Climate Change and Disaster Management

Ross Prizzia

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Dedicated to my children, Frances, Rossi, and Rocco.

Thanks and Aloha,
Ross
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Evidence of Climate Change

The scientific opinion on climate change is that the Earth's climate system is unequivocally warming, and it is extremely likely (at least 95% probability) that humans are causing most of it through activities such as deforestation and burning fossil fuels that increase concentrations of greenhouse gases (GHG) in the atmosphere. This scientific consensus is expressed in synthesis reports by scientific bodies of national or international standing and by opinion surveys among climate scientists. Individual scientists, universities, and laboratories contribute to this overall scientific opinion via peer-reviewed publications. The areas of collective agreement are summarized in these high level, reputable reports and surveys.

The assessments of global warming by national and international science academies and scientific societies are generally consistent with the conclusions of the Intergovernmental Panel on Climate Change (IPCC). The IPCC Fourth Assessment Report summarized: Warming of the climate system is unequivocal as evidenced by rising global average sea levels, increases in global average air and ocean temperatures, and widespread melting of snow and ice. Most of the global warming since the mid-20th century is very likely due to human activities. Benefits and costs of climate change for [human] society vary widely by location and scale. Some of the effects in temperate
and polar regions are positive and others elsewhere are negative. Overall, net effects are more likely to be strongly negative with larger or more rapid warming. The current warming trend is of particular significance because most of it is proceeding at a rate that is unprecedented in the past 1,300 years.

Technological advances, including earth orbiting satellites, have enabled scientists to collect many different types of information about our planet and its climate that show climate change on a global scale. Scientific observations of above average global sea rising levels, increased global average air and ocean temperatures, and widespread melting of snow and ice provide evidence of the increase in the extent and rate of climate change. The changing sea levels are measured by the presence of coral reefs and sediment from the sea floor shows changes in ocean temperature. The volume of polar ice caps indicates change by their chemical composition and the presence of warm or cold water fossil species. The most useful evidence is found from analyzing ice cores from ancient glaciers in Greenland and Antarctica. These show changes in concentrations of gas bubbles such as carbon dioxide and methane over millions of years. The heat-trapping nature of carbon dioxide and other gases was demonstrated in the mid-19th century. Their ability to affect the transfer of infrared energy through the atmosphere is detected by scientific instruments flown by NASA. Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers reveal that the Earth's climate responds to changes in solar output, in the Earth's orbit, and in greenhouse gas levels. Increased levels of greenhouse gases cause the Earth to warm in response. The large changes in climate have occurred very rapidly, geologically-speaking, in tens of years, not in millions or even thousands.

The evidence for rapid climate change is compelling. Global sea level rose about 17 centimeters (6.7 inches) in the last century. The rate in the last decade, however, is nearly double that of the last century. All three major global surface temperature reconstructions show that Earth has warmed since 1880. Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past 12 years. Although the 2000s witnessed a solar output decline resulting in an unusually deep solar minimum in 2007-2009, surface temperatures continue to rise. The oceans have absorbed much of this increased heat, with the top 700 meters (about 2,300 feet) of ocean showing warming of 0.302 degrees Fahrenheit since 1969.

Data from NASA's Gravity Recovery and Climate Experiment show Greenland and Antarctic ice sheets have decreased in mass. Greenland lost 150 to 250 cubic kilometers
(36 to 60 cubic miles) of ice per year between 2002 and 2006, while Antarctica lost about 152 cubic kilometers (36 cubic miles) of ice per year between 2002 and 2005. The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing since 1950. The U.S. has also witnessed growing numbers of intense rainfall events. Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30 percent. This increase is the result of humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the oceans. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year (http://climate.nasa.gov/evidence/).

The rate of global warming is accelerating. The 20th century's last two decades were the hottest in 400 years and possibly the warmest for several millennia, according to a number of climate studies. The United Nations' Intergovernmental Panel on Climate Change (IPCC) reports that 11 of the past 12 years are among the dozen warmest since 1850. The Arctic is feeling the effects the most. Average temperatures in Alaska, western Canada, and eastern Russia have risen at twice the global average, according to the multinational Arctic Climate Impact Assessment report compiled between 2000 and 2004. Arctic ice is rapidly disappearing and the region may have its first completely ice-free summer by 2040 or earlier. Polar bears and indigenous cultures are already suffering from the sea-ice loss.

After studying these climate data collected over many years, most of the leading scientific organizations worldwide have issued public statements acknowledging certain undisputed facts about the Earth’s climate. The Earth's climate is warming rapidly and much of it in the past century is very likely due to human activities.

**The Impact of Climate Change on National Security**

The Intergovernmental Panel on Climate Change (IPCC), the international authority on the science of climate change, concluded in its most recent report that climate change is a reality; it is already happening. The measured increase in the global average temperature by 0.6°C over the last century can be linked largely to increases of greenhouse gas concentrations in the atmosphere due to human activities. The ten warmest years on record have all occurred since 1990, including every year since 1997 (WMO, 2004).
addition, a growing number of physical and biological responses, such as the melting of glaciers in most regions of the world and changes in the behavior and distribution of species are being detected (IPCC, 2010 a, b).

Projections of future changes suggest that the global average temperature will increase by 1.4 to 5.8°C by the end of the 21st century in comparison to 1990 levels. This average increase in temperature is associated with local and regional changes in climatic conditions. The magnitude of change is likely to be unprecedented for at least the last 1,000 years (IPCC a).

Climate change has far reaching implications for disaster risk management. The catastrophic impacts of climate change threaten the safety and stability of worldwide communities. According to a 2003 U.S. Defense Department study, climate change is a significant security threat. This analysis projected widespread regional conflict and even riots in some countries with a scarcity of food, water, and energy and argued that global warming and climate change “must be viewed as a serious threat to global stability and should be elevated beyond a scientific debate to a national security concern” (Miller, 2005).

In October 2009, President Obama issued Executive Order EO 13514 requiring federal agencies to support the U.S. Government’s efforts to develop a national climate change adaptation strategy. Coordinated across the U.S. Government through the Interagency Climate Change Adaptation Task Force, this process will ultimately establish and implement climate change adaptation plans for all federal departments and agencies. Moreover, in reference to Mission 1: Preventing Terrorism and Enhancing Security, EO 13514 warned that:

“The impacts of climate change could directly affect the nation’s critical infrastructure. In U.S. coastal regions, rising sea levels, higher storm surge, and increased erosion could damage or destroy critical infrastructure. In Western States, higher temperatures and more frequent or severe heat waves could buckle railways, damage roads, and strain power systems. Indirectly, climate change acts as a “threat multiplier,” aggravating stressors abroad such as poverty, environmental degradation, and social tensions, resulting in conditions that could enable terrorist activity, violence, and mass migration” (EO 13514, 2009).

In a speech in October 2010, Admiral Mike Mullen, Chairman of the Joint Chiefs of Staff, recognized climate change as a threat to national security and emphatically stated that:
“The scarcity of and potential competition for resources like water, food and space, compounded by an influx of refugees if coastal lands are lost, does not only create a humanitarian crisis but creates conditions of hopelessness that could lead to failed states and make populations vulnerable to radicalization. These challenges highlight the systemic implications and multiple-order effects inherent in energy security and climate change” (National Security Strategy, 2010).

In his 2015 State of the Union address to the congress and the nation, President Obama cautioned against ignoring the findings of the best scientists in the world informing us that human activities are changing the global climate with massive negative effects that pose immediate threats to our national security. It behooves us to pay attention to the risks (State of the Union, 2015).

**Worldwide Awareness of Climate Change and Natural Disasters**

The destructive effects of climate change in varied regions around the world have raised awareness of future dire consequences if left unchecked. More than 80 percent of people around the world think climate change will lead to more natural disasters in the future, while nearly the same number fear they will be affected by a natural disaster in the next 20 years, according to a poll released by the European insurance giant Swiss Re. The average person around the world is “acutely aware” of the climate risks ahead in the not-too-distant future and members of the public also want their government leaders to do more to prepare for a riskier world (Johnson, 2013).

This Swiss Re risk perception survey polled nearly 22,000 people aged 15 and older across five continents. Findings include:

- 84 percent believe climate change will be responsible for more natural disasters in the future.
- Nearly 8 in 10 fear damage from an earthquake, flood, or other natural disaster sometime in the next 20 years.
- 75 percent would use renewable energy if it were more available.
- 91 percent want their government to do more to promote energy efficiency.
Of those who felt threatened by the risks that climate change poses where they live, 58 percent said it would contribute “to a great extent” or “to some extent” to natural disasters in the future (Johnson, 2013).

**Changes in the Magnitude and Frequency of Climatic Extremes**

Disasters are associated with extreme climatic events. For example, climate change can lead to higher maximum temperatures and heat waves over almost all land areas (IPCC, 2001). That heat waves can have devastating impacts even in developed countries became glaringly clear in 2003, when a heat wave—with temperatures rising above 40°C (WMO, 2004)—was linked to more than 35,000 excess deaths in France, Italy, the Netherlands, Portugal, Spain, Germany and the United Kingdom (Koppe et al., 2004). Recent research suggests that past human induced greenhouse gas emissions have at least doubled the risk of the occurrence of heat waves (Stott et al., 2004).

In addition, climate change is expected to lead to more intense precipitation events for many areas causing a higher probability of floods, landslides, avalanches, and soil erosion with associated damages (IPCC, 2001). Conversely, for most mid-latitude continental interiors, increased summer drying is likely with subsequent risk of droughts. Peak wind intensity of cyclones, hurricanes, and typhoons is likely to increase in some areas. While it is not fully established, it is also possible that the distribution of tropical cyclones may change (IPCC, 2001). Since 1975, El Niño events have become more frequent in comparison to La Niña episodes. Climate change is likely to intensify droughts and floods associated with El Niño events.

The number of great natural catastrophes per decade increased fourfold and the number of economic losses increased 14 times, if the period 1990-1999 is compared to 1950-1959. It is, however, striking that while the intensity and frequency of weather related (hydro-meteorological) hazards have increased in many regions, the number of geological hazards (e.g. earthquakes, volcano eruptions) reflect long time-scale variations but not trends, as noted by the United Nations International Strategy for Disaster Reduction (UNISDR) (UNISDR, 2008). The increase in hydro-meteorological disasters is due to many human related factors, including uncontrolled urbanization in hazard prone areas and environmental degradation. As climate change alters the magnitude and frequency of extreme climatic events it is important to recognize that
Coping and response mechanisms and economic planning based on past vulnerabilities may no longer suffice for what is to come. Indeed, in many countries these existing mechanisms are already insufficient at the current level of vulnerability.

**Changes in Average Climatic Conditions and Climate Variability**

Beyond affecting the climatic extremes, climate change also alters average climatic conditions and climate variability. While more subtle in nature and not necessarily hazards in themselves, these changes affect underlying risk factors and thereby the ability to cope with and recover when climate extreme events and other natural hazards strike, thus compounding their impact. For example, where a shift from a productive to a marginal agricultural area occurs, the impact of a drought or a flood on climate sensitive livelihoods such as farming and cattle ranching is likely to be especially difficult if remedial measures are not taken. Rural livelihoods and food security in Africa are particularly threatened by climate change as shown in a comprehensive assessment by the Insurance Institute of South Africa (IISA) (Fischer et al., 2005).

Changing baselines of environmental conditions where disasters occur must be recognized for their implications for disaster risk management planning efforts. While most impacts of climate change are exacerbations or alterations of existing threats, some impacts induced by global warming in recent history may be new to a region and, consequently, there is little experience in dealing with such impacts. Many disasters may be threshold events. For example, coral bleaching occurs when water temperatures exceed a threshold and coral expel symbiotic algae. Where the warming is sustained, coral reefs may not recover and thus die. Such changes, in combination with rising sea levels, threaten the livelihood and safety of island nations where coral reefs sustain fisheries and provide protection from storm surges. Knowing how to mitigate or deal with such threshold events can help to maintain the health of ecosystems by reducing compounding impacts.

The globally observed retreat of glaciers is another example where climate change may lead to new disaster threat levels. The accumulation of water in natural dams as a result of glacial melt may lead to glacial lake outburst floods (GLOFs) with destructive down-stream effects. As temperatures increase even at higher altitudes in the lower troposphere, the melting of glaciers has been considerable in many regions, exposing
areas and valleys to the risk of GLOFs. Because the magnitude of the threat is new, its implications may not have been considered in earlier government settlement planning and policies.

Other environmental threats are related to climate induced spatial and temporal changes. These include, for example, the spread of climate sensitive diseases into regions where these diseases did not occur before (McMichael, 2003), the appearance of invasive species in areas where they previously did not exist, as well as the disappearance of species from areas that are no longer suitable to them (IPCC, 2001). Many changes like these can be anticipated and planned for through a combination of scientific research, monitoring, and foresight planning, if the thresholds are known. However, climate change may also cause unforeseen events – surprises – with negative consequences that are not anticipated. The climate system is a complex one with multiple feed-back loops among the ocean, atmosphere, and terrestrial ecosystems. The more rapidly the climate system is affected by increasing levels in greenhouse gases, the higher the potential for surprises. Therefore, reducing greenhouse gas emissions and other harmful impacts on the environment is a precautionary measure that in the long term will reduce the risk of surprises with adverse consequences.

**Climate Change Related Disasters**

According to the National Climatic Data Center, 2014 was the warmest January-November in the 1880-2014 record, surpassing the previous record set in 2010 by 0.02°F, with extreme weather and climate events which began in January. During this time, Alaska had temperatures as much as 40 degrees above average, forcing several sled-dog races to be canceled because of lack of snow and fear that onlookers would fall through thin river ice. Also, in Melbourne in January, the thermometer registered an infernal 109 degrees. The extreme heat had players at the Australian Open volleysing vomit instead of tennis balls and, in the case of Canada's Frank Dancevic, hallucinating about Snoopy before passing out. That same month a scientific publication reported Australia should brace for more brutal heat if carbon emissions continued at their dramatic rate. By February, the heat spell intensified the spread of major wildfires around Melbourne, which from the air looked like a flaming nightmare (Associated Press, 2014).

Recently published data collected by the World Meteorological Organization (WMO) show there were close to five times as many weather—and climate change—related
disasters in the first decade of this century than in the 1970s. As many as 1.94 million people lost their lives due to these catastrophic weather events between 1970 and 2012, which cost U.S. $2.4 trillion in economic losses, according to the Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2012). The 44-page atlas, a joint publication of the Geneva-based UN agency WMO and the Centre for Research on the Epidemiology of Disasters (CRED) of the Catholic University of Louvain in Belgium, examined major reported disasters linked to weather, climate, and water extremes. The atlas included 8,835 major disasters in the four decades between 1970 and 2010. The largest increase, however, was between 1971 and 1980 with 743 extreme events and between 2001 and 2010 with 3,496 events. Flooding and storms were the main cause of the disasters in the last decade but the data also show heat waves are becoming more deadly and more common. In releasing the report, WMO Secretary-General Michel Jarraud stated that “Disasters caused by weather, climate and water related hazards are on the rise worldwide. Both industrialized and non-industrialized countries are bearing the burden of repeated floods, droughts, temperature extremes and storms” (Rose, 2014).

Another WMO report found that weather and climate change related disasters caused nearly 2 million deaths globally since 1971. The report focused on six types of hazards: floods, droughts, extreme temperatures, storms, wildfires, and landslides from 1971-2010 (Kahn, 2014). Temperature anomalies during the 2003 European heat wave that caused more than 72,200 deaths were observed and recorded by NASA (NASA Earth Observatory, 2014).

According to a report from the New England Journal of Medicine, the incidence of natural disasters worldwide has steadily increased, especially since the 1970s. The main reason for this is the continual increase of climate change related disasters. Since 1990, natural disasters have affected about 217 million people every year. Climate change related disasters include hydrological events such as floods, storm surges, and coastal flooding, and meteorological events such as storms, tropical cyclones, heat/cold waves, drought, and wildfires. Geophysical disasters include earthquakes, volcanoes, dry rock falls, landslides, and avalanches. While the number of geophysical disasters has remained fairly stable since the 1970's, the number of climate change related (hydro-meteorological) disasters has greatly increased. As a result, the extent of economic damage due to these natural disasters has seen a steady upturn. There were three times as many natural disasters from 2000 to 2009 compared with 1980 to 1989. A
vast majority (80%) of this growth is due to climate change related events. According to the New England Journal of Medicine, the scale of disasters has expanded, owing to increased rates of urbanization, deforestation, environmental degradation, and to intensifying climate variables such as higher temperatures, extreme precipitation, and more violent wind/water storms.

A research study conducted by Camilo Mora from the University of Hawaii (Mora et al., 2013) found that human-caused global warming is inevitable. The Earth is racing towards an apocalyptic future in which major cities such as New York and London could become uninhabitable within 45 years because of irreversible human-caused climate change. The first signs of change will occur at the end of this decade. The study predicts that even if we utilized all available resources to stop our current carbon emissions, the changes are irrevocable and might only be postponed. Humankind needs to prepare for a world where the coldest years will be warmer than what we remember as the hottest. As a result, a humanitarian crisis could unfold as hundreds of millions of global warming refugees pour illegally across borders fleeing the consequences of the temperature rises. This mass movement could leave entire regions of the planet extinct of life (Mora et al., 2013).

Mora and the University of Hawaii climate researchers’ study shifts the focus of the impacts of greenhouse emissions. While most climate scientists concentrate on the rapidly warming climate in the Arctic and the effects on wildlife such as polar bears and also on rising sea levels, Mora’s team is concerned with the effects on people in the tropics where the majority of the world's population lives and whose citizens have contributed the least to global warming. It is in the already warm tropics that an increase of only a couple of degrees can alter the balance of life, crippling crops, spreading disease, and leading to mass migration to cooler climates. Mora and his colleagues collated global climate models and built an index of estimates on when a given spot on the globe will change beyond temperatures experienced on Earth over the past 150 years between 1860 and 2005. This new index indicates the year when the projected mean climate of a given location moves to a state continuously outside the bounds of historical variability under alternative greenhouse gas emissions scenarios. According to the new index the first U.S. cities to feel the changes would be Honolulu and Phoenix, followed by San Diego and Orlando in 2046. New York and Washington will experience new climates around 2047, with Los Angeles, Detroit, Houston, Chicago, Seattle, Austin and Dallas following slightly later (Mora et al., 2013).
In another part of the world, climate scientists warn that if a giant chunk of ice from the Hualcan glacier breaks off it could trigger a tsunami-like wave in Laguna 513 and send a lethal torrent of water cascading down the valley. It has happened before in the Andean nation. In 1970, a 7.9 magnitude earthquake shook ice blocks into highland lakes and unleashed an avalanche that buried the town of Yungay killing more than 20,000 people. Peru has more tropical glaciers than any other nation but rising temperatures linked to global warming have decreased the ice masses by up to 40 percent. As the glaciers retreat, the ice contorts and fissures and lumps fall off filling existing lakes to the brim and spawning hundreds of new ones (Taj, 2014).

**Climate Change and Disasters in Asia**

**Pacific Region**

Climate change has impacted many parts of Asia. Some rural and agricultural regions (e.g., the Indo-Gangetic Plain, the breadbasket of South Asia) face severe water shortages brought about by a drier climate and a diminished flow from the shrinking Himalayan glaciers, while other regions face the prospect of increased floods. Intensified heat waves will increase mortality, especially among the elderly and in large cities that are already affected by a significant rise in temperatures caused by the effects of urban “heat islands.” For example, in the case of Ho Chi Minh City, it is estimated that there is as much as 10°C difference between the city and vegetated surroundings. Climate change will also likely increase the occurrence of vector-borne and diarrheal diseases (Kovats and Akhtar, 2008).

Most vulnerable to the impacts of climate change are Asia’s low-lying coastal regions and especially its large river deltas including the Ganges-Brahmaputra, Yangtze, and Mekong deltas. Identified by the Intergovernmental Panel on Climate Change (IPCC) as “hot spots” of vulnerability, they are also the sites of some of the world’s largest megacities (large urban regions variously defined as having more than 8 or 10 million people), significant not only from the standpoint of their large populations, but also their economic infrastructures and dominant roles in national and regional economies. The growing physical risks to Asian coastal regions result from a combination of factors related to climate change, including a rise in sea level and a likely increase in intensity of tropical cyclones, bringing higher winds and heavier precipitation, stronger storm surges, and increased coastal flooding. These “natural hazards” are largely attributed
to human activities related to climate change caused by the unremitting increase of greenhouse gas emissions, resulting sea level rise, and land subsidence caused by withdrawal of groundwater (Nicholls and Wong, 2007).

Because of the built-in momentum in the climate system resulting from past emissions and the limited capacity of the oceans to absorb and neutralize the harmful impacts, the physical risks posed by climate change will continue to grow into the next century, even if a dramatic reduction in greenhouse gas emissions is achieved. Rather than slowing, climate change will likely accelerate as emissions continue to grow. Recent modeling results suggest a possible warming of 5.2°C by 2100 (MIT News, 2009). A growth in mean temperature is only part of the problem. Climate change may also be causing a change in the paths of tropical cyclones, bringing destructive storms into places previously spared and perhaps even shifts in the Asian monsoon system, with potentially dire socioeconomic consequences (Fu and Chen, 2006). Risks posed by cyclonic storms and storm surges will be compounded by a rising sea level resulting from the thermal expansion of ocean water and the melting of glaciers and ice sheets. Sea level is projected to rise at an increasing rate during the twenty-first century and will continue to rise for centuries after global temperatures have stabilized. Earlier IPCC projections of an 18-59 cm rise in global sea level by 2055 omitted possible effects of Greenland’s ice sheet melting and are now considered far too low. One study suggests sea level could rise between 0.75 to 1.9 m by 2100, two or three times the IPCC estimate (Vermeer and Rahmstorf, 2009).

Land subsidence further adds to the growing risk of coastal flooding. Many coastal megacities in Asia are built on deltas where significant sinking is occurring due to soil compacting or groundwater withdrawal for household or industrial purposes. Groundwater that flows out to the sea contributes to rising sea levels. A global study of sinking deltas using historical maps and satellite images identified the Pearl River Delta (China) and Mekong Delta (Vietnam) as particularly at risk, with much of their surface areas already below sea level and with only limited coastal barrier protection (Syvirski and Keemer, 2009). In a number of Asian cities the magnitude of land subsidence is greater than global or regional sea level rise. In Bangkok, the Gulf of Thailand is rising about 0.25 cm per year, but the city is sinking at a far faster rate, up to 4 cm per year (Associated Press, 2007). In north Jakarta, land subsidence has been measured at 6 cm per year, and sinking bridges have now become obstructions to water discharge. Cumulative land subsidence is about 3 m in the Yangtze Delta (Shanghai) and Tianjin.
City (Xu, Zhang and Shen, 2009). Floodwalls along the Suzhou River in Shanghai have already been raised three times since the 1960s to accommodate land subsidence and a rise in relative local sea level. A floodwall that was built to withstand a 1 in 1000 year surge was already nearly overtopped in a 1997 typhoon.

Rising sea levels have many adverse impacts, including inundation of coastal plains, increased beach and coastal erosion, removal of protective sand dunes and vegetation, and intrusion of salt water into freshwater supplies, already a concern in many Asian coastal cities. However, the effects of sea level rise will be felt most severely in the form of amplified storm surges and flooding that can accompany tropical cyclones that threaten much of the region annually. What in the past have been 1 in 100-year flood events may in the future become 1 in 10-year storms, with far-reaching implications for unprepared coastal populations. The enormous human and economic loss will weigh heavily on government officials caught unaware of the increasing frequency, magnitude, and extent of severe flooding related to climate change. Past surge and flood events have already caused havoc in many coastal regions. For example, around the Bay of Bengal there has been an estimated 1.3 million cyclone-related deaths over the past 200 years (Small and Nicholls, 2003). More than 10 million people each year, most in Asia, experience some flooding due to storm surges (Mimura, 2009). Major recent coastal floods include Bangladesh’s in 1991, which killed 140,000 people and left 10 million homeless, and Myanmar’s in 2007, when 146,000 people were killed due to storm surges up to 6 m in height that reached inland some 30 km, causing an estimated economic toll of U.S. $17 billion. Storm-related floods in recent years have inundated 70-80 percent of both Jakarta and Manila. One estimate suggests that by the year 2100, even with a sea level rise of only 59 cm, a 100-year storm surge could inundate areas in Asia, affecting 362 million people, 10 percent of the projected Asian population (Mimura, 2009). This estimate will need upward revision in view of recent projections of even more rapid sea level rise.

According to Indian Meteorological Department (IMD) Director General Laxman Singh Rathore, there has been an annual increase in hydro meteorological disasters by 7.4 percent due to climate change. There are reduced number of rainy days during rainy season, unseasonal thunderstorms/lightning, and a rise in global temperatures. Winds, thunderstorms, floods, and other severe atmospheric phenomena are examples of hydro meteorological disasters. Rathore reported that the Asian countries were facing almost 85 percent of the world’s disasters and 90 percent of floods occurred only in India. India
faces a gross domestic product (GDP) loss of 2.25 percent in terms of economy and 12-15 percent in terms of revenue because of natural disasters. While 58.6 percent of land in India was prone to earthquakes, the scientists observed a steady rise in natural disasters such as thunderstorms, winds, hail storms, and air quantum disasters in urban areas in recent times due to rapid industrialization.

Millions of people in Asia, the world's most disaster-prone region, face the threat of major climate-linked disasters and food crises. A year after Typhoon Haiyan wreaked havoc in the Philippines, Oxfam warned that governments needed to do more to prevent loss of lives and homes to extreme weather. With 4.3 billion people or 60 percent of the global population, Asia has borne almost half the estimated economic cost of all disasters over the past 20 years, amounting to around U.S. $53 billion annually. Without greater investment in climate and disaster-resilient development and more effective assistance for those at risk, super Typhoon Haiyan-scale disasters could fast become the norm, not the exception (Oxfam, 2014). Asian states have started to adopt policies and programs to reduce the risks of disasters and adapt to climate change impacts such as extreme weather and rising sea levels. The report by Oxfam urged the Association of Southeast Asian Nations (ASEAN) to create a regional resource base to help member states carry out projects to adapt to climate change impacts and manage risk (Oxfam, 2014).

Less fresh water, more coastal erosion, and degraded coral reefs are among the impacts climate change is already having on Hawaii and other Pacific islands associated with the United States, according to a major new climate report, the Third National Climate Assessment (Thompson, 2014). More than 300 scientists contributed to the report which was released by the White House, confirming that extreme weather events linked to climate change—including heat waves, heavy downpours, floods, and droughts—have become more frequent and intense throughout the United States. These events are disrupting people's lives and hurting the economy. Highlights from the section on Hawaii and the Pacific include:

- Decreasing rainfall in low-lying areas, combined with a rise in sea levels that pushes seawater into aquifers, will put greater limits on the availability of fresh water.
- Rising sea levels combined with increased storm runoff will increase coastal flooding and erosion, damaging coastal ecosystems, infrastructure, and agriculture.
• A warming ocean will increase coral bleaching and disease outbreaks on coral reefs.
• Rising temperatures and reduced rainfall in some areas will put native plants and animals at greater risk for extinction.
• Pacific Islanders will find it increasingly difficult to sustain their traditional ways of life as climate change forces them to leave coastal areas.

Climate scientists continue to provide data that confirm that the Earth's climate system is unequivocally warming and that human activities such as deforestation and burning fossil fuels that increase concentrations of greenhouse gases in the atmosphere are causing most of it. Communities worldwide have suffered the destructive impacts of climate change that reportedly will continue with increasing severity. To ignore the warnings and counsel of the world's best climate scientists is to risk annihilation.

Questions for Review

1. What are climate change and global warming, and how are they related?
2. What is the scientific consensus on the causes and consequences of climate change?
3. What role does human activity play in the current global warming trend?
4. What role do natural forces play in the current global warming trend?
5. What are some of the impacts we can expect from climate change?
6. What can we do right now to slow climate change and make a real difference?
7. What role can businesses play in curbing climate change?
8. What role can governments play in addressing climate change?
9. Which countries contribute the most to global warming?
10. Why is the Asia Pacific region most affected by climate change?
11. Should I be worried about climate change? Will it affect me personally?
12. Could climate change ever "wipe us out"?
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Climate Change Management

Climate change is a reality the world cannot ignore without grave socio-economic and ecological consequences. While there is consensus among most climate scientists that climate change is a major contributor to global warming, there is less agreement on what should be done about climate change. Like-minded practitioners tend to gravitate toward one of three main schools of thought: "wait and see" until more definitive research can be done; act now to prevent, slow, or mitigate global warming; or act now to adapt to the ravages of climate change.

The fact is that climate change has already irreversibly altered the Earth's climate and ecosystems and three major strategies or policy options operate to address the threats, risks, and damages of climate change. They are:

1. Mitigation. This strategy involves curtailing greenhouse gases to prevent, minimize, or slow global warming.
2. Adaptation. This strategy assumes humans can adapt to climate change by adjusting to and dealing with its impacts.
3. Geoengineering. This strategy employs technical measures to counteract climate change, such as space mirrors, stratospheric dust, etc.
These three policy options are not mutually exclusive. The two main policy responses to climate change are mitigation and adaptation. Mitigation addresses the root causes of climate change by reducing greenhouse gas (GHG) emissions, while adaptation seeks to lower the dangerous risks that are consequences of climate changes. Because of its proactive nature, mitigation reduces risks at an early stage and therefore decreases the need for adaptation. Both strategies, however, are necessary because even if GHG emissions are dramatically decreased by mitigation in the next decade, adaptation will still be needed to deal with the global environmental changes that have already been set in motion. Thus, mitigation and adaptation should not be seen as alternatives to each other, as they are not discrete activities but rather a combined set of actions in an overall strategy to reduce GHG emissions.

The Intergovernmental Panel on Climate Change (IPCC) defined adaptation as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderates harm or exploits beneficial opportunities (IPCC, 2007). From its beginning, the international climate effort has focused primarily on mitigation—reducing GHG emissions. However, in recent years, more attention is being given to adaptation—adjusting to and dealing with the impacts of climate change. A successful adaptation can reduce vulnerability by building on and strengthening existing coping strategies. In general, the more mitigation there is, the less will be the impacts of climate change that we must adapt to and the less the risks we must prepare for. Further, the greater the degree of preparatory adaptation, the less may be the impacts of any given degree of climate change.

Social and Economic Trends That Counter Adaptation and Mitigation

Socio-economic and behavioral trends and unabated economic development that increase total energy use, especially in developed countries and high-income groups in developing countries, run counter to the technological and economic potential to reduce GHG emissions. In developed countries, and especially the U.S., sales of larger, heavier, and less efficient vehicles are increasing as well as larger dwelling units, and the use of electrical appliances in households and electrical office equipment in commercial buildings. These trends place heavy demands on energy resources.

Some adaptation is occurring now to observed and projected future climate change, but on a limited basis (IPPC, 2015). In 2007, an extensive literature assessment
conducted of sustainability and climate change suggested with high confidence that up to the year 2050, an effort to cap GHG emissions at 550 ppm would benefit developing countries significantly. This was judged to be the case especially when combined with enhanced adaptation. By 2100, however, it was predicted that there would be significant climate change impacts even with aggressive mitigation and significantly enhanced adaptive capacity.

**Adaptation Strategies**

Humans have been adapting to their environments throughout history by developing practices, cultures, and livelihoods suited to local conditions—from the Mediterranean siesta to the Vietnamese practice of building homes on stilts to protect against monsoonal rains. This potential and capacity to adapt is referred to as “adaptive capacity.” Human societies have varying adaptive capacity to respond to or anticipate climate changes. However, there are climate changes in temperature, storm frequency, flooding, and other weather events that previous experience has not prepared them for. Adaptation measures can help to reduce vulnerability to climate change by building adaptive capacity as well as allowing populations to benefit from opportunities resulting from climatic change, such as growing new crops in areas that were previously unsuitable (IPCC, 2011).

The IPCC describes 3 factors that determine vulnerability to climate change (IPPC, 2011):

1. Exposure to hazards such as reduced rainfall,
2. Sensitivity to those hazards such as an economy dominated by rain-fed agriculture, and
3. The capacity to adapt to those hazards, for example, whether farmers have the money or skills to grow more drought-resistant crops.

The efforts to reduce vulnerability to climate change include various adaptation measures that may be planned in advance or put in place spontaneously in response to local pressure. They include large-scale infrastructure changes such as building defenses to protect against sea level rise or improving the quality of road surfaces to withstand hotter temperatures, as well behavioral modifications such as individuals using less
water, farmers planting different crops, and more households and businesses buying flood insurance.

Adaptive strategies encourage actions to decrease, spread, or transfer the risk of damages. Although it may be preferable to take a proactive approach to eliminate the cause of the risk, reactive post-harm compensation may be a last resort effort to rebuild communities after adverse impacts from extreme weather events. Insurance for flooding and other catastrophes allow for post disaster resilience of individuals and communities. Where there are failures in the private insurance market, the public sector creates residual market mechanisms (RMM) to encourage individual risk reduction by subsidizing premiums. A study in 2013 identified key equity issues for policy considerations (McAneney et al., 2013):

1. Transferring risk to the public purse does not reduce overall risk,
2. Governments can spread the cost of losses across time rather than space,
3. Governments can force home-owners in low risk areas to cross-subsidize the insurance premiums of those in high risk areas,
4. Cross-subsidization is increasingly difficult for private sector insurers operating in a competitive market, and
5. Governments can tax people to pay for tomorrow's disaster.

