PARAMETERS TO FACILITATE THE CREATION OF INITIAL RESPONSE

CAPSULES FOR SURVIVORS OF PRODIGIOUS DISASTERS

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PARAMETERS TO FACILITATE THE CREATION OF INITIAL RESPONSE CAPSULES FOR SURVIVORS OF PRODIGIOUS DISASTERS

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A Thesis

Submitted to

the Graduate Faculty of

Auburn University

in Partial Fulfillment of the

Requirements for the

Degree of

Master of Industrial Design

Auburn, Alabama
December 15, 2006

PARAMETERS TO FACILITATE THE CREATION OF INITIAL RESPONSE

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Master of Industrial Design, December 15, 2006
(B.S., Auburn University, 2005)
(B.S., Auburn University, 2002)

128 Typed Pages

Directed by Chris Arnold

The psychological and physiological effect that a catastrophic event has on a person is staggering. Soon after a disaster, many survivors become unruly, hysterical, and in the worse cases even suicidal. After tragedy happens, most people don't want handouts; they want to help themselves and their family recover. They want to find that sense of normalcy as quickly as possible. If you can give them the tools, the recovery process is accelerated. This study includes research on basic human needs and the impact of large-scale disasters with a brief look into psychological studies of color. The collection and organization of this data makes it possible to create a methodological system to design and construct a prototypical Initial Response Capsule which would provide basic human needs for two weeks, the typical length of time before organized emergency response can arrive. The capsule contains a basic signaling system, rations, water collection and purification system, first aid, and a shelter system.

ACKNOWLEDGMENTS

The author would like to thank Assistant Professor Christopher Arnold for his thoughts on social design and his ability to push the status quo. Further thanks go to Professor Bret Smith, Assistant Professor Ahn Sang-Gyeun and Clark Lundell for their positive influence during the writing of this document.

A heartfelt thanks to Andrea Ray for her complete dedication and unswerving encouragement through this long journey. To Mom, Dad, Jay, Amanda, Karen, Ratan, Felix, Zack, Donna, Foster, Abby, Dan, Robby, Sawyer, Owen, Joe, Chad, Shae, Kim, Liu, Chelsea, James, Beth, Lucian, Cliff, Matt, Libby, Nic, Brett, Penny, Elisa, Don, Eric, Sydney, Carolyn, Kate, Scott, Jenn, Kathy, Ellary, Whitney, Brett, Tin-Man, Randy, Sylvia, Becky, David, JR, Chris, Katie Beth, Chet, Nancy, Kim, A-Young, Chris, Katie, Dan, Anjuli, Janet, Syrah, Sam, Jay, Laura, Aaron, Rachel, Dan, Peter, Carol, Ben, Hayley, Jacqueline, Carson, Sally, Drew, Jared, Marise, Lauren, Patricia, Blake, Juice, Matt, Coral, Charles, Will, Michael, Kerenza, Rachel, Hope, Alex, Jeff, Nate, Bethany, Klise, Andrew, Meaghan, Roxy, Josh, Wright, Corin, Joan, Beth, Molly, Chase, Ryan, Addie, Hillary, Tom, Michelle, Stephanie, Gaines, Tyler, Eric, Louisa, Andrew, Jay, Taylor, Rickelle, Dan, Tom, Mary Catherine, Jason, Aran, Brittany, Matt, and Rob: I thank you for your support and friendship during my education.

Style Used: Department of Industrial Design

Software Used: Microsoft Word, Apple Pages, Adobe Photoshop, Microsoft Excel, Apple iTunes, Rhino, Flamingo, Adobe Acrobat, iFlash, Apple Safari, Adobe Illustrator

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1.0 Disasters

Disasters emerge from the fact that all societies regularly face geophysical, technological, and especially recently, climatological events that unveil their physical and social vulnerabilities. In response, societies engage in activities and develop specific technologies that are designed to provide protection from such threats (Tiernay, 2001). Throughout the years, researchers have tried to define what a disaster is. Two typical paradigms have emerged: the war analogy, which sees disaster as an external agent "attacking" and disrupting the social system and the view that disaster is a manifestation of fundamental vulnerabilities in the social system. The latter argues that disasters occur because human activities, which have both intended and unintended consequences that are not well understood, interact and come into conflict with ongoing technological and natural processes (Tiernay, 2001). Frequently, we don't know that human activities and natural processes are on a collision course until a disaster actually happens.

One major factor in raising our vulnerability in recent years has been the move towards heavy urbanization in some of the most hazard-prone regions of the world. For the first time in history, more people are now living in urban environments than in the rural countryside; many are crammed into poorly sited and carelessly constructed mega-cities with some populations in excess of 8 million people (McGuire, 2002). Societies tend occupy physically vulnerable locations in the course of their search for resources such as fertile land, commercially advantageous locations, and even attractive surroundings and scenic views. Disasters tend to occur when the risk area population adopts patterns of land use, building construction, and economic activity that are vulnerable to the physical impacts of extreme events in the environment. Apparently, the number of annual disasters due to storms, floods, landslides, and droughts has doubled from around two hun-

Disaster - an event that threatens the psychological and physiological functions of its victims, while from an economic perspective it is an event that produces measurable material losses and threatens the flow of goods and services.

dred in 1996 to, more recently, over four hundred. The United States Federal Emergency Management Agency, FEMA, however, reports that still only 10 percent of all weather-related emergencies are officially declared (McGuire, 2002).

A slightly different point of view is that the natural/technological distinction is an artificial one because human interference is the pivotal factor in all disaster events. Disasters are the products of human activity; potential energy is built-up through our oblivious and destructive acts while we wait for an event in nature to trigger the collapse in the unstable relationship and cause a disaster event. This approach to disasters led to an analysis of the causes of devastating floods that occurred in 1981 along China's Yangtze River. Deforestation in the Yangtze catchment started early in the last century when trees were cut for imperial palaces. The process accelerated during China's disastrous leap toward rapid industrialization, which included a campaign to establish backyard iron furnaces that needed wood for fuel. The rainfall may have been the trigger for the flooding, but the flood disaster, an outcome directly traceable to deforestation and unthoughtful land reclamation, was socially generated and left seven hundred fifty-three dead, five hundred fifty-eight missing, twenty-eight thousand one hundred forty injured and one and a half million homeless (McGuire, 2002). The distinction between natural and technological disasters seems to be becoming more difficult to pinpoint. Could the growing population of the planet be causing a rise in large scale disasters? This truth, no matter how inconvenient to us and our need to expand is, seems to connect disasters with the broader concept of sustainability. Along with environmental degradation and resource depletion, disaster impacts are now commonly seen as part of a complex of negative environmental outcomes resulting from policies that emphasize growth at the expense of safety and from the operation of political-economic forces that depend on the exploitation of natural and environmental resources (Tiernay, 2001).

This brings up a major debate on the issue of whether natural and technological disaster agents differ in ways that are significant for our understanding of preparedness and response activities. This debate has been fueled in part by the aftermath of catastrophic events like the Three Mile Island and Chernobyl nuclear accidents as well as by the conflicts and controversies generated by toxic chemical and hazardous wastes. One body of research suggests that disasters caused by technological agents constitute a distinct genre because the social and behavioral patterns that occur in emergencies and disasters involving technological agents differ from those that are commonly observed in natural disasters, and because the two

types of events tend to differ in their short and longer term consequences. Some researchers, therefore, take the point of view that research findings based on studies of natural disasters cannot be generalized to crises originating in failures of technology (Tiernay, 2001).

Current disaster research focuses to some degree on preparedness from before the catastrophe to immediate post-impact response activities and then secondarily on disaster recovery (Tiernay, 2001). Modern disaster research needs to address a broader range of hazard agents, including both natural and technological hazards, and focus on describing and understanding the activities of various social units, ranging from households to community groups and organizations and governmental authorities at the local, state, and federal levels.

1.1 Natural

At any single point and at any one time the Earth and its enclosing atmospheric envelope give the impression of being mundanely stable and benign. This is, however, an entirely misleading notion. Nearly one thousand four hundred earthquakes rocking the planet every day and a volcano erupting every week. Each year the tropics are battered by up to forty hurricanes, typhoons, and cyclones, while floods and landslides occur everywhere in numbers too great to keep track of (McGuire, 2002). These acts of nature occur at any hour and often with little warning. Each time, the damage can range from a few trees uprooted to the near-obliteration of entire communities.

Although often charitable, nature can be a terrible competitor and mankind has fought a near-constant battle against the results of its unpredictability. So far we have been very fortunate, and our current civilizations have grown and developed against a backdrop of relative climatic and geological calm. The omens for the next century and beyond, however, are far from encouraging. An example just recently fully appreciated is the El Nino´ and La Nina´ events in the tropical Pacific; they disrupt jet streams and regions of high and low pressure in the ocean-atmosphere system. These disruptions can potentially increase or decrease weather-related disasters such as extreme heat and cold, floods, hurricanes, and thunderstorms (Liebsh, 2005). Combine these with a now consistent increase in average global temperature, inevi-

table rising in sea levels, overpopulation, and unrestrained land exploitation. This combination has and will result in huge increases in vulnerability of modern society to natural catastrophes.

While we now know far more about natural hazards, the mechanisms that drive them, and their sometimes awful consequences, any benefits accruing from this knowledge have been at least partly negated by the already mentioned increased vulnerability of large sections of the Earth's population, which has doubled between 1960 and 2000. The bulk of this rise has occurred in poor, developing countries, many of which are particularly susceptible to a whole spectrum of natural hazards (McGuire, 2002). Ninety-six percent of all deaths from natural hazards and environmental degradation now occur in developing countries. Each of the last three decades of the twentieth century saw a billion or so people suffer due to natural disasters. Every year hundreds of millions of people worldwide are evacuated or driven from their homes due to natural disasters. There is little sign that hazard impacts on society have diminished as a consequence of improvements in forecasting and hazard mitigation, and the outcome of the battle against nature's dark side remains far from a forgone conclusion (McGuire, 2002).

We must face the fact that as long as we are all confined to a single planet in a single solar system, the long-term survival of our race is always going to be tenuous. Living on possibly the most active body in the solar system, we must always keep in our minds that we exist and thrive only by geological accident. However powerful our technologies become, as long as we remain on Earth we will always be dangerously exposed to all of nature's arsenal.

1.1.1 Tornado

A tornado is a violently rotating column of air which is in contact with both a cumulonimbus cloud and the surface of the earth. They are the most destructive storms on earth; some tornadoes can have winds of more than five hundred kilometers per hour, be more than three kilometers across, and stay on the ground for forty kilometers or more. They have been observed on every continent except Antarctica; however, a significant percentage of the world's tornadoes occur in the United States - about one thousand two hundred a year. This is mostly due to the unique geography of the country which allows the conditions that

breed strong, long-lived storms to occur many times a year. Other areas which often experience tornadoes are northwestern Europe, east-central South America, South Africa, Australia, and south-central Asia.

Despite a higher number of tornadoes reported in recent years, the number of fatalities and injuries due to tornadoes has been decreasing. This is thanks in part to better National Weather Service tools in detecting tornadoes, namely the NEXRAD doppler radar network installed in the mid-1990's. Also, the ability of alerting the public has improved as well with more National Weather Service radio transmitters and a close relationship with media outlets. In fact, the increasing number of tornadoes reported may be a direct result of improved communications networks, public awareness, warning systems and training.

Figure 0: The Great Tri-State Tornado of 1925

The Great Tri-State Tornado of Wednesday, March 18, 1925, crossed from southeastern Missouri, through southern Illinois, then into southwestern Indiana, and was the deadliest tornado in U.S. history, with seven hundred forty-seven confirmed fatalities. The continuous three hundred fifty-two kilometer track left by the tornado was the longest ever recorded in the world. It was given the maximum issued rating of F5 on the Fujita Scale. The tornado was part of a larger tornado outbreak with several other destructive tornadoes in Tennessee, Kentucky, and Indiana. Three states, thirteen counties, and more than nineteen communities, four of which were essentially erased, were in the path of the record three and a half hour long tornado. Total damage was estimated at sixteen and a half million; adjusted for wealth and inflation, the toll , is over one and a half billion. In addition to the dead and injured, thousands were left without shelter or food. Additionally, fires erupted exacerbating the damage. Recovery was generally slow with the event leaving a lasting blow to the region. Over fifteen thousand homes were destroyed by the Tri-State Tornado, elevating this event as one of the most destructive and expensive tornadoes ever in the United States.

1.1.2 Hurricane

A hurricane is a severe tropical storm that forms in the North Atlantic Ocean, the Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean. Hurricanes need warm tropical oceans, moisture and light winds above them. If the proper conditions last long enough, a hurricane can produce violent winds, incredible waves, torrential rains and floods. In other regions of the world, these types of storms have different names; Typhoon, Tropical Cyclone, and Cyclonic Storm. An average of five hurricanes strike US soil each year and over seventy-five million Americans live in hurricane areas. When hurricanes move onto land, the heavy rain, strong winds and heavy waves can damage buildings, trees and cars. The heavy waves are called a storm surge. The storm surge is dangerous and a major reason why you must stay away from the coast during a hurricane.

In 1992, Hurricane Andrew virtually obliterated southern Miami in one of the costliest disasters in US history, resulting in losses of forty-five billion dollars. This epic storm brought wind speeds up to three hundred kilometers per second; three hundred thousand buildings were damaged or destroyed and left one hundred fifty thousand people homeless (McGuire, 2002).

Hurricane Katrina in August 2005 was the costliest and one of the deadliest hurricanes in the history of the United States. It was the eleventh named storm, fifth hurricane, third major hurricane, and second category five hurricane of the 2005 Atlantic hurricane season, and was the sixth-strongest Atlantic hurricane ever recorded. It is possible that Katrina was the largest hurricane of its strength to approach the United States in recorded history; its sheer size caused devastation over one hundred sixty kilometers from the center. The storm surge caused major or catastrophic damage along the coastlines of Louisiana, Mississippi, and Alabama, including the cities of Mobile, Alabama, Biloxi and Gulfport, Mississippi, and Slidell, Louisiana. Levees separating Lake Pontchartrain

Figure 1: Hurricane Rita 2005

from New Orleans, Louisiana were breached by the surge, ultimately flooding roughly eighty percent of the city and many areas of neighboring parishes. The hurricane left an estimated three million people without electricity. Federal disaster declarations covered two hundred thirty-three thousand square kilometers of the United States, an area almost as large as the United Kingdom, UK. Severe wind damage was reported well inland, and hurricane force wind gusts were reported from Baton Rouge, Louisiana to Dothan, Alabama. Katrina is estimated to be responsible for over one hundred fifteen billion dollars in damages, making it the costliest disaster in U.S. history. The storm killed at least one thousand six hundred four people and left over five hundred thousand people homeless, making it the deadliest U.S. hurricane since the 1928 Okeechobee Hurricane. Sadly, as of March 3, 2006, more than two thousand people still remained unaccounted for.

Shortly after the hurricane ended on August 30, some residents of New Orleans who remained in the city began looting stores. Many looters were in search of food and water that was not available to them due to the destruction. Drug, convenience, and clothing stores in the French Quarter and on Canal Street were among the hardest hit. There were many reports of car-jacking, murders, thefts, and rapes flooded the news, thankfully all but one of the stories were determined to likely be based on rumors. Thousands of National Guard and federal troops were mobilized and sent to Louisiana along with numbers of local law enforcement agents from across the country who were temporarily deputized by the state.

Many U.S. states have offered to shelter refugees displaced by the storm, including places as far away as Oregon and California. The majority of the refugees were taken to Texas, with over two hundred thirty thousand people taking shelter in Houston by September 5, 2005. As Texas shelters became filled to capacity, it became a way-point for the other refugees still leaving the area of crisis. From Texas, thousands of refugees have been dispersed to other states. Two weeks after the storm, over half of the States were involved in providing shelter for refugees. By four weeks after the storm, refugees had been registered in all fifty states and in eighteen thousand seven hundred zip codes - half of the nation's residential postal zones. Most refugees had stayed within four hundred kilometers, but two hundred forty thousand households went to Houston and other cities and another sixty thousand households went over one thousand two hundred kilometers away.

1.1.3 Extraterrestrial

Perhaps the greatest threat to life on Earth comes not from home but from above. Although the near constant bombardment of our planet by large chunks of space debris ended a couple millennia ago, the threat from asteroids and comets remains real and is treated increasingly seriously. Recently, the reality of our situation set-in and funding was accumulated for a new research center dedicated to the study of the impact threat and its consequences. The true numbers of these Earth crossing asteroids are impossible to determine, but current estimates are pretty frightening. The chances are one hundred percent that Earth will collide with a large asteroid or comet again. The vital questions are when and how bad this will be for the human race. The latter depends largely upon how big a chunk of rock hits us (McGuire, 2002). In all, up to twenty million pieces of rock over ten meters across may be hurtling across our planet's path during its journey around the sun. Up to one hundred thousand of these are thought to be over one hundred meters in diameter - big enough to obliterate London or New York given a direct hit - and maybe twenty thousand are half a kilometer across, sufficient to wipe out a small country if they strike land, or generate devastating tsunamis if they impact in the ocean. Fewer in number, but enormously more destructive if they hit, are those asteroids one kilometer or more in diameter. Recent estimates suggest that around a thousand asteroids with diameters of one kilometer or more have orbits around the sun that cross the Earth's path. One kilometer is the impactor diameter threshold for initiating a cosmic winter, due to dust lifted into the stratosphere blocking out solar radiation, for wiping out a quarter or so of the human population, and for causing general mayhem worldwide (McGuire, 2002). It is easily recognized as the critical size threshold at or above which a collision would have devastating consequences on a global scale.

If we are to realistically assess the threat of future impacts to our civilization, then clearly it is vital that we resolve as soon as possible whether the number of collisions continues at its current rate or are we going to have a disastrous surprise in store somewhere down the line. If the former proves to be correct, we can expect business as usual, meaning a collision with a fifty-meter potential city-destroyer every fifty years or so, a half kilometer small-country obliterator every ten millennia, and a one kilometer global impact event every one hundred thousand to three hundred thousand years - depending on whose figures you accept. Fortunately for us, gigantic extinction level events, ELEs, like the ten kilometer one that ended the

reign of the dinosaurs sixty-five million years ago, appear to happen every fifty to one hundred million years, so the chance of one striking the Earth soon are tiny (McGuire, 2002). What this all amounts to is that during your lifetime your chance of dying due to an asteroid or comet impact could be twice as great as being killed in an air crash; a pretty sobering though.

One theory on extraterrestrial impactors is that major impact events happen every twenty-six to thrity million years. It is linked to the orbit of the solar system circling the center of the Milky Way galaxy, an orbit that moves up and down in a wave-like motion. Every thirty million years or so, this undulating path takes the sun and its family through the plane of our galaxy, when the gravitational pull from the huge mass of stars at the galaxy's core provides extra tug. This is sufficient pull to disturb the orbits of the Oort Cloud comets and send an influx of new comets into the heart of the solar system, dramatically raising the frequency of large impacts on Earth. It has been a few million years since our system last plunged through the galactic plane - could a phalanx of comets be heading for us at this very moment (McGuire, 2002)?

Another, very intriguing theory is that the Earth is struck by clusters of objects every thousand years, and that our planet was bombarded by one of these clusters as recently as the Bronze Age - just four thousand years ago. To find out what might cause such a bombardment we need to return to the Oort Cloud in deepest space. Leaving aside disturbance of the cloud due to the passage of the solar system around the galaxy, normality sees a new comet from the cloud every now and again falling in towards the inner solar system - maybe as frequently as every twenty thousand years. The newcomer is rapidly 'captured' and torn apart by the strong gravitational fields of either the sun or Jupiter, forming a ring of debris out along its orbit, but concentrated particularly around the position of the original comet itself. A large comet, broken up in this way can 'seed' the inner solar system with perhaps a million kilometer-sized lumps of rock, dramatically increasing the numbers of Earth-threatening objects, and significantly raising the chances of our planet being hit. It is proposed that the last giant comet from the Oort Cloud entered our solar system towards the end of the last Ice Age - a mere ten thousand years or so ago - breaking up to form a mass of debris known as the *Taurid Complex*. Every December the Earth passes through part of this debris stream, resulting in the sometimes spectacular light show put on by the Taurid meteor storm as small rocky fragments and gravel-sized stones burn up in the upper atmosphere. These innocuous bits and pieces only represent the tail end of the Taurid Complex, however, the heart of which contains a five kilometer-wide Earth

crossing comet known as *Encke* and at least forty accompanying asteroids, any one of which would create global havoc if it struck our planet (McGuire, 2002). Most years the Earth's orbit crosses that of the Taurid Comlex at the point where there is little debris, resulting in a pre-Christmas spectacle and little else. Every two thousand five hundred to three thousand years or so, the Earth passes through the main group of debris - and finds itself on the receiving end of a volley of rocky chunks perhaps up to two hundred to three hundred meters across. Some believe that just such a bombardment around four thousand years ago led to the fall of many early civilizations during the third millennium BC. They have interpreted contemporary accounts in terms of a succession of impacts, too small to have a global impact but quite sufficient to cause mayhem in the ancient worlds, largely through generating destructive atmospheric shock waves, earthquakes, tsunamis, and wildfires. Many urban centers in Europe, Africa, and Asia appear to have collapsed simultaneously around 2350 BC, and records abound of flood, fire, quake, and general chaos (McGuire, 2002). Correlating these finding, there have been seven impact craters found in Australia and Argentina that have been determined to have been created around 2000 BC. Even more difficult to defend are propositions by some that the collapse of the Roman Empire and the onset of the Dark Ages may somehow have been triggered by increased numbers of impacts when Earth last passed through the dense part of the Taurid Comlex between 400-600 AD. Hard evidence for these theories are weak and periods of deteriorated climate attributed to impacts around this time can equally well be explained by large volcanic explosions (McGuire, 2002).

An asteroid large enough to destroy London, New York, or Paris strikes the planet a couple times a century.

In 1908 a small asteroid estimated around fifty meters across, penetrated the Earth's atmosphere and exploded less than ten kilometers above the surface of Siberia in a region known as Tunguska. This huge blast, which expended energy roughly equivalent of eight hundred Hiroshima atomic bombs, was heard over an area four times the size of the UK and flattened over two thousand square kilometers of full grown forest. The blast registered on seismographs thousands of kilometers away and the atmospheric shock wave was picked up by barographs time and time again as it traveled three times around the planet before dissipating (McGuire, 2002). Four hours later the Earth would have rotated sufficiently to bringing the great city of St. Petersburg into the asteroid's range and the result would have been catastrophic.

Figure 2: The Tunguska Event 1908

Even if it turns out that there is no coherence in the timing of impact events, there is statistically no reason why we cannot be hit next year by an undiscovered Earth-crossing asteroid or by a long period comet that has never before visited the inner solar system. Small impactors on the Tunguska scale struck Brazil in 1931 and Greenland in 1997, and will continue to pound the Earth every few decades. Even though their destructive footprint is tiny compared to the surface area of the Earth, the result would be a social, economical, biological catastrophe if one of these hit a heavily-populated area. But the highest probability is crashing into the open ocean. Both the nature and scale of devastation also depends upon whether the impactor hits the land or the sea. Two-thirds of our planet's surface is covered by water, so statistically this is where the majority of asteroids and comets strike. In such cases, the amount of pulverized rock hurled into the atmosphere might be reduced, compared to a land collision (McGuire, 2002). However, this small benefit is partly countered by the formation of giant tsunamis capable of wreaking havoc across an entire ocean coastline. A five hundred meter rock landing in the Pacific Basin, for example, would generate gigantic tsunamis that would obliterate just about every coastal city in the hemisphere within twenty hours or so. The chances of this happening are actually quite high - about one percent in the next hundred years - and the death toll could well top half a billion (McGuire, 2002).

1.1.4 Volcano

A volcano is a summit that opens downward to a reservoir of molten rock below the earth's surface. Unlike mountains, which are pushed up from the earth's crust, volcanoes are formed by their buildup

of lava, ash flows, and airborne ash and dust (Liebsh, 2005). Fresh volcanic ash is not like soft ash in a fireplace. Volcanic ash is made of crushed or powdery rocks, crystals from different types of minerals, and glass fragments that are extremely small like dust. But it is hard, gritty, smelly, sometimes corrosive or acidic, and does not dissolve in water. When pressure from gases and molten rock becomes strong enough to cause an explosion, it erupts and starts to spew gases and rocks through the opening. Volcanic eruptions can hurl molten material and hot ash for at least twenty miles and causes earthquakes, thunderstorms, flash floods, wildfires, and tsunamis.

Estimates of the number of active volcanoes vary, but there are possibly over two thousand five hundred; more then sixty-five potentially active volcanoes exist in the US alone. This does not include the large number of eruptions from an estimated one million young volcanoes on the ocean's floor which pump out roughly three-quarters of the lava reaching the earth's surface (McGuire, 2002). Every year around fifty volcanoes erupt, some of which - like Kilauea on Hawaii or Stromboli in Italy - are almost constantly active. Others, however, may have been quiet for centuries or in some cases millennia and these tend to be the most destructive. The most violent volcanoes occur at destructive plate margins, where one plate is consuming another. Their outbursts rarely produce quiet flows of red lava and are more likely to blast enormous columns of ash and debris twenty kilometers or more into the atmosphere. Carried by the wind over huge areas, volcanic ash can be extremely disruptive, making travel difficult, damaging crops, poisoning livestock, and contaminating water supplies (McGuire, 2002).

Just two million years ago, a mighty eruption at Yellowstone in Wyoming was violent enough to leave behind a gigantic crater up to eighty kilometers across, and pump out ash that fell across the planet. Another huge eruption occurred at Yellowstone around one million years ago and yet another just six hundred fifty thousand years ago. It is a little worrying, however, that these huge blasts seem to occur every six hundred fifty thousand years or so. Perhaps then, we are due another any time now? If this last cataclysm occurred today it would leave the United States and its economy in tatters and the global climate in dire straits. The eruption would scour the surrounding countryside with hurricane-force blasts of mol-

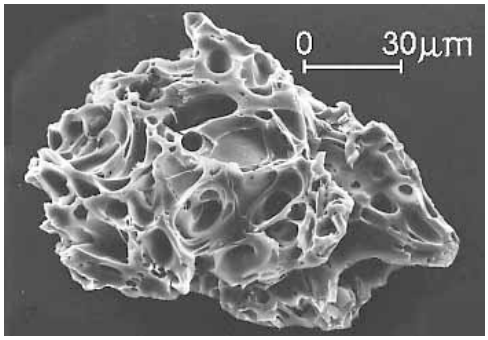


Figure 3: Volcanic Ash

ten magma and incandescent gases - known as pyroclastic flows - with a volume sufficient to cover the entire US to a depth of eight centimeters (McGuire, 2002). On the grandest scale, volcanic super-eruptions have the potential to affect us all through plunging the planet into a frigid volcanic winter and by devastating harvests worldwide.

