortunately, timely arrival of food aid averted a famine crisis. In 1998, high sea levels and silting from increased deforestation upriver contributed to massive floods, killing 1500 people and causing $2 billion in damages. Farms were inundated and 26,000 cattle perished, destroying livelihoods for millions. In the aftermath of the flooding, cases of diarrheal diseases reached epidemic proportions, with 50,000 cases reported daily. The risk for other diseases, such as hepatitis,

typhoid fever, and measles, was elevated because of contaminated water supplies. Destruction of almost 4 million hectares of crops and partial damage to 3 million hectares left a shortfall in annual grain requirements of 1 million tons and placed the population at risk of famine. India also suffers frequent catastrophic floods, the most recent being in October 2009, when flooding occurred across South India. It was one of the worst floods in the area in the last 100 years, killing 250 people and leaving 500,000 homeless.

In 2007, the United Nations (UN) reported the "floods of Africa" to be one of the worst flood events in recorded history, affecting 14 countries; 250 people were killed and 2.5 million others were affected by the disaster. Warnings of waterborne diseases and locust infestations were issued. The countries most affected were Ghana, Sudan, Ethiopia, Uganda, and Rwanda. In November 2009, record-breaking amounts of rain were dumped on Cumbria, England, and Cork, Ireland, causing minor floods in Cork and major floods in Cumbria. During the floods, waters reached a UK record of 2.4 m (8 feet) deep in Cockermouth, Cumbria.

Pakistan Flood Disaster of 2010

In 2010, from mid-July until mid-August, all four of Pakistan's provinces (Balochistan, Khyber Pakhtunkhwa, Punjab, and Sindh), as well as the Azad Jammu and Kashmir Region of Pakistan, flooded during the monsoon rains when dams, rivers, and lakes overflowed, killing at least 1750 people, injuring 2500, and affecting 23 million. The flood is considered the worst in Pakistan's history, and the number of individuals affected by the flooding exceeds the combined total of those affected by the 2004 Indian Ocean tsunami, the 2005 Kashmir earthquake, and the 2010 Haiti earthquake. The flooding eventually affected about one-fifth of the country (nearly 62,000 square miles, an area larger than England) and formed what was called by some the largest freshwater lake in the world. Six weeks after the floods began, as rivers continued to devour villages and farmland in the southern province of Sindh, losses of crops, seed for the next planting season, and livelihoods were predicted. The UN Relief Web reported in January 2011 that millions of flood-affected people had still not received food and medicines, primarily because of inadequate relief resources and some villages being cut off from assistance by the flood waters.

Causal Phenomena

The most important cause of floods is excessive rainfall. Rain may be seasonal and occur over wide areas or may be the result of localized storms; the latter produce the highest-intensity rainfall. Some storms are attributed to atmospheric and oceanic processes, such as the El Niño southern oscillation or strong jet streams. Melting snow is another major contributor.

Types of Floods

Flash Floods. Flash floods are usually defined as floods that occur within 6 hours of the beginning of heavy rainfall. This type of flooding requires rapid local warnings and immediate response by affected communities if damage is to be mitigated. Flash floods are normally a result of runoff from a torrential downpour, particularly if the catchment slope is unable to absorb and hold a significant part of the water. Other causes of flash floods include dam failure or sudden breakup of ice jams or other river obstructions. Flash floods are potential threats, particularly where the terrain is steep, surface runoff is high, water flows through narrow canyons, and severe rainstorms are likely.

River Floods. River floods are usually caused by precipitation over large catchment areas, by melting of the winter accumulation of snow, or by both. The floods take place in river systems with tributaries that may drain large geographic areas and encompass many independent river basins. In contrast to flash floods, river floods normally build up slowly, are often seasonal, and may continue for days or weeks. Factors governing the amount of flooding include ground conditions (amount of moisture in the soil, vegetation cover, depth of snow, cover by impervious urban surfaces such as concrete), and size of the catchment basin (Figure 85-22).

Coastal Floods. Some flooding is associated with tropical cyclones (also called hurricanes and typhoons). Catastrophic flooding from rainwater is often aggravated by wind-induced storm surges along the coast. Saltwater may flood the land by one or a combination of effects from high tides, storm surges, or tsunamis. As in river floods, intense rain falling over a large

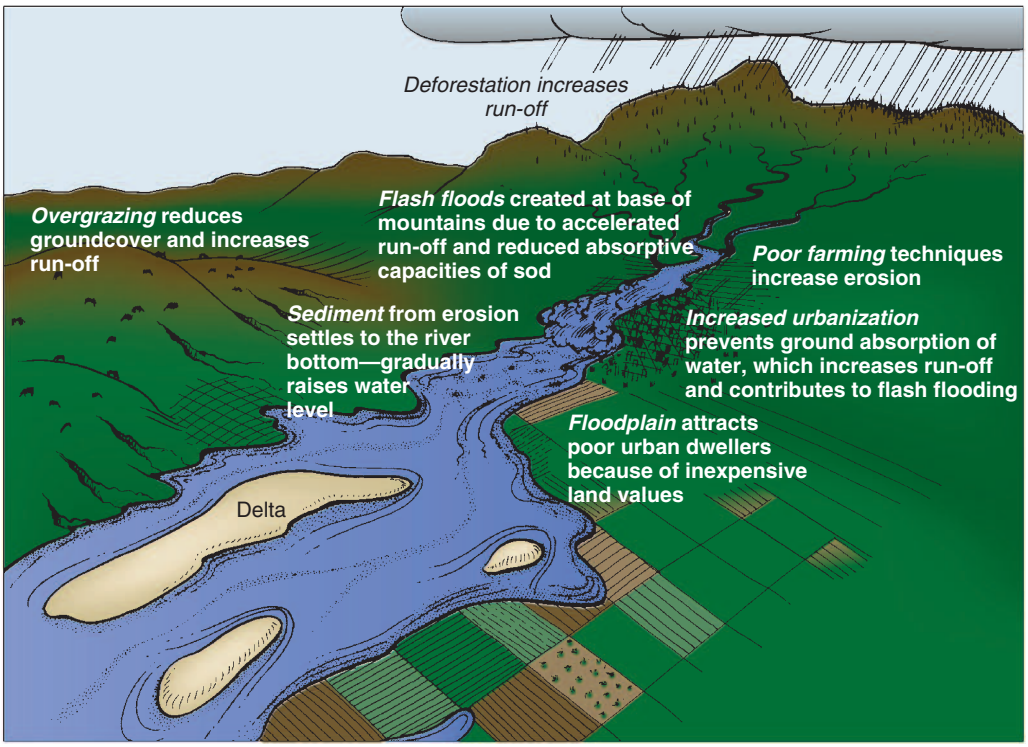


FIGURE 85-22 Flooding and its causes. *(Courtesy Disaster Management Center, University of Wisconsin.)*

geographic area will produce extreme flooding in coastal river basins.

Contribution by Humans

Floods are naturally occurring hazards but can become disasters when they affect human settlements. The magnitude and frequency of flooding often increase because of human actions. Settlement on floodplains contributes to flooding disasters by endangering humans and their assets. However, economic benefits of living on the floodplain outweigh the dangers for some societies. Population pressure is now so great that people have accepted the risk associated with floods because of the greater need for a place to live. In the United States, billions of dollars have been spent on flood protection programs since 1936. Despite this, the annual flood hazard has become greater because people have built on floodplains faster than engineers can design better flood protection. The Mississippi River, which had been protected by 5600 miles of levees, flooded in 1993, affecting nine states. Some 70% of levees failed to protect against the record rainfall.

Urbanization contributes to urban flooding. Roads and buildings prevent infiltration of water, so runoff forms artificial streams. The network of drains in urban areas may deliver water and fill natural channels more rapidly than natural drainage routes, or drains may be insufficient and overflow. Natural or artificial channels may become constricted by debris or obstructed by river facilities, impeding drainage and overflowing the catchment areas. Failure to maintain or manage drainage systems, dams, and levees in vulnerable areas also contributes to flooding. Central Europe experienced severe flooding in 2002 and incurred $18 billion in damages, with the cities of Dresden and Prague particularly affected.

Deforestation and removal of root systems increase runoff. Subsequent erosion causes sedimentation in river channels, which decreases their capacity.

Catastrophic flooding may become worse in the United States and has become more frequent in the Midwest over the last 50 years. In the summer of 2014, the Midwest was inundated with 2 months' worth of rainfall in just 1 week, submerging farms and killing crops. A Federal Emergency Management Agency assessment found that due to rising seas and more severe storms, flooding in certain areas of the United States may increase by as much as 45%.

Predictability

Riverine flood forecasting estimates the river level stage, discharge, time of occurrence, and duration of flooding, especially of peak discharge at specific points along river systems. Flooding resulting from precipitation, snowmelt in the catchment system, or upstream flooding is predictable from 12 hours to as much as several weeks ahead of events. Forecasts issued to the public result from regular monitoring of the river heights and rainfall observations. Flash flood warnings, however, depend solely on meteorologic forecasts and knowledge of local geographic conditions. The very short lead time for development of flash floods does not permit useful monitoring of actual river levels for warning purposes.

Flood hazard mapping supports flood management plans, land use planning, emergency evacuation plans, and increased public awareness. For comparison with previous flood events and conversion to warning information, assessment of the following elements should be included: flood frequency analysis, topographic mapping and height contouring around river systems with estimates of water-holding capacity of the catchment area, precipitation and snowmelt records, soil filtration capacity, and, if in a coastal area, tidal records, storm frequency, topography, coastal geography, and breakwater characteristics.

An effective means of monitoring floodplains is through remote sensing techniques. The images produced by satellites can be interpreted to map flooded and flood-prone areas. Other efforts to improve forecasting are being implemented by UN organizations, such as the WMO (using its World Weather Watch program), and the Global Data Processing System. These systems are strategic when flood conditions exist across international boundaries. The great majority of river and flash flood forecasts, however, depend on observations made by national weather services for activation of flood alert warnings.

Vulnerability

As with other hazards, perceptions by the general public of the flood hazard have improved by using flood mapping and public awareness campaigns. People in flood-prone areas in developing countries may assume high risks due to overcrowding and the need to use the land for livelihood purposes.

At notable risk in floodplain settlements are buildings made of earth or with soluble mortar, buildings with shallow foundations, or buildings that are nonresistant to water force and inundation. Infrastructural elements at particular risk include utilities, such as sewer systems, power and water supplies, and machinery and electronics belonging to industrial plants and communications groups. Of great concern are food stocks and standing crops, confined livestock, irreplaceable cultural artifacts, and fishing boats and other maritime industries.

Other factors affecting vulnerability are lack of adequate refuge sites above flood levels and accessible routes for reaching those sites. Also, lack of public information about escape routes and other appropriate response activities renders communities more vulnerable. Vietnam, which has 3444 km (2149 miles) of coastline and a complex and ancient system of sea dikes, is chronically vulnerable to floods. The government is promoting a strong institutional network to support citizens to "live with floods," reducing their vulnerability and providing social safety nets to assist with recovery.

Typical Adverse Effects

Structures are damaged by receiving the force of impact of flood waters, floating away on rising waters, becoming inundated, collapsing because of undercutting by scouring or erosion, and being struck by waterborne debris.

Damage is likely to be much greater in valleys than in open, low-lying areas. Flash floods often sweep away everything in their path. In coastal areas, storm surges are destructive both on inward travel and on outward return to the sea. Mud, oil, and other pollutants carried by water are deposited and ruin crops and building contents. Saturation of soils may cause landslides or ground failure.

Casualties and Public Health. Currents of moving or turbulent water can knock down and drown people and animals in relatively shallow depths. Major floods may result in large numbers of deaths from drowning, particularly among young and weak persons, but generally inflict few serious, nonfatal injuries requiring hospital treatment. Slow flooding causes relatively few direct deaths or injuries, but often increases the occurrence of snakebites.

Endemic disease will continue in flooded areas, but little evidence exists of floods directly causing any large-scale additional health problems besides diarrhea, malaria, and other viral outbreaks 8 to 10 weeks after the flood.

Water, Crops, and Food Supplies. Open wells and other groundwater supplies may be contaminated temporarily by debris carried by flood waters or by saltwater brought in by storm surges. They are contaminated by pathogenic organisms only if bodies of people or animals are caught in the sources or if sewage is present. Normal sources of water may not be available for several days.

Food stocks may be lost by submersion of crop storage facilities, resulting in immediate food shortages. An entire harvest may be lost, along with animal fodder, resulting in long-term food shortages. Grains quickly spoil if saturated with water, even for a short time. Most agricultural losses result from inundation of crops or stagnation of standing water, as in the 1988 Bangladesh flood.

Large numbers of animals, including draught animals, may be lost if they are not moved to safety. This may reduce availability of milk and other animal products and services, such as preparation of the land for planting. These losses, in addition to possible loss of farm implements and seed stocks, may hinder future planting efforts.

Floods bring mixed results in terms of their effects on the soil. In some cases, land may be rendered infertile for several years after a flood because of erosion of topsoil or salt permeation, as in the case of a coastal flood. Heavy silting may have adverse effects or may significantly increase fertility of the soil.

In coastal areas, where fish provide a source of protein, boats and fishing equipment may be lost or damaged.

On the positive side, floods may flush out pollutants in the waterways. Other positive effects include preserving wetlands, recharging groundwater, and maintaining river ecosystems by providing breeding, nesting, and feeding areas for fish, birds, and wildlife.

Flood Risk Reduction Measures

The major means of addressing flooding is through prevention. However, people may be lured to the floodplain with false hopes of avoiding floods. Most dams and channels are not strong enough to withstand the heaviest water pressures and if they break down, flooding can be catastrophic. Furthermore, as levees and other physical barriers age, they become more likely to fail. European countries employ a variety of means to reduce the flood risk, such as a series of reservoirs in France called Les Grands Lacs de la Seine (or Great Lakes), which help to remove pressure from the Seine during floods (especially during the regular winter flooding); protection from sea flooding by a huge mechanical barrier across the Thames River in London; underground canals that drain part of the flow of the Adige River in northern Italy; and a series of flood defenses in The Netherlands called the Delta Works, with the Oosterschelde Dam as its crowning achievement.

Because flooding may be beneficial to environmental regeneration, the challenge is to allow this while also ensuring personal and economic safety. The concept of integrated flood management, developed by the WMO in 2004, embraces floodplain land use that does not have adverse environmental impacts. Aspects include (1) integrated flood control that considers social and ecologic processes, (2) prioritization of floodplain land use, (3) integration of local stakeholder concerns, (4) a flexible approach to flood control, and (5) extensive continuous monitoring of flood control measures and flooding events. Since 2005, when Hurricane Katrina struck, flood prevention measures in New Orleans have included $14 billion spent for upgraded levees, floodwalls, and gates to form an integrated system that is designed to withstand the kind of storm that might occur every 100 years. Coastal restoration efforts are also under way to help reduce the risks to southeast Louisiana. The test came in 2012 when Hurricane Isaac struck. The system spared residents serious flooding. However, there would still be risks if an every-100-year type of storm were to occur, because the metro system is not totally protected and some communities are not covered by the federal system of flood control. Storms so intense that they occur only every 500 years are also possible; they would seriously challenge the system if rainfalls of as much as 13 inches in 24 hours were to develop.

DROUGHT

Of all natural disasters, droughts potentially have the greatest economic impact and affect the greatest number of people. They invariably have a direct and significant impact on food production and the overall economy. Because of the slow onset of droughts, their effects may accumulate over time and linger for many years. Their impact may be less obvious than that of other natural hazards but may be spread over a wider geographic area. Because of the pervasive effects of droughts, assessing their impact and planning assistance become more difficult than with other natural hazards.

No universal definition exists for drought. In general, drought is temporary reduction in water or moisture availability that is significantly below the normal or expected amount for a specified period. Because droughts occur in nearly all regions of the world and have varying characteristics, however, working definitions must be regionally specific and focus on the impacts that result from discrepancies between the supply and demand for water.