Government-subsidized insurance, such as the U.S. National Flood Insurance Program, is criticized for providing a perverse incentive to develop properties in hazardous areas, thereby increasing overall risk. This possibility may be countered with appropriate land use policies that limit new construction in areas that have potential climate risks and/or encourage the adoption of climate resilient building codes to mitigate potential damages.

Adaptive capacity and sound development policy and strategies are strongly intertwined. Climate change is now central to national planning processes and to development assistance. It is a major consideration in Climate Risk Management (CRM), a generic term referring to an approach to climate-sensitive decision making that is informed by a large and growing body of work bridging the climate change adaptation, disaster management, and development sectors. CRM seeks to promote sustainable development by reducing the vulnerability associated with climate risk. It covers a broad range of potential management tools including early response systems,
strategic diversification, dynamic resource allocation rules, financial instruments, infrastructure design and capacity building. CRM employs strategies aimed at maximizing positive and minimizing negative outcomes for communities in fields such as agriculture, food security, water resources, and health. In addition to avoiding adverse outcomes, a CRM strategy may maximize opportunities, such as the use of scientific technologies that allow farmers in climate-sensitive economic sectors to use favorable seasonal forecasts to maximize their crop productivity (Hellmuth et al., 2007).

There are limits to adaptation. A compelling example of this is small island developing states threatened by sea level rise that have few options to adapt. Rising sea level defenses are particularly costly for low-lying islands and may do little to protect the tourism and fisheries that sustain the local economy. While development and diversification are still important strategies wherever possible, ultimately the international community will have to find ways to support alternative responses, including the managed resettlement of some people in these states. There will be greater pressures if unabated climate change leads to sea level rise that threatens much larger populations in low-lying coastal areas (Stern, 2007). There are some impacts of climate change that humankind simply cannot adapt to.

**Sharing the Cost of Adaptation**

Adaptive capacity is closely linked to social and economic development (IPCC, 2007) and thus is unevenly distributed across different regions and populations. Developing countries generally have less capacity to adapt (Schneider et al., 2007). However, adaptation to climate change is especially important in developing countries because they are more vulnerable to climate risks and they are predicted to bear the brunt of the effects of climate change. The poorest countries and people will suffer earliest and most and when the damages from climate change occur it will be too late to reverse the process (World Bank, 2010). Further, in developing countries, some adaptation measures such as increasing access to education and health facilities draw from funds attached to existing development programs. However, adaptation goes beyond just development to include measures that address risks specifically caused by climate change, such as raising the height of sea defences. It is still unclear how expensive these measures will be or who will pay for them, but the World Bank suggests adaptation could cost the same as the world currently spends on development assistance (World Bank, 2011).
The economic costs of adaptation are likely to amount to billions of dollars annually for the next several decades, though the sum of money needed is unknown. According to an Asian Development Bank report, “the effect of climate change can cause losses equal to almost 10 percent of a country’s annual gross domestic product (GDP) by 2100” (ADB, 2012).

Economist Nicolas Stern believed that we should do something now about climate change rather than wait until it would be 20 times the cost or up to $4 trillion by 2100. Stern felt that the cost of investing in the right technologies now would be trivial compared with the future potential damage (Stern, 2007). Stern summarized that:

1. The benefits of strong, early action on climate change outweigh the costs.
2. The scientific evidence points to increasing risks of serious, irreversible impacts from climate change associated with business-as-usual (BAU) paths for emissions.
3. Climate change threatens the basic elements of life for people around the world—access to water, food production, health, and use of land and the environment.

While the economic costs of climate change are staggering, they pale in comparison to the destruction of human life and ecological systems.

The aggregate of current climate change adaptation programs will not raise enough money to fund adaptation to climate change. There are, however, several programs and proposals to finance adaptation to climate change in developing countries. The United Nations Framework Convention on Climate Change (UNFCCC) runs a program called the Global Environmental Facility (GEF), that provides some funding for adaptation to least developed countries and small island states. Under the GEF umbrella, the GEF Trust Fund, the Least Developed Countries Fund (LDCF), and the Special Climate Change Fund (SCCF) operate to facilitate the climate change adaptation financing goals of the GEF (McAneney et al., 2013). Also under the UNFCCC, as the result of negotiations during COP15 and COP16 (“Conference of the Parties”), the Adaptation Fund provides funding for projects that prove to have significant benefits for adaptation to climate change (McAneney et al., 2013). The UNFCCC helps least developed countries (LDCs) identify climate change adaptation needs by funding the development of the National Adaptation Program of Action (NAPA). NAPAs are meant to provide LDCs with an opportunity to identify their “urgent and immediate needs”
for adapting to climate changes (Spence, 2011). At the 2010 United Nations Climate Change Conference, the Copenhagen Accord committed developed countries to a goal of sending $100 billion per year through 2020 to assist developing countries in their struggle with climate change (McAneney et al., 2013). However, although a fund called the Green Climate Fund was set up in 2007, pledges by developed countries have not been forthcoming (Muller, 2008).

Many other climate change adaptation finance proposals use official development assistance (ODA). These proposals range from World Bank programs, to auctioning of carbon allowances, to a global carbon or transportation tax, to compensation-based funding. Other proposals suggest using market-based mechanisms, rather than ODA, such as the Higher Ground Foundation’s vulnerability reduction credit (VRC) or programs that aim to raise private money for climate change adaptation.

**The Need for Adaptation**

The United Nations Framework Convention on Climate Change (UNFCCC) refers to adaptation in several of its articles: Article 4.1(f)—All Parties shall:

> “Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change” (UNFCCC, 2012).

In 2007, a team of science policy experts maintained that adapting to climate change is a more effective means of dealing with global warming than reducing GHG emissions (Nature, 2007). Because of the current and projected climate disruption precipitated by high levels of GHG emissions by the industrialized nations, and also because we cannot be certain that all climate change can be mitigated, adaptation is necessary at all scales to complement mitigation efforts. It is highly likely that in the long run there will be more global warming given the high level of GHGs in the atmosphere and the several decades delay between emissions and impact.

Adaptation has the potential to reduce adverse impacts of climate change and to
enhance beneficial impacts, but it will incur costs and will not cover all damages. Weather extremes, variability, and erratic rates of change, not simply changes in average climate conditions, increase vulnerability and confound adaptation to climate change.

Human and natural systems to some degree will adapt independently and spontaneously to climate change. Planned adaptation can supplement this adaptation. It is possible to offer incentives to human systems to adapt, but this is not the case for natural systems. The ability of human systems to adapt to and cope with climate change depends on such factors as wealth, technology, education, infrastructure, access to resources, management capabilities, acceptance of the existence of climate change and the consequent need for action, and socio-political will. Populations and communities are highly variable in their endowments of these attributes, with developing nations being among those worst-placed to adapt to global warming (Yohe, 2007).

Many communities and regions that are vulnerable to climate change are also under pressure from forces such as unchecked population growth, resource depletion, and poverty. Policies that minimize pressures on resources, improve management of environmental risks, and increase the welfare of the poorest members of society, can simultaneously advance sustainable development and equity, enhance adaptive capacity, and reduce vulnerability to climate and other stresses. Consideration of climatic risks in the design and implementation of national and international development initiatives can promote equity and development that are more sustainable and that reduce vulnerability to climate change.

Adaptation occurs over a range of inter-linking scales, and can occur either in anticipation of change (anticipatory adaptation), or in response to change (reactive adaptation). Most adaptation at present is responding to immediate climate trends and variability, for example increased use of artificial snow production in the European Alps. Some adaptation measures, however, are anticipating future climate change, such as the construction of the Confederation Bridge in Canada at a higher elevation to take into account the effect of future sea level rise on ship clearance under the bridge (Yohe, 2007).

Adaptive capacity is driven by a complex of economic, social, political, behavioral, and other societal factors. It is important to understand the ways in which the different drivers of adaptive capacity operate and interact. Physical constraints may impede adaptive capacity, but in most cases it is social processes that increase or decrease adaptive capacity. The social drivers of adaptive capacity are varied and may include
national institutional structures and economic and political processes, as well as structures and processes which operate at a very local scale, such as social networks and relationships within a community involved in decision-making.

Adaptive capacity at a local scale is constrained by larger scale processes. For example, a farmer's adaptive capacity will not only depend on access to resources (both physical and social) within the community which allow a crop to be grown successfully, but also the effect of macro-scale economic processes on the price received for the crop. Further, some groups may be more vulnerable to climate change. For example, a 10 percent decrease in rainfall may be acceptable and manageable to members of a community who have access to improved agricultural techniques or whose livelihoods are in some way diversified, whereas marginalized members of the community may not be able to cope with the change (Yohe, 2007). It is not just the changes in climate that will affect vulnerability and livelihoods, but the way that these changes are negotiated through complex social systems (Yohe, 2007). Adaptation can be seen as a social and institutional process that requires skillful management in navigating through the maze of bureaucracy in responding to current trends and projected changes in climate. An understanding of how adaptive capacity is socially constructed is key to managing the risks and impacts of climate change for the common good.

Adaptation has far reaching impacts over time, space, and people. Although much adaptation takes place in relation to short term climate variability, this may cause maladaptation to longer term climatic trends. For example, the expansion of irrigation in Egypt into the Western Sinai desert due to a period of higher river flows is a maladaptation when viewed in relation to the longer term projections of drying in the region (UNDP, 2008). Adaptations at one location and time can create problems at another location or time by reducing the adaptive capacity of other actors.

The varied and even conflicting needs of different communities underscore how complex adaptation can be. Practitioners need to draw upon all the accumulated knowledge in addition to the new technologies that become available. Traditional knowledge and coping strategies must be maintained and strengthened, otherwise adaptive capacity may be weakened as local knowledge of the environment is lost. Strengthening these indigenous techniques and building upon them also make it more likely that adaptation strategies will be adopted, as they create more community ownership and involvement in the process. In some cases, however, this will be not
be enough to adapt to new conditions which are outside the range of those previously experienced, and new techniques will be needed (UNDP, 2008).

Adaptation Criteria

James Titus, project manager for sea level rise at the U.S. Environmental Protection Agency (EPA), identifies the following criteria that policy makers should use in assessing responses to global warming (Titus, 2011):

1. Economic Efficiency: Will the initiative yield benefits substantially greater than if the resources were applied elsewhere?
2. Flexibility: Is the strategy reasonable for the entire range of possible changes in temperatures, precipitation, and sea level?
3. Low Cost: Does the strategy require minimal resources?
4. Equity: Does the strategy unfairly benefit some at the expense of other regions, generations, or economic classes?
5. Institutional Feasibility: Is the strategy acceptable to the public? Can it be implemented with existing institutions under existing laws?
6. Unique or Critical Resources: Would the strategy decrease the risk of losing unique environmental or cultural resources?
7. Health and Safety: Would the proposed strategy increase or decrease the risk of disease or injury?
8. Consistency: Does the policy support other national, state, community, or private goals?
9. Private vs. Public Sector: Does the strategy minimize governmental interference with decisions best made by the private sector?

Adaptation Through Local Planning

Local land use and municipal planning are important avenues for adaptation to global warming. These forms of planning are central to avoiding the impacts of climate related hazards such as floods and heat stress, preparing for demographic and consumption transition, and promoting ecosystem conservation. Local level planning is different from the National Adaptation Programs of Action (NAPA) which are intended to be frameworks for prioritizing adaptation needs. While prioritizing adaptation needs
is necessary, at the local level, municipalities are often in the midst of struggling with the immediate impacts of climate change in the forms of inundation, bushfires, heat waves and rising sea levels (Measham, 2011).

There are two distinct modes of local planning that address adaptation. The first is strategic planning, which is not unique to local governments. At the local scale it fosters community vision, aspirational goals, and disaster site selection, along with defining pathways to achieve set goals. The second form is land-use planning which is focused on the allocation of space to balance economic prosperity with acceptable living standards and the conservation of natural resources. These two types of planning are quite different in practice, and in many cases are managed by different governmental departments. However, both are necessary to achieve adaptation at the local scale. Significant constraints that hinder planning for adaptation include limited resources, lack of information, competing planning agendas, and complying with requirements from other levels of government (Lausche and Maier, 2012).

Local planning efforts include developing policy and proposing reforms designed to increase adaptive capacity. In the U.S., many state and local governments are now assessing innovative, locality-specific options that increase adaptation. Although adaptation planning occurs through a variety of processes, local adaptation initiatives in the U.S. often pass through three stages of adaptation planning (Ludi and Levine, 2013):

1. Building community awareness,
2. Undertaking a scientific assessment of risks in the medium and long-terms, and
3. Using a public process to develop an adaptation plan and supportive policies.

There is growing recognition of the need for ongoing and locally supported planning to adapt to climate change.

**Adaptation Imperative**

At the United Nations meeting on climate change on January 8, 2015, in Lima, Peru, much of the world’s attention focused on how strongly countries would commit to a framework for cutting GHG emissions. Government commitment is vital to ensure that the agreement to be signed in Paris in December 2015 will keep global temperatures
from rising more than 2° Celsius above pre-industrial levels (UN, 2015). The Lima “Call for Climate Action” made sufficient progress to enable preparations for a comprehensive climate agreement to be signed in Paris. It also left many questions unresolved – a shortcoming that was reflected in discussions on adaptation (UN, 2015).

The means to deliver the funding, technology, and knowledge that countries, communities, and ecosystems need to adjust to climate change require further articulation. Communities are already facing more extreme and frequent droughts, floods, and other severe weather events that will continue to increase. Moreover, the UN Environment Program’s first adaptation report released in Lima showed that the world remains unprepared to cover the costs of adaptation, and those costs will be far higher than was previously thought. Even if the temperature target is met, the cost of adaptation will reach 2-3 times the anticipated $70-100 billion per year by 2050. The report notes that an increase as much as fivefold is possible, though less likely (UN, 2015).

If global temperatures exceed the 2° Celsius ceiling significantly, adaptation costs could reach double the worst case figures, placing a crippling burden on the world economy. The burden of adaptation will be borne by everyone. However, it will be heaviest for developing countries, least-developed countries, and small island developing states. Although international funding will be available, costs will fall largely to afflicted countries, with governments forced to divert scarce resources from development projects to adaptation initiatives.

There has been some progress in addressing adaptation needs. The impacts of climate change are increasingly, though still inadequately, being factored into national and local budgets. On the international level, the Green Climate Fund was brought to nearly $10.2 billion from pledges by Australia, Austria, Belgium, Colombia, Norway, and Peru at the 2015 UN meeting on climate change in Lima, Peru. The Green Climate Fund is supposed to reach $100 billion per year – ten times higher than it is now – in the next five years (UNFCC, 2014). The original Copenhagen Accord committed developed countries to sending $100 billion per year through 2020 to the Green Climate Fund. The glaring funding gap now and more so after 2020 is huge. Commitments to adaptation in the Paris agreement would greatly help in closing this gap. In addition, the international auctioning of emissions allowances and allowances in domestic emissions-trading schemes, a carbon tax, revenues from international transport, a surcharge on electricity transmission, and financial transaction taxes could generate as much as $220 billion per year in additional revenues.

Funding is not the only component of a successful adaptation strategy. Closing
gaps in technology and knowledge is also crucial (UN, 2015). Many technologies that could help countries adapt to the consequences of climate change already exist. For example, by planting scientifically engineered crops that grow faster, farmers can harvest them before cyclone season, which will become increasingly more violent as global temperatures rise. However, significant social and economic barriers thwart adoption—barriers that governments might dismantle through a combination of incentives, regulatory reform, and institutional improvement. The benefits of adopting scientific agricultural technologies would extend beyond increased climate resilience. Accelerating harvests would mean higher, more reliable production with less labor—a formula for stronger, more stable livelihoods. Policymakers might thus pursue integrated financing and technological solutions that address climate change adaptation and mitigation needs as well as broader societal concerns, including development (UNFCC, 2014).

**Some Adaptation Initiatives**

On January 5, 2015, the Massachusetts Executive Office of Energy and Environmental Affairs released for public comment a draft policy on Climate Change Adaptation and Resiliency under the Massachusetts Environmental Policy Act (MEPA). MEPA's proposed policy, roughly a year in the making, would require a project proponent to address both the impacts of climate change on a project and the project’s impacts on climate change. Once the policy becomes effective a project proponent is required to include a “Climate Impact Assessment” in an Environmental Notification Form (ENF) (Corbett and Kiefer, 2015). Projects that filed an ENF before the effective date of the policy would be exempt, except that for a project that has already submitted an ENF, the MEPA office would determine on a case-by-case basis whether a subsequent filing of Notice of Project Change would require compliance with the policy.

The climate impact assessment must evaluate the potential impacts of climate change on a proposed project, including sea level rise, coastal flooding, storm surge, and changes in precipitation and temperature, and consider the effectiveness and feasibility of measures to reduce hazards and increase the project’s resiliency. The assessment also evaluates how a project can reduce negative impacts or exploit opportunities of climate change. MEPA includes appendices with best practices and references to relevant literature. Project proponents are encouraged to identify specific measures that
would reduce GHG emissions and/or enhance adaptation. A project that completes the Climate Change Resiliency Questionnaire as part of Boston’s Article 80 Large Project Review would likely comply at least in part with this new policy (Corbett and Kiefer, 2015).

On June 25, 2013, President Obama announced plans to reduce carbon pollution, move the economy toward American-made clean energy sources, and begin to slow the effects of climate change. The Administration made strides to cut the carbon pollution that causes climate change and threatens public health. States, cities, and communities were urged to protect themselves by updating building codes, improving the management of natural resources, investing in more resilient infrastructure, and planning for rapid recovery from damages that do occur.

The President’s plans build on the steps the Administration has taken since its earliest days to improve the nation’s disaster preparedness and resilience. Shortly after coming into office, President Obama established the Interagency Climate Change Adaptation Task Force, co-chaired by the Council on Environmental Quality (CEQ), the Office of Science and Technology Policy (OSTP), and the National Oceanic and Atmospheric Administration (NOAA), with representatives from more than 20 federal agencies. On October 5, 2009, President Obama signed an Executive Order directing the Task Force to recommend ways federal policies and programs can better prepare the nation for climate change (EO, 2009).

In its October 2010 Progress Report, the Interagency Climate Change Adaptation Task Force called for collaboration within the government to address major crosscutting issues related to climate change preparedness and resilience. This was to ensure the alignment of federal agencies’ adaptation planning efforts to build a coordinated and comprehensive response to the impacts of climate change on public health, communities, oceans, wildlife, and water resources.

On November 1, 2013, President Obama signed an Executive Order on Preparing the United States for the Impacts of Climate Change mandating federal agencies to assist American communities to strengthen their resilience to extreme weather and to prepare for other impacts of climate change (EO, 2013). The Executive Order instructs agencies to update federal programs to support climate-resilient investments, plan for climate change related risks to federal facilities, operations, and programs, and provide the information, data, and tools that state, local, and private-sector leaders need to make smart decisions to improve disaster preparedness and resilience.

The Executive Order also established a Task Force of state, local, and tribal leaders
from across the country who will use their first-hand experiences in dealing with the impacts of climate change in their own communities to advise the Administration on how the federal government can bolster disaster preparedness and resilience in communities nationwide. This Task Force was part of a joint effort including federal agencies and other stakeholders to develop the Climate and Natural Resources Priority Agenda. This agenda is a first of its kind, comprehensive commitment across the federal government to support resilience of our natural resources. It identifies strategies the federal government will use to increase the resilience of America's natural resources as well as their ability to absorb carbon dioxide (EO, 2013).

The EPA and other federal agencies joined in the collaborative efforts to address climate change. On October 31, 2014, the White House released the final versions of Climate Change Adaptation Plans produced by federal departments and agencies including the EPA. EPA's final Climate Change Adaptation Plan (PDF, 64pp, 1.7mb) and the Program and Regional Offices 17 (7 national programs and 10 regions) Climate Change Adaptation Implementation Plans describe how EPA will integrate considerations of climate change into its programs, policies, rules and operations to ensure they are effective even as the climate continues to change (EPA, 2014).

In June 2014, The Corporation for National and Community Service (CNCS), an independent executive branch agency whose mission is to engage Americans in service and volunteering across the country to improve lives, strengthen communities, and foster civic engagement, announced its commitment to fulfilling its responsibilities under Executive Order (E.O.) 13514, Federal Leadership in Environmental, Energy, and Economic Performance, and E.O. 13653, Preparing the United States for the Impacts of Climate Change. The EOs promote programs dedicated to emergency management support, environmental stewardship, and energy conservation (CNCS, 2014). The CNCS vision for adapting to climate change is threefold. First, CNCS will model awareness and preparedness in protecting our national service resources across the nation. Second, CNCS will continue to prepare national service members to assist in mitigating the effects of climate change, and in responding to potential disasters caused by climate change. Third, CNCS will collaborate with other federal agencies to ensure the coordination of federal efforts (CNCS, 2014).
Climate Change Mitigation

The urgency of climate change mitigation is now far more apparent with new observations indicating that on many fronts climate change and its impacts are occurring faster than expected. The global GHG emissions have jumped to a record volume according to the latest research conducted by the U.S. Department of Energy. Data indicate that the GHG emissions have crossed the worst case scenario limits outlined by climatologists. The resulting global warming is already wreaking havoc worldwide. Global communities suffering the effects of unabated climate change are keenly aware of the need to prevent or limit global warming.

Parties to the 2010 United Nations Framework Convention on Climate Change (UNFCCC) entered an international treaty agreeing that future global warming should be limited to below 2.0 °C (3.6 °F) relative to the pre-industrial level (UNFCC, 2010). Scientists say that meeting the 2 °C target would require annual global GHG emissions to peak before the year 2020 and decline significantly thereafter, with emissions in 2050 reduced by 30-50 percent compared to 1990 levels. Some climate scientists say “there is little to no chance” of meeting the target (Anderson and Bows, 2011), while others say the target might still be achievable if more stringent mitigation policies are adopted immediately (Alcamo et al., 2013). Effective mitigation policies would surely encourage mitigation proponents to respond forcefully in addressing global warming. However, analyses by the United Nations Environment Program and International Energy Agency (IEA) suggest that current mitigation policies (as of 2012) are too weak to achieve the 2 °C target.

Most countries are parties to the UNFCCC whose ultimate objective is preventing dangerous anthropogenic (i.e., human) interference of the climate system. As stated in Article 2 of the Convention, this requires that GHG concentrations are stabilized in the atmosphere at a level where ecosystems can adapt naturally to climate change, food production is not threatened, and economic development can proceed in a sustainable fashion (Oppenheimer et al., 2014). Anthropogenic GHGs include carbon dioxide (chemical formula: CO2), methane (CH4), nitrous oxide (N2O), and a group of gases referred to as halocarbons. Stabilization of the increasing GHG concentrations in the atmosphere has been a major issue and challenge. The emissions reductions necessary to stabilize the atmospheric concentrations of these gases vary. Mitigation efforts have focused on CO2 because it is emitted in much greater volume than any other
anthropogenic GHGs. In year 2010 alone, the world pumped in nearly 564m tons more of CO2 into the atmosphere than in year 2009. This indicates an alarming 6 percent rate of increase.

Stabilizing CO2 emissions at their present level would not stabilize atmospheric concentrations of CO2. In fact, stabilizing CO2 emissions at current levels would result in the continuing rise of atmospheric concentrations of CO2 over the 21st century and beyond. (Oppenheimer et al., 2014). Stabilizing the atmospheric concentrations of CO2 at a constant level would require CO2 emissions to be effectively eliminated. The reason for this is that human activities are adding CO2 to the atmosphere far faster than natural processes can remove it. This is analogous to a flow of water into a bathtub. So long as the tap runs water (analogous to the emission of carbon dioxide) into the tub faster than water escapes through the plughole (analogous to the natural removal of carbon dioxide from the atmosphere), the level of water in the tub (analogous to the concentration of carbon dioxide in the atmosphere) will continue to rise.

According to some studies, stabilizing atmospheric concentrations of CO2 would require anthropogenic CO2 emissions to be reduced by 80 percent relative to the peak emissions level. An 80 percent reduction in emissions would stabilize CO2 concentrations for around a century, but even greater reductions would be required beyond this. Other research has found that after leaving room for emissions for food production for 9 billion people, and to keep the global temperature rise below 2°C Celsius, emissions from energy production and transport will have to peak almost immediately in the developed world and decline at about 10 percent per annum until zero emissions are reached around 2030. In developing countries, energy and transport emissions would have to peak by 2025 and then decline similarly. Stabilizing the atmospheric concentration of the other GHGs humans emit also depends on how fast their emissions are added to the atmosphere and how fast the GHGs are removed (Bows, 2012).

Climate change mitigation aims to reduce GHG emissions and/or hasten the removal of these gases from the atmosphere through carbon sinks, for example. Even the most effective reductions in emissions, however, would not prevent further climate change impacts, making the need for adaptation unavoidable (UNEP, 2012; IEA, 2012). Still, climate change mitigation can reduce human-generated (anthropogenic) emissions of GHGs and help to limit the magnitude and/or rate of long-term climate change. Examples of mitigation include switching to low carbon energy sources such
as renewable and nuclear energy, expanding the capacity of forests, grasslands, and other “sinks” to remove greater amounts of carbon dioxide from the atmosphere, and increasing energy conservation by improving the insulation of buildings, using energy efficient automobiles (e.g., electric hybrids), making individual lifestyle changes (e.g., cycling instead of driving) and changing business practices (e.g., requiring fuel efficient air and ground transport) (IEA, 2012).

Carbon capture and storage (CCS) is an example of a mitigation process that removes CO2 from the atmosphere by capturing CO2 from large point sources such as power plants and storing it away safely instead of releasing it into the atmosphere. The IPCC says CCS could contribute between 10 and 55 percent of the cumulative worldwide carbon mitigation effort over the next 90 years. The IEA says CCS is “the most important single new technology for CO2 savings” in power generation and industry. Although it requires up to 40 percent more energy to run a CCS coal power plant than a regular coal plant, CCS could potentially capture about 90 percent of all the CO2 emitted by the plant. Norway, which first began CCS, has cut its emissions by almost a million tons a year or about 3 percent of the country’s 1990 levels. As of late 2011, the total CO2 storage capacity of all 14 projects in operation or under construction is over 33 million tons a year. This is broadly equivalent to preventing the emissions from more than six million cars from entering the atmosphere each year (Saini, 2011).

To create lasting climate change mitigation, the replacement of high carbon power sources, such as conventional fossil fuels—oil, coal and natural gas—with low carbon power sources is required. Fossil fuels supply humanity with the vast majority of energy demands and at a growing rate. Imposing direct quotas on global fossil fuel production or strongly pushing for reduced use could also help to curtail the growth. In 2012, the International Energy Agency (IEA) noted that coal accounted for half the increased energy use of the prior decade, growing faster than all renewable energy sources. Both hydroelectricity and nuclear power together provided the majority of the low carbon power fraction of total global power consumption (IEA, 2012). Studies suggest that GHG emissions can be reduced using a portfolio of low carbon technologies. The crux of most proposals is the reduction of GHG emissions through reducing energy waste and switching to low carbon power sources of energy. Because the cost of reducing GHG emissions in the electricity sector appears to be lower than in other sectors such as in the transportation sector, the electricity sector may deliver the largest proportional carbon reductions for the price paid (IEA, 2012).
A range of mitigation technologies that utilize renewable energy sources is becoming more available. Renewable energy flows include natural resources such as sunlight, wind, tides, plant growth, and geothermal heat that are replenished constantly (IEA, 2012). Other sources of renewable energy include nuclear power, the use of carbon sinks, and carbon capture and storage. In its various forms, renewable energy is derived from natural processes directly from the sun or from heat generated deep within the earth. Included in the definition are electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and biofuels and hydrogen derived from renewable resources (IEA, 2012).

Renewable energy use has grown much faster than anticipated. There has been increasing growth in the renewable energy industries engaged in mitigation. Globally, there are an estimated 3 million direct jobs in renewable energy industries, with about half of them in the biofuels industry (Morris, 2012). Leading renewable energy companies include BrightSource Energy, First Solar, Gamesa, GE Energy, Goldwind, Sinovel, Suntech, Trina Solar, Vestas and Yingli (Bows, 2012). An overriding goal for these companies is to replace high carbon power sources with low carbon power sources. Low carbon renewable energy replaces conventional fossil fuels in three main areas: power generation, hot water/space heating, and transport fuels. In 2011, the share of renewables in electricity generation worldwide grew for the fourth year in a row to 20.2 percent, with the global share of electricity from hydro power staying roughly constant at 16.3 percent. The IPCC notes that there are few fundamental technological limits to integrating a portfolio of renewable energy technologies to meet most of the total global energy demand. At the national level, at least 30 nations around the world already have renewable energy contributing more than 20 percent of energy supply (Bows, 2012).

The incentive to use 100 percent renewable energy is reinforced by the disasters and the threat of disasters caused by global warming. According to Mark Z. Jacobson, Professor of Civil and Environmental Engineering at Stanford University and director of its Atmosphere and Energy Program, producing all new energy with wind power, solar power, and hydropower by 2030 is feasible and existing energy supply arrangements could be replaced by 2050. Jacobson maintains that energy costs with a wind, solar, or water system should be similar to today’s energy costs. Barriers to implementing the renewable energy plan are seen to be "primarily social and political, not technological or economic" (Delucchi and Jacobson, 2011; Jacobson, 2012).
When there is informed and supportive public policy and political leadership, renewable energy technologies gain wider acceptance. As of 2011, 118 countries had targets for their own renewable energy futures and have enacted wide-ranging public policies to promote renewable energy. According to a 2011 projection by the IEA, solar power generators may produce most of the world's electricity within 50 years, dramatically reducing harmful GHG emissions (IEA, 2012). Even now the Andasol solar power station, a commercial solar thermal power plant located in Spain, uses tanks of molten salt to store solar energy so that it can continue generating electricity for 7.5 hours after the sun has stopped shining. As of 2012, renewable energy accounts for almost half of new electricity capacity installed and costs are continuing to decline. In his 2012 State of the Union address, President Barack Obama restated his commitment to renewable energy and mentioned the long-standing Interior Department commitment to permit 10,000 MW of renewable energy projects on public land in 2012.

Some countries, with favorable geography, geology, and weather well suited to an economical exploitation of renewable energy sources already get most of their electricity from renewables, including from geothermal energy in Iceland (100 percent), and hydroelectric power in Brazil (85 percent), Austria (62 percent), New Zealand (65 percent), and Sweden (54 percent) (Lovins, 2012). Renewable power generators are spread across many countries, with wind power providing a significant share of electricity in some regional areas; for example, 14 percent in the U.S. state of Iowa, 40 percent in the northern German state of Schleswig-Holstein, and 20 percent in Denmark.

Solar water heating makes an important and growing contribution in many countries, most notably in China, which now has 70 percent of the global total 180 GWth (gigawatts-thermal). Worldwide, total installed solar water heating systems meet a portion of the water heating needs of over 70 million households. The use of biomass for heating continues to grow as well. In Sweden, national use of biomass energy has surpassed that of oil. Direct geothermal heating is also growing rapidly. Renewable biofuels for transportation, such as ethanol fuel and biodiesel, have contributed to a significant decline in oil consumption in the U.S. since 2006. The 93 billion liters of biofuels produced worldwide in 2009 displaced the equivalent of an estimated 68 billion liters of gasoline, equal to about 5 percent of world gasoline production (Lovins, 2012).
Thorium-based nuclear power is gaining renewed interest as an alternative to uranium fueled nuclear power. Thorium is four times more abundant within the earth’s crust than uranium, and the world’s current supply is capable of generating enough energy to power the world for thousands of years. Thorium fuels prove to be more beneficial in comparison to uranium based nuclear reactors, as they are safer, cleaner, and proliferation resistant. Heavily researched, molten salt reactors using thorium fuels have been designed to be meltdown proof. In the event of a power failure or unusually high fuel temperatures, a plug at the bottom of the reactor will melt, allowing the fuel to drain into an underground storage tank for safe storage. This technology will prevent large scale nuclear disasters such as those in Chernobyl and Fukushima.

The World Nuclear Association reported that nuclear electricity generation in 2012 was at its lowest level since 1999. Several earlier international studies and assessments suggested that as part of the portfolio of other low carbon energy technologies, nuclear power would continue to play a role in reducing GHG emissions. A 2014 Brookings Institute publication, The Net Benefits of Low and No-Carbon Electricity Technologies, reported after performing an energy and emissions cost analysis, that “The net benefits of new nuclear, hydro, and natural gas combined cycle plants far outweigh the net benefits of new wind or solar plants,” and the most cost effective low carbon power technology was nuclear power (Brookings Institute, 2014).