Approximately seventy-four thousand years ago on the island of Sumatra, Indonesia, a volcanic eruption so violent occurred that it proved to be apocalyptic for the human race. Scientists estimate that it erupted with an energy release equivalent to about one gigaton of TNT. Along with huge quantities of ash, the Toba Volcano's blast may have poured out enough sulphur gases to create up to five thousand million tons of sulfuric acid aerosols in the stratosphere. This would have been sufficient to cut the amount of sunlight reaching the surface by ninety percent, leading to global darkness and bitter cold. Temperatures in tropical regions may have rapidly dropped to fifteen degrees Celsius, wiping out the sensitive tropical vegetation, while over the planet as a whole the temperature drop is likely to have been around five or six degrees Celsius (McGuire, 2002). Soon afterwards the planet entered the last Ice Age, and there is some speculation that, in this respect, the cooling effect of the Toba eruption may have been the final straw, tipping an already cooling Earth from interglacial into a glacial phase from which it only fully emerged around ten thousand years ago. The severe drop in global temperatures had catastrophic effects on vegetation and the food chain dependent upon it for survival - including humans. This massive environmental change is believed to have created population bottlenecks in the various human species that existed at the time; this in turn accelerated differentiation of the isolated human populations, eventually leading to the extinction of all the other human species except for the one that became modern humans, Homo-sapiens. Some geological evidence and computed models support the plausibility of the Toba catastrophe theory, and genetic evidence suggests that all humans alive today, despite their apparent variety, are descended from a very small population, perhaps around ten thousand individuals. Using the average rates of genetic mutation, some geneticists have estimated that this population lived at a time coinciding with the Toba event. But could an eruption like that happen again? Some scientists are studying the evidence and believe that there's a real possibility it did and could happen again in the Yellowstone Caldera.

Although by no means the largest volcanic event of the twentieth century, the spectacular 1980 eruption of Mount St. Helens, in Washington State, was certainly the most filmed. From a scientific point

of view, however, the eruption was a watershed, because it drew attention to a style of eruption that had previously attracted little interest from volcanologists. Most eruptions involve the ejection of eruption debris from a central vent, but the climactic eruption of Mount St. Helens was quite different. Lava and debris from the previous eruption - one hundred twenty years earlier - had blocked the central conduit ensuring that the fresh magma rising into the volcano could not easily escape. Instead it forced its way into the volcano's north flank, causing it to swell like a giant boil. By mid-May the carbuncle was two kilometers across and one meters high, and very unstable. Just after eight thirty in the morning on May 18, a moderate earthquake beneath the volcano caused it to shrug off the bulge, which within seconds broke up and crashed down the flank of Mount St Helens as a gigantic landslide. With this huge weight removed from the underlying magma, the gases contained therein decompressed explosively, blasting northwards with sufficient force to flatten fully grown fir trees up to twenty kilometers away and obliterating, in all, over six hundred square kilometers of forest. The landslide material rapidly mixed with river and lake water forming raging mud-flows that poured down down the river valleys draining the volcano, while pyroclastic flows tore down the flanks and ash fell as far away as Montana, one thousand kilometers away (McGuire, 2002).

The Mount St Helens blast killed fifty-seven people and was a disaster for the region, but its scientific importance lies squarely in its clarification of the mechanism known as volcano lateral collapse. Most of us view volcanoes as static sentinels: bastions of strength and rigidity that are unmoving and immovable.

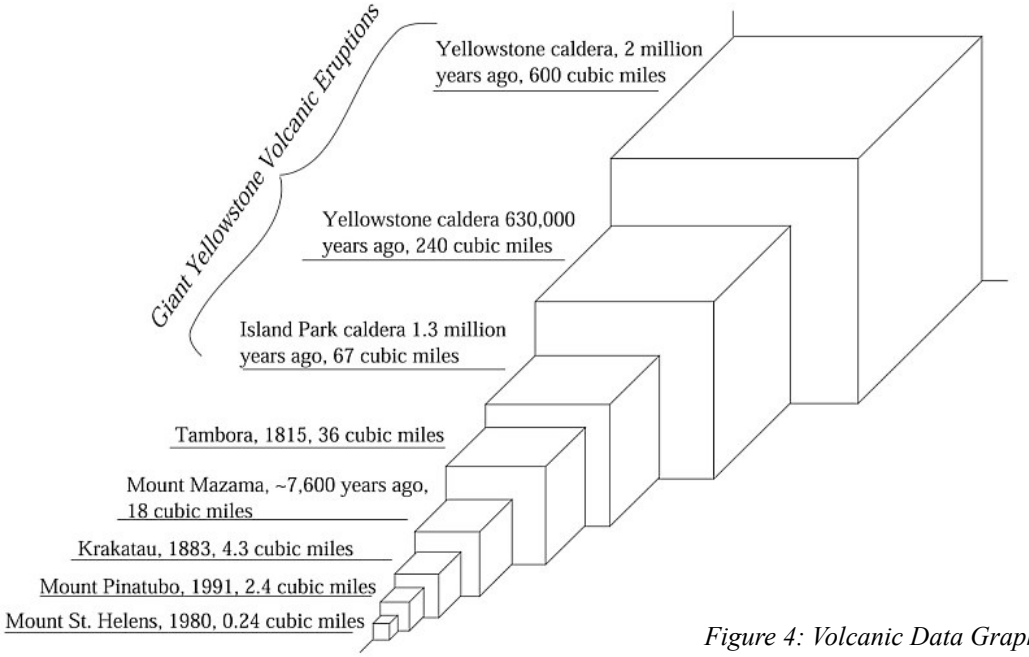


Figure 4: Volcanic Data Graphic

In fact, however, they are dynamic structures that are constantly shifting and changing. Far from being strong, they are little more than unstable pile of ash and lava. The numerous studies that followed Mount St Helens eruption revealed that collapse of the flanks and the formation of giant landslides is a normal part of the life-cycle of many volcanoes, and probably occurs somewhere on the planet around half a dozen times a century. Furthermore, they showed that the Mount St Helens landslide was tiny compared to the greatest known volcano collapse - with a volume of less than a cubic kilometer compared with over a thousand cubic kilometers for the prodigious chunks of rock that have, in prehistoric times, sloughed off the Hawaiian Island volcanoes (McGuire, 2002). Provided that the collapse occurs into the ocean, an event of this nature could have a global impact.

Figure 5: Mount St Helens 1980

Underwater images of the seabed surrounding the Hawaiian Islands shows that they are surrounded by huge aprons of debris shed from their volcanoes over tens of millions of years. Within the medley of volcanic cast-offs, nearly seventy individual giant landslides have been identified, some with volumes in excess of a thousand cubic kilometers. The last massive collapse in the Hawaiian Islands occurred just over one hundred thousand years ago from the flanks of the Mauna Loa volcano on the Big Island (McGuire, 2002). Giant tsunamis resulting from entry of this huge mass of rock into the Pacific Ocean have been responsible for carrying coral-reef debris to an altitude of over three hundred meters above sea level on the neighboring island of Lanai - three quarters of the height of the Chicago Sears Tower. Deposits

of a similar age, which may be tsunami-related, have also been recognized fifteen meters above sea level and seven thousand kilometers away on the southern coast of New South Wales in Australia.

It seems, then, as if major collapses at ocean island volcanoes are perfectly capable of producing waves that are locally hundreds of meters high and remain tens of meters high even when they hit land half an ocean away. The next collapse on the Hawaiian Islands is likely, therefore, to generate a series of giant tsunamis that will devastate the entire Pacific Rim, including many of the world's greatest cities in the United States, Canada, Japan, and China. In deep water, tsunamis travel with velocities comparable to a jumbo jet, so barely twelve hours will elapse before the towering waves crash with force of countless atomic bombs onto the coastlines of North America and Eastern Asia (McGuire, 2002).

Cumbre Vieja is a volcanic ridge on the island of La Palma in Spain's Canary Islands. At some point in the possibly near future the west flank of the Cumbre Vieja on La Palma will collapse, and the resulting tsunamis will ravage the entire Atlantic Rim. Steven Ward of the University of California at Santa Cruz and Simon Day of University College London's Benfield Greig Hazard Research Center created quite a stir recently when they published a scientific paper that modeled the future collapse of the Cumbre Vieja and the passage of the resulting tsunamis across the Atlantic. Within two minutes of the landslide entering the sea, an initial dome of water an almost unbelievable nine hundred meters high will have been generated, although its height will rapidly diminish. Over the next forty-five minutes, a series of gigantic waves up to a hundred meters high will pound the Canary Islands, obliterating the densely inhabited coastal strips before crashing onto the African mainland. As the waves head further north they will start to break down, but Spain and the UK will still be battered by tsunamis up to twelve meters high. Barely six hours after the landslide, waves tens of meters high will inundate the north coast of Brazil, and a few hours later pour across the low-lying island of the Caribbean and impact all down the east coast of the United States (McGuire, 2002). Bays, estuaries, and harbors may increase wave heights to fifty meters or more; this could greatly damage if not completely destroy cities along the United States' East Coast, such as New York, Boston, Washington, DC, Norfolk, Virginia, and Miami.

The destructive power of these waves cannot be underestimated. Unlike the wind-driven waves that crash everyday onto the beaches around the world, and which have wavelengths of a few tens of meters, tsunamis have wavelengths that are typically hundreds of kilometers long. This means that once a

tsunami hits the coast as a towering, solid wall of water, it just keeps coming - perhaps for ten or fifteen minutes or more - before taking the same length of time to withdraw (McGuire, 2002). Under the terrible onslaught, all life and all but the most sturdily built structures will be obliterated.

Without considerable forward planning, it is unlikely that the nine hours it will take for the waves to reach the North American coastline will permit effective, large-scale evacuation, and the death toll is certain to run into the millions, if not tens of millions. Furthermore, the impact on the US economy will be close to terminal, with the insurance industry wiped out and global economic meltdown following swiftly on its heels. In this way, a relatively minor geophysical event at a remote Atlantic volcano will affect everyone on the planet. Like volcanic super-eruptions, these giant tsunamis constitute perfectly normal, albeit infrequent, natural phenomena (McGuire, 2002).

1.1.5 Tsunami

As described earlier, a tsunami is a series of waves generated when a body of water, such as a lake or ocean, is rapidly displaced on a massive scale. Earthquakes, landslides, volcanic eruptions and large extraterrestrial impacts all have the potential to generate a tsunami. Scientists have found traces of an asteroid-collision event three and a half billion years ago that they say would have created a giant tsunami that swept around the Earth several times, inundating everything except large mountain ranges. The coastline of the continents were changed drastically and almost all life on land was exterminated. The effects of a tsunami can range from the unnoticeable to the devastating. A tsunami may be less than thirty centimeters in height on the surface of the open ocean, which is why they are not noticed by sailors. When the ocean is deep, tsunamis can travel unnoticed on the surface at speeds up to eight hundred kilometers per hour, crossing the entire ocean in a day or less. Scientists are able to calculate arrival times of tsunamis in different parts of the world based on water depths between and distances from, the event that generated them. Once a tsunami reaches shallow water near the coast it is slowed down. The top of the wave moves faster than the bottom, causing the sea to rise dramatically.

The Pacific Ocean is by far the most active tsunami zone, according to the U.S. National Oceanic and Atmospheric Administration (NOAA). During the past hundred years, more than two hundred tsunamis

have been recorded in the Pacific Ocean due to earthquakes, and Japan has suffered a majority of them (Liebsh, 2005). But tsunamis have been generated in other bodies of water, including the Caribbean and Mediterranean Seas, and the Indian and Atlantic Oceans. In 1775, a North Atlantic tsunami was formed from the Lisbon Earthquake that killed more than sixty thousand people in Portugal, Spain, and North Africa. This quake caused a tsunami as high as seven meters in the Caribbean as well. The Caribbean has been hit by thirty-seven verified tsunamis since 1498. Some were generated locally and others were the result of events far away, such as the earthquake near Portugal. The combined localized death toll from these Caribbean tsunamis is about nine thousand five hundred. On the opposite side of the continent, the Alaskan Tsunami Warning Center reported a 1958 landslide-generated tsunami in Lituya Bay, Alaska; it produced a five hundred twenty-five meter wave (Liebsh, 2005).

The December 26, 2004, Sumatra-Andaman Earthquake was an undersea earthquake that triggered a series of lethal tsunamis, with waves up to thirty meters high, that spread throughout the Indian Ocean, killing close to three hundred thousand people and devastating coastal communities across South and South East Asia, including parts of Indonesia, Sri Lanka, India, Thailand and elsewhere. This catastrophe is still one of the deadliest disasters in modern history. The magnitude of the earthquake has been recorded as nine point three. At this magnitude, it is the second largest earthquake ever recorded on a seismograph and it was large enough that it caused the entire planet to vibrate over a centimeter. It also triggered earthquakes in other locations as far away as Alaska. It caused serious damage and deaths as far as the East Coast of Africa, with the furthest recorded death due to the tsunami occurring at Port Elizabeth in South Africa,

Figure 6: Sumatra-Andaman Earthquake

eight thousand kilometers away from the epicenter. The plight of the many affected people and countries prompted a widespread humanitarian response. In all, the worldwide community donated more than seven billion dollars in humanitarian aid to those affected by the earthquake. Two million people were reported homeless after the tsunami.

1.1.6 Earthquake

In the most generic sense, the word earthquake is used to describe any seismic event, whether a natural phenomenon or an event caused by humans, that generates seismic waves. On the Earth's surface, earthquakes may manifest themselves by a shaking of the ground inflicting damages and causing loss of human life and destruction of property.

Most naturally occurring earthquakes are related to the tectonic nature of the Earth. The Earth's lithosphere is a patchwork of plates in slow but constant motion caused by the heat in the Earth's mantle and core. Plate boundaries glide past each other, creating frictional stress. When the frictional stress exceeds a critical value, a sudden failure occurs. The boundary of tectonic plates along which failure occurs is called the fault line. The failure at the fault line results in a violent displacement of the Earth's crust, thus causing an earthquake.

Some earthquakes are the result of a number of anthropogenic sources, such as extraction of minerals and fossils fuel from the Earth's crust, massive explosions, and collapse of large buildings. A rare few earthquakes have been associated with the build-up of large masses of water behind dams, such as the Kariba Dam in Zambia, Africa, and with the injection or extraction of fluids into the Earth's crust. Such earthquakes occur because the strength of the Earth's crust can be modified by fluid pressure. Earthquakes have also been known to be caused by the removal of natural gas from subsurface deposits and the detonation of powerful explosives, such as nuclear explosions.

Earthquakes occur on a daily basis around the world, most detected only by seismometers and causing no damage at all. The US Geological Survey estimates there are five hundred thousand detectable earthquakes in the world each year (Liebsh, 2005). Over three thousand quakes a year reach at least a magnitude 6 on the well-known Richter Scale. The larger earthquakes can cause serious destruction and mas-

sive loss of life, particularly when they strike poorly constructed and ill-prepared population centers in developing countries (McGuire, 2002). Most large earthquakes are accompanied by other, smaller ones that can occur either before or after the main shock; these are called foreshocks and aftershocks, respectively. Aftershocks may be felt for several days, weeks, months or even years depending on the force of a major earthquake. The power of an earthquake is always distributed over a significant area, but in large earthquakes, it can even spread over the entire planet. Several recent significant earthquakes have occurred on faults that were considered inactive or were totally unknown to geologists. Earthquake faults crisscross the entire US. The fact that most of them have not moved significantly in the recent geological history does not mean that they can't or won't move within our lifetime (Stein, 2000).

September 1, 1923, dawned like any other day for the inhabitants of Tokyo and Yokohama, but for many it would be their last. A low, deep rumbling grew rapidly to a monstrous roar as a fault below Sagami Bay ripped itself apart and sent shock waves tearing northwards towards the twin cities, crashing first into Yokohama and then forty seconds later into the heart of the capital itself. The quake registered a massive eight point three on the Richter Scale, and so severe was the ground shaking that it was impossible to even stand. Within seconds, thousands of buildings, many with the traditional wooden walls and heavy tiled roofs, collapsed into heaps of rubble (McGuire, 2002). But, that wasn't the end: fires started by thousands of overturned stoves began to devour the city. The fires continued to consume what remained of the cities for two days and nights, before finally burning themselves out to reveal a post-apocalyptic scene of utter devastation. The true total will never be known but up to two hundred thousand people may have lost their lives in the quake itself and fires that followed (McGuire, 2002). The cost to the Japanese economy was phenomenal - around two hundred billion dollars at today's prices - and a combination of the quake and the Great Depression six years later led to economic collapse and severe hardship.

In 1995, the people of Japan were hit with another devastating earthquake; this time the target was Kobe, which is four hundred kilometers south of Tokyo. The Kobe earthquake killed over six thousand, injured approximately thirty thousand, and left three hundred twenty thousand people homeless out of one and a half million in the impact area (Tiernay, 2001). In Kobe, serious fire damage contributed significantly to the overall destruction and to the huge economic losses and it was clear that emergency preparedness and response were far from effective, and certainly well below the rest of the world's expectations, given the

general perception of Japanese society as a model of efficiency. For one reason or another, the authorities were simply unable to cope with the chaotic aftermath of the event. Plans were not in place to ensure transport of emergency supplies and equipment to where they were needed, roads were blocked by debris and railways out of commission, and many of the city's hundreds of thousands of homeless received little or no help for several days after the quake (Stein, 2000). It is fair to say that some at least of the problems encountered at Kobe reflect the hierarchical structure of Japanese society, which stifles independent decision making and action and hinders rapid response in emergency situations (McGuire, 2002).

Figure 7:San Francisco Earthquake 1906

On October 8, 2005, the Kashmir area of Pakistan was hit with a seven point six magnitude earthquake. That strength makes it a major earthquake similar in intensity to the 1935 Quetta earthquake, the 2001 Gujarat Earthquake, and the 1906 San Francisco earthquake. The Pakistani government estimated that the death toll is well over a hundred thousand. Most of the affected people lived in mountainous regions with access impeded by landslides that blocked the roads, leaving an estimated 3 million three hundred thousand homeless in Pakistan. The UN reported that more than four million people were directly affected from the quake. Relief efforts in many remote villages are hampered, as roads were buried in rubble and many affected areas remained inaccessible. Heavy equipment was needed to clear the roads and to rescue survivors buried under the earthquake wreckage, as many rescuers were still picking the rubble with pickaxes and their bare hands, looking for survivors. Rescue efforts are also affected by the numerous aftershocks that continued to rattle the region and put rescue workers in danger as they searched through the

wreckage for survivors. The earthquake also affected some parts of the Pakistani province of Punjab and the city of Karachi experienced a minor aftershock of magnitude four point six. There was more than nine hundred seventy-eight aftershocks with a magnitude of four and above. Kashmir lies in the area of collision of the Eurasian and Indian tectonic plates. The geological activity born out of this collision, also responsible for the birth of the Himalayan mountain range, is the cause of unstable seismicity in the region.

1.1.7 Flooding

Floods are the most frequent type of disaster worldwide. More then ninety percent of declared disasters include flooding. Thus, it is often difficult or impossible to obtain insurance policies which cover destruction of property due to flooding since floods are a relatively predictable risk. A flood happens when an area of land, usually low-lying, is inundated with water. The worst floods usually occur when a river overflows its banks and the soil and vegetation cannot absorb all the water; it then runs off the land in quantities that cannot be carried in stream channels or kept in natural ponds or man-made reservoirs. Periodic floods occur naturally on many rivers, forming an area known as the flood plain. These river floods usually result from heavy rain, sometimes combined with melting snow. As flood plains all over the world become more crowded, the loss of life and damage to property caused by swollen rivers has increased dramatically. In the spring of 1993, the Mississippi and Missouri Rivers burst their banks, inundating nine Midwest states, destroying fifty thousand homes and leaving damage totally twenty billion dollars (McGuire, 2002).

A flood that rises and falls rapidly with little or no advance warning is called a flash flood. Flash floods usually result from intense rainfall over a relatively small area. Many rivers that flow over relatively flat land border on broad flood plains. When heavy rainfall or melting snow causes the river's depth to increase and the river to overflow its banks, a vast expanse of shallow water can rapidly cover the adjacent flood plain. Flooding deposits silt on the flood plain, improving its fertility. Throughout history, this has attracted agriculture and other human development. In order to preserve these farms and cities, some rivers prone to flooding have had extensive and elaborate systems of dikes constructed along their shores and surrounding nearby cities. Unfortunately, by restraining flood waters, these dikes can result in much greater flooding downstream and in locations where they break. Because of the dikes, the difference between

water-level during flood and the surface of the inland increases and the potential devastation of the flood increases. The control of annual flooding, by dikes and by dams, also prevents the deposition of silt on the rich farmlands and can result in their eventual depletion. The annual cycle of flood and farming was of great significance to many early farming cultures, most famously to the ancient Egyptians of the Nile River and to the Mesopotamians of the Tigris and Euphrates Rivers.

Coastal areas are occasionally flooded by high tides caused by severe winds on ocean surfaces, or by tidal waves caused by undersea earthquakes. The Worldwatch Institute reports thirteen of the world's nineteen megacities (cities with over ten million people) are in coastal zones -- and two billion (or one in three) people live within sixty miles of a coastline. In Europe, flooding from the sea may occur as a result from heavy Atlantic storms, pushing the water inland. Especially in combination with high tide this can be damaging. Floods from the sea can cause over-topping of flood-defenses like dikes as well as flattening of dunes or buffs. Land behind the coastal defense may be inundated or experience major damage. Floods from sea may be caused by storm surge, high tide, a tsunami or a combination thereof. As most urban communities are located near the coast, this is a major threat around the world. Hurricanes have a number of different features which, together, can cause devastating flooding. One is the storm surge sea, a possible eight meter rise in water level, caused by the leading edge of the hurricane when it moves from sea to land. Another is the large amounts of precipitation associated with hurricanes. The eye of a hurricane has extremely low pressure, so sea level may rise a few meters in the eye of the storm.

Figure 8: Great Mississippi Flood 1927

The Great Flood of 1993 was a huge, costly, and devastating flood that occurred in the American Midwest from April to October of 1993. It was the worst such US disaster since the Great Mississippi Flood of 1927, as measured by duration, square miles inundated, persons displaced, crop and property damage, and number of record river levels. Uniquely extreme weather and hydrologic conditions led to the flood. The stage was set in 1992 with a wet fall which resulted in above normal soil moisture and reservoir levels in the Missouri and Upper Mississippi River basins. These conditions were followed by persistent weather patterns that produced storms over the same locations. The persistent, repetitive nature of the storms and extensive coverage throughout the late spring and summer bombarded the Upper Midwest with voluminous rainfall amounts. Some areas received more than a meter of rain during the period. Soon, reports of levee breaks became common. These breaches acted to delay the flood crests, temporarily storing excess water in the adjacent lowlands, but the rain kept falling. The Mississippi River crested at fifteen meters, nearly six meters above flood stage and had a peak flow rate of thirty thousand six hundred meters cubed per second. At this rate, a bowl the size of a large sports stadium would be filled to the brim in sixty nine seconds.

Super Typhoon Nina caused major damage and deaths in China in 1975 mainly from the collapse of the Banqiao Dam. Hundreds of thousands of people died as a result of the floods. Nina was only a tropical storm at landfall on mainland China, but set the highest rainfall record of one thousand sixty-two millimeters per twenty four hour period in mainland China. This caused the Banqiao Dam received two thousand year flood conditions and collapsed, which in turn caused other dams to collapse. In all, sixty-two dams failed during the disaster, causing large temporary lakes and over a billion dollars in damage. The death toll from the floods will most likely never be known for sure.

Although nature is normally blamed for the damage, people are at least partly responsible for the presence of human activities in areas prone to the hazard of floods. Prevention is often aimed at containing floods with defenses, often increasing the potential damage in the long run.

1.1.8 Global Warming

Global warming refers to the increases in the average temperature of the Earth's atmosphere and oceans that have been observed in recent decades. The Earth is now warmer then it has been for over ninety percent of its four and a half billion year history (McGuire, 2002). The predicted effects of global warming are many and various, both for the environment and for human life. The increase in global temperatures is expected to result in other changes, including rises in sea level and changes in the amount and pattern of precipitation along with increasing the frequency and intensity of extreme weather events, such as floods, droughts, heat waves, and hurricanes. It may cause lower agricultural yields, glacier retreat, reduced summer stream-flows, contribute to biological extinctions, and help spread disease. Although warming is expected to affect the number and magnitude of these events, it is difficult to connect particular events to global warming.

There is a dispute within the scientific community about how fast the Earth is warming up. The dispute lies in whether or not the warming we are now experiencing simply reflects a natural turnabout in the recent global temperature trend or results from the polluting impact of human activities since the industrial revolution really began (McGuire, 2002). The climate system varies both through natural "internal" processes as well as in response to variations in external "forcing" from both human and non-human causes, including solar activity, volcanic emissions, and greenhouse gases. Climatologists accept that the earth has warmed recently, but the cause or causes of this change is more controversial, especially outside the scientific community. Various alternative hypotheses have been proposed to explain the observed increase in global temperatures, including but not limited to: the warming is within the range of natural variation; the warming is a consequence of coming out of a prior cool period — the Little Ice Age; the warming is a result of variances in solar irradiance.

We know from the studies of polar ice cores that before the Industrial Age, the concentrations of greenhouse gases in the atmosphere had been pretty much constant since the glaciers retreated at the end of the last Ice Age. Since pre-industrial times, however, carbon dioxide levels in the atmosphere have risen by thirty percent, alongside sharp increases in other greenhouse gases, in particular methane and nitrous oxide (McGuire, 2002). It was discovered through studying ice field cores that climatic temperature changes up

to eighteen degrees have occurred during a period of time as short as ten years (Stein, 2000). These drastic temperature changes occurred at the onset of an ice age. Traditionally, scientists believed that major climate changes like the start and finish of ice ages took place gradually over periods ranging from several centuries to several thousand years.

It has become fashionable to blame every weather-related natural disaster on global warming. While it is not possible to say that a specific storm or flood is due to warming, there is accumulating evidence for ever greater numbers of extreme weather events. Extreme precipitation events have increased by up to four percent at high and mid latitudes during the second half of the twentieth century, and more rainstorms, floods, and windstorms are forecast. Current climatic characteristics are likely to be enhanced, so regions that are already wet will get wetter and those that are dry will suffer from prolonged and sustained drought. Northern Europe and the UK will therefore face more floods, while the North African deserts begin to creep towards southern Europe, and Australia begins to bake beneath blazing sun (McGuire, 2002). The Atlantic's "Hurricane Alley," as seen is recent years, is likely to get much busier in the next half century. Also, there is speculation that global warming could, via a shutdown or slowdown of the thermohaline circulation, trigger localized cooling in the North Atlantic and lead to cooling, or lesser warming, in that region. This would affect in particular areas like Scandinavia and Britain that are warmed by the North Atlantic drift.

One of the reasons the loss of the planet's ice cover is accelerating is that as the poles' bright white surface disappears it changes the relationship of the Earth and the sun. Polar ice is so reflective that ninety percent of the sunlight that strikes it simply bounces back into space, taking its energy with it. Ocean water does just the opposite, absorbing ninety percent of the light and heat it receives, meaning that each mile of ice that melts vanishes faster than the mile that preceded it (www.cnn.com). This is what scientists call a feedback loop, and a similar one is also melting the frozen land called permafrost, much of which has been frozen -- since the end of last ice age in fact, or at least eight thousand years ago. Sealed inside that cryonic time capsule are layers of decaying organic matter, thick with carbon, which itself can transform into CO2. In places like the southern boundary of Alaska the soil is now melting and softening. As fast as global warming is changing the oceans and ice caps, it's having an even more immediate effect on land. Droughts

are increasingly common as higher temperatures also bake moisture out of soil faster, causing dry regions that live at the margins to tip into full-blown crisis.