Droughts are most often associated with low rainfall and a semiarid climate. However, they also occur in areas with normally abundant rainfall. Humans tend to stabilize their activities around the expected moisture environment. Thus, after many years with above-average rainfall, people may perceive the first year of average rainfall as a drought. A rainfall level that meets the needs of a pastoralist may constitute a serious drought for a farmer growing corn. To define drought in a region, it is necessary to understand both the meteorologic characteristics and human perceptions of drought.

Types of Droughts

Meteorologic Drought. Meteorologic drought results from a shortfall in precipitation and is based on the degree of dryness relative to the normal or average amount, and on the duration of the dry period. This comparison must be specific to each region and may be measured against daily, monthly, seasonal, or annual rainfall amounts. Meteorologic drought usually precedes the other types of drought.

Hydrologic Drought. Hydrologic drought involves reduction of water resources, such as streams, groundwater, lakes, and reservoirs. It involves data on availability and off-take rates in relation to the normal operations of the system (domestic, industrial, irrigated agricultural) being supplied. One impact is competition between users for water in these storage systems.

Agricultural Drought. Agricultural drought is the impact of meteorologic and hydrologic droughts on crops and livestock production. It occurs when soil moisture is insufficient to maintain average plant growth and yields. The impact of agricultural drought is difficult to measure because of the complexity of plant growth and possible presence of other factors that may reduce yields, such as pests, weeds, low soil fertility, and low crop prices.

Famine drought can be regarded as an extreme form of agricultural drought in which food shortages are so severe that large numbers of people become unhealthy or die. Famine disasters have complex causes, such as civil war or external conflict, chronic food insecurity, or inflicted food insecurity due to political manipulation. Although scarcity of food is the main factor in a famine, death can result from other complicating influences, such as disease or lack of access to water and other services. Most deaths related to famine occur in the semiarid areas of sub-Saharan Africa. It was hoped that the lessons learned in mitigating the famine droughts in Ethiopia and Sudan in 1984 and 1985, where an estimated 900,000 people died, would prevent similar tragedies in the future. However, subsequent devastating famines occurred in Somalia in 1991 to 1992 (300,000 deaths); in North Korea in 1996 (200,000 to 3.5 million estimated deaths); again in Sudan in 1998 (70,000 deaths); again in Ethiopia in 1998 to 2000; and again in Somalia in 2011 to 2012. The Second Congo War from 1998 to 2004 caused approximately 3.8 million deaths, mainly from starvation and disease. Famine also occurred in six West African countries in 2012 due to the Sahel drought.

Socioeconomic Drought. Socioeconomic drought correlates supply and demand of goods and services with the three other types of drought and emphasizes the relationship between drought and human activities. When the supply of some goods or services, such as water, hay, or electric power, is dependent on weather, drought may cause shortages. During the drought of 2014 to 2015 that affected western U.S. states, snow shortages caused closures and severe reductions in business in ski areas; Tahoe City, California, experienced a snow deficit in the winter of 2014 to 2015 of 132.9 inches (338 cm).

Causal Phenomena

The reasons for deficiency of precipitation are not well understood. Dry seasons are typical in the tropics, when land and water reservoirs dry up and wildlife migrate to seek more fertile areas. Displacement of the normal path of the jet stream may steer rain-bearing storms elsewhere.

Recent research has focused on teleconnection, or linkages to global interactions, between the atmosphere and the oceans. Sea surface temperature anomalies influence heat and moisture, such that warm surface water may create air conditions favorable for

cyclone formation. A large-scale sea surface temperature anomaly is linked to the El Niño southern oscillation events in the Pacific. These involve periodic (every 2 to 7 years) invasion of warm surface waters into the normally colder waters off the coast of South America. Droughts of 1982 to 1983 in Africa, Australia, India, Brazil, and the United States coincided with a major El Niño.

Human causes of drought, which include land use practices that give rise to desertification, such as deforestation, overcultivation, overgrazing, and mismanagement of irrigation, are thought to result in greater persistence of drought. Traditional drought-coping systems in Africa, such as pastoralists' use of seasonal grazing lands and farmers' use of fallow periods, have been reduced because of population pressures and economic policies (see Desertification, later). The global climate changes under way are expected to trigger more agricultural droughts, especially in developing countries, although global rainfall as a whole may increase.

Droughts vary in terms of intensity, duration, and coverage. Droughts tend to be more severe in drier areas of the world because of low mean annual rainfall and longer duration of dry periods. In dry areas, drought builds up slowly over several years of poor rainfall. Dry conditions in the African Sahel over a 16-year period led to widespread famine in 1984 to 1985. The quarter-century of drought conditions in the Sahel was interrupted by heavy rains in 1994. The effect of drought on food security depends, among other factors, on the size of the area affected by drought, as well as overall size of the country. Larger countries, such as India and Brazil, are rarely completely affected by drought, but smaller countries may be totally affected (Figure 85-23). In Syria in 2009 and 2010, 300,000 families moved to Damascus, Aleppo, and other cities in what constituted one of the largest internal displacements in the Middle East prior to the outbreak of conflict in Syria in 2011. This was due to rainfall averaging between 45% and 66% less than normal in three eastern provinces. Worldwide food availability may be adversely affected by drought in nations that export grain.

Severe droughts that plagued China during the spring of 2010 affected 10 regions of southwestern China, as well as parts of Southeast Asia, including Vietnam and Thailand. Resultant dust storms in March and April affected much of East Asia. This drought has been referred to as the worst in a century in southwestern China. The China Meteorological Administration recorded temperatures averaging 2°C warmer than normal over 6 months, and one-half the average precipitation for the past year across the region. The higher temperatures and drop in precipitation were unprecedented since at least the 1950s. The effects of El Niño were believed to have contributed to the drought, which may have been exacerbated by global warming and resulting climate change.

FIGURE 85-23 Victims of drought in Ethiopia. *(Courtesy United Nations.)*

Predictability

Modern meteorologic monitoring and telecommunications systems can prevent casualties from drought-induced food shortages. The slow onset of drought allows a warning time, usually several months, between the first indications and when the population will be affected. In 1987, satellite imagery and rainfall reports indicated areas within Ethiopia with below-normal moisture and allowed timely intervention to avert a major food shortage. Longer-term prediction requires analysis of a century of rainfall data, which do not exist for some parts of the world. The WMO has established a base in Niamey, Niger, to promote regional training on agricultural production and drought response. The UN International Strategy for Disaster Reduction convened panels of experts to steer development of the integrated Drought Early Warning System, which focuses on strengthening data networks and data sharing on drought indicators.

Most countries in sub-Saharan Africa have installed famine early warning systems after the 1980s drought. The UN Food and Agriculture Organization Global Information and Early Warning System and the USAID-sponsored Famine Early Warning System issue regular bulletins on rainfall, food production, and famine vulnerability. These systems rely on satellite remote sensing to detect a reduction in vegetation. In addition to the unique vantage point and condensed view, remote sensing provides a permanent historical record. The National Oceanic and Atmospheric Administration satellites provide twice-daily coverage of the planet's surface. These data are available at many receiving stations around the world. The administration has developed crop-monitoring technology for large areas of the Sahel.

Vulnerability

Although drought is more likely in dry areas with limited rainfall, physical factors, such as the moisture retention of soil and timing of rains, influence the degree of crop loss. Dependency on rain-fed agriculture increases vulnerability. Farmers unable to adapt with repeated plantings may experience crop failure. Populations dependent on livestock without adequate grazing territory are also at risk. Farmers dependent on stored water resources or irrigation are more vulnerable to water shortages and may face competition for water.

Drought-related effects are more severe in countries with yearly food deficiencies and in systems that largely rely on subsistence-level farming and pastoralism. Food shortages have the greatest impact where malnutrition already exists. Most deaths related to food shortages occur in the semiarid countries of sub-Saharan Africa, whereas in more developed countries the consequences are largely economic. Adverse effects may be more serious where the drought response has not been adequately planned and where assistance measures may be poorly targeted or ineffective. There are indications that incidences of drought may increase, although this remains controversial. In any case, it is certain that societal vulnerability to drought is on the rise in many parts of the world.

Typical Adverse Effects

The effects of drought can be grouped as economic, environmental, and social. Economic effects include losses in crops, dairy and livestock, timber, fisheries, national economic growth, and income for farmers and others. Decreased tourism, loss of hydroelectric power and increased energy costs, increased food prices, unemployment, and losses of revenue to governments are other economic effects. Environmental effects include fires and dust storms; damage to animals, fish, and plant species and habitat; wind and water erosion of soils; reduced water quality or altered salinization; and reduced air quality from dust and pollutants. Social effects include food shortages (malnutrition, famine), loss of human life, conflict between water users, health problems from decreased water flow, decline in living conditions, increased poverty, social unrest, and population migration for employment.

Drought Risk Reduction Measures

A number of drought mitigation activities focus on restoring or conserving water resources. These include cloud seeding to

induce rainfall, desalination of seawater for irrigation or consumption, rainwater harvesting or collection and storage of rainwater from roofs or other suitable catchments, recycling water (such as wastewater that has been treated and purified for reuse), building canals or redirecting rivers in massive attempts at irrigation within drought-prone areas, and outdoor water use restriction.

As described earlier, drought monitoring is critical for forecasting and warning and can help to prevent human-made drought. For instance, analysis of water usage in Yemen revealed that the water table (underground water level) has been put at grave risk by overuse to fertilize khat, the largest cash crop. Land use measures include carefully planned crop rotation to help minimize erosion and allow farmers to plant fewer water-dependent crops during drier years.

WINTER STORMS

Winter storms feature strong winds, extreme cold, ice storms, and heavy snowstorms. These are often deceptive killers because most deaths are indirectly related to the storm, such as those from traffic accidents and hypothermia. In the United States, of deaths related to ice and snow, about 70% occur in automobiles, and 25% are people caught out in a storm. The majority are men older than 40 years. For deaths related to cold, 50% are people over 60 years old, more than 75% are males, and about 20% occur in the home.

When temperatures are below freezing, everyone is at potential risk from winter storms. In areas of the world where roads are rarely maintained to mountainous areas, such as Nepal, Iraq, and Russia, local populations cope by storing provisions for the winter months. In more heavily populated areas, individual and societal precautions must be taken to avoid the effects of winter storms. The cost of cleaning up after winter storms and loss of business during the storm can have significant economic impact. The winter of 2010 to 2011 in Europe began with an unusually cold November caused by a cold weather cycle that started in southern Scandinavia and subsequently moved south and west over both Belgium and The Netherlands and into the west of Scotland and northeast England. Cold weather and record snowfalls resulted in airport closures and cancellations of hundreds of flights due to the snow itself, leading to backups in connecting flights throughout Europe, stranding thousands in November and again in December. The January 2015 North American blizzard, unofficially named Winter Storm Juno, affected Canada and the central and eastern United States, moving on to Greenland and Western Europe. Snow emergencies were declared in six states and travel bans enacted in four of them, as well as in New York City. Up to 88 cm (34.5 inches) of snow fell in Worchester, Massachusetts, the largest storm accumulation on the city's record.

Causal Phenomena

Cold air and below-freezing temperatures in the clouds and near the ground are necessary to make snow and ice. Moisture is needed to form clouds and precipitation. The source of moisture may be air blowing across a body of water, such as a large lake or the ocean. *Lift,* or the required force needed to raise the moist air to form the clouds and cause precipitation, can occur when warm air collides with cold air and is forced to rise over the cold dome. The boundary between the warm and cold air is called a *front.* Lift might also occur from air flowing up a mountainside.

Strong Winds. Strong winds that sometimes accompany winter storms can create blizzard conditions with blinding wind-driven snow, severe drifting, and a dangerous windchill factor. Strong winds with these intense storms and cold fronts can knock down trees, utility poles, and power lines. Storms near the coast can cause coastal flooding and beach erosion, as well as sink ships at sea. Winds descending from mountains can gust to 160 km/hr (100 mph) or more, damaging roofs and other structures.

The windchill factor is based on the rate of heat loss from exposed skin caused by combined effects of wind and cold. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. Animals are also affected by windchill.

Extreme Cold. Extreme cold often accompanies a winter storm or is left in the aftermath. What constitutes extreme cold varies in different areas. For example, in areas unaccustomed to winter weather, temperatures at the freezing mark may be considered extreme. Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation.

Prolonged exposure to cold can cause frostbite (damage to body tissue caused by tissue being frozen) or hypothermia (low body temperature) (see Chapters 6 and 9). Infants and elders are most susceptible.

Ice Storms. Even a small amount of ice poses a significant hazard to motorists and pedestrians. Accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communication and power can be disrupted for days while utility companies work to repair extensive damage.

Snowstorms. Snow may fall as flurries, showers, squalls, blowing snow, or blizzards, the last where winds over 56 km/hr (35 mph) and blowing snow reduce visibility. The 1993 "superstorm" that reached from Canada to Central America was manifest as a blizzard in most of the affected areas. In the United States, the storm was responsible for 300 deaths and loss of electric power to more than 10 million persons. Sleet (raindrops that freeze into ice pellets before reaching the ground) can accumulate and cause problems. Heavy snow can immobilize a region and paralyze a city. Travelers can be stranded and emergency services disrupted. In rural areas, homes and farms may be cut off for days, and livestock may die if unprotected. The probability of avalanches increases in the mountains.

Predictability

Although winter storm patterns are known in most areas of the world, predicting the intensity and characteristics of winter storms is not an exact science. The effects of El Niño on the winter storm patterns of 1998 are still being debated. Typical U.S. storm patterns include the "nor'easter," which affects the mid-Atlantic coast to New England from low-pressure areas off the Carolina coast. Research is continuously under way to improve forecasting tools and techniques. For example, the Center for Analysis and Prediction of Storms at the University of Oklahoma provides feedback for the National Weather Service, National Aeronautics and Space Administration, and Department of Defense.

The capacities of most national weather services allow individuals and public services to prepare for winter storms. Winter storm watches and warnings and winter weather advisories are normally issued in most vulnerable areas. In the 2015 Winter Storm Juno, the mayor of New York City received criticism for shutting down the subway system when much less snow fell than was predicted because he had relied on models that were 50 miles off target. However, previous "nor'easters" had resulted in heavier, more disabling snowfalls for the city.

Vulnerability

Lack of a preparedness plan by individuals and communities and lack of understanding of the effects of winter storms increase vulnerability. Failure to heed warnings, lack of communication facilities to receive warnings, and insufficient preparation to cope with the cold or possible isolation from heavy snow can lead to casualties. For example, a person stranded in a vehicle or home during a winter storm without a storm survival kit or without adequate heat, food, or water may become hypothermic or dehydrated. Lack of protection for the infrastructure, utilities, and houses can result in damage, loss of service, and roof collapse from heavy snow. Downed trees may later cause forest fires. Motorists unaccustomed to driving in winter storms cause more accidents. People living in uninsulated or unheated buildings are at greater risk for hypothermia.

The 1998 Ice Storm

A storm of unprecedented impact began on January 5, 1998, and ultimately damaged about 18 million acres of rural and urban forests throughout Maine, New Hampshire, Vermont, upstate

New York, and southeastern Canada. The storm severely affected the dairy industry, maple sugar industry, small businesses, public facilities, and infrastructure elements. Power outages lasted for up to 23 days. Thousands of people required shelter for an extended period, and nine people died in the United States.

The causal factors of the storm were both natural and human-made. The population and urbanization had recently increased in the area. Cold surface temperatures were overrun by a warm moist tropical air mass, resulting in record rainfall of 5 to 15 cm (2 to 6 inches). Below-freezing temperatures caused the rain to freeze on contact, producing ice accumulations of more than 7 to 10 cm (3 to 4 inches). These factors were intensified by the long duration and significant scope of the storm, resulting in severe flooding and ice damage. Much of the damage could not be assessed until the spring thaw. As a result of the storm, the Federal Emergency Management Agency reviewed the mitigation measures in place and made new recommendations.