Historically, the use of nuclear power is estimated to have prevented the atmospheric emission of 64 gigatons of CO2-equivalent as of 2013 (WNA, 2013). In its 2014 report, the IPCC comparison of energy sources global warming potential per unit of electricity generated, which included albedo effects, found that nuclear power’s median CO2-equivalent value of 12 g CO2-eq/kWh is the lowest global warming forcing of all base load power sources; comparable low carbon power base load sources such as hydropower and biomass both produce substantially more global warming forcing, 24 and 230 g CO2-eq/kWh respectively (IPCC, 2014).

Cost-wise nuclear power may be uncompetitive compared with fossil fuel energy sources in countries without a carbon tax program, and in comparison to fossil fuel plants of the same power output, nuclear power plants take a longer amount of time to construct (Lovins, 2012). However, during his presidential campaign, Barack Obama stated, “Nuclear power represents more than 70 percent of our noncarbon generated electricity. It is unlikely that we can meet our aggressive climate goals if we eliminate nuclear power as an option” (Morris, 2012).
A first of its kind European Pressure Reactor (EPR) under construction in Finland and France has been delayed and is running over-budget. However, learning from experience, another two EPRs under construction in China are on, and ahead, of schedule respectively. As of 2013, according to the International Atomic Energy Agency (IAEA) and the European Nuclear Society, worldwide there were 68 civil nuclear power reactors under construction in 15 countries. China has 29 of these nuclear power reactors under construction as of 2013, with plans to build many more, while in the U.S. the licenses of almost half its reactors have been extended to 60 years and plans to build another dozen are under serious consideration. There is also a considerable number of new reactors being built in South Korea, India, and Russia (IAEA, 2013).

Public opinion about nuclear power varies widely among countries. Concerns surrounding its use include the fate of spent nuclear fuel, nuclear safety, and security risks which are considered unique among low carbon energy sources. A 2011 poll by Gallup International assessed public opinion about nuclear power in 47 countries. The poll was conducted following the tsunami and earthquake that caused the nuclear accident at the Fukushima nuclear power plant in Japan. Forty-nine percent reported that they held favorable views about nuclear energy, while 43 percent reported unfavorable views. Another global survey by Ipsos, a global market research company in France, assessed public opinion about energy sources in 24 countries. Respondents to this survey showed a clear preference for renewable energy sources, including nuclear energy over coal. Solar and wind energy sources were seen as being more environmentally friendly and more viable long-term energy sources relative to nuclear power and natural gas (Ipsos, 2012). However, solar and wind power were viewed as being less reliable relative to nuclear power and natural gas in surveys by Ipsos in 2011 and 2012 (Ipsos, 2011, 2012). A 2012 poll conducted in the UK found that 63 percent of those surveyed supported nuclear power and 11 percent did not. In Germany, strong anti-nuclear sentiment caused eight of the seventeen operating nuclear reactors to be permanently shut down following the March 2011 Fukushima nuclear disaster (Lovins, 2012).

Nuclear fusion research in the form of the International Thermonuclear Experimental Reactor is underway. Fusion powered electricity generation was initially thought to be as readily achievable as fission power had been. However, the extreme requirements for continuous reactions and plasma containment have extended the projections for completion by several decades. In 2010, more than 60 years after the first attempts, commercial fusion powered electricity production was still judged to be unlikely before 2050.
From the largest and most developed nations to the smallest and least developed states, from countries such as U.S, China, and India that contribute the most GHG emissions to those contributing the least, such as small island developing states, there must be worldwide cooperation and support of mitigation efforts to stem the global warming brought about by climate change. The analytical tools and scientific technologies to do this are already available. For example, the IEA maintains that economic and social welfare analysis, including cost-benefit analysis, can be useful in designing climate change mitigation and adaptation policies that can make real differences in addressing climate change. The tools for assessing the pros and cons of taking or not taking action, of investing or not investing in particular technologies, as well as other economic, scientific, and social considerations on climate change mitigation are necessary to inform decision-makers. Often competing interests and goals of countries, institutions, and individuals, or political and social attitudes impede or hasten actions taken to reduce global warming (Bows, 2011). Scientific analysis can provide objective data on the impacts of climate change, but deciding when and how to deal with them require value judgments (Oppenheimer et al., 2014). The ecological and socio-economic well-being of the world community rest in large part on the mitigation (and adaptation) policies and programs in place today.

**Climate Change Mitigation Measures**

The IPPC advocated the need for climate change mitigation and proposed measures which can curb the emission of GHGs into the atmosphere. Some of the measures suggested by IPCC:

1. Implementing cost-effective fuel switching measures from high carbon fuels to low or zero carbon fuels such as renewables.
2. Implementing energy efficiency measures and providing global platforms for energy efficiency improvement programs.
3. Improving existing policies and practices to limit GHG emissions e.g. controlling subsidies on fuels.
4. Taking action to raise and expand carbon sinks that trap carbon dioxide such as forest management and proper land management.
5. Improving technology and developing techniques to control the sources of methane, nitrous oxide, and other GHG emissions.
6. Pre-planning for the adaptation to climate change consequences in the worst case scenario.
7. Promoting the use of non-fossil fuel energy sources and conducting research to reduce emissions from existing fossil fuels.
8. Revising and implementing current energy efficiency standards globally to check emissions.
9. Increasing international collaboration among various climate groups and organizations to better understand the causes and impacts of climate change.
10. Continuing research to reduce critical scientific uncertainties and improve existing climate models for better predictions of climate change.
11. Promoting environmental education and awareness training in schools and colleges for climate change and associated environmental issues.
12. Conducting volunteer programs and forming regional action groups to implement climate change mitigation measures.

The earth's climate is so complex that human alterations to the atmosphere can amount to an “experiment” having an unknown and possibly life threatening outcome. Alteration on a regional level will not have its impacts on a regional level alone; climate change is a global phenomenon. All the nations of the world must adopt climate mitigation measures to reduce global warming (IPPC, 2012).

**Federal Actions**

The federal government has taken action to promote energy efficiency, clean technologies, and alternative fuels. It has established GHG regulations, other rules and regulations with climate co-benefits, and various standards and subsidies; supported research and development, and improved federal procurement practices – all to reduce the risks of climate change. The U.S. Environmental Protection Agency (EPA) has a 40-year history of regulating the concentration and deposition of criteria pollutants (six common air pollutants that affect human health). A 2012 Supreme Court decision upheld the EPA's finding that GHGs "endanger public health and welfare" (EPA, 2012). This decision added the regulation of GHG emissions to the EPA's authority under the Clean Air Act. Actions taken and proposed under EPA's authority have focused on road transport and electric power generation.
The U.S. Department of Energy (DOE) is the lead agency of the U.S. Climate Change Technology Program (CCTP), a multi-agency planning and coordination entity whose purpose is to accelerate the development and deployment of technologies that can reduce, avoid, or capture and store GHG emissions. CCTP was established administratively in 2002, authorized by the Energy Policy Act of 2005, and appropriated funds in 2007 (DOE, 2013). The DOE provides most of the funding for a broad range of programs for energy research, development, and demonstration. DOE has the authority to regulate the standards for efficiency of appliances and building codes for manufactured housing. In addition to the DOE, most of the other federal agencies, including the Department of Defense, Housing and Urban Development, Transportation, and Agriculture, have programs that support GHG mitigation (DOE, 2012).

The Administration's Climate Action Plan advocates a broad range of mitigation, adaptation, and preparedness measures. The mitigation measures and aspects of the Plan are in part a response to the commitment made during the 2010 Cancun Conference of the parties of the UNFCCC to reduce U.S. emissions of GHGs by 17 percent below 2005 levels by 2020 (UNFCCC, 2010). Actions proposed in the Plan include:

1. Limiting carbon emissions from both new and existing power plants,
2. Continuing to increase the stringency of fuel economy standards for automobiles and trucks,
3. Continuing to improve energy efficiency in the buildings sector,
4. Reducing the emissions of non-CO2 GHGs through a variety of measures,
5. Increasing federal investments in cleaner, more efficient energy sources for both power and transportation, and
6. Identifying new approaches to protect and restore our forests and other critical landscapes in the presence of a changing climate.

City, State, and Regional Actions

Jurisdiction for GHG and energy policies and regulation is shared between the federal government and the states. For example, states regulate the distribution of electricity and natural gas to consumers, while the Federal Energy Regulatory
Commission regulates wholesale sales and transportation of natural gas and electricity. Many states have adopted climate initiatives as well as energy policies that reduce GHG emissions. The most ambitious state initiative is California’s Global Warming Solutions Act (AB 32), a law that sets a state goal to reduce GHG emissions to 1990 levels by 2020. The state program caps emissions and uses a market-based system of trading in emissions credits (cap and trade), and it adheres to a number of regulatory measures.

The most well-known multi-state effort to reduce GHG emissions is the Regional Greenhouse Gas Initiative (RGGI) formed by ten northeastern and Mid-Atlantic states - Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont (New Jersey exited in 2012). RGGI is a cap and trade system to reduce CO2 emissions applied to the power sector. The revenue from states’ sales of emission allowances through auctions is invested in energy efficiency, renewable energy, and other programs that benefit consumers. The RGGI is the first market-based regulatory program in the U.S. to reduce GHG emissions. Following a comprehensive 2012 program review, the RGGI states implemented a new 2014 RGGI cap of 91 million short tons. The RGGI CO2 cap will then decline 2.5 percent each year from 2015 to 2020. The RGGI CO2 cap imposes a regional limit for CO2 emissions for the power sector (RGGI, 2014). Mitigation initiatives like the RGGI are spurring innovation in the clean energy economy and creating green jobs in the RGGI states.

**Voluntary Actions**

Corporations, individuals, and non-profit organizations have initiated a host of voluntary actions to reduce GHG emissions. Some examples of the range of voluntary actions include:

1. The Carbon Disclosure Project has the largest global collection of self-reported climate change and water use information. The system enables companies to measure, disclose, manage, and share climate change and water use information. Some 650 U.S. signatories include banks, pension funds, asset managers, insurance companies, and foundations.

2. Many local governments are undertaking initiatives to reduce GHG emissions within and outside of their organizational boundaries. For example, over 1,055 municipalities from all 50 states have signed the U.S. Mayors
Climate Protection Agreement, and many of these communities are actively implementing strategies to reduce their GHG footprint.

3. Under the American College and University Presidents’ Climate Commitment (ACUPCC), 679 institutions have pledged to develop plans to achieve net-neutral climate emissions through a combination of on-campus changes and purchases of emissions reductions at off-campus sites.

4. There is widespread voluntary compliance with efficiency standards developed by industry and professional associations, such as the building codes of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

5. Federal voluntary programs include Energy STAR, an EPA voluntary program that identifies energy efficient products for use in residential homes, commercial buildings, and industrial plants; and programs and partnerships devoted to reducing methane emissions from fossil fuel production and landfill sources and high global warming potential (GWP) emissions from industrial and related activities.

Cost of Emissions Reductions

The national cost of achieving U.S. emissions reductions over time depends on the level of reduction sought and the particular measures employed. Studies of price-based initiatives such as the cap and trade system indicate that a 50 percent reduction in emissions by 2050 could be achieved at a cost of a year or two of projected growth in gross domestic product over the period (Paltsev et al., 2009; EIA, 2009). However, because of differences in methods of analysis and in assumptions about economic growth and technology change, cost projections vary considerably. Comparisons of emissions reduction by price versus regulation show that a regulatory approach can cost substantially more than a price-based approach.

The benefits of strong, early mitigation considerably outweigh the costs. The Copenhagen Accord was agreed on to assure commitment by developed countries to provide new and additional resources approaching USD $30 billion for the period 2010-2012, with balanced allocation between adaptation and mitigation. This would be in the context of meaningful mitigation actions and transparency on implementation. Developed countries committed to a goal of mobilizing jointly USD $100 billion a year by 2020 to address the needs of developing countries (World Bank, 2010). A key
point of contention among donor states was, if aid was to be given, how would it affect other levels of development aid (World Bank, 2010). In this context, the concept of "additionality" arose and the European Union (EU) asked its member states to provide definitions of what they understood additionality to mean. The four main definitions are (Brown et al., 2010):

1. Climate finance classified as aid, but additional to (over and above) the '0.7%’ Official Development Assistance (ODA) target;
2. Increase on previous year’s ODA spent on climate change mitigation;
3. Rising ODA levels that include climate change finance but where it is limited to a specified percentage; and
4. Increase in climate finance not connected to ODA.

The main concern regarding additionality is how to resolve the conflict among competing needs such as the Organization for Economic Cooperation and Development (OECD) states budget deficit cuts, the need to help developing countries adapt to develop sustainably, and the need to ensure that funding does not come from cutting aid to other important Millennium Development Goals (Brown et al., 2010).

Studies of the threat and impacts of climate change clearly suggest speedy and efficient response. The National Research Council (NRC) proposes national-level strategies that might include an economy-wide system of prices on GHG emissions and a portfolio of possible regulatory measures and subsidies. Deciding these matters is an ongoing task. The U.S. Administration and Congress face a long series of choices about whether and when to take mitigation actions and how best to do it. Integral to this process are consideration of innovative technologies and development of ever-more-useful assessments of the cost effectiveness and benefits of policy choices (NRC, 2012).

Effective technologies are potentially available to accomplish emissions reduction, but cost may be prohibitive. Cost effective analysis of ways to improve existing technologies, invent new ones, reduce cost, and other cost related concerns is needed. While some research and development are carried out by private sector firms with their own funds, the federal government traditionally supports major programs to advance research and technology. This support is accomplished in part by credits and deductions in the tax code, and in part by federal expenditure. For example, the 2012 federal budget devoted approximately $6 billion to clean energy technologies. Success in lowering
the cost of GHG reduction can make a valuable contribution to future climate policy choices (GCP, 2012).

Because they are in various stages of market maturity, the cost and effectiveness of many technologies remain uncertain. Continuing study of their performance is essential in determining their future use. Research data from a range of disciplines that evaluate broad policies and particular mitigation measures can help to inform decisions. Mitigation research can use energy-economic models that do not assume large changes in the mix of technologies or changes in the structure of the economy. However, analysis over the time spans relevant to stabilization of GHG concentrations requires Integrated Assessment Models that consider all emissions drivers and policy measures that affect them, and that take into account how they are related to the larger economy and features of the climate system. This type of analysis is also useful for exploring the relations between mitigation and adaptation.

Continued improvement of these analytical capabilities can provide data to make informed decisions about national mitigation and the U.S. position in international climate negotiations. Further, behavioral and institutional research on individuals and communities can reveal attitudes and perceptions about climate change. Knowledge and understanding of public opinion and perspectives can provide insight into designing climate policies and programs that will meet with public support and approval.

**Geoengineering**

Geoengineering is a third option for addressing climate change in addition to mitigation and adaptation. Geoengineering is seen by some as an alternative to mitigation and adaptation, but by others as an entirely separate response to climate change. A study of the Royal Society, the world's oldest scientific academy in continuing existence, defined geoengineering as a “deliberate large-scale intervention in the Earth's climate system, in order to moderate global warming” (The Royal Society, 2009). Geoengineering engages in interventions such as:

1. Carbon dioxide removal (CDR), which boosts CO2 removal from the atmosphere by various means such as fertilizing ocean processes and promoting land use practices that help take up carbon,
2. Solar radiation management (SRM), which reflects a small percentage of sunlight back into space by using techniques such as space sunshade, stratospheric sulfur aerosols, and white roofing and paving materials to offset global warming,

3. Direct capture and storage of CO2 from the atmosphere, and

4. Hydrological geoengineering, which typically seeks to preserve sea ice or adjust thermohaline circulation by using methods such as diverting rivers to keep warm water away from sea ice or tethering icebergs to prevent them drifting into warmer waters and melting.

Although current research suggests that SRM or CDR could diminish the impacts of climate change, there are accompanying risks. Once undertaken, sudden cessation of SRM would exacerbate the climate effects on human populations and ecosystems, and some CDR might interfere with oceanic and terrestrial ecosystem processes. SRM undertaken by itself would not slow increases in atmospheric CO2 concentrations. Furthermore, existing international institutions are not equipped to manage such global interventions. The risks associated with such purposeful perturbations to the Earth system are poorly understood. There is need for caution and comprehensive research, including consideration of the implicit moral hazards (IPCC, 2014).

Geoengineering plays a growing role in reducing GHG emissions. Carbon dioxide removal has been proposed as a method for reducing the amount of radiative forcing. A variety of means of artificially capturing and storing carbon as well as enhancing natural sequestration processes is being explored. The main natural process is photosynthesis by plants and single-celled organisms. Artificial processes vary, and there are concerns about the long-term effects of some of these processes. Other geoengineering emission reduction practices are used in the construction of new energy efficient buildings, such as passive solar building design, low or zero energy building techniques, and renewable heat sources. Renewable heat sources such as shallow geothermal and passive solar energy reduce the amount of GHGs emitted.

**Technology Transfer**

Many developing and developed countries aim to use cleaner technologies that aid mitigation and could result in substantial reductions in CO2 emissions (World Bank, 2010). Meaningful climate policies that include targets for emissions reductions,
increased use of renewable energy, and increased energy efficiency would help to achieve this aim. It is often argued that the results of climate change are more damaging in poor nations where infrastructures are weak and few social services exist. The Commitment to Development Index is one attempt to analyze rich countries' policies intended to reduce their disproportionate use of the global commons. Countries do well if their GHG emissions are falling, if their gas taxes are high, if they do not subsidize the fishing industry, if they have a low fossil fuel rate per capita, and if they control imports of illegally cut tropical timber (World Bank, 2011).

With rapid urbanization and social change, developing countries use more and more of the world's energy resources and contribute more to GHG emissions. The International Energy Agency (IEA) estimates that by 2020, 60 percent of GHG emissions will come from economies in transition and developing countries, emphasizing that these countries will need to “leapfrog a technological generation or two” if they are to avoid the fossil-fuel trap and move directly to environmentally sound technologies (IEA, 2012). Technology transfer from developed to developing countries and increasingly between developing countries will be needed on what the secretariat of the UNFCCC describes as an unprecedented scale. A major, ongoing focus of the UNFCCC discussions is how best to make this happen. Strategies include funding mechanisms, capacity-building, international collaborative research networks, public-private partnerships, and using multilateral and bilateral trade cooperation agreements to create incentives (UNFCCC, 2013).

Technology transfer involves the intellectual property (IP) rights system and patent information. The IP rights system promotes the development and diffusion of new technologies to address climate change in the environmental field much as it does in any other innovative technology field. It encourages innovation by providing the means to generate a commercial return on investment in new technologies such as low carbon technologies (particularly as demand builds when the market is primed by appropriate policies). IP gives companies the confidence to license their proprietary technologies for use or further development where they are most needed.

Published patent documents offer a vast, freely accessible source of technological information on which others may build, which is beneficial to technology transfer. The development of hydrogen fuel cells as a renewable energy source is just one example of how new innovation grew from research results contained in earlier patent information.

As the process of technology transfer of affordable climate-friendly technologies
to developing countries accelerates, ongoing scrutiny will be required to ensure that the IP rights system is operating effectively to facilitate this process and to address any problem areas. Such scrutiny is already underway with groups such as the Third World Network expressing concern that patents on the new technologies may be keeping prices too high and restricting access by developing countries. Further, a European Parliament report included a proposal to study the feasibility of amending the World Trade Organization Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) in order to allow for the compulsory licensing of “environmentally necessary” technologies.

National Risk Management Research Laboratory (NRMRL)

EPA's top priority is to take action on climate change. The inherent perils involved in dealing with urgent and complex impacts of climate change pose a tremendous risk management challenge to the agency. It must be informed about 'best practice' policies, programs, and technologies to achieve its goals. EPA's National Risk Management Research Laboratory's (NRMRL) climate change research develops data and modeling tools to study climate change and its impacts and how best to manage them. NRMRL's risk management efforts are focused on providing EPA and others with information about technologies and practices that are needed to keep the impacts of climate change to a minimum. The information is used to develop improved mitigation and adaptation strategies to deal with large and small scale impacts of global warming and to ensure even as technologies and practices change, we maintain and improve the environment to protect the quality of air, water, land, and ultimately human and ecosystem health (NRMRL, 2012).

The U.S. energy system is so complex, even strategies that effectively reduce GHGs and other pollutants have potential to cause adverse and unintended consequences. Scientific evaluations of energy and GHG reduction technologies are conducted to determine their expediency and effectiveness, as well as the implications for changes in air pollution and other environmental impacts that might occur as these technologies are put into everyday use. NRMRL's focus is on the energy system because many of the strategies to reduce GHG emissions are related to how we produce and use energy (NRMRL, 2012).
NRMRL's climate change and technology assessment research takes a two-pronged approach to study climate change technologies. On the one hand is the detailed analysis of different technologies, and on the other hand is the overall consideration of how they will be used as part of the interconnected system of technologies and practices for producing and using energy. NRMRL researchers work with experts in industry, government, and academic institutions to collect and evaluate data on climate change technologies to determine performance, applicability, availability, cost, the extent to which they are ready for use, or if additional research is needed before they can be used in a meaningful way. Technologies that are not cost effective, widely applicable, or need major improvements to be commercially viable are not relied upon in the near term but considered for future use (NRMRL, 2012).

NRMRL researchers have developed a database of energy technologies for use in the market allocation (MARKAL) model, which simulates the U.S. energy system and enables researchers to study how changes in technologies might impact how energy is produced and used as well as the implications those changes have for air pollutant and GHG emissions. The data from NRMRL's evaluations are consolidated and used to ascertain the potential these technologies have to make a significant difference in reducing GHG emissions and other undesirable environmental impacts at national and international scales (NRMRL, 2012). Some of the initiatives and projects of the HRMRL include:

1. Providing information on emissions from future technologies as input to a larger Office of Research and Development (ORD) program planned to assess the implications of climate change on air quality
2. Increasing emphasis on decision support tools
3. Helping to evaluate air quality adaptation options, Greenhouse Gas (GHG), and criteria pollutants co-benefits of specific technologies
4. Applying MARKAL to understand consumption and production of energy in the agricultural sector under alternative long-run climate and energy scenarios
5. Using MARKAL to evaluate the potential of innovative energy technologies to reduce GHG emissions
6. Improving the representation of the industrial sector in MARKAL
7. Improving the representation of state and regional renewable portfolio standards and renewable energy technology resources in MARKAL
8. Advancing regional and state-level decision support of technology and policy evaluations to achieve multiple environmental benefits
9. Evaluating tipping points for maximizing energy efficiency and GHG reductions for materials and waste management
10. Assessing the retrofitability of GHG mitigation technologies for coal-fired power plants
11. Characterizing emissions under simulated oxygen-rich combustion conditions
12. Developing a database of GHG mitigation technologies
13. Researching issues associated with waste glycerol combustion for biodiesel production
14. Assessing environmental consequences of biomass fast pyrolysis for biocrude production
15. Evaluating GHG source measurement methods

Climate change management is an enormous task that challenges governmental, environmental, and energy-related institutions in the U.S. and the world community. The repeated warnings of the dangers of climate change by climate scientists cannot be ignored. The urgent state of global warming leaves humankind little choice but to act swiftly, prudently, and justly if we are to survive the inevitable present and future impacts of climate change.

Questions for Review

1. Describe and explain how climate change adaptation and mitigation are similar? How are they different?
2. Describe some important climate change adaptation initiatives. Explain how and why they are important.
3. Describe some important climate change mitigation initiatives. Explain how and why they are important.
4. What is geoengineering in the context of climate change? What contributions has geoengineering made in addressing the impact of climate change?
5. Identify and describe the role and importance of international, regional, and national organizations involved in climate change adaptation, mitigation and geoengineering.
6. Identify and describe the role and importance of international, national, and local organizations involved in climate change adaptation, mitigation and geoengineering in the United States.

7. Which climate change innovations and advances in technology described in this chapter do you believe to be most effective in the long term?
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Chapter 3

Disaster and Climate Change Preparedness

Although climate change has not been specifically identified in emergency preparedness plans, many communities have had all-hazards emergency management plans for all types of emergencies including climate change and weather related disasters. The serious threat of global warming compels scientists and planners in the field of disaster preparedness and emergency management to emphasize the importance of including climate change in emergency preparedness plans. The field is evolving as more and more information becomes available and agencies begin developing best practices in response.

Climate scientists and emergency managers recognize that the impacts of climate change are becoming more severe and that adapting and planning for more and possibly new weather-related threats need to be incorporated into preparedness procedures. Because of climate change, global warming, and climate crisis, many communities have developed climate action plans.

Climate Change Preparedness at the Local Level

At the local level, California began including climate change in its emergency planning and hazard mitigation plans in 2007. The 2007 version of its Multi-Hazard
Mitigation Plan included the claim that until Hurricane Katrina in 2005 drew the attention of the news media to scientific evidence on intensification of storm events, climate change was not recognized as an important emergency management topic. The plan contains information on climate related hazards such as avalanches, coastal flooding, erosion and sea-level rise, drought, extreme heat, and severe weather and storms. It assumes that most hazards aggravated by climate change will intensify over the long term; therefore, there is need for immediate action to mitigate certain expected impacts. The Multi-Hazard Mitigation Plan has been updated every three years. The 2010 and 2013 updates have a more central focus on climate change with added reports on its forecasted effects and more scientific evidence to support its claims.

In 1998, the state of Hawaii issued a report on the anticipated effects of climate change on the islands with recommendations and action plans to improve energy efficiency and reduce greenhouse gas (GHG) emissions over a broad range of industries. In 2007, Hawaii enacted “A Global Warming Solutions Act 234” to cap GHG emissions to the 1990 level by 2020. Also in 2007, Hawaii enacted an energy law mandating that 25 percent of Hawaii’s electricity must come from renewable energy sources by 2020 and 40 percent by 2030 (State of Hawaii, 2007). As part of the Environmental Protection Agency’s (EPA) Clean Energy State Partnership Initiative to support the introduction and use of clean, renewable energy, in 2008, Hawaii launched a Clean Energy Initiative with the goal of creating a 70 percent clean-energy economy within a generation. The state imposes a $1 surcharge on each barrel of oil imported into the state. Funds collected are earmarked for the development of clean, renewable energy.

Although Hawaii emits only 0.4 percent of the total U.S. GHGs and is therefore one of the lowest state GHG emitters in the nation, as a result of its geographical location and lack of fossil fuel resources, Hawaii is the most oil-dependent state in the U.S., getting 90 percent of its energy needs from imported oil. In a memorandum of understanding signed in 2008, the U.S. Department of Energy (DOE) agreed to assist Hawaii to achieve the goal of reducing its dependence on oil for electricity generation. The potential to do this is high as Hawaii has renewable energy options including biomass, hydro, wind, geothermal, ocean waves, and solar power to transition to a renewable energy economy.

Hawaii is particularly vulnerable to flooding as it has the fourth largest coastline of all U.S. states, yet it was one of the last states to adopt a statewide adaptation plan. However, in 2014, Hawaii passed a climate change adaptation law to protect the state
against the impacts of rising oceans and dying coral reefs. The new law established a climate council as of January 2015, to coordinate climate planning across different departments within the state government and it will guide state efforts to adapt to climate change up to 2050. The law states that climate change is the “paramount challenge of this century” and poses an urgent threat to the state’s economy, sustainability, security, and way of life (Yeo, 2014).

In the state of Washington, the 2007 King County Climate Plan is an early example of a climate change preparedness plan at the local level. This Plan includes specific goals that governments can set and achieve by developing relevant guiding principles and milestones (2007 King County Climate Plan; See Exercise D at the end of this chapter).

The Connecticut Climate Change Preparedness Plan in 2011, focused on adaptation strategies for agriculture, infrastructure, natural resources, and public health climate change vulnerabilities. The plan was developed by workgroups that provided “overarching and specific adaptation strategies” grouped into three categories (CT Climate Preparedness Plan 2011):

1. Best Management Plans,
2. Research, Monitoring, and Education, and
3. Policy, Legislation, Regulation, and Funding.

Decision makers and others responsible for policy, legislation, regulation, and funding were required to:

1. Intensify efforts to ensure preparedness planning,
2. Integrate climate change adaptation planning into existing plans,
3. Update standards to accommodate anticipated change expected during design life (i.e., build for conditions of the future),
4. Plan for flexibility and monitor change, and
5. Protect natural areas and landscape features that buffer changing climatic conditions.

In June 2013, forty five leading local elected officials met in Washington D.C. and committed to creating more resilient cities, towns, and counties in the face of unprecedented extreme weather and energy challenges that threaten communities
across the country. The “Inaugural Signatories” of the Resilient Communities for America Agreement, which included Mayors of Washington D.C., Denver, Cincinnati, Sacramento, San Diego, Milwaukee, El Paso, Broward County, and others, pledged to take cost-effective actions to prepare to protect their communities from the increasing disasters and disruptions caused by climate change, such as heat waves, floods, droughts, severe storms, and wildfires. In addition, they called for more action and support from federal leaders.

**Climate Change Preparedness at the National Level**

In 2013, President Obama issued an executive order directing federal agencies to help states and communities prepare for the effects of climate change, including sea-level rise, storms, and droughts (EO, 2013). The executive order, “Preparing the United States for the Impacts of Climate Change,” established a “Task Force on Climate Preparedness and Resilience” composed of state and local leaders to advise the president on how the federal government can help communities facing “the impacts of climate change” (EO, 2013). The executive order stated that “the Federal Government must build on recent progress and pursue new strategies to improve the Nation’s preparedness and resilience” (EO, 2013). The following key directives were given:

1. **Federal infrastructure spending will have to take climate into account.** Agencies are required to examine their policies and find ways to help states prepare for the effects of climate change. For example, federal disaster relief programs that help coastal communities rebuild after a storm or flood must take into account the possibility that the next storm or flood could be even worse. Likewise, roads and bridges built with federal money must be planned with changing climate conditions, such as future sea-level rise, in mind.

2. **Water and land management will be revamped.** Agencies like the Environmental Protection Agency (EPA) and the Department of Interior are to review their land and water management policies to take shifting conditions into account. For example, agencies must evaluate how to better promote natural storm barriers such as dunes and wetlands and determine how to protect the carbon sequestration benefits of forests and lands to help reduce the carbon pollution that causes climate change.
3. The federal government will work to provide better data on what climate impacts are actually coming.

Agencies are directed to offer better information “that state, local, and private-sector leaders need to make smart decisions.” For example, information will be provided to everyone, from “farmers deciding which crops to grow, to city planners deciding the diameter of new replacement storm sewers, to electric utilities regulators deciding how to protect the power grid” (EO, 2014).

The federal Climate Action Plan in 2014 included a commitment to provide better climate data to the public. As a follow up to this commitment the Obama administration launched the Climate Data Initiative in March 2015. This initiative urges America’s top private sector innovators to leverage the federal government’s open, extensive, freely-available climate-relevant data resources and datasets to build tools that will make America’s communities more resilient to climate change and to forge cross-sector partnerships to make those tools as accessible and useful as possible. The response to this call to action resulted in a number of commitments by federal agencies and private sector partners to actively support the nation’s goal of disaster preparedness (White House Press Release, March 18, 2015).

In April 2014, the EPA Strategic Plan 2014–2018 was released which included Goal 1: Addressing Climate Change and Improving Air Quality with the following objectives (EPA, 2014):

1. Minimize the threats posed by climate change by reducing GHG emissions and taking actions that help to protect human health and assist communities and ecosystems become more sustainable and resilient to the effects of climate change.
2. Reduce GHG emissions from vehicles and trucks in coordination with the Department of Transportation’s fuel economy standards program.
3. Achieve and maintain health- and welfare-based air pollution standards and reduce risk from toxic air pollutants and indoor air contaminants.
4. Restore and protect the Earth’s stratospheric ozone layer and protect the public from the harmful effects of ultraviolet (UV) radiation.
5. Minimize releases of radioactive material and be prepared to minimize exposure through response and recovery actions.
Also in April 2014, the White House Council on Environmental Quality hosted a Champions of Change event for citizen, business, and community leaders working to prepare their cities and towns for the consequences of climate change. The purpose of the event was to recognize and learn from these leaders and share climate preparedness strategies to create more climate change resilient communities (FEMA, 2014). A champion’s work may involve:

1. Improving the resilience and reliability of local infrastructure in the face of climate change impacts.
2. Researching and accounting for the costs of climate related disasters to communities.
3. Teaching and involving our younger generations to create more resilient, prepared communities.
4. Developing innovative solutions for protecting communities from climate related risks such as rising sea levels, surging storms, or extreme heat.
5. Ensuring survival of wildlife and ecologically sensitive areas in a changing climate.
6. Helping small business and outdoor recreation leaders to recognize the cost of impacts to their bottom line and take action to build resilient businesses.
7. Supporting farmers who develop innovative means to manage the risks of climate change in agricultural practices.
8. Helping underserved communities in the U.S. and abroad prepare for and recover from climate-related disasters.

The Federal Emergency Management Agency’s (FEMA) National Preparedness System includes the National Incident Management System and Strategic National Risk Assessment that focus on climate change preparedness.

The National Preparedness System outlines an organized process for everyone in a community to assist with preparedness activities to achieve FEMA’s goal of national preparedness. FEMA’S National Preparedness System addresses six areas of preparedness: (FEMA, 2015; see also Exercise E).