Even a relatively small rise in sea level would make some densely settled coastal plains uninhabitable and create a significant refugee problem. If the sea level were to rise in excess of four meters, almost every coastal city in the world would be severely affected, with the potential for major impacts on world-wide trade and economy. It is estimated that around two hundred million people could be affected by sea level rise, especially in Vietnam, Bangladesh, China, India, Thailand, Philippines, Indonesia and Egypt.

It seems like the present climate system is very delicately poised and the system could suddenly snap. Suddenly and unexpectedly, the crisis would be upon us. From heat waves to storms to floods to fires to massive glacial melts, the global climate seems to be crashing around us

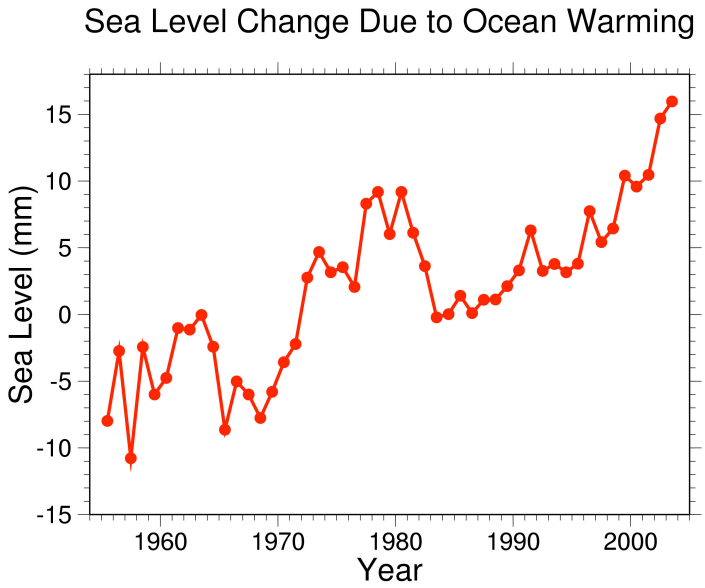


Figure 9: Sea Level Change

1.2 Manufactured

We are living in a finite world with growing populations, whose expanding appetites for consuming the world's resources are threatening the quality of life on the planet. We cannot continue to consume resources at our current rate much longer, and certainly can't maintain a continuously increasing rate. Business-as-usual has already taken a severe toll on our planet's major ecosystems and is beginning to reap frightening results, such as global warming, severe weather, crop failures, failed fisheries, and epidemics of modern diseases like AIDS, hepatitis, and cancer (Stein, 2000). The world population continues to grow by about seventy-six million people annually, which is roughly equal to adding one third of the population

of the United States every year. At this rate the global population will double in less than fifty years, but few scientists believe that the planet will be able to sustain growth. Until recently, food production gains were spread across three categories, but now it appears that the world's fisheries and pasturelands have reached or exceeded their sustainable loads. The world's agricultural system has had to increase production to supply to make up the differences. Several factors have contributed to the unprecedented rise in the world's agricultural output over the past century. This century has seen the introduction of chemical fertilizers and pesticides, the replacement of beasts of burden by modern farm machinery, the introduction of genetically manipulated strains of high-productivity crops, and the explosion in the use of irrigation both to boost crop returns and expand cropland to areas that do not normally receive enough rainfall. However, the combination of population growth, desertification, soil depletion, insect resistance pesticides, over-pumping of ground water, and the drying up of major rivers appears to have caught up with worldwide efforts to pace food production gains with population growth through improved productivity and by farming ever-increasing amounts of land.

Meanwhile, international exchange of products and ideas has made possible the blossoming of technology on an unprecedented scale. New materials and sources of energy have been discovered, new tools for farming and construction have been fashioned, and new types of transportation and communication have been developed. There have been a veritable revolution in the way people conduct their lives - both in their homes and workplaces (Halpern, 1998). We have left behind a millennium of phenomenal progress. The social condition of the human race has changed so much in the past thousand years. As a species, our political and economic growth has been amazing. We have evolved from a patchwork arrangement of city-states, farming communities and nomadic tribes to a highly complex network of multinational organizations. No longer can large segments of the globe remain isolated and indifferent to the world at large (Halpern, 1998). Sadly, parallel to this growth in the constructive use of technology has come a corresponding increase in the destructive power of weaponry.

Technological disasters are considered distinctive in several ways. Some studies suggest that technological disaster agents produce responses in the public that differ from what commonly occurs in natural disaster situations. It is normally difficult to bring about compliance with disaster warnings: people show a general tendency to normalize, to discount threat messages, and to seek confirmation before consid-

ering action. Researchers have moved toward seeing natural and technological disasters as quite different in the effects they have on individuals and communities, particularly in situations involving nuclear hazards (Tiernay, 2001). While natural disasters are widely believed to produce few discernible serious or long-standing mental health problems in victim populations, some studies report heightened levels of psychological distress in the wake of nuclear accidents and other technological emergencies. These negative psychological impacts are attributed both to the distinctive properties of technological agents and to the community problems they produce. The uncertainty and ambiguity that accompany exposure to human-induced technological hazards, such as pollution, nuclear events and the side effects of war, are thus thought to inflict a more potent level of psychological stress than naturally occurring ones.

1.2.1 Pollution

Pollution is the release of environmental contaminants and it affects every aspect of the world around us. Humankind has had some kind of effect upon the natural environment ever since we became social creatures. Some of the different forms of pollution include air, water, soil, radioactive, thermal, noise, and light pollution. Carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs), and nitrogen oxides produced by industry and motor vehicles are common air pollutants. The US, Russia, China and Japan are the world leaders in air pollution emissions. Human wastes have always polluted rivers or water sources to some degree. Water pollutants may consist of a wide range of organic and inorganic chemicals such as heavy metals, petrochemicals, chloroform, and bacteria. Water pollution may also occur in the form of thermal pollution and dissolved oxygen depletion. Soil contamination is an important

Figure 10: Costal Pollution

aspect of environmental pollution; this phenomenon occurs when chemicals are released by spill or underground storage tank leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, MTBE, herbicides, pesticides and chlorinated hydrocarbons.

Recently, a new and very hazardous waste has been showing up in landfills. E-waste is the carcasses of our ever-evolving technical evolution. Due to the extreme rates of obsolescence, E-waste produces much higher volumes of waste in comparison to other consumer goods. Where once consumers purchased a stereo console or television set with the expectation that it would last for a decade or more, the increasingly rapid evolution of technology combined with rapid product obsolescence has effectively rendered everything disposable. Consumers now rarely take broken electronics to a repair shop as replacement is now often easier and cheaper than repair. The average life-span of a computer has shrunk from four or five years to two years. Part of this rapid obsolescence is the result of a rapidly evolving technology. But it is also clear that such obsolescence and the throw-away ethic results in a massive increase in corporate profits, particularly when the electronics industry does not have to bear the financial burden of downstream costs. When discarded computers vanish from desktops around the world, they often end up in Guiyu, China, which may be the electronic-waste capital of the globe. The city is a sprawling computer slaughterhouse. Some sixty thousand laborers toil here at primitive E-waste recycling even as the work imperils their health amid a runoff of toxic metals and acids. Computer carcasses line the streets, awaiting dismemberment. Circuit boards and hard drives lie in huge mounds. At thousands of workshops, laborers shred and grind plastic casings into particles, snip cables and pry chips from circuit boards. Workers pass the boards through red-hot kilns or acid baths to dissolve lead, silver and other metals from the digital detritus. The acrid smell of burning solder and melting plastic fills the air.

The US government doesn't ban, or even monitor, E-waste exports. What's more, the Environmental Protection Agency has no certification process for electronic-waste recyclers. Any company can claim it recycles waste, even if all it does is export it. No effective federal plan exists to maximize recycling and minimize waste even though the federal government took ultimate responsibility for the nation's waste management in The Solid Waste Disposal Act of 1976. The Act requires states to develop and implement plans to maximize recycling and minimize waste, but after twenty-six years, the states have yet to comply and the EPA is not enforcing the Act. Many states point to the lack of a comprehensive federal

waste and recycling plan as the reason for their failure to successfully implement their own plans. Foreign waste imports and US domestic waste exports are virtually uncontrolled under federal law. Since 1997, fifty states imported forty-eight million tons more waste than they exported, according to data in *Biocycle* magazine, an industry publication. Over-population makes waste reduction extremely difficult, if not impossible. Most population experts believe that the ideal population for the US ranges between a hundred and a hundred fifty million people, compared to our current population of three hundred million, which is growing by three million people annually.

Figure 11: Neighborhood Landfill in Water Source

Much of the waste we create comes from our power sources. Essentially, except for geothermal and nuclear power, all other sources of power and energy come from the sun. It is the sun that grows the plants we burn for fuel and eat for food. It is commonly believed that decayed vegetation from giant prehistoric forests formed the subterranean beds of coal, gas, and oil that have fueled the unprecedented growth of the industrial revolution and modern society. When we burn these fuels, we are burning the stored energy of millions of years of ancient sunlight. When these fuels are gone, it will take millions more years for sunlight and plant growth to recreate them (Stein, 2000). After peaking in the mid-1960's, discoveries of new oil fields have dropped to the point where we are now consuming oil six times as fast as we are discovering new reserves. As we begin to draw on the second half of the world's oil reserves, we will see increasing amounts of energy required to extract oil from deposits that are deeper in the ground or harder to refine (Stein, 2000). On the other hand, renewable energy sources are renewed on a daily basis by the

power of the sun or the heat stored within the earth. The great wind and ocean currents swirling around out planet are driven by thermal differences powered by the sun.

Pollution can also be the consequence of a natural disaster. Hurricanes often involve water contamination from sewage, and petrochemical spills from ruptured boats or automobiles. Larger scale and environmental damage is not uncommon when coastal oil rigs or refineries are involved. Some sources of pollution, such as nuclear power plants or oil tankers, can produce widespread and potentially hazardous releases when accidents occur.

One of the greatest problems we will face will be a desperate shortage of water. The Earth is seventy-one percent water, yet only one percent of that is directly accessible potable water. By polluting the environment we require to survive in, we have detrimentally effected our own water and food sources. Even today, one billion seven hundred thousand people - a third of the world's population - live in countries where supplies of potable water are inadequate, and this figure will top five billion in just twenty-five years, triggering water conflicts across much of Asia and Africa. Alongside this, crop yields are forecast to fail in tropical, subtropical, and many mid latitude regions, leading to the expansion of deserts, food shortages, and famine. The struggle for food and water will lead to economic migration on a gigantic scale, dwarfing anything seen today, bringing instability and conflict to many parts of the world (McGuire, 2002).

For mankind, technology is a distinguishing and critical consideration, both as an enabler and an additional source of byproducts. Unfortunately, the technology is not being used to its full ability to battle our ever growing self-pollution predicament.

1.2.2 Nuclear

A nuclear weapon is a weapon which derives its destructive force from nuclear reactions of either nuclear fission or the more powerful fusion. As a result, even a nuclear weapon with a relatively small yield is significantly more powerful than the largest conventional explosives. A single weapon is capable of destroying or seriously disabling an entire city. When discussing nuclear weapons, analysis can be divided into two subgroups. The first, a limited nuclear war that consists of only the use of a small number of weapons in a tactical exchange aimed primarily at the opposing military forces. The second type is a full-

scale nuclear war, that consists of large numbers of weapons used in an attack aimed at an entire country, including both military and civilian targets. A nuclear war, unlike a conventional war, causes widespread destruction at a large scale and has long-term globally damaging effects. It has been proposed that a full-scale nuclear war could cause permanent damage to most complex life on the planet, effect global climate patterns and, bring about the extinction of the human race. It has been said that nine Americans out of every ten could perish in an all-out nuclear attack against the United States. Not all of these would die instantly; many deaths would be delayed for hours, days or weeks before injuries, severe burns and radiation sickness took their toll. In the following months epidemics of disease, worsened by an almost lack of medical facilities, starvation and the breakdown of law and order could kill yet more citizens (Goodwin, 1981).

In the history of warfare, nuclear weapons have been used only twice, both during the closing days of World War II. The first event occurred on the morning of August 6, 1945, when the United States dropped a uranium gun-type device code-named "Little Boy" on the Japanese city of Hiroshima. The second event occurred three days later when a plutonium implosion-type device code-named "Fat Man" was dropped on the city of Nagasaki. The use of these weapons, which resulted in the immediate deaths of around a hundred thousand to two hundred thousand individuals and even more over time, was and remains controversial. Critics charged that they were unnecessary acts of mass killing, while others claimed that they ultimately reduced casualties on both sides by hastening the end of the war (Goodwin, 1981). Since that time, nuclear weapons have been detonated on over two thousand occasions for testing and demonstration purposes. The nuclear bomb dropped on Hiroshima, twelve and a half kiloton, would be considered small on today's standard. Many of today's are one megaton, eighty times as powerful and still there are many that are much larger than that.

The thought of nuclear warfare is a very frightening one for all of us, and even more frightening is the thought of how exposure to nuclear detonation can affect our health, assuming of course, that it doesn't kill us outright. The effects can be spread far and wide, and can continue to affect us and our families for generations. The obvious risk from exposure to nuclear warfare is immediate death. This can occur due to the blast from the explosion, from flying debris, from burning, and from instant vaporization due to gamma rays. The blast from a nuclear explosion can cause injury and death, and the nearer you are to the blast the

higher the risk. When dealing with the initial blast, you would need to shield yourself from the force of the explosion as well as from the heat and radiation that is being emitted. Once the initial explosion is over, you will need to be prepared for nuclear fallout where the wind carries the radioactive materials through the air. This means that very large areas could become contaminated. You will need to find shelter that is as far as possible from the blast and also look for shelter that is upwind from the blast. You may need to stay away for a long period of time depending on the extent and severity of the contamination. Two weeks is the minimum length of time to stay in the shelter before emerging to survey the damage. Shelters can be effective and could save lives but there are problems. Obviously you would have to be inside the shelter if it were to be of any use, and this could prove difficult if there were no more than a few minutes warning of nuclear attack. Secondly, a shelter could only protect you for a limited time: the usual recommended shelter period is two weeks. If the wind has accumulated more fallout around your shelter, the length of time will have to be extended. Unfortunately many of the problems which would probably arise in the aftermath of a nuclear strike might be even more severe after two weeks than immediately after the attack (Goodwin, 1981). If you need to exit the shelter for any reason, when you return, contain all clothes in a garbage bag until they can be destroyed and wash the entire body. Also, you should expect no medical help because the sheer magnitude of the crisis would indeed overwhelm organized emergency services. Your shelter could become your coffin if you wait around to be saved (Goodwin, 1981). If you aren't demoralized yet, after a nuclear attack, short wave radio transmissions might not reach you for many hours because of temporary changes in

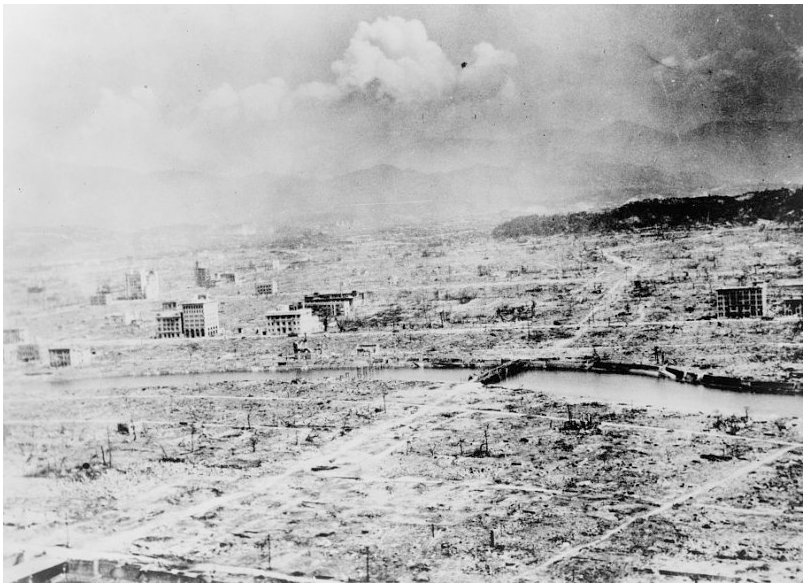


Figure 12: Hiroshima, Japan 1945

the ionosphere caused by the nuclear explosions. The final outcome of the attack would be unknown: Did we win or lose? Are there enemy troops coming? Is the nuclear bombardment over (Goodwin, 1981)?

With the increased threat of terrorist attacks coupled with the advancement of technology, the prospect of a nuclear attack is becoming a more realistic and frightening prospect to millions of people around the world. Many more people have therefore started to formulate plans and procedures to protect themselves and their families in the event that there is an attack. It is important for everyone to be prepared for a nuclear attack, however unlikely that prospect might seem. The simple fact of the matter is that nobody knows what dangers lurk around the corner, and if there is an attack you need to know what to do to minimize on the risks. The government and official agencies have their own procedures in the case of emergencies such as this; however, it will be each person's responsibility to know what to do and to help themselves and one another.

Another type of nuclear based disaster, just as detrimental as a localized limited nuclear attack, is an accident at a nuclear power station or in the transportation of nuclear material. According to the World Nuclear Association, about twenty million packages of all sizes containing radioactive materials are routinely transported worldwide annually on public roads, railways and ships in secure containers (Liebsh, 2005). The most immediate danger from an nuclear accident is localized exposure to high levels of radiation. However, winds and weather could possibly impact people up to two hundred miles away from the accident site (Liebsh, 2005).

The World Nuclear Association reports as of January 2005 there are four hundred thirty-nine nuclear power reactors in thirty countries with one hundred thirty-six more reactors under construction or planned. The US has over a hundred commercial power plants across the country and Canada has twenty power stations, meaning millions of US citizens live within ten miles of an operating reactor (Liebsh, 2005). Even though governments and associations monitor and regulate construction and operation of plants, accidents are possible and do happen. An accident could result in dangerous levels of radiation that could affect the health and safety of the public living near a nuclear reactor power plant, as well as people up to two hundred miles away depending on winds and weather - so tens of millions of North Americans could potentially be affected (Liebsh, 2005).

The Chernobyl disaster occurred on April 26, 1986 at the Chernobyl nuclear power plant in Pripyat, Ukraine and is regarded as the worst accident in the history of nuclear power. There was no containment building in place to control the plume of radioactive fallout that drifted from the collapsed reactor over parts of the western Soviet Union, Europe, Scandinavia, the British Isles, and North America. Large areas of Ukraine, Belarus, and Russia were badly contaminated, resulting in the evacuation and resettlement of over three hundred thousand people. About sixty percent of the radioactive fallout landed in Belarus. According to a report, half of the radioactive fallout landed outside the three Soviet republics. The disaster released as much as three hundred times more radioactive fallout than the atomic bomb of Hiroshima (Liebsh, 2005). The accident raised concerns about the safety of the Soviet nuclear power industry, slowing its expansion for a number of years, while forcing the Soviet government to become less secretive. The now-independent countries of Russia, Ukraine, and Belarus have been burdened with continuing and substantial decontamination and health care costs of the Chernobyl accident (Halpern, 1998). It is difficult to accurately tally the number of deaths caused by the events at Chernobyl, as Soviet-era cover-up made it difficult to track down victims. Most of the expected long-term fatalities, especially those from cancer, have not yet actually occurred, and will be difficult to attribute specifically to the accident. A 2005 report prepared by the Chernobyl Forum, led by the International Atomic Energy Agency (IAEA) and World Health Organization (WHO), attributed fifty-six direct deaths (forty-seven accident workers, and nine children with thyroid cancer), and estimated that as many as nine thousand people, among the approximately 6.6 million most highly exposed, may die from some form of cancer (Halpern, 1998).

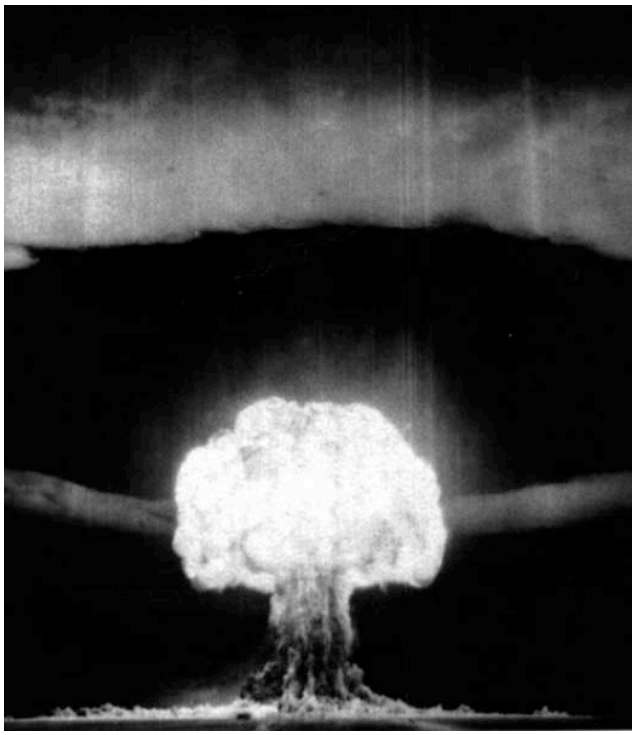


Figure 13: Atomic Weapon Testing

According to official estimates, about ninety-five percent of the fuel, about one hundred eighty tons, in the reactor at the time of the accident remains inside the shelter, with a total radioactivity of nearly eighteen million curies. The radioactive material consists of core fragments, dust, and lava-like "fuel-containing materials" (FCM) that flowed through the wrecked reactor building before hardening into a ceramic form. By conservative estimates, there are at least four tons of radioactive dust inside the shelter (Liebsh, 2005).

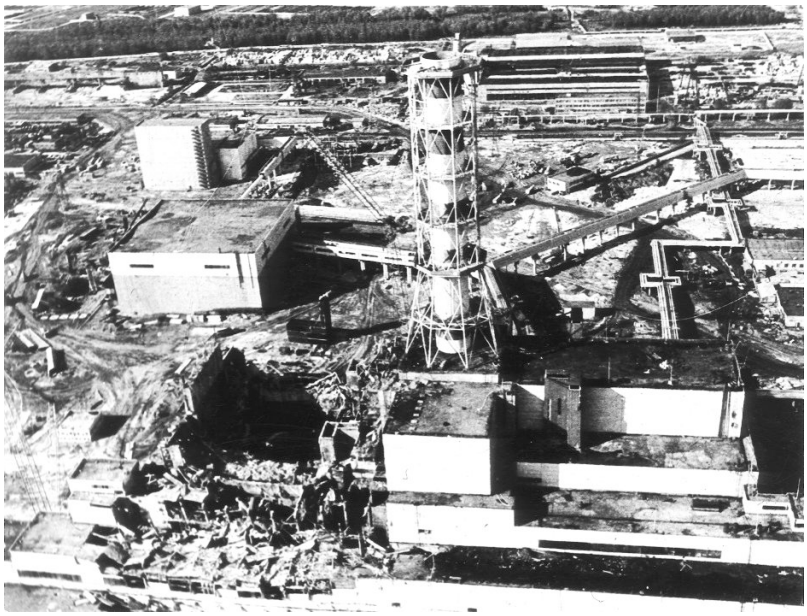


Figure 14: Chernobyl Nuclear Power Plant Disaster, 1986

After the disaster, a sarcophagus was constructed around the reactor and surrounding debris. The sarcophagus is not an effective permanent enclosure for the destroyed reactor. Its hasty construction, in many cases conducted remotely with industrial robots, is aging badly. Water is leaking into the shelter, spreading radioactive materials throughout the wrecked reactor building and potentially into the surrounding groundwater (Halpern, 1998). The basement of the reactor building is slowly filling with water that is contaminated with nuclear fuel and is considered high-level radioactive waste. Though repairs were undertaken to fix some of the most gaping holes that had formed in the roof, it is by no means watertight, and will only continue to deteriorate. The sarcophagus is so badly damaged that a small earthquake or severe wind could cause the roof to collapse (Halpern, 1998). If it collapses another cloud of radioactive dust could be released.

With the end of the Cold War and the collapse of the Soviet Union, conflict between the United States and Russia appears much less likely. Stockpiles of nuclear warheads are being reduced on both sides and tensions between the two countries have greatly reduced. The concerns of political strategists have now

shifted to other areas of the world. Current fears of nuclear war are mainly centered around India, Pakistan, China, North Korea, and Iran. There are currently only seven countries that have successfully exploded nuclear weapons. Five are considered to be "nuclear weapons states," an internationally recognized status conferred by the Nuclear Non-Proliferation Treaty (NPT). In order of acquisition of nuclear weapons these are the United States of America, Russia, the United Kingdom, France, and the China. Since the formulation of the NPT, two non-signatory states of the NPT have conducted nuclear tests: India and Pakistan. Israel is also strongly suspected to have an arsenal of nuclear weapons though it has never confirmed or denied this, and there have been reports that over a hundred nuclear weapons might be in its inventory. This status is not formally recognized by international bodies; none of these three countries is currently a signatory to the Nuclear Non-Proliferation Treaty (www.cnn.com). North Korea has publicly declared itself to possess nuclear weapons though it has not conducted any confirmed tests and its ultimate status is still unknown. Iran has been accused by Western nations of attempting to develop uranium enrichment technology for weapons purposes.

The size and composition of India's nuclear arsenal is difficult to determine because all of its delivery systems can carry both nuclear and conventional warheads. The dual capability of its nuclear-capable systems has significant implications for crisis stability on the subcontinent. In a war, especially in the opening stages, the launch of Indian ballistic missiles with conventional warheads could easily be mistaken for a nuclear strike and trigger nuclear attack. Inaccurate or exaggerated claims by government and industry officials combined with unsubstantiated rumors in the media and expert community about weapon systems' capabilities contribute to uncertainty about India's nuclear forces. The 2005 Defense Ministry annual report states that India's nuclear doctrine is "based on the principle of a minimum credible deterrent and no-first-use as opposed to doctrines or postures of launch-on-warning." It is estimated that India currently has a stockpile of approximately forty to fifty assembled nuclear warheads, but this number is likely to increase over the next decade. An unnamed Defense Ministry source told Defense News in late 2004 that in the next five to seven years India will have three hundred to four hundred nuclear and thermonuclear weapons distributed to air, sea, and land forces. Over the next decade, according to Defense Ministry sources cited in Defense News, India expects to spend two billion dollars a year to create a Strategic Forces Command infrastructure.

On February 10, 2005, North Korea announced for the first time that it possesses nuclear weapons. The claim grabbed headlines, but it is difficult to substantiate. In the early 1990s, the CIA, Central Intelligence Agency, concluded that North Korea had effectively joined the nuclear club by building one or possibly two weapons from plutonium it produced before 1992. As of now, North Korea has never conducted a nuclear test, and although it has extracted weapon-grade plutonium, it has never conclusively demonstrated that it possesses operational nuclear warheads. It is known, however, that Pyongyang has a nuclear program. By cataloging the program's capabilities and quantity of separated plutonium, it is possible to estimate how many nuclear weapons they might have (www.cnn.com). North Korea's probable possession of nuclear weapons presents a serious and extremely complicated problem, with implications that could drastically affect Asian security and, by extension, US interests as well. By violating the Nuclear Non-Proliferation Treaty (NPT), North Korea has weakened the treaty and sent signals that obtaining nuclear weapons has geopolitical benefits, at least when confronting the United States. A document leaked in March 2001 showed that the US Government was willing to use nuclear weapons against North Korea and so the North Koreans argue that a nuclear weapons program is no more than a valuable deterrent against aggression by the US. Pyongyang started its program in the 1960s with Soviet assistance, and over the next two decades China provided various kinds of support (Tiernay, 2001). In 1986, the North began operating a newly constructed twenty megawatt thermal (MWt) reactor near the city of Yongbyon--a major milestone. More recently, Pakistan has played a substantial role in the progress of North Korea's nuclear program. In the second half of the 1990s, Abdul Qadeer Khan, scientist and "father" of Pakistan's nuclear program, supplied uranium enrichment equipment and perhaps even warhead designs to North Korea, according to some news reports (www.cnn.com).