ENVIRONMENTAL HAZARDS

ENVIRONMENTAL POLLUTION

The world population, now around 7.3 billion, is expected to reach 9.7 billion by 2050. Despite the pressures placed on natural resources by the expanding population, many poor countries still desperately need the benefits accompanying industrialization and economic growth. In general, people in developing countries are much more vulnerable to the effects of environmental degradation because they are poorer and depend more directly on the land.

Causal Phenomena

Various parts of the environment are subjected to the effects of toxic (poisonous) chemicals produced in manufacturing, such as paint and metal production, and the burning of fossil fuels, such as gasoline, coal, and oil. Some of these chemicals are heavy metals, such as lead, which are essentially nondegradable. Other toxic compounds, such as pesticides, are purposely introduced into the environment. Toxic chemicals may accumulate and affect the quality of air and water. Other pollutants of importance are from biologic sources, such as human waste, soil sediments, and decaying organic matter.

Air Pollution. Much of the world's urban population breathes polluted air at least part of the time. China, the United States, Russia, India, Mexico, and Japan lead the world in air pollution emissions. Sulfur dioxide, a major pollutant, is a corrosive gas harmful to humans and the environment. Electricity generation using fossil fuels is the key source of sulfur dioxide in industrialized countries. In developed countries the burning of fossil fuels also contributes to its creation. Other air pollutants include nitrogen oxides, CO_2, and lead, mainly from vehicle exhaust. China surpassed the United States as the biggest producer of CO_2 in 2007.

Marine Pollution. Sewage is the major cause of ocean pollution. Raw sewage containing human excreta and domestic wastes is disposed of in large quantities directly into the ocean. In the summer of 1993, thousands of ocean beaches were closed in the United States because of high levels of pathogens from human and animal waste. Industrial effluents are also piped into the ocean.

Other pollutants include marine litter, oil spills, and dumped chemical compounds, such as those containing mercury and radioactive substances. In April 2010, the *Deepwater Horizon* offshore drilling rig exploded in the Gulf of Mexico. Oil began to leak at the wellhead more than 1400 m (5000 feet) below the surface, ultimately spilling more than 4.8 million barrels of oil, or 205.8 million barrels of crude oil, before the flow was completely stopped in September 2010. The event surpassed by 20 times the *Exxon Valdez* disaster of 1989 in Alaska's Prince William Sound as the largest oil spill in history originating in U.S. waters. Efforts were made to dilute, disperse, and contain the oil, but as much as 75% of the oil remains unaccounted for. The environmental damage affected eight U.S. national parks and more than 400 animal species that live in the Gulf islands and marshlands. The spill had short-term and long-term impacts on fishing revenue owing to closure of shrimping waters and loss of 20% of juvenile bluefin tuna (which were already declining in numbers) in the area, and on tourism in Louisiana.

Freshwater Pollution. Human waste and other domestic wastewaters are often discharged directly into nearby bodies of water, particularly in urban areas. In developing countries, this waste may be completely untreated. Industrial effluents from paper-making, chemical, metal-working, textile, and food-processing industries reach bodies of water by direct discharge or by leaching from dumps. In August 2015, the abandoned Gold King Mine in Colorado discharged an initial 3 million gallons of contaminated water, and then continuously 500 gallons a minute into the Animas River, which posed a danger to humans and animals due to arsenic content.

Clearing the land for agriculture and using irrigation, fertilizers, and pesticides have seriously affected water quality in many countries. Unprecedented deforestation has led to soil erosion, causing accelerated runoff and sediment deposits in riverbeds. The sediment level in rivers may increase 100-fold in deforested areas during rainy seasons.

Runoff of nitrogen from fertilizers, particularly in industrialized nations, renders some water unfit to drink without treatment. Use of irrigation systems may lead to increased salinity of water sources and saltwater intrusion on coastal areas where water is withdrawn. Approximately 25% of the world's pesticide production is used in developing countries, mainly on cash crops. Accumulations of pesticide toxins are found in food, soil, and water. Although data from Africa are lacking, studies in Asia indicate that rivers and lakes in Indonesia and Malaysia have very high levels of polychlorinated biphenyls and some pesticides.

Ozone Depletion. Ozone is a form of oxygen composed of three atoms of oxygen. Most atmospheric ozone is concentrated in the upper atmosphere, or stratosphere. The ozone layer ranges from 13 to 40 km (8 to 25 miles) above Earth. Ozone screens out harmful wavelengths of ultraviolet radiation that originate from the sun, protecting life on Earth (see Chapter 16). Ultraviolet light is associated with increased nonmelanoma skin cancer, ocular cataracts, and deterioration of the retina and cornea. In addition, oceanic phytoplankton are reduced, with damage to fish larvae and young fish. Because fish provide on average approximately 14% of the animal protein consumed worldwide (60% of that in Japan), the impact could be significant. A hole in the ozone layer has been detected over Antarctica. This hole appears seasonally and is roughly the size of the United States. Thinning of the ozone layer is caused by fluorinated gases, mainly CFCs, chemicals used in refrigeration, foam products, and aerosol propellants. Although they make up a fraction of greenhouse gases, they account for 20% of the warming trend caused by radioactive trapping potential (10,000 times greater than that of CO_2).

The 1987 Montreal Protocol, an international agreement to reduce ozone depletion, was ratified by 170 countries and has successfully led to decreased ozone-depleting chemicals in the lower atmosphere. Hydrofluorocarbons were largely developed to replace CFCs as required by the Montreal Protocol. However, hydrofluorocarbons are potent greenhouse gases with a long atmospheric life and may also contribute to global warming.

Climate Change and Global Warming. For the past several decades, the climate of Earth has been changing rapidly as a result of warming of the troposphere. Scientific evidence indicates that there has been warming of the atmosphere in the last 35 years that has manifested in an increase in sea surface temperatures; widespread melting of snow, glaciers, ice sheets, and permafrost; and a significant increase in the rate of sea level rise. Over the past 50 years, the average global temperature has increased at the fastest rate in recorded history; the 10 warmest years in the 134-year record have all occurred since 2000, with the exception of 1998, and the year 2014 was the warmest on record. Put in perspective, the climate of Earth over the past 3.2 million years has fluctuated greatly, with glacial and warmer interglacial intervals and accompanying adjustment by ecosystems and living creatures. A present concern is whether the

changes are occurring too rapidly to allow adjustments to take place.

One explanation for global warming is the *greenhouse effect,* which is used to describe the role of atmospheric gases (such as CO_2, methane, and water vapor) in trapping radiation that would otherwise leave the atmosphere. Without this canopy of gases and clouds, the temperature of Earth would be extremely cold. The atmospheric gases therefore behave similarly to a greenhouse.

Since the beginning of the Industrial Revolution in the late 18th century, CO_2 in the atmosphere has increased by almost 25%, mainly from combustion of coal, oil, natural gas, and gasoline. A strong scientific consensus states that buildup of greenhouse gases is warming the global atmosphere. Computer models used to examine the climatic effects of increasing CO_2 suggest that if it doubles, global surface temperatures would increase on average by 1.5° to 4.5°C (2.7° to 8.1°F).

Because burning of fossil fuels is the primary cause of global warming, developed countries are mainly at fault, and poorer countries are more likely to be the victims. However, scientists estimate that between 15% and 20% of greenhouse gases (mainly CO_2) are generated by deforestation, a trend occurring at a devastating rate in developing countries, particularly in tropical rainforests. Trees play a vital role in recycling CO_2 by taking it in, transforming it chemically, storing the carbon, and releasing oxygen into the air. When trees are cut down, left to decay, or burned, they release stored carbon into the air as CO_2. Recently in Central Africa, virgin rainforests were found to have air pollution levels comparable to those in industrial areas. A major cause of this pollution is smoke from fires that rage for months across huge stretches of land. These fires are set to clear shrubs and trees for production of crops and grasses. The effects of acid rain (pollutants that are held in the clouds and fall back to Earth in rainwater) and air pollution in Europe, Canada, and the United States also contribute to increased CO_2.

Another greenhouse gas is methane. Methane is generated by bacteria as they break down organic matter. It is emitted largely by landfills, cattle, and fermenting rice paddies. The concentration of methane gas in the atmosphere has doubled in the past 200 years, mainly because of expanded animal husbandry and rice cultivation, more landfills, and leaking natural gas pipelines.

The single biggest factor in vulnerability to climate change is poverty. Climate change will most greatly affect poor communities across Africa, Asia, and South America.

Characteristics and Typical Adverse Effects

Air Pollution. Pollution of the troposphere (lower atmosphere) is damaging to agricultural crops, forests, aquatic systems, buildings, and human health. Primary pollutants often react to form secondary pollutants (acidic compounds), a frequent cause of environmental damage. The following effects are possible:

- Crop and vegetation damage by injury to plant tissue, increasing susceptibility to disease and drought
- Decline in forests caused by leaf damage by acidic compounds, acidic soils, and stresses of multiple pollutants
- Damage to aquatic ecosystems so that they no longer support life
- Degradation of building materials, such as metal, stone, and brick
- Adverse impact on human health by damage to respiratory tracts

Marine Pollution. Marine pollution has the following major effects:

- Spread of pathogens from human wastes, including viruses and protozoa, that cause hepatitis, cholera, typhoid, and other infectious diseases
- Release of nondegradable materials, such as plastics and netting, which may injure marine mammals
- Oil pollution from oil spills
- Spread of hazardous chemicals and radioactive substances into the marine ecosystem, where they may accumulate in seafood

Freshwater Pollution. Freshwater pollution results in the following adverse effects:

- Untreated wastewater carrying viruses and bacteria from human feces into human drinking water, which can result in illness or even in infant deaths
- Eutrophication, or decay of organic matter, which decreases oxygen levels in water, upsetting the balance of the aquatic ecosystem
- Adverse health effects in persons drinking untreated water from tainted sources
- Water acidification, which reduces water's capacity to support aquatic life
- Runoff sediment from eroded soil deposits in drainage basins, reducing basin capacity and exacerbating flooding
- Salinization from irrigation, with harmful effects on downstream agriculture
- Pesticides and fertilizer chemicals, which accumulate in water and affect tissues in living organisms

Global Warming. The impacts of global warming are still uncertain. Computer models are unable to make reliable predictions of regional changes. In all likelihood, the changes will lead to an increase in disasters, including those caused by drought, floods, tropical cyclones, and tornadoes. The following changes may occur.

Rise in Sea Levels. Melting of the Arctic ice sheets and alpine glaciers could cause the seas to expand and sea levels to rise. Depending on the degree of global warming, the seas may rise 30 cm to 2 m (12 inches to 7 feet) by 2075, jeopardizing coastal settlements and marine ecosystems. A rise of 1 m (3.28 feet) in sea levels could flood 15% of arable land in Egypt's Nile Delta and would flood 12% of Bangladesh, displacing 11 million people. The tiny island of the Maldives, inhabited by 200,000, would be submerged (Figure 85-24).

Climate Change. Natural disasters, such as superhurricanes, could become common. A temperature increase of a few degrees in tropical seas can intensify hurricane production. The warmer oceans may increase the El Niño phenomenon near the coast of Peru. The El Niño southern oscillation inhibits phytoplankton growth, causes fish and shellfish to migrate or die, and forces

FIGURE 85-24 Islands with diminishing shorelines in the Maldives. *(Courtesy Sheila B. Reed.)*

higher forms of life (e.g., birds, humans) dependent on this sea life to migrate or die.

Other climatic changes could lead to warmer and drier conditions in middle latitudes, higher temperatures in semitropical and tropical areas, and higher rates of evaporation. Rainfall patterns may also change. The combined effects of increased CO_2 and climate changes may alter plant and animal productivity. Plants may grow faster and larger but may have reduced nutritive value.

Changes in Ecosystems. In warmer climates, grasslands, savannas, and deserts may expand, rendering them vulnerable to increased degradation through erosion and fire. Animal species that do not adapt to the temperature increases may have to relocate to survive, which would be difficult, given population pressures on land. Plant species unable to adapt would perish.

Public Health Impact. Global warming may affect mortality rates because of heat stress and may increase the incidences of respiratory diseases, allergies, and reproductive illnesses. Geographic ranges of vector-induced diseases (e.g., mosquito-borne malaria, yellow fever) and parasitic diseases might increase.

Measurement of Pollutants

Air and Water Pollutants. Pollutants are measured worldwide, but to a much lesser degree in developing countries. The most comprehensive data collection system is the Global Environment Monitoring System of the UN Environmental Programme, which provides data on sulfur dioxide and particulate matter in urban air and contaminants in water resources. Pollution production is related to per capita consumption, so that as countries develop, pollution tends to increase.

Ozone Depletion. Ozone levels are regularly monitored annually all over the world, especially in the Southern Hemisphere, where a seasonal ozone hole opens over Antarctica every year. As of 2002, there were 5791 kilotons of CFCs in existing products, such as refrigerators, air conditioners, aerosol cans, and others. However, the ban on CFCs and reduction in other fluorocarbons should result in a smaller ozone hole by 2040. By 2100, the ozone hole may completely disappear, assuming full compliance with the Montreal Protocol.

Greenhouse Effect. Greenhouse gas emissions are regularly measured throughout the world. Even if the exact levels of future greenhouse emissions were available, however, predicting the effects on global climate would be difficult. Climatic models are used to study climate change, but the models differ in their interpretation of the various interactions in Earth's systems, partly because information put into the system is incomplete; however, linkages between variables are becoming more clearly understood.

Environmental Pollution Risk Reduction Measures

Air and Water Pollution. Most nations are acting individually to control air pollution. However, since the 1986 Chernobyl Nuclear Power Plant accident in Ukraine, transboundary pollution has been recognized as an environmental hazard necessitating a multinational approach. Basic goals are to set ambient air quality standards that measure pollutants away from the source, set controls on acceptable levels, and require that every source of an air pollutant meet certain emission limits. In some cases, technologies still need to be developed to make these goals possible.

Pollution control of coastal areas in the past has proved that recovery is possible to some extent. The banned pesticide DDT, which had been found in many forms of marine life, is now decreasing in concentration. Most strategies for protecting the oceans must address broader ranges of pollutants from sewage to industrial effluents. More national and international efforts should focus on establishing the policy for protection of coastal areas. The *Deepwater Horizon* oil spill of 2010 in the Gulf of Mexico illustrated certain management issues related to offshore drilling. Government regulatory agencies were not fully aware of the cost-saving measures used by the companies involved; these measures were deemed directly responsible for causing the disaster. More strict regulations need to be imposed and monitored.

Improvement of soils can decrease the possibility of water contamination by toxic chemicals and decrease runoff, thereby lessening silting and sedimentation of waterways. Establishing terraces and contour bounds, stabilizing sand dunes, building check dams, and planting trees and shrubs can help to stabilize soil. Watershed mapping, management, and protection are also of vital importance in ensuring a safe and plentiful drinking water supply. Proper systems to dispose of human waste should be promoted.

Regulations must be established and enforced by government agencies to protect citizens against the toxic effects of pesticides and other chemicals. Improvement of soils will also help to absorb and degrade toxins. Further studies must be made on the effects of pesticide residues. Farmers may use crop types resistant to pests or an integrated approach to pest management requiring less pesticide.

Ozone Depletion. International cooperation to limit CFC emissions should reduce production and use of CFCs in industrialized nations by 50% from 1986 levels, with developing countries allowed to increase their use slightly. Research is addressing the need for developing CFC substitutes, for minimizing loss to the atmosphere, and for recycling. Countries can regulate import and use of aerosols and disposal of refrigeration units.