1. Identifying and Assessing Risk
2. Estimating Capability Requirements
FEMA’s preparedness system assists communities in developing disaster preparedness plans. In January 2015, President Obama issued an executive order directing federal, state, and local agencies to incorporate projections for sea level rise in planning and construction along the nation’s coasts. This is a significant shift, as agencies have typically used historic information on sea level and flooding for planning rather than future projections. The executive order states, “These impacts are anticipated to increase over time due to the effects of climate change and other threats. Losses caused by flooding affect the environment, our economic prosperity, and public health and safety, each of which affects our national security” (EO, 2015). The resulting new Federal Flood Risk Management Standard requires that all federally funded projects located in floodplains, including buildings and roads, be built to withstand flooding to “reduce the risk and cost of future flood disasters” and “help ensure federal projects last as long as intended” (EO, 2015).

According to the National Oceanic and Atmospheric Administration (NOAA), the U.S. can expect to see up to two feet of sea level rise by the end of the century largely due to climate change. Warmer temperatures are causing thermal expansion in the oceans as well as the melting of sea ice, which is pushing sea levels higher globally. A study from the U.S. Geological Survey found that half of the U.S. coastline is at high or very high risk of destructive environmental impacts due to sea level rise.

The executive order directs agencies to use the “best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science” when evaluating what is in the flood plain. They also have the option of building 2 feet above current base flood elevations for “non-critical” infrastructure and 3 feet above current base flood elevations for “critical” infrastructure, or building to the standard of the 500-year flood which is a flood with an estimated 0.2 percent chance of happening in any given year (EO, 2015).

The new Federal Flood Risk Management Standard gives agencies three options for establishing the flood elevation and hazard area they use in siting, design, and construction of federal projects (EO, 2015).
1. Use data and methods “informed by best-available, actionable climate science”,
2. Build two feet above the 100-year flood elevation for standard projects and three feet above the 100-year flood elevation for critical buildings such as hospitals and evacuation centers, and
3. Build according to the 500-year flood elevation (EO, 2015).

In December 2014, NOAA predicted coastal areas will face 30 or more days of flooding by mid-century due to sea level rise. According to the National Climate Assessment, more than $1 trillion of property and structures in the U.S. are at risk of inundation from sea level rise of two feet above current sea level, an elevation that could be reached by that same point in time (Sheppard, 2015). In spite of the warnings, new home owners continue to move to the coasts. More than half the U.S. population resides in coastal counties, according to administration officials. Although some progress has been made, Jerry Howard, president and CEO of the National Association of Home Builders stated that his industry recognizes “the need to prepare for and build more resilient buildings and communities” (Sheppard, 2015).

More than 350 state and local governments have already adopted flood standards along the lines of what the Obama administration is now requiring. Perdido Beach, Ala., a small waterfront community of 581 people, adopted an ordinance in 2010 requiring any new construction to be built three feet above the 100-year flood elevation for standard projects. The town’s mayor, Patsy Parker, said that in April 2014, “the town experienced its worst deluge of rain in a century;” 25 inches within two days, which caused major damage (Sheppard, 2015). Within the D.C. region, two counties—Ocean City, Md. and Stafford County, Va.—already require standard projects to be built three feet above the 100-year flood elevation. Nine counties in Maryland and Virginia demand they be built two feet above that height, and D.C. requires projects to be built 1.5 feet above that level.

In the wake of Hurricane Katrina, Hurricane Sandy, and many other weather related disasters, the national government has made progress in raising the standards for protection and safety of communities based on scientific projections of climate change. Senior administration officials say that building to the stricter federal standards will add between 0.25 percent and 1.25 percent to the cost of construction, but in the long run the move could save taxpayers money because it could significantly cut the nation's
recovery costs. The greater cost in human lives, however, is immeasurable. Leadership at the national level is essential to prepare the nation for inevitable impacts of climate change.

**Disaster and Climate Change Preparedness in the Asia Pacific Region**

Both developing and developed countries of Asia and the Pacific are particularly exposed to natural hazards. Of the 12 disasters with the highest death tolls across the world since 1980, 9 occurred in Asia. In 2011, 80 percent of global disaster-related economic losses occurred in the Asia Pacific region. The losses caused by these disasters were immense not only in terms of human lives but also in terms of property destroyed. A conservative estimate of the average annual direct economic damage due to disasters in countries of Asia and the Pacific in the period 2001–2011 was US$60 billion (UNESCAP, 2011).

Economic losses from natural hazards differ widely among countries, even when accounting for the intensity of the disaster. The economic impact of climate change can be devastating for developing countries. A study funded by the World Bank Group and Global Facility for Disaster Reduction and Recovery (GFDRR) found that disasters' impact on gross domestic product (GDP) is 20 times higher in developing countries than in industrialized nations (World Bank, 2014). Even more, for every person in wealthy countries who died in a disaster in the last 50 years, almost 30 individuals died in poor countries (UNESCAP, 2011).

Nearly 40 percent of all the disasters triggered by natural hazards in the world occur in Asia, and 88 percent of the people affected reside in this region. Of the total number of people affected in Asia, the People's Republic of China (PRC) and India account for just over 40 percent, reflecting their population size and land mass. However, after accounting for population size and land area, Bangladesh, Philippines, India, the PRC, Maldives, and Japan (in this order) have been the top six countries affected since 2000. Floods are by far the most frequently occurring disasters in Asia and claim the highest numbers of victims.

Experiencing recurrent small scale events as well as devastating large scale catastrophes, no other region in the world is more affected by disasters than East Asia and the Pacific. In the last decade, Ho Chi Minh City, Jakarta, Manila, and many other cities have been repeatedly hit by floods. In the last five years, Asia has experienced a large share of wide scale natural catastrophes, including earthquakes in the Tohoku
region in 2011, Padang in 2009, and Wenchuan in 2008; typhoons in 2009 in the Lao People’s Democratic Republic, the Philippines, and Vietnam; a cyclone in Myanmar in 2008; and large scale floods in 2011 in Cambodia, Thailand, and the Philippines. The year 2011 was the costliest year on record for natural disasters with cascading effects (Japan) and trans-boundary consequences (Thailand), adding up to US$380 billion in economic losses, far greater than the 2005 record of US$262 billion. In the first nine months in 2011, East Asia sustained about 80 percent of all disaster losses worldwide (World Bank, 2013).

Like other countries in the Asia Pacific region, Australia faces the twin challenges of dealing with extreme weather-related disasters and adapting to the impacts of climate change. Recognizing the enormous environmental and socio-economic toll climate disasters have on the country, the Australian government called for action to develop an integrated approach across and between the different levels of government to address the impacts of climate change. A team of researchers from Griffith University and RMIT University was funded over one year (2012) by the National Climate Change Adaptation Research Facility (NCCARF) to develop the foundations for a nationally consistent approach to disaster risk management and climate change adaptation that would provide a set of appropriate reforms to governing institutions.

The research team focused on a three-way comparative case study of the 2009 Victorian bushfires, the 2011 Perth Hills bushfires, and the 2011 Brisbane floods. The research involved an analysis of the reports generated by the official inquiries into these disasters, interviews with key stakeholders, and stakeholder workshops in Perth, Melbourne, and Brisbane (NCCARF, 2013). The final research report, entitled “The Right Tool for the Job: Achieving Climate Change Adaptation Outcomes through Improved Disaster Management Policies, Planning and Risk Management Strategies”, offered data driven insights and recommendations that range from the conceptual to the practical (NCCARF, 2013).

First, it was argued that a reconceptualization of terms such as ‘community’ and ‘resilience’ is necessary to take into account socio-economic diversity and allow for more tailored, context-specific risk analyses and responses. This is particularly important with regard to policymaking and planning processes and community engagement. Second, it was suggested that the high level of uncertainty inherent in disaster risk management and climate change adaptation requires a more interactive approach to policymaking and planning. Third, some specific institutional reforms were proposed that included:
1. Creating a new funding mechanism that would encourage communication and collaboration between and across different levels of government as well as promote partnerships with businesses and the community,

2. Improving community engagement through new resilience grants run by local councils,

3. Embedding climate change researchers within disaster risk management agencies to promote institutional learning and more integrated risk-context analyses, and

4. Creating an inter-agency network that encourages collaboration among organizations to support the proposed reforms.

The Australian research project is an example of how government can overcome political, social, and economic barriers in the interest of national preparedness for impending disasters. The findings of the research project offer guidelines for improving mitigation and adaptive responses as well as a starting point for better integration of disaster risk management and climate change adaptation. Efforts such as this one are of benefit to countries of the Asia Pacific region and the world.

**Role of International Organizations in Climate Change Preparedness in the Asia-Pacific Region**

In 2011, the United Nations Office for Disaster Risk Reduction—Regional Office for Asia and Pacific (UNISDR AP) issued a comprehensive report that provided a summary of how disaster risk reduction (DRR) and climate change adaptation (CCA) are undertaken and integrated in the Asia Pacific region. DRR is the concept and practice of reducing disaster risks through analysis and management of causal factors. It reduces exposure to hazards and lessens the vulnerability of people and assets. DRR also improves management of the land, the environment, and preparedness for adverse events (UNISDR, 2009). CCA is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as “adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects that moderate harm and exploit beneficial opportunities. This can include: (a) adapting development to gradual changes in average temperature, sea level and precipitation; and (b) reducing and
managing the risks associated with more frequent, severe and unpredictable extreme weather events” (UNISDR, 2010). As experience with DRR and CCA grows, there is increasing recognition that both share a common focus: reducing the vulnerability of communities and contributing to sustainable development. The high level of climate related risks in the Asia Pacific region make DRR and CCA key policy goals.

The 2011 UNISDR AP report provides best practices on how to improve the Asia Pacific regional planning and programming for DRR and CCA and highlights areas for cooperation among regional and sub-regional organizations. It proposes ways and means to support both national and regional stakeholders in DRR and CCA, such as governments, UN agencies, intergovernmental organizations, research and technical organizations, non-government organizations (NGOs), and especially the UN International Strategy for Disaster Reduction (UNISDR) Asia Partnership on Disaster Reduction members, in order to enhance regional planning, programming, and cooperation (UNISDR AP, 2011). Follow up on the United Nations (UN) UNISDR AP report showed actual improvement in climate change preparedness in the Asia-Pacific region. This was noted in a subsequent UN report in 2014, “10 years after Indian Ocean Tsunami, Asia-Pacific Region Better Prepared” (UNNC, 2014).

The Indian Ocean Tsunami, the world’s worst recorded natural disaster, hit the Asia Pacific region in December 2004, killing more than 200,000 people, leaving 1.4 million survivors homeless, and destroying the entire food production systems on which whole populations depended (UNNC, 2014). The devastation alarmed the world community. The UN Economic and Social Commission for Asia and the Pacific (ESCAP) and the German Federal Ministry for Economic Cooperation and Development (BMZ) have partnered with the German Ministry contributing 250,000 euros to the ESCAP Multi-Donor Trust Fund for Tsunami, Disaster, and Climate Preparedness, adding to an initial 500,000 euros contribution made in December 2013 (UNNC, 2014). The UN report noted that some of the countries that were worst affected by the Indian Ocean Tsunami are now better prepared for disasters and better positioned to respond more effectively.

In the Pacific, as elsewhere, global climate change disasters have their greatest impact at the local level. Studies show that the accumulated impacts of small and medium disasters may be equivalent to, or exceed, those of large disasters. Increases in the frequency of these lower intensity hazards have a major impact on poverty. The countries studied are typical in terms of the current low level of integration of DRR and CCA. While there may be institutional arrangements that suggest some progress with
integration at the national policy and institutional levels, the practical reality is that little is happening on the ground at the operational level. Although there is much work to be done, progress at the local level is being made. Tonga is clearly the lead example of local level integration of DRR and CCA. Tonga developed an integrated plan for Disaster Risk Management (DRM) and climate change (including the reduction of GHG emissions) and established a National Advisory Committee on Climate Change to take responsibility for DRM (World Bank, 2013).

Mainstreaming DRM in development planning can help to address some of the root causes of rising disaster impact. The annual damages from unabated economic development, population growth, and rapid urbanization that exacerbate climate change are expected to triple to $185 billion by 2100, even without factoring in climate change. DRM can help to reverse the current trend of rising disaster impact by acting swiftly and decisively to cut costs and losses due to problems of unchecked development. Lives and assets can be protected with wise policy and planning. However, many developing countries lack the tools, expertise, and instruments to factor the potential impacts of adverse natural events in their investment decisions (World Bank, 2013).

The goals of the United Nations Climate Summit in September 2014, were to reduce GHG emissions, strengthen climate resilience, and mobilize political will for a meaningful legal global agreement in 2015, because the 'Hyogo Framework for Action 2005-2015: Building Resilience of Nations and Communities for Disasters' was scheduled to end in 2015. The United Nations General Assembly Resolution 66/199 requested UNISDR to facilitate the development of a Post-2015 Framework for Disaster Risk Reduction (UNISDR, 2014). A report which synthesizes consultations held at the regional, national, and community levels throughout the Asia Pacific region on the Post-2015 Framework for Disaster Risk Reduction was particularly targeted at countries and stakeholders from the region. The report describes the consultation approach that has been adopted in the Asia Pacific region and summarizes the key issues and proposals resulting from these consultations (UNISDR AP, 2013). The findings from the report add to the growing body of information needed to deal with climate change.

As more research is conducted, trend analyses of disaster occurrence and impact will address whether their determinants can be established. In Asia and elsewhere, factors that play a role in determining disaster trends are a mix of physical characteristics of the event itself and the socioeconomic context in which they occur. Earthquakes, for example, have short prediction times and therefore allow little time for disaster preparedness. In contrast, slower onset disasters such as droughts and floods are more
predictable and generally result in fewer direct victims, but their real cost is in the medium and long-term and is usually not assessed. Population density, urbanization, and demographic profiles are context-specific factors that are likely to contribute to the number of deaths and degree of damages. DRM policies and practices that are based on evidence can help to prepare for and reduce these and other risk factors.

To provide evidence-based information, reliable and time series data on impact is central. Global databases such as the International Disaster Data Base (EM-DAT), NatCat (Munich Re), or Dartmouth Flood Observatory provide valuable insights into trends and patterns. Substantial progress has been made in standardizing classification systems and definitions at global levels by Munich Re and EM-DAT, but international norms are still needed. Higher resolution impact monitoring data, sample surveys of risk factors, and other methods of gathering information will be required to provide data to develop more effective international DRM policy and practice. Because the cost to accomplish this will be great realistic financing options are essential.

In light of the significant costs of risk financing instruments, the challenge is to identify the appropriate layers of risk to cover, including a risk acceptance threshold, the lowest cost/risk solutions, and links to risk reduction. Strengthening the current innovative financing systems will be key. External involvement of governments, donors, and multi-lateral development banks is required to support communities and local institutions, build risk culture, reduce transaction costs in terms of bringing the products to the people (e.g., by providing support for mobile phone infrastructure), and pay or subsidize premiums.

International organizations will continue to play an active role in advancing climate change preparedness in the Asia Pacific region and the world. Only a collaborative and concerted effort will make a difference.

The Asian Development Bank (ADB)

The Asian Development Bank's (ADB) vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region’s progress in many development areas, Asia is home to two-thirds of the world’s poor: 1.7 billion people live on less than $2 a day and 828 million people struggle on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration. Based in Manila, ADB is owned by 67
members, including 48 from the region. Its main tools for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

ADB’s ongoing efforts to mainstream disaster risk management into its lending strategies strengthen the governance for disaster risk reduction, disaster and climate change preparedness, and disaster response in the region; improve the effectiveness of post-disaster reconstruction; and develop new financial instruments to help meet the costs of such activities through international, particularly regional, cooperation. In the process of dealing with numerous disasters in the Asia Pacific region, lessons learned about pre-disaster risk mitigation and post-disaster response are identified and concrete recommendations for action are suggested.

**Recommendations to Improve Disaster and Climate Change Preparedness in the Asia Pacific Region**

The 2011 Great East Japan Earthquake and other disasters confirm that government’s capacity to manage disaster risks is critical in terms of prevention, preparation, response, recovery, and reconstruction. DRM governance must be streamlined as part of the development agenda for most developing countries. The structure and quality of governance of governing bodies at all levels, from central to local to community levels throughout Asia and the Pacific need to be improved to lead DRM initiatives. Moreover, DRM planning calls for widespread public involvement from all sectors of the community as well as from non-governmental organizations (NGOs). Existing evidence points to the crucial role of governance for an effective national DRM strategy and program. This relates to DRM policy and practices both at the national and local level.

At the local level, primary issues include:

1. **Linking local and national disaster preparedness:** Disasters are usually local phenomena and the local governments along with the communities are the first responders. However, large-scale disasters require national or international efforts. Thus, for effective preparedness it is important to have specific links in terms of policy, plan, and action at the national and local level.

2. **Coping with the changing nature of disasters:** The nature of disasters, especially hydro-meteorological disasters, is changing and becoming more of
a local phenomenon (especially in terms of rainfall patterns). This creates an increasing need for local capacities at the government, non-government, and community levels to cope with such disasters.

3. Addressing the needs of diverse communities: Communities vary from place to place and their perception and ways of responding to disasters also vary. Therefore, it is important to decentralize policies and customize them according to local needs and priorities.

4. Learning from past disasters: Accumulating evidence from past disasters suggest that informed and well-prepared local governments and local communities can minimize the impacts of disasters. This is the case even with mega disasters like the Great East Japan Earthquake in which over 18,000 people died mostly from drowning.

5. Increasing global awareness of local needs: Over the past two decades, there has been growing global and regional awareness about the effectiveness of focusing on local needs and priorities. Most of the global and regional frameworks call for local capacity building and policymaking, national developmental strategies, and cooperation among emerging economies of Asia to improve their disaster risk management practices.

**Improving Preparedness Though Innovation**

Human ingenuity is challenged to invent new ways of dealing with the tremendous threats, risks, and impacts of global climate change in order to thrive into the far future. Innovation in all fields of science and technology, social sciences, business and finance, is needed to improve worldwide disaster preparedness. Creative financing and insurance practices comprise technical breakthroughs, such as insuring farmers or governments against droughts or storms based on physical parameters (index-based [parametric] insurance) covering events that cause loss, rather than the loss itself. This option substantially decreases transaction costs (Linnerooth-Bayer et al., 2011). Community-based organizations have innovatively experimented with microloans and savings with disaster micro-insurance in various set ups, which, with a number of caveats, provide a useful way forward.

Social innovation is equally important. Social grants awarded to communities encourage local ownership of preparedness projects, transparency, and accountability.
The support enhances local decision-making processes. Local communities are empowered to decide where and how to increase community resilience with particular attention to smaller scale, less media-compatible hazards and events that often evade attention (O'Donnell, 2009). The focus on local level leadership and responsibility for disaster preparedness reinforces meaningful and effective community involvement in disaster prevention, preparation, response, recovery, and reconstruction.

Kleinfelder, an Australia based consulting firm, created an innovative approach to developing practical preparedness plans which consists of three components:

1. Climate Change Projections derive the local effects of changes in temperature, precipitation patterns, sea level rise, and extreme events to be used in the vulnerability assessment.

2. The Vulnerability and Risk Assessment evaluates the susceptibility of individual assets based on climate change projections and then combines that data with the probability and consequence of the climate impact occurring to identify the highest risks as priorities for the adaptation/resiliency plan.

3. The Adaptation/Resiliency Plan identifies actions to address crucial climate change impacts, considering both short and long-term responses, building and policy solutions, and all feasible options that are evaluated using multiple criteria including the client's interests.

Kleinfelder's multidisciplinary climate change team of academics and consultants includes internationally recognized leaders in climate science, infrastructure resiliency, vulnerability assessment, disaster planning and response, and preparedness planning. As the team conducts research and pioneering projects, first of their kind methods and techniques for responding to climate change impacts are developed. Innovations recommended by the team emerge from evidence-based research.
The Role of Global Climate Organization System (GCOS) in Disaster and Climate Change Preparedness

Global Climate Organization System (GCOS) is a joint undertaking of the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational Scientific and Cultural Organization (UNESCO), the United Nations Environment Program (UNEP), and the International Council for Science (ICSU). Its goal is to provide comprehensive information on the total climate system, involving a multidisciplinary range of physical, chemical, and biological properties and atmospheric, oceanic, hydrological, cryospheric (the frozen part of the Earth's surface) and terrestrial processes. It is built on the WMO Integrated Global Observing System (WIGOS), the IOC-WMO-UNEP-ICSU Global Ocean Observing System (GOOS), the UN Food and Agriculture Organization (FAO)-UNEP-UNESCO-ICSU Global Terrestrial Observing System (GTOS), and a number of other domain-based and cross-domain research and operational observing systems. It includes both in situ and remote sensing components, with its space based components coordinated by the Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS). GCOS is intended to meet the full range of national and international requirements for climate and climate related observations. As a system of climate-relevant observing systems, it constitutes, in aggregate, the climate observing component of the Global Earth Observation System of Systems (GEOSS).

The international collaboration of the Global Climate Organization System (GCOS) facilitates data collection from the world's leading climate data, monitoring and research centers. These data, together with climate information collected through a unique survey of the world's National Meteorological and Hydrological Services, were used to produce The Global Climate 2001–2010 report. A perspective, by decades, makes it possible to assess trends and anticipate the future. It can also inform operational climate services that provide information and forecasts for decision-making in agriculture, health, disaster risk, water resources, and other sectors. These efforts are coordinated through the WMO-led Global Framework for Climate Services (WMO, 2013).

The kinds of information needed to answer questions climate scientists and others struggle with, for example distinguishing between natural climate variability and human
induced climate change or discovering trends in extreme weather events, clearly requires more complete and long term datasets. A decade is the minimum possible timeframe for detecting temperature changes, and assessing trends in extreme weather and climate events requires an even longer time frame because, by definition, these events do not occur frequently (WMO, 2013). Longitudinal studies of comprehensive datasets will allow more robust analyses of trends in the frequency and intensity of extreme weather events such as tropical cyclones and extra-tropical storms at the global level.

Science-based methodologies and instruments are being designed that seek to determine with more confidence how climate change is affecting extreme weather events that are increasing in frequency and intensity worldwide. WMO’s Commission for Climatology is currently addressing new approaches for the improved characterization, assessment, and monitoring of these events. Promising new research into the attribution of individual extreme events based on observational and model data is gaining momentum. Ongoing studies using the best research methodologies and tools are needed to address the most urgent climate change threats such as the melting glaciers and ice sheets that cause sea level rise. Long-term cryosphere monitoring and analyses can dispel some of the uncertainty about the future evolution of glacier and ice sheet melting. Understanding cryosphere variability will help to improve sea level rise projections, which in turn will contribute to more effective coastal planning and management. As scientific observation, modeling, and analyses of the climate system advance, scientists will be able to provide more reliable and useful information for decision makers responsible for disaster and climate change preparedness in their communities. This will also greatly benefit international cooperation through the United Nations Framework Convention on Climate Change and the Global Framework for Climate Services. WMO remains essential to supporting these efforts through its members, its programs, and the regular reports made possible by the WMO Climate System Monitoring network (WMO, 2013).

Questions for Review

1. What goals, guiding principles, and action items would you include in a climate plan outline for your community?
2. What is the most important thing you learned about Climate Change?
Preparedness from this chapter? Explain why you believe it is important.

3. What is the most interesting thing you learned about Climate Change Preparedness from this chapter? Explain why.

4. Why is Climate Change Preparedness especially critical in the Asia Pacific region?

Exercise A. Natural Disasters and Climate Change Preparedness

Severe Storms and Hurricanes

Heavy storms and hurricanes are expected to become stronger with climate change and cause more damage to coastal communities. Heavy storms and flooding also affect people who live in floodplains near rivers, or in cities that lack good drainage. Learn about who is most affected and some of the things we can do to prepare now and in the future:

Who Is Most Affected?

- People living near the coast
- People living in low-lying areas that flood easily
- Tourists and beachgoers
- Businesses that depend on tourists

During Hurricane Season

- Pay attention to hurricane warnings
- Have emergency supplies ready
- Have a full tank of gas and be ready to evacuate
- Know the evacuation route and where emergency shelters are

To Prepare for the Future....
• Build houses that can withstand strong storms
• Don't build in areas that are likely to flood
• Set up reinforced shelters for people who cannot evacuate
• Preserve natural barriers like sand dunes that provide protection against storms

Flooding

Who Is Most Affected?
• People living near rivers and streams
• People who live in areas with poor drainage
• Farmers

To Prevent Flooding...
• Keep storm drains clear
• To Prepare for the Future...
• Avoid building homes in floodplains
• Plant flood-resistant crops
• Reserve wetlands and other places that can store water

Rising Seas

Who Is Most Affected?
• People living in coastal communities
• Tourists and beachgoers
• Businesses that depend on tourists

To Deal With Flooding...
• Use protective barriers like sandbags around buildings and roads
• Have an evacuation plan ready and evacuate if ordered
To Prepare for the Future...

- Preserve wetlands and floodplains that protect coastlines from flooding and damage
- Protect barrier beaches and reduce erosion
- Improve drainage systems
- Elevate existing structures or build protective barriers in vulnerable places
- Build houses further from the shoreline and other areas that could flood easily

Droughts and Wildfires

Higher temperatures brought on by climate change are expected to increase the amount of moisture that evaporates from land and water, which will also cause rainfall patterns to shift. In many areas, these changes will lead to more frequent and severe droughts, which occur when an area receives less water than usual. Hot temperatures and dry conditions also increase the likelihood of wildfires. Learn about who is most affected and some of the things we can do to prepare now and in the future:

Droughts

Who Is Most Affected?

- Farmers
- Ranchers
- People living in places that are already dry

If a Drought Occurs...

- Conserve water in your home and workplace
- Use irrigation techniques that use less water

To Prepare for the Future...
• Plant crops and grasses (for livestock) that can handle drought
• Landscape your yard with plants that don’t require a lot of water
• Use water-efficient appliances and fixtures in your home

Wildfires

Who Is Most Affected?
• People living in wildfire-prone areas, such as California and the Rocky Mountain states
• People with asthma or other lung or heart conditions
• Campers
• Hikers

To Prevent Wildfires...
• If you build an outdoor fire, make it safe and make sure it’s completely out when you’re done
• Don’t use stoves, lanterns, or heaters inside a tent
• Have fire extinguishers on hand
• To Prepare for the Future...
• Avoid building homes in extremely fire-prone areas
• Build homes that are more fire resistant
• Plant fire-resistant shrubs and trees around homes

Health and Heat

Heat waves, air pollution, allergens like pollen and ragweed, and diseases linked to climate already threaten people’s health in many areas of the world. Global climate change will increase these threats.
• As the Earth gets warmer, there will be more heat waves and they will last longer. More people will be at risk for illnesses like heat stroke and heat exhaustion.
• Warmer weather could also increase the amount of smog that forms in some
areas. Smog can irritate your lungs, trigger asthma attacks, and even lead to serious heart and lung diseases.

- A warmer climate is also expected to promote the growth of mold, weeds, grasses, and trees that trigger allergic reactions and asthma in some people.
- Warmer temperatures can allow mosquitoes and other pests to spread to areas that were once too cold for them and allow them to transmit disease for a longer part of the year. Climate change can also increase the risk of waterborne diseases in some areas. Learn about who is most affected and some of the things we can do to prepare now and in the future:

Heat Waves

Who Is Most Affected?

- People living in cities
- Children and elderly people
- People who are poor or living alone and without air conditioning
- People with lung or heart diseases

If a Heat Wave Occurs...

- Stay inside where it is cool
- Drink plenty of fluids
- Wear cool, loose clothing and hats if you go outdoors
- Check up on friends, relatives, and neighbors who don’t have air conditioning and might need help

To Prepare for the Future...

- Set up warning systems to alert people about heat emergencies
- Set up emergency cooling centers for people without air conditioning
- Make cities “cooler” by planting more trees and creating more parks
Disease

What Is Most Affected?
- People in hot, tropical areas
- Campers, hikers, and others who spend time outdoors

To Keep From Getting Sick...
- Wear long sleeves and pants to avoid insect bites
- Use insect repellent
- Check yourself (and your pets) for ticks after you've been outside
- Know the symptoms of diseases like Lyme disease, and seek immediate medical attention if you suspect a problem

To Prepare for the Future...
- Track cases of infectious disease to see if they are spreading
- Make sure people get proper health care and vaccines

Air Pollution and Allergens

What Is Most Affected?
- People with allergies and asthma (especially children)
- People with heart or lung diseases
- People living in cities

To Protect Your Health...
- Check the daily air quality forecast in the newspaper, on TV, on weather websites, or at www.airnow.gov
- Limit outdoor exercise when air pollution is high
- To Prepare for the Future...
- Track allergy hotspots
- Reduce air pollution
Exercise B. Learn what you can do to help plants and animals adapt to climate change: Plants, Animals, and Ecosystems

Plants and animals have adapted to changes in the environment for millions of years. However, today’s changes are happening faster and on a larger scale than in the past, which makes it difficult for plants and animals to adapt. Changes in climate can affect the types of plants that can grow in an area. Animals' food supplies, water, life cycles, breeding habits, and habitats also will be affected.

Some animals will adapt to changing conditions or move elsewhere, but others could have trouble surviving. Some unwelcome invaders (invasive species) could benefit from climate change by expanding their range or being able to survive through the winter in new places.

All these changes will affect the way ecosystems function, and changes to ecosystems affect people, too. That is because we rely on ecosystems to provide us with many services, like clean water, food, and medicines.

Preserve Habitats

You can provide wildlife in your very own backyard with food, water, cover, and shelter for raising their young. And it doesn’t matter whether your “backyard” is an apartment balcony or a grassy meadow. Visit the National Wildlife Federation’s website to learn more.

Protect Threatened Ecosystems

Coral reefs face a double threat as ocean temperatures rise and seawater becomes more acidic. You can help keep corals healthy by reducing other stresses on reefs. At the beach, be sure to dispose of your trash properly. If you snorkel or dive don’t touch or step on the corals. When boating, steer clear of reefs, and don’t drop your anchor near them. Check out steps, big and small, that you can take even if you don’t live near a coast.
Be a Citizen Scientist

Volunteer to keep records of the seasonal changes you see in nature, such as when certain flowers bloom in the spring. You can be part of a network of citizens who are gathering important information that can help scientists understand how climate change is affecting plants and animals. Learn more about how you can be a scientist, too!

Exercise C. Example of Climate Change Preparedness by Volunteer Agency

In accordance with Executive Order (E.O.) 13514, Federal Leadership in Environmental, Energy, and Economic Performance, and E.O. 13653, Preparing the United States for the Impacts of Climate Change, the following plan was developed by The Corporation for National and Community Service (CNCS), an independent Executive Branch (CNCS, 2014).

1. Model and improve awareness and preparedness.
   a. Create an agency working group on Climate Change adaptation.
   b. Distribute Climate Change Adaptation Plan documents to all staff and tonational service participants.
   c. Design and deliver annual required training for all staff on the CNCS Continuity of Operations Plan.

2. Prepare national service participants to mitigate the effects of climate change and respond to potential disasters caused by climate change.
   a. Add Climate Change Adaptation elements to national service orientation.
   b. Measure performance of national service participant activities using current environmental stewardship and disaster management performance measures.
   c. Plan and implement a climate change taxonomy to categorize and measure climate change adaptation impact of current efforts.

3. Collaborate with other federal agencies to ensure coordination of efforts.
   a. Continue to engage in collaborations focused on disaster
management or environmental stewardship

b. Create new models and programs focusing on climate change adaptation with existing partners. Cultivate new strategic partnerships focused on climate change adaptation interventions.

Exercise D. Relevant Action Items for the 5 Guiding Principles of the 2007 King County Climate Plan

Guiding Principle #1: Increase public awareness of climate change and its projected impacts on your community.

Example: “King County departments will raise awareness about climate change impacts, adaptation, and mitigation, and will collaborate interdepartmentally with climate science experts, other agencies, and other governments to adapt to climate change.” (2007 King County Plan)

Example: “King County will help the region to understand and reduce risks of fall and winter flooding associated with climate change impacts.” (2007 King County Climate Plan)

Guiding Principle #2: Increase your technical capacity to prepare for climate change impacts.

Example: “King County will be a primary leader in research, monitoring, and use of climate science in public policy decisions.” (2007 King County Climate Plan)

Guiding Principle #3: “Mainstream” information about climate change vulnerabilities, risks and preparedness into planning, policy, and investment decisions.