On April 11, 2006, Iranian President Mahmoud Ahmadinejad announced Iranian scientists working at the facility at Natanz had successfully enriched uranium. In a televised address from the city of Mashhad, Mahhmoud said, "I am officially announcing that Iran has joined the group of those countries which have nuclear technology" (www.cnn.com). Originally started under the Shah of Iran in the 1950s, with the help of the United States, the Iranian nuclear program is an effort by Iran to develop nuclear technology. After the 1979 revolution, the program was temporarily disbanded. It was soon resumed, albeit with less Western assistance than the pre-revolution era. Iran's current nuclear program consists of several re-

search sites, a uranium mine, a nuclear reactor, and uranium processing facilities that include a uranium enrichment plant. The Iranian government asserts the program's only goal is to develop the capacity for peaceful nuclear power generation. The new discoveries could destabilize a region already dangerously on edge in anticipation of war in Iraq. Israel — which destroyed an Iraqi nuclear plant in Osirak in a 1981 raid — is deeply alarmed by the developments. "It's a huge concern," says one Israeli official. "Iran is a regime that denies Israel's right to exist in any borders and is a principal sponsor of Hezbollah. If that regime were able to achieve a nuclear potential it would be extremely dangerous." Israel will not take the "Osirak option" off the table, the official says, but "would prefer that this issue be solved in other ways" (www.cnn.com).

It is evident that Iran's efforts are focused both on uranium enrichment and a parallel plutonium effort. Iran claims it is trying to establish a complete nuclear fuel cycle to support a civilian energy program, but this same fuel cycle would be applicable to a nuclear weapons development program. Iran appears to have spread their nuclear activities around a number of sites to reduce the risk of detection or attack. Iran does not currently have nuclear weapons, and would appear to be about two years away from acquiring nuclear weapons. By some time in 2006, however, Iran could be producing fissile material for atomic bombs using both uranium enriched at Natanz and plutonium produced at Arak. The Natanz facility might produce enough uranium for about five bombs every year, and the Arak facility might produced enough plutonium for as many as three bombs every year. If Iran did acquire atomic bombs, it would put pressure on other countries in the region do the same. Many Arab countries believe it is unfair that Israel has nuclear weapons. If Arab countries, notably Saudi Arabia but also Egypt and possibly Syria, found themselves caught between a nuclear-armed Israel and a nuclear-armed Iran, it would greatly increase pressures to pursue their own nuclear options (www.armageddononline.net). This could result in a regional arms race in the Middle East which is likely to be quite destabilizing, given the number and intensity of conflicts and instabilities in the region. In fact, the world does well to remember that most Middle East weapons programs began as a response to Israel's development of nuclear weapons. That program started in the early 1950s — and had secretly yielded a bomb by 1968 (www.en.wikipedia.org).

Israel, whose nuclear capability is arguably the most secretive weapons of mass destruction program in the world, is widely believed to possess a substantial arsenal of between a hundred and two hun-

dred nuclear weapons and the intermediate-range ballistic missiles to deliver them. There is also heavy speculation that Israel may have chemical and biological weapons programs as well (www.cnn.com). The Israeli nuclear weapons program grew out of the conviction that the Holocaust justified any measures Israel took to ensure its survival. Consequently, Israel has been actively investigating the nuclear option from its earliest days. Interestingly though, there is no evidence that Israel has ever carried out a nuclear test; how-

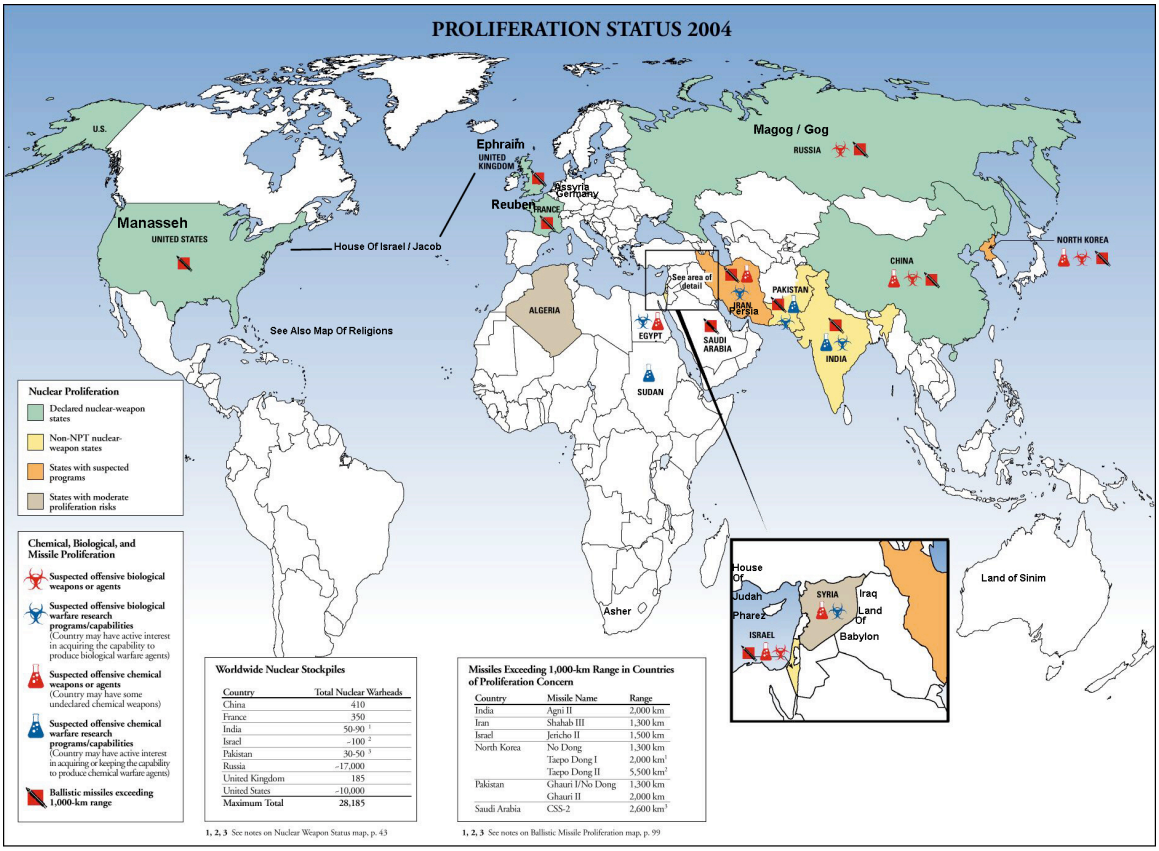


Figure 15: Proliferation of Weapons of Mass Destruction, 2004

ever, there is substantial speculation that a suspected nuclear explosion in the southern Indian Ocean in 1979 was a joint Israeli-South African test. Post-segregated South Africa has since dismantled its nuclear weapons program (www.en.wikipedia.org). Unlike Iran and North Korea - two countries whose alleged nuclear ambitions have recently come to the fore - Israel has never signed the Nuclear Non-Proliferation Treaty, designed to prevent the global spread of nuclear weapons. As a result, it is not subject to inspec-

tions and the threat of sanctions by the United Nations nuclear watchdog, the International Atomic Energy Agency (www.cnn.com).

Newly available information on the Chinese nuclear arsenal requires us to reassess our previous estimate of Beijing's stockpile. In 2005, the Defense Department published a detailed breakdown of the Chinese missile force. Taken together with a vague 2004 Chinese Foreign Ministry declaration about the size of the Chinese nuclear arsenal and other information, it is estimated that China deploys approximately one hundred thirty nuclear warheads for delivery by land- and sea-based missiles, and bombers. Additional warheads are thought to be in storage for a total stockpile of approximately two hundred warheads (www.en.wikipedia.org). China continues to modernize its nuclear forces, though its recent developments are less dramatic than many analyses have suggested. There continues to be a number of substantial unknowns about the composition of China's future forces, including if and how it will respond to the U.S. deployment of a ballistic missile defense system.

Russia is continuing to transition from its Cold War nuclear stockpile, further reducing its total nuclear forces in 2005 but also announcing plans for new weapon systems and upgrades of existing ones. The Russian government appears to be attempting to reassert its nuclear strength after years of decline in order to underscore its status as a powerful nation (www.armageddononline.net). To this end, President Vladimir Putin said Russia has reinstated large-scale military exercises, and military officials made several statements about the role of Russia's nuclear posture. It is estimated that as of early 2006, based on the best available data, that the current stockpile of intact warheads is around sixteen thousand, with approximately five thousand eight hundred operational nuclear warheads in its active arsenal. This includes about three thousand five hundred strategic warheads, a decrease of some three hundred from last year's level due to the withdrawal of approximately thirty-six intercontinental ballistic missiles (ICBMs) from operational service (www.cnn.com). Estimating the size, composition, and status of the total Russian nuclear stockpile has always been difficult due to the lack of official information. Some may be officially retired and awaiting disassembly; others may be in short- or long-term storage, similar to the US categories (www.cnn.com).

Since the end of the Cold War, the United States continues to spend billions of dollars annually to maintain and upgrade its nuclear forces (www.cnn.com). It is deploying a larger and more accurate preemptive nuclear strike capability in the Asia-Pacific region, and shifting its doctrine toward targeting US strate-

gic nuclear forces against "weapons of mass destruction" complexes and command centers. As of January 2006, the US stockpile contains almost ten thousand nuclear warheads. This includes five thousand seven hundred thirty-five active or operational warheads (five thousand two hundred thirty-five strategic and five hundred non-strategic warheads). Approximately four thousand two hundred twenty-five additional warheads are held in the reserve or inactive stockpiles (www.armageddononline.net).

France currently has two nuclear weapons systems: submarine-launched ballistic missiles and medium-range air-to-surface missiles (www.armageddononline.net). Though France is a signatory to the Nuclear Non-Proliferation Treaty and is bound by Article VI's goal of nuclear disarmament, it shows no signs of giving up its remaining arsenal. Instead, it is making plans to develop, procure, and deploy new nuclear weapons, and to maintain its existing arsenal without nuclear testing for years to come. French President Jacques Chirac set out his country's nuclear plans in February 1996 when he announced broad military reforms for 1997-2002. The plans called for consolidating French nuclear forces on fewer platforms and developing a new generation of nuclear weapons (www.cnn.com). During a visit to Moscow on September 26, 1997, Chirac confirmed that none of France's nuclear weapons remained aimed at designated targets. Chirac and the government presented a new five-year military plan on September 11, 2002. Adopted on January 27, 2003, the plan, for the most part, continues to fund programs first presented in 1996. France's 2005 budget authorizes about four billion dollars for nuclear weapons, with about two and a half billion dollars of the total going toward the submarine program (www.cnn.com).

Since Britain withdrew its last WE177 gravity bomb from service in March 1998, it has relied on a single nuclear weapon system, its fleet of nuclear-powered ballistic missile submarines. Though the fleet is expected to be in operation until 2020 or beyond, attention is now turning to the question of whether Britain requires a new generation of nuclear weapons (www.cnn.com). The debate is in its early stages, but it has already proved contentious. Just before he died, Robin Cook, the former foreign secretary, called upon Prime Minister Tony Blair to "break from the past" and make "the case that nuclear weapons now have no relevance to Britain's defenses in the modern world." It is suspected by some that Blair has already secretly decided to build a new generation of nuclear weapons to replace the aging Trident system (www.en.wikipedia.org). The debate is unfolding against the backdrop of global concerns about nonprolif-

eration, especially in Iran and North Korea, and about Britain's long-standing nuclear "special relationship" with the United States.

1.2.3 Terrorism

The term "terrorism" comes from the French word terrorisme, which is based on the Latin verb terrere, to frighten. Terrorism is not new, and even though it has been used since the beginning of recorded history, it can be relatively hard to define. Terrorism refers to a strategy of using political violence, social threats or coordinated attacks closely related with unconventional warfare in manner of conduct and operation. Terrorism has been described variously as both a tactic and strategy; a crime and a holy duty; a justified reaction to oppression and an inexcusable abomination. Obviously, a lot depends on whose point of view is being represented. Terrorism is a method of waging war used by those who are militarily weak or wish to hide their real agendas. The goal of terrorism is to make everyone feel vulnerable every moment and, therefore, capitulate to the terrorists in order to have “peace” or safety (Spigarelli, 2002). Theses organizations tend to have power with many of the advantages of military force at a fraction of the cost. Due to the secretive nature and small size of terrorist organizations, they often offer opponents no clear organization to defend against or to deter. Those accused of being terrorists rarely identify themselves as such, and instead typically use terms that refer to their ideological or ethnic struggle, such as separatist, freedom fighter, liberator, revolutionary, vigilante, militant, paramilitary, guerrilla, rebel, jihadi or mujaheddin (one engaged in holy war), or fedayeen (prepared for martyrdom) (Spigarelli, 2002).

Terror events have become a major part of daily life throughout the world and because of their uncertainty they are the most difficult hazards to prepare for.

First it must be said that the real terror of any terrorist attack lies not in the act itself but the way in which the act is disseminated through culture behind the mask of “informing the public” of the incident. The amount of people actually terrorized by the act itself is always invariably smaller than those terrorized by the coverage of the act. With close to four hundred known world-wide terror organizations; the world population are becoming apprehensive about the possibility of it happening “close to home.” Much of the

nervousness stems from the unlimited tools that terrorists can use to cause panic. Anything from small conventional weapons, vehicles, chemical, biological or even small nuclear devises can be employed. The threat of marginalized terrorist organizations using nuclear, chemical, and biological weapons, especially very small ones, such as suitcase nukes, has been a threat in American rhetoric and culture since at least the 1970s. According to the International Atomic Energy Agency, there have been over six hundred fifty confirmed incidents of illicit trafficking in nuclear and radioactive materials worldwide since 1993. Nearly a hundred such incidents occurred in 2004 alone, eleven of which involved nuclear material (Liebsh, 2005). Recently, there have been reports from the US Department of Defense and the CIA that thirty-six nations possess and are further developing chemical agents for weaponization and at least ten countries possess and are researching biological agents. Using such a weapon as a foundation, a terrorist might even create a dirty bomb. These are salted bombs capable of dispersing radioactive contamination over a large area, killing a greater number of people than the explosion itself (Goodwin, 1981).

Devastating acts, such as the terrorist attacks on the World Trade Center, have left many concerned about the possibility of future incidents in the United States and their potential impact. They have raised uncertainty about what might happen next, increasing stress levels. All of a sudden America went from being the invincible to a nation where we could be attacked anywhere, at any time, by anyone. Within this new world of constant media-covered terrorism it is expected to turn on the news and hear about the daily terror attacks.

The first World Trade Center bombing was February 26, 1993. A car bomb was planted by an Islamist terrorist group, al-Qaeda, in the underground parking garage below Tower One. It killed six and injured over a thousand. The goal of the attack was to devastate the foundation of the north tower in such a way in that it would collapse onto its twin. Thankfully, the towers were not destroyed. The bomb cut off the center's main electrical power line and telephone service for much of lower Manhattan. The bomb caused smoke to rise up to the ninety-third floor of both towers and cut off the towers' four stairwells and emergency lighting system. Also, as a result of the loss of electricity, most of New York City's radio and television stations lost their over-the-air broadcast signal for almost a week. Despite its relatively low death toll, the bombing shocked the American public. Only once before the 1993 attack had the FBI recorded a bomb of that force to have been used.

Figure 16: World Trade Center, Ground Zero, 2001

The second WTC assault happened on September 11, 2001. These were a series of coordinated terrorist attacks upon the United States of America, allegedly by nineteen men affiliated with al-Qaeda that hijacked four commercial passenger jet airliners (www.cnn.com). The attackers crashed two planes into the Twin Towers of the World Trade Center in New York City, one plane into each tower, causing the collapse of both towers within two hours. Hijackers of the third aircraft crashed that plane into the Pentagon in Arlington County, Virginia. Passengers on the fourth hijacked aircraft attempted to retake control of their plane from the hijackers, which crashed into a field in rural Somerset County, Pennsylvania. Approximately three thousand people died in these attack (www.en.wikipedia.org). Affected property owners and their insurers incurred billions of dollars in damages.

In the aftermath of the attacks, many U.S. citizens held the view that these events had "changed the world forever," that the United States was now vulnerable to terrorist attacks in ways it had not been previously. The Bush administration declared a war on terrorism, with the stated goals of bringing Osama bin Laden and al-Qaeda to justice and preventing the emergence of other terrorist networks. These goals would be accomplished by means including economic and military sanctions against states perceived as harboring terrorists and increasing global surveillance and intelligence sharing (www.cnn.com).

Terrorism erodes—at both the individual level and the community level—the sense of security and safety people usually feel. Terrorism challenges the natural need of humans to see the world as predictable, orderly, and controllable. Research has shown that deliberate violence creates mental-health effects that have longer average durations than those from natural disasters or accidents. The consequences for both

individuals and the community are prolonged, and survivors often feel that injustice has been done to them. This can lead to anger, frustration, helplessness, fear, and a desire for revenge (Hamblen, 2005).

1.3 Reaction + Preparedness

A disaster is the impact of a natural or man-made hazard that negatively effects society and/or the environment. Disasters by nature have a spatial as well as a temporal dimension and occur defined their vulnerable locations. A disaster's four temporal stages are the pre-impact/hazard mitigation stage, the immediate relief phase (which could last two to three weeks from time of impact), the rehabilitation stage (which can last last up to six months), and the reconstruction period (that could last as long as three years). Disasters vary in frequency and regularity, as well as in the extent to which they are accompanied by environmental cues. These attributes have been found to have important consequences for both emergency preparedness and response. The regularity and speed of onset affect the ability to forecast the location and timing of a disaster's impact, making it possible to issue warnings to the public and to increase response capability. Forewarning also allows threatened communities to engage in expedient mitigation actions, such as boarding up windows and tying down objects. We would expect response activities, therefore, to be more effective and losses to be lower in disasters for which warning is possible (Tiernay, 2001). The amount of time to evacuate obviously depends on the type of disaster. Hurricanes can be tracked and allow a day or two notice to get ready, but many types of disasters happen without much notice. Disasters can happen anytime and anywhere and when disaster strikes, you may not have much time to respond. Many times services may be cut off or first responders can't reach people right away. Would you and your family be prepared to cope until help arrives?

By looking at the size of an effected area, a distinction can be made between disasters that result in relatively localized areas of severe damage and disruption and those in which impacts are spread over a wide geographic area (Tiernay, 2001). At one extreme are disasters, such as the Oklahoma City bombing, in which severe-damage was concentrated among a few city blocks. At the other end are events like the record flooding that struck the Midwest in 1993, in which nine states were inundated. One way to describe the geography of a disaster event is through a series of concentric zones. At the center is an area of very

severe impact, which is surrounded by a fringe area in which there is also significant damage and disruption. Aid passes through adjacent filter zones in order to reach the hardest hit areas, and more distant community and regional aid zones that are not directly affected by the disaster act as suppliers of resources. But, when a major disaster occurs, it threatens the potential collapse of the interconnected socio-technical system that provides technical, social, economic, and cultural services to a specific region or community. The disaster threatens not only the destruction of technical infrastructure such as power lines, roads, and communication lines but also the social, organizational, and economic structures that support the daily operations of the community (Comfort, 2004). The socio-technical infrastructure in most communities is not a robust system but rather a fragile, interdependent system that is sensitive to shocks and disruptions. In such systems, disruption triggers unexpected consequences and cascading failure.

The first of four phases is the hazard mitigation phase: it involves actions taken before a disaster to decrease vulnerability, primarily through measures that reduce casualties and provide passive protection from damage during the impact. The major dilemma is that effective preparation has rarely been a part of disaster relief activities. Mitigation measures can include government dictated land-use regulations that reduce hazards, such as wind, water, or seismic forces (Tiernay, 2001). This pre-disaster period should include preparing for possible instabilities and failures in technology and the central services that we have come to rely on for our daily sustenance and commerce. Preparedness also aims at ensuring that resources necessary to carrying out an effective response are in place prior to the onset of disaster or that they can be obtained promptly when needed (Stein, 2000). For communities, preparedness encompasses a wide range of activities. These include formulating disaster plans; providing training for disaster responders and the general public to improve their understanding of what to do in a disaster as well as their performance of disaster-related tasks; and conducting emergency response drills and exercises. Other preparedness activities include acquiring equipment, facilities, and other material resources that will enable an effective response when a disaster strikes and carrying out actions aimed at increasing public hazard awareness.

Disasters tend to be portrayed both as societal abnormalities and as discrete events, without reference to the larger societal context. The overall message is that since disasters are unfortunate, if inevitable acts of nature, perhaps the best we can do is cope with them, clean up, provide relief and go on. Society tends to have a short attention span; when the emergency periods ends, so does the public's interest - until

the cycle resumes with the next disaster (Tiernay, 2001). Another way human development helps to produce disastrous consequences is by compromising the ability of the natural environment to contain the effects triggering events. An example is the extensive networks of roadways and other paved surfaces and dense concentrations of buildings that characterize today's built environment undermine the land's capacity to absorb flooding. Over more, the walls, levees, and other public works that make up modern flood control systems only set the stage for larger future flood losses (Tiernay, 2001).

Disasters disrupt the social order but they do not obliterate it.

In addition to differences in levels of awareness, rates of adoption for different preparedness measures are also likely to be influenced by the time, expense, and effort involved in adoption, as well as to the extent to which measures are seen as serving multiple uses. Research has suggested the importance of four attributes: awareness, perceived effectiveness, cost/effort, and the knowledge required to implement the measure. Other influential factors may include whether a particular protective measure is mandatory or voluntary, whether it can be done by the average lay-person or needs to be carried out by a professional, and whether it can be performed on a one-time basis or needs to be carried out repeatedly (Tiernay, 2001). In conjunction with the protective measures, research literature suggests that prior experience engenders higher levels of preparedness and more effective performance during the response period, largely because it leads to greater awareness of the consequences of disasters and the demands that disasters generate. Evidently, adaption and learning take place as a result of involvement in disaster situations, so that threats are taken more seriously and necessary tasks and activities are carried out more effectively in subsequent crises (Tiernay, 2001).

As expected, culture plays a huge role in the consistent use and rate of adoption for preparedness activities and products. The concept of culture encompasses the values, beliefs, assumptions about the world, and distinctive behavioral practices that groups and societies share. Important cultural elements are generally reflected both formally, in laws and regulations, and informally, in customs and the behavioral expectations held by members of a society or group. Cultural expectations and practices inform hazard-related behaviors and practices just as they do other aspects of social life. Cultures differ, for example, in ideas about risk-taking, individual versus collective responsibility for loss reduction, notions about the rela-

tionship between human beings and nature, and ideas about people's rights and ethical responsibilities in situations involving risk (Tiernay, 2001).

The immediate relief period consists of actions taken during and soon after the disaster impact to reduce casualties, damage, and disruption and to respond to the immediate needs of disaster victims. These measures include detecting threats, disseminating warnings, evacuating threatened population, searching for and rescuing trapped disaster victims, providing emergency medical care, taking action to contain ongoing threats, and providing emergency food and shelter (Tiernay, 2001). This is the phase focused on within this thesis document.

We need to be aware of the fact that we are all occupants of a fragile planetary ecosystem that is showing severe signs of strain from expanding global population and the business-as-usual ideal of continuously increasing consumption.

The post-disaster recovery phase comprises actions taken during the reconstruction period to repair, rebuild, and reconstruct damaged properties and to restore disrupted community social routines and economic activities. Recovery activities typically center on the provision of aid for temporary housing and residential reconstruction, the restoration and reconstruction of public infrastructure and facilities, and the provision of assistance to households and business that experienced physical damage and other losses. They also aim at reversing whatever negative effects a disaster may have had on the quality of life in an affected community and on the psychosocial well-being of victims. Depending on the severity of the disaster, recovery may take weeks, months, or years. The recovery period is typically also a time in which new mitigative activities are undertaken or at least considered, marking the beginning of another phase in the cycle (Tiernay, 2001).

Disasters have been and will continue to be regular features in human history and our understanding of both our physical environment and the ways in which environment and society interact remains incomplete. For the foreseeable future, we will be living with the consequences of having steadily, if unintentionally created vulnerable communities by placing them in harm's way. While taking every opportunity to reduce this vulnerability, US society must still be ready to respond when disasters strike, as it inevitably will. However, if as a society, we succeed in bringing about fundamental changes in the manner in which hazards are perceived and managed, we can all face the unexpected with greater confidence.

1.3.1 Government

United States disaster research originated in questions that the US military had about maintaining social order in wartime situations - for example, whether community residents would panic when faced with a potential or actual nuclear attack. The focus of that research was on disaster events and their immediate consequences, and the primary interest was in practical and applied issues, not necessarily in theorizing about the social origins of disasters (Tiernay, 2001). It is clearly incorrect to view states merely as a "pass through" for federal assistance in disasters or as unimportant players in the management of hazards. States can take an active or passive role in promoting preparedness and response, and what they do undoubtedly makes a difference at the local level. However, without research that takes an in-depth look at what states are actually doing, researchers can conclude little about their role in the preparedness process (Tiernay, 2001). States possess broad authorities and play a key role in emergency preparedness and response, both supporting local jurisdictions and coordinating with the federal government on a wide range of disaster-related tasks. Federal resources cannot be mobilized in a disaster situation without a formal request from the governor, and states have a number of their own resources at their disposal for use in emergencies, including the personnel and resources of the National Guard. States are also required to develop their own disaster plans, and they typically also play role in training local emergency responders. States have significant responsibilities for environmental protection and the delivery and the delivery of emergency medical services, and state emergency management duties have broadened in recent years as a result, which required states to coordinate the chemical emergency preparedness activities (Tiernay, 2001).

As a culture, we seem more focused than ever before on disasters. The daily news contains a steady stream of stories about how communities across the country are coping with the latest flood, tornado, wild fire, or chemical release. These accounts invariably focus on the steps taken by official agencies to manage disaster impacts and on stories of individual heroism and courage.

US society has followed the practice of "fix upon failure," mobilizing massively when disaster strikes, providing material aid to victims, and then restoring damaged communities as rapidly as possible, even if it meant providing little protection against future damage. The nation's alarming expanding expenditures on disaster response and post-disaster aid are one indication of the extent to which this society deals

with disasters in a reactive and event-focused, rather than a proactive and comprehensive, fashion (Tiernay, 2001). The response-driven, technological image of hazard management obscures other more viable strategies that would focus on reducing risk rather than dealing with the consequences of ignoring it. In keeping with the theme of the assessment, it's possible to use the term "sustainable hazard and disaster management" to describe these strategies (Tiernay, 2001). The overall goals of sustainable hazard and disaster management are to reduce physical, social, and economic vulnerability and to facilitate the effective provision of shorter emergency assistance and longer-term recovery aid.

