Chapter 9
Lessening the Impacts from Non-Tectonic (Natural) Hazards and Triggered Events

9.1 Floods

Floods are a global problem. They are predictable to some degree by weather forecasting but to a greater degree and with more accuracy when drainage basin monitoring equipment is in place. This includes stream gauges that telemeter the elevation of stream/river surface in a channel and the rate of water flow to a central computing station. The computed data from the telemetered sites plus the input of stream/river channel cross-sections data allow prediction of where flooding will be a problem, when the flooding will reach an area, and to what level out of a channel (magnitude) the flood is estimated to reach. This gives the populations at risk of the flooding early warnings (hours, days) and time to prepare for the floodwaters or to gather important documents and evacuate to safe higher ground.

Floods are not preventable but their effects can be mitigated to a good degree if flood control management is in place. Flood control is achieved in several ways so that waters can be retained and released slowly after the threat has passed (dams), or kept from moving out of their natural channels (levees, dikes). In addition, existing channels can be modified so that they can carry greater volumes of water without overflowing their banks and move more quickly through flood zones (deepen, widen, straighten channels), and by adding a flood wall to retain waters that exceed volumes carried in the modified channels. Sandbagging around structures may keep floodwaters from invading them.

Floods are often recurring events although their magnitudes may vary greatly. The recurrence intervals between floods of given magnitudes can be determined from an analysis of historical and modern records. These are generally reported in terms of probability of flood levels to be reached every 100 years, every 200 years, every 500 years (1 %, 0.5 %, and 0.2 % probability, respectively) and so on. These estimates are only suggestive but are used in determining whether building permits

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will be issued for residences or other structure for areas proximate to rivers, whether flood insurance for structures will be written for a given zone, and if written, what the cost of flood insurance will be.

Floods can cause landslides and potential health problems for populations when there is torrential rain that is long lasting. First, depending on the location of a flooding river channel, rushing water can undermine bank material or erode base of valley walls causing landslides that could affect people living in the threatened areas. Second, torrential rains can overload sewer systems so that sewerage carrying pathogens are discharged into waters that may affect water users downstream. Populations warned of these potential flood-triggered hazards can follow advisories to evacuate if necessary and drink bottled water if their water supply is tainted.

Preparedness against floods includes warning/alert systems sent by weather bureaus and flood management agencies and, of course, evacuation plans showing routes to safe sites with staffs and supplies in place to help displaced citizens.

An Intergovernmental Panel on Climate Change report suggests that flooding has been more frequent and more severe in some regions and that there is less flooding in other regions [1]. The report projects that extreme precipitation events will occur over most of the mid-latitude land masses and that those over wet tropical regions will become more intense and frequent. These extreme precipitation events often cause flooding that endangers people and property especially if early warning systems are not in place.

Natural changes in river flow other than those that result in flooding can be categorized as disasters for people and for a country. For example, the Semliki River marks the border between Uganda and the Democratic Republic of Congo (DRC). In recent years, and perhaps as a result of global warming/climate change, the volume of water discharged into the river from melting snow and ice from mountain peaks has been reduced as the ice has receded and less snow has fallen. In addition, there have been periods of erratic rainfall and the wet season is wetter. The result has been a meandering of the river that has flowed through Uganda fields and left them as part of the DRC. Ugandan farmers and herders have to pay DRC owners of the “new land” a tribute to be able to cross 15 m of river water to continue to work the fields and care for their herds on the other side of the river that was Ugandan territory before the border shifted as the river meandered. There is international intervention that is working to set a fixed border so that land that was lost can be assigned correct ownership and Ugandan territory can stop shrinking [2].

9.2 Mass Movements

9.2.1 Landslides

Landslides also called landslips are the best known of the disaster class called mass movements. Mass movements are a world wide problem that cause 4500 deaths and hundreds of millions of dollars damage each year to homes, infrastructure, and utilities. Other movements in this grouping include: (1) subsidence or a lowering of an area of the Earth's surface; (2) collapse of soil/rock into a void in the subsurface; (3) rockfalls; and (4) mudflows (debris flows). The latter is activated when torrential or sustained rain over a period of time loads water weight into slopes and seeps into earth materials there, lubricating them and also pushing grains apart because of increased water pressure. The heavy, lubricated, destabilized matter finally breaks loose and speeds downslope without warning at as much as a mile a minute (96 km/ph). The destabilization can be further abetted when some of the earth materials comprising a slope is composed of the clay mineral class called smectite (montmorillonite/bentonite), a mineral that expands when it is wetted and shrinks when it dries. A combination of the expansion and lubrication from added water and its weight can bring down a hillside. Populations at the base of slopes and beyond are at risk of sudden burial with major loss of life. It should be noted that away from hillsides, soils that expand when wet and shrink when dry cause cracks in basements and foundations of buildings that rest on them, a property damage problem but a problem that is not a threat to the well being of people. Avoidance of possible building sites underlain by expansive/shrinkage soils or extraction of the soils prior to construction can mitigate the potential basement/foundation problem. Keeping the soils wet with an irrigation system that activates during dry weather has been used to stabilize the reactive soils.