Climate Change and Global Warming. All countries need to work together to minimize the effects of climate change as it directly affects our daily lives and health and the survival of species. The UN Framework Convention on Climate Change of 1994 has 194 participating states and organizations. Its ultimate objective is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that is not dangerous. The Kyoto Protocol of 2005 is linked to the UN Framework Convention on Climate Change and sets compulsory emission targets for industrialized countries. The Bali Action Plan (2008) focused on ways to adapt to climate change and enhanced access by developing countries to predictable and sustainable financial resources for adaptation. The basic steps that need to be taken include:

- Significantly reduce greenhouse gases in the next decade by enacting the needed regulatory, technologic, and behavioral changes, such as regulations to curb pollution from traffic emissions and industry
- Reduce the rate of deforestation; plant trees to solve community needs for wood, such as fuel wood, or to provide profits for individual farmers with agroforestry
- Increase energy production and use; promote energy efficiency in urban areas, and support renewable energy sources, such as wind, water, geothermal, and solar power; these may be of great use in areas where no electricity sources exist

Education is a vital tool for environmental awareness. By understanding relationships of ecosystems and long-term effects of degradation, people are motivated to act. Women's groups in India have established a tree protection lobby. Their motto is "trees are not wood," a concept that promotes trees as a vital part of the ecosystem, providing CO_2 exchange in the air and a root system to hold down the soil. Education regarding the environment should begin in children's early years. Education for adults may take place in farmers' cooperatives, women's cooperatives, and village settings or may accompany programs to distribute seeds and tools.

Saving the Arctic

The Arctic Ocean, a semienclosed ocean surrounded by land and composed mainly of snow and ice, is warming at a rate twice as fast as the rest of the world, partly due to black carbon pollution. Black carbon is a component of soot that peppers the snow and ice with heat-absorbing black particles. The changes are affecting the land and livelihoods of Native Alaskan coastal communities and melting the Greenland ice sheet, driving sea level rise. Over the past 7 years, snow and ice coverage has been the least ever recorded. Other pollutants affecting the Arctic include Arctic haze from long-range pollutants and bioaccumulation of polychlorinated biphenyls in Arctic wildlife and people.

The Arctic Counsel is an eight-nation body, chaired by the United States, established to take the reins about the fate of the Arctic. U.S. regulations on diesel fuel may help to reduce black carbon emissions; however, these cuts may be undermined by resumption of oil exploration in Alaska.

DEFORESTATION

Deforestation is removal or damage of vegetation in a region that is predominantly tree covered. Deforestation is a slow-onset hazard that may contribute to disasters caused by flooding, landslides, and drought. Deforestation reaches critical proportions when large areas of vegetation are removed or damaged, harming the land's protective and regenerative properties. The rapid rate of deforestation in some parts of the world is a driving force in the yearly increase of flood disasters in these areas.

Changes reported by the Food and Agriculture Organization in its Global Forest Resources Assessment 2015 indicated encouraging news, namely, that the global rate of deforestation has decreased and substantial progress has taken place in forest management. Over the past 25 years, the forest area has decreased by approximately 3.1%, but there are positive trends for reduction in forest loss. Although there was annual global deforestation of 7.6 million hectares between 2010 and 2015, there was an annual gain of 4.3 million hectares. This resulted in a net decrease of 3.3 million, compared with 9.4 million deforested hectares per annum in the 1990s. The biggest forest area loss continues to be in the tropics, particularly South America and Africa, although those rates have also decreased substantially in the past 5 years. Forests coming under management plans have increased from 27% of production forest in the 1990s to 52% of the total forested area in 2010.

The countries with the highest net loss of forest area between 2010 and 2015 are Brazil, Indonesia, Myanmar, Nigeria, Tanzania, Paraguay, Zimbabwe, Democratic Republic of the Congo, Argentina, and Venezuela. Those with the highest net gain of forest area during this period were China, Austria, Chile, the United States, the Philippines, Gabon, Laos, India, Vietnam, and France. Globally, natural forest area (also an indicator in biodiversity) is decreasing, and planted forest is increasing. Natural forest accounts for 93% of the total forest area in 2015.

The average per capita forest area has decreased from 0.8 hectare to 0.6 hectare per person during the years 1990 to 2015. Forests provide subsistence and income for nearly 1.6 billion people; the economic benefits must be considered while planning management programs. Although the amount of forestland coming under protection or conservation is growing, the future still poses problems because of rapidly increasing pressures of development and exploitation.

Causal Phenomena

The principal causes for loss and degradation of forests are conversion to other land uses (mainly agriculture and grazing) and overexploitation of forest products (industrial wood, fuel wood).

Underlying the obvious causes are fundamental problems in development, such as the use of inefficient agricultural practices (e.g., overgrazing), insecure land tenure, rising unemployment, rapid population growth, and failure to regulate and preserve forestlands. Contributing factors are air pollution, storms, pests, and diseases. A significant contributing cause in the 1990s was the number of wildfires that occurred in the western United States, Ethiopia, the western Mediterranean, and Indonesia.

Conversion of Forests to Agricultural Land. The major cause of forest loss is the spread of farming. Land may be cleared for commercial ventures such as sugar cane, coffee, or rubber plantations, which are principal causes of deforestation in Central America. In tropical rainforests, both legal colonists and squatters (i.e., illegal settlers) are trying to farm the former jungle lands, where soil conditions are fragile. Up to 90% of the nutrients are in vegetation rather than in the soil. When the forest is cut and burned, a nutrient surge occurs in the soil, lending initial fertility. After cropping and exposure to sun and rain, however, soil fertility rapidly declines, and the area becomes unproductive, perhaps prompting the farmer to slash and burn new forest areas.

Many indigenous people in the Amazon Basin, Central Africa, and Southeast Asia still practice shifting cultivation techniques, allowing fallow periods between cropping for soils to regenerate. This practice becomes unsustainable if populations increase to the extent of forcing people into smaller areas. Insecure land tenure or fixed land titles may also force overuse of the land.

Because of crowded conditions in cities and farm areas, many people migrate to areas of marginal fertility, where they must keep moving their fields to produce sufficient food. Where this occurs, the migrant farmer may damage timber, wildlife, and human resources. In Venezuela, a country that has a high rate of unemployment and rising numbers of landless peasants, 30,000 families live and farm in national parks, forest reserves, and other legally protected areas. An influx of cultivators who settled on the watershed above the Panama Canal has caused increased silting of a major reservoir that supplies Panama City.

In Central and South America, large areas of tropical forest have been cleared to create grazing lands. A major portion of this can be attributed to economic enterprises designed for meat production. The Brazilian government has granted large land concessions to domestic and foreign corporations wanting to raise cattle in the Amazon area. In Central America, virgin forest is being destroyed by ranchers who intend to export beef to the United States.

Overexploitation of Forest Products. Extensive logging in humid tropical forests, particularly in Asia and in temperate and mountainous forests, is conducted by large multinational corporations for export or to fill building needs in cities. The procedure usually involves either clear-cutting or creaming (selective logging) of the forest's small proportion of valued species. Creaming, even though it is a less radical alternative to clear-cutting, causes significant damage to vegetation and wildlife that is not apparent from statistics. A study in Indonesia revealed that logging operations damaged or destroyed about 40% of trees left behind. The roads created by logging operations may encourage settlers to enter the forest and begin slash and burn agriculture, so that eventually, even more of the forest is lost.

Firewood collection can contribute to the depletion of tree cover, particularly in lightly wooded areas. Because of a lack of alternative fuels and fuel-efficient stoves, this is especially a problem in Africa and in Asian highland countries such as Nepal. In areas of dense woods, dead material may fill local requirements for fuel. The outright destruction of trees for fuel occurs most commonly around cities and towns, where commercial markets for firewood and charcoal exist. Well-organized groups and individuals bring fuel wood by vehicle, pack animal, and cart into many cities, hastening local deforestation.

Fuel Wood Crisis. About 100 million people in developing countries cannot meet their minimum needs for energy, and almost 1.3 billion consume fuel wood resources faster than they are being replenished. In parts of West Africa, some urban families spend one-fourth of their income on wood or charcoal for cooking. In India, firewood is subsidized for the poor to prevent starvation.

Characteristics

Trees play a vital role in regulating Earth's atmosphere, ecosystems, and weather systems. They recycle CO_2, a gas now increasing in the atmosphere and thought to contribute to global warming. They release moisture to the air, thus contributing to rainfall and moderating the local and global climate. Their roots trap nutrients, improve soil fertility, and trap pollutants, keeping these from the water supply. Trees provide habitats for species, engendering diversity. They nurture traditional cultures by giving shelter, wood, food, and medicinal products. These benefits are lost as trees are destroyed.

The root systems of vegetation help retain water in the soil, anchor the soil particles, and provide aeration to keep soil from compacting. When vegetation dies, the nutrients go back to the soil. When root systems are removed, soil becomes destabilized. Water tends to flow off the top of the soil instead of percolating in, and carries valuable topsoil along with it. This soil eventually forms sediment in the drainage basins.

Deforestation poses the most immediate danger by its contribution to the following hazards:

Destabilized soils are more susceptible to landslides and may increase landslide risk in areas vulnerable to earthquakes and volcanoes.

Loss of moisture from deforestation may contribute to drought conditions, which in turn may trigger famines. Soil nutrients may also be lost through erosion of topsoil, resulting in decreased food production and possible chronic food shortages.

Erosion and dry conditions, combined with loss of vegetation and soil compaction, result in desertification and unproductive lands.

Dryness may accelerate spread of fires.

Loss of CO_2 from dying trees and fires may add to global warming.

Deforestation of watersheds, especially around smaller rivers and streams, can increase severity of flooding, reduce stream flows, evaporate springs in dry seasons, and increase the amount of sediment entering waterways.

Of all the hazards associated with deforestation, flooding may be the most serious. Usually, curative measures (e.g., dredging and dam building) rather than preventive measures are taken to solve flooding problems. As flooding worsens in developing countries, more attention is given to protection of watersheds. In India, flood damages between 1953 and 1978 averaged $250 million per year. Today, even more people live in flood-prone areas. Flood problems may not be lessened without reforestation of the increasingly denuded hills of northern India and Nepal.

Predictability

Forest resource data are being generated at a greater frequency. As of 2014, 112 countries had national forest inventories, covering 82% of the forested areas. Data are lagging in the topics and low-income countries. Measurement and monitoring of forested areas may be conducted through ground-level sampling and aerial or satellite surveys. Each method has drawbacks. Ground sampling is tedious and difficult to extrapolate, aerial surveys are expensive, and satellite imagery poses difficulty in distinguishing forests from other vegetation. Combinations of methods usually produce the best results.

Vague definitions in the study of deforestation continue to make exact determinations and forecasting difficult. According to the World Wildlife Fund's "Living Forests Report" of 2015, up to 170 million hectares of forest could be lost between 2010 and 2030 in the Amazon, Atlantic Forest and Gran Chaco (Amazon Basin), Borneo, Cerrado (Brazil), Choco-Darien (Central America), Congo Basin, East Africa, East Australia, Greater Mekong, New Guinea, and Sumatra. In addition to forest loss, productivity of forest is another sustainable indicator that needs to be measured. Forest degradation may be gauged in terms of loss of any of the goods and services that forests provide, such as fiber, food habitat, water, carbon storage, and other protective and sociocultural values. This measurement is not an exact science, but the Food and Agricultural Organization is studying the economic benefits from forests and how to improve them with policy measures linked to the benefits.

Typical Adverse Effects

The specific impacts of deforestation include:

Loss of soil fertility in the tropics and loss of productive capacity

Soil erosion and deposition of sediment

Increased runoff

Reduction in rainfall and increase in temperature

Destruction of biodiversity and traditional cultures

Loss of "free" and extracted goods, such as fuels, food, and medicines

Exacerbation of other disasters

Economic Impact. Most developing countries are already importers of forest products, especially paper. Because the amount of wood and wood products available per person in the world is falling and thus their prices are increasing, and because of shortages of foreign currencies, import of forest products may be increasingly prohibitive for these countries. Commercially marketed firewood is becoming scarcer, and prices are climbing. Wood for construction is also scarce in many countries, which adversely affects availability of housing.

Deforestation Risk Reduction Measures

Various types of forest management, reforestation, and community participation can reduce deforestation. Over the past 25 years, countries have significantly increased knowledge of their forest resources, and most governments now recognize the vital importance of national forestry programs. Foresters help people meet their basic needs for forest products, and not always from the traditional forest or concentrated woodlot. Farmers who practice reforestation on their lands contribute effectively to the environment. Reforestation has become intrinsically interwoven with other government policies that affect the population. Forestry therefore should be considered an integral part of land use and natural resource planning sectors of government.

Forests should be viewed by governments as capital resources to be managed. Management of the system should discourage concessionaires who have been given rights to sell wood obtained from property belonging to the government or others from practices that are not sustainable. Good management encourages highly selective harvesting without undue waste of remaining trees, especially in tropical forests. Involvement of communities in forest management is now a significant feature of national forest policies throughout the world. Forest management policies must consider the need to protect forests in conflict areas and to avoid exacerbating conflict over forest resources. For any country to address its loss of forests and ensure that forests will yield economic benefits well into the future, following steps must be taken:

Forest law or basic forest policy must be written that clearly states the objective of long-term sustainable management of the forest.

Forest regulations or management guidelines must be written and followed.

Sufficient financial and human resources must be allocated.

Forest management must be considered in the broadest sense of land use planning to include solutions for people as well as for trees. Compromises between complete destruction of the forests and complete conservation might entail regulated clearing of forests for shifting cultivation, habitation, or hunting; voluntary and intentional protection of forests or individual species by designating areas for reserves or national parks; and enrichment of the forest with species from other places. The last option may be considered risky, because pests and other problems specific to certain species may accompany introduction of nonnative species.

Many unresolved scientific issues in forest management remain. How can the ever-expanding areas of secondary vegetation and degraded soils be managed to be more productive for the local people? Because most primary forests have disappeared, what type of forest can be established that would be stable and productive and that would ensure the conservation of biologic diversity? What further types of basic ecologic research are needed to manage natural forests? How can the benefits from forest utilization effectively reach communities?

DESERTIFICATION

Desertification is defined as land degradation in arid, semiarid, and dry subhumid areas, resulting mainly from human actions. Poor land use is a significant contributing factor, but desertification can also be caused by natural cycles of climate change. It affects both developed and developing regions, including Africa, the Middle East, India, Pakistan, China, Australia, Eastern Europe, Central Asia, the central and southwestern United States, and many Mediterranean countries. A slow-onset disaster, desertification worsens conditions of poverty, brings malnutrition and disease, and destabilizes the social and economic bases of affected countries.

Causal Phenomena

Climate Conditions. Vulnerability to desertification and severity of its impact are partially governed by climatic conditions of an area. The lower and more uncertain the rainfall, the greater is the potential for desertification. Other influencing factors are

seasonal patterns of rainfall and high temperatures that increase evaporation, land use, and the type of vegetation cover.

The world's drylands, which are inhabited by more than 2.1 billion people, are found in two belts centered approximately on the Tropic of Cancer and the Tropic of Capricorn (23.5 degrees north and south of the equator, respectively) and cover 41% of Earth's surface. More than 80% of the total area of drylands is found on three continents: Africa (37%), Asia (33%), and Australia (14%). The drylands can be further classified into hyperarid, arid, and semiarid zones, depending on the average amount of rainfall received per year. Other factors, such as temperature and soil conditions, must be considered when determining the dryness ratio.

Both natural and human-derived climatic changes may contribute to desertification. Natural effects, such as long-term climatic cycles and the basic geometry of the earth and the sun, have resulted in drier conditions in the Sahara. Human influence is associated with the predicted global warming trend and local climatic changes, in which deforestation has reduced moisture-holding capacity of soil and decreased cloud formation. The result is less rainfall and higher temperatures.

Despite the common misperception that desertification is caused by the desert advancing itself, land degradation can occur at great distances from deserts. Desertification usually begins as a spot on the land where land abuse has been excessive; from that spot, land degradation can spread outward with continued abuse (Figure 85-25). Desertification does not cause drought but may result in greater persistence of, or susceptibility to, drought. Drought, on the other hand, contributes to desertification and increases the rate of degradation. When the rains return, however, well-managed lands recover from droughts with minimal adverse effects. Land abuse during periods of good rains and its continuation during periods of deficient rainfall contribute to desertification.

Poor Land Use Management. Desertification can be caused by five main types of poor land use, degradation, and removal of vegetation: overcultivation, cash cropping, overgrazing, deforestation, and poor irrigation practices.