Example: “King County will review and update King County’s land use and environmental policies and regulations to protect natural resources from global warming threat.” (2007 King County Climate Plan)
Example: “King County will protect the integrity and safe operation of regional transportation infrastructure from climate change impacts.” (2007 King County Climate Plan)

Example: “King County will use its existing waste and wastewater infrastructure for multiple uses and in innovative ways that... provide an additional natural resources hedge against impacts expected from global warming such as declining water supply.” (2007 King County Climate Plan)

**Guiding Principle #4: Increase the adaptive capacity of built, natural, and human systems.**

Example: “King County will use land use and transportation plans... to conserve natural resources and protect environmentally sensitive areas in ways that are coordinated, equitable, and supportive of global warming mitigation and adaptation.” (2007 King County Climate Plan)

Example: “King County will work to support the resilience of salmon, fish, wildlife, habitat conditions, and biodiversity to climate change impacts.” (2007 King County Climate Plan)

**Guiding Principle #5: Strengthen community partnerships that reduce vulnerability and risk to climate change impacts.**

Example: “King County plans will guide the region to build preparedness for climate change impacts into all major investments in land and infrastructure.” (2007 King County Climate Plan)

Example: “King County will implement the adopted 2006 King County Flood Hazard Management Plan, work to create a Flood Control Zone District by June 1, 2007, and work to establish a countywide fee for funding of necessary investments in the areas that are most vulnerable to increased fall and winter flooding.” (2007 King County Climate Plan)

**Exercise E. Outlining a Climate Change Preparedness Plan for Your Community**

Select one of the 6 parts of FEMA's Preparedness System relevant to climate change preparedness and utilize the information, tools, and resources provided below to
prepare a 5-7 page outline and narrative of a Climate Change Preparedness Plan applicable to your community.

FEMA's National Preparedness System outlines an organized process for everyone in the community to assist with preparedness activities to achieve FEMA's National Preparedness Goal. FEMA's National Preparedness System has six parts that follow (FEMA, 2015).

• Identifying and Assessing Risk. This part involves collecting historical and recent data on existing, potential, and perceived threats and hazards. The results of these risk assessments form the basis for the following steps.

• Estimating Capability Requirements. Next, you can determine the specific capabilities and activities to best address those risks. Some capabilities may already exist and some may need to be built or improved. FEMA provides a list of core capabilities related to protection, prevention, mitigation, response, and recovery, the five mission areas of preparedness. To see a full list of the core capabilities, including details about each one, visit FEMA's Core Capabilities page on its website.

• Building and Sustaining Capabilities. This involves figuring out the best way to use limited resources to build capabilities. You can use the risk assessment to prioritize resources to address the highest probability or highest consequence threats.

• Planning to Deliver Capabilities. Because preparedness efforts involve and affect the whole community, it's important that you coordinate your plans with other organizations. This includes the whole community: individuals, businesses, nonprofits, community and faith-based groups, and all levels of government.

• Validating Capabilities. Now it's time to see if your activities are working as intended. Participating in exercises, simulations, or other activities helps you identify gaps in your plans and capabilities. It also helps you see progress toward meeting preparedness goals.

• Reviewing and Updating. It is important to regularly review and update all capabilities, resources, and plans. Risks and resources evolve—and so should your preparedness efforts.

• Specific Tools and Resources

• Depending on your role in the community, you may need specific tools and resources to help you through the cycle of the National Preparedness System. Below see FEMA list with links for more information.
- Strategic National Risk Assessment. This document identifies the types of incidents that pose the greatest threat to the nation's homeland security.
- Threat and Hazard Identification and Risk Assessment (THIRA). Guidance for conducting a THIRA at all levels of government can be found in Comprehensive Preparedness Guide (CPG) 201, Second Edition.
- State Emergency Operations Plans. Guidance for creating these plans can be found in CPG 101.
- National Incident Management System.
- Remedial Action Management Program.

**Download Materials**

- National Preparedness System full document
- Strategic National Risk Assessment
- CPG 201, Second Edition

**Key Climate Change Preparedness Terms**

**Adaptive capacity**: describes the ability of built, natural, and human systems to accommodate changes in climate (including climate variability and climate extremes) with minimal potential damage or cost. As a general rule, systems that have high adaptive capacity are better able to deal with climate change impacts. For instance, agriculture in a given region will have greater adaptive capacity if the farms of that region have a choice of water sources for irrigation (i.e., in the face of water shortage) and the financial ability and training to switch crop types (i.e., if another crop was proven to grow better based on new climate characteristics).

**Climate resilient community**: one that takes proactive steps to prepare for (i.e., reduce the vulnerabilities and risks associated with) climate change impacts.

Implementation tools: the authorities and/or avenues over which your government has control or influence in policy, planning, and infrastructure in order to execute your preparedness actions successfully.

**Measure of resilience**: a quantitative or qualitative judgment that you make and
track over time to determine how well your actions meet the preparedness goals you have set.

**Planning areas**: the areas in which a government or community manages, plans, or makes policy affecting the services and activities associated with built, natural, and human systems. Planning areas can be as broad or as specific as you deem necessary. Examples of planning areas include water supply, wastewater treatment, public health, road operations and maintenance, forestry, and parks. Planning areas are a subset of sectors.

**Preparedness action**: the activity or activities that your government undertakes to achieve its preparedness goals.

**Preparedness goal**: what you want to accomplish in your priority planning areas through preparedness action.

**Priority planning areas**: the planning areas which your community or government determines to be most important for focusing your preparedness efforts, based on your community’s vulnerabilities to climate change and associated risks.

**Sector**: a general term used to describe any resource, ecological system, species, management area, activity, or other area of interest that may be affected by climate change. General examples include forests (a resource), wetlands (an ecological system), salmon (a species), water supply (a management area), agriculture (an activity), or human health. The term may also be used to describe more specific aspects of these examples that are important to the community, such as water quality, coastal marshes, Oregon Coast Coho salmon (Oncorhynchus kisutch), dryland wheat farming, or elderly populations.

**Sensitivity**: the degree to which a built, natural, or human system is directly or indirectly affected by changes in climate conditions (e.g., temperature and precipitation) or specific climate change impacts (e.g., sea level rise, increased water temperature). If systems in a planning area are likely to be affected as a result of projected climate change, then that system should be considered sensitive to climate change. For instance, a community of cold water fish at the southern edge of its range is highly sensitive to
changes in climate, because even a slight warming may make its habitat unsuitable. In turn, regional economies based on fisheries solely targeting those fish would also be highly sensitive to changes in climate.

**Systems:** refer to the built, natural, and human networks that provide important services or activities within a community or region. Built systems can refer to networks of facilities, buildings, and transportation infrastructure such as roads and bridges. Natural systems can refer to ecological networks of fish, wildlife, and natural resources like water. Human systems can refer to networks of public health clinics, courts, and government.

**Vulnerability:** the susceptibility of a system to harm from climate change. Vulnerability is a function of a system's sensitivity to climate and the capacity of that system to adapt to climate changes. In other words, systems that are sensitive to climate and less able to adapt to changes are generally considered to be vulnerable to climate change impacts. For example, coral reefs are vulnerable to damage from climate change, as they are sensitive to changes in climate and have limited capacity to adapt to those changes.
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Effective disaster and climate change response and recovery are central concerns for the international community. Climate and non-climate disasters alike threaten the safety and sometimes survival of states and individuals around the globe. Responding to and recovering from an increasing array of climate related disasters require cooperation for the mitigation, preparation, response, and recovery phases of the disaster management cycle. In most disasters, during the response and recovery phases of the disaster management cycle, heavy reliance is placed on government agencies at all levels of government, especially at the community level, and private non-profit humanitarian organizations. Disaster response usually takes place immediately after a disaster occurs and includes actions such as warning, evacuating, and sheltering those most affected. Disaster recovery, in contrast, involves long term actions to return the persons and community most affected back to a normal or improved condition.

The aim of disaster response is to provide immediate assistance to maintain life, improve health, and support the morale of the affected population. Such assistance may range from providing specific but limited aid such as assisting refugees with transport, temporary shelter, and food to establishing semi-permanent settlement in camps and other locations. It also may involve initial repairs to damaged infrastructure. The focus in the response phase is on meeting the basic needs of the people until more permanent
and sustainable solutions can be found. Humanitarian organizations often actively assist in this phase of the disaster management cycle. Ideally, there should be a smooth transition from response to recovery.

As the disaster is brought under control, the affected population is capable of undertaking a growing number of activities aimed at restoring their lives and the infrastructure that supports them. There is no distinct point at which immediate relief changes into recovery. There will be many opportunities during the recovery period to enhance prevention and increase preparedness, thus reducing vulnerability. Recovery activities continue until all systems return to normal or better. Recovery measures, both short and long term, include returning vital life-support systems to appropriate operating standards, temporary housing, public information, health and safety education, reconstruction, counseling programs, and economic impact studies. Information resources and services include data collection related to rebuilding and documenting lessons learned.

**Climate Change Response and Recovery at the Federal Level in the United States**

The National Response Plan (NRP) was a U.S. national plan to respond to emergencies such as natural disasters or terrorist attacks. It came into effect in December 2004, and was superseded by the National Response Framework (NRF) on March 22, 2008. The NRF is a planning document that describes what the government will do in catastrophic disasters. It deals with immediate post disaster needs. The National Disaster Recovery Framework (NDRF), in contrast, is a guide that enables effective long-term rebuilding in disaster stricken areas. It provides disaster recovery managers with a flexible structure to restore affected communities. Some of the organizations involved in these plans take on primary responsibilities, while others perform support functions.

By adopting the term “framework” within its title, the NRF became more accurately aligned with its intended purpose. Effective response to an incident is a shared responsibility of governments at all levels, the private sector, non-government organizations (NGOs), and individual citizens. This Framework commits the federal government, in partnership with local, tribal, and state governments and the private sector to complete both strategic and operational plans for the incident scenarios.
specified in the National Preparedness Guidelines (NRF, 2008) (See also Appendix A).

The term "response" as used in the NRF includes immediate actions to save lives, protect property and the environment, and meet basic human needs. Response also includes the execution of disaster and emergency plans and actions to support short term recovery. The Framework is always in effect, and elements can be implemented as needed on a flexible, scalable basis (NRF, 2008).

The NRF is a guide to how the U.S. conducts all hazards response. It explains the common discipline and structures that have been exercised and matured at the local, tribal, state, and national levels over time. The NRF is built upon adaptable coordinating structures that align key roles and responsibilities across the nation. It identifies specific responsible agencies and best practices for managing incidents that range from the serious but purely local, such as floods, to large scale terrorist attacks or catastrophic natural disasters.

The NRF documents and publicizes key lessons learned, for example from Hurricanes Katrina and Rita, focusing particularly on how the federal government is organized to support communities and states in catastrophic incidents. Most importantly, it builds upon the National Incident Management System (NIMS), which provides a common template for managing disasters. The NIMS is a companion document that specifies standard command and management structures that apply to response activities. This system provides a uniform and consistent nationwide template to enable federal, state, tribal, and local governments, the private sector, and NGOs to work together to prepare for, prevent, respond to, recover from, and mitigate the effects of disasters regardless of cause, size, location, or complexity. This consistency provides the foundation for using the NIMS for all incidents ranging from daily emergency occurrences to disasters requiring a coordinated federal response (NRF, 2015).

The National Disaster Recovery Framework (NDRF), which serves as a companion document to the National Response Framework (NRF), was released by FEMA in September 2011. The NDRF defines core recovery principles, roles, and responsibilities of recovery coordinators and other stakeholders, a coordinating structure that facilitates communication and collaboration among all stakeholders, guidance for pre- and post-disaster recovery planning, and the overall process by which communities can capitalize on opportunities to rebuild stronger, smarter, and safer (NDRF, 2011). The NDRF is a guide to effective post disaster recovery, particularly for those incidents that are large scale or catastrophic.
Similar to how the NRF is the overarching inter-agency response coordination structure for both the Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) and non-Stafford Act incidents, the NDRF is the overarching inter-agency coordination structure for the recovery phase for Stafford Act incidents, and elements of the framework may also be used for serious non-Stafford Act incidents. The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) is a U.S. federal law designed to bring an orderly and systematic means of federal natural disaster assistance to state and local governments to carry out their responsibilities to aid disaster stricken citizens. Congress' intention was to urge states and localities to develop comprehensive disaster preparedness plans, prepare for better intergovernmental coordination in the face of a disaster, encourage insurance coverage, and provide federal assistance programs for losses due to a disaster. The Stafford Act is a 1988 amended version of the Disaster Relief Act of 1974. It created the system in place today that authorizes the President to declare a disaster or emergency that triggers financial and physical assistance through the Federal Emergency Management Agency (FEMA). The Act gives FEMA the responsibility for coordinating government wide relief efforts. It is named after Senator Robert Stafford (in Senate 1971-89), who helped pass the law. Congress amended it by passing the Disaster Mitigation Act of 2000, and again in 2006 with the Pets Evacuation and Transportation Standards Act.

The NDRF created several new key roles and functions:

1. Federal Disaster Recovery Coordinator (FDRC) – As the level of response activities declines and recovery activities accelerate, the Federal Disaster Recovery Coordinator (FDRC) will communicate with the Recovery Support Function (RSF) agencies to organize and coordinate federal recovery assistance. During this early recovery phase, the FDRC and the RSF coordinators work closely with Emergency Support Function (ESF) to share information about impacts, assistance provided, and working relationships at all levels.

2. State Disaster Recovery Coordinator (SDRC), Tribal Disaster Recovery Coordinator (TDRC), and Local Disaster Recovery Manager (LDRM) - The NDRF strongly recommends that state governors as well as local government and tribal leaders, as part of their disaster recovery plans, appoint SDRCs, TDRCs, and LDRMs to lead disaster recovery activities for the jurisdiction.
The role of the SDRCs, TDRCs, and LDRMs is to organize, coordinate, and advance the recovery at the local, state, or tribal level. The experience and skill sets of these individuals should include a strong basis in community development and knowledge of the community's demographics. While these positions will often interact with the emergency management community, it is not necessary that these individuals be emergency management professionals. Their primary role is to manage and coordinate the redevelopment and building of the community. In addition, the individuals occupying the positions should be able to represent and speak on behalf of their respective chief executives (e.g., mayor, governor, tribal leader). The LDRMs and TDRCs serve as the jurisdiction's primary point of contact (POC) with the SDRC.

3. Recovery Support Functions (RSFs) - The RSFs are:
   a. Community Planning and Capacity Building
   b. Economic
   c. Health and Social Services
   d. Housing
   e. Infrastructure Systems
   f. Natural and Cultural Resources

The NDRF is consistent with the vision set forth in climate related Presidential Policy Directives (PPDs). It bolsters core recovery capabilities by supporting operational plans as an integral element of the National Preparedness System (NPS). It is an important step toward the nation's objective to achieve a shared understanding and a common, integrated perspective across all mission areas of prevention, protection, mitigation, response, and recovery in order to achieve unity of effort and make the most effective use of the nation's limited resources (PPD, 2015).

For the most part, those in the private sector will operate independently in the response and recovery phases of a disaster, taking care of its own needs and interests. However, at other times, the private sector will help the community to deal with the disaster and may be a vital asset for those working in disaster management. The responsibilities of the private sector are broad and range from emergency medical care to reporting and to settling insurance claims. Faith-based organizations such as the Salvation Army perform some of the same functions as other nonprofits, but they are
associated with religious organizations. The U.S. military is also involved in rapid-onset natural disasters, which make up over two-thirds of U.S. military disaster responses. Although the military responds to a wide range of disasters, the vast majority of responses are to floods, tropical storms, and earthquakes.

**White House Innovation for Disaster Response and Recovery Initiative Demo Day**

The White House Innovation for Disaster Response and Recovery Initiative was developed by the Administration in the wake of Hurricane Sandy to find the most effective ways technology can empower survivors; first responders; and local, state, tribal, territorial, and federal governments with critical information and resources. To address the challenges that severe weather and other disasters can pose to our communities, the White House hosts the Innovation for Disaster Response and Recovery Initiative Demo Day. This event brings together technologists, entrepreneurs, and members of the disaster response community to showcase tools that can make a tangible impact in the lives of survivors of large-scale disasters. Building on the innovations highlighted as part of the President’s Hurricane Briefing in May 2014, these innovations enable, empower, and strengthen survivors and their communities in the wake of a disaster. In line with the Administration’s goal of better preparing and supporting survivors and communities following a disaster, public and private entities demonstrated a host of new initiatives, tools, and services at the White House Innovation for Disaster Response and Recovery Initiative Demo Day in July 2014. Some of the participants are listed below along with their noteworthy contributions to disaster and climate change response and recovery (Pittman, 2014; See Appendix B for a more complete list).

**National Geospatial-Intelligence Agency (NGA).** NGA announced GeoQ, a tool that crowd sources geo-tagged photos of disaster-affected areas to assess damage over large regions. Developed in coordination with NGA, the Presidential Innovation Fellow Program, FEMA, and other disaster analysts, GeoQ improves the speed and quality of disaster-related data coordination by using a data crowd-sharing framework. Programmers can use the existing services and add features to customize the GeoQ code for their own community.

**The U.S. Geological Survey (USGS).** USGS highlighted ShakeMap and other post-
earthquake information tools that offer rapid situational awareness for disaster response and recovery. Using data from seismic monitoring systems maintained by USGS and its state and university partners, ShakeMap provides a rapid graphical estimate of ground shaking in an affected region on the web within minutes of an event. The maps and underlying data, which can be downloaded in numerous formats for use in GIS and other applications, are also the basis for ShakeCast, which enables emergency managers at a growing number of companies, response organizations, and local governments to automatically receive USGS shaking data and generate their own customized impact alerts for their facilities.

The U.S. Department of Energy (DOE). DOE previewed “Lantern Live,” a mobile app that provides helpful information and assistance during a disaster. The mobile app is designed to provide consumers timely disaster preparedness tips and recommendations, allow consumers to report and access information on power outages and fallen power lines, and help users find fuel and report the status of gas stations.

The Federal Emergency Management Agency (FEMA). FEMA announced that the FEMA app has been downloaded more than 225,000 times. Disaster Reporter, a crowd-source feature within the FEMA app, allows citizens to take a photograph in a disaster area and share it, along with a short description of the image—with the goal of allowing survivors, first responders, emergency managers, community response and recovery teams, and others to view and contribute information on a publicly accessible map during a disaster. There are currently 186 photos available on the Disaster Reporter map including photos from Colorado flooding, the Washington mudslide, and other disaster-related events.

Department of Health and Human Services (HHS). The Assistant Secretary for Preparedness and Response (ASPR) at HHS launched nowtrending.hhs.gov—a website created as a result of the challenge competition Now Trending: #Health in My Community in 2012. This competition challenged entrants to create a web-based application to search open-source Twitter data for health and natural disaster topics and deliver analysis of those data for both a specified geographic area and at the national level. The information and analytic charts available on the website can assist local and state health departments and other public health emergency entities by serving as indicators of potential health issues emerging in a population, building a baseline
of trend data, engaging the public on trending health or disaster topics, or cross-referencing other data sources. HHS’s Office of the ASPR and Centers for Medicare and Medicaid Services also announced the development of an HHS At-Risk Resiliency Interactive Map, an open data map featuring the number of electricity-dependent Medicare beneficiaries at the U.S. territory, state, county, and zip code level, along with National Oceanic and Atmospheric Administration (NOAA) real-time weather tracking capabilities to identify areas that may be impacted by severe weather and at risk for prolonged power outages. Together, these data can assist community partners, such as hospitals, emergency medical services, and emergency managers to better anticipate, plan for, and rapidly assist electricity-dependent individuals within their communities. The HHS At-Risk Resiliency Interactive Map was launched on www.phe.gov in September 2014.

U.S. Agency for International Development (USAID) and the Department of State. USAID’s Office of U.S. Foreign Disaster Assistance and the U.S. Department of State are collaborating with partner organizations to build tools and platforms for creating and sharing Open Data and to educate the public about how to use these tools and platforms. Emergency managers can learn more about these initiatives by visiting MapGive and the United Nations Office for the Coordination of Humanitarian Affairs – Humanitarian Data Exchange.

Disasters.data.gov. Disaster.data.gov features tools built by members of the private and public sectors as well as disaster-related datasets. The site incorporates feedback from emergency managers, first responders, survivors, and the public and private sector and provides a resource for the community to improve preparedness for response and recovery after a disaster.

The American Red Cross. The American Red Cross’ suite of six disaster preparedness apps helps deal with first aid emergencies, weather emergencies, and natural disasters. These apps allow users to view information in either English or Spanish, with or without data connectivity, and provide real time weather alerts from the federal government during events such as hurricanes, tornadoes, earthquakes, wildfires, and floods. Users can also use these apps to let loved ones know they are safe and share important emergency information on their social networks.

Big City Emergency Managers. Big City Emergency Managers have committed to
share their technological innovations and tools with emergency managers and their staff
from cities across America. With participation by emergency managers of the 15 largest
cities and jurisdictions in the U.S., Big City Emergency Managers share lessons learned
and best practices for disaster response and recovery.

**Civic Ninjas.** Civic Ninjas' Shining Light Project developed a wearable device for
emergency responder credentialing and disaster access control. The Shining Light
device has color-coded LEDs that indicate whether an emergency responder is allowed
into an area based on geo-fenced GPS information. The device uses Bluetooth Low
Energy to tether to smart devices running a native app for real-time device control. In
addition to perimeter access control the device can also show search grid locations and
provide time-based go/no go signaling for personnel needing to cycle back to their base
of operations.

**Getaround.** Getaround developed a disaster assistance policy and web portal to help
educate people about how to find or share a vehicle following a disaster.

**Google.** Google developed a Crisis Map, an open source and freely available web
mapping tool, to include crowd-sourcing capabilities. Google recently updated this
tool to enable users to contribute information and updates about a disaster event, such
as whether a gas station has fuel available. In addition, a number of electric utilities
and technology companies—including Duke Energy, BGE, ComEd, PECO, SDG&E,
Southern California Edison, National Grid, and iFactor Consulting—have agreed to
publish power outage and restoration data openly on Crisis Map.

**FEMA’s Disaster Response and Recovery**
**Efforts at the National and Local Level**

FEMA's response includes agency policies covering response and recovery topics and
specifically individual assistance, long-term community recovery, and public assistance.
FEMA's response efforts coordinate federal operational and logistical disaster response
capability needed to save and sustain lives, minimize suffering, and protect property in
a timely and effective manner in communities that become overwhelmed by disasters.
FEMA's recovery supports individuals and communities affected by disasters in their efforts to recover. Individual and public assistance programs as well as long term community recovery efforts assist individuals and communities in FEMA's collective effort to prepare for, respond to, and recover from all hazards (FEMA, 2015; See also Appendix C). This includes implementation of the National Incident Management System (NIMS) (FEMA, 2015).

NIMS is a systematic, proactive approach to guide departments and agencies at all levels of government, NGOs, and the private sector to work together seamlessly and manage incidents involving all threats and hazards, regardless of cause, size, location, or complexity in order to reduce loss of life, property, and harm to the environment. NIMS is the essential foundation to the National Preparedness System (NPS) and provides the template for the management of incidents and operations in support of all five National Planning Frameworks.

At the county and community levels, FEMA's Community Emergency Response Team (CERT) Program educates people about disaster preparedness for hazards that may impact their area and trains them in basic disaster response skills such as fire safety, light search and rescue, team organization, and disaster medical operations. Using the training learned in the classroom and during exercises, CERT members can assist others in their neighborhood or workplace following an emergency when professional responders are not immediately available to help. CERT members also are encouraged to support emergency response agencies by taking a more active role in emergency preparedness and disaster response projects in their community (FEMA, 2015). Often the main objective is to use CERT to perform the large number of varied tasks needed in emergencies. This frees highly trained professional responders for more technical tasks. The Incident Command System (ICS) is a systematic tool used for the command, control, and coordination of emergency response during response and recovery operations, which include establishing FEMA Operational Centers of Excellence and compliance with the Emergency Notification System (ENS) Directive. Much of CERT training concerns the ICS and its organization, so CERT members fit easily into larger command structures.

CERTs may self-activate (self-deploy) when their own neighborhood is affected by disaster. An effort is made to report the response status to the sponsoring agency. Self-activated teams will assess and evaluate the loss in their neighborhoods and begin using the skills they learned to minimize further loss of life, property, and environment.
CERTs continue to respond safely until redirected or relieved by the sponsoring agency or professional responders.

Teams in neighborhoods not affected by disaster may be deployed or activated for assistance by the sponsoring agency. The sponsoring agency may communicate with neighborhood CERT leaders through a communication team. In some areas the communications may be by amateur radio, FRS, GMRS, or MURS radio, dedicated telephone or fire alarm networks. In other areas, relays of bicycle equipped runners can effectively carry messages between the teams and the local emergency operations center.

A sponsoring federal agency may activate and dispatch teams to affected neighborhoods to gather or respond to vital information about an incident, or to an Incident Command Post or Emergency Operations Center to augment support staff engaged in response and recovery operations. Additional teams may also be formed and dispatched to guard a morgue, locate supplies and food, convey messages to and from other CERT teams and local authorities, and perform other duties on an as-needed basis as identified by the team leaders.

In the short term, CERTs perform data gathering especially to locate mass casualties requiring professional response or situations requiring professional rescues, simple fire-fighting tasks (e.g. small fires, turning off gas), light search and rescue, damage evaluation of structures, triage and first aid. In the longer term, CERTs may assist in the evacuation of residents or with setting up a neighborhood shelter. While responding, CERT members are temporary volunteer government workers. In some areas such as California, Hawaii, and Kansas, registered and activated CERT members are eligible for worker’s compensation for on-the-job injuries during declared disasters.

Disaster and Climate Change Response and Recovery in the United States at the Local Level

In the U.S., all disasters are initially local, with local authorities, usually a law enforcement agency (LEA), taking charge. If the event becomes overwhelming to local government, state (the primary government structure of the U.S.) emergency management becomes the controlling emergency management agency. As part of the Department of Homeland Security (DHS), FEMA is the lead federal agency for emergency management. The U.S. and its territories are divided into ten regions for
FEMA’s emergency management purposes. FEMA supports but does not override state authority.

Disaster management in the U.S. has utilized the functional all hazards approach for over 20 years. This approach has disaster managers develop processes such as communication, warning, or sheltering processes that can be applied to all hazards rather than developing single-hazard or threat focused plans, such as a tornado plan. One or more particular processes can be mapped to specific hazards or threats with the local emergency manager (LEM) looking for gaps, overlaps, and conflicts between processes. This approach provides uniform, flexible, and readily applied processes that can be used to develop comprehensive plans for unique disaster occurrences. The common processes are applied by stakeholders to their unique situations. For example, a public works director can use the general process for traffic or transportation to create a traffic management plan that is appropriate for his or her particular location and situation (See Appendix D for Response Planning Guidelines, Sample Disaster Response IT Plan, and Sendai Disaster Response Plan).

As the national coordinating agency for the Citizen Corps, FEMA works closely with other federal entities, state and local governments, first responders and emergency managers, the volunteer community, and the Corporation for National and Community Service. The Citizen Corps is an organization of volunteer service programs administered locally and coordinated nationally by FEMA. It seeks to mitigate disasters and prepare the population for emergency response through public education, training, and outreach. Citizen Corps was created to help coordinate volunteer activities that will make communities safer, stronger, and better prepared to respond to any emergency situation. It provides opportunities for people to participate in a range of activities to make their families, homes, and communities safer from the threats of crime, terrorism, and disasters of all kinds. Citizen Corps programs build on the successful efforts that are in place in many communities around the country to prevent crime and respond to emergencies. Programs that started through local innovation are the foundation for Citizen Corps and the national approach to citizen participation.

Most disaster response is carried out by volunteer organizations. In the U.S., the Red Cross is chartered by Congress to coordinate disaster response services, including typically being the lead agency handling shelter and feeding of evacuees. Because of their ability to provide volunteers quickly, religious organizations are usually critical during the response process. The larger organizations are the Salvation Army whose
primary focus is on chaplaincy and rebuilding, and Southern Baptists who focus on food preparation and distribution (The Salvation Army, 2015). Similar services are also provided by Catholic Relief Services, Methodist Relief Services, the Lutherans, and Samaritan's Purse. In addition, unaffiliated volunteers assist at most large disasters.

**Disaster and Climate Change Response and Recovery in the Asia Pacific Region**

Between 2005 and 2014, disasters have claimed some 403,000 lives in Asia alone, while the losses have totaled $436 billion, or $120 million per day. Climate change means disasters will become more frequent and more intense. Communities are warned to take immediate action to better prepare themselves for future disasters that threaten to destroy homes, farmlands and jobs, and hit the poorest of the region particularly hard since they often live in flood-prone coastal areas or river plains. With little or no financial cushion to fall back on, it can take some families a decade or more to recover. Despite the alarming statistics, the past decade has seen significant progress in large part due to the commitments of support by the international community made in 2005.

Early warning systems and evacuation capabilities have improved because of better forecasting and information dissemination. Due to improvements like these, a powerful cyclone that struck densely populated areas along India's east coast in 2013 resulted in only 47 fatalities despite affecting 13.2 million people. Scientific tools such as satellites and remote sensing technologies as well advances in disaster modeling have also created huge opportunities for better management of disaster risk through supporting measures such as risk-sensitive land use planning, enhanced infrastructure design, and sustainable disaster risk transfer solutions. “Building back better” has become a new mantra. Governments and development partners recognize that disaster recovery and reconstruction efforts must integrate measures to strengthen resilience to future natural hazards.

Despite the progress made in some Asian countries, it has been disappointing in many other Asian countries where enhanced disaster risk information and disaster risk management legislation have not yet translated into significant action on the ground to strengthen resilience. Fiscal management of disaster risk remains weak in developing Asia. Less than 5 percent of disaster losses are insured compared to 40 percent in developed countries, and use of capital market instruments to offset risk is rare.

The U.S. Congress established the Center for Excellence in Disaster Management and
Humanitarian Assistance (COE) as the principal agency to promote disaster awareness and preparedness in the Asia-Pacific region. In a 2010 report, Asia's Response to Climate Change and Natural Disasters, energy experts, climate change specialists, and architects from the Center for Strategic International Studies in Washington, DC concluded that the U.S. will continue to play a critical role in supporting the region's response to many of the natural disasters it will face (Freeman et al., 2010). The authors of this report recommend that the U.S. seek to focus Asia's attention on the long term threat of climate change and other slow onset disasters. As the authors explain, not only is the region expected to be a major victim of the consequences of climate change, it is a source of the threat itself. They recommend that the U.S. continue its bilateral and multilateral programs to increase energy efficiency and the use of alternative energy and clean-coal technology and that it also begin to explore broad, secure, low-carbon pathways within the Asia-Pacific Partnership on Clean Development and Climate (Freeman et al., 2010).

Because natural disasters in the Pacific are often affected by climate change, disaster response plans for the Pacific region need to include climate change response expertise. A 2013 research report addressed this issue and focused on the immediate humanitarian needs following a climate disaster, drawing upon adaptive capacity as a concept to assess the resilience of individual organizations and the broader system of disaster response (Gero et al., 2013). Four case study countries (Fiji, Cook Islands, Vanuatu and Samoa) were chosen for deeper investigation of the range of disaster and climate issues that threaten the Pacific region. The research process was guided by a Project Reference Group which included key stakeholders from relevant organizations involved in Pacific disaster response to guide major decisions and the progression of the research process. Given the complexity of issues involved, including the contested definitions of adaptive capacity, the research team developed a conceptual framework to underpin the research. This framework drew upon concepts from a range of relevant disciplines including earth system governance, climate change adaptation, health resources, resilience in institutions, and climate change practice and theory.

The research used objective and subjective determinants of adaptive capacity to assess the 'disaster response system' comprised of actors and agents from government and non-government sectors and the governance structures, policies, plans, and formal and informal networks that support them. Results revealed the most important determinants of adaptive capacity in the Pacific were communications and relationships,
and both informal and formal mechanisms were found to be essential. Human, financial, and technical capacity, leadership, management and governance structures, and risk perceptions were also highly important determinants of adaptive capacity. The research also found that in small Pacific island bureaucracies, responsibility and capacity often rest with individuals rather than organizations. Leadership, trust, informal networks and relationships were found to have a strong influence on the adaptive capacity of organizations and the broader disaster response system. A common finding across all four case study countries affecting adaptive capacity was the limited human resources for health and disaster response more generally, both in times of disaster response and in day-to-day operations (Gero et al., 2013). Another common finding was the gap in psychosocial support after a disaster. Although water, sanitation, and hygiene (WASH), as immediate post-disaster humanitarian needs were relatively well established among responding organizations, long term WASH issues were not resolved. Other humanitarian needs such as health care, food and nutrition were at varying stages of response capacity, often limited by lack of human, financial, and technical resources (Gero, et al., 2013). Adaptive capacity was constrained by current gaps as well as anticipated future disaster risk. Drawing on these and other findings, practical means to improve and strengthen key determinants of adaptive capacity were recommended to relevant stakeholder groups including policy makers and practitioners in the disaster and emergency response sectors in the Asia Pacific region.

Southeast Asian countries such as Cambodia which border the Mekong River are extremely vulnerable to flooding. In the last decade, Cambodia has halved its poverty rate and improved the living conditions of its population. However, because of extreme climate events that regularly descend on the country, Cambodia remains one of the most disaster-vulnerable countries in Southeast Asia. In 2013 alone, losses caused by floods added up to USD $356 million. However, disasters and climate change also present an opportunity to promote what the United Nations Development Program (UNDP) refers to as “risk-informed development” (UNDP, 2015). Communities affected by climate disasters learn to work together to create effective, multi-disciplinary approaches to respond to and recover from disasters as well as promote disaster risk reduction.