9.2.1.1 Observation and Measurements that Reveal Landslide Prone Regions

Landslides occur in hilly topography (elevated terrain, >15° slopes) where the soils are well developed, where poorly consolidated sedimentary rocks comprise the hills, where the structure of the rocks dip (angle) downward and outward from the at risk slopes, and where there is considerable rainfall. These are predictive observations that suggest the possibility of a landslide prone region. Landslides are a threat when water seeps into the hills adding water weight that increases the pull of gravity on the earth materials, increases groundwater (pore) pressure that pushes grains apart, and acts as a lubricant for subsurface earth materials. Other observations that alert citizens that there is a downslope movement of soil are cracks in the ground and trees that tilt back into a slope. A geologist's observations of scarps in a hilly area attests to it being landslide prone. Scarps are mini-cliffs often with exposed soil caused by a landslide but that may be hidden from the untrained eye by overgrowth. Tilt-meters (inclinometers) are electrical driven pieces of equipment that can be installed in slopes to telemeter movement or deformation data that suggests the possible onset of a landslide. A recent approach to identify the strong probability of a landslide and thus could serve as an early warning system that allows people to evacuate to safety uses fiber-optic strain sensors complemented by rainfall data [3]. These sensors render continuous monitoring in time and space. Fiber-optic sensors that can detect displacement, groundwater pore pressure, displacement (slow slope slippage), ground vibrations, and temperature, are glued equally spaced to the surface of a PVC (flexible) pipe and embedded in shallow trenches in a soil. The pipe can bend or twist with pre-slope failure tensile strain (e.g., elastic, plastic, shear, viscous volumetric) registered as 3D deformation. The various sensors will register the location of the deformation on monitors at an off slope location.

Physically, a landslide appears as a block of earth materials that breaks from a slope along a scarp and slides down along a concave surface pushing lobes of slide materials out at the base of the block. The areas affected by landslides are generally limited and distances landslide move are generally small although in areas of very steep topography the momentum of a landslide can carry the detached mass a significant distance and across adjacent terrain. As noted previously, landslide moving into a river valley can act as a dam, cause flooding initially upstream and subsequently downstream when the temporary dam is breached.

9.2.1.2 Human Activity that Can Cause Landslides

In addition to landslides starting as a response to an earthquake's shaking, jarring, rolling motions and excessive rainfall, human activity can lead to landslides as well. This can happen when toes of slopes that give stability to hills in landslide prone regions are cut away to establish a road. This disturbs a slope's equilibrium and is an example of bad land use planning that creates conditions that can lead to landslides. Similarly, landslides may be caused if the head of a slope at equilibrium between gravity stress trying to pull soils and rocks down and the strength of the mass resisting slope is weakened by overloading the head with housing and well-travelled roads. The added weight (stress) and vibrations from vehicular traffic can result in a slope failure. Also, sliding can be abetted by loss of anchoring vegetation especially where logging has been active.

9.2.1.3 Protection Against Landslides

In landslide prone areas as evaluated by geologists and geological engineers, citizens can be protected to a good degree from injury, loss of property, and even death in two ways. One is zoning that prevents habitation where conditions are conducive for landslips if a slope were to be loaded with destabilizing weight such as the earlier cited homes and well trafficked roads. Second, for existing habitation or planned habitation, geological engineering can diminish the threat of landslides. This is done by (1) redirecting rainwater or snowmelt so that it does note invade slopes at risk; (2) by installing retaining walls with perforations that allow in seeping water to exit a slope; and (3) by installing concrete caissons, a few feet in diameter down to base rock along the front of a vulnerable slope. These efforts are costly so that economic constraints prevent their general use. In areas of Japan where topography is hilly and where landslides threaten infrastructure including critical transportation systems, the Japanese government has invested in landslide prevention. They sealed hills with shotcrete so that rainwater or snowmelt can not seep into the hills and destabilize them with added weight and lubrication at earth material slide planes. Preparedness would require that earth moving equipment and search teams be available to rescue people who survived but are trapped by displaced earth materials.