A major problem with the way in which the First World countries deals with disasters is by using the newest technologies to protect its citizens from nature's power. Our over-reliance on new technologies may actually undermine the ability of our governments to learn from their own mistakes in disaster management. Recognizing the management of hazards is fundamentally social in nature and not something that can be achieved strictly through technological upgrading (Tiernay, 2001). The technologies that are available to societies, communities, public and private organizations, households, and other social units clearly have a major impact on the ways in which disasters are managed. Disasters are generally not a high priority for most governmental units, and disaster-related needs rarely receive the resources they warrant. Merely providing technology will not change that situation (Tiernay, 2001). In our fascination with the promise of technology, we should not lose sight of the fact that many proven ways of dealing with disaster-related problems are and will remain decidedly low-tech. The notion that technology will save us is as invalid for hazard management as it is for everyday social life in general. More importantly, since many disasters can render useless the very technologies on which our society has come to rely, we should avoid being overconfident that those technologies will be there when we need them. Indeed, as devastating disasters like Hurricane Andrew have illustrated, disaster can often involve the extended loss of even the most taken-for-granted daily needs, such as televisions, electricity, and air conditioning (Tiernay, 2001).

There are many reasons to remain skeptical about the idea that technology will provide a panacea for emergency management problems.

Even in an era when high-tech search and rescue equipment is commonly available at disaster sites, survivors still tend overwhelmingly to be rescued by their family members, friends and neighbors

working with their own hands. While technology can help in many ways, a great deal of work that needs to be done in disasters still involves routine labor on the part of large numbers of people: sand-bagging, cleaning up debris, handing out food and water, and providing face-to-face help and advice to victims (Tiernay, 2001).

On the same note, introducing advanced technologies will almost certainly widen the gap between the rich and poor in society, as well as between industrialized nations and the developing world. The proposed technological fixes can become ends in themselves, driving governmental decisions and priorities rather then the other way around, and the communications revolution can result in information overload and the dissemination of incorrect and outdated information as well as inaccurate guidance (Tiernay, 2001). Those already at a disadvantage in so many other ways, could also be left behind in an emergency driven technology revolution that fails to address their needs.

These problems have been the norm for imported design solutions from different cultures rather than the exception, yet they remain unrecognized by the majority of designers and manufactures. Even if such solutions could be seen to be effective in logistical and functional terms, they also raise other, less easily quantifiable issues. In terms of design of refugee settlements, virtually all current solutions are based on a military type layout that puts expediency and perceived efficiency before sensitivity to the inhabitants' social, cultural and historical living patterns. This type of organization can in fact hinder the recovery process of the people. Military organizations seek uniformity and conformity. This concern for order is simply too much to expect from a civilian population stricken by disaster. The period immediately after an impact is a time when people need to get together and develop collective responses. A military hierarchy of decision-making inhibits this organic social process (Kronenburg, 2002).

Viewing the threat of disasters from the perspective of sustainability, the key to protecting society against future disaster losses lies in reversing current short-sighted development practices and substituting alternative approaches that are sustainable in the longer term (Tiernay, 2001). Government officials and city planners need to understand that sustainable and disaster-resistant communities are those that simultaneously pursue both safety and other civic goals using a diverse set of strategies. First, they minimize the exposure of people and property to natural disasters, recognize ecological limits, and direct their efforts toward enhancing the integrity of ecosystems. Second, they try to promote a deeper understanding of the

natural environment and reduce the demands people place on land and rescuers. Third, they link environmental, social, and economic goals and focus on protecting the community's "ecological capital." Fourth, they replace disjointed, contradictory policies with more comprehensive ones that seek to address broad community needs, including the need for housing, protection of the environment, and disaster resistance - in a coherent way rather than in isolation. Finally, they view environmental resource conservation and protection against natural hazards in moral and ethical terms, seeking social equity through environmental and hazards policy (Tiernay, 2001). Communities are not accustomed to thinking in these ways about hazards, but successful implementation of strategies like these would almost certainly result in a steady if slow decline in disaster losses.

The approaches used by different societies to manage hazards and disasters are in large measure a reflection of the distinctive characteristics of those societies. Preparedness and response activities take place within particular governmental systems and are shaped by larger cultural, economic, and political forces. Taking these broader societal factors into consideration can shed light on the manner in which hazard management activities are organized and the reasons why particular hazard adjustments are preferred over others. It can also help explain why some approaches to loss reduction succeed in particular societal settings while others fail and still others are never considered at all. There are two factors that complicate the conduct of hazard reduction activities. First, responsibility for different aspects of the disaster problem is diffused among many agencies at different governmental levels. Second, authority relationships among those agencies are weak, which impedes implementation and lessens accountability (Tiernay, 2001). Local governmental politics in the US are bewilderingly complex, with three thousand counties, sixteen thousand seven hundred townships, and twenty-nine thousand special districts, each with their own policy making structure.

Impact relief organizations tend to plan for disasters in isolation from one another.

The Office of the United Nations, in trying to provide direction for governments of disaster effected countries to disseminate information and orders, created this tri-level system:

Tertiary Level [national level] Policy-making administrators

- Directors of government building research bodies

- Directors of government housing, reconstruction and emergency planning agencies
- Directors of international voluntary relief development agencies
- Directors of housing finance institutions

Secondary Level [regional/provincial] Project managers of shelter or housing programs

- Field staff of governments; international organizations; voluntary organizations; relief agencies
- Professional groups; architects, engineers, planners
- Private sector; building contractors, suppliers of materials, equipment

Primary Level [local] Local groups from the surviving community

- Local community leaders
- Local teachers/trainers
- Local builders/craftsmen

Higher levels of government use a variety of mechanisms to influence activities at lower levels. Those mechanisms include incentives, or rewards that are given for voluntary compliance; mandates, or rules for which violation is punished and guidelines that accompany funds and other types of assistance. While most national-level programs have focused on mitigation rather than preparedness and response, the federal government expended some effort on encouraging sub-national levels of government to improve their disaster management capabilities (Tiernay, 2001). While not mandates in the strict sense, these approaches have attempted to provide "guidance" and to specify performance standards and goals.

First, an effective response is characterized by few discrepancies between government's performance, which is based largely on bureaucratic norms, and the norms and definitions of the situation that emerge in the public. In contrast, poorly-managed events reveal large gaps between the actions government takes and the public's collective definitions (Tiernay, 2001). Government, in other words, is not perceived as attending to the needs people consider most important, or is not acting swiftly enough.

A second and related point is that response activities tend to be judged more positively when they develop from and are largely under the control of lower levels of government. Conversely, poor evaluations of government performance are more likely in situations where there is confusion about which governmental levels are responsible for which tasks. The public and the media become aware of this when there is a lack of coordination among agencies and levels of government. The most visible indication of

poor performance by local jurisdictions occurs when a higher level of government intervenes to assume major responsibility for emergency operations (Tiernay, 2001).

Third, actual and perceived government effectiveness are related to three general factors: disaster magnitude; the extent to which governmental agencies prepare effectively for disasters; and the public's capacity to cope with disaster impacts. The worst-case situation - the disaster that involves the most serious gaps between bureaucratic performance and public expectations - is one in which disaster impacts are very severe, governmental responders are unprepared, and are unable to mobilize its own resources effectively. This is also the kind of situation in which a high degree of federal intervention in the performance of response- and early recovery-related tasks is most likely (Tiernay, 2001).

There is a trend toward broadening federal emergency management programs over time to include more hazards and different forms of assistance, and the persistence of the "dual use" orientation, which emphasizes preparedness for both war-related emergencies and disasters (Tiernay, 2001). Federal emergency preparedness evolved out of an earlier concern for civil defense, and for many years planning for nuclear war persisted as a key element in federal preparedness activities. At different times, this emphasis has made implementing preparedness measures difficult (Tiernay, 2001). More recently, federal preparedness initiatives have reflected growing concerns about the domestic risks posed by terrorism and weapons of mass destruction.

National level preparedness initiatives are shaped to a considerable extent by dramatic disaster events. For example, the Three Mile Island nuclear accident stimulated federal action to encourage extensive evacuation planning for areas around nuclear power plants. Similarly, many provisions in the Oil Pollution Act of 1990 came about as a direct response to the 1989 Exxon Valdez oil spill. The federal response plan already had been developed prior to the 1992 occurrence of Hurricane Andrew, but the delayed and uncoordinated response to that disaster prompted strong criticisms and calls for improved response planning (Tiernay, 2001). In the US, we believe that allowing responsibility for managing emergencies to reside at the local level provides the best way of ensuring that emergency management organizations act in ways that are responsive to local needs (Tiernay, 2001). The US pattern of organization would seem to be particularly well-suited to situations in which there is sufficient capacity at the local level to handle

emergency-related demands. What about nations that do not divide powers and authorities among different governmental levels, or countries that do not have sufficient resources at the local level?

In many societies the military plays a prominent role in disaster management, while in others it is kept in the background. In Japan, for example, the public frowns on the use of the military in disaster, and distrust of the military was one reason its personnel and equipment were not well-utilized following following the 1995 Kobe earthquake. In countries that are currently ruled by authoritarian military regimes or those that have been in the past, the military may possess substantial resources and be an object of public fear and hatred. After Hurricane Andrew, US observers called for greater disaster involvement by the military in domestic situations, while others criticized the role played by the armed forces (Tiernay, 2001).

The US Army is often called upon to set up emergency tent camps for disaster victims. Unfortunately, as noted earlier, these camps tend to be too rigid in layout, too uniform, too large, too dense, and often too far from homes and work, and they are the source of many unforeseen problems: either they remain half-empty, or they breed environmental and social ills because of induced proximity. In the administration of emergency shelter programs, military organizations seek uniformity and conformity. This concern for order is simply too much to expect from a civilian population stricken by disaster. The period immediately after a disaster is a time when people need to get together and develop collective responses. A military hierarchy of decision-making inhibits this organic social process. The US is considering establishing a new military unit capable of quicker response to major natural disasters like hurricanes, floods or earthquakes. Many consider it a major priority after Hurricane Katrina to find ways the active duty military could respond faster in a crisis. One official said the force could be as large as a brigade, or about four thousand troops. The unit's expertise would include communications, logistics, medicine and engineering. The problem with this new quick response unit is that they would still follow typically military, rigid, dense emergency shelter organization.

The increase in altruistic behavior that accompanies disasters also means that victims themselves become valuable resources in preparedness and response efforts.

1.3.1 Organizations

Organizations experience the impact of disaster through entire communities as a situation producing organizational stress. This stress occurs because sharp and unanticipated demands exceed the capacity of organizations to respond. Further, those demands, which may be quite unusual for a given organization, threaten central values and thus require immediate action. At the same time, organizational capabilities are insufficient to meet escalating demands, both because of the sheer size of the demand and because the disaster itself has degraded capabilities by affecting the availability of personnel and damaging and disrupting facilities. This unexpected, excessive demand requires organizations to adapt if they are to respond effectively. A large-scale, rapid-onset disaster is likely to also require a timely and coordinated response by many public and private sector organizations working together to minimize damage and disruption and restore the community to routine functioning (Tiernay, 2001). Such coordinated responses may be problematic both because of the magnitude and unexpected nature of the disaster demands and because the organizations that are required to respond lack sufficient training and practice. Professionals and outside organizations are important sources of assistance when the level of need is high, but they must not and cannot supplant natural helping networks. People should not abandon their routine social activities because these keep people informed about the relative needs of network members, provide natural forums for sharing experiences, and preserve a sense of social embeddedness.

Recently, there has been much uncertainty in the quality of disaster organizations. The feelings stem from the lack of a consistent resource base for disaster operations, public indifference to the emergency management function, and confusion over organizational bases of authority and task domains. Through research it has been concluded that the emergency management function for natural disasters is not well-institutionalized in US communities. Large disasters have more of a tendency to disrupt the infrastructure of an affected area, making damage assessment, communication, the movement of resources, and other response-related tasks more difficult. Moreover, in disasters with a large scope of impact there are typically fewer unaffected community residents available to provide assistance to victims. This necessitates the mobilization of emergency aid from other areas, the activation of mutual aid agreements, and participation by state, regional, and federal agencies, thus expanding the need for inter-organizational and

inter-governmental coordination (Tiernay, 2001). Preparedness activities were found to be fragmented rather than integrated across different organizations and sectors. As a result, organizations tended to plan for disasters in isolation from one another.

While there is general agreement that preparedness capability has increased, we still understand little about the factors that foster successful and effective emergency management units. Most of what has been learned in the last twenty-five years concerning the preparedness activities of emergency service providers comes from studies that were conducted during the mid to late 1970's, and little new research on emergency preparedness has been done since that time. This research, much of which is now nearly 2twenty-five years old, suggests that like police and fire departments, emergency organizations tend to plan in relative isolation from broader community-wide preparedness efforts and to see disaster response as primarily as extension of their everyday lifesaving and emergency activities (Tiernay, 2001). Lack of cohesive planning stems in part from the same kinds of problems that plague the "everyday" provision for emergency response organization: conflicts among the various professions involved, between high and low status hospitals, and between public and private sector service providers. Disasters do not receive a higher priority because such events are infrequent in any given locality, responders tend to over-generalize from their experiences with routine emergencies, and nonspecialists tend either to underestimate the magnitude of disaster demands, resulting in unrealistic optimism, or grossly overestimate them, resulting in fatalism.

The International City Management Association's 1982 survey of more than six thousand local and county emergency response units found considerable structural variation and lack of standardization. For example, communities differed in terms of where in government the emergency management function was located; in whether the office was independent or embedded in a larger organizational structure; in emergency management staff size; and in whether the emergency management director's position was a full- or a part-time job (Tiernay, 2001).

There are a number of organizations trying to seek autonomy due to staff commitment to professional ideologies, differences in organizational technologies and resource needs, fears about the loss organizational identity, concerns about loss of scarce resources and the proliferation of organizations and interest groups across political jurisdictions, and perceived differences in the costs and benefits of cooperation. However, the greater the autonomy of organizations in the network and the greater the density of contacts,

the lower the preparedness. The total number of contacts, which was positively related to preparedness, was negatively correlated with both autonomy and density (Tiernay, 2001). Like their state-level counterparts, emergency management agencies tend to work closely within various offices and branches of state government. While organizational location is probably a factor in the effectiveness of a state-level emergency management agency, its relationship with the governor's office is likely to be even more important (Tiernay, 2001).

Emergency response organizations must first recognize that disasters are qualitatively different from small events such as accidents or routine emergencies. In contrast with these kinds of events, disasters place community systems under extreme stress; responders face new and different demands, and large numbers of often unfamiliar organizations are involved. Thus planning for disasters cannot be merely an extension of planning for everyday emergencies. Second, while disaster agents differ from one another and typically require specialized resources, planning efforts should be generic rather then agent-specific, because the same general tasks must be performed regardless of the type of disaster. No matter what type of disaster occurs, for example, there will also be a need for emergency protection, expedition hazard mitigation, population protection, and incident management. Third, planning is most effective when it is integrated rather than fragmented. Rather than planning independently of one another, the organizations and community sectors responsible for the performance of disaster-related task should emphasize community preparedness efforts. This principle applies not only to the development of formal disaster plans, but also to disaster exercises, training activities, and other aspects of preparedness (Tiernay, 2001).

Most disaster response activities consist of actions taken at the time a disaster strikes that are intended to reduce threats to life safety, to care for victims, and to contain secondary hazards and community losses. These actions may be initiated before disaster impact if there is adequate forewarning, but usually can take place only after impact in the case of agents such as earthquakes, which occur without warning. Typical emergency response measures include *population protection* activities, such as warning, evacuation, search and rescue, and the provision of emergency shelter and emergency medical care. They also include *expedient hazard mitigation* actions, such as installing temporary hurricane shutters, sandbagging flooded rivers, and controlling the secondary impacts that result from disasters such as earthquake-induced fires (Tiernay, 2001).

Organizations responding during disaster situations face a number of challenges. Upon notification of an actual or imminent disaster they must mobilize, assess the nature of the emergency, prioritize goals, tactics, and resources, and coordinate with other organizations and the public, while making an effort to overcome the operational impediments posed by the disaster. All of these activities must be accomplished under conditions of uncertainty, urgency, limited control, and limited access to information (Tiernay, 2001).

Unfortunately, in attempting to arrange for the provision of post-disaster housing, organizations have a tendency to react to conflicts with disaster victims by defining the victims themselves as the problem, when in fact their own activities are the source of difficulty. Instead, the problem can more usefully be framed as a conflict between two very different cultures. The culture of the aid-giver is defined by the rule-bound requirements of administering a bureaucracy, while the culture of many aid-receivers is defined by the demands of living on the social and economic margins of society. Housing-related problems are often exacerbated by ineffective organizational mobilization, failure to take advantage of existing community resources, lack of inter-organizational coordination, failure to recognize pre-impact conflicts differences in community power, and poor inter-group communication (Tiernay, 2001).

1.3.3 Survivors

There are many myths that surround the response of victims of disasters, myths often perpetuated, if not created, by the media. For example, it is a common and understandable misconception that disaster victims are dazed and helpless, simply waiting for outside aid. It is true there is a short period of shock, but very quickly they are usually able to react, and they become actively involved in the task of saving lives and property. Another is that people camped out in the wreckage of their home impede reconstruction efforts. In fact, these are the first coherent acts of rebuilding property and community: inhabitants staying close to their belongings to protect them and maintain their personal geographical identity (Kronenburg, 2002).

On average, a disaster occurs somewhere in the world each day. It may be a flood, hurricane, or earthquake, a nuclear, industrial, or transportation accident, or peacetime terrorist attack. What these vari-

ous events share in common is their potential to affect many persons simultaneously and to engender an array of stressors, including threat to one's own life and physical integrity, exposure to the dead and dying, bereavement, profound loss, social and community disruption. As a result of both the high prevalence and high stressfulness of disasters, the question of whether they impact mental health has been of interest for decades. Most people respond appropriately during the impact of a disaster and react to protect their own lives and the lives of others. This is a natural and basic reaction. After the fact, people may judge their actions during the disaster as not having fulfilled their own or others' expectations of themselves.

During the impact phase, a low percentage of people respond in a way that is disorganized and stunned, and they may not be able to respond appropriately to protect themselves. Such disorganized or apathetic behavior may be transient or could extend into the post-disaster period, so that people may be found wandering helpless in the devastation afterwards. These reactions may reflect cognitive distortions in response to the severe disaster stressors and may for some indicate a level of dissociation. Several stressors may occur during impact, which may subsequently have consequences for the person:

- Threat to life and encounter with death
- Feelings of helplessness and powerlessness
- Feelings of loss
- Dislocation from secure environment
- Feeling responsible for occurrences
- Human malevolence

The immediate relief phase is associated with a honeymoon phase deriving from the altruistic and therapeutic community response immediately following the disaster. This is where the recoil from the impact and the initial rescue activities commence. Initial mental-health effects also may begin to appear. People can begin to display traits of confusion, are stunned, or demonstrate high anxiety levels. Emotional reactions will be variable and depend on the individual's perceptions and experience of the different stressor elements noted earlier. Necessary activities of the rescue phase may delay these reactions, and they may appear more as the recovery processes get under way. Reactions may include:

- Numbness
- Denial or shock
- Flashbacks and nightmares
- Grief reactions to loss
- Anger
- Despair
- Sadness

The rehabilitation and recovery phases are the prolonged period of adjustment and return to equilibrium that the community and individuals must go through. It commences as rescue is completed and individuals and communities face the task of bringing their lives and activities back to normal. Much will depend on the extent of devastation and destruction that has occurred as well as injuries and lives lost (Raphael, 1993). This period may be a disillusionment phase where the disaster is no longer on the front pages of newspapers, organized support starts to be withdrawn, and the realities of losses, bureaucratic constraints, and the changes wrought by the disaster must be faced and resolved (Raphael, 1986).

During the stage of acute danger, the priority for all is basic safety and survival. Once this is relatively secured, other needs emerge that are both physiological and psychological. And once manifested, these needs are typically left frustrated and unfulfilled for a prolonged period of time. Many times, through the media, retribution, or continued violence, the community in question is exposed to further traumatic events. It is particularly important to remember that emotional needs may be very significant, especially for those who have been severely affected. They may only start to appear during this phase. People may also be hesitant to express distress, concern, or dissatisfaction, feeling they should be grateful for the aid given or because they have suffered less than others have. Many people may encounter behavioral and emotional readjustment problems. Many post-traumatic stress symptoms are normal responses to overwhelming stressors. Exposure to these overwhelming stressors may change our assumptions about life and create distress, but the intensity of this distress will subside with time. Experts agree that the amount of time it takes people to recover depends both on what happened to them and on what meaning they give to those events.

Looking at socio-economic factors, the available research indicates that minorities find it harder to cope with disaster because they tend to have less wealth and lower incomes, and also because they are more likely than the majority to experience problems communicating with authorities. Ethnicity and income are also associated with differences in other factors that affect the ability to cope in disaster situations, such as education and access to social support networks (Tiernay, 2001). With respect to the credibility and believability of hazard-related messages, a variety of studies document that minority citizens are less likely than the majority population to perceive majority group authorities as credible information sources. This is significant, since perceptions of credibility are linked with warning belief and perceptions of personal risk.

Research recently completed in the US tallied African-Americans, Mexican-Americans, and Caucasians answers to identify credible sources of hazard information. White respondents had a tendency to identify public authorities and mass media as sources of disaster information.. While blacks also found authorities credible, they cited social network sources as credible sources more often than whites, and they rarely relied on the media. The distinctive pattern of Mexican-Americans was to place highest confidence in the credibility of social networks. With respect to post-disaster shelter seeking, African-Americans, Caucasians, and Mexican-Americans all tended to seek shelter with family members or friends. They tended to differ in that African-Americans were more likely than the other two groups to use public shelters, and in the non-urban areas Mexican-Americans were less likely to do so (Tiernay, 2001). Latino community residents prefer outdoor sheltering over the use of publicly designated shelters and other forms of indoor sheltering. It is believed that this pattern is attributed to residents' prior experiences with damaging earthquakes in the native countries, and their desire to stay close to their homes to keep an eye on their property.

The most important rule for anyone who is suddenly faced with a survival situation is to keep from panicking.

Dominant cultural assumptions can also disadvantage some groups when disasters strike. In all societies, the interests of socially and economically privileged groups are embedded in mainstream cultural practices, which in turn become ingrained in the ways in which organizations and institutions operate. The literature on disasters contains numerous examples of the ways in which these hegemonic ideas shape the activities of preparedness and response organizations, resulting in the failure to take cultural differences into account in the delivery of disaster-related services. In disasters, the practices of crisis relevant organizations reflect prevailing social hierarchies and the differential value placed on different groups, subcultures, and lifestyles. These influences are becoming more evident as researchers have turned their attention to the ways in which social and cultural diversity shape disaster experiences and on recent major disaster events that have affected highly diverse communities. As these studies show, because services are geared toward the needs of the dominant majority, minority disaster victims in shelters may be given food that is very different from what they ordinarily eat, non-native English speakers may be required to fill out extensive forms in English, and immigrant victims may be justly fearful of seeking needed serv-

ices for which they qualify out of fear of deportation (Tiernay, 2001). Programs can fail to accommodate households made up of more than one nuclear family and otherwise fail to recognize cultural variations in living arrangements, such as those involving extended and multi-generational families and "doubling-up" for economic reasons.

With regard to evacuation transportation assistance, the proportion of US residents without access to cars is relatively small but varies by region, with household vehicle ownership being lower in eastern, lower-income urban areas then in rural western regions. Unsurprisingly, lack of access to a vehicle can also be a serious impediment to evacuation compliance for members of lower income groups. In many cases, those who do not own vehicles will obtain evacuation transportation assistance from the same people who routinely help them on a daily basis, public transportation. It is important to recognize that households lacking evacuation plans are less likely to evacuate and slower to act when they do evacuate, and that they also have a tendency to evacuate to even more dangerous locations rather than safer ones. And for the majority of evacuating households in the US who will use their own vehicles, emergency managers must anticipate traffic management problems such as overcrowded evacuation routes, accidents, and vehicle breakdowns (Tiernay, 2001).

During the research it was concluded that ethnicity was related to the propensity to prepare. It was also noted that whites were more likely than African-Americans to engage in preparedness activities (Tiernay, 2001). Of those responding the surveys, just under thirty percent had attended public meetings to obtain more information about the earthquake hazard, and twenty percent reported making physical changes to their homes to reduce potential earthquake damage. At the same time, sixteen percent indicated that they had not done anything to plan for a coming earthquake and they did not intend to do so.

Some ethnic group members in the US may also have immigration-related concerns that influence the ways in which they respond when a disaster occurs. They may avoid public and other services for fear of being discovered by the Immigration and Naturalization Service and being deported - a fear that is justified, since that is what happened to Hispanics and Haitians following Hurricane Andrew (Tiernay, 2001). It is because of these immigration-related problems that social attachments and relationships are key considerations of the preparedness and response behaviors undertaken by different social units. Strong and extensive bonds generally have a positive effect on emergency response-related behaviors. Social connected-

ness, measured in various ways, has been shown to foster adaptive behavior during both the pre- and post-disaster periods. When people do leave their homes to seek emergency shelter or temporary housing, social ties are a key factor determining where they go: people who are able to do so prefer to stay with relatives, neighbors, and friends. Disasters tend to be disproportionately severe on poor and minority residents because these are the groups most likely to live in overcrowded, substandard, and easily-damaged housing, such as older unreinforced masonry buildings affordable housing in earthquake-prone cities like San Francisco and Los Angeles (Tiernay, 2001). Mobile homes are another source of housing that are used primarily by low-income people. They are also highly susceptible to disaster damage as seen in 1994 when nearly forty percent of all tornado fatalities occurred in mobile homes.

Worldwide, it is clear that higher levels of affluence are associated with lowers levels of disaster vulnerability, particularly in terms of lives lost in disasters; the damages wrought by disasters in the Third World far exceed those experienced in developed countries. Countries that cannot feed their people might understandably view spending on disaster programs as a luxury, and in many parts of the world disaster vulnerability increasingly pales in the face of more pressing problems such as war, economic dislocation, genocide, and forced migration. Many societies today exist in a more or less permanent state of crises that both constrains the ability to plan for disasters and at the same time makes them more likely (Tiernay, 2001).

When dealing with the elderly, physical disabilities that are correlated with age will put them at a disadvantage in emergency situations, particularly if rapid action or physical exertion is required. Elderly people, particularly those with limited financial resources, may also be more likely to reside in disaster-vulnerable structures. In the 1995 Kobe earthquake, for example, mortality was strongly correlated with age, because older people tended to live in traditionally constructed houses that were more likely to collapse. Further, the elderly were more likely to live in the densely populated, lower income sections of the city that burned following the earthquake (Tiernay, 2001).