Overcultivation. Overcultivation damages the structure of the soil or removes vegetation cover, leaving the soil vulnerable to erosion. Reasons for overcultivation include drought, increasing demand for food because of population growth, cropping on

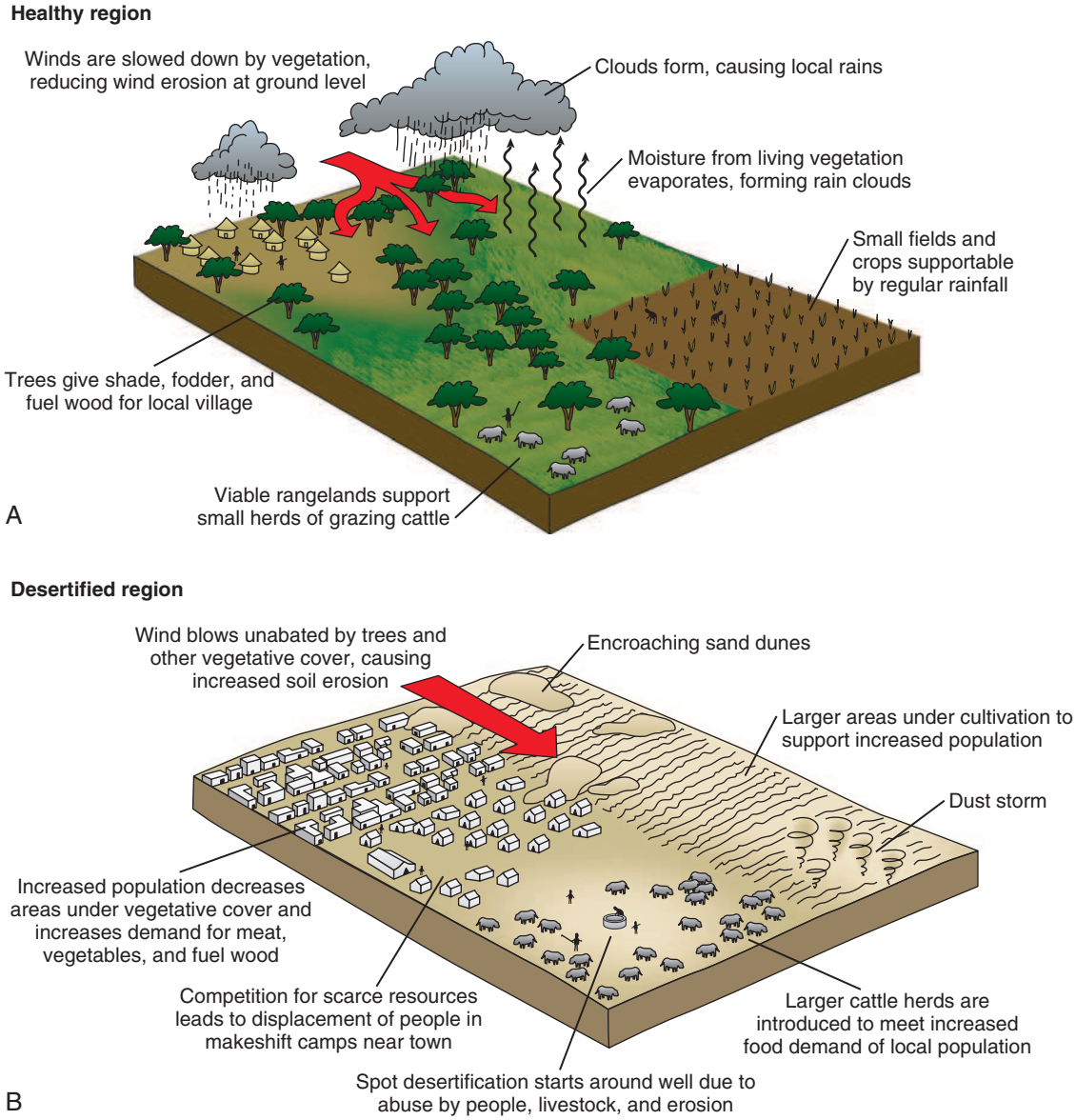


FIGURE 85-25 Comparison of healthy and desertified regions. *(Modified from United Nations Development Programme,* Introduction to hazards, *ed 3, New York, 1997, Disaster Management Training Programme, UN Office for the Coordination of Humanitarian Assistance.)*

marginal rangelands unsuitable for long-term production, land tenure restrictions confining sectors of the population to marginal lands, mechanized farming, and expansion of cash cropping.

Cash Cropping. Although a large part of agricultural production in developing countries fills subsistence needs, some cash crops are grown for foreign exchange. Unfortunately, a feature of most cash crops is their extreme demand for nutrients and optimum conditions. Degradation of land occurs directly through improper management of such crops and indirectly by displacing subsistence crops and pastoralism to marginal lands.

Overgrazing. Overgrazing is a major cause of desertification (rangelands account for 90% of desertified lands) and occurs when too many animals are pastured. The number of cattle in Niger, for example, increased an estimated 450% between 1938 and 1961 and an additional 29% by 1970, when the majority were killed by starvation. Livestock density increases when herd sizes grow too large in wet years and cannot be sustained in dry years. Lucrative markets for meat, such as Nigeria and the Middle East, have resulted in cattle ranches, where concentrated activity threatens land, with poor returns for the investment.

Better veterinary care has decreased mortality rates. Deep wells increase availability of water, allowing larger, less mobile herds that congregate in the well area and degrade the vegetation and soil.

Deforestation. Land is cleared for agriculture, livestock, and fuel wood production. Deforestation is the first step toward desertification, removing vegetative barriers and exposing land to sun, wind, and rain. In Africa, demands for fuel wood and charcoal exert considerable stress on wood resources.

Poor Irrigation Management. The concept of using irrigation to ward off the threat of crop failure during drought has been promoted by many development agencies. Ironically, poor management of irrigation projects has been a cause of desertification. In some cases, productivity falls and soils become salinized, alkalinized, or waterlogged. The major problem is usually inadequate drainage, and damage may be irreversible. A key example is the Greater Mussayeb irrigation project in Iraq, begun in 1953. By 1969, waterlogging was widespread, and two-thirds of the soil was saline. In 1970, a project to reclaim the salinized land was begun; because of technical and organizational limitations, the project was not successful. Egypt, Iraq, and Pakistan have lost more than 25% of their irrigated areas to salinization and waterlogging.

Role of Government Policy. Population growth and economic expansion also contribute to desertification. As populations grow, government and multilateral policies must promote increased food production through appropriate technologies that prevent soil degradation and erosion. Government policy should also address the causes of poverty, or disadvantaged peoples will place more stress on land to obtain needed resources. Some governments choose to expand cash crop cultivation to improve foreign currency holdings rather than promote food security for the poor, or they fail to resolve conflicts over scarce resources. Policies may mandate land uses that are difficult to enforce and that result in breakdown of customary land tenure or natural resource management institutions.

Characteristics

The two main characteristics of desertification, degradation of soil and degradation of vegetation, have the same result: reduction of productivity.

Degradation of Vegetation. Vegetation in arid lands adapts to the cycle of water availability by adjusting its growth. The drier the area, the farther apart plants grow. Some plants grow only during rainy seasons. Degradation of vegetation occurs initially in the early stages of desertification with deforestation, but continues after soil fertility declines.

The two main forms of vegetation degradation are overall reduction of density of the vegetation cover, or biomass, and a more subtle change in types of vegetation to less productive forms. For example, rangeland perennial grasses may be replaced by less palatable annual varieties, or more saline-tolerant crops, such as barley, may be substituted for traditional crops because of low yields from waterlogging and salinization.

Degradation of Soil. Soil degradation occurs in four major ways: water erosion, wind erosion, soil compaction, and waterlogging, which result in salinization and alkalinization.

Water Erosion. Vegetation normally protects soil from being washed away by rain and also from splash erosion by raindrops. The raindrops move the soil particles and pack them together on the surface, sealing the pores and thereby decreasing infiltration and increasing runoff. Sheet erosion is a more serious form of erosion in which fine layers of topsoil carrying soil nutrients are washed away. Unless the nutrients are replenished artificially, crop yields decline. Gullies are created by the runoff and, unless reclaimed by conservation measures, render the land unusable.

Wind Erosion. Wind erosion occurs when finer components of the soil, such as silt, clay, and organic matter that contain most of the nutrients, are blown away, leaving behind the less fertile sand and coarse particles. Sand itself may start to drift, forming dunes, but this accounts for a minor proportion of the effects of wind erosion. Strong winds may form dust storms that damage crops by shredding leaves.

Soil Compaction. Nearly complete compaction can occur when soil of poor structure is compressed by heavy machinery or by hooves of large herds of animals. A less serious form of compaction, called *surface crusting,* results when high-speed mechanical cultivation or dry season cultivation turns particles into thin powder, which then forms a crust when pelted with raindrops. Crusting and compaction make the soil less permeable for germination of new plants.

Waterlogging (Salinization and Alkalinization). These effects result from poor management of irrigation and water supplies in general. When the soil is waterlogged, the upward movement of saline in groundwater leaves salt on the surface when the water evaporates.

Predictability

Desertification is a direct socioeconomic threat to more than 200 million people and a less direct threat to 700 million, but data are still insufficient to quantify the extent of the problem and its progression. It leads to estimated losses in agricultural production of $42 billion. Databases are incomplete or do not exist for many countries. More information is needed on the characteristics and status of dryland ecosystems. Understanding climatic changes, including effects of possible global warming, is crucial to predictability. Socioeconomic indicators showing trends in human health, income, and welfare must be collected to understand related issues.

The International Soil Reference and Information Centre and UN Environmental Programme support the Global Assessment of Soil Degradation, which uses a geographic information system to access data for different areas of the world and estimate land degradation.

Rate and Scope

Although the numbers remain controversial, yearly losses to desertification are estimated at 1 to 1.3 million hectares of irrigated land, 3.5 to 4 million hectares of rain-fed cropland, and 4.5 to 5.8 million hectares of rangeland. These estimates represent an increase of 3.4% from estimates in 1994, indicating that the situation is worsening. The area of desertification is thought to be increasing at about 60,000 km^2 per year. The Global Assessment of Soil Degradation estimates for extent of desertification between 1983 and 1990 were 20% of dryland soil.

Desertification affects drylands in more than 110 countries but is concentrated in Asia and Africa, which together account for 70% of all desertified land. Scientists have tried to quantify the areas desertified on a worldwide basis. The physical damage can be measured in reduced productivity of soils and loss of vegetation. The number of casualties cannot be scientifically extrapolated, but deaths occur, directly from famine or indirectly from reduced standards of living.

Desertification Risk Reduction

The Secretariat of the UN Convention to Combat Desertification, an organization with 193 countries as parties by 2009, works with

governments to highlight national focal points to communicate with scientific communities, civil society organizations, the public, and other stakeholders on matters related to desertification, land degradation, and drought. A number of innovative methods are in use to help mitigate desertification, but a great deal more effort and resources are required to stop progression. Mitigation measures should be included in national action plans to address agricultural development, drought, deforestation, and loss of biodiversity, among others. Educating children in schools and community members about the desertification hazard and dangers of deforestation is critical, as are supporting planting of seedlings and promoting other local mitigation measures. Solutions to the need for cooking fuel include solar ovens and efficient wood-burning cook stoves, which have helped to relieve pressure on the environment; however, these may be too costly for the poor to afford unless they are subsidized.

Techniques to improve and rejuvenate soil include the use of seawater that is desalinated and pumped inland. Fixating the soil is often done through use of shelterbelts, woodlots, and windbreaks. A "Green Wall of China," eventually intended to stretch more than 5700 km (3500 miles) in length (nearly as long as China's Great Wall), is being planted in northeastern China to protect deserts created by human activity. Soil enrichment and restoration of its fertility are often accomplished by planting such foods as grains, barley, and dates, as well as legumes, which extract nitrogen from the air and fix it in the soil. Sand fences can also be used to control drifting of soil and sand erosion.

ACKNOWLEDGMENTS AND RESOURCES

This chapter builds on the original teaching concept developed in Introduction to Hazards, *third edition (1997), a module prepared by this contributing author and by InterWorks of Madison, Wisconsin, for the UN Development Programme's Disaster Management Training Programme and the UN Office for the Coordination of Humanitarian Assistance. Another background document is* Natural Hazards: Causes and Effects, *a course text published in 1986 by the Disaster Management Center at the University of Wisconsin–Madison.*

SUGGESTED READINGS

Complete suggested readings used in this text are available online at expertconsult.inkling.com.

CHAPTER 86

Global Crimes, Incarceration, and Quarantine

MICHAEL VANROOYEN AND SHAWN D'ANDREA

Most physicians and medical personnel practice in relatively safe and stable environments, although some health care providers have chosen to work in conflict or other crisis settings that involve some degree of political instability and personal danger. To health care workers interested in working internationally, remote climates may seem inherently dangerous, but the opposite is often the case. For example, a rural setting in Sudan may be remote and relatively austere but is likely to be safe and secure; alternatively, working in the inner city of Nairobi, Kenya, may be much more dangerous.

Traveling and working in conflict areas or regions with significant political or social volatility requires a far more detailed understanding of the unique attributes of conflict areas. Judging whether a certain geographic region is dangerous requires significant knowledge of that area's unique political, economic, social, and cultural context. It is important to realize the relative risk of travel itself, as well as the likely causes of illness and death among travelers. The most frequent killers of travelers are cardiovascular disease and accidental injuries (most commonly motor vehicle accidents). As this chapter reviews the unique risks to workers in hostile geopolitical environments, conflict settings, war zones, and unstable social environments, it is important to keep in mind the more predictable risks of accidents and underlying health issues in travelers, in order to plan and deploy mitigation strategies.

There is very good evidence that health care workers and humanitarians working in areas of modern conflict around the world have a significantly increased risk of being killed or injured as a result of violent causes. One needs to determine the degree of risk that accompanies spending time in any particular locale. Determination of the degree of danger is a complex and dynamic process, and cannot be adequately ascertained solely from media reports or U.S. State Department travel advisories. The risk of an adverse event while traveling is closely linked to the traveler's behaviors and abilities to adapt to the shifting political and security environments in regions that may be inherently dangerous as a result of military presence, differing ethnicities, and political volatility. The contents of this chapter cover a range of considerations for travelers and aid workers traveling to settings affected by social or political instability. This information is not intended to substitute for comprehensive training programs in safety and security provided by aid organizations, the United Nations, and academic and other institutions. The authors strongly recommend that any individual considering travel to or work in such environments obtain comprehensive safety and security training.

HOSTILE GEOPOLITICAL ENVIRONMENTS AND POLITICAL INSECURITY

Certain locations frequented by civilian travelers and international workers are known to be more dangerous than others. Modern conflict over the last two decades has increasingly victimized civilians and nonwarring parties, including women and children. International workers and local and foreign staff of humanitarian agencies have been increasingly targeted for crime and other

SUGGESTED READINGS

Borgati L, Mauro S. Landslides and climatic change. In: Alcantara-Ayala I, Goudie A, editors. Geomorphological hazards and disaster prevention. Cambridge: Cambridge University Press; 2010. p. 87–95.

Bryant E. Natural hazards. Cambridge: Cambridge University Press; 2005.

Centre for Research on the Epidemiology of Disasters. The human cost of natural disasters. CRED; 2015 <cred.be/>.

Dregne HM. Desertification assessment and control. Lubbock, Texas: Texas Tech University, International Center for Arid and Semiarid Land Studies; 1996.

Drought: living with risk: an integrated approach to reducing societal vulnerability to drought. International Strategy for Disaster Reduction (ISDR) Ad Hoc Discussion Group on Drought; 2003.

Dudley WC, Lee M. Tsunami. 2nd ed. Honolulu: University of Hawaii Press; 1998.

Eight years after Katrina, a stronger system of storm protection (Editorial). Times-Picayune August 18, 2013.

Erikson J. Quakes, eruptions and other geologic cataclysms. revised ed. New York: Facts on File; 2001.

Federal Emergency Management Agency. <fema.gov>.

Food and Agriculture Organization of the United Nations. The state of the world's forests. Rome: Food and Agriculture Organization; 2005 and 2009.