Recurrence of landslides is associated with the amounts of rainfall an area receives over a period of time. Landslide activity will increase in some global areas and in some regions as a result of increased rainfall because of climate change. As mentioned in the previous section on flooding, extreme precipitation events, or simply increases in annual mean precipitation is likely for the high latitudes, the equatorial Pacific region, and mid-latitude wet regions and can provide the stimulus for landslide activity. Central America and South America are especially ar risk [1].

9.3 Avalanches: Mass Movements of Snow in Alpine Settings

An avalanche is a large mass of snow that suddenly slides downslope. There are two general types of avalanches: (1) sloughs that are small flows of powdery snow that are unlikely to kill people or destroy structures; (2) full depth avalanches that are massive slabs of snow that break loose from a mountain and cause death and destruction. The latter may carry ice, soil, and rock debris. Avalanches generally occur without warning on slopes >30° and <45°at alpine areas worldwide (e.g., Swiss mountains, Western Canada, New Zealand, Alaska, the Himalayas). One or a combination of factors can contribute to an avalanche event. These include storminess, slope shape, orientation of steep slopes with respect to the sun, the rough or smooth character of the ground beneath a snowpack, vegetation, the nature of the layers of a snowpack, and vibration. Thus, if there is a 30 cm (12 in.) or more snowfall in a 24 h periods, there is likely to be an overloading and an avalanche depending on how the layers in a snowpack are bound together. Most avalanches occur during snow storms and blizzards. Clearly, a steeper convex slope is more conducive to avalanche activity. A rapid temperature increase can cause melting of a layer in the snowpack that results in an avalanche. The more vegetation there is deters the down flow of an avalanche as would a rough rocky surface beneath a snowpack. Vibrations from activity on a slope (skiers, snowboarders, snowmobiles), thunder storms, low flying jet planes, and explosions can set off an avalanche. During WWI, thousands of soldiers in Alps regions were killed by avalanches triggered by artillery fire. Avalanches can flow downslope at speeds of 130 km/h (80 mph) or more. Depending on the mass being moved, an avalanche can kill people, and damage or destroy structures and infrastructure (homes, recreational areas, bridges, tunnels [block road and/or railway movement]), pipes and utility lines (water, natural gas, electricity), and put workmen maintaining an infrastructure at risk. Hundreds of people are killed by avalanches each year. During 2014 and 2015, avalanches in Nepal, triggered by an earthquake and by unseasonal severe rain and snow blizzards, roared downslope from Mount Everest and other peaks in the region. Many trekkers were killed, as were Sherpa guides and climbers preparing for the climb to the summit of Mount Everest.

9.3.1 Protection from Avalanches

People can be protected by zoning that evaluates the history of avalanches, the paths they follow, and their frequency and reach in an alpine area to prepare risk maps to prevent use or allow limited or full use of the zoned terrain. In areas where use of terrain is allowed, warning systems are in place so that when sounded, citizens will not enter a threatened area, or if there, evacuate it immediately. Avalanches can not be prevented but defensive structures can be used in established populated areas to try to divert them such as snow fences or snow walls. Avalanche sheds can be used to protect structures and transportation routes by making the flow of snow ride over them. Dangerous buildups of snow on slopes that are known for avalanches can be set off as snow slides or snow slips using vibrations caused by controlled explosions with explosives implanted in the snowpack, dropped by helicopter, or delivered by artillery shells. Excellent sources of information on avalanches can be found at *www.ussartf.org/avalanches.htm* and at *www.conserve-energy-future.com/types-causes-effects-of-avalanches*.

9.4 Rockfalls

9.4.1 Conditions that Favor Rockfalls

A rockfall happens when a mass of rock from a very steep to vertical cliff detaches from the face of a cliff and free falls down. The rocks bounce off underlying rocks, often detaching them as well. The falling rocks crash onto the base of a cliff sometimes running out damaging structures and/or infrastructure, blocking roads and putting vehicles at risk. In addition to steep topography, the geological character of the rocks comprising a cliff, the climate, and sometimes vegetation are factors that influence the risk of a rockfall but do not predict when one may occur. Fractures and fissures in rocks can fill with water during a winter day and freeze at night causing ice wedging that weakens rocks against the pull of gravity. Trees that root in cracks and crevices in a rock cause root wedging that does the same. Stress when an earthquakes strikes an area can loosen rocks to the point that they fall from a cliff face.