Research on disasters has proceeded on the assumption that societies and communities are systems organized around necessary social functions that from time to time are disrupted by natural and technological agents. After a crisis period necessitating adaption, the social system readjusts and recovery takes place (Tiernay, 2001). During this adaption phase communities evaluate the situation and begin to align them-

selves appropriately. The heightened community consensus is generally characteristic only of the emergency response phase during and immediately following impact; conflict is common both before disaster strikes and during the post-disaster recovery period. Second, generalizations about community consensus and the emergence of pro-social norms are based largely on U.S. society, and we actually know little about how applicable they are to other countries, because so little disaster research has been done in other societal settings. Third, high levels of consensus are probably more characteristic in situations defined as acts of nature than in other kinds of emergencies (Tiernay, 2001). However, instances of community conflict in all types of disaster situations may also be increasing for a variety of reasons. As knowledge about the social sources of hazard vulnerability is becoming increasingly widespread, members of the public are becoming more aware than before of the ways which the actions of others can cause disasters or make their impacts more severe. An instance of victimization that once may have been seen as resulting from an act of God, the uncontrollable forces of nature, or sheer bad luck may now be seen as having been caused by some party's negligence. These new interpretations can in turn lead to conflict, criticism of organizational performance, and in some cases, litigation. Moreover, members of the public may now expect more from government when disasters strike then they once did. Consequently, problems such as traffic jams during pre-impact evacuation and delays in infrastructure restoration and service delivery following disasters may now be judged more harshly by those who are affected. As the widespread criticisms and the subsequent investigation of federal emergency management policies following Hurricane Andrew showed, the public expects government to respond swiftly and effectively in emergencies and has little tolerance when those expectations are not met (Tiernay, 2001).

Perhaps more than any other thing, your survival may depend on your state of mind.

In the US, individualism and the sanctity of private property are important cultural values. These cultural values helped shape the laissez-faire, persuasion-oriented approach that is generally taken to encouraging the adoption of hazard-reduction measures. Despite the American focus on individualism, altruism is a very strong cultural force that also shapes the way disasters are handled. Throughout its history the US has had a strong tradition of volunteer behavior and community involvement, and this altruistic orientation carries over and is amplified in disaster situations. Community residents engage in pro-social be-

havior on a large scale during an emergency period. Families and neighbors care for one another and donations pour into affected communities (Tiernay, 2001). While post-disaster volunteering and pro-social behavior have been observed in the US, it also exists in many different societal settings. As stated earlier, following the 1995 Kobe earthquake, which killed as estimated six thousand people and injured thirty thousand, many emergent groups formed to assist disaster victims, and organized volunteering took place on a very large scale. As many as a million and half people took part in the massive volunteer effort that developed in the days and weeks following that earthquake. Students traveled to the disaster area from around the country, and volunteer groups provided many different kind of services, from preparing and distributing meals to giving free haircuts. A massive public response of this kind would not have been considered at all unusual in the US. However, spontaneous help-giving had not been common in peacetime emergencies in Japan, and the fact that it did occur following the Kobe disaster has become a topic for study among Japanese researchers (Tiernay, 2001).

We still understand little about why emergent groups form, what facilities emergence, how emergent structures develop, and why some emergent groups persist while others disappear. In Japan, 1995 became known as "the first year of the volunteer" because individuals and groups had volunteered in unprecedented numbers at the time of the Kobe earthquake. The fact that a disaster-related pattern that the US research takes almost for granted - the convergence of volunteers and the formation of emergent groups - was considered remarkable in Japanese society shows how much societies can differ, as well as how much still remains to be learned about group behavior in disaster situations. A number of citizen groups that emerged in the aftermath of the Kobe event have continued to exist as organizations, and many provided volunteers to aid in the response to the large oil spill that occurred in the Sea of Japan (Tiernay, 2001).

Following the Kobe earthquake, neighborhood schools provided shelter, which was an intended function, but also served as improvised medical care facilities, community information centers, and temporary morgues, because they were often the only community institutions to which victims could turn. The overwhelming need for emergency shelter also led owners of many private businesses and office buildings to open their doors to victims needing shelter (Tiernay, 2001). Culturally, members of Japanese society tend to feel a much greater sense of social obligation to their families and to secondary groups to which they belong, such as schools and employers, than they do to strangers. Volunteerism, which had had a long

history in Japan, declined after World War II as the state and its large bureaucracy increasingly took on functions that had previously been performed in the no-governmental sector.

Unless you've been in a disaster before, it is hard to imagine how you will handle the situation. Coping with the human suffering and confusion of a disaster requires a certain inner strength. Disasters can cause you to lose a loved one, neighbor or friend, or cause you to lose your home, property and personal items. The emotional effects of loss and disruption can show up right away or may appear weeks or months later (Liebsh, 2005). Since disasters usually happen quickly and without warning, they can be very scary for both adults and children. They also may cause you to leave your home and your daily routine and deal with many different emotions, but realize that a lot of this is normal behavior. It is very important that you understand no matter what the loss is, there is a natural grieving process and every person will handle that process differently.

The elderly, though physically weak, can bring psychological strength to a group. Much of the research shows that older adults have been found to have better mental health than their younger counterparts.

It is said that the most important survival tool is the mind. But to keep the mind functioning smoothly, you must establish and maintain a positive attitude. Within hours or even minutes after the onset of survival stress, the attitude you take - and the decisions that result from it - may mean the difference between life and death. Over time, how you feel about yourself will determine how well you adapt to your new environment and its changing conditions. And no matter how long the survival situation may last, your outlook will affect the quality of your experience, just as it does in everyday life (Brown, 1983). Most disaster survivors only experience mild, normal stress reactions. Disaster experiences may even promote personal growth and strengthen relationships. However, as many as one out of every three disaster survivors experience some or all stress symptoms, which may lead to lasting Post-traumatic Stress Disorder (PTSD), anxiety disorders, or depression.

Clearly, one of the most significant impediments to enhancing emergency preparedness among households is the low salience of disasters in most people's lives. Members of the public may not receive preparedness information, fail to act or put off taking action, or lack the resources to prepare (Tiernay, 2001). Emergency preparedness was found to be significantly related to the level of hazard awareness,

with those who had heard, understood, and personalized the risk being much more likely than those who had not heard about potential disasters. Nevertheless, the majority of the population took no preparedness measures at all. The researchers found that levels of preparedness were related to recent experience with a disaster and personal contact with friends, relatives, and others who were trying to prepare for one (Tiernay, 2001). A typical response to warnings is that even when a damaging disaster has recently occurred, households that escaped damage may subsequently have a tendency to disregard messages about an ongoing threat. These findings are consistent with characterizations of people as "prisoners of their experience." Evidently many people have a tendency to believe that what already has happened is the worst that can happen (Tiernay, 2001).

For many years, research equated protective response with evacuation and relocation, but over the past two decades researchers have begun to examine other types of protective actions that can be undertaken by threatened populations. Sheltering in place is increasingly being seen as a protective action that can used in response to various hazards, including tornadoes, hurricanes, and hazardous chemical releases. However, recommending that other people shelter in place will not work unless people are convinced that doing so provides adequate protection. The idea of sheltering in place may be more appealing to urban populations, or to people who live in particular regions of the country like densely populated coastlines on the Atlantic Ocean and the Gulf of Mexico (Tiernay, 2001).

Early studies on community response to disasters documented a number of changes that occur at the community level in disaster situations. These include enhanced community solidarity and morale, suspension of pre-disaster conflicts, a leveling of status differences, increased levels of community involvement and participation, and shifts in community priorities to emphasize central tasks such as the protection of human life. More generally, the disaster-stricken community has been described as altruistic, therapeutic, consensus-oriented, and adaptive. Disasters create unity rather than disorganization. The consequence of a disaster event on a locality is in the direction of the 'creation' of community, not its disorganization, because during the emergency period a consensus of opinion on the priority of values within a community emerges. A set of norms which encourages and reinforces community members to act in an altruistic fashion develops; also, a disaster minimizes conflict which may have divided the community prior to the disaster event (Tiernay, 2001).

Figure 17: Kobe , Japan Earthquake, 1995

As mentioned earlier, individual responses, disaster volunteers, and emergency aid research has shown that disasters result in heightened levels of pro-social behavior. Cooperation and consensus are high during the emergency response phase, self-interested activity is discouraged, and existing community conflicts are temporarily set aside. Correspondingly, disaster-specific anti-social behavior, such as looting that is often anticipated by authorities, the media, and the public fails to materialize, and the incidence of "ordinary" crimes such as theft and murder declines.

When disasters force alterations in daily activities and routine patterns of behavior, altruistic response become more likely. Related social-structural changes constitute another condition for the emergence of helping behavior on a large scale. When normal routines are upset, people are more structurally available for involvement in organized pro-social behavior. Thus, "mass assaults" by volunteers can be expected in severe and highly disruptive disasters (Tiernay, 2001).

2.0 Basic Human Needs

Two and a half million years ago our genus, *Homo*, began its long relationship with Mother Nature. Since then, we have adapted and competed against other *Homo* species such as Homo-erectus, Homo-neanerthalensis, and Homo-geogicus, just to name a few. However, it was not just a competition amongst ourselves, but with the rest of life on the planet for enough resources to survive. As time passed, to help in the locating and production of resources, we banded together and formed tribes. These scattered tribes helped build a stronger global connection between groups of humans and the Earth. The tribal culture spread across the planet, living in sustainable harmony with nature. As recently as the 1800s, tribes populated half the earth, but now they comprise only one to two percent of the world's population. Since then, we have built large urban centers that house millions of people that seem to live oblivious to the impact they have on the planet and the resources they use. In most societies today, food seems to always be available, water is relatively plentiful, and shelter is generally provided if you have none of your own. What if this wasn't the case? Do you know what it would take to keep you alive? What about your family?

Disaster impacts are situations in which thousands of people can find themselves without water, food, and shelter. If we want to survive through these droughts of resources and better understand our impact on this planet, we must know the amount of resources it takes to comfortably keep ourselves alive. Through this understanding, a widely used and acknowledged hierarchy of physiological and psychological needs was created to help comprehend the requirements for a fulfilling existence.

2.1 Maslow's Theory

Abraham Maslow developed the hierarchy of needs model in the 1940-50's, and the theory remains valid today for understanding human motivation. Each of us is motivated by needs. Our most basic

needs are inborn, having evolved over tens of thousands of years. Abraham Maslow's hierarchy of needs helps to explain how these needs motivate us all. Maslow's theory is most often displayed as a subdivided pyramid. The lowest levels of the pyramid make up of the most basic needs and the more complex needs are displayed at the top. It states that we must satisfy each need in turn, starting with the first, which deals with the most obvious needs for survival itself. Only when the lower-order needs of physical and emotional well-being are satisfied are we concerned with the higher-order needs of influence and personal development. Conversely, if the things that satisfy our lower-order needs are swept away, we are no longer concerned about the maintenance of our higher-order needs (Harmondworth, 1971). The thwarting of needs is usually a cause of stress, and is particularly so at level four. Maslow believed that these needs are similar to instincts and play a major role in motivating behavior. Physiological, security, social, and esteem needs are deficiency needs, meaning that these needs arise due to deprivation. Satisfying these lower-level needs is important in order to avoid unpleasant feelings or consequences. Maslow term the highest-level of the pyramid a growth need. Growth needs do not stem from a lack of something, but rather from a desire to grow as a person (Harmondworth, 1971).

Biological + Physiological Needs

This level includes the most basic needs that are vital to survival, including the need for water, air, food, and sleep. Maslow believed that these needs are the most basic and instinctive needs in the hierarchy because all needs become secondary until these physiological needs are met.

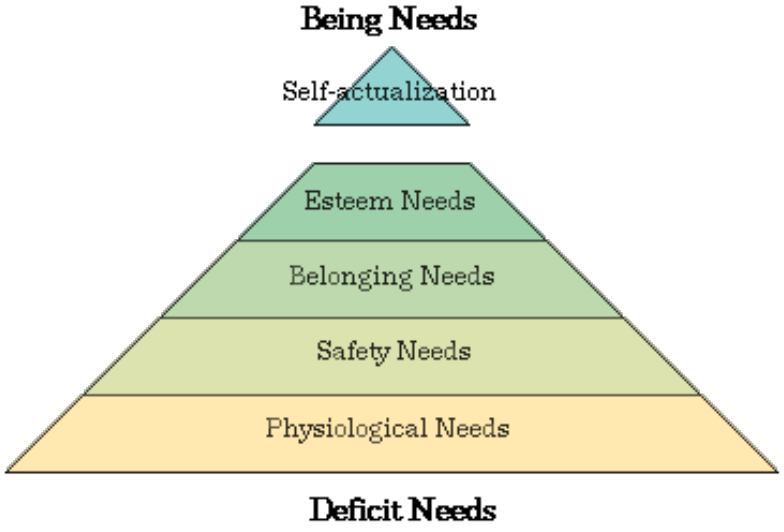


Figure 18: Maslow's Hierarchy of Needs

Safety + Security Needs

The second echelon includes the need for safety and security. Security needs are important for survival, but they are not as demanding as the physiological needs. Shelter from the environment, stability, and laws are examples in this level of the pyramid.

Social + Love Needs

The third level includes needs of belonging, love, and affection. Maslow considered these needs to be less basic than physiological and security needs. Relationships such as friendships, romantic attachments, and families help fulfill this need for companionship and acceptance, as does involvement in social, community, or religious groups.

Esteem Needs

After the first three needs have been satisfied, esteem needs becomes increasingly important. This includes the need for things like reflection on self-esteem, personal worth, social recognition, and accomplishment.

Self-actualizing Needs

This is the highest level of Maslow's hierarchy of needs. Self-actualizing people are self-aware, concerned with personal growth, less concerned with the opinions of others, and interested in fulfilling their potential.

Obviously, all of these needs are part of a complex web of human psychological and physiological needs. Nonetheless, when dealing with survivors of disaster impacts, the focus, as stated above, needs to begin at the base of the hierarchy of needs. The accepted order of actions taken should be:

1 - Render First Aid
2 - Prepare Signaling Devices
3 - Procure Water
4 - Find or Build a shelter
5 - Procure Food

2.2 First-Aid

When preparing a first-aid kit, it is necessary to collect enough supplies to successfully react to many different types of injuries. A kit could include thousands of different items, but for this particular project, resources for a family of four will do. Also, by planning ahead and allowing for items to be used for multiple types of injuries, it decreases the space allocated for first-aid within the kit. Injuries can have a major psychological and physiological effect on a family trying to endure a catastrophe. By creating an easy to follow a set of instructions to administer aid and provide positive reinforcements to the injured psyche, the situation becomes less hectic and could influence the way the rest of the survival scenario plays out. Below is a list of expected supplies in a full first-aid kit:

2.2.1 Medical Dressings

- Sealed Sterile Gauze Pads 4” x 4”
- Sealed Sterile Gauze Pads 2” x 2”
- Elastic Compress-Type Bandages 3" Wide Rolls - 2
- Muslin Bandage Sheet 37" x 52"
- Adhesive Cloth Tape Roll 2” Wide
- Trauma Pads 5” x 9”
- Adhesive Wound Closure Strips 1/4” x 3”
- Variety of Adhesive Bandages 1 Box
- Triangular Bandages - 2
- Alcohol-Soaked Packaged Pads - 10

Figure 19: Basic First Aid Kit

2.2.2 Repellant, Ointment, Medicine, Sterilizer

- Baking Soda
- Insect Repellent
- Anti-diarrhea pills
- Laxatives
- Pain Relief Tablets
- Local Antiseptic Solution
- Sunburn Prevention Ointment
- Alcohol [in plastic container]
- Triple Antibacterial Ointment
- Antihistamine Tablets
- Antihistamine Cream
- Chapstick
- Epinephrine for Bee Stings

Figure 20: EMT Shears

- Sterile Applicator Sticks - 3
- Syrup of Ipecac
- Burn Gel
- Calamine Lotion
- Eye Wash
- Medicated Body Powder

Figure 21: Purell Anti-Bacterial Lotion

2.2.3 Hygiene

- Sanitary Napkins
- Toilet Paper
- Toothbrushes - 4
- Toothpaste
- Germicidal Soap
- Deodorant
- Antibacterial Lotion
- Small Trowel
- Shampoo

Figure 22: Quick Clot Powder

2.2.4 Ancillary

- Bandana
- CPR Mask
- Emergency Dental Kit
- 90 MPH Military Tape
- Thermometer
- Ammonia Inhalants [1/3cc, 10 units]
- Snakebite Kit
- N95 Style Gas Mask
- SAM Moldable Aluminum Splint
- Instant Cold/Heat Packs - 2 of Each
- Blood Clot Powder
- Instruction Booklet
- Goggles
- Radiological Protection Tablets - Neumune

Figure 23: SAM Moldable Aluminum Splint

2.2.5 Tools

- Scissors
- Tweezers
- Straight Needles
- EMT Shears
- Safety Pins
- Single Edged Razor Blades
- Irrigation Syringe

2.3 Signaling Devices

Once first-aid has been been administered and the family is in a safe location, it recommended to start signaling for additional aid and possible rescue. Signaling devices can range anywhere from a match to a two-way radio. Below are some options to include in disaster-relief kits:

- Radio - Two-Way Voice Hand Crank or Combo with Solar Power
- Mirror
- Whistle
- Battery-Less Flashlight
- Signal Flares
- Smoke Signals
- Illustrations of Ground-to-Air Signals
- Chemical Light Stick
- Utility Butane Lighter
- ACR Personal Locator Beacon

Figure 24: Signal Mirror

2.4 Water

Water is absolutely essential for human survival because it plays a part in all of the body's bio-chemical reactions. Humans can go days, even weeks, without food but we must have water to live. Water requirements vary depending on activity level and temperature. Your body loses precious water by sweating and breathing and, of course, by urinating. In fact, you can tell if you are getting dehydrated by the color of your urine. When you drink enough water, your urine will be light-colored or bright yellow, but when dehydrated, it will be dark colored and you'll urinate in smaller amounts (Stein, 2000).

The absolute minimum for survival is about one quart of drinking water per day, with little or no activity and cool conditions. Two quarts of water per day will usually sustain moderate activity at an acceptable level of comfort, under cool conditions with minimal urination. In fact, the standard hospital maintenance level for adults with no activity is roughly two

Figure 25: Sealed Emergency Water

and a half quarts of intravenous fluids per day to maintain comfort and good kidney function. When the weather is hot, just a few hours without water leads to dehydration and fatigue. The typical adult requires two quarts of drinking water per day under normal conditions and one to two gallons per day in hot-weather conditions, unless consuming dehydrated foods; then you will require more water in any set of conditions. Usually one gallon per adult per day is enough for drinking and some limited washing. Some items to collect to aid in the collection and purification of water are as follows:

- Pre-Sealed Emergency Water
- Five Gallon Plastic Container
- 6' x 6' Plastic Sheet Material
- Purification Tablets [Halazone]
- Illustration and Instruction of Solar Stills
- Sponges - 4
- Plastic bags 2' x 4'
- Flexible Canteens - 4
- Water Purifier and Filter System

After collecting enough water to drink, the foremost concern is establishing that the water is safe. There are many ways to make kill off bacteria, parasites, and protozoa, and other contaminants. Most western nations have developed vast systems of water purification, storage, and distribution systems designed to protect us from traditional problems that continue to plaque most of the population of this planet, particularly in developing countries. Even though there might be steps taken to protect its citizens, when disasters hit, typically water systems are polluted and people are forced to protect themselves. Whenever in doubt, boil or otherwise purify tap water, until authorities say the water is fit for drinking. It can be deadly to drink from a water source without running it through a portable filter, chemically treating it, or boiling it to remove or kill organisms such as Giardia or Cryptosporidium.

All surface water sources in the United States should be considered unsafe to drink without treatment.

2.4.1 Infected Water

Bacteria

Bacteria are tiny, on the order of .3 microns to several microns in size and visible only under a powerful microscope. Some examples of harmful water-borne bacteria are Cholera, Campylobacter jejuni,

Salmonella, and some varieties of E. coli. Given a positive growth environment, like feces-polluted water, one bacterium cell may multiply into millions within just a few hours. Signs of bacterial infection usually show up from six hours to three days after exposure (Stein, 2000). Bacteria are killed by boiling or chemical treatment, provided the chemicals are applied at the proper concentration, temperature, and for the proper length of time.

Chemical and radioactive contaminants

Organic compounds are large molecules that consist of chains of carbon and hydrogen atoms with various other atoms attached to them. The modern world have invented huge numbers of organic compounds and refined and concentrated many other naturally occurring organic compounds. Some examples of these are gasoline, solvents, pesticides, latex paint, and plastics. When chlorine combines with organic debris like dead leaves, it makes carcinogenic compounds called trihalomethanes. Boiling your water will kill microorganisms, but will usually have no effect on chemical or radioactive pollutants. To remove volatile organic compounds, use an activated carbon filter (Stein, 2000).

Parasites

Parasites live off the bodies of host organisms for at least part of their life cycles. Parasites may be microscopic, such as those causing malaria or trichinosis. Single-celled animals, like Giardia and Cryptosporidium, can also be considered parasites. Some parasites are several inches long, such as liver flukes, or several feet long such as intestinal tapeworms. Parasites are killed by boiling and may survive iodine and chlorine treatments if they are in cyst form (Stein, 2000). Their relatively large size makes them easy to filter out of the water. All known parasites are filtered out of water by filters rated at two microns or less.

Protozoa

Protozoa are microscopic but relatively large, three to ten microns, which makes them them considerably easier to filter out of your drinking water. However, they have the capacity to transform themselves into a cyst, which is a form that is very tough to kill, even with traditional iodine and chlorine water treatments. Boiling will, however, kill protozoa and their cysts. Protozoan infections usually take considerably longer to show symptoms - from a week to several months - and they can be extremely difficult to treat once they have become entrenched in the body (Stein, 2000).

2.4.2 Purification

Figure 26: Aqua Mira Water Treatment

Contrary to popular opinion, clear sparkling water is many times unsafe for drinking, even fresh spring water. Boiling all your daily drinking water is time and energy consuming. Chemical treatments, except for possibly the new Aquamira products, do not provide guaranteed protection from Cryptosporidium cysts, which have been found to survive a 24-hour soak in undiluted household bleach. The safest method for portable, fast reliable water disinfection is a combination of chemical treatment and filtration.

Water sterilization by boiling is preferred over any method of chemical disinfection. This time-honored method is a safe and sure thing, because disease-causing microorganisms cannot survive the heat of a sterilizing boil. The Centers for Disease Control and Prevention (CDC) recommend that you boil water at a vigorous rolling boil for at least 1 minute at sea level. Remember though, boiling usually has no impact on chemical or radioactive pollutants, which must be dealt with by other means.

Many home and portable water filters will remove unpleasant tastes and odors, but will not remove microorganisms. If designed to remove all protozoa, bacteria, or viruses, then the filters will be noted as a "purifier." Most backcountry filters, even those not given a "purifier" rating, will do a decent job of removing most protozoa and their cysts, like Giardia and Cryptosporidium. The majority of "purifying" filters have iodine-impregnated resin beads in the filter media which release iodine into the water to kill viruses and bacteria. These chemically active resins require sufficiently warm water temperatures and contact time to kill bacteria and viruses. Filters that are used for large quantities of filtration are fitted with a ceramic filter element, like the Katadyn or MSR units. These units offer far longer life at a much lower cost per filtered gallon than carbon-based or pleated-membrane filter elements. Ceramic cartridges will clog faster than other types of cartridges, but can be

The safest method for portable, fast reliable water disinfection is a combination of chemical treatment and filtration.

serviced fairly easily to remove the outer clogging layer and restore the filter to near its original performance (Stein, 2000). Unless you will only use your back-country water filter with extremely clean water, figure on a realistic life of roughly one-third the manufacturer's rated life.

Filters generally work on two principles. The first principle is called "sieving." Sieving is the same as straining particles out through holes in a screen. If the particle is too big to fit through the hole, it doesn't pass through the screen. Most filter media are very thick and create a tortuous path that strains out particles much smaller than the average pore size. Ceramic filter media and most filter membranes work primarily on the principle of sieving.

The second filter principle is called "adsorption." When a particle sticks to the filter media, the way iron filings stick to a magnet, the process is called adsorption. All filters use a combination of sieving and adsorption, but activated carbon filter media are heavy on the adsorption side. Activated carbon has millions of tiny nooks and crannies. A teaspoon of activated carbon has an adsorption surface area about equal to the size of a football field, making it an excellent adsorption material. Carbon is great for sucking up pesticides, iodine, and organic compounds that tend to give water a bad taste. After a while, the sticky adsorption surfaces of the activated carbon get filled up, so the filter stops removing bad tastes, chemicals, and odors.

Filter Recommendations

The Mountain Safety Research (MSR) units, which are used by the US Marine Corps, and the Katadyn Combi filters have the benefit of activated carbon, which help remove chemicals, bad tastes, and unpleasant odors until the carbon is used up. The ceramic filter element should continue to provide bacterial and protozoa protection long after the carbon is spent. Even though these units remove around ninety-nine percent of most viruses, they are not rated as purifiers, so you should chemically treat your water before running it through one of these filters whenever viruses are concerned.

Figure 27: MSR Water Filter

Unlike the above, large gravity-fed units either have a top reservoir that holds the source water while it slowly percolates though the filter media into the bottom reservoir of purified water, or they are siphon-type units designed to siphon water from one container to another. The per gallon cost of these units is a fraction of the cost per gallon of using a small portable pump purifier, plus you don't have to manually pump for long periods of time to provide a large quantity of purified water. Gravity-fed units require no pumping but cannot produce water nearly as fast as the recommended high volume, pump unit. When viruses are a concern, you should chemically treat you water before running it through one of these filters. The AquaRain models use state of the art, award-winning ceramic cartridges from *MSR* and contain replaceable silver impregnated activated carbon cartridges that remove chemicals, tastes and odor.

Figure 28: AquaRain Filter

The AquaPak is a polyethylene solar water pasteurizer designed to achieve water temperature of sixty-seven degrees Celsius, which if maintained for fifteen minutes, will reduce all pathogens ninety-nine percent. Solar water pasteurization is the most economical and safe way to eliminate pathogens like Cholera and Salmonella from fresh water sources. For this reason pasteurization is the process of choice for millions of gallons of milk, beer, wine, honey and many other beverages in the industrialized world. The key to solar water pasteurization is to ensure that the water gets hot enough for long enough time (www.solarsolutions.info).

Figure 29: AquaPack

LifeStraw is a simple device, still in a prototype phase, designed for those unfortunate people in the Third World who do not have access to clean drinking water. The pipe is composed of two textile filters, followed by a chamber with beads impregnated with iodine. What first meets the water when sucked up is a pre-filter of PE filter textile with a mesh opening of one hundred micron, shortly followed by a second textile filter in polyester with a mesh opening of fifteen micron. In this way all big particles are filtered out;

even clusters of bacteria are removed. Then the water is led into a chamber of iodine impregnated beads, where bacteria, viruses and parasites are killed. The second chamber is a void space, where the iodine that does get washed off the beads can be maintained to preserve their killing effect. The last chamber consists of granulated active carbon, which absorbs the foul smell of iodine, and to take the parasites that have not been taken by the pre-filter or killed by the iodine. The biggest parasites will be taken by the pre-filter, the weakest will be killed by the iodine, and the medium range parasites will be picked up by the active carbon. This is better than tap water in many developed countries (www.medagadget.com).

Figure 30: LifeStraw

Chemical Sterilization

Various forms of chlorine and iodine chemical treatments are commonly used to disinfect drinking water. Chlorination is the most common method of chemically disinfecting water because it is easy to apply, readily available, and inexpensive. Chemical treatments usually leave an after-taste that some people may find unpleasant. The taste is caused by traces of chlorine or iodine, which are active halogens that can cause harmful health effects. It is possible to remove the taste by running the water through an activated carbon filter.