Global Information and Early Warning System on Food and Agriculture. <GIEWS@fao.org>.

Grainger A. The threatening desert: controlling desertification. London: Earthscan; 1990.

Hanley ML. Can the Black Sea be saved? World Dev 1990;3:6.

Hazlit Data Base, University of Colorado. <colorado.edu/hazard/litbase>.

International Tsunami Information Center. <itic@itic.noaa.gov>.

Keller EA, Blodgett R. Natural hazards: Earth's processes as hazards, disasters, and catastrophes. 2nd ed. Upper Saddle River, New Jersey: Pearson Prentice Hall; 2008.

Kovach R, McQuire B. Guide to global hazards. Richmond Hill, Ontario, Canada: Firefly Books; 2004.

Living with Risk. A global review of disaster reduction initiatives. New York: United Nations Inter-Agency Secretariat of the International Strategy for Disaster Reduction (ISDR); 2004.

National Earthquake Information Center. <quake@gldfs.urgs.gov>.

National Oceanic and Atmospheric Association. <noaa.gov>.

Petley D. Landslide hazards. In: Alcantara-Ayala I, Goudie A, editors. Geomorphological hazards and disaster prevention. Cambridge: Cambridge University Press; 2010.

Perritano JV. The truth about environmental hazards. New York: DJW Books; 2010.

Schwab JC, editor. Hazard mitigation: integrating best practices into planning. Chicago and Washington, DC: American Planning Association; 2010.

Smith K. Environmental hazards: assessing risk and reducing disaster. 4th ed. London: Routledge; 2004.

Tilling RI. Volcanic hazards. In: Marti J, Ernst GJ, editors. Volcanoes and environment. Cambridge: Cambridge University Press; 2005.

Twigg J. Disaster risk reduction: mitigation and preparedness in development and emergency programming. Good Pract Rev 2004;9.

United Nations Convention to Combat Desertification. <unccd.int>.

United Nations Development Programme Bureau for Crisis Prevention and Recovery. Gender and disasters. United Nations Development Programme; 2010 <undp.org>.

United Nations Environmental Programme. <unep.org>.

United Nations Economic and Social Commission for Asia. <unescap.org>.

United Nations Office for Coordination of Humanitarian Affairs, Relief Web. <reliefweb.int>.

United States Agency for International Development. Disaster reduction: a practitioner's guide. Washington, DC: United States Agency for International Development, Bureau for Democracy, Conflict, and Humanitarian Assistance; 2002.

United States Environmental Protection Agency. Ozone layer protection. <3.epa.gov/ozone/strathome.html>.

United States Geological Survey. <usgs.gov>.

Vickers DO. Tropical cyclones. Nature Resources 1991;27:31.

Wikipedia. *Deepwater Horizon* Oil Spill: <en.wikipedia.org>.

Wikipedia. Drought: <wikipedia.org>.

Wikipedia. Tornadoes: <wikipedia.org>.

Wilhite DA, editor. Drought: a global assessment, vol. 1 and 2. London: Routledge; 2000.

World Meteorological Organization, Integrated Flood Management. 2004: <wmo.int>.

hostile activities. The conduct of war has changed considerably during the last decades in the following ways:

INCREASING NUMBERS OF VIOLENT REGIONAL ETHNIC CONFLICTS

As the Cold War era ended, the new world order quickly gave rise to a variety of ethnic tensions devoid of superpower arbitration. During the 1990s, civil conflicts erupted in the Balkans, Central Asia, and the Middle East and throughout Africa. At the time of writing, the world has more than 40 ongoing armed conflicts.[9] Many of these conflicts are intrastate struggles, with many deemed ethnic or religious wars. These conflicts are in contrast to previous international cross-border conflicts launched as proxy wars between the United States, the Soviet Union, and other neocolonialists. The net result of modern civil conflict has been massive-scale refugee emergencies and public health disasters as well as an influx of foreign workers. In addition to formally defined intrastate and international armed conflicts, there are many countries with levels of violence reflected in violent death rates that exceed those of countries at war. For example, domestic gang conflict and drug trafficking in countries in Latin America, such as Honduras, are thought to be among many factors that contribute to markedly elevated rates of homicide in the region that exceed those of many countries in the midst of internationally recognized armed conflict.[21,26]

CIVILIAN CASUALTIES

Drafting of the Geneva Convention and adoption of the tenets of international humanitarian law and codes of conduct in war have not stemmed the tide of human rights abuses and deliberate targeting of civilians during the past three decades. There is ongoing debate regarding the exact impact of war on civilian populations, but reports consistently demonstrate that the civilian population bears a very high burden of morbidity and mortality in conflict.[22] Although causes of death include violence, most deaths occur from communicable diseases and other preventable illnesses.[2] Attacking and controlling civilian populations has been a method of securing territory in conflicts, as in Darfur, the Democratic Republic of the Congo, and Syria. Civilians and foreigners can be targeted by combatants or used to advance a political or ideologic agenda.

HUMAN RIGHTS ABUSES

Violations of human rights often accompany wars. Recent conflicts have seen adoption of practices that are grave human rights abuses, including forced labor, child soldiers, sexual slavery, and the weaponization of rape. Asymmetric warfare is when one party has significant weaknesses in terms of deployable resources and therefore turns to nontraditional methods of warfare to exploit the weaknesses of the other side. Tactics used by weaker parties include insurgency, terrorism, and methods to control territory by human rights abuses, sexual violence, and child exploitation. Asymmetric warfare creates a very unstable environment for civilian workers, who can be exploited by loosely aligned militias for political and military gain.

DANGER BY GEOGRAPHY: THE WORLD'S MOST DANGEROUS PLACES

Assessment of the level of danger of a city, country, or region requires broad examination of a range of factors and cannot be determined by any single variable, such as homicide rate. A 2012 report of aid worker security noted a steady increase of attacks, including kidnapping of aid workers, since 2002. The majority of incidents are reported to have taken place in a relatively few countries, including Afghanistan, Somalia, South Sudan, Pakistan, and Sudan. Humanitarian response organizations should provide a security assessment for personnel intending to deploy to a given region.[5]

BOX 86-1 Countries With Highest Aid Worker Murder Rates From 2006 to 2010

Somalia	Pakistan
Sri Lanka	Sudan
Central African Republic	Yemen
Chad	Occupied Palestinian Territories
Afghanistan	Democratic Republic of Congo

Adapted from *Aid Worker Security Report 2014: Unsafe passage: road attacks and their impact on humanitarian operations,* Humanitarian Outcomes, 2014, New York: aidworkersecurity.org/sites/default/files/Aid%20Worker%20Security%20Report%202014.pdf.

BOX 86-2 Countries With the Highest Murder Rates in 2012

Honduras	Belize
Venezuela	Guatemala
Jamaica	Lesotho
Colombia	South Africa
El Salvador	Trinidad and Tobago

Data from World Health Organization: Global Health Observatory Data Repository: Homicide estimates by country (2012): apps.who.int/gho/data/node.main-amro.VIOLENCEHOMICIDE?lang=en.

In contrast to countries known to be especially dangerous to aid workers, other regions, such as the Caribbean basin, are home to cities with the highest homicide rates in the world. Travelers to such areas should be aware of the increased risk of exposure to and victimization from violence. Box 86-1 lists the aid worker murder rates from 2006 to 2011, in contrast with Box 86-2, which shows the countries with the highest homicide rates for the overall population in 2012.

REASONS FOR ENHANCED PERSONAL RISK IN POLITICALLY UNSTABLE REGIONS

Increasing Civilian Nongovernmental Organization Involvement in Unstable Regions

Escalation of ethnic and intrastate conflicts during the early 1990s after the conclusion of the Cold War led to a significant increase in civilian nongovernmental organization involvement in active conflict settings. The number and size of these organizations grew significantly during this period (Figure 86-1). They employed a large number of civilian health professionals in areas of active conflict, including the former Yugoslavia, the Great Lakes region of Africa, Somalia, and West Africa. Civilian medical and public health personnel found themselves working in settings with

FIGURE 86-1 Bosnian soldiers watch the frontlines. Sarajevo, 1992. *(From* Welcome to Sarajevo, 1997. *Copyright Miramax Film NY, LLC.)*

active combatants, migratory populations, and international military forces, and the humanitarian needs were of a large scale.

Targeting of Civilians on the Basis of Nationality

During the post-9/11 era, following the war in Iraq, ongoing war in Afghanistan, and ongoing internal conflict in Syria, it has become increasingly difficult for Western workers to travel in several regions that are dominated by persons who are ideologically opposed to Western involvement. Although the dynamics of this change are complicated and beyond the scope of this chapter, the net result is that an American traveling in the Palestinian territories, Lebanon, Pakistan, Afghanistan, and regions of North Africa and the Middle East must consider these risks very carefully, understand local political nuances, and take the appropriate safety precautions.

Targeting Aid Workers

Intentional targeting of civilian aid workers and erosion of neutrality exemplify major changes in the recognition of the neutrality of Western aid organizations. Analysis of 382 aid worker deaths from 1985 to 1998 revealed the alarming fact that most (68%) were intentional, resulting from aggravated assault and murder. The second leading cause of death (17%) among these individuals was motor vehicle accidents.[12] Annual aid worker security reports have shown a steady rise in the number of violent attacks on workers, with 2013 noted to have the greatest number, a total of 250 incidents affecting 260 aid workers and resulting in 155 deaths. Countries with the greatest numbers of attacks on aid workers in 2013 included Afghanistan, Syria, South Sudan, Pakistan, Sudan, Somalia, Democratic Republic of the Congo, Kenya, Central African Republic, and Yemen.[6]

Restricted Access in Politically Unstable Regions

There remain several regions that are quite restrictive with regard to the numbers and types of travelers allowed into their countries. North Korea remains one of the most highly restricted countries; increasing restrictions apply to travel in countries such as Eritrea and Sudan (especially outside Khartoum). Travel restrictions remain in effect (often for obtuse reasons) in Cuba and Iran; travel to these regions may require special arrangements.

Working in settings of active conflict or social disruption caused by political instability creates high-risk situations that require a deep understanding of regional politics and local people of influence. In many of these settings, travelers encounter informal militia groups, banditry, and obstructed access. It is essential to become familiar with the range of possible threats before encountering them (Figure 86-2). Such information is frequently most reliably gathered from local sources.

Weapons

At least one aspect defining a hostile environment for travelers and health care workers is the presence of a variety of weaponry.

FIGURE 86-2 The author working with the Mai Mai militia in the Eastern Democratic Republic of the Congo. *(From Harvard World Media and Justin Ide.)*

FIGURE 86-3 The AK-47. Ethiopian National Defense Force 1st Lieutenant Ayella Gissa takes aim with an AK-47 assault rifle on a simulated enemy. *(From Chief Mass Communication Specialist Eric A. Clement, U.S. Navy. March 5, 2007.)*

The most common weapon-related threat to international tourists, health care workers, and explorers is a gun in the possession of someone willing to use it for ill gain. Guns are used to protect and intimidate people and to create a threatening environment. Police, military, local militia, security personnel, and civilian gun owners create a dangerous environment for travelers. In a 2002 review of the impact of small arms assaults on aid workers, it was found that more than 220 United Nations civilian staffers have died as a result of malicious acts since 1992, and at least 265 have been taken hostage while serving in United Nations operations. This is added to the thousands of assaults on aid workers and foreign travelers in politically insecure areas, which have resulted in hundreds of deaths.[14]

The most commonly encountered weapons in most conflict areas are personal assault rifles, primarily variations of the Russian-made AK-47 (the name *AK-47* refers to "automatic Kalashnikov, 1947," for its designer, Mikhail Kalashnikov, and the first year of its production).[10] Because of their simplicity, durability, dependability, and ease of assembly, variations of the AK-47 are used more readily throughout the world than all others combined (Figure 86-3). In some regions of the world, an AK-47 can be purchased for as little as $50 to $100. Handguns are also frequently encountered weapons. They are considered close-range or self-defensive weapons, and are commonly found among military and "irregular" militias.

Encountering individuals or groups, whether they are members of a formal military group or an informal militia, with weapons is a common occurrence. As a civilian working in an unstable setting, protection is accomplished by presenting oneself and one's organization as civilian and interested in providing impartial assistance. When an individual encounters groups with weapons, it is essential to develop a clear line of communication with an unambiguous message that he or she is a civilian, is unarmed, and is not a party to the politics of the setting. It is never recommended that civilians carry a weapon. Carrying a firearm identifies a person as a possible threat and thus removes the perception of neutrality. However, it may be necessary to employ armed guards in certain situations to protect a vehicle, staff member, home, or office. The decision to employ armed guards needs to be made in a local context and by someone with deep local and regional experience.

Risk Reduction Strategies for Situations in Which There Are Armed Combatants. When traveling or working in a region that has armed combatants, there are some simple ways to avoid getting into trouble:

Do Not Carry a Gun. This may seem like simple logic, but a number of travelers who work or recreate in exotic locations feel that they will be safer when armed. This logic is almost

always false. Carrying a gun, as it turns out, is by far more likely to lead to an adverse event or even death.

Avoid Places Where There Is a Danger of Being Injured. Certain locations are notorious places for explosive and gun-related violence. These include large political gatherings, checkpoints, and border crossings. The less time spent in these locations, the more likely an individual is to avoid being targeted or caught in the crossfire.

Avoid Confrontations With Local Militias or Thugs. This includes avoiding areas described above, as well as avoiding provoking military or paramilitary personnel by walking outside past curfew, taking photos of guards or military installations, or displaying an attitude that is less than polite when being questioned by militia.

Avoid Celebrations Where Guns Are Being Fired. Bullets shot off in celebration can return to Earth (or skull) at 152.4 m/sec (500 feet/sec). Celebrations in crowded areas, where those reveling in the moment are shooting bullets up in the air, are treacherous settings. Three-quarters of the injuries that occur in these situations are to the head, and many of these lead to death.

Stay Low to the Ground. For situations in which there is shooting nearby, immediately drop to the floor or get down as low as possible and crawl to a sheltered location. Do not run, and do not attempt to use a weapon unless trained and equipped to do so. If it is necessary to move, crawl along the floor and find a place to hide, preferably near a concrete wall or large solid objects.

Land Mines and Unexploded Ordnance

Travelers to areas that have historically suffered from conflict should be aware of the very real threat of land mines and unexploded ordnance. This is especially the case in regions that are currently stable but have been contested in the recent past. An estimated 60 countries worldwide remain contaminated with land mines, which cause approximately 4000 casualties annually.[7] Countries with the highest numbers of land mine injuries since the year 2000 include Afghanistan, Colombia, Cambodia, Iraq, Somalia, Ethiopia, Democratic Republic of the Congo, Sudan, Chad, South Sudan, and Sudan.[8]

Mine Types. Mines are a multibillion-dollar weapons industry. There is a wide range of antipersonnel mines produced internationally, from large antitank mines to "toe poppers" and other small devices that are intended to maim rather than kill. In general, mines are designed to injure (not kill), create terror, and disrupt military targets by injuring soldiers. They can be detonated by direct pressure, vibration, or trip wires, sending high-velocity projectiles of metal, dirt, and debris into the tissues and bones of victims (Figure 86-4). Antipersonnel land mines continue to threaten civilians and noncombatants, despite a growing number of conventions intended to ban them.

Effects of Land Mines on Populations and Health. Land mines represent both an immediate health risk and a delayed threat. More than 110 million land mines have been deployed worldwide. Between 1999 and 2009, more than 73,000 land mine casualties were reported, of which more than 70% were civilian casualties.[8] The epidemiology of land mine injuries is not known, but case fatality rates are very high. Land mine injuries pose a major problem for health care providers, who may be poorly equipped to manage the severe penetrating trauma, blast injuries, and consequent infections and gangrene. Trauma from land mine injuries requires high-level surgical services and can monopolize health care resources.

Another major problem with land mines is that they outlast any conflict, and their removal is difficult and costly. The reality of land mines is that no one truly knows how many exist or where they are located. Despite the activities of de-mining programs, land mines cause significant economic, social, and psychological disruption to communities.