9.4.2 Rockfall Prediction, Protection for Citizens

A geological evaluation of an area can reveal areas that have suffered rockfalls and areas likely to have rockfalls but geologists can not reliably predict when a fall will occur. To protect an area and its inhabitants, infrastructure, and businesses from rockfalls, municipalities have options. They can install catchment fences at the base of cliffs to prevent run outs, require that rock bolts be inserted to stabilize an at risk rock face or that chain-link fencing be fastened to the rock face.

9.5 Subsidence

9.5.1 Cause of Subsidence

Subsidence of an area of the Earth's surface is the result of the continuous extraction of large volumes of groundwater or petroleum from underlying sedimentary rocks without recharge or replenishment of fluids. Fluids in subsurface rocks provide buoyancy pressure that strengthens the resistance of the rocks to compaction and hence subsidence of the Earth's surface. If volume loss does take place in subsurface rocks, subsidence may or may not occur depending on the strength and thickness of overlying rocks. Overlying rocks may be inherently strong enough so that they do not subside. Conversely, they can respond to the compaction of underlying rock by subsiding.

9.5.2 Mitigating Subsidence

Subsidence can be arrested or even reversed somewhat in some geological settings if a degree of buoyancy pressure is reestablished by re-injecting fluid (e.g., brine) into the rock. For example, in oil fields, eight barrels of brine are extracted with one barrel of crude oil. The brine can be recycled into the oil reservoir under pressure. Similarly, if extraction of groundwater from aquifer rock is replenished by groundwater recharge, any subsidence that has taken place should stop. Oil production at the Wilmington Field in southern California, USA, began in 1938 and caused a subsidence that by 1958 reached 9.5 m (31 ft) at Long beach Harbor and extended to parts of Los Angeles Harbor. The subsidence damaged oil wells, pipelines harbor infrastructure, railroad tracks, streets, and bridges and reversed the flow of sewers and storm drains. Repair cost more than U$S 100 million at that time. Brine re-injection was used to arrest the subsidence and there was stabilization and a rebound of 30 cm (12 in.) [4].

Mitigation of a possible subsidence problem can be determined by geologists and geological engineers who study samples of the sequence of rocks from the surface to the oil or water reservoir. They can predict whether or not subsidence will take place and if it is realistic to plan to recharge the extraction reservoir with volumes of fluid that equal the volumes withdrawn, thus maintaining buoyancy pressure in the reservoir/aquifer. This can prevent or at least minimize subsidence if it begins.

9.5.3 Economic Problems from Subsidence

Governments can be stressed two ways economically because of subsidence. First is the cost to repair the damage done to infrastructure and structures in the areas affected by subsidence. Second are the economic losses that can be incurred if a productive sector is slowed down by not being able to extract critical fluids from the subsurface without having to invest more funding to improve extraction by drilling wells deeper. This would likely mean an increase in the price of a commodity used to make or grow a product and hence be inflationary for the public. A case in point is the more than four year severe drought being suffered in 2015 in the Central Valley (especially the San Joaquin Valley) of California, USA where subsidence has been a recurring problem during past droughts as groundwater was extracted, but not excessively, from aquifers to make up for the shortage of surface water. However, excessive groundwater pumping during the existing extended drought, mainly by the agricultural sector, has lowered groundwater tables to 100 ft (~30 m) lower than recorded in the past. As a result some areas experienced a subsidence of up to two inches (5 cm) a month as fine-grained layers in the aquifer were depleted of their buoyancy pressure and compacted. If the compaction is tight enough, part of the storage capacity (porosity) and permeability (ability to transmit fluids) of an aquifer could be lost. The subsidence varies with location in the valley. One area subsided at 1/2 in. a month. The maximum subsidence was about a foot (12 in. or 30 cm) a month [5]. Another result of the over pumping is a reduction of fresh water pressure in the aquifer that could result in salt water intrusion where the aquifer extends to the marine continental shelf.