In 2013, a combination of heavy rains and the swelling of the Mekong River caused widespread damage to infrastructure and crops, the death of 168 people, most of them children, and devastation to 20 provinces. Following the floods, the Cambodian
government requested that UNDP work with various partners to carry out a post flood early recover needs assessment. Drawing on the expertise of UNDP’s country office, as well as the skills and knowledge of government partners, NGOs, and civil society organizations, measurements of the flood damage and an assessment that clearly articulated the needs of the various communities were accomplished (UNDP, 2015).

In February 2015, mayors and municipal leaders from the Asia Pacific region met to discuss a more coordinated response to and recovery from the effects of climate change. The resulting report called for community engagement, innovation, and local and global partnerships that would help prevent and manage risk. The leaders stated, “There is a need to do things differently; to be prepared; to innovate; to constantly learn and adapt; and to enact the full spectrum of resilience actions, including disaster prevention, preparedness, response and recovery, for current and projected risks” (Associated Press, 2015). That same resolve and spirit of cooperation appear to be growing as Vanuatu assessed how to recover from Cyclone Pam’s devastation. Vanuatu’s president appealed to the international community for aid. In response, New Zealand pledged 1 million New Zealand dollars ($734,000) towards relief efforts, and Australia sent a crisis response team to Vanuatu (Associated Press, 2015).

On March 18, 2015, the World Conference on Disaster Risk Reduction (DRR) was held in Sendai, Japan and attended by over 6,500 participants including 2,800 government representatives from 187 governments. The Public Forum had 143,000 visitors over the five days of the conference making it one of the largest UN gatherings ever held in Japan (UN, 2015). Representatives from the 187 UN member states adopted the Sendai Framework for Disaster Risk Reduction 2015-2030, the first major agreement of the Post-2015 development agenda. The Sendai Framework is a far reaching document for disaster risk reduction with seven targets and four priorities for action.

The seven global targets to be achieved over the next 15 years include substantial reduction in (1) global disaster mortality, (2) numbers of affected people, (3) economic losses in relation to global GDP, and (4) disaster damage to critical infrastructure and disruption of basic services. It also aims to achieve (5) an increase in the number of countries with national and local DRR strategies by 2020, (6) enhanced international cooperation, and (7) increased access to multi-hazard early warning systems and disaster risk information and assessments.

The four priority actions are (1) understanding disaster risk, (2) strengthening
disaster risk governance to manage disaster risk, (3) investing in DRR for resilience, and (4) enhancing disaster preparedness for effective response and to ‘Build Back Better’ in recovery, rehabilitation, and reconstruction.

The Sendai Framework calls for concrete indicators of progress towards set goals to be measured against the disaster losses in the decade after the adoption of the 2005 Hyogo Framework for Action. To reach its goals, the Framework calls for actions to not only protect populations and promote quick recovery, but also to prevent new risks such as those caused by ill planned urban growth in areas subject to flooding, landslides, and effects of climate change. Integration with global regimes to mitigate and adapt to climate change and promote sustainable development is among the key objectives of the Sendai Framework, as is inclusively addressing risk through economic, governmental, structural, legal, social, cultural, educational, and health-related sectors, and UN organizations.

The Role of Humanitarian and Professional International Organizations

During a disaster, humanitarian agencies are often called upon to deal with immediate response and recovery. To respond effectively, these agencies must have experienced leaders, trained personnel, adequate transport and logistic support, appropriate communications, and guidelines for working in emergencies. If the necessary preparations have not been made, the humanitarian agencies will not be able to meet the immediate needs of the people. Professional international organizations and government agencies also provide assistance and support in disaster and climate change response and recovery. Some of these organizations and agencies are the following:

The International Emergency Management Society. The International Emergency Management Society (TIEMS) is an international non-profit NGO registered in Belgium. TIEMS is a global forum for education, training, certification and policy in emergency and disaster management. TIEMS' goal is to develop and bring modern emergency management tools and techniques into practice through the exchange of information, innovative methodologies, and new technologies. TIEMS provides a platform for stakeholders to meet, network, and learn about new technical and operational methodologies. TIEMS' focus on cultural differences is reflected in its organizational perspective, training, and educational programs. It has established local
chapters worldwide in Benelux, Romania, Finland, Italy, Middle East and North Africa (MENA), Iraq, India, Korea, Japan, and China.

**International Association of Emergency Managers.** The International Association of Emergency Managers (IAEM) is a non-profit educational organization that promotes the goals of saving lives and protecting property during emergencies. The mission of IAEM is to serve its members by providing information, networking and professional opportunities, and to advance the emergency management profession. It has seven councils around the world: Asia, Canada, Europa, International, Oceania, Student, and USA (IAEM, 2012). Affiliated by membership with the IAEM, the Air Force Emergency Management Association provides emergency management information and networking for U.S. Air Force emergency management personnel.

**International Recovery Platform.** The International Recovery Platform (IRP) was conceived at the World Conference on Disaster Reduction (WCDR) in Kobe, Hyogo, Japan in January 2005, as part of the Hyogo Framework for Action (HFA) 2005–2015. The HFA is a global plan for disaster risk reduction adopted by 168 governments. The key role of IRP is to identify gaps in post disaster recovery and to serve as a catalyst for the development of tools and resources for recovery efforts (IRP, 2015).

**Red Cross/Red Crescent.** The International Federation of Red Cross and Red Crescent Societies (IFRC) works closely with national Red Cross/Red Crescent societies in responding to emergencies, often playing a pivotal role. The IFRC may deploy assessment teams, e.g. Field Assessment and Coordination Teams (FACT), to the affected country if requested by the national society. After assessing the needs, Emergency Response Units (ERUs) may be deployed to the affected country or region. They are specialized in the response component of the emergency management framework.

**United Nations.** The United Nations system rests with the Resident Coordinator within the affected country. However, in practice, the UN response will be coordinated by the UN Office for the Coordination of Humanitarian Affairs (UN- OCHA) by deploying a UN Disaster Assessment and Coordination (UNDAC) team in response to a request by the affected country's government.
World Bank. Since 1980, the World Bank has approved more than 500 projects related to disaster management dealing with both disaster mitigation and reconstruction projects amounting to more than US$40 billion. These projects have taken place all over the world in countries such as Argentina, Bangladesh, Colombia, Haiti, India, Mexico, Turkey, and Vietnam (World Bank, 2015). Prevention and mitigation projects include forest fire prevention measures, such as early warning measures and education campaigns; early warning systems for hurricanes; flood prevention mechanisms (e.g. shore protection, terracing, etc.); and earthquake-prone construction. In a joint venture with Columbia University under the umbrella of the ProVention Consortium, the World Bank established a Global Risk Analysis of Natural Disaster Hotspots (World Bank, 2015). In June 2006, in response to the HFA, the World Bank established the Global Facility for Disaster Reduction and Recovery (GFDRR), a partnership with other aid donors to reduce disaster losses. GFDRR helps developing countries fund development projects and programs that enhance local capacities for disaster prevention and emergency preparedness.

European Union. In 2001, the European Union adopted Community Mechanism for Civil Protection to facilitate cooperation in the event of major emergencies requiring urgent response actions. The Community Mechanism applies to situations of imminent threat as well. The heart of the Community Mechanism is the Monitoring and Information Center (MIC) which is part of the European Commission's Directorate-General for Humanitarian Aid & Civil Protection. Accessible 24 hours a day, it gives countries access to a one-stop-shop of civil protections available to all the participating states. Any country inside or outside the EU affected by a major disaster can make an appeal for assistance through the MIC. It acts as a communication hub and provides useful and updated information on the actual status of an ongoing emergency (europa.eu, 2015; See Appendix E for obstacles to disaster climate change response and recovery in Europe).
Lessons Learned: Guidance for Climate Change Disaster Recovery

1. Recovery impacts are best observed and understood at the local level. Observing outcomes at the local level gives disaster managers and practitioners a better understanding of the actual impacts of recovery decisions made at higher levels. They see how recovery policies, programs, and projects are implemented on the ground and what they actually deliver to people. Are individuals and households able to strengthen their livelihoods, improve their quality of life, and reduce their vulnerability to future climate change shocks and stresses?

2. Understanding local contexts and engaging local actors during recovery are essential because once a disaster is declared a relatively short period of time exists in which to plan and initiate recovery operations. This period is a dynamic, urgent time when critical decisions concerning complex issues with long term consequences must be made.

3. The primary objective of “build back better” is to reduce pre-existing vulnerabilities to achieve maximum recovery. This means enhancing the resilience of communities, creating a stronger infrastructure, and strengthening institutions against the eventualities of future climate change events. Resilience has been placed firmly at the heart of the development agenda following the adoption of the Sendai Framework for Disaster Risk Reduction 2010-30. The Sendai Framework guides UN member states in strengthening their resilience to shocks and stresses and improving recovery and reconstruction. “What's needed is risk-informed development. It's not just about rebuilding after a disaster. It's about risk-informed rebuilding,” said Jo Scheuer, Director of Public Policy and Support Bureau at the UN Development Program and Chair of the International Recovery Platform Steering Committee (Japan Times, January 2015).

4. The overall recovery success of NGOs can be attributed to their long term involvement in the affected areas. Familiar with and knowledgeable about the disaster areas, personnel in local organizations can accurately and swiftly
identify the most vulnerable people and their needs and design interventions in the unfolding recovery process in ways that are most suitable for reducing future vulnerability.

5. Recovery should not merely restore the previous level of development but promote activities that will lead to reductions in the vulnerability of the population and infrastructure to future disasters. When a disaster emergency is largely over and some stability has returned to the lives of the affected population, it is worth taking the time to carry out an additional needs assessment after the standard initial Recovery Needs Assessment (RNA) for emergency intervention. This is to prioritize communities' and individuals' needs under a climate change scenario, with reference to recovery with adaptation options.

6. Community-based targeting (CBT) and need assessments at the community level help to establish target priorities and in turn suitable program activities. CBT consults with communities in slow-onset crises to obtain information about resources, needs, coping strategies, and other valuable inside data to develop interventions that build on community priorities and capacities during the disaster recovery phase. At the very least, agencies must be aware of existing community-based organizations and self-help mechanisms that should be tapped to play active roles in disaster response, recovery, and risk reduction.

7. Effective disaster preparedness and management require coordination and collaboration among public and private agencies and organizations on the local, state, national, and even international levels. The massive potential and actual loss of life and property due to natural and human caused disasters compel emergency planners and managers to improve upon existing disaster readiness and response plans and actions to minimize the devastating consequences. Glaring deficiencies of the emergency response systems were exposed in the wake of disasters such as the terrorist attack on the World Trade Center and the Pentagon on September 11 and the battering of Hurricane Katrina. The unprecedented terrorist attack of 9/11 turned attention
to homeland security threatened by human-caused disasters, whereas Hurricane Katrina exposed the vulnerability of an uncoordinated emergency command system overwhelmed by a natural disaster. The technical, resource, political, and bureaucratic problems that surfaced seemed to be eclipsed by the woeful lack of coordination and collaboration among key elements in the emergency response systems. Prior to any disaster, intra—and interagency cooperation among administrators and the rank and file must exist to assure a disaster ready emergency response system with interoperable communication systems, highly trained personnel, adequate equipment, and other necessities ready to be deployed when disaster strikes. Subsequent analysis of recent disasters suggests that the all hazards approach in the preparation and response to both human-caused and natural disasters may help to mitigate the problems of coordination by building a strong, basic capacity for local emergency response. This would include a first-response system with personnel trained and equipped to handle a wide range of climate disaster emergencies (Prizzia, 2008, 2012).

**Recommendations and Best Practices of Climate Change Disaster Response and Recovery**

1. **Comprehensive, Cooperative Framework.** A comprehensive, cooperative framework can support national response plans that facilitate climate-resilient development. Each country should implement early warning systems, disaster and climate change reduction strategies, and preparedness and response plans.

2. **Coordination of Trans-Boundary Response and Recovery.** The UN, along with its governmental and nongovernmental partners, can help coordinate trans-boundary sharing of post-disaster response and recovery plans, warning system infrastructure, and complex engineering and legal expertise. Collaborative disaster response and recovery activities already underway will benefit from increased international support. Awareness-raising efforts on the part of environmentally minded organizations can build capacity. Multilateral forums and agreements sustain focus on the myriad of climate responses.
that can build resilience. Resilience is the common ground upon which the international community can continue to build international consensus.

3. **Sharing Best Practices.** Sharing best practices in a culturally sensitive manner that allows local communities to implement successful climate change response and recovery strategies can build capacity. Such capacity building includes training with disaster resilience in mind. Climate change recovery in the form of post-disaster rebuilding should involve local communities and materials. Given the reality that poor people in developing countries construct their own homes, the international community can facilitate capacity building by providing model homes that emphasize resilience to disasters likely to impact a given region. This effort can combine local traditional knowledge with structural engineering developments to achieve safe, affordable, and sustainable buildings throughout the world.

4. **Zoning and Building Codes.** Zoning and building codes can have an enormous impact on climate change response and recovery. For example, Hawaii requires solar hot water heaters in residential construction recognizing that heating hot water can contribute up to 25 percent of a household's energy consumption (Hawaii Revised Statutes, 2010). Green roofs also offer substantial opportunities to both mitigate and adapt to climate disruptions. In addition to reducing GHG emissions, green roofs can absorb water on site that otherwise would contribute to increased storm water flooding. Germany and Switzerland mandate the use of green roofs, whereas Seattle requires the use of green landscaping.

5. **Clearly Defined Roles and Responsibilities.** Having clearly defined, well-understood roles and responsibilities for all levels of government and their nongovernmental partners is critical in coordinating the development and implementation of the responsibilities of the various parties involved in response and recovery operations.

6. **Developing and Assessing Capabilities.** Developing the capabilities needed for catastrophic disasters should be part of an overall national effort designed to define and coordinate what needs to be done, where, by whom, and how
well. Equally important are the creation and use of metrics for assessing current capabilities and identifying key gaps that need to be filled. Ensuring essential capabilities are ready requires effective planning and coordination plus robust training and exercises. In the process, capabilities are realistically tested and problems are identified and subsequently addressed in partnership with federal, state, local, and nongovernmental stakeholders. In addition, integrating an all hazards risk management framework into decision making is central to assessing catastrophic disaster risks and guiding the development of national capabilities to prevent or mitigate where possible and respond to such risks.

7. **Effective Coordination and Collaboration among Relevant Stakeholders.** Response to and recovery from a major disaster is a complex process that involves an extensive group of participants both across the federal government and at the state and local level. Recovery may take years. At least 14 federal departments and agencies are responsible for administering dozens of recovery related programs, many of which rely heavily on active participation by state and local government for their implementation. Because these parties are dependent on each other to accomplish recovery goals, sustained focus and effective coordination and collaboration among relevant stakeholders are essential (Prizzia, 2006, 2008, 2012).

8. **Accountability.** Following a catastrophic disaster, decision makers must address the tension between the demand for rapid response and recovery assistance and implementing accountability controls and mechanisms. A system of accountability controls and mechanisms must be in place to ensure that resources are used appropriately for valid purposes.

9. **Periodic Evaluation and Reporting of Coordinated Efforts.** Collaboration among recovery partners can be enhanced by periodically evaluating and reporting on what worked and what improvements must be made to address long term recovery goals. The ongoing feedback will assist decision makers and stakeholders to improve policy and operational effectiveness of recovery efforts.
Questions for Review

1. Describe and explain the role of FEMA in response and recovery at the national, state, local and community level, and provide at least two examples at the community level?

2. What is the role of humanitarian organizations in response and recovery at the local and community level? Provide examples.

3. What is the role of the United Nations and other International organizations in response and recovery at the local and community level? Provide examples.

4. How important are governmental and nongovernmental partnerships and multi-level government agreements in response and recovery at every level of government? Explain and provide examples.

5. Explain the importance of collaboration, coordination and communication in response and recovery at every level of government and provide examples.

6. Explain the importance of disaster and climate change response and recovery in the Asia Pacific Region and provide examples.

7. Explain the importance of the National Response Framework (NRF) and the National Disaster Recovery Framework (NDRF) and provide examples.

Appendix A January 2008

National Response Framework

An effective, unified national response requires layered, mutually supporting capabilities. The Framework systematically incorporates public-sector agencies, the private sector, and NGOs. It also emphasizes the importance of personal preparedness by individuals and households.

Communities, tribes, States, the Federal Government, NGOs, and the private sector should each understand their respective roles and responsibilities, and complement each other in achieving shared goals. Each governmental level plays a prominent role in developing capabilities needed to respond to incidents. This includes developing plans, conducting assessments and exercises, providing and directing resources and capabilities, and gathering lessons learned. These activities require that involved organizations understand their roles and responsibilities, and how they fit within and are supported by the Framework.
It is important that each level of government adapt and apply the general roles outlined in the Framework. To do this, organizations should define key leadership and staff functions, adopt capabilities-based planning as the method to build response capabilities, and impose the discipline needed to plan and operate effectively. Partner Guides that summarize core Framework concepts and are tailored specifically to leaders at different levels and types of organizations are provided through the online NRF Resource Center.

Even when a community is overwhelmed by an incident, there is still a core, sovereign responsibility to be exercised at this local level, with unique response obligations to coordinate with State, Federal, and private-sector support teams. Each organization or level of government therefore has an imperative to fund and execute its own core emergency management responsibilities.

Below is a brief summary of emergency management roles at the local, tribal, State, and Federal levels, as well as the roles of private-sector organizations. Emergency management is the coordination and integration of all activities necessary to build, sustain, and improve the capability to prepare for, protect against, respond to, recover from, or mitigate against threatened or actual natural disasters, acts of terrorism, or other manmade disasters.

Local Governments. Resilient communities begin with prepared individuals and depend on the leadership and engagement of local government, NGOs, and the private sector. Individuals, families, and caregivers to those with special needs should enhance their awareness of risk and threats, develop household emergency plans that include care for pets and service animals, and prepare emergency supply kits (More information on preparing a household emergency plan is available at http://www.ready.gov) Individuals can also volunteer in their communities.

Local police, fire, emergency medical services, public health and medical providers, emergency management, public works, environmental response professionals, and others in the community are often the first to detect a threat or hazard, or respond to an incident. They also are often the last to leave an incident site or otherwise to cope with the effects of an incident. The local senior elected or appointed official (the mayor, city
manager, or county manager) is responsible for ensuring the public safety and welfare of residents. In today's world, senior officials and their emergency managers build the foundation for an effective response. They organize and integrate their capabilities and resources with neighboring jurisdictions, the State, NGOs, and the private sector. Increasingly, businesses are vital partners within communities wherever retail locations, service sites, manufacturing facilities, or management offices are located. NGOs and not-for-profit organizations also play a key role in strengthening communities' response efforts through their knowledge of hard-to-reach populations, outreach, and services.

States, Territories, and Tribal Governments. States, territories, and tribal governments have responsibility for the public health and welfare of the people in their jurisdiction. State and local governments are closest to those impacted by incidents, and have always had the lead in response and recovery. During response, States play a key role coordinating resources and capabilities throughout the State and obtaining resources and capabilities from other States. States are sovereign entities, and the Governor has responsibility for public safety and welfare. While U.S. territories, possessions, freely associated states and tribal governments also have sovereign rights, there are unique factors involved in working with these entities. Stafford Act assistance is available to States and to Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands, which are included in the definition of "State" in the Stafford Act.

States have significant resources of their own, including State emergency management and homeland security agencies, State police, health agencies, transportation agencies, incident management teams, specialized teams, and the National Guard. The role of the State government in response is to supplement local efforts before, during, and after incidents. If a State anticipates that its resources may be exceeded, the Governor can request assistance from the Federal Government and/or from other States through mutual aid and assistance agreements such as the Emergency Management Assistance Compact (EMAC) (A reference paper on EMAC is available at the NRF Resource Center http://www.fema.gov/NRF).

The Federal Government. The Federal Government maintains a wide array of capabilities and resources that can be made available upon request of the Governor.
When an incident occurs that exceeds or is anticipated to exceed State, tribal, or local resources, the Federal Government may provide resources and capabilities to support the State response. For incidents involving primary Federal jurisdiction or authorities (e.g., on a military base or a Federal facility or lands), Federal departments or agencies may be the first responders and first line of defense, coordinating activities with State, territorial, tribal, and local partners. The Federal Government also maintains working relationships with the private sector and NGOs.

Pursuant to the Homeland Security Act of 2002 and Homeland Security Presidential Directive (HSPD) 5, the Secretary of Homeland Security is the principal Federal official for domestic incident management. Incident management refers to how incidents are managed across all homeland security activities, including prevention, protection, and response and recovery. Other Federal departments and agencies have key responsibilities to support national response activities and carry out those responsibilities within the overarching coordinating mechanisms of this Framework. DHS coordinates with other agencies to surge Federal support at the headquarters, regional, and field levels.

The Private Sector and NGOs. The private sector and NGOs contribute to response efforts through engaged partnerships with each level of government. Private-sector organizations and NGOs are encouraged to develop contingency plans and to work with State and local planners to ensure that their plans are consistent with pertinent plans, the NIMS, and this Framework.

The Framework is applicable to U.S. possessions and insular areas, as well as the Federated States of Micronesia and the Republic of the Marshall Islands. The U.S. Government does not provide disaster assistance to the Republic of Palau, in accordance with the Compact of Free Association. Insular areas include Guam, the Commonwealth of the Northern Mariana Islands, American Samoa, and the U.S. Virgin Islands. (Often throughout this Framework, discussion of authorities and roles of States is also intended to incorporate those of U.S. territories and possessions and tribal nations. A reference paper on EMAC is available at the NRF Resource Center, http://www.fema.gov/NRF).

Private-sector organizations play an essential role in protecting critical infrastructure systems and implementing plans for the rapid restoration of normal commercial
activities and critical infrastructure operations in the event of disruption. The protection of critical infrastructure and the ability to rapidly restore normal commercial activities can mitigate the impact of an incident, improve the quality of life of individuals, and accelerate the pace of recovery for communities and the Nation. There are not-for-profit owners/operators of critical infrastructure and key resources (CIKR) facilities, notably in healthcare and power generation. NGOs also serve a vital role at the local, State, and national levels by performing essential service missions in times of need. They provide sheltering, emergency food supplies, and other vital support services. NGOs bolster and support government efforts at all levels.

Response: The What and the How. The National Response Framework is always in effect, and elements can be implemented at any level at any time. The Framework is capabilities based, which is to say that local governments, tribes, States, and the Federal Government all develop functional capabilities and identify resources that may be required based on hazard identification and risk assessment, threats, and other potential incidents such as those represented by the National Planning Scenarios.

The Framework describes what we do and how we respond. In short, the National Response Framework explains how, at all levels, the Nation effectively manages all-hazards response consistent with the National Strategy for Homeland Security.

Framework Scope. The response doctrine that animates Framework and the preparedness strategy of which it is a part correlates with the outline of the overall document. The Framework provides structures for implementing nationwide response policy and operational coordination for all types of domestic incidents. It can be partially or fully implemented in the context of a threat, in anticipation of a significant event, or in response to an incident. Selective implementation allows for a scaled response, delivery of the resources needed, and an appropriate level of coordination. In this document, incidents include actual or potential emergencies or all-hazards events that range from accidents and natural disasters to actual or potential terrorist attacks. They include events wholly contained within a single jurisdiction and others that are catastrophic in nature and national in their scope or consequences.

Additional information on protection of critical infrastructure and key resources (CIKR) can be found in the CIKR Support Annex available at the NRF Resource Center, http://www.fema.gov/NRF. The American Red Cross is a federally chartered

Appendix B  White House Innovation for Disaster Response and Recovery Initiative Demo Day

   Environmental Protection Agency (EPA). EPA showcased its I-WASTE tool, a flexible, web-based, planning and decision-making tool to address disaster waste management issues. I-WASTE offers emergency responders, industry representatives, and responsible officials reliable information on waste characterization, treatment, and disposal options, as well as guidance on how to incorporate waste management into planning and response for natural disasters, terrorist attacks and animal disease outbreaks.

   The U.S. Department of Homeland Security (DHS). The DHS Science and Technology Directorate, the Feast, and Intel hosted a Hardware Hackathon in New York on October 10-11, 2014. The hackathon gathered together hardware-focused innovators to explore what could be created to help make our cities more resilient, and to prototype solutions in a local context in Red Hook, Brooklyn—a area which was still recovering from the destruction of Hurricane Sandy. Technologists and entrepreneurs had the opportunity to pilot their solutions in the Red Hook community and get their hardware to local stakeholders and gather insight and feedback in order to refine their prototypes into tools that address pressing needs.

   DHS also demonstrated its Next-Generation Incident Command System (NICS)—a collaborative, online incident-map capability that improves situational awareness for first responders in the field—to a group of more than 200 volunteer organizations. This situational awareness mapping tool is currently operational or being evaluated in 25 states across the country, as well as by international partners. Any credentialed responder can mark up the map, add data, or type a message on the interface.

   To date, NICS has been used for more than 300 live operational incidents since 2010, including wild land fires, floods, search and rescue, and special events. DHS
transitioned the ongoing operational maintenance of NICS to the NICS Users Group, a California-based group of more than 200 volunteer organizations representing the fire, law, and medical communities. DHS and the Zoonotic and Animal Disease Defense Center of Excellence also piloted the AgCONNECT suite of pluggable mobile and web-based desktop applications in 15 states and over 60 laboratories nationwide. To demonstrate how data aggregation and information sharing support business continuity during animal disease incidents, DHS piloted AgCONNECT to link agriculture industry and government officials to data sources through user-defined and access-controlled common operating pictures. The applications provide utility to the animal agriculture sector on a daily basis but have also been developed to assist animal health officials to prepare for and make available information to validated and accredited first responders.

**Airbnb.** Airbnb is partnering with the cities of San Francisco and Portland to encourage greater collaboration with regional disaster relief organizations and build city-resilience before, during, and after disasters. The partnerships pre-identify hosts for displaced persons and service workers when an emergency occurs, facilitate disaster and emergency-preparedness education, provide alerts via mobile and web technology, and cultivate hosts as trained leaders in their neighborhoods through community response training.

**Appallicious.** Appallicious launched the first demo of its Disaster Assistance and Assessment Dashboard (DAAD) to help communities and economies survive disaster. DAAD was initially developed as an outcome of the White House Office of Science and Technology Policy (OSTP) Safety Datapalooza, in collaboration with FEMA and the OpenFEMA Labs, to empower government and citizens to better assess and improve their pre-disaster resiliency. DAAD visualizes nearby environmental hazards, and allows local government to identify community resources, creating an economy that can better recover from within.

**The City of San Francisco and IDEO.** The City of San Francisco and IDEO launched the City72 Toolkit, an open-source, turnkey solution to enable communities to customize and build their own preparedness platforms. Modeled after SF72, San Francisco's emergency preparedness hub, the City72 Toolkit is designed for local
governments and allows any community to create an effective preparedness platform. The tool includes open source code that offers local governments and web developer's universal and free access to the City72 design, and provides universal redistribution of the design, including any improvements made by other communities or developers. The toolkit contains guides to help users create their own City72 site and a City72 content editor, as well as planning tips and resources based on San Francisco's experience developing SF72. Johnson County, Kansas is using the toolkit to launch their own JoCo72 today.

**International Association of Emergency Managers.** The International Association of Emergency Managers, representing more than 6,000 emergency management professionals worldwide, have agreed to share their tools event with emergency managers around the world.

**LDLN.** LDLN released Base Station Version 2.0, an open-source repository for data collection and synchronization. LDLN is a communications system providing field agents with inexpensive portable base stations and mobile apps to collect data and synchronize them with the rest of their organization, without relying on Internet, cell service, satellite uplink, or radio. Version 2.0 adds many useful tools for NGO and governmental organizations, including full end-to-end encryption to ensure survivor and employee security; web-socket syncing technology for faster and more consistent communication; and a new form builder tool, allowing agencies to customize the data they collect on-the-fly and in the field.

**Riskpulse.** Riskpulse developed a free weather-tracking application that aggregates and displays risk and weather information to enhance government use and decision making.

**Humetrix.** Humetrix provides an ICEBlueButton “In Case of Emergency” App for medical information and emergency contacts. ICEBlueButton is a smartphone “In Case of Emergency” (“ICE”) app that lets emergency responders immediately access an individual's important medical information and emergency contacts. ICEBlueButton can also send automatic email alerts to emergency contacts when the QR code is scanned, along with a map of the individual's location.
Microsoft. Microsoft has added the Yammer survivor network to its disaster response program's portfolio of rapidly deployable solutions for use in the wake of a disaster. Yammer's deployment in the wake of the Boston Marathon Bombings and Hurricane Sandy aims to connect and provide a support network for survivors and responders as they recover and rebuild.

The MITRE Corporation. The MITRE Corporation demonstrated three of its tools for disaster response and recovery operations. The Smart Phone Ad-hoc Networking (SPAN) project creates a framework for communication between individuals and external cell networks when typical infrastructure is unavailable; Sociocultural Analytics for the Global Environment (SAGE) provides near real-time understanding of online and social media sources to support rapid situational awareness and decision making during disaster response and recovery; and "Incident Command Net" enables first responders to share information using the OASIS Emergency Data Exchange Language (EDXL) standards to enhance situational awareness and command and control capabilities.

NPR Labs. NPR Labs developed an emergency-alerting system to provide timely and potentially life-saving emergency information to the 36 million Americans who are deaf and hard-of-hearing, using a battery-operated radio and Android tablet. The broadcast technology uses secure satellite and over-the-air broadcasts that are available regardless of power outages, Internet, or cellular-service limitations.

SeeClickFix. SeeClickFix is sharing its database of citizen requests for on-the-spot services (such as removal of fallen debris) to help generate clear and actionable data regarding the current state of infrastructure during and immediately after a natural disaster.

TaskRabbit. TaskRabbit announced a new mobile web interface, the TaskRabbit Needs for First Responders, which provides a safe and efficient marketplace to connect local service providers with those who need assistance. Using the interface, authorized individuals can post requests for help during a disaster and can connect to interested "taskers," pre-vetted volunteers who can assist them in real time on the ground.

Twilio. Twilio provides an open-source framework for developers to stand up
effective communications solutions during an emergency response. Without any on-site equipment or telecommunications expertise, Twilio’s Rapid Response Kit delivers nine tools that developers can mix, match, and customize to meet the changing communications needs of a response on the ground. Tools such as SMS-powered volunteer signup and survivor surveys, flexible push and pull conference calling, and rapid IVR phone tree configuration can provide developers a foundation for responding to events with effective communication.

The Weather Company. The Weather Company developed a localized alerting platform that will enable state, local, and private authorities to manage and distribute alerts. These alerts will go out via The Weather Channel and existing local distribution points, and incorporate NWS and existing IPAWS alerts. This tool aims to help local emergency managers evaluate if and how a severe weather event or non-weather situation will impact citizens; localize the alert with actionable messages to citizens geo-targeted to specific areas; and communicate the impact to millions of people immediately through websites, mobile devices, TV, radio, and regional locations via an API.

Appendix C  FEMA Disaster Response and Recovery Assistance

Individual Assistance. Individual Assistance (IA) programs help individuals and households recover from all hazards. These programs provide and/or coordinate emergency housing, financial and direct assistance, assistance to address other needs, disaster unemployment assistance, disaster legal services, crisis counseling, and disaster case management for disaster survivors. Information regarding FEMA’s individual assistance policies and doctrine are highlighted below (FEMA, 2015).

- Assistance for Privately Owned Access Routes
- Critical Needs Assistance for Displaced Individuals and Households
- Disaster Assistance for Childcare
- Disaster Assistance for Flood Damaged Basements
- Disaster Recovery Centers-Services and Providers
- Establishment Criteria for Disaster Recovery Centers
- Funeral Assistance
Long-Term Community Recovery. The Long Term Community Recovery (LTCR) program helps disaster-impacted communities in their recovery efforts by assisting communities in (1) collectively identifying their long-term recovery vision; and (2) identifying and coordinating resources and funding sources to support the long-term recovery vision. LTCR also builds federal, state, and local capacity for sustaining recovery efforts by facilitating partnerships for implementation of recovery activities and for use in future disasters. FEMA’s “Building a Long-Term Community Recovery Program” is described below (FEMA, 2015). Typically, there are 13 separate steps that comprise the Long-Term Community Recovery (LTCR) planning process. Some steps must be completed chronologically and others can be done concurrently (FEMA 2015). The typical LTCR steps are:

Step 1: Assessing the Need - Do we need long-term community recovery planning?
Step 2: Selecting an Overall Leader and Outlining a LTCR Program - Where do we begin?
Step 3: Securing Outside Support - Where can we get help?
Step 4: Establishing a Public Information Campaign - How do we keep the community informed and involved in the process?
Step 5: Reaching a Consensus - How do we secure community buy-in to move forward?
Step 6: Identifying the LTCR Issues - What are our opportunities?
Step 7: Articulating a Vision and Setting Goals - What will strengthen and revitalize our community?
Step 8: Identifying, Evaluating and Prioritizing the LTCR Projects - What makes a good project?
Step 9: Developing a Recovery Plan - How do we put it all together?
Step 10: Choosing Project Champions - Who will provide leadership for each project?
Step 11: Preparing a LTCR Funding Strategy - Where do we get the funding for these projects?
Step 12: Implementing the Plan - How do we make it all happen?
Step 13: Updating the Plan - When are we finished?