Risk-Reduction Strategies When Traveling in Regions That Are Mined. It is important for international travelers, aid workers, and tourists to be aware of mine threats in many places in the world. Travel agencies will not be aware of these hazards, but there may be significant mine threats in regions frequented by travelers. Some of the steps travelers can take to avoid mined areas are listed in Box 86-3.

FIGURE 86-4 Land mines. From left to right, M14, Valmara 69, and VS-50. *(From Nation Defense Days, Esplanade des Invalides, Paris, France, September 24 and 25, 2005.)*

Banning Land Mines. The 1997 Ottawa Treaty, or Mine Ban Treaty (formally the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction), completely bans all antipersonnel land mines.[7] It has been signed by 162 countries since 1997, but only antipersonnel mines are covered. Mixed mines, antitank mines, remote-controlled M18 Claymore mines, and antihandling devices (i.e., booby traps) are not covered by the treaty.[7,8] Among the 35 nations that have yet to sign the treaty are China, Russia, India, and the United States.[7]

HIGH-RISK SITUATIONS FOR INTERNATIONAL TRAVELERS

When traveling to regions affected by political instability, it is important to be aware of particular settings that may create

BOX 86-3 Avoiding Mine Risks

- Obtain information about the country in which you will be traveling. There are a number of Internet sites useful for determining the regional risks of unexploded ordnance; see the-monitor.org/index.php/publications.
- Consult local officials if traveling or working in a mined region. If you are with a guided group, ask your guide about mine risks.
- Stay on well-traveled roads and paths. Do not leave the paved areas of the road—not even to walk along the side of the road to take a photograph. Avoid being the first person or vehicle in a convoy that is going into a region that may be freshly mined. Follow behind larger vehicles, and allow them to be at least 100 m (328 feet) ahead of you.
- If you have a flak jacket and are working in a mined area, sit on the jacket while driving.
- Never touch or handle suspicious items or devices, and do not pick up objects that appear to have a military function as souvenirs. Many tourists to prior conflict areas have been injured when collecting souvenirs that turned out to be unexploded ordnance.

dangerous situations for travelers. Many of these situations are avoidable by recognizing them and planning in advance what to do if they are encountered.

CHECKPOINTS

Checkpoints and military barriers are notoriously high-risk places. Checkpoints can be as simple as a local militia man with or without a uniform (but almost always carrying a weapon) standing in the middle of the road, or an official barricade with sandbags, concrete barriers, razor wire, and guard stations with an organized military presence. In general, checkpoints indicate an area of passage into areas controlled by military forces. In conflicts where child combatants are present, child soldiers may also be present at checkpoints. These areas are often points of high traffic and high tension. Avoid them if possible.

INFORMAL ROADBLOCKS

Informal roadblocks are different than official military checkpoints. Informal roadblocks are often set up by robbers or carjackers, and are most often encountered in tourist areas or on roads leading from a city to a tourist destination. These should be anticipated and avoided. Plan the travel route carefully, particularly if traveling between urban areas on narrow roads without a local driver. If an informal roadblock is encountered, either turn around or move beyond it as quickly as possible.

DEMONSTRATIONS

Crowds, demonstrations, and protests are particularly high-risk events and should be avoided whenever possible. Driving through an agitated crowd as a foreigner is potentially dangerous and can result in theft, assault, or worse. If there is a demonstration or a crowd in the street that is obstructing the route, stop the vehicle, back up or turn around, and take an alternate route (Figure 86-5).

RISK-REDUCTION STRATEGIES FOR TRAVEL BETWEEN BORDERS AND MILITARY CHECKPOINTS

Because checkpoints and guard stations are placed at frequently crossed borders, many cannot be avoided. If an individual has to cross at a manned barrier, a good strategy is to spend as little time as necessary in the vicinity of the checkpoint. Travelers should pay close attention to signs and instructions around a checkpoint and follow instructions carefully. Approach the checkpoint slowly in the vehicle, and stop when directed to do so. Keep hands visible, and remain in the vehicle unless asked to step out. Remain polite and business-like, and have appropriate documents available. If questioned, remain calm, and avoid sudden movements or erratic behavior.

FIGURE 86-5 Roadblock during an ethnic clash in Kisumu, Kenya. *(With permission from* dailymail.co.uk/news/article-510828/Kenya.*)*

GLOBAL CRIMES: PATTERNS AND IMPLICATIONS FOR TRAVELERS

Changes in global patterns of crime and criminal behavior reflect both historic roots of criminal activity and the growing influence of globalization. Criminal activities during the 21st century involve high-tech tools to advance criminal networks; computer technologies are used to market and track the illegal drug trade, coordinate the laundering and smuggling of money, and create networks of communication and exchange for trafficked goods, services, and people. The high volume of global travel and shipping via air, ground, and sea has created additional challenges for addressing the movement of people and contraband. Economic disparities create greater incentives for people to participate in illegal activity and thus create entire populations that are at risk of falling prey to exploitation.

Failed states and weak governance in many nations create an environment in which the economy is largely based on crime. From the illegal mining of minerals and diamonds in the Democratic Republic of the Congo to opium cultivated in Afghanistan to the sex-slave trade in Asia, crime and trafficking have grown and prospered in a global economy. According to the United Nations Millennium Project, transnational organized crime continues to expand despite attempted multinational counterstrategies. There is an estimated volume of illicit trade of well over $1 trillion per year, generated in part by counterfeiting and intellectual property piracy at $654 billion, the global drug trade at $411 billion, and human trafficking and prostitution business totaling $240 billion.[18]

THE SCOPE AND ARRAY OF GLOBAL CRIME

Human Trafficking and Sex Slavery

The practice of profiting from the sale and exploitation of women and children has expanded into a modern-day slave trade that extends throughout Eastern Europe, Southeast Asia, and West Africa into Indonesia, Thailand, Malaysia, Europe, Japan, and the United States. Trafficking of persons, including prostitution and slavery, is more prevalent today than at any time in human history. Current worldwide estimates suggest that there are an estimated 21 million victims of human trafficking.[19] International sex tourism feeds the sex-trade industry and has expanded into a multibillion-dollar global industry. The trafficking trade ranks second in dollar income after drug smuggling. Millions of trafficked people, mostly poor women and children, are moved each year into the sex industry and become forced laborers.[16]

Advice to foreign workers and travelers regarding trafficking is simple. Do not participate in the commercial sex trade or frequent brothels, massage parlors, or similar venues. Such participation directly fuels the sex-trade industry and abduction of young women and children. The only ways to enforce a ban on such practices are to remove demand and place economic and political pressure on nations that support these industries.

Terrorism

One definition of the word *terrorism,* as used by the U.S. government, is "premeditated, politically motivated violence perpetrated against noncombatant targets by sub-national groups or clandestine agents usually intended to influence an audience."[3] The use of the word *terrorist* is often contextual, and has been expanded considerably to include many of the activities aimed at combating efforts of those doing the naming. Regardless of the application or misapplication of the term, *terrorist activity* typically refers to acts that target those persons viewed as being related to an occupying power or those nearby the target.

As terrorist networks have expanded and become more organized, the threat of attacks has increased. Terrorist groups can employ chemical and biologic weapons, bombs and explosive devices, nuclear materials, and, as was seen during the September 11, 2001, attacks on the World Trade Center and the Pentagon, use of commercial aircraft as weapons. Terrorism and use of indiscriminate violence against civilian populations continue to be major threats worldwide. During travel to selected regions of the world, terrorist threats may be aimed directly at travelers

BOX 86-4 Strategies to Reduce the Risk of Terrorist Attack When Traveling to High-Risk Areas

- Schedule direct flights, if possible, and avoid stops in high-risk airports or areas.
- Try to minimize the time spent in the public area of an airport, which is a less protected area. Move quickly from the check-in counter to the secured areas. Upon arrival, leave the airport as soon as possible.
- Refuse unexpected packages. Keep an eye out for abandoned packages, briefcases, or other suspicious items. Report them to airport authorities, and leave the area promptly. Avoid obvious terrorist targets, such as places where Westerners are known to congregate, including nightclubs, shopping malls, and tourist destinations.
- Keep a mental note of safe havens, such as police stations, hotels, and hospitals. Develop a plan of action for what you will do if a bomb explodes or if there is gunfire nearby.
- Select your own taxicabs at random. Do not take a vehicle that is not clearly identified as a taxi. Compare the face of the driver with the one on his or her posted license. Check for loose wires or other suspicious activity around your car. Drive with car windows closed in crowded streets, because bombs can be thrown through open windows.
- If you are ever in a situation where somebody starts shooting, drop to the floor or get down as low as possible. Do not move until you are sure that the danger has passed. Do not attempt to help rescuers, and do not pick up a weapon. If possible, shield yourself behind a solid object. If you must move, crawl on your stomach.

or used in places likely to be frequented by travelers, such as large hotels and resorts with high concentrations of international tourists. Most terrorist attacks are the results of site evaluation and careful planning. Just as a car thief will first be attracted to an unlocked car with the key in the ignition, terrorists are looking for the most accessible targets. Therefore, the chances are slight that a tourist traveling with an unpublished program or itinerary would be the victim of terrorism.

Terrorist activities may appear to be random and unpredictable, but there are several precautions that travelers can take to avoid such attacks. The first such protection is to avoid traveling to areas that are prone to terrorist acts, such as high-risk regions in Iraq, Afghanistan, and Pakistan. It is also advisable to avoid destinations that have a known record of terrorism, kidnapping, or politically motivated assault on civilians, such as selected cities in Mexico, Colombia, and Brazil. Other precautions include minimizing time spent in airports, shopping malls, large markets, nightclubs, and other places frequented by tourists.

Risk-Reduction Strategies for Terrorist Attacks. Reducing the risk of a terrorist attack requires a series of precautions that can provide some degree of protection. These precautions may serve as practical and psychological deterrents to would-be terrorists; see Box 86-4.

Kidnapping and Hostage Situations

Kidnapping has become a profitable industry as foreign businesses expand their reach into emerging markets. Numbers of kidnapping and abduction incidents worldwide are notoriously difficult to ascertain, partly because up to half of all kidnappings are not reported to the authorities; most of these involve businessmen, children of parents in custody disputes, or victims of politically motivated abductions. Countries with the highest numbers of kidnappings include Mexico, India, Pakistan, Iraq, and Nigeria. Regions with the highest incidence of kidnapping are Africa (34% of total reported kidnappings), followed by the Middle East (30% of total reported kidnappings). Most abducted victims are local nationals; Africa and the Middle East have the highest percentages of foreign national abduction victims, at 65% and 33%, respectively.[11]

Kidnapping is most commonly used as a means of extortion, either from the local population or from wealthy expatriates living abroad. Some of the most common ongoing kidnapping threats are in regions in which there is a large Western industrial presence and rich foreign workers. In some settings, kidnapping for political purposes is also a major threat; this includes kidnapping of Western aid workers and journalists as a terror tactic in Iraq and Syria.

Being taken hostage, whether for political or economic reasons, is a rare but terrifying occurrence. Each hostage situation is unique and requires a tailored approach by authorities. Regardless of the variations of a hostage situation, the U.S. government's position remains that it will negotiate but not make concessions (e.g., payments) to kidnappers. U.S. government officials employ diplomatic processes and engage resources of the host country to secure the safety and release of hostages.

Risk-Reduction Strategies in Kidnapping or Hostage Situations. The U.S. Department of State provides instruction to personnel who might find themselves in a possible hostage situation. Much of this advice is predicated on the notion that the most dangerous times for any hostage are during abduction, when assailants are tense and anxious, and at any time there is a rescue attempt.

Although each hostage situation is different, there are general considerations to keep in mind. At the outset of a terrorist incident, terrorists are typically tense and high strung and may behave irrationally. They are prone to erratic and potentially violent behavior. Particularly during the early stages of a hostage situation, it is extremely important that the hostage remain calm and alert and control his or her own behavior. Some recommendations for behavior in the event of a hostage situation are outlined in Box 86-5.[4]

Piracy and Threats While Traveling at Sea

Piracy is a criminal act involving theft or violence at sea perpetrated by persons who are not affiliated with a government. Recent high-profile media reports of Somali pirates have brought attention to the phenomenon of piracy and the widespread degree of violation of national and international laws. Piracy is rampant and flourishing in East African and Southeast Asian seas, and is a significant consideration for commercial vessels, large cruise ships, and even smaller private vessels. Seaborne piracy targeting commercial and industrial ships has created a global criminal enterprise leading to worldwide losses of $13 to $16 billion per year. Many of these attacks occur in the waters between the Red Sea and Indian Ocean, off the Somali coast, and in the Strait of Malacca near Singapore.[17]

The International Maritime Bureau reports that the major type of violence during an act of piracy is hostage taking, commonly

BOX 86-5 Advice for Abductees in Hostage Situations

- Avoid resistance and sudden or threatening movements. Do not struggle or try to escape unless you are certain of being successful. Do not try to be a hero; this could endanger yourself and others.
- Consciously put yourself in a mode of passive cooperation. Talk normally. Do not complain; avoid belligerency; and comply with all orders and instructions.
- If questioned, keep your answers short. Do not volunteer information or make unnecessary overtures.
- Make a concerted effort to relax. Prepare yourself mentally, physically, and emotionally for the possibility of a long ordeal.
- Try to remain inconspicuous. Avoid direct eye contact and the appearance of observing your captors' actions.
- Avoid alcoholic beverages. Eat what they give you, even if it does not look or taste appetizing, and keep consumption of food and drink at a moderate level. A loss of appetite and weight is normal.
- If you are involved in a lengthier and drawn-out situation, try to establish rapport with your captors, and avoid political discussions or other confrontational subjects.
- Establish a daily program of mental and physical activities.
- Think positively, and avoid a sense of despair. You are a valuable commodity to your captors, and it is important to them to keep you alive and well.

for ransom. In 2006, there were 239 attacks during which 77 crew members were kidnapped and 188 taken hostage. Of these attacks, only 15 resulted in murder. In 2007, attacks by pirates rose by 10% to 263 attacks. There was a 35% increase in reported attacks involving guns. Crew members that were injured numbered 64, as compared with just 17 in 2006. Attacks continued to escalate in 2009 and 2010, and piracy is expected to be an ongoing problem for international trade and tourism.[20]

As in any major international criminal activity, the best protection is avoiding confrontation in the first place. In the case of piracy, ensure that the commercial or industrial vessel has an appropriate monitoring capacity when traveling in international waters near unstable settings, such as the coastal waters near Somalia and regions in Southeast Asia. If a civilian traveler is a victim of abduction at sea, the same principles of personal protection apply as are listed elsewhere in this chapter.

INCARCERATION AND QUARANTINE

INCARCERATION AND DETENTION: A GLOBAL PERSPECTIVE

International travelers and foreign workers rarely experience meaningful encounters with the foreign legal system. However, for those who do, the experience will likely be transformative. In 1994, Michael Fay, an 18-year-old American convicted of vandalizing cars and stealing road signs in Singapore, received international attention after being sentenced to 4 months in jail, a $2200 fine, and six strokes on the buttocks with a rattan cane. President Bill Clinton protested Fay's extreme punishment and asked the government of Singapore for clemency in his case; Fay's punishment was later reduced to four strokes in a concession to President Clinton. On May 5, 1994, Michael Fay received four strokes of the cane across his bare buttocks at Queenstown Remand Centre.[13] Although Singapore's criminal laws appear severe in contrast with American ideas of human rights, the punishment exacted on Fay served as a stark reminder that U.S. citizens residing or traveling in a foreign country are subject to the laws of that country. It is therefore the responsibility of every individual traveling abroad to understand foreign laws and regulations and to obey them.

Criminal activity in other nations can lead to severe consequences. Even relatively innocent actions such as purchasing antiques, taking photographs of a government installation, or minor traffic infractions may have serious ramifications. Thousands of Americans are arrested and detained abroad each year, with a large number of these individuals held on drug charges. Laws and regulations in foreign countries may differ significantly from those in the United States, and may not provide the protections or due process that Americans consider routine. Penalties for breaking the law in foreign nations can be more severe than in the United States for similar offenses. For example, in certain countries, drug convictions can result in life imprisonment or the death penalty.