The differential subsidence in the San Joaquin Valley has caused damage to infrastructure, the most important of which may be the California aqueduct comprised of canals, pipelines, tunnels and pumping stations. The aqueduct carries water from northern California rivers that receive melt from the Sierra Nevada snowpack and from rainwater some 400 miles (~600 km) to southern California. Change in the fall (inclination) of sections of the aqueduct from subsidence and low spots on the system prevent the water from flowing as well as it did pre-subsidence and thus needs reworking. Changes in the fall of sewer lines have to be repaired to prevent sewage backup and its consequences from a reversal of slope. Similarly, water pipelines have to be reset to allow efficient flow of water. Some bridges have subsided to the degree that they are no longer above the water surface. Roads are ruptured and have to be repaired. Levees in place for flood control when the rains come have sunk and have to be raised. Building foundations sink as well and need correction. Very important in this agriculturally dependent valley and its towns has been the destruction of thousands of public and private well casings. California and the agriculture industry have the economic wherewithal to make the necessary repairs once the drought breaks. The Central Valley grows about 50 % of the vegetables and fruits sold in the United States. As previously indicated, if crops fail or yields drop because of the lack of water for irrigation, the cost of the produce and fruit will increase. The state is investing large sums of money to develop a capital improvement program.

9.6 Collapse/Sinkholes

9.6.1 How Sinkholes Form

Collapse of a small areas of the Earth's surface into voids in the subsurface causes sinkholes. This is an action that takes place most often where there is a relatively high water table in terrain underlain by limestone, a rock type that houses many famous cave systems worldwide. In this scenario, groundwater moving slowly through limestone continually during geologic time (millions of years) dissolves the limestone leaving voids in the subsurface. When these are large enough and the roof rock strength cannot resist the pull of gravity, the roof rock collapses into the subsurface cavity. The areas affected are generally small, rounded or oval shaped, and tens of meters or less across. Sinkholes have caused structural damage to buildings, swallowed homes and car dealerships, ruptured roads (pavements) including highways, and in rare cases have caused injury and death. Sinkholes have developed as well in terrain underlain by salt-rich (evaporite) strata that are dissolved by irregular groundwater flow. In some cases, water pipes underlying roadways have broken and the released water has washed out the earth materials around a ruptured waterlines creating open spaces in the subsurface into which earth/road materials have collapsed. Underground coal fires can create cavities into which the overlying rock and soil can subside and ultimately collapse.

9.6.2 Minimizing Risk to Land Used for Housing and Development

To lessen the risk of suffering loss from collapse from a future sinkhole when buying a home or business or land to develop and build on, one should commission an evaluation of the terrain by experts that will predict its vulnerability for collapse. For example, a geologist will first assess the geology of the area under study (especially when underlain by limestone or dolostone), the topography, and determine the position of the water table that could cause dissolution of underlying rock. He/she will review the history of insurance claims against collapse situations in the area. In a surface analysis, the geologist will look for signs of potential surface movement that could portent sinkhole activity by examining building foundations in the neighborhood for visible cracks, especially arcuate ones, cracks in roads or sidewalk pavement, and depressions or low spots in the terrain as well as the presence of small ponds that could represent former sinkholes. This study will suggest the level of risk in an area but only an investigation of the subsurface conditions can give more accurate vulnerability information. This can be done using ground penetrating radar (GPR) that takes a short time using modern equipment that digitizes data for ready presentation and interpretation [6]. In one Florida study, the GPR data for nine 60 m lines were generated in 2 h. Another option is to do a seismic study that will yield information as to the solid rock nature or void presence in the subsurface. Studies such as these, where collapse is an endemic problem, but on a larger, perhaps county scale, can result in sinkhole vulnerability maps that can guide land use planning for small scale evaluations of potential sites for buildings or infrastructure. Where there is a void in the subsurface but there is a need to use the terrain, it may be possible to fill the void with grout to stabilize the surface but this can be very costly.

9.6.3 Prediction/Mitigation

A question exists as to whether scientists can spot an incipient sinkhole as it develops so as to be able to warn inhabitants of at-risk homes to evacuate. The possibility exists using the NASA satellite system InSAR (Interferometric Synthetic Aperture Radar) that detects small movements on the ground. A study of an area in Louisiana, USA and noted that the ground shifted horizontally 10 in. (25 cm) in a section of the survey. A sinkhole opened up there a month later and the horizontal displacement observed was towards the center of the sinkhole [7]. Scientists believe that there is the potential to use this deformation as an early warning system in other sinkhole prone areas so that people can remediate the condition or evacuate buildings that might be at risk of a calamitous collapse. This is a step towards preparedness. However, they noted that not all sinkhole sites have surface shifting before a collapse, making necessary the previously cited methods to detect subsurface cavities that could become sinkholes.