Each of the above steps is important in the overall process.

Public Assistance. The Public Assistance program provides assistance to state, tribal, and local governments, as well as certain private nonprofit organizations, to help repair and rebuild public infrastructure, and to help pay for the cost of debris removal and emergency protective measures. Information regarding FEMA's public assistance policies and doctrine are highlighted below (FEMA, 2015).

- Public Assistance Program Administration and Appeals: 9510
- 9510.1 Coordination Requirements for Public Assistance and Fire Management Assistance Program Documentation and Appendix

Applicant Eligibility: 9521
- 9521.1 Community Center Eligibility
- 9521.2 Private Nonprofit Museum Eligibility
- 9521.3 Private Nonprofit Facility (PNP) Eligibility
- 9521.4 Administering American Indian and Alaska Native Tribal Government Funding
- 9521.5 Eligibility of Charter Schools

Emergency Work: 9523
- 9523.1 Snow Assistance Policy
- 9523.2 Eligibility of Building Inspections in a Post-Disaster Environment
- 9523.3 Provision of Temporary Relocation Facilities
- Provision of Temporary Relocation Facilities - Waiver Request
- 9523.4 Demolition of Private Structures
- 9523.5 Debris Removal from Waterways
- 9523.6 Mutual Aid Agreements for Public Assistance and Fire Management Assistance
- 9523.7 Public Assistance Funding for Public Housing Facilities
• 9523.8 Mission Assignments for ESF #10
• 9523.9 100% Funding for Direct Federal Assistance and Grant Assistance
• 9523.10 Eligibility of Vector Control (Mosquito Abatement)
• 9523.11 Hazardous Stump Extraction and Removal Eligibility
• 9523.12 Debris Operations – Hand-Loaded Trucks and Trailers
• 9523.13 Debris Removal from Private Property
• 9523.15 Eligible Costs Related to Evacuations and Sheltering
• 9523.17 Emergency Assistance for Human Influenza Pandemic
• 9523.18 Host-State Evacuation and Sheltering Reimbursement
• Host State Policy Clarification Memorandum
• 9523.19 Eligible Costs Related to Pet Evacuations and Sheltering
• 9523.20 Purchase and Distribution of Ice

Restoration of Damaged Facilities: 9524
• 9524.1 Welded Steel Moment Frame Inspections
• 9524.2 Landslides and Slope Failures
• 9524.3 Rehabilitation Assistance for Levees and Other Flood Control Works
• 9524.4 Repair vs. Replacement of a Facility under 44 CFR §206.226(f) (The 50% Rule)
• 9524.5 Trees, Shrubs and Other Plantings Associated with Facilities
• 9524.6 Collections and Individual Object Eligibility
• 9524.7 Interim Welded Steel Moment Frame Policy for the Nisqually Earthquake Disaster
• 9524.8 Eligibility for Permanent Repair and Replacement of Roads on Tribal Lands
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• 9580.8 Eligible Sand Replacement on Public Beaches
• 9580.100 Fact Sheet: Mold Remediation
• 9580.101 2006 Special Community Disaster Loan Program
• 9580.102 Fact Sheet: Permanent Relocation
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• 9580.103 Fact Sheet: GSA Disaster Recovery Purchasing Program
• 9580.104 Fact Sheet: Public Assistance for Ambulance Services
• 9580.105 H1N1 Influenza Frequently Asked Questions (FAQs)
• 9580.106 Fact Sheet: Pandemic Influenza Fact Sheet
• 9580.107 Child Care Services
Appendix D  Response Planning Guidelines, Sample Disaster Response IT Plan, and Sendai Disaster Response Plan

Response Planning Guidelines. The actions taken in the initial minutes of an emergency are critical. A prompt warning to employees to evacuate, shelter or lockdown can save lives. A call for help to public emergency services that provides full and accurate information will help the dispatcher send the right responders and equipment. An employee trained to administer first aid or perform CPR can be lifesaving. Action by employees with knowledge of building and process systems can help control a leak and minimize damage to the facility and the environment.

The first step when developing an emergency response plan is to conduct a risk assessment to identify potential emergency scenarios. An understanding of what can happen will enable you to determine resource requirements and to develop plans and procedures to prepare your business. The emergency plan should be consistent with your performance objectives.

At the very least, every facility should develop and implement an emergency plan for protecting employees, visitors, contractors and anyone else in the facility. This part of the emergency plan is called “protective actions for life safety” and includes building evacuation (“fire drills”), sheltering from severe weather such as tornadoes, “shelter-in-place” from an exterior airborne hazard such as a chemical release and lockdown is protective action when faced with an act of violence.

When an emergency occurs, the first priority is life safety. The second priority is stabilization of the incident. There are many actions that can be taken to stabilize an incident and minimize potential damage. First aid and CPR by trained employees can save lives. Use of fire extinguishers by trained employees can extinguish a small fire.
Containment of a small chemical spill and supervision of building utilities and systems can minimize damage to a building and help prevent environmental damage.

Some severe weather events can be forecast hours before they arrive, providing valuable time to protect a facility. A plan should be established and resources should be on hand, or quickly, available to prepare a facility. The plan should also include a process for damage assessment, salvage, protection of undamaged property and cleanup following an incident. These actions to minimize further damage and business disruption are examples of property conservation.

**Sample Disaster Response IT Plan.** The following section details the elements in a DR plan in the sequence defined by ISO 27031 and ISO 24762.

Important: Best-in-class DR plans should begin with a few pages that summarizes key action steps, such as where to assemble employees if forced to evacuate the building and lists of key contacts and their contact information for ease of authorizing and launching the plan.

1. **Introduction.** Following the initial emergency pages, DR plans have an introduction that includes the purpose and scope of the plan. This section should specify who has approved the plan, who is authorized to activate it and a list of linkages to other relevant plans and documents.

2. **Roles and responsibilities.** The next section should define roles and responsibilities of DR recovery team members, their contact details, spending limits (for example, if equipment has to be purchased) and the limits of their authority in a disaster situation.

3. **Incident response.** During the incident response process, we typically become aware of an out-of-normal situation (such as being alerted by various system-level alarms), quickly assess the situation (and any damage) to make an early determination of its severity, attempt to contain the incident and bring it under control, and notify management and other key stakeholders.

4. **Plan activation.** Based on the findings from incident response activities, the next step is to determine if disaster recovery plans should be launched, and which ones in particular should be invoked. If DR plans are to be invoked, incident response activities can be scaled back or terminated, depending on
the incident, allowing for launch of the DR plans. This section defines the criteria for launching the plan, what data are needed and who makes the determination. Included within this part of the plan should be assembly areas for staff (primary and alternates), procedures for notifying and activating DR team members, and procedures for standing down the plan if management determines the DR plan response is not needed.

5. Document history. A section on plan document dates and revisions is essential, and should include dates of revisions, what was revised and who approved the revisions. This can be located at the front of the plan document.

6. Procedures. Once the plan has been launched, DR teams take the materials assigned to them and proceed with response and recovery activities as specified in the plans. The more detailed the plan is, the more likely the affected IT asset will be recovered and returned to normal operation. Technology DR plans can be enhanced with relevant recovery information and procedures obtained from system vendors. Check with your vendors while developing your DR plans to see what they have in terms of emergency recovery documentation.

7. Appendices. Located at the end of the plan, these can include systems inventories, application inventories, network asset inventories, contracts and service-level agreements, supplier contact data, and any additional documentation that will facilitate recovery.

8. Further activities. Once your DR plans have been completed, they are ready to be exercised. This process will determine whether they will recover and restore IT assets as planned. In parallel to these activities are three additional ones: creating employee awareness, training and records management. These are essential in that they ensure employees are fully aware of DR plans and their responsibilities in a disaster, and DR team members have been trained in their roles and responsibilities as defined in the plans. Also, since DR planning generates a significant amount of documentation, records management (and change management) activities should also be initiated. If your organization already has records management and change management programs, use them in your DR planning (Kirvan, 2011).

Sendai Disaster Response Plan. Sendai – Four years from the devastating
earthquake and tsunami that struck Japan, the country’s business sector has lived up to its reputation for resilience and shown clearly why disaster preparedness and response plans are important for recovery. The Great East Japan Earthquake and Tsunami of 11 March 2011 battered the city of Sendai, which has just hosted the World Conference on Disaster Risk Reduction, an event that offered a key opportunity to showcase the hazard-prone country’s ability to deal with a crisis and to build back better. The magnitude 9.0 quake, which was among the strongest recorded in more than a century, claimed over 18,000 lives, left almost 230,000 people temporarily homeless and caused damage worth billions of dollars.

Among the companies hit hard was Kirin Brewery, a leading Japanese beer and beverages maker. But the firm’s Sendai plant has also recovered rapidly. The reason: a disaster preparedness plan. Key elements of the plan included regular evacuation drills and building stockpiles of bottled water, hard dry biscuits and blankets for the 400 staff and people living in areas surrounding the plant, which is around 45 times the size of a football field. In addition, buildings already had top-floor rooftop evacuation sites and the plant’s machinery and fittings were fixed so as to lessen injuries and damage. The disaster plan was based on a hypothetical magnitude 6.0 earthquake, meaning that it faced a major challenge in 2011. Nor did it foresee a massive tsunami with an unprecedented amount of damage. When the earthquake struck, waves 7.6 meters high reached the nearby Sendai Port, subsequently flooding the brewery. Fortunately, the emergency drills paid off and all staff, visitors and neighborhood residents were safely evacuated.

On the business side, it was different. Products and equipment floated out of the factory premises. “The tsunami washed up approximately 70 million cans,” Mr. Noriya Yokota, the Executive Officer of Kirin’s Production and Quality Control Department, told participants in a study tour organized for delegates at the World Conference on Disaster Risk Reduction. All stored beer had to be disposed of due to a lack of temperature control. The disaster forced the plant to be closed temporarily. Business resumed, albeit only partially, in November 2011 when the company held a ceremony to mark its first post-disaster shipment. “It took us about one year to complete the restoration of the brewery,” added Mr. Yokota, who said the operation cost about six billion yen (US$50 million). Without the disaster resilience plan it would have taken far longer.

Like Japanese authorities, other businesses and the wider population, the brewery has
drawn lessons from the 2011 disaster. “We have strengthened our disaster preparedness level in case another tsunami strikes,” said Mr. Yokota. New preparedness measures include structural adjustments to defend the site against tsunami waves measuring 7.6 meters at low tide and 8.8 meters at high tide. Hand rails have been installed to secure the top floor evacuation sites and a broadcast facility set up. In addition, emergency stockpiles have been increased, with enough food for 700 evacuees to eat twice – they only had one meal in 2011. Other current supplies include food, water, lighting, power generators, fuel, blankets and televisions. An earthquake notification system that can detect primary waves and promptly activate an alarm system has also been installed. Backup generators that will operate in case of a power outage are in place to keep communication lines open. “Our priority is to save human lives by all means,” said Mr. Yokota. (Weru, Ann, April 7, 2015, United Nations Office for Disaster Risk Reduction, Hyogo Liaison Office (UNISDR Hyogo); United Nations Office for Disaster Risk Reduction, Regional Office for Asia and Pacific (UNISDR AP). For Additional information see http://www.unisdr.org/archive/43571)

Appendix E  Are European Cities at Risk?

In March 2015, E3G, an environmental organization published a report “Underfunded, underprepared, underwater? Cities at risk.” The report provided an updated analysis revealing how a lack of responsibility and funding will result in the majority of European cities being unprepared to respond to the worst impacts of climate change. Continued government inaction could result in the economic hubs of Europe facing billions of Euros in damages each year by the second half of the century (EG3, 2015).

With 78% of European citizens living in cities and 85% of the EU’s GDP being generated in these economic hubs, the importance of effective climate risk management cannot be overestimated. The infrastructure failures caused by hurricane Sandy in New York in 2012 and the huge economic costs induced by the eight meter-high floods witnessed in Dresden during the 2013 Elbe flooding give a preview of the complex failures that are becoming the “new normal” which cities must navigate( EG3, 2015).

Over the past three decades, Europe has seen a 60% increase in extreme weather events. In early 2014, flooding and winter storms caused an estimated €20bn in
economic damages in the UK alone. The 2003 summer heat wave caused between 55,000 and 70,000 deaths across Europe. Experts estimate that, unless action is taken now, economic costs to EU cities could reach over €190bn annually by 2070 (EG3, 2015).

However, despite will and best efforts, many cities are unable to protect themselves against these risks, as they are working on limited resources and with no guidance. Governments are shifting responsibility for climate risk management to city administrations, but do not provide them with powers to act. On the contrary, many cities have faced budget cuts from their central governments over the past five years (EG3, 2015).

The EG3 report proposes several solutions to address the current shortcomings. First and foremost, governments must be clearer on who is responsible for managing climate risks and ensure that national and regional infrastructure investments are consistent with a 2, 3 or 4°C warmer world. As part of this transition, new duties on public bodies must be introduced, and companies need to disclose the physical and economic risks from climate change to the public, their shareholders and their operations (EG3, 2015).
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Climate Change, Sustainable Development and Equity

Climate change involves complex interactions among climatic, environmental, economic, political, institutional, social, and technological processes. It cannot be addressed or comprehended in isolation of broader societal goals such as sustainable development and equity. In the United Nations Framework Convention on Climate Change (UNFCCC) three conditions are made explicit when working towards the goal of greenhouse gas (GHG) stabilization in the atmosphere (UNFCCC, 2011). The conditions are:

1. It should take place within a time frame sufficient to allow ecosystems to adapt naturally to climate change,
2. Food production is not threatened, and
3. Economic development should proceed in a sustainable manner.

Climate change is an inevitable and urgent global challenge with long term implications for the sustainable development of all countries. To eliminate or reduce the risk of climate change to human life and property, ideally both policy instruments and
technology must be used in the context of sustainable development and equity. This can mean examining issues such as equality, human rights, collective rights, and historical responsibility in relation to climate change.

The United Nations International Strategy for Disaster Reduction (UNISDR) office maintains that climate change adaptation should be a part of disaster risk reduction (UNISDR, 2004). The Intergovernmental Panel on Climate Change (IPCC) Working Groups affirm that mitigation and adaptation are necessary and complementary components of an effective response strategy to global warming. While all nations of the world are at risk, the developing countries, those with the least resources and capacity to adapt, are the most vulnerable. Mitigation, adaptation, sustainable development, and equity can and should be mutually reinforcing components of disaster risk and response strategies.

The term “sustainable development” was introduced into the language of international environmental diplomacy by the United Nations’ World Commission on Environment and Development in its widely circulated 1987 report, Our Common Future. Sustainable development referred to “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). The 1987 report, known as the Brundtland Commission Report, contained two key concepts: (1) needs to which overriding priority should be given, particularly to the world's poor, and (2) limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs (WCED, 1987). This view of sustainable development requires conservation of the resource itself, and not mere alleviation of immediate environmental harms. The resource base is comprehensive, including water, air, minerals, land, and all the complex interrelationships woven in ecology, including humans in their cultural and social systems. The Brundtland Commission Report emphasized reconciling global environmental protection, social welfare, and national economic development.

Subsequent definitions of sustainable development proliferated, but in practice it has come to mean development that achieves a balance among economic, environmental, and social objectives for present and future generations. Sustainable development requires that priority be given to maintaining the value of renewable resources and ecosystems more generally. It does not require that every tree harvested must be replaced, but it does not allow development to impair future output. It supports
activities that do not disadvantage future generations, and thus, it is a concept that advocates intergenerational equity. The optimal definition of sustainable development recognizes and incorporates the social, economic, and ecological objectives of multi-generations.

While the concept of sustainable development can be grasped at a conceptual level, it has proven more difficult to apply concretely. The Brundtland Commission Report advised that qualitative development must replace quantitative growth in achieving sustainable development. Underlying conditions that could promote the process were described. These include: (1) broad citizen participation, (2) an economic system that produces sustainable surpluses and technical knowledge, (3) systems and processes for resolving disputes, (4) a system of production based on preserving the ecological base, (5) international economic and social systems that foster sustainable trade and finance, and (6) a flexible administrative system (WECD, 1987).

The Brundtland Commission Report recognized, however, that even if all of these conditions were in place, the transition to a sustainable society would be difficult. Many existing institutions and practices would need to change. The report asserted that “painful choices have to be made. Thus, in the final analysis, sustainable development must rest on political will” (WCED, 1987). Clear paradigm shifts were identified as essential to sustainable development, but debate remained over the nature of these paradigm shifts and what they implied for the economic and social organization of a sustainable world (Caldwell, 1990).

The increasing evidence of the damaging impacts of climate change on this and future generations cannot be ignored. The 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report warned of changing weather patterns and rising sea levels due to accelerating GHG emissions from human activities (IPCC, 2007). The IPCC projected that by 2080, millions of people will be displaced due to sea level rise with densely-populated and low-lying countries, like many Small Island Developing States (SIDS), facing the greatest threat from storm surges and rising seas. Climate change has no boundaries and it is a fact that poor and developing countries, particularly the Least Developed Countries (LDCs), will be among those most adversely affected and least able to cope with the anticipated shocks to their social, economic and natural systems. For many countries a warming climactic system is expected to impact the availability of basic necessities like fresh water, food security, and energy.

The links between climate change and sustainable development are strong. The
short- and long term implications of climate change for the sustainable development of countries around the world call for a global response that is swift and exacting. The efforts to redress climate change both through adaptation and mitigation have informed and shaped the global development agenda. Internationally agreed upon frameworks and goals have set an agenda for integrating climate change and sustainable development.

Stockholm and Rio de Janeiro

The 1972 Conference on the Human Environment in Stockholm, Sweden and the 1992 UN Conference on the Environment and Development (UNCED), also known as the Earth Summit, in Rio de Janeiro, were significant events in the evolution of an international agenda, principles, and action plans for sustainable development, equity, and climate change.

Attended by 113 states and representatives from 19 international organizations, the 1972 Conference on the Human Environment in Stockholm, Sweden was the first truly international conference devoted exclusively to environmental issues. The major tenets of this conference were the basis of the 1987 Brundtland Commission Report, Our Common Future. It placed environmental issues on the global agenda, created a set of principles and an action plan for environmentally sound management, and led to the creation of the United Nations Environmental Program (UNEP). This conference played a catalytic role in promoting the subsequent adoption of international agreements concerned with ocean dumping, pollution from ships, and the endangered species trade (Cicin-Sain, 1993). It also adopted the "Stockholm Declaration on the Human Environment" which included forward looking principles, such as Principle 13, that declared the need for integration and coordination in development planning to allow for environmental protection (Matsui, 1995).

In December 1989, the United Nations General Assembly passed Resolution 44/228 that called for a conference that should "elaborate strategies and measures to halt and reverse the effects of environmental degradation in the context of increased national and international efforts to promote sustainable and environmentally sound development in all countries" (Chasek, 1994). In response, the UNCED (Earth Summit), was held in Rio de Janeiro, Brazil during the summer of 1992. This Earth Summit was an unprecedented historical event with the largest gathering of 114 heads of state,
10,000 representatives from 178 countries, and 1400 non-governmental organizations (NGOs) represented by additional thousands.

The two week Earth Summit was the climax of a process begun in December 1989, of planning, education, and negotiations among all member states of the United Nations. The conference "produced the Rio Declaration on Environment and Development; Agenda 21 (a voluminous list of suggestions on how to promote sustainable development, conserve resources and reduce energy costs); Forest Principles; the Convention on Biological Diversity and the Framework Convention on Climate Change" (UN, 1997). The Earth Summit influenced all subsequent UN conferences which have examined the relationships among human rights, population, social development, women and human settlements, and the need for environmentally sustainable development. The World Conference on Human Rights held in Vienna in 1993, for example, underscored the right of people to a healthy environment and the right to development, controversial demands that had met with resistance from some member states until the 1992 Earth Summit (UN, 1997).

**Agenda 21**

The commitment of leaders from around the world to sustainable development was clearly articulated in Agenda 21, the key document of the UNCED (Earth Summit). The "21" in Agenda 21 refers to the 21st Century. It is a wide-ranging blueprint for action to achieve sustainable development worldwide.

Agenda 21 has been affirmed and modified at subsequent UN conferences. It is a non-binding, voluntarily implemented action plan of the UN with regard to sustainable development. It is an action agenda for the UN, other multilateral organizations, and individual governments around the world that can be executed at local, national, and global levels (UN, 1992).

Agenda 21 activities are organized under environmental and development themes: quality of life, efficient use of natural resources, protection of the global commons, management of human settlements, and sustainable economic growth. Agenda 21 recognizes that the persistence of severe poverty in several parts of the world alongside a standard of living based on wasteful consumption of resources in other parts is not a sustainable model, and that environmental management must be practiced in developing and industrial countries alike. During the 1992 conference it was agreed that to implement Agenda 21, countries should prepare a national sustainable...
development strategy.

Agenda 21 addresses climate change under its Chapter 9 (Protection of the Atmosphere) and recognizes, "that activities that may be undertaken in pursuit of the objectives defined therein should be coordinated with social and economic development in an integrated manner, with a view to avoiding adverse impacts on the latter, taking into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty" (UN, 1992). The 300-page Agenda 21 document was made public at the UNCED (Earth Summit) in 1992, when 178 governments voted to adopt the program. The final text was the result of drafting, consultation, and negotiation beginning in 1989 and culminating at the two-week conference. It is divided into 40 chapters that have been grouped into 4 sections:

- **Section I: Social and Economic Dimensions** is directed toward combating poverty, especially in developing countries, changing consumption patterns, promoting health, achieving a more sustainable population, and sustainable settlement in decision making.
- **Section II: Conservation and Management of Resources for Development** includes atmospheric protection, combating deforestation, protecting fragile environments, conservation of biological diversity (biodiversity), control of pollution, and the management of biotechnology, and radioactive wastes.
- **Section III: Strengthening the Role of Major Groups** includes the roles of children and youth, women, NGOs, local authorities, business and industry, and workers; and strengthening the role of indigenous peoples, their communities, and farmers.
- **Section IV: Means of Implementation** includes science technology transfer, education, international institutions, and financial mechanisms.

In 1997, five years after the UNCED (Earth Summit), the UN General Assembly held a special session, informally referred to as Rio +5, to appraise the status of Agenda 21. The Assembly recognized progress as “uneven” and identified key trends including increasing globalization, widening inequalities in income, and continued deterioration of the global environment (See Appendix A). A new General Assembly Resolution (S-19/2) promised further action.

In September 2002, the World Summit on Sustainable Development (Earth Summit
2002, informally aka Rio +10) held in Johannesburg, South Africa, agreed upon the
Johannesburg Plan of Implementation (JPOI) affirming UN commitment to “full
implementation” of Agenda 21, alongside achievement of the Millennium Development
Goals (MDGs) and other international agreements.

In June 2013, twenty years after the UNCED (Earth Summit), the attending members
of the Rio +20 Conference on Sustainable Development reaffirmed their commitment
to Agenda 21 in their outcome document called “The Future We Want.” The conference
secured more than $500 billion and over 700 commitments to take action on sustainable
development initiatives. However, it “was characterized as ‘modest,’ primarily because
it failed to secure a Grand Bargain that the countries of the world would accept that
would identify specific actions and timelines to confront the devastating consequences
of climate change” (UNEP, 2012).

The path to a binding global climate pact has been long and tenuous but ever in
view. The UN Commission on Sustainable Development acts as a high level forum
on sustainable development and has acted as a preparatory committee for summits
and sessions on the implementation of Agenda 21. The UN Division for Sustainable
Development acts as the secretariat to the Commission and works “within the context
of” Agenda 21. Both Agenda 21 and the JPOI assert the leadership role of the UN in
advocating worldwide sustainable development, with the United Nations Convention on
Climate Change (UNFCCC) as the key instrument for addressing climate change.

The international Kyoto Protocol, which entered into force on February 16, 2005, set
binding emission reduction targets for industrialized countries for the first commitment
period 2008-2012. Later reports on the status and progress of Agenda 21’s climate
change environmental and development activities and initiatives followed the first
commitment period. Participating governments and organizations submitted written
comments and observations that were analyzed by the Intergovernmental Panel on
Climate Change (IPCC) for a Fourth Assessment Report (IPCC, 2013). The report was
delivered in stages, beginning with Working Group I’s report on the physical science
basis, based on 9,200 peer-reviewed studies (Nesbit, 2013; Readfearn, 2013). The IPCC
Fifth Assessment Report finalized in 2014 was developed through a scoping process
which involved climate change experts from all relevant disciplines, users of IPCC
reports, and in particular, representatives from governments. It is anticipated that the
Fifth Assessment Report will pave the way for a global, legally binding treaty on reducing
carbon emissions at the UN Climate Change Conference in Paris during late 2015.
Meeting in Lima

On December 14, 2014, at a meeting in Lima, Peru, after more than 36 straight hours of negotiations, top officials from nearly 200 nations came to an agreement committing every country in the world to reducing the fossil fuel emissions that cause global warming. The Lima Accord, as it is known, represents a breakthrough in the two-decade effort to forge a significant global pact to counter climate change. It is the first time that all nations, rich and poor, have agreed to cut back on the burning of oil, coal, and gas. The driving force behind the new agreement was not the threat of sanctions or other legal consequences. It was global peer pressure.

The strength of the Lima Accord is that every country pledged to put forward a plan to reduce emissions at home; the weakness is that there are no legally binding requirements that countries cut their emissions by any particular amount. This omission was to get every country to agree to the deal, including the U.S., historically the world's largest carbon polluter. With no language requiring the significant cuts scientists say are needed to stave off the costly effects of global warming, countries can put forth weak plans that amount to little more than business as usual. Countries can even choose to ignore the deal and submit no plan at all (Davenport, 2014). However, experts say by asking countries to put forward plans dictated by their own economies and domestic politics rather than a top-down mandate, the Lima Accord secured the agreement of every nation to some kind of carbon-cutting action.

Each nation agreed to enact domestic laws to reduce carbon emissions and put forth a plan by March 31, 2015 laying out how much each one will cut emissions after 2020, and what domestic policies it will pass to achieve the cuts. Countries that miss the March 2015 deadline are expected to report their plans by June. The plans from every country, known within the UN as “Intended Nationally Determined Contributions,” form the basis of a sweeping new deal to be signed in Paris in late 2015.

Climate Change as a Moral Imperative

As noted previously, sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Highlighted in the Brundtland Commission Report, sustainable development should be achieved with a balance among global environmental protection, social welfare, and national economic development, with special concern
over the needs of the world's poor. Addressing the impact of climate change in ways that do not disadvantage future generations or the poor and that promote intergenerational equity is essential and has become a moral imperative in the view of many world leaders.

A June 25, 2013 White House Press release detailing “President Obama’s Plan to Fight Climate Change,” announced that “President Obama believes we have a moral obligation to lead the fight against carbon pollution” (White House Press Release, June 25, 2013). In his State of the Union Address on January 28, 2014, President Barack Obama proclaimed that, “Climate change is a fact. And when our children’s children look us in the eye and ask if we did all we could to leave them a safer, more stable world, with new sources of energy, I want us to be able to say yes, we did” (White House Press release, January 28, 2014).

On October 16, 2014, Archbishop Bernardito Auza, the Vatican’s representative at UN headquarters in New York, in an address to a UN session on sustainable development emphasized that, “Climate change is not only an environmental question, it is also a question of justice and a moral imperative” (CWN, 2014). Archbishop Auza called particular attention to the concerns of small island nations that have reported that rising ocean levels could endanger their future. “This is paradoxical and unjust,” the archbishop said, “given that the primary factors of climate change, like high consumption and high-quantity greenhouse gas emissions, characterize highly industrialized societies” (CWN, 2014). Notably, Pope Francis has been outspoken on the issue of sustainability and climate change and in the summer of 2013, the Vatican sponsored a four-day meeting on “Sustainable Humanity, Sustainable Planet, Our Responsibility” (CWN, 2013).

On April 15, 2015, Catholic officials announced plans for a landmark climate change-themed conference - “Protect the Earth, Dignify Humanity. The Moral Dimensions of Climate Change and Sustainable Development” was hosted by Pope Francis at the Vatican on April 28, 2015, in concert with Pope Francis’ faith-rooted campaign to raise awareness about global warming. The conference brought together scientists, global faith leaders, and influential conservation advocates such as Jeffrey Sachs, Director of the UN Sustainable Development Solutions Network. UN Secretary General Ban Ki-moon delivered the opening address. The goal of the conference was to “build a consensus that the values of sustainable development cohere with values of the leading religious traditions, with a special focus on the most vulnerable” (Jenkins,
2015). The conference undoubtedly built momentum for the Pope's forthcoming encyclical on the environment, an influential papal document expected to be released in July of 2015. The Catholic Church has a long history of championing conservation and green initiatives, but Pope Francis has made climate change a fixture of his papacy (Jenkins, 2015).

**Climate Justice**

'Climate justice' is a term generally used for viewing climate change as an ethical issue. The causes and effects of climate change are considered in relation to the concept of justice, particularly environmental justice and social justice. The term is also used with reference to legal systems where justice is achieved through enacting and enforcing laws related to climate change that protect the common good.

The call for climate justice is a renewed grassroots response to the climate change crisis. This emerging movement is rooted in land-based and urban communities around the world that are already experiencing the impacts of global climate disruptions. Climate justice advocates contend that there is evidence of patterns of inequality and environmental injustice that permeate the daily life and threaten the current and future health and well-being of some of the poorest and most vulnerable people around the world (Walker, 2012). They recognize that those least responsible for climate change experience its greatest impacts.

Supporters of climate justice see the need to view interconnections between climate change impacts and related patterns of consumption and production. This perspective clearly reveals who benefits at the expense of others. The consequence is that for many already economically, politically, and environmentally marginalized groups, climate change presents compounding forms of injustice (Walker, 2012). Climate justice highlights the social justice and human rights dimensions of the climate change crisis using creative direct action to press for needed systemic changes.

Environmental justice groups in the U.S. and elsewhere have added climate change to their established campaign themes. They have developed programs to redress social injustices and inequities associated with climate change. These include the ‘Environmental Justice and Climate Change Initiative’ based in the U.S. which describes itself as a movement from the grassroots to address solutions to climate and energy problems that ensure the right of all people to live, work, play, and pray in safe, healthy,
and clean environments (Environmental Justice and Climate Change Initiative 2008). This initiative brings together environmental justice, climate justice, religious and policy networks to promote just and meaningful climate policy through leadership training and advocacy work.

In Canada, 'Just Earth' describes itself as a coalition for environmental justice focused on carbon mitigation. 'Just Earth' puts forward profiles of climate justice actions by individuals and organizations and a declaration calling for ambitious targets and commitments by the Canadian government. These activities are mobilized around climate justice as a "new social movement for atmospheric rights" (Pettit, 2004). Climate justice and environmental justice traditions share much in common, being concerned with questions of inequality and fairness (Angus, 2009).

Climate justice has provided the organizing framework for regional coalitions such as the Pan African Climate Justice Alliance, for groups traditionally focused on development such as Oxfam, and for religious groups such as the Catholic Agency for Overseas Development (CAFOD). CAFOD, previously known as the Catholic Fund for Overseas Development, is the Catholic aid agency for England and Wales. It is an international aid agency working to alleviate poverty and suffering in developing countries. It is funded by donations from the Catholic community in England and Wales, the British Government, and the general public. In April 2015, the CAFOD website urged everyone to join their One Climate, One World campaign because "Climate change is the biggest threat to people living in poverty" (www.cafod.org.uk, April 19, 2015).

Christian Aid chief executive Loretta Minghella said, "It is poor and marginalized people who are most vulnerable to the impact of climate change, suffering loss of their homes, jobs, crops – and even lives" (Malone, 2014). In 2014, the IPCC, the leading authority on climate science, published The Right Climate for Development: Why SDGs Must Act on Climate Change, warning that the impacts of climate change could cause poverty and conflict (IPCC, 2014). The report further cautioned that climate change is a threat to poverty reduction and sustainable development. IPCC advised that climate change, poverty eradication, and sustainable development cannot be tackled as separate entities, and argued instead, for a new set of Sustainable Development Goals (SDGs) that considers all of these factors interrelated and crucial. Numerous other studies have also acknowledged the link between climate change and climate justice issues, particularly as related to the basic needs of the poorest in the world.
2015 A Special Year for Climate Change and Sustainable Development

In February 2015, as the UN member states came together to launch the future sustainable development agenda, a former UN official remarked that “2015 seems set to be a year of momentous change for the international community” (UN, 2015). The year 2015 marked the end of implementation of the landmark UN Millennium Development Goals (MDGs) which world leaders agreed on in 2000 to address poverty and climate change and pave the way towards a more gender equal global society. The new targets, known as the Sustainable Development Goals (SDGs), define the way forward on the world’s most pressing issues until the next critical deadline in 2030.

Overall, there has been significant progress in meeting the MDGs. Global poverty has been halved well ahead of the 2015 deadline. In developing countries, 90 percent of children now enjoy primary education, the number of people lacking access to improved drinking water has halved, and the fight against malaria and tuberculosis has shown results (UN, 2015).