Improperly stored water quickly grows bacteria, which may have effects ranging from unpleasant to life-threatening. The ancients knew about the antibacterial properties of silver. Alexander the Great used silver urns to store water for his troops on extended sea journeys. They didn't know anything about bacteria, but they knew that drinking "old water" could make them sick, unless it was stored with silver. Solid silver will not usually disinfect water, but putting some old silverware or some jewelry into a storage container is a good way to prevent the growth of potentially harmful bacteria over long periods of time (Stein, 2000). The silver introduces metal ions into the water that retard or prohibit bacterial growth.

With the discovery that Cryptospordium cysts pose a significant health threat and often survive traditional chlorine water disinfection treatments, many municipalities have included chlorine dioxide in their water treatment process. Much like ozone water treatments, chlorine dioxide is a powerful oxidizing agent that can kill Cryptosporidium cysts and rapidly purify water. It does not leave the active halogen of

free chlorine in the water, so it makes for better-tasting water than water treated with traditional chlorination (Stein, 2000).

Recommended Chemical Additive

Called PUR - Purifier of Water, the chemical system consists of a packet containing a grayish powder composed of a variety of chemicals that collectively are capable of removing contaminates within minutes of being added to water. The main active ingredients of the powder are calcium hypochlorite, bleach, which can kill a wide range of deadly pathogens, and ferric sulfate, a particle binder that can remove impurities such as dirt and also disease-causing pathogens that aren't killed by the bleach. The packets can kill water-born pathogens that cause Cholera, Typhoid and Dysentery; remove a variety of toxic metals, including lead, arsenic and mercury; and also remove dangerous pesticides like DDT and PCB. The device is very efficient: a single packet can decontaminate two and a half gallons of drinking water, or enough drinking water to sustain a typical household for about two to three days. The packet is added to a large container of impure water, stirred, filtered through a cloth to remove impurities and then allowed to sit for twenty minutes (www.newswise.com). The net result is clear, safe drinking water.

Figure 31: PUR Powder

There's clearly a need for simple, safe and effective decontamination systems for Third World countries. Unlike large stationary purification systems, the packets are extremely small and portable, which allows them to be easily used in remote locations and emergency situations (Stein, 2000). This tiny system seems to fit that bill by quickly providing high water quality that can rival that of a modern treatment plant. In randomized, controlled trials conducted by the CDC involving a total of twenty five thousand people in three countries — Guatemala, Pakistan and Kenya — the chemical packets reduced the incidence of diarrhea by about fifty percent. The packets also were tested by researchers from Johns Hopkins University at a refugee camp in Liberia, where they produced more than a ninety percent reduction in diarrhea.

2.5 Shelter

Shelter and personal protection are extremely important components of survival. In a survival situation, you can quickly become incapacitated by the elements. This could include hyperthermia, heat that causes your body temperature to rise above thirty-seven degrees Celsius, or hypothermia, cold that causes your body temperature to drop below thirty-seven degrees Celsius. If your body enters either of these conditions, your mental and physical abilities diminish rapidly, and your chances of building a fire, signaling, navigating, etc. are drastically reduced. The same is true if you get severe sunburn or are swollen from unrelenting insect bites. Although not as debilitating as the above conditions, these still impede your ability to think clearly, which is why shelter and personal protection are of major importance (McCann, 2005). Once shelter has been acquired, it is important to stay protected from the elements as much as possible. Use the protection to keep any collected firewood dry and if it's possible use the shelter to collect heat from the fire. This arrangement will help dry out clothes and keep the firewood ready for use.

2.5.1 Personal Protection

Personal protection consists of anything that provides a positive advantage against the environment on a person by person basis. It could range anywhere from sunglasses or a poncho. Much of your body heat exists the body out of the top of the head so in order to preserve a body's core temperature it is vital to have head protection of some kind. This protection can also double to protect the head from the sun when necessary. Escaping heat can also be contained by emergency blankets. Some are cheap Mylar based sheets with aluminum coating on one side. The next step up would be a Thermo-lite based blanket manufactured by Adventure Medical Kits. The edges of the blanket are reinforced with waterproof binding tape. They print survival and first-aid instructions on a bright orange stripe on one side. It measures one hundred fifty centimeters by two hundred thirteen centimeters and is more durable for more frequent use. The most durable option is the MPI Outdoors All-Weather Blanket - a heavy duty blanket measuring one hundred fifty-two centimeters by two hundred thirteen centimeters. It is made from two layers of low density polyethylene blended with vapor-deposited aluminum. It is not as reflective as the thinner blankets and

is also only coated on one side. The other side is a solid color - red, blue, orange or olive. It is water-proof so it can be used as a ground cloth or shelter. It has a hood in one corner and hand inserts in two other corners, so you can hold the blanket around you with out exposing your hands to the weather. Of course, in a pinch, an emergency poncho can be used for rain protection, a waterproof ground cloth and a personal shelter if need be.

Figure 32: MPI All-Weather Blanket

2.5.2 Group Shelter

When setting up a group shelter it is important to take into account the context of site. One must understand how the runoff from rain interacts with the shelter. How much sunlight will the site get during the day? Is it possible to distribute the the shelter from the air? Is the site a safe environment? How far is the site from a water source? Will the shelter material be able to withstand the effects from the environment? These are some of the important questions to ask when setting up a shelter.

A tensile shelter fabric may be made of many materials including cotton, nylon, and polyester. Cotton absorbs water, so it can become very heavy when wet, but the associated swelling tends to block any minute holes so that wet cotton may be more waterproof than dry cotton. Nylon and polyester are much lighter than cotton and do not absorb much water; with suitable coatings they can be very waterproof, but they may deteriorate more over time due to a slow chemical breakdown caused by ultra-violet light found in sunlight. Since stitching makes tiny holes in a fabric, it is important that any seams are sealed or taped to

Figure 33: Small Tensile Structure

block up these holes.

It is possible to erect a tensile shelter out of an almost infinite list of materials, but for the purpose of this research a limited list will be recorded:

- Insulating Blankets
- Emergency Space Blankets
- Military Style Ponchos
- Mosquito Netting
- Tarpaulin Sheeting
- Canvas

There are three basic types of tents, but each type may appear in many different styles. A single skin or single wall uses a single waterproof layer of fabric, comprised of at least a roof and walls. A single skin with rain fly is the next. The rain fly is suspended over and clear of the roof of the tent; it often overlaps the tent roof slightly, but does not extend down the sides or ends of the tent. The last is the double skin or double wall version. The outer tent is like a rain fly, but extends right down to the ground all round. One or more inner tents provide sleeping areas. The outer tent may be just a little larger than the inner tent, or it may be a lot larger and provide a covered living area separate from the sleeping area. An inner tent does not need to be waterproof. When an outer tent is used, it is important that there be no contact with the inner tent it is protecting; this keeps the inner dry even if the outer is wet. Expedition tents often have extra poles to help ensure that wind does not blow the two layers into contact. The double layer will also provide some insulation.

Figure 34: A-Frame Tent with Rain Fly

Figure 35: Expedition Tent

A ground-sheet is used to provide a waterproof barrier between the ground and a sleeping bag. With double skin tents, the inner tents normally have a sewn-in ground-sheet, but a separate flat ground-sheet may be provided for any living area. With single skin tents,

the ground-sheet may be sewn in or separate. Normal practice with sewn-in ground-sheets is for it to extend some fifteen cm up the lower part of the walls; this deals with a situation where water seeps under the side walls of the tent.

Structural support typically comes from some type of pole system. They tend to be collapsible for easier transport and storage. Most designs use rigid or semi-rigid poles, typically made of metal, wood, fiberglass, or sometimes, metal alloys. Recently there have been a few companies that are exploring the use of pneumatic structure systems. There are two ways to construct this type of pole system. The first would be the integration of the bladder in the construction of the tent. The second would be a sleeve that would house a separate bladder that would be inserted into the skin of the shelter. The latter pneumatic option would allow a replacement bladder to be inserted if a hole was found in the structural member.

Multiple air vents should be provided to help reduce the effects of condensation. When people breathe, they expel quite a lot of water vapor. If the outside of the tent is colder than the inside, then this vapor will condense on the inside of the tent, on any clothing lying about, on the outside of a sleeping bag, etc, so that everything is damp in the morning. Hence it is important to have plenty of ventilation to help dispel the vapor and get it outside the tent, even if this lets in cold air and makes the tent feel a little cooler. Many inner tents are made of some breathable material so that water vapor can more easily pass through it.

Most pre-manufactured shelters don't require any construction or collection of external materials to erect them. However, after a disaster impact, there is a high probability that it will be necessary to construct a shelter out of debris. The process of providing shelter for your friends and family will be expedited if tools are available. The list below are tools that are suggested to have in a response kit to help with construction:

- Parachute Cord
- Instructions and Illustrations of Shelters
- Knife With Solid Blade That Extends Through The Handle
- Whetstone
- Axe or Hatchet
- Wiresaw With Straps or Rings On The Ends
- Military Style Poncho
- Emergency Blanket
- Folding Saw
- Military Style Shovel

Figure 36: Wiresaw with Rings

2.6 Food Preparation

A common belief is that people will eat anything if they are hungry enough. While this is obviously true of many, experience shows that a substantial proportion will go without, even starve, rather then eat unfamiliar or distasteful foods. This is particularly true of the young, ill and aged. The stress of crisis tends to increase rejection of strange foods even more then during normal times (Spigarelli, 2002).

2.6.1 Ration Types

When planning ahead for survival food, it is important to look at nutritional value. What sustenance is available needs to be of the highest quality. Traditional high heat canning processes destroy about sixty to eighty percent of a food's nutritive value, but low heat dehydration results in a loss of only about ten percent (Stein, 2000). Canned food is also bulky and adds extra weight to the kit. A popular choice is an all-in-one dehydrated meal packet. These type of packets were originally designed for the military and are known as Meals Ready to Eat (MREs). They have been extremely successful and have since spread into the consumer market. Each plastic pack contains an entree, side item, snack, salt, pepper, and a wet napkin. They are a well-rounded meal with lots of nutritional value, plus they deliver the required caloric intake.

Age Group	*1 - 3*	*4 - 6*	*7 - 10*	*11 - 14*	*15 - 18*	*19 - 59*	*60 - 74*	*75 +*
Male Caloric Needs	*1230*	*1715*	*1970*	*2220*	*2755*	*2550*	*2350*	*2100*
Female Caloric Needs	*1165*	*1545*	*1740*	*1845*	*2110*	*1940*	*1900*	*1810*

Table 1: Required Daily Caloric Intake

The big difference between MREs and previous types of military rations is that these taste good. MREs are packaged in a specially designed triple-layer foil and plastic pouches that are sealed, cooked and not ex-

posed to air until opened. MREs typically have a five to seven year shelf life if stored in a cool environment. But the nutritional value and taste deteriorate with an increase in ambient storage temperature. MREs are available in full meals that contain a meat, vegetable or fruit, peanut butter, high protein crackers, freeze-dried fruit bar, beverage base, accessory packet and a spoon. A useful feature is that they can be both eaten warm or cool. They can be heated by an internal heat pouch or just boiling the sealed bags.

Figure 37: Meal-Ready-to-Eat

Another option is a high calorie "trail bar." These are specially formulated bars that are non-thirst provoking and high in protein to help in a high stress situation. Each bar exceeds the normal daily requirements for vitamins and minerals. They typically have a five-year storage life and can withstand extreme temperature ranges, negative forty degrees Celsius to on eighty-nine degrees Celsius. A typical three day package contains nine bars which is close to three thousand six hundred calories per package. Because of their wide storage-temperature range and relative small size and weight, they are ideally suited for emergency kits.

Figure 38: MAYDAY Rations

Another option are freeze-dried long shelflife packages. The packs are nitrogen flushed, and have an expected shelf life of at least ten to fifteen years. This is the type of food you will want to obtain and store to prepare for a long-term survival situation. One important note is that dehydrated and freeze-dried food will require clean water to be able to reconstitute.

When an emergency happens, your first line of defense is the food in your refrigerator and pantry, assuming you are at home. Even if you have to flee, you will likely want to raid the pantry on the way out. The disadvantages to this as the only supply of emergency food is that this type of food typically has a relatively short shelf life, and most contain their own liquid water, and are therefore heavy to transport. With all

this in mind, below is a comprehensive list with different types of foods and condiments that should be considered when constructing an emergency food source.

- Hard Glucose Candy
- Beef Jerky
- Pre-Packaged Dehydrated Meals
- Bouillon Cubes
- Sugar
- Extended Life Freeze Dried Meals
- Salt
- Tea Bags
- Compact High-Calorie Bars

When in a survival situation, having the right tools can make all the difference. These tools allow for an easier transition from a typical post-disaster meal schedule to survival behavior. Some are for collecting food sources; others allow for easier and safer processing of meals.

- Gill Net
- Small Caliber Rifle
- Extra Ammunition For Rifle
- Slingshot
- 3” or Larger Solid Bladed Knife
- Fishing Line
- Fishing Hooks
- Basic Fishing Lures
- Wire For Snares

2.6.1 Stove Types

Once the initial confusion settles, after water sources have been procured, a shelter has been erected, and a system is in place for signaling aid, then preparing a meal should be on the mind of the survivors. As mentioned previously, there are ways of finding sustenance without actually preparing a meal. However, one great thing a warm meal does is boost low morale. If the conditions are favorable then preparing a hot meal should be a high priority. Open flame, gas fuel, liquid fuel, and solid fuel tablets are a few methods that can be followed to produce a heat source.

Open Fire

The tried and true method of using an open fire is a great way to prepare a meal. A campfire, by nature, exudes a feeling of safety and security and is a perfect way to increase low morale. By using some magnesium filings, a quick fire can be made in the wettest of conditions by igniting them with either waterproof matches or with a butane lighter. Once the fire has settled, a metal grill or even folded aluminum foil

can be used as a base to cook food on. Under the worst conditions an extended-time candle can even be used as a heat source. If there is a way to suspend a metal container over the flame the food can be slowly warmed. Of course, this method might not be able to thoroughly cook through some thicker meat. Precautions should be taken to prevent sickness from improperly cooked food.

Figure 39: Magnesium Block

When dealing with a gas or liquid fuel stove there are many options to understand before deciding on which stove you want to rely on in a survival situation. There are different fuel types, distinctive size classifications and varying levels of technology. All of these help determine the correct stove for the needs of the users.

Family camping stoves

These stoves are easy to use and designed with safety in mind, with the expectation that the users are relatively inexperienced. They are the largest of the three types, partly because they need to feed a family and partly because weight is less of an issue than the following two types. As a minimum, they will have a large gas cooking element, also known as a hob, much like one would find on a domestic gas stove, but it is common to have more than one and some even have a grill attached as well. In addition to the stove itself being relatively large, the gas canister attached to it will be relatively large as well.

Figure 40: Coleman Family Stove

Backpacking stoves

These stoves are designed with the idea that they will be carried substantial distances in a

Figure 41: MSR Backpack Stove

backpack during hiking, rambling, cycling or fishing trips. Consequently, weight is an important issue, so they tend to be smaller then family camping stoves and of a lighter construction. To meet this requirement, they will generally have only one hob, which is of moderate size. They may be gas or a liquid fuel; in any case the fuel container will be smaller than with a family camping stove; partly to save weight, partly because the intention is to provide a very basic small group meal.

Mountain stoves

These stoves are designed for minimum size and weight, both in terms of the stove itself and the fuel. It also operates very well under very cold conditions and in low atmospheric pressure. Consequently, they are very lightweight and generally use a liquid fuel. Liquid fuels give the best performance under difficult conditions and also give the most heat for a given amount of weight. One can also find mountain stoves that use a gas as a fuel. To save on size and weight they have only a single, small hob. They may also be more complicated to use, as ease-of-use is also sacrificed to save weight and space.

Figure 42: Lightweight Hiking Stove

2.6.2 Gas Fuel

A gas canister consists of a metal container filled with burnable gas such as butane or propane, much the same as the container for a gas barbecue, except smaller. Stoves using gas are generally easy to start and to use; just turn on the gas and light it. However, they are not as suitable for high altitudes or very cold conditions as other fuel options might be. Also, when the container is empty, it may not be possible to refill it, so one must dispose of the canister and buy a new one, which is wasteful and makes this fuel type more expensive, as one has to pay not only for the fuel, but for the container each time. The gas can be Propane, Butane or a mixture of multiple. Gas stoves tend to be less expensive than liquid fuel stoves to buy but have a higher running cost, because the fuel is more expensive. With some gas stoves the gas can-

ister connects directly to the stove whereas with others, the gas canister connects via tubes or gas lines. The former tends to be a lighter and simpler package overall.

Propane

Propane burns cleanly and produces a hot, steady flame. It works well in very cold temperatures and at high altitudes. However, the gas canisters for propane have thick metal walls, making them unsuitable for applications where weight is important, like mountain or long distance backpacking.

Butane

Butane burns well and work at high altitudes. However, it is not very hot and does not work well at low temperatures, as the gas doesn't vaporize well. However, the gas canister is lighter than for Propane.

2.6.4 Liquid Fuel

A liquid fuel will work more efficiently in harsh conditions than gas, as in very cold conditions and in low atmospheric pressure conditions. It burns hotter than gas, food cooks quicker, and performs better in windy conditions. It has a better heating capacity to weight performance than gas, so it is often preferred in conditions where weight is important. It also has a lower running cost by just simply refilling the canister when empty, rather than buying a new canister. With gas stoves the heating capacity drops as the gas canister empties due to a drop in pressure, but with liquid fuel stoves, the heating capacity is unaffected by the amount of fuel left. However, stoves based on liquid fuel are somewhat more complicated and take more effort to light. To start the stove the fuel has to be pressurized, normally by a pump built into the stove, and priming is needed to pre-heat the fuel and convert it to gas.

With liquid fuel stoves, in addition to the intended type of liquid fuel, white gas or Coleman fuel, the stoves will often burn a variety of different liquid fuels such as diesel, kerosene, alcohol, and gasoline. While these alternative fuels are generally inferior to the standard liquid fuels, they are readily available almost anywhere. Consequently, if traveling in undeveloped countries or remote regions where standard camping stove fuels are unavailable, the ability to use these backup fuels may be important to you.

White Gas (Coleman fuel)

This fuel burns cleanly and provides strong heat which provides fast cooking times. It performs very well in most weather conditions. If spilled, it evaporates quickly and without leaving an odor. It is widely available in the UK and North America, but may be difficult to find in many countries. Coleman fuel is a proprietary version of white gas which has been specifically created for Coleman stoves, but is ideal for most liquid fuel stoves.

Alcohol

Alcohol burns cleanly and is a relatively safe fuel. If spilled, it evaporates quickly and also without leaving an odor. However, it burns cooler than other fuels and with less efficiency; it has a poor heat to weight ratio. Plus, it is also relatively expensive. Also, with clear alcohol it can be difficult to see the flame, which can be a safety issue.

Kerosene

Kerosene is inexpensive and widely available in almost all countries. However, it is a dirty fuel and can gum up fuel lines, requiring more cleaning and maintenance of your stove. Also, the fumes smell and are toxic. However, it is somewhat safer than gasoline.

Unleaded gasoline

Gasoline is widely available and relatively inexpensive, but burns very dirty. It also tends to gum up fuel lines. If it spills, it can ignite easily and under certain conditions can easily explode. The fumes are toxic and should be used in a well-ventilated space. Consequently, it is an undesirable fuel which should only be used if no suitable fuels are available.

Methylated Spirits

Methylated spirits is a safe fuel as it is less explosive and burns at a lower temperature. However, the fact that it burns at a lower temperature means that your stove takes longer to cook your food.

2.6.5 Other Fuel

Solid Fuel and Gels

Stoves that use solid fuel tablets or gels are generally safe, inexpensive and lightweight. However, it is difficult to regulate the temperature of the fuel. Also, stoves based on these fuel types do not to cook food as quickly as gas canisters and liquid fuel.

Other fuels

There are a range of stoves which use other fuels, including ones designed for burning wood that one finds in the forest. Finally, there are solar stoves, which are very environmentally friendly but have the drawback of being very slow and dependent on the weather.

2.6.6 Cooking + Eating Equipment

Having the appropriate stove is a great advantage in an already stressful environment, but so is having the appropriate supporting cooking equipment and eating utensils. The following list is common gear that will help create a positive meal experience for those in a primitive cooking situation.

- Aluminum Foil 1 sq yd. - 2
- Butane Lighter
- Flint and Steel
- Extra Solid Fuel Tablets
- Cooking Utensils
- Waterproof Matches
- Candles
- Foldable Steel Grill for Open Fire
- Extra Fuel Bottles
- Magnesium Fire Starter
- Lightweight Pot for Boiling Water
- Compact Plates and Bowls
- Lightweight Eating Utensils

3.0 Design

The purpose of this study was to locate difficulties we, as a society, have with our preparation and response to disasters and then use this knowledge to find the best method of implementing the answers. We knowingly put people in harm's way through our dangerous building and community planning practices, poor disaster planning and preparation, and ineffective response practices. We then wonder why it happened to us when we get caught in a major catastrophe. We use natural resources without trying to replenish them and rarely wonder how our environment will react without them around. Our relationship with nature needs to change. Instead of seeing nature as a source of raw materials, we should see nature as a source of ideas, as a mentor. This would change everything, ushering in a new era based not on what we can extract from nature, but on what we can learn from it (Lefteri, 2006). No matter where disasters happen, they are affecting an increasing number of people every year; this is due to our constant increase in population. As long as we call Earth our home, these growing pains will continue until we decide to change our ways or learn to control nature. It's obvious which one of these will happen first.

Many of those people that are affected by a disaster are those displaced due to the loss of their homes. Sending aid to these people instead of forcing them to leave their communities can help both the families and neighborhoods begin the rebuilding process quicker. One of the major problems in allowing the survivors to stay in the impact zone is trying to get supplies to them. A reoccurring problem is that debris blankets the routes that aid would be brought into the area. This dilemma was fully experienced after Hurricane Andrew. It took days to weeks to fully reach all those in need.

Designing a response system that can be air-dropped or trucked-in would assist survivors begin their normal life again. All of their physiological needs would be protected, waiting for them to unlock the shell and access them. The important part about this is, once these biological needs are met, the survivors are free to begin the reconstruction process. They can look for missing loved ones, locate family heirlooms within the debris or start cleaning their neighborhood. The significant thing is that they are still around

their friends, family, and coworkers, instead of being shipped-off to a shelter in possibly another state.

These families would be living with the supplies needed to sustain life through the early stages of the disaster-relief phase. They are alive and with those they care about. We should use this time to subconsciously influence new opinions on life requirements. We can show people they can live with the land, with friends and family, and with all that is needed to have a fulfilling life without having to collect a wealth of material goods. It would be a communal way of life where you rely on your neighbors and they rely on you. It is a way of life that is being lost to the modern society of anonymity.

The first-response capsules presented here are created from the analyzation of all the information presented earlier. The outcome is a kit that includes resources for four family members to live on for seventy-two hours without assistance from exterior aid. This includes first-aid, shelter, water, food, and signaling equipment. The seventy-two-hour life-span can be extended by providing additional food sources and supplying minimal items of comfort such as clothing and additional blankets.

3.1 Storage Case

3.1.1 Design

The storage case that protects all of the supplies and tools is divided into three sections. One side houses the group shelter system and its pneumatic-inflation kit. The middle section is a three-quarter length backboard with perforations for tool storage. The other side contains the supplies and equipment for first aid, rations, and water collection and purification.

Figure 43: First Response Kit

All parts that make up the kit could be made from polypropylene, PP. It's a good material choice due to its exceptional strength and resilience. PP is also a relatively environmentally-friendly plastic. It's an inert material made through the most energy-efficient process among commodity polymers and is very easy to recycle (Ashby, 2002

Figure 44: Single Disconnected Shell

The shell, backboard, and locking handle pieces are all rotational-molded. Rotational-molding is one of the few processes able to make hollow shapes. It works very well for rounded forms without much fine detail. Tooling and equipment costs are low compared to other molding methods, but the time per piece is longer (Ashby, 2002).

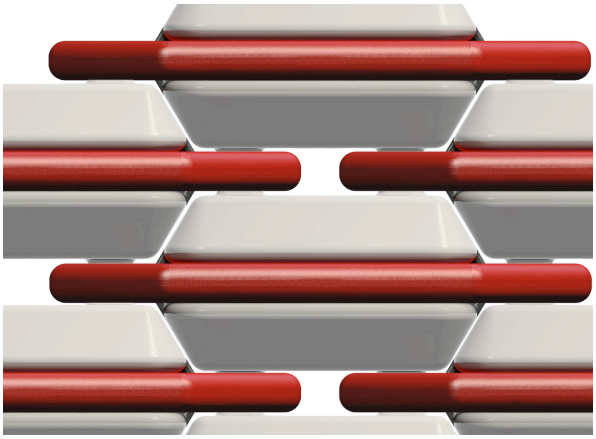


Figure 45: Nested Response Kits

The design of the case allows many of them to be securely interlocked together so they can be shipped on a pallet. Once on a pallet, the group of response kits can be air-dropped or trucked into the impact area. The symmetrical raised sections on the outside of the shell pieces allow a positive lock into the handles of the backboard from another kit.

3.1.2 Product Language + Color Theory

Of all the forms of non-verbal communication, color is the most instantaneous method of conveying messages and meanings. Before humans learned to appreciate the aesthetics of color, there were far more practical aspects of communicating with color. Our very survival depends on the ability to identify necessary objects and warning signals. Much of the reaction to color is subliminal and people are generally unaware of the pervasive and persuasive effects of color. Cross-culturally, there are some generalities that can be made about the human response to color, largely because of the psychological associations and physiological reactions to color that are universal. The psychological effect is instantaneous as color stimulates the senses and exerts its power of suggestion (Eiseman, 2000). Below are the colors for each part of the storage shell and why they were chosen:

Containment Shells - White

White imparts a sense of purity and simplicity. When out among the built-environment white is seen as a brilliant color. For that reason, it works well in this situation where we want it to catch the eye of a survivor. When the color is used for products, it produces a sense of cleanliness and good hygiene. By using a glossy white shell for all of the life sustaining resources, it helps promote the feeling that everything within is sanitized and ready for use (Eiseman, 2000).

Figure 46: White Storage Shell

Backboard - Red

Red has a psychological association to blood and fire, two very important elements that are necessary to sustain life. Red has a tendency to alter body chemistry, causing one to breathe more rapidly, in-

crease blood pressure, the flow of adrenaline, and also causes mild perspiration. As a result, red is indelibly imprinted on the human mind, commanding attention and demanding action. The textured red handles stick out past the shells inviting users to grab them. The numerous handles allow the case to be carried by multiple people on either side or by a single survivor with it hanging to one side. The backboard is designed to be a portable toolkit. A small shovel, foldable saw, and prybar/ hammer combination tool are housed within the thickness of the backboard. This purpose of embedding the tools within the board is to allow the user an easy way to carry the necessary tools when out trying to locate and extract others from the surrounding ruins (Eiseman, 2000).

Figure 47: Red Backboard with Embedded Tools

Figure 48: Gray Handle in Locked Position

Locking Handles - Gray

Gray is seen as solid and enduring and produces a sense of durability and permanence. It produces a feeling of quality where dependable performance is of the utmost importance. The textured handles align with the exterior skin to protect them from being accidently released; however, due to the shape, color, and surrounding depressions, the product language tells the user to flip them down. While rotating down they force the shell up and away from the base and unlock it to access the supplies protected inside (Eiseman, 2000).