Mitigation of an economic loss of home or business to a collapse into sinkhole event can be achieved by having collapse/sinkhole insurance as part of a home owners policy or an insurance policy that covers a business structure and inventory. The policies should cover collapse whether the event is from natural processes (e.g., subsurface dissolution of limestone) or from the failure of a water or sewer pipe and subsequent washout of supporting earth materials that leads to a collapse of an overlying home, business structure, road, highway, or bridge. Because many home buyers and home owners are unaware of their vulnerability (risk) from a collapse/sinkhole event, the state of Florida, USA mandates that home owners carry Catastrophic Ground Collapse Coverage. In the United States, Alabama, Kentucky, Missouri, Pennsylvania, Texas, and Tennessee are states with collapse into sinkhole problems and their own insurance requirements.

9.7 Health Hazards

9.7.1 Diseases

Infectious/communicable diseases are natural hazards abetted in some instances by human actions or inactions. Some of these diseases have been eradicated (smallpox) or nearly eliminated (polio, measles, guinea worm disease [dracunculiasis]). Others are treatable (malaria) or can be stabilized (HIV/AIDS), and still others are not preventable (dengue fever) but the exposure to which can be alleviated to some degree. Still others for which prevention and/or curing/stabilization medications are not available are being researched intensely such as an Ebola vaccine because of the 2014–2015 West African outbreak of the disease. In the most recent clinical trial of an Ebola vaccine, the success rate was 100 %, encouraging but requiring more testing before it is approved for universal application.

9.7.2 Mitigation

The threat or onset of infectious disease can be mitigated in several ways. First is prevention. There are vaccines available that can protect citizens against contracting specific infectious diseases. In the case of measles and polio, the actions of religious zealots (Taliban sect) who have burned down health clinics and injured or killed health workers have prevented vaccinations for all so as to achieve global eradication of poliomyelitis in two countries where it still occurs (Pakistan and Afghanistan) and measles (globally), especially in Asia and Africa. However, this not withstanding, vaccination programs for measles are making good progress. From 2000 to 2012 the number of deaths from measles has dropped 78 %, from 562,400 to 122,000. Mumps and measles (MMR vaccine) and whooping cough (DTaP vaccine) are two other infectious/communicable diseases that can be eliminated if vaccinations are given. In the case of children, a second application of the MMR vaccine is necessary to give them lasting immunity to mumps and measles.

It should be noted that vaccinations may not be close to 100 % effective. Scientists have modeled the probable effectiveness of vaccinations for endemic infections [8]. They conclude that vaccines denominated as "leaky" provide the same degree of resistance to a disease to all who have been vaccinated and gives a partial immunity after being vaccinated. A vaccine called "All-or-Nothing (AoN)" is best applied when the probability of re-infection is high, transmission is likely, or when a vaccine has low power to reduce the risk of infection. In contrast to a "leaky" vaccine, an AoN vaccine completely protects a major number of vaccinated persons but others in the population receive no direct benefit from it.

Some infectious/communicable diseases such as tuberculosis can be cured with medicines taken over a prescribed period of time. Chagas is a disease that is endemic in 21 Latin American nations. It can be cured if medication is taken early enough after the onset of the disease. If this does not happen the persons with Chagas disease can look forward to a middle age with cardiac and gastrointestinal problems with the healthcare burden this implies. Cholera is an infectious disease that can be controlled with access to adequate sanitation or cured by rehydrating victims with oral rehydration salts. If a cholera victim's dehydration is severe, IV plus antibiotics are used to cure the patient. A short term lasting cholera vaccine is available and used by health workers where there is a cholera epidemic.

AIDS/HIV is an infectious/communicable disease that is not curable and that has killed 40 million people. The disease can be stabilized if an infected individual has access to (or the funds to pay for) a cocktail of antiretroviral medications taken during a lifetime. This allows an HIV/AIDS carrier to live an otherwise healthy life and be productive in his/her community. About 15.8 million of the 36.9 million people with the disease are now taking the retroviral medications. Seventy percent of the global total of two million new cases are in Sub-Saharan Africa [9]. Unless the 21.1 million infected individuals not on antiretroviral medications get access to them and follow prescription protocols, the disease will continue spreading through populations.

Some infectious diseases can be controlled but not eliminated. Influenza is controlled by a seasonal vaccination that is prepared according to what scientists consider will be the dominant strains of the influenza virus during a coming influenza season. A strain was missed during the 2014–2015 season and more people suffered sickness as a result. Although some people do contract the disease, the vast majority of the vaccinated population is protected. If some do contract influenza from the unaccounted for strain, its effects are generally less than they would be without the vaccination.