Travelers who are arrested abroad may face confinement without being charged with a crime. Few countries provide trial by jury or even legal representation. Being accused of a crime abroad may involve months of incarceration in prisons that lack basic necessities such as reasonable nutrition, sanitation, or access to clean water. Physical punishment and abuse by guards and other prisoners are also possible.

If an individual is arrested, he or she should immediately ask to speak to a consular officer at the nearest U.S. embassy or consulate. Under international agreements, the U.S. government has the right to provide consular assistance at the request of the detainee, can provide the detainee with a list of attorneys, and can help him or her to contact family or friends. The U.S. government can also monitor the detainee's health and welfare and the conditions under which he or she is being held.[23]

DRUG OFFENSES ABROAD

Production, processing, and distribution of illicit drugs remain threats to the national security of many nations, and involve roughly half a trillion dollars in annual revenues. The illegal drug trade creates a climate of violence in many areas of the world that leads to economic and social instability. International travelers may be exposed directly to the illicit drug trade through the acquisition of illegal drugs, or be indirectly affected by theft or violence.

Every year, several hundred Americans are arrested abroad on drug charges. Persons caught with illegal drugs in a foreign country are subject to the drug laws of that country and not those of their home countries. Ignorance of the law is no excuse. In many countries, the burden of proof is on the accused to show that he or she is innocent of the charges. Every aspect of a drug arrest abroad can be different from U.S. practice. For example, few countries provide a jury trial, and many countries imprison accused offenders while they are awaiting trial, sometimes in solitary confinement, which can last for several months. It would be no surprise to find that many foreign prisons lack even minimal comforts, including beds, toilets, and adequate food. Foreign prisoners may also suffer physical abuse, confiscation of property, degrading treatment, and extortion. If convicted, one can face extremely harsh sentences ranging from fines and jail time to years of hard labor or even the death penalty.

QUARANTINE

Quarantine is the voluntary or compulsory isolation of a person or animal to contain the spread of a dangerous illness or disease. The term *quarantine* is derived from the Italian word *quarantena,* meaning "forty-day period." Quarantine has been used for decades to contain the spread of infectious diseases, and is actively used in many countries to control exposure to diseases with epidemic and pandemic potential. Quarantining people often raises questions of civil rights, especially in cases of compulsory confinement or segregation from society, such as that of Mary Mallon (i.e., Typhoid Mary), a carrier of typhoid fever who spent the last 24 years of her life under quarantine.

Quarantine Within the United States

Recent outbreaks of disease, including influenza, Middle East respiratory syndrome, and Ebola virus disease, have heightened concerns for worldwide spread of disease. In the United States, the Centers for Disease Control and Prevention (CDC) has a permanent presence of personnel in U.S. Quarantine Stations at 20 U.S. ports of entry and land border crossings in major cities where international travelers arrive. The stations are part of a comprehensive quarantine system network that serves to limit introduction of infectious diseases into the United States and to prevent their spread. The stations are staffed with quarantine medical and public health officers from the CDC, who decide whether ill persons can enter the United States and what measures should be taken to prevent the spread of infectious diseases.[1]

The CDC has the legal authority to detain any person who may have an infectious disease that is considered to be quarantinable. These diseases include cholera, diphtheria, infectious tuberculosis, plague, smallpox, yellow fever, viral hemorrhagic fevers, severe acute respiratory syndrome, and pandemic influenza. The CDC has the authority to deny ill persons with these diseases entry into the United States or to require them to be admitted to a hospital or confined to home for a certain amount of time to prevent the spread of disease[1] (Figure 86-6).

The 2013 West Africa Ebola virus disease outbreak brought the issue of isolation and quarantine of health workers into the public spotlight. Multiple expatriate health workers who may have been infected with the Ebola virus in West Africa (and some who were infected) required repatriation to the United States. During the response to the outbreak, U.S. state lawmakers mandated a wide range of self-isolation policies for returning health workers. Some of these policies were more restrictive than CDC recommendations, causing frustration and social isolation of health care workers. Depending on the insurance carrier, evacuation insurance held by many international travelers and aid workers may have exclusion policies for evacuation

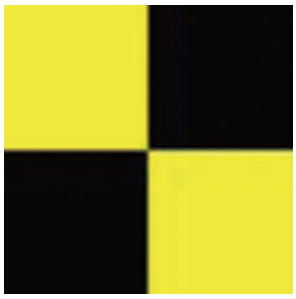


FIGURE 86-6 The "Yellow Jack" signal flag, which is flown in a harbor when a ship is under quarantine.

in the event of specific infectious diseases such as Ebola virus disease. When considering deployment with an organization in response to an emerging infectious disease, it is essential that the volunteer vet the response organization's evacuation and security plans and resources. Health care workers responding to international epidemics of emerging infectious disease should be aware that when they return to the United States, they may be subject to legally mandated restrictions on work, social activity, and travel.

Quarantine Abroad

The U.S. Department of State cannot demand immediate release of private American citizens who have been detained or quarantined abroad in accordance with local public health regulations and legal authorities. Every effort will be made to assist American citizens, but U.S. government offices overseas are unable to provide medications or administrative assistance. After the pandemic subsides and travel resumes, the U.S. Department of State can once again provide full consular services to American citizens, including routine repatriation assistance.[24]

If a traveler is overseas during the outbreak of a global pandemic, travel restrictions may limit his or her ability to return to the country of origin until travel restrictions are lifted. Given this possibility, all expatriate workers and travelers, especially those deploying to work in relief efforts in the event of an infectious disease pandemic, should anticipate the possibility of travel restrictions. Depending on the nature of the epidemic, responders may need to follow social distancing guidelines, including avoiding public gatherings and physical contact with other individuals.[15]

SAFETY AND SECURITY STRATEGIES FOR TRAVELERS

The decision to travel in an area of conflict or recently ended conflict, a region that is subject to political or military turmoil, or a country affected by an emerging infectious disease is a serious one. The more complicated the situation at the destination, the more one needs to make advance arrangements and judge the overall personal risk. International travelers and foreign workers must address the risks that they will face when crossing borders. The traveler needs to take into consideration a number of complex and dynamic features, including the risk of theft, abduction, or encounters with militia or with those who are hostile to an international presence.

International travelers, particularly expedition travelers, often have a strong motivation to press onward and continue their journey despite warning signs. The tendency of novice adventurers to blindly keep moving forward can lead one to ignore warning signs and discard pragmatism and sound judgment. The seasoned traveler, particularly one with experience in conflict settings, will be able to discern when to continue onward and when to pause and consider a new strategy. Before describing specific strategies for travelers, it is useful to consider some of the ways that people—even expert travelers—can get into trouble.

APPROACHES THAT MAY BE COUNTERPRODUCTIVE

Being Overconfident

Unrealistic optimism is a common bias in many adventure or expedition travelers, and contributes to the assumption that the ultimate outcome in any situation will be positive. This can lead to overconfidence during one's assessment of a situation. A guide with limited experience may display overconfidence because he or she has traveled to the area before without any problems. This mindset can cause one to ignore signs of danger or potentially explosive situations.

Escalating Activities

Linked to overconfidence is the notion of escalation, where one proceeds forward despite poor results. This may arise from wanting to salvage a project or an expedition or out of a desire to validate a series of poor prior decisions to get a project back on track. This commonly occurs when attempting to reach a destination despite delays, changes in weather, and the uncertainty of traveling at night in unfamiliar settings. A guide may promote risk taking to enhance his or her image, give himself or herself a sense of purpose, or create the image that he or she is in charge of the situation.

Relying on Limited Information

Making judgments about risk in a complex environment requires knowledge of the geography, political climate, and immediate threats. Those who are invested in the progress of an expedition may have limited knowledge and may be unwilling to consider things that they deem as unknowns. Risk taking also occurs as a result of pressure from headquarters, when people in leadership positions who are not in the field create pressure to "press forward" and "get the job done" without knowing the conditions on the ground. In general, decisions about field safety must be made by field personnel who are experiencing the sense of threat or uncertainty rather than by remote leadership with an unrealistic agenda.

Becoming Desensitized to Risks

For individuals or organizations in areas of relatively high risk, basic precautions and safety measures may become mundane and unimportant. Perceptions of risk can diminish, even if the true threat has not changed or is increasing. International relief personnel commonly face—and become immune to—daily threats and security issues because they become routine. In such cases, it is useful to develop and adhere to an established security protocol so that individuals or teams do not develop a sense of complacency.[15]

TRAVELING AND WORKING IN A CONFLICT ZONE: INDIVIDUAL CONSIDERATIONS

Civilians should only consider the prospect of traveling or working in an active war zone under well-defined circumstances, such as with a reputable relief organization or another organization that has significant logistic and security capabilities. In addition to the strategies discussed throughout this chapter, travelers may wish to consider the following strategies:

CONTACTS AND RESOURCES

When traveling to regions affected by conflict, it is important to have local contacts and resources. Be cautious about discussing the itinerary with strangers, and remain vague about personal matters, family members, and finances. When traveling in regions with militia or in tense political climates, make an extra effort to ensure personal security by attending to the issues noted in Box 86-6.

Many seasoned travelers working in conflict areas find it useful to register with the nearest U.S. embassy or consulate through the U.S. State Department's smart traveler enrollment

BOX 86-6 Checklist for Personal Security While Traveling

- Arrange an alternative to your hotel or lodging so if you are forced to flee, you have a safe haven.
- Establish contact with someone local who can be trusted, and keep his or her contact information handy.
- Make a special note of United Nations compounds, international organizations, and high-end hotels as possible destinations if you are in trouble.
- Remain aware of people loitering around your hotel or people who keep reappearing to assist you. Remain friendly, but avoid discussing personal matters, your itinerary, or your program.
- Do not leave personal or business papers in your hotel room, and keep copies of your documents in an alternate location.
- Avoid predictable times and routes of travel, and report any suspicious activity to local police and the nearest U.S. embassy or consulate.
- Be sure of the identity of visitors before accepting riders or opening the door of your hotel room or any vehicle.
- Do not meet strangers at unknown or remote locations.
- Make a plan in the event that there is a bomb blast, gunfire, or sudden military activity in or around your hotel. Check exits and access routes in advance.

program website at step.state.gov. Registering with U.S. authorities allows individuals to be contacted in the event of rapidly developing political situations, and can assist the government in evacuation or tracking of individuals if such persons become trapped or unable to move as a result of insecurity or military threat. Providing a detailed itinerary, copies of one's passport, and multiple contact numbers can assist the consulate with locating an individual during an emergency.

ASSISTANCE FOR VICTIMS OF CRIME OVERSEAS

If an individual is the victim of a crime overseas, the Overseas Citizens Services of the U.S. Department of State's Bureau of Consular Affairs is committed to assisting American citizens who are traveling, working, or residing abroad. Government officials known as *consuls* or *consular officers* at embassies and consulates in nearly 250 cities throughout the world are responsible for assisting U.S. citizens in foreign countries. Consular duty personnel are available for emergency assistance 24 hours a day, 7 days a week, at embassies, consulates, and consular agencies overseas and in Washington, DC. To contact the Office of Overseas Citizens Services in the United States, call 1-888-407-4747 from the United States or Canada or 1-202-501-4444 from outside the United States or Canada. Contact information for U.S. embassies, consulates, and consular agencies overseas can be found at travel.state.gov/content/passports/english/emergencies/victims.html.

Consuls and consular agents can help American crime victims with issues such as replacing lost or stolen passports, contacting family and relatives, obtaining medical care, and providing information about the local criminal justice system and victim assistance programs. Consular officials do not investigate crimes or provide direct legal advice, but can refer interested parties to local attorneys.[25]

SUMMARY: TRAVELING AND WORKING IN POLITICALLY INSECURE REGIONS

International travelers, expeditions, and humanitarian organizations may venture into regions that are affected by war or political instability. Traveling to a conflict area or war zone is complex and requires a detailed understanding of the political and military context and the potential for threats to personal security. It is essential to work with reputable agencies that have a significant presence on the ground and understand the risks of the region. Significant advance preparation is required. Diligent attention to the details of personal security, situational awareness, and contingency planning is essential when traveling to countries or regions in the midst or the aftermath of armed conflict.

REFERENCES

Complete references used in this text are available online at expertconsult.inkling.com.

REFERENCES

1. Centers for Disease Control and Prevention. <cdc.gov>.
2. Coghlan B, Brennan RJ, Ngoy P, et al. Mortality in the Democratic Republic of Congo: a nationwide survey. Lancet 2006;367:44.
3. Cornell Law. <law.cornell.edu/uscode/text/22/2656f (26)>.
4. <huizenga.nova.edu/ifs/DEPARTMENT_OF_STATE_PUBLICATION-Security_Awareness_Overseas.pdf>.
5. Humanitarian Outcomes. Aid Worker Security Report, 2012: <humanitarianoutcomes.org/sites/default/files/AidWorkerSecurityReport2012.pdf>.
6. Humanitarian Outcomes. Aid Worker Security Report, 2014: <humanitarianoutcomes.org/sites/default/files/Aid%20Worker%20Security%20Report%202014.pdf>.
7. International Campaign to Ban Landmines. <icbl.org>.
8. International Campaign to Ban Landmines. Landmine and cluster munition monitor: <the-monitor.org>.
9. International Institute for Strategic Studies. Armed Conflict Database: <acd.iiss.org>.
10. Poyer J. The AK-47 and AK-74 Kalashnikov rifles and their variations. Tustin, California: North Cape Publications; 2004.
11. Risk Map 2015. <https://www.controlrisks.com/en/our-thinking/analysis/top-ten-kidnap-countries-2014>.
12. Sheik M, Gutierrez MI, Bolton P, et al. Deaths among humanitarian workers. BMJ 2000;321:166.
13. Shenon P. A flogging sentence brings a cry of pain in U.S. The New York Times March 16, 1994. (21).
14. Small Arms Survey, Bachelor P, Huag M, et al. Caught in the crossfire: the humanitarian impacts of small arms. In: The Small Arms Survey 2002: Counting the human cost. Oxford, UK: Oxford University Press; 2002.
15. State Department Options During a Pandemic. <travel.state.gov/content/passports/english/emergencies/pandemics.html>.
16. The economics of sexual exploitation. <pulitzercenter.org/blog/untold-stories/economics-commercial-sexual-exploitation>.
17. The Heritage Foundation, Dillon D. Piracy in Asia: a growing barrier to maritime trade: <heritage.org/Research/Reports/2000/06/Piracy-in-Asia-A-Growing-Barrier-to-Maritime-Trade>.
18. The Millennium Project. <millennium-project.org/millennium/Global_Challenges/chall-12.html>.
19. The Polaris Project. <polarisproject.org/human-trafficking/international-trafficking>.
20. United Nations News Centre. UN maritime agency welcomes Security Council action on Somalia piracy: <un.org/apps/news/story.asp?NewsID=26893&Cr=somalia&Cr1=. (20)>.
21. United Nations office on Drugs and Crime. Global Study on Homicide, 2011: <unodc.org/documents/data-and-analysis/statistics/Homicide/Globa_study_on_homicide_2011_web.pdf>.
22. United Nations/UNICEF. Impact of Armed Conflict on Children: <unicef.org/graca/patterns.htm>.
23. U.S. Department of State. Arrest/detention of an American citizen abroad: <travel.state.gov/travel/tips/emergencies/arrest/arrest_3879.html>.
24. US State Department. Avian influenza A (H5N1) and pandemic influenza: <travel.state.gov/content/passports/english/go/health/avian-influenza-a–h5n1–and-pandemic-influenza.html>.
25. U.S. State Department. Help for U.S. victims of crimes overseas: <travel.state.gov/content/passports/english/emergencies/victims.html>.
26. World Health Organization. Estimated rate of homicide per 100,000 population, 2012: <apps.who.int/gho/data/node.main.VIOLENCEHOMICIDE?lang=en>.