3.2 Preservation

The first response kit will include most of the medical, fabrication, and sanitation items discussed earlier along with a few extra things. Below is a list of the products included:

3.2.1 Medical Dressings

- Sealed Sterile Gauze Pads 3” x 3”
- Sealed Sterile Gauze Pads 2” x 2”
- Elastic Compress-Type Bandages 3" Wide Rolls - 2
- Muslin Bandage Sheet 37" x 52"
- Adhesive Cloth Tape Roll 1” Wide
- Trauma Pads 5” x 9”
- Adhesive Wound Closure Strips 1/4” x 3”
- Variety of Adhesive Bandages 1 Box
- Triangular Bandages - 2
- Alcohol-Soaked Packaged Pads - 10
- Eye Wound Gauze Pads - 2

Figure 49: Medical Dressings

3.2.2 Repellant, Ointment, Medicine, Sterilizer

- Baking Soda
- Insect Repellent
- Anti-diarrhea pills
- Laxatives
- Pain Relief Tablets
- Local Antiseptic Solution
- Sunburn Prevention Ointment
- Alcohol [in plastic container]
- Triple Antibacterial Ointment
- Antihistamine Tablets
- Chapstick
- Sting and Bite Kit
- Sterile Applicator Sticks - 3
- Burn Gel
- Calamine Lotion
- Eye Wash
- Medicated Body Powder

Figure 50: Ointments and Repellants

3.2.3 Hygiene

- Sanitary Napkins
- Toilet Paper
- Toothbrushes - 4
- Toothpaste
- Camp Soap
- Deodorant
- Antibacterial Lotion

Figure 51: Hygiene Components of Kit

3.2.4 Ancillary

- Bandana
- CPR Mask
- Emergency Dental Kit
- 90 MPH Military Tape
- Thermometer
- Ammonia Inhalants [1/3cc, 10 units]
- N95 Style Gas Mask
- SAM Moldable Aluminum Splint
- Instant Cold/Heat Packs - 2 of Each
- Blood Clot Powder
- Instruction Booklet
- Goggles
- Radiological Protection Tablets - Neumune
- AM/FM Weather Multi-Power Radio
- Crayons
- Entertainment Book

Figure 52: Supplementary Items

3.2.5 Tools

- Scissors
- Tweezers
- EMT Shears
- Safety Pins
- Single Edged Razor Blades
- Irrigation Syringe
- Hatchet
- Small Foldable Shovel
- Demolition Tool
- Single Piece Knife
- Manual Chain Saw

Figure 53: Tools Included in the Kit

3.2.6 Personal Protection

- Gloves
- Emergency Poncho - 4
- Emergency Blanket - 4
- Thermal All-Weather Blanket - 4

Figure 54: Personal Environmental Protection

3.3 Shelter

Disasters invariably bring out proposals for so-called emergency housing. Architects in the past have proposed a variety of ingenious shelters, including prefabs, inflatables, geodesic dome kits, sprayed polyurethane igloos, and temporary housing made of cardboard tubes and plastic beer crates. These new ideas are often untested "universal" solutions generally prohibitively expensive, and their exotic forms are usually ill-suited to local conditions. That may be why such shelters, when they have been deployed, have frequently been rejected by users, and why historically the most common temporary shelter is the tent (Rybczynski, 2005). Emergency housing sounds compelling, but due the concerns previously mentioned it almost never works.

The least popular forms of emergency housing are communal shelters. In an emergency, people seek the support of the family. Since our idea of the family is inextricably linked to having a space of one's own, what people want is some kind of home. When offered the choice, people put temporary shared-housing very low on the preference list. Disaster after disaster demonstrates that what people want is not a temporary roof, but to go home, to be among surviving family and friends, and to start rebuilding their lives (Rybczynski, 2005).

The vast international experience of governmental and non-governmental disaster relief agencies around the world suggests that the best strategy is to begin reconstruction as soon as possible. The reason for this is that the universal characteristic of post-disaster recovery is human improvisation and inventive

resourcefulness. After the first shock, people invariably bounce back (Rybczynski, 2005). The more resources are poured into temporary arrangements—such as trailers and cruise ships—the less that are available for reconstruction. In many cases, the longer that people are being taken care of, the later they start to live in their own houses on their own streets, and the later they begin their long road back to a normal life. Most of the rebuilding of cities will not be done by government but by the private sector, much of it by small contractors, do-it-yourselfers, and volunteers. Americans, more than most, are a nation of handymen. Their individual spirit of improvisation and inventiveness must be allowed to do its part.

An emergency shelter serves several vital functions:

1. Protection against cold, heat, wind, and rain
2. Storage of belongings and protection of property
3. The establishment of territorial claims - ownership and occupancy rights
4.. Emotional security and the need for privacy
5. An address for the receipt of services - medical, food, etc
6. The establishment of a staging point for future actions
7. Shelter within commuting distance of employment

The nature of nomadic and migratory peoples' relationship with the lands they inhabit should be examined in order to develop our understanding of one of the crucial factors in creating meaningful environments: the creation of a sense of place. Nomadic peoples have no permanent geographical base, though they do generally range within a defined territory, often associating specific parts of that territory with certain times of the year. This may be linked with climate, as in the herding tribes on North Africa, or linked with the migration or availability of their prey, as in the case of hunters. These societies generally have no more possessions than those that they carry with them, objects which may be shared among the group or individually owned. Because everything must be transported, very little is there which is not required for survival, though this does not mean that dwellings and possessions are not without comfort and beauty. The relationship with the territory is more profound than in permanent settlements as the nomad not only passes through the land but lives off it and must be receptive to its nuances (Kronenburg, 2002).

A suitable shelter can play a major role in preventing further distress, illness, and death if it is made available immediately. Therefore, emergency shelter must be in use by the victims within the first few days of the post-disaster situation if it is to be at all effective. It should therefore be capable of being speedily erected with minimum effort, and of fulfilling its function for the duration of the emergency period with minimal maintenance (Kronenburg, 2002).

3.3.1 Design

As mentioned earlier, this shelter was designed around a family of four. Extra storage and space for a restroom are located across an open air gathering space from the sleeping compartment. This exterior space can be used to cook meals, it helps produce air flow through the shelter, and it can be used to store supplies and found items.

The tent's structure is a series of air bladders designed to deliver constant pressure from one bladder to another as it travels around the shelter. The bladders are designed like an unrolled bicycle's tire inner-tube. The bladders are sheathed inbetween the main compartment and the rain cover. This helps keep the two fabrics apart, which keeps the inner tent dry and insulated. Included in the kit is a one-time-use gas canister to inflate the tent for the first time. The pressurized air allows the tent to be erected in less than a minute. Also included is a small integrated pump. This will help keep the structure at optimal pressure to withstand gravity and the effects from the environment.

The outer layer rain cover protects the inner tent from the elements and also provides protection over the open air space between the two compartments. On one side of the shelter there is a funnel formed into the rain cover to collect water and direct it into a filtration and collection system. More will be discussed about this later, but the filter and water storage come disconnected until the shelter is erected. The rain cover also provides protection for the windows in the inner tent so they can open, providing cross ventilation, while still providing a defense against the environment.

3.3.2 Color Theory

Color has always been used symbolically, whether painted directly on the body or worn through garments to announce the wearer's social status, their tribe, or other significant group. By using color, these shelters will announce to those passing through, to those coming to help, and to those who live in them that they are part of the same tribe. They are a tribe banded together against the ruinous situation and attempting to beat the odds to rebuild their neighborhood lost due to the effects of a disaster. Below are the colors chosen for parts of the shelter system and why they were chosen:

Rain Cover - Orange

Temperature wise, orange is seen as the hottest of all colors. It contains some of the drama of red, tempered by the cheerful humor of yellow. Orange has been known to help strengthen the immune system. It has also been shown to have only positive affects on your emotional state. This color relieves feelings of self-pity, lack of self-worth, and unwillingness to forgive. Orange opens your emotions and is a terrific antidepressant (Eiseman, 2000).

Figure 55: Sketch of Shelter with Orange Rain Cover

Inner Tent - Blue

In contrast to red, blue proves to lower blood pressure. Blue also has a very cooling and soothing affect, often making us calmer. It can stimulate the pituitary gland, which then regulates our sleep patterns.

This color can be very useful in eliminating insomnia. Blue inspires mental control, clarity, and creativity (Eiseman, 2000).

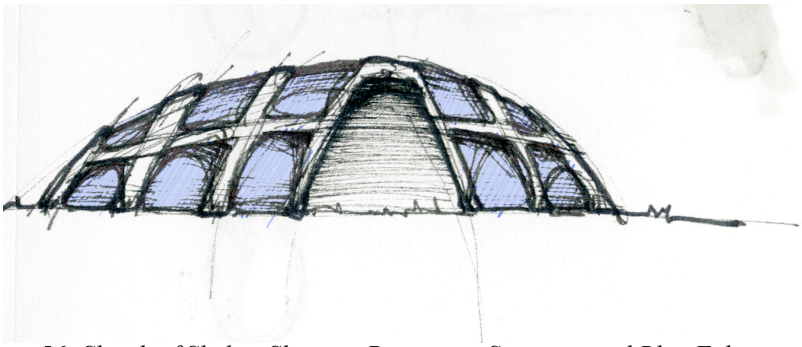


Figure 56: Sketch of Shelter Showing Pneumatic Structure and Blue Fabric

3.3.3 Materials

By utilizing state of the art materials, it is possible to turn a simple tent structure into a comfortable environment that even the most diehard urbanite can endure. By separating the skin into two layers it helps twofold. One, as previously mentioned, it helps with the protection and insulation of the interior space. Second, it allows two different material technologies to be utilized.

Rain Cover

The rain cover is made with a new solar collection system embedded into the fabric. The flexible, power-generating material looks like denim and can be draped over just about any shape. Unlike conventional solar cells, the new, cheap material has no rigid silicon base. Instead, it is made of thou-

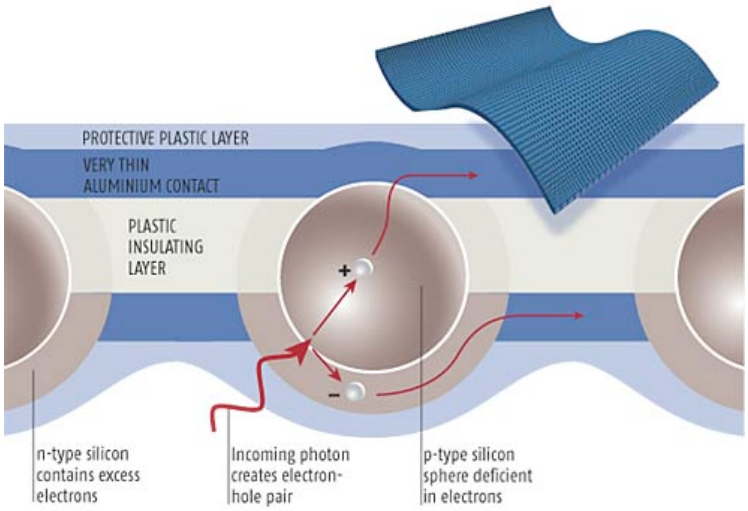


Figure 57: Silicon-Bead Solar Collection Fabric

sands of inexpensive silicon beads sandwiched between two thin layers of aluminum foil and sealed on both sides with plastic fabric (www.newscientist.com, 2003). Each bead functions as a tiny solar cell, absorbing sunlight and converting it into electricity. The aluminum sheets give the material physical strength and act as electrical contact.

The manufacturing process uses waste silicon from the chip-making industry, which is melted down and shaped into spheres about one millimeter across. The bumpy surface presented by the spheres offers a large area for absorbing light, giving the material an overall efficiency of eleven percent. This is comparable to the performance of conventional photovoltaic cells, and much better than proposed flexible designs based on conducting polymers (www.newscientist.com, 2003).

Inner Tent

The second method of energy collection is through a radiation conversion material that is blended onto the fabric of the inner tent. Organic photovoltaic technology is ultra-low cost high-power solar cells that are responsive to light in the near-infrared (NIR) range of the solar spectrum. NIR radiation is invisible to the human eye. Night-vision devices operate by sensing infrared light which is emitted by warm objects and makes up a substantial portion of all energy reaching the earth from the sun (www.oemagazine.com). Under only NIR radiation, the solar cell would appear to be generating power in the dark, as the human eye is only sensitive to visible light.

These organic devices are assembled literally a molecule at a time in highly efficient nanostructures. These devices have layers and structural elements that can be extremely small -- at only 0.5 billionth of a meter thick and can be applied to low-cost, flexible surfaces. This latest break-though demonstrates that significant power can be harvested from the IR and near-IR portion of the solar spectrum. In fact, this novel approach has the potential to double the power output of organic solar devices with power harvested from the near-IR and IR portion of the solar spectrum (www.oemagazine.com, 2006).

3.3.4 Power Storage

In order to store the power supplied from the solar collection systems, an ultra-capacitor stored in the same location as the structural inflation system would be utilized. Technology is being developed to improve ultra-capacitors by swapping in carbon nanotubes, thereby greatly increasing the surface area of electrodes and the ability to store energy (Bullis, 2006). Ultra-capacitors are a higly-improved version of the capacitors widely used in electronics. They're well-known for being powerful, that is, able to quickly absorb and release electricity, but they can't store much energy so their stored electricity is depleted in a matter of seconds. A way to improve the endurance of ultra-capacitors several-fold is by allowing the devices to retain the power and longevity advantages, while storing about as much energy as the batteries used in hybrid cars. The amount of energy ultra-capacitors can hold is related to the surface area and conductivity of their electrodes. This is attained by increasing the surface area by using carbon nanotubes. One square centimeter of conductive plate when coated with the nanotubes has a surface area of about fifty thousand square centimeters, compared with two thousand square centimeters using the carbon in a commercial ultra-capacitor today, thereby, producing a small, powerful, and quickly rechargeable power storage solution (www.technologyreview.com, 2006).

3.3.5 Lighting

To utilize the energy stored in the ultra-capacitor, a new energy efficient high-brightness solid-state lighting (HBLEDs) system can be woven into the skin of the tent. This new technology means that a bright digital light of eighty lumens per, watt which is bright enough to read, work, and illuminate areas at night, can be produced by a single miniature diode and powered by just a small amount of power (www.caup.umich.edu).

3.4 Water

Considering how important water is to the survival of our species, water is an integral part of this survival system. The first thing the user will encounter after opening the kit is a reserve of sealed emergency water. These packets have a very long shelf-life and pack relatively flat. Two packets per day is the recommended minimum consumption.

Figure 58: Emergency Water and Containers

The filtration and purification system includes a product similar to the Lifestraw discussed earlier. The adapted version would include connections on both ends to connect to the included five gallon collapsible storage container and the funnel-system in the rain cover. Once the container is full, it can be disconnected from the shelter and stored for later consumption. Other components of the collection and filtration system include a collapsible funnel to facilitate the transfer of collected water to other containers, four collapsible wide-mouth canteens, and purification tablets to drop in collected water.

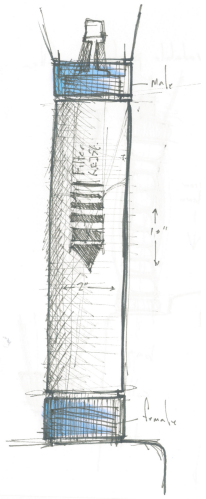


Figure 59: Sketch of Water Filter

3.5 Food

3.5.1 Supplied Rations

Mountain House is the same company that supplies freeze-dried meals for the NASA space program and most of the food on the space shuttle. Freeze-dried meals from Mountain House are lightweight and yet are still able to offer hearty servings. The packets have a super long shelf-life of up to five years. Freeze-dried foods are easy to prepare by just adding hot water. If a heat source is not available, room temperature or cold water can be used, too. Since cooking is not needed, these foods require much less water and fuel than most fresh, frozen, or dehydrated foods.

Figure 60: Dehydrated Meal Packets

3.5.2 Cooking Supplies

The only real cooking supplies needed would be a pot to boil water in, a small pan, and the utensils needed to cook with. The height of the pot would be limited to two and a half inches due to the interior height restrictions. There are a few off-the-shelf lightweight hiking cook kits that would meet the equipment restrictions. Pictured here are two steel pots that store nested within one another. The dimensions are within the required limits. The sizes are small, but it is important to remember that during the initial relief phase the main purpose is going to be just boiling water. When exterior help arrives, more complex packaged meals will arrive with the appropriate hardware.

Figure 61: Basic Cooking Pots

3.5.3 Fire Starting + Stove Equipment

Included in the kit are flint and steel fire-starting tools. They are very dependable redundancy to the water-proof matches that are also included in the response kit. An included small block of magnesium will provide an extremely hot, two thousand two hundred degree Celsius flame to catch even the wettest tinder on fire. When a spark is used on a small pile of scraped-off magnesium it will continue to stay explosively lit until all of the shavings are consumed.

Figure 62: Multi-Fuel Stove

The included stove is the Brunton Optimus Nova, a small lightweight hiking stove. This multi-fuel stove efficiently burns almost every type of liquid fuel - diesel, kerosene, white gasoline, Coleman fuel, automotive fuel, jet fuel, and other similar fuels. It is nine by eleven by six centimeters when folded. The Nova has precision simmering control which allows for better control of the heat during cooking.

3.5.4 Eating Utensils

Included is a lightweight, highly portable place-setting manufactured by Orikaso. These durable pieces are made from polypropylene, a material that is lighter than titanium. This product is endorsed by Greenpeace because it is made from recycled materials. They pack up nicely and once they are packed together, they are less than a half inch in thickness for the entire set. They are derived from origami. A flat piece of material is folded to create a cup, bowl, or plate (www.orikaso.com). This already good solution could get better by replacing the polypropylene with a bio-plastic, which is a plastic derived from a rapidly renewable source that it is both biodegradable and compost-able.

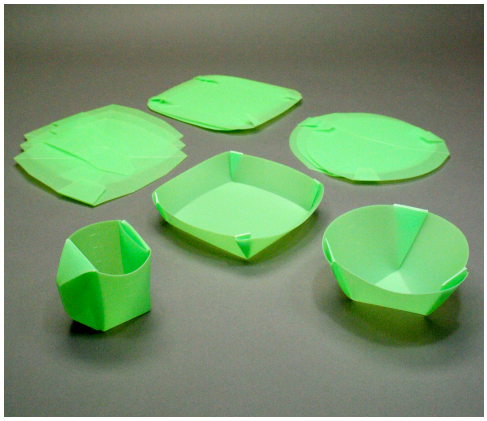


Figure 63:Origami Place Settings

Earthware Biodegradables uses a bio-plastic in their new cooking and eating utensils. They offer a wheat-based spoon, fork, knife and spoon/fork combinations. They exceed US government standards for biodegradation and can safely be composted, breaking down completely in three to six weeks. The wheat-based cutlery is heat resistant and excellent for hot foods and beverages. They have a five year shelf-life.

Figure 64: Spoon, Fork, and Knife Combo

2.5 Signaling

The two signaling devices included are a whistle and an emergency mirror. A chemical light stick, flashlight, and an open fire can also be used as a signaling device during the evening.

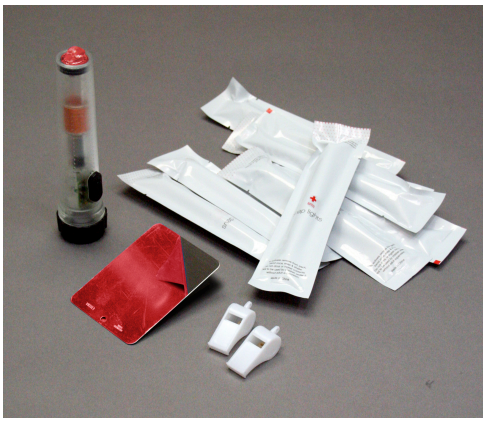
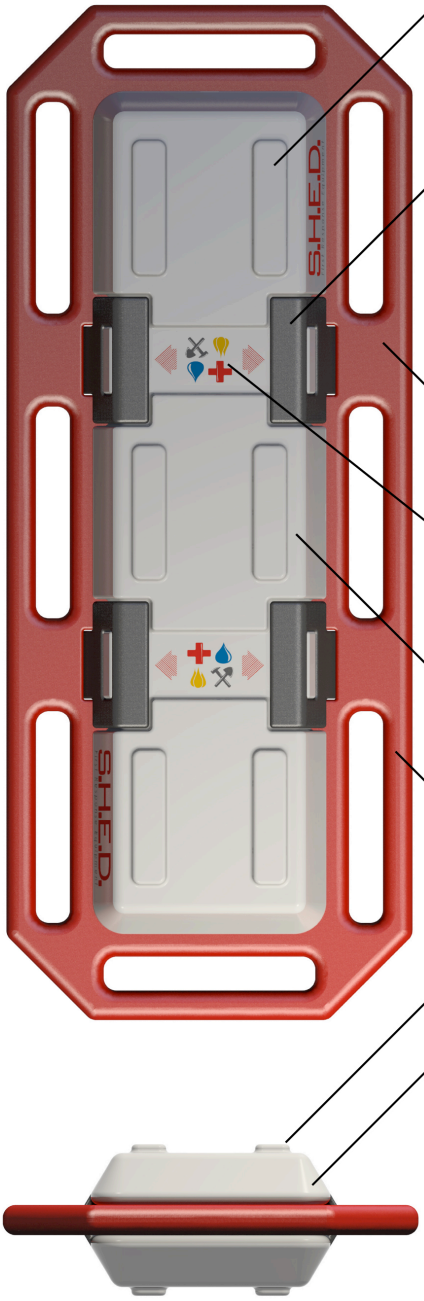


Figure 65: Signaling Equipment

4.0 Visual Conclusion



Raised section locks into main board
Dof other kits for transportation.

Handle locks into main board
and onto white storage shell.

Red was used to catch the attention of the user.

Graphic information guides the user to choose which side of the case to open.

The shells are white so they stand out among typical urban debris.

Handles on every side allow the kit to be carried by many people or just one.

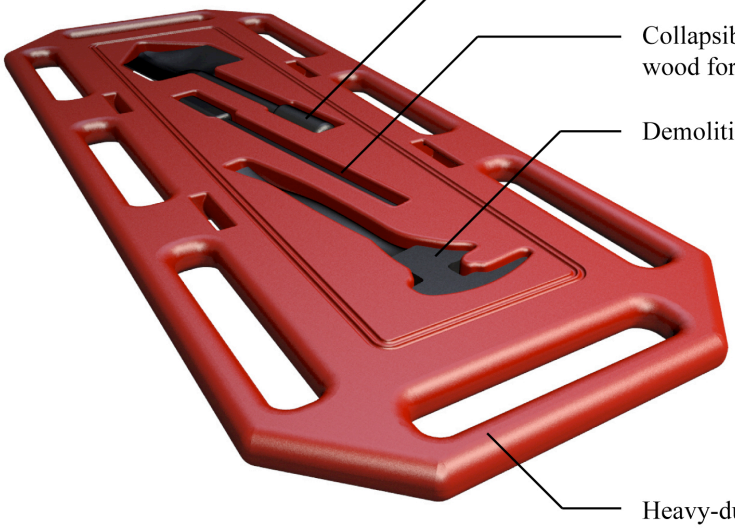
The raised section act as barriers to help protect the case against rough environments.

Low profile design allow one person to carry this product along their side.

Hooks extend into boardto lock down the shell.

Double o-ring provide a waterproof seal protecting the contents from the environment.

Interior compartment for survival resources.

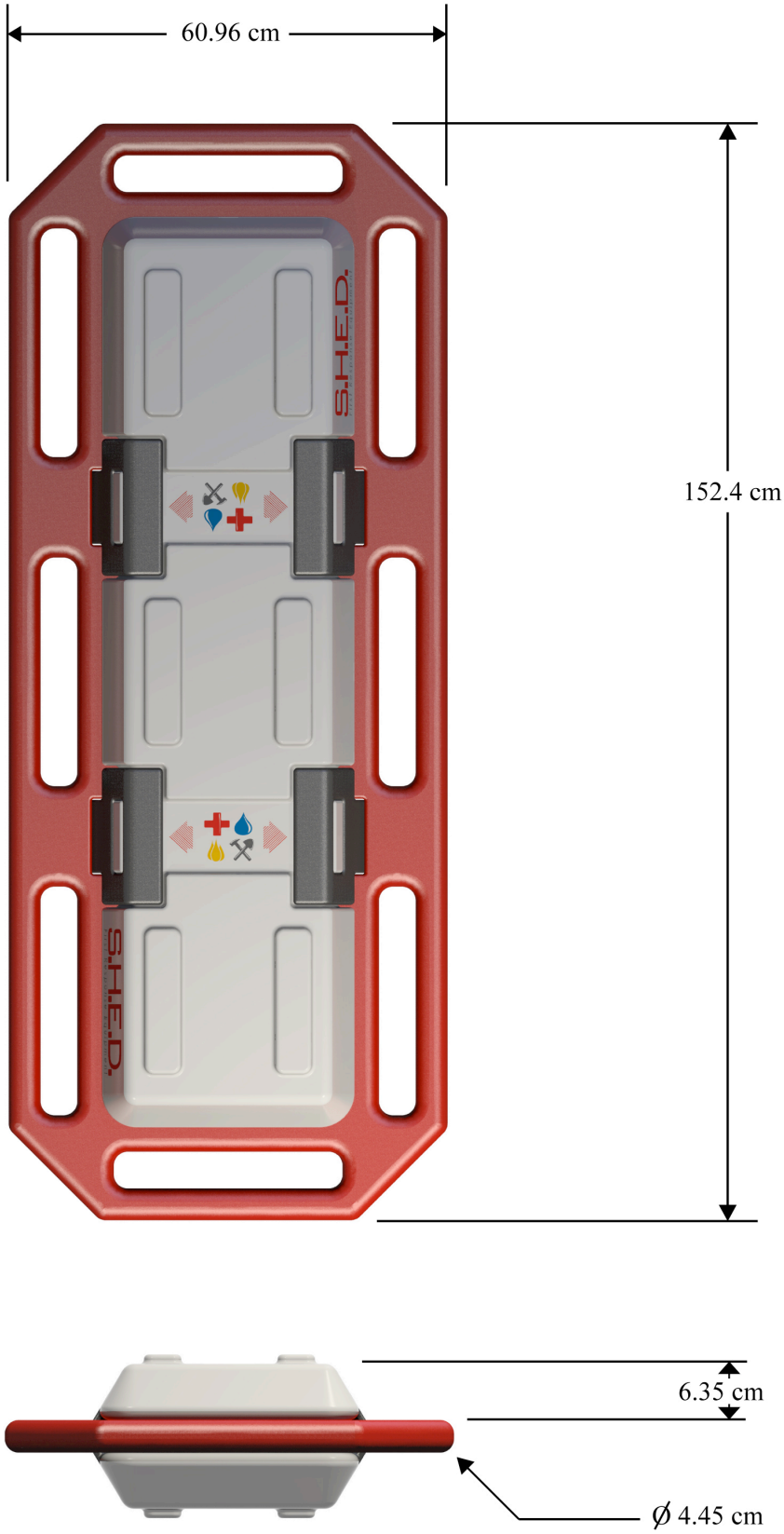


Shovel for trench building, latrine construction and waste burial.

Collapsible saw for construction and sizing wood for fire building.

Demolition tool for resue and construction.

Heavy-duty handles allow for postive grip.


60.96 cm
152.4 cm
S.H.E.D.
S.H.E.D.
6.35 cm
Ø 4.45 cm