The earlier cited Ebola epidemic that raged in Liberia, Sierra Leone, and Guinea, Western Africa controlled and the region declared free of the disease after more than 11,000 deaths of more than 27,000 infected. The Ebola epidemic shows how vulnerable many countries/regions are because of an inadequate health infrastructure that is not prepared to cope with a disease once identified, its spread, and the care and treatment of large numbers of infected people. Ebola is transmissible by body fluid contact and this had to be learned by family members and others caring for infected individuals as a first phase in controlling and ultimately leaving a country Ebola free. The spread of this disease to other countries, regions, or around the world was limited by the general immobility of people from afflicted countries and controls at transportation centers and by immigration controls at adjacent countries for those from the disease ridden countries who were mobile and presented a transmission risk. As the disease progressed in the afflicted nations, help arrived rapidly from developed nations that had experience in disease control that experts applied on site and taught to health givers in spite of the fact that WHO delayed before putting out a public health emergency alert. Laboratories that had been researching vaccines against Ebola increased their efforts and laboratory testing on animals. Test results of the promising vaccines on human subjects have been encouraging for two of the vaccines developed. Although the vaccines may prove to be effective against Ebola after future positive test results, they were not available at the time the epidemic was identified in West Africa.

9.7.3 Preparedness

Preparedness is the key to dealing with the outbreak of an infectious disease that could develop into an epidemic/pandemic. As noted above, initial preparedness such as protocols in the physical contact with afflicted persons that caused transmission of the disease, their treatment, and burial practices of their kin were lacking in the West African Ebola outbreak. A November, 2015 report by a panel from the Harvard Global Health Institute and the London School of Hygiene and Tropical Medicine critiqued the WHO for not declaring a public emergency until 5 months after being informed of the Ebola outbreak by Guinea and Sierra Leone [10]. The Panel recommended several ways in which the WHO could improve its role in preparing for and dealing with an infectious disease crisis. Among the recommendations were the following: (1) the need to invest in developing a nation's core capacity, that is, its ability to detect, report, and respond rapidly to outbreaks; (2) the strengthening of incentives for early reporting of outbreaks and science-based justifications for trade and travel restrictions to prevent transmission of a disease; (3) the creation of a WHO Center with adequate capacity to respond quickly to a disease outbreak; (4) an assurance of access to the benefits of research that yield improved diagnostics, and the most effective medicines and vaccines; (5) information on best protocols to follow in treating an infectious disease and on cultural awareness and traditions to account for when dealing with families of the afflicted or dead; and (6) availability of funding to put these and other recommendations into practice [10].

With respect to improved diagnostics (4 above), Nature published a December 2015 supplement in which contributors modeled the impact of new diagnostic and prognostic technologies for lessening the global burden of infectious diseases [11]. They are of the opinion that new diagnostics can more rapidly direct patient treatment and limit disease transmission to the general population thus effectively reducing the spread of epidemics. The effectiveness lies in the education of on-site health providers in the new diagnostics and protocols as they become operational. The contributors also believe that research can come up with new and rapid diagnostic protocols for multiple diseases that affect populations worldwide, that are effective and reduce costs that existing protocols incur, especially in less developed and developing countries.

The Ebola outbreak and spread by direct or indirect contact of an infectious disease raises the question of whether the world is prepared to combat an infectious disease, natural or from bioterrorism, that is transmitted through the air we breathe. Given the ease of transmission, the mobility of disease carriers within a country or internationally, the populated venues where transmission through respiration can take place (e.g., airplanes, cruise ships, theaters, arenas, subways, malls), the answer is no for many less developed and developing countries that do not have a well functioning health infrastructure… not enough doctors, nurses, well equipped clinics, hospitals, laboratories, medicines, or vaccines. Thus, a virulent disease transmitted through the air could infect and kill millions of people before medical care to treat it or vaccines and medicines to cure it are found and tested so as to control and/or eliminate a killer virus. It is possible to minimize the spread of an easily transmittable infectious disease but this requires a major investment. A proactive action would be for the health capable and economically advantaged nations to work with less prepared ones to create a good healthcare infrastructure, a mission of the WHO that has been neglected [10]. This would include training personnel as deemed necessary, building clinics where hospital care may be lacking, setting up laboratories that can identify diseases at their onset rather than waiting for results from a central laboratory, and by educational programs for citizenry. Response team training in all countries is essential to initially deal with a disease. Obviously, there has to be open and clear lines of instant communication between health organizations locally, regionally, nationally, and internationally when disease surveillance detects an outbreak node of a known or unidentified infectious disease. This allows a global response to begin on how to cope with the outbreak of a deadly viral disease in order to minimize its spread and develop a treatment protocol.

9.7.4 Diarrheal Diseases

Diarrheal disease that affect 100 s of millions of people each year can be controlled in two ways. First, they can be countered and their impact on society lessened by the use of antibiotics assuming medications are available and economically accessible. Second, is the identification and elimination of the sources of diarrheal diseases. Basically this means improving sanitation conditions and food storage, preparation, and handling operations. Investment by governments to provide access to advanced sanitation systems and for education with respect to food cleanliness can lessen the onset and spread of diarrheal infections and limit employee sick days, thus helping a country's productivity and economic development.

9.7.5 Vaccines in Research Phases

There are several infectious/communicable diseases that do not fall into the categories described in previous paragraphs. Vaccines and medications are being researched with some in trial stages. These diseases include malaria, dengue fever, yellow fever, West Nile virus, plague, and most recently Ebola because of the West African epidemic. As already noted, in the case of the Ebola epidemic, preliminary tests of new vaccines being researched have had good results on human volunteers. However, it is uncertain whether the positive results are because of the vaccines or the care factor given to those with the disease. A Zika vaccine is scheduled for Phase 1 clinical trials during the latter period of 2016.

Lastly it should be noted that Science Magazine commissioned a survey to prioritize ten potential vaccines that would merit increased government and industry funding for their research and development. These vaccines do not show clear scientific or safety obstacles and would benefit societal health conditions mainly in less developed and developing countries. The surveys were sent to 100 vaccine experts globally who were asked to prioritize the listed vaccines based on scientific feasibility, morbidity and mortality, and societal/economic impact. Fifty experts filled the survey. The overall priority ranking results in 2015 were (1) Ebola Sudan, (2) Chikungunya, (3) MERS, (4) Lassa fever, (5) Marburg, (6) Paratyphoid fever, (7) Schistosomiasis, (8) Rift Valley fever, (9) SARS, and (10) Hookworm [12]. Vaccines for some of these (1, 3, 4, 5, 8, and 9) could prevent or reduce the chances of serious outbreaks in the near future. Zika would be a 2016 addition.

9.8 Mental Stress

9.8.1 Mental Stress Evoked from Living Through Hazards

The psychological impact of living through a natural or anthropogenic hazard that injures or kills family and friends, and damages and destroys homes, business, and places of employment is a shock to citizens that puts them in a state of disbelief and distress. For that reason, the preparedness sections on hazards recommends that mental health professionals be available to the suffering populations. Mental health is considered here as a health hazard that in this text is triggered by a primary event but may result from a secondary event (e.g., earthquake aftershock) or a triggered hazard. The stresses caused can affect populations for reasons other than suffering physical, biological, and chemical dangers environments can present [13].

9.8.2 Principal Causes of Stress from Surviving a Killing, Destructive Hazard

Citizens living through a natural or anthropogenic hazard and secondary hazards that can occur suffer stress from several results of the event. The immediate stress factor is a concern for families in the degree of destruction citizens see wreaked on their environment. Stress levels heighten from the loss of or injury to family and friends and loss of home and possessions. The greater the loss, the higher the level of stress. Other factors that stress populations suffering through the immediate aftermath of a major hazard event include displacement, sense of vulnerability and insecurity, apparent slowness of assistance midst the chaos a hazard can cause, fear of what might come next, and physical exhaustion. There are ongoing discussions on coping with the stress of disaster [14, 15]. Post hazard stress arises from loss of employment and income, apparent slowness in recovery leading to societal normalcy, and reconstruction. In a latter section of this book, different classes of insurances are discussed that can, if purchased, mitigate economic stress from hazards losses. The number of people susceptible to hazard-caused stress and their resulting mental health problems will increase in the future because of population growth and increased population density in urban centers that have experienced recurring hazards. This is especially true for major cities (perhaps greater than one million inhabitants) and for mega-cities with more than ten million people. Easing or mitigation of stress levels involves having access to mental health professionals who can help relieve people's lasting anxieties, receiving social support from family and friends, focusing on the present and future rather than reliving the past, and taking care of oneself physically.

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