However, numerous challenges still persist. Worldwide, an estimated 805 million people are chronically undernourished. Since many persons with disabilities live in poverty, these two large populations overlap to a considerable extent, making food security an urgent need. Today’s generation of youth is the largest the world has ever known. Most of these young people live in developing countries and lack access to education and other services. Globally, an estimated 73 million young people are looking for work while many are trapped in exploitative jobs. In recent years, more than two and a half million more children in affluent countries fell into poverty, bringing the total above 76 million (UN, 2015). Further, children and adolescents are at risk and continue to bear the brunt of some of the world’s deadliest conflicts in the Central African Republic, Gaza, Syria, Iraq, and South Sudan. “Put simply, young people deserve a better deal,” UNDP chief, Helen Clark said. “And let's hope the post-2015 development agenda delivers that” (UN, 2015).

As the UN moves forward with the SDGs, questions inevitably arise. How will the SDGs and the post-2015 development agenda differ from its predecessor MDGs? What are the challenges that lie on the road ahead? And what is needed to make a new sustainable development agenda work?

Sir Richard Jolly, a former UN Assistant Secretary General, who also held senior
positions at the UN Children’s Fund (UNICEF) and the UN Development Program (UNDP), noted in the Human Development Report that while the MDGs had established an initial consensus on what the development goals for the 21st century should be, the SDGs remained “fundamentally” and “strategically” different (UN, 2015).

“The SDGs are universal, which is a major advance,” explained Jolly in an interview with the UN News Centre. “Instead of the North speaking to the South, we are now really recognizing that all countries need to take action for all peoples. Secondly, the SDGs are integrating sustainability and climate change. That again is a fundamental shift from the MDGs that I think was very important” (UN, 2015).

The 17 new SDGs, crafted by a working group of the 193 member UN General Assembly and expected to be adopted by world leaders in September 2015, placed sustainability and the battle against climate change to the forefront of the UN agenda. Twelve of the 17 goals underscore the importance of sustainable development in key areas, from urban planning to economic growth, while acknowledging the need to take “urgent action to combat climate change and its impacts” across the planet (UN, 2015). Jolly noted,

“With respect to climate change, the evidence is becoming so overwhelming that last year (2014) was the hottest year ever recorded in Britain and ever recorded in the world...Gradually, people are beginning to see these problems despite the naysayers. I think there is the recognition that some global action on climate change, though probably implemented nationally and with a rather weak international agreement, is going to happen” (UN, 2015).

In January 2014, the World Bank released a statement warning that climate change is a challenge for sustainable development in developing countries, and it “threatens to drag millions of people into grinding poverty” (World Bank, 2014). The World Bank stated it will take combined efforts of development banks, financial institutions, export credit agencies, institutional investors, and public budgets to meet the climate and development challenge. The World Bank affirmed support of the ‘Sustainable Energy for All’ goals of doubling both the rate of improvement of energy efficiency and the share of renewable energy in the global energy mix from 18 percent to 36 percent by 2030 (World Bank, 2014).

In early February 2015, the UN World Meteorological Organization (WMO) again confirmed that 2014 was the hottest year on record and part of a larger climate
trend of devastating weather patterns and increasing temperatures. Other extreme weather events battered the global community. High sea temperatures contributed to exceptionally heavy rainfall and floods in many countries and extreme drought in others. Twelve major Atlantic storms struck the United Kingdom in the early months of 2014, while floods devastated much of the Balkans throughout May. The monthly precipitation over the Pacific side of western Japan for August 2014 was 301 percent above normal, the highest since area-averaged statistics began in 1946 (UN, 2015).

At the same time, crippling droughts struck large swathes of the continental U.S., while north-east China and parts of the Yellow River basin did not reach half of the summer average rainfall, causing severe drought. The brutal reality of the changing global climate was brought into clearer perspective when the WMO also pointed out that 14 of the 15 hottest years recorded have all been in the 21st century. Given the rising levels of GHGs in the atmosphere and the increasing heat content of the oceans, this pattern of global warming is likely to persist into an even warmer future.

In addition, notwithstanding the gains made by the MDGs, economic problems continue to plague many countries across the globe and pose potential problems for the SDG roll-out. Currently, some 770 million people worldwide lack access to an improved water source and 2.5 billion lack access to basic sanitation. The UN has long urged countries to collaborate on increasing access to clean water and sanitation and to improve water management for irrigation and productive uses which have the potential of lifting millions out of poverty and hunger (UN, 2015). Still, with optimism Jolly contends that the continuing work to reach development goals has boosted awareness of poverty, prompting the need for national and international bodies to take action which was “positive.” Further, the SDGs and the MDGs have achieved significant progress that is impressive and important to recognize. Jolly considers it an “extraordinary positive” that climate change and sustainability are making people realize there is a single global system (UN, 2015).

In March 2015, at the World Conference on Disaster Risk Reduction (DRR) in Sendai, Japan, the session on ‘Climate Services and Applications for Disaster and Climate Risk Management in a Changing Environment’ organized by members of the Asian Disaster Preparedness Centre (ADPC), members of International Centre for Integrated Mountain Development (ICIMOD), and other panel members highlighted the importance of climate services and showcased applications that have been developed.
to reduce loss of lives and damage to property. ICIMOD is working with regional and international partners to address mountain development challenges and providing information services on a variety of topics like glaciers and snow dynamics, status of glacial lakes and GLOFs, regional flood outlook, disaster information management system, agriculture, forest fire detection and monitoring with Short Message Service (SMS) alerts, and community-based early warning system. ICIMOD demonstrated the importance and value of science and technology with examples of its products for improving climate services (ICIMOD, 2015).

Climate Change and Sustainable Development in the United States

Serious consideration of sustainable development in American political practice and public policy is relatively recent. Although recognition of its importance is widespread, efforts to translate its implicit principles into political practice have been uncoordinated and inconsistent. At the federal, state, regional, and local levels, however, accumulating evidence shows that many of the ideas advocated by proponents of sustainability are being applied, often experimentally, in different policy domains.

As early as 1993, the National Commission on the Environment, a prestigious group of private individuals including four former heads of the U.S. EPA, called for rethinking environmental policies and urged that “U.S. leadership should be based on the concept of sustainable development, and the merging of economic and environmental goals in the concept of sustainable development can and should constitute a central guiding principle for national environmental and economic policymaking” (PCSD, 1996).

In 1997, President Clinton took up the challenge by appointing a new President's Council on Sustainable Development. The council, consisting of some twenty-five leaders from industry, government, and the environmental community met over a period of six years and issued several reports. However, after 1997, the Republican-dominated Congress was indifferent or hostile to the idea of sustainability and the council's work was largely disregarded by other federal agencies. The EPA did introduce some new community-based environmental protection programs to encourage state and local governments to adopt sustainable development projects, and other departments attempted to define sustainability goals and to remediate environmental degradation caused by federal agencies including the Department of Defense (Prizzia, 2001).
The federal government continues to promote the concept of sustainable development through incremental modest innovations in its own structures, such as the Interagency Working Group on Sustainable Development Indicators and numerous study initiatives within virtually all major federal departments. For example, in 2002 and 2003 the EPA initiated several important reforms of innovative community-based approaches to environmental management that focus on citizen participation (Prizzia, 2004, 2005; Irvin, 2004). Several state governments in the U.S. have adopted environmental policy innovations in the management of hazardous waste. These state-sponsored, non-federally mandated initiatives to protect the environment support the general principles of sustainable development (Sapat, 2004).

Among federal agencies, the ecological precepts on which sustainability ideas are grounded are being tested and implemented by the major land management agencies—Bureau of Land Management, Forest Service, National Park Service, and Fish and Wildlife Service—through the development of ecosystem management. For the most part, however, prior to 2000, sustainable development was regarded as “someone else’s problem” and was not a priority, particularly at the national level (Bryner, 2000). Also, President George W. Bush did not support the concept of sustainable development, preferring instead the older concept of environmental “stewardship.” His policies assumed that scientific and technological advances brought about by global economic growth would allow humans to overcome or adapt to future environmental challenges. As in the Reagan Administration, environmental concerns were relegated to the margins of policymaking.

In fact, empirical evidence indicated that the U.S. did not fare well on measures of environmental sustainability during this period and it continues to lag behind other industrialized countries. One quantitative index, developed at Yale and Columbia Universities, ranked the U.S. 45th out of 146 countries studied in 2005—behind nations such as Japan, Germany, Russia, and even Botswana, Croatia, and Estonia (Esty, 2005). Further, the fact that the U.S. did not ratify international environmental treaties such as the Stockholm Convention on the Law of the Sea (1982), the Basel Convention on trans-boundary movement of hazardous wastes (1989), the Kyoto Protocol (1997), the Convention on Biological Diversity (1992) and its Biosafety Protocol (2000), did not speak well of U.S. global environmental stewardship.

President George W. Bush’s rejection of the Kyoto Protocol, which entered into effect on February 16, 2005, isolated the U.S. from virtually the rest of the world on climate
change diplomacy. More than 140 other nations have ratified the protocol, including all other industrialized nations. Moreover, the U.S. attempted to block negotiations on targets for further GHG reductions following the end of the first five year commitment period of the Kyoto Protocol in 2012.

Several climate change bills have been introduced in the U.S. Congress. The Climate Stewardship Act of 2003, sponsored by Senators Joseph Lieberman (Democrat, Connecticut) and John McCain (Republican, Arizona), failed to pass by a 43-55 vote on October 30, 2003. When similar bipartisan legislation was considered again in the 109th Congress (2005-2007), an agreement was reached to cap GHG emissions from electricity generation, transportation, industrial, and commercial sectors in the U.S. at 2000 levels in 2010 and at 1990 levels in 2016.

The European Union created a cap-and-trade program covering about half of its industrial carbon dioxide emissions, beginning in 2005. Because many multinational corporations are subject to these and other national restrictions (e.g. in Japan and China), pressure continues to mount for a similar U.S. system that might be linked to an international trading regime in the future. However, many state and local governments in the U.S. took actions to stem GHG emissions without waiting for the federal government to act (Sanders, 2005; PCGCC, 2005).

The governments of many countries, particularly those associated with the Organization for Economic Cooperation and Development (OECD), have adopted many of the international standards for sustainable development in their national strategies and practices. However, the U.S. remains one of the few OECD countries that does not have a national sustainable strategy. The U.S. instead adopted a decentralized approach and emphasized public/private sustainable development partnerships to promote economic growth, social development, and environmental "stewardship" (EEAC, 2005).

The U.S. agreed along with all of the other UN member states to develop and implement a National Strategy for Sustainability, first during the Earth Summit Conference in Rio de Janeiro in 1992, and then again during the World Summit on Sustainable Development in Johannesburg in 2002. The 2002 World Summit urged all countries to make progress in formulating national strategies for sustainable development and also "to begin their implementation by 2005" (NSSD, 2013). President Bill Clinton established a President's Council on Sustainable Development that met for six years during the 1990s and developed a series of reports and recommendations for creating a more sustainable America. As of 2010, a Director of Sustainable Development
in the U.S. Department of Agriculture had a mission of advancing the principles and goals of sustainable development through partnerships, collaboration, and outreach.

Most of the sustainable development recommendations for the U.S. that were made were not implemented. A number of Working Groups wrote to the Obama Administration urging it to develop and implement a viable National Strategy for Sustainability. Recommendations and guidelines were developed and published for how such a strategy ought to be developed, including by the Organization for Economic Cooperation and Development (OECD), International Union for Conservation of Nature (IUCN), and the United Nations. President Obama's Climate Action Plan of 2013 and his 2015 Executive Order 13693 - Planning for Federal Sustainability in the Next Decade - complied with many of the recommendations of these international organizations. However, “A national sustainable development strategy is not simply a document, rather it is a continuing and adaptive process of strategic and coordinated action” (NSSD, 2013).

**Government Regulations, Practices, and Policy:** In February 2002, the U.S. government announced a strategy to reduce GHG emissions by 18% over a 10-year period from 2002-2012. This policy involves reducing emissions through technology improvements and dissemination, improving the efficiency of energy use, voluntary programs with industry, and shifts to cleaner fuels. Other U.S. and international policies such as the Climate Change Science Program and the Climate Change Technology Program have been reinstated with a comprehensive objective of reducing GHG emissions through international cooperation. As the U.S. and other governments of the world continue to understand and acknowledge the threat of global warming to our livelihood, we are closer to reducing GHGs to a manageable size.

A series of Executive Orders (EO) were enacted including EO 13423: Strengthening Federal Environmental, Energy, and Transportation Management of 2007, which set policy and specific goals for federal agencies to conduct their environmental, transportation, and integrated, energy-related activities under the law in support of their respective missions in an environmentally, economically and fiscally sound, continuously improving, efficient, and sustainable manner. This was followed by EO 13514 in 2009 which enhanced EO 13423 and established an integrated strategy towards sustainability in the federal government and made reduction of GHG emissions a priority for federal agencies.

In March 2015, President Obama signed EO 13693: Planning for Federal
Sustainability in the Next Decade which revoked multiple prior EOs and memoranda including EO 13423 and EO 13514. Executive Order 13693 outlined forward-looking goals for federal agencies in the areas of energy, climate change, water use, vehicle fleets, construction, and acquisition (See Appendix B).

The latest information from federal agencies relevant to developing and maintaining sustainable facilities and to developing and promoting sustainable practices within their environmental programs can be found at the Federal Government Sustainability website (See Appendix B). Leading the way to a Green America, the Environmental Protection Agency (EPA) is implementing a wide range of programs to reduce the environmental impact of its facilities and operations, from building new, environmentally sustainable structures to improving the energy efficiency of older buildings.

**Role of the Environmental Protection Agency (EPA)**

The origin of the Environmental Protection Agency (EPA) is related to the Clean Air Act which is a “United States federal law designed to control air pollution on a national level” (EPA, 2014). The Clean Air Act (CAA) of 1963 was the first federal legislation to actually address ‘controlling’ air pollution by establishing a federal program within the U.S. Public Health Service for this purpose and authorizing research into techniques for monitoring and controlling air pollution. The Air Quality Act of 1967 expanded the purview of the federal government by authorizing investigation into enforcing regulations and research into monitoring, inventoring, and controlling pollution. Subsequent major amendments to the CAA requiring regulatory controls to protect the public from airborne contaminants were passed in 1970, 1977, and 1990, each expanding the role and authority of the federal government. Of note, the CAA was the first U.S. environmental law that included the provision for citizen suits. To integrate, coordinate, and institutionalize the efforts and goals of the CAA, “The Environmental Protection Agency was established on December 2, 1970 for the purpose of consolidating pertinent federal research, monitoring, standard-setting and enforcement activities into one agency that ensures environmental protection” (EPA, 2014).

In 2009, EPA determined that long-lived GHG emissions that build up in the atmosphere severely threaten public health and welfare, particularly among the young, elderly, and poor (USGCRP, 2009). Scientific literature has repeatedly confirmed the
lethal serial effects of GHG pollution from increases in ground-level ozone pollution (CCSP, 2008) to the potential spread of some waterborne and pest-related diseases and increased production or dispersion of airborne allergens (Confalonieri et al., 2007). In May 2010, an assessment by the National Research Council (NRC) the operating arm of the National Academy of Sciences, concluded that “climate change is occurring, is caused largely by human activities, and poses significant risks for – and in many cases is already affecting – a broad range of human and natural systems” (NRC, 2010). The NRC and other scientific bodies have emphasized the urgency of reducing GHGs without delay because, once emitted, GHGs persist in the atmosphere for long time periods. The NRC explained in a recent report, “The sooner that serious efforts to reduce greenhouse gas emissions proceed, the lower the risks posed by climate change, and the less pressure there will be to make larger, more rapid, and potentially more expensive reductions later” (NRC, 2011).

Under the Clean Air Act, EPA is taking initial steps to limit GHG pollution from large sources:

- EPA and the National Highway and Traffic Safety Administration between 2010 and 2012 issued the first national GHG emission standards and fuel economy standards for cars and light trucks, and for medium- and heavy-duty trucks.
- In 2011, EPA and states began requiring preconstruction permits that limit GHG emissions from large new stationary sources such as power plants, refineries, cement plants, and steel mills when they are built or undergo major modification.
- In September 2013, EPA proposed carbon pollution standards for new power plants built in the future and kicked off the process of engagement with states, stakeholders, and the public to establish carbon pollution standards for existing power plants.

On June 25, 2013, the President announced his plan to cut carbon pollution and prepare the U.S. for the impacts of climate change. The U.S. government has partnered with representatives of other nations to promote worldwide reductions in global pollutants. In addition, EPA works with various public and private sector partners in programs to reduce GHGs in ways that reduce energy use and save industries and consumers money.

While overall emissions of hazardous air pollutants (e.g., benzene, found in gasoline; perchloroethylene, emitted from some dry cleaning facilities; methylene chloride, used as a solvent and paint stripper; dioxin, asbestos, and metals such as cadmium,
mercury, chromium, and lead compounds) have declined significantly since 1990, substantial quantities of toxic pollutants continue to be released into the air. Hazardous air pollutants include 187 pollutants listed in the Clean Air Act. EPA can add pollutants that are known or suspected to cause cancer or other serious health issues such as reproductive effects or birth defects, or to cause adverse environmental effects. Benzene and formaldehyde are two of the biggest cancer risk drivers and acrolein tends to dominate non-cancer risks. Most air toxics originate from human-made sources, including mobile sources such as motor vehicles, industrial facilities, and small “area” sources. Numerous categories of stationary sources emit air toxics including power plants, chemical manufacturing, aerospace manufacturing, and steel mills. Some air toxics are released in large amounts from natural sources such as forest fires.

EPA's 2005 national assessment of inhalation risks from air toxics estimated that the whole nation experiences lifetime cancer risks above ten in a million, and that almost 14 million people in more than 60 urban locations have lifetime cancer risks greater than 100 in a million (EPA, 2005). Elevated risks are often found in the largest urban areas where there are multiple emission sources, communities near industrial facilities, and/or areas near large roadways or transportation facilities. Since the 2005 assessment, EPA standards have required significant further reductions in toxic emissions.

**EPA Role with States and Communities to Reduce Toxic Air Pollution:** EPA standards based on technology performance have been successful in achieving large reductions in national emissions of air toxics. As directed by Congress, EPA has completed emissions standards for all 174 major source categories, and 68 categories of small area sources representing 90 percent of emissions of 30 priority pollutants for urban areas. In addition, EPA has reduced the benzene content in gasoline and has established stringent emission standards for on-road and non-road diesel and gasoline engine emissions that significantly reduce emissions of mobile source air toxics. As required by the Clean Air Act, EPA has completed 23 residual risk assessments and technology reviews covering over 40 regulated source categories to assess whether more protective air toxics standards are warranted. EPA has updated standards as appropriate. Additional residual risk assessments and technology reviews are currently underway.

EPA also encourages and supports area-wide air toxic strategies of state, tribal, and local agencies through national, regional, and community-based initiatives. The initiatives include the National Clean Diesel Campaign, which through partnerships and grants reduce diesel emissions for existing engines that EPA does not regulate;
Clean School Bus USA, a national partnership to minimize pollution from school buses; the Smartway Transport Partnership to promote efficient movement of goods; wood smoke reduction programs; a collision repair campaign involving auto body shops; community-scale air toxics ambient monitoring grants; and other programs such as the Community Action for a Renewed Environment (CARE). The CARE program helps communities develop broad-based local partnerships that include business and local government to conduct community-driven problem solving as they build capacity to understand and take effective actions that address environmental problems.

**Air Pollution Challenges: Protecting the Stratospheric Ozone Layer:** The ozone (O3) layer in the stratosphere protects life on Earth by filtering out harmful ultraviolet (UV) radiation from the sun. When chlorofluorocarbons (CFCs) and other ozone-degrading chemicals are emitted, they mix with the atmosphere and eventually rise to the stratosphere. There, the chlorine and bromine they contain start chemical reactions that destroy ozone. This destruction has occurred at a more rapid rate than ozone can be created through natural processes, depleting the ozone layer.

Higher levels of UV radiation reaching the Earth's surface lead to health and environmental effects such as a greater incidence of skin cancer, cataracts, and impaired immune systems. Higher levels of UV radiation also reduce crop yields, diminish the productivity of the oceans, and possibly contribute to the decline of amphibious populations that is occurring worldwide.

In observance of an international treaty known as the Montreal Protocol, countries around the world are phasing out the production of ozone depleting substances (ODS) that destroy ozone in the Earth's upper atmosphere. Under provisions of the CAA enacted to implement the Montreal Protocol, the U.S. already has phased out production of those substances having the greatest potential to deplete the ozone layer. These chemicals include chlorofluorocarbons (CFCs), halons, methyl chloroform and carbon tetrachloride. The U.S. and other countries are currently phasing out production of hydrochlorofluorocarbons (HCFCs), chemicals used globally in refrigeration and air-conditioning equipment and in making foams. Phasing out CFCs and HCFCs is beneficial in protecting the Earth's climate as these substances are damaging GHGs.

Under the Clean Air Act, EPA implements regulatory programs to:
- ensure that refrigerants and halon fire extinguishing agents are recycled properly,
- ensure that alternatives to ODS are evaluated for their impacts on human health
and the environment,

- ban the release of ozone depleting refrigerants during the service, maintenance, and disposal of air conditioners and other refrigeration equipment, and
- require that manufacturers label products either containing or made with the most harmful ODS.

These vital measures are helping to protect human health and the global environment, but the work of protecting the ozone layer is not finished. EPA plans to complete the phase-out of ODS that continue to be produced and bolster efforts to minimize releases of ODS still in use. Since ODS persist in the air for long periods of time, the past use of these substances continues to affect the ozone layer today. To expedite the recovery of the ozone layer EPA plans to:

- educate the public, especially children, on how to protect themselves from excess exposure to UV radiation through the SunWise program,
- foster domestic and international partnerships to protect the ozone layer, and
- encourage the development of products, technologies, and initiatives that reap co-benefits in climate change and energy efficiency.

**President Obama’s Climate Change Adaptation Plans and Sustainability Plans**

As part of President Obama’s Climate Action Plan, federal agencies have developed plans for reducing their GHG emissions and are preparing for climate change impacts such as flooding, sea level rise, severe weather, and temperature extremes. The agencies’ Climate Change Adaptation Plans and Sustainability Plans comply with the President’s Executive Order on Environmental, Energy and Economic Performance which set aggressive energy, climate, and environmental targets for federal agencies. In their plans, federal agencies detail how their actions have already reduced the federal government’s direct emissions by more than 17 percent since 2008 – the equivalent of permanently taking 1.8 million cars off the road.

To recognize extraordinary achievement in pursuit of the President’s federal sustainability goals, the White House presents GreenGov Presidential Awards each year honoring federal agency teams and individuals who take innovative approaches to curbing waste, reducing energy use, and saving taxpayer money in federal agency operations. To solicit the best ideas for new climate and sustainability initiatives from
the federal community, the White House launched the GreenGov Challenge, an online tool for federal employees from across the country to suggest and vote on ideas for new ways to meet the President's sustainability goals.

**Climate Change Adaptation Plans:** When he laid out his Climate Action Plan to cut carbon pollution, prepare communities for the impacts of climate change, and lead international efforts to reduce GHG emissions, the President reiterated his commitment for the federal government to lead by example. The climate change impacts that strike communities across the country – ranging from more severe droughts and wildfires to record heat waves and damaging storms – also affect federal facilities, operations, and resources. The President directed agencies to assess their vulnerabilities to these impacts in Climate Change Adaptation Plans and outline how they will protect federal programs and taxpayer investments. Thirty-eight agencies ranging from the Department of Justice to the Department of the Interior released plans detailing how climate change is expected to affect their missions and operations. Examples include:

- The Department of Defense found that climate change is a national security "threat multiplier" that could exacerbate global challenges from infectious disease to terrorism; that coastal military installations are vulnerable to rising sea levels and increased flooding; and that droughts, wildfires, and more extreme temperatures could endanger training activities.
- The National Park Service reported that climate change is already affecting its ability to conserve park resources and that climate change will fundamentally alter iconic features of parks. Glacier National Park has lost more than 83 percent of its glaciers since 1850, and experts predict the remaining glaciers will disappear as soon as 2030. In other locations, the effects of climate change such as temperature extremes and sea level rise may impact park accessibility, safety, and visitor experiences.
- The Department of Agriculture estimated an increase of as much as 100 percent in the number of acres burned by wildfires annually by 2050, putting residents and firefighting employees at greater risk, further impacting the agency's budget and resources, and reducing its capacity to provide other critical services. Fire suppression funding has already grown from 16 percent in 1995 to 42 percent of the U.S. Forest Service's budget.
- The Department of Health and Human Services considers climate change to
be one of the top public health challenges of our time. It will increase the risk from diseases and conditions such as heart and lung ailments, allergies and asthma, and alter the transmission of food and waterborne diseases. Its greatest impact will be on people whose health status is already at risk and who have the fewest resources to address or adapt to climate change risks. Hazards linked to climate change also include more severe climate-related extreme weather events potentially disrupting continuity of care and access to essential health and human services.

- The Postal Service is concerned that increased flooding, rising sea levels, more intense weather events, and changes in temperature and precipitation patterns could disrupt its ability to provide mail service and increase costs for maintaining infrastructure. These concerns could jeopardize delivery to Postal Service customers and the safety of the nearly 500,000 USPS employees who deliver mail and perform other critical tasks.

- NASA found that 66 percent of its assets located along America’s coasts are within 16 feet of mean sea level, and its facilities are currently threatened by beach erosion that will accelerate with sea level rise and increased storm intensity. Additionally, electrical black-outs and brown-outs associated with heat waves threaten energy utilities that power NASA facilities that receive and process data from space.

The agencies’ plans outline steps they will take to address their areas of vulnerability, protect their programs, and incorporate climate change considerations into their decision-making. The plans include work by the Department of Commerce to stimulate new technologies and initiatives to build resilience in American communities; efforts by the General Services Administration to identify and address vulnerabilities in agencies’ data center, telecommunications equipment and services supply chains; an initiative by the Department of Housing and Urban Development (HUD) to require higher flood elevation for HUD-funded hospitals, housing, and other vital community resources; and work by the Centers for Disease Control and Prevention to release case studies from state and city health departments that have conducted climate vulnerability assessments. Agencies are also working to factor resilience to the effects of climate change into grant-making and investment decisions and in the design and construction of new and
existing agency facilities and infrastructure.

The current agencies' Climate Change Adaptation Plans build on the first set of plans which was released in February 2013, and respond to a November 2013 Executive Order on Preparing the U. S. for the Impacts of Climate Change that established requirements for updating and reporting on progress made on agencies' adaptation plans.

**Sustainability Plans:** To do its part to help prevent the worst impacts of climate change, as the largest energy user in the nation, the federal government must lead by example to reduce its GHG emissions. In 2010, the President set a goal for the federal government to reduce its direct GHG emissions by 28 percent by 2020. The federal government is on track to meet that goal having already reduced its GHG emissions by 17 percent. In their Fiscal Year 2015 Sustainability Plans, federal agencies outline the actions they will take to continue their progress. Examples include:

- EPA will reduce heating and cooling loads at its labs and further save energy by converting from constant to variable air flow systems that respond to ventilation demand.
- The General Services Administration will implement innovative energy conservation measures such as reducing nighttime base loads on buildings, including external lighting, and validating established building temperature settings.
- The Federal Bureau of Investigation will issue sustainable design and construction specifications that require new buildings to exceed current standards by 30 percent where cost effective.
- The Department of Veterans Affairs will complete updates to data collection systems to provide accurate estimates of GHG emissions and help facilities better understand emissions management.

The Sustainability Plans also outline how agencies are meeting additional water, energy and waste targets. Overall, the federal government has already reduced its water use by 19 percent since 2007, ahead of schedule to meet a goal of 26 percent by 2020, and is now getting more than 9 percent of its energy from renewable sources – exceeding the goal of 7.5 percent and on track for a new goal set by the President last year of 20 percent renewable energy use by 2020.

Agencies are required to update their Sustainability Plans annually under the President's 2009 Executive Order on Environmental, Energy and Economic Performance.
President Obama’s Climate Action Plan:

- Directs EPA to work closely with states, industry and other stakeholders to establish carbon pollution standards for both new and existing power plants;
- Makes up to $8 billion in loan guarantee authority available for a wide array of advanced fossil energy and efficiency projects to support investments in innovative technologies;
- Directs DOI to permit enough renewables projects—like wind and solar—on public lands by 2020 to power more than 6 million homes; designates the first-ever hydropower project for priority permitting; and sets a new goal to install 100 megawatts of renewables in federally assisted housing by 2020, while maintaining the commitment to deploy renewables on military installations;
- Expands the President’s Better Building Challenge, focusing on helping commercial, industrial, and multi-family buildings cut waste and become at least 20 percent more energy efficient by 2020;
- Sets a goal to reduce carbon pollution by at least 3 billion metric tons cumulatively by 2030—more than half of the annual carbon pollution from the U.S. energy sector—through efficiency standards set over the course of the Administration for appliances and federal buildings;
- Commits to partnering with industry and stakeholders to develop fuel economy standards for heavy duty vehicles to save families money at the pump and further reduce reliance on foreign oil and fuel consumption post-2018; and
- Leverages new opportunities to reduce pollution of highly potent GHGs known as hydrofluorocarbons; directs agencies to develop a comprehensive methane strategy; and commits to protect our forests and critical landscapes.

(White House Press release, June 25, 2013. For a more complete list of actions of the Climate Action Plan see Appendix C)

Questions for Review

1. What is sustainable development? Provide at least 3 examples.
2. How is climate change related to sustainable development? Describe and explain how they are related and provide at least 3 examples.
3. What is the significance of the conferences at Stockholm and Rio de Janerio for sustainable development and climate change? Explain by providing provisions of the agreements reached at each conference.
4. What is Agenda 21? How does Agenda 21 address the issues of sustainable development and climate change? Explain and provide examples.

5. Why have some world leaders referred to the impact of climate change as a moral imperative? Explain and provide examples.

6. What is climate justice? Explain and provide examples.

7. Has sustainable development been a priority in the United States at the national level over the past 20 years? Explain and provide examples?

8. Has climate change been a priority in the United States at the national level over the past 20 years? Explain and provide examples?

9. What is the role of the EPA in addressing the issues of sustainable development and climate change? Explain and provide examples?

10. What do you believe are the 3 most important actions of President Obama's Climate Action Plan? Explain and provide examples.

Appendix A The Climate Divide:
Rich Nations find it Easier to Adapt

Over the last few decades, as scientists have intensified their studies of the human effects on climate and of the effects of climate change on humans, a common theme has emerged: in both respects, the world is a very unequal place.

In almost every instance, the people most at risk from climate change live in countries that have contributed least to the atmospheric buildup of carbon dioxide and other greenhouse gases linked to the recent warming of the planet.

Those most vulnerable countries also tend to be the poorest. And the countries that face the least harm - and are best equipped to deal with the harm they do face - tend to be the richest. To advocates of unified action to curb greenhouse gases, this growing realization is not welcome news. “The original idea was that we were all in this together, and that was an easier idea to sell,” said Robert Mendelsohn, an economist at Yale University. “But the research is not supporting that. We’re not in it together.”

The large industrialized countries are more resilient partly because of geography; they are mostly in mid-latitude regions with Goldilocks climates - neither too hot nor too cold. Many enjoy gifts like the thick rich soil and generous growing season of the American corn belt or the forgiving weather of France and New Zealand.
But a bigger factor is their wealth - wealth built at least partly on a century or more of burning coal, oil and the other fossil fuels that underlie their mobile, industrial, climate-controlled way of life. The United States, where just 4 percent of the economy is in agriculture, can endure a climatic setback far more easily than a country like Malawi, where 90 percent of the population is rural and where about 40 percent of the economy is driven by rain-fed agriculture.

As big developing countries like China and India climb out of poverty, they emit their own volumes of greenhouse gases; China is about to surpass the United States in annual emissions of carbon dioxide. But they remain a small fraction of the total human contribution to the atmosphere's natural heat-holding greenhouse effect, which is cumulative because of the long-lived nature of carbon dioxide and some other heat-trapping gases. China may be a powerhouse now, but it has contributed less than 8 percent of the total emissions of carbon dioxide from energy use since 1850, while the United States is responsible for 29 percent and Western Europe 27 percent.

Disparities like these have prompted a growing array of officials in developing countries and experts on climate, environmental law and diplomacy to insist that the first world owes the third world a climate debt.

"We have an obligation to help countries prepare for the climate changes that we are largely responsible for," said Peter Gleick, a co-founder of the Pacific Institute for Studies in Development, Environment and Security in Berkeley, California. Around the world, there are abundant examples of how wealth is already enabling some countries to gird against climatic and coastal risks while poverty, geography and history are placing some of the world's most crowded, vulnerable regions directly in harm's way.

Climate change and a deteriorating environment is a key challenge to sustainability, bio-diversity, food security and stability across Africa. Pollution, deteriorating soil quality, desertification and poor air quality are threatening the lives and futures of all of the continent's people. (Reference: Andrew C. Revkin, Published: Monday, April 2, 2007, Climate Progress)

**Appendix B Executive Order 13693-**
Planning for Federal Sustainability in the Next Decade

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to maintain Federal leadership in sustainability and greenhouse gas emission reductions, it is hereby ordered as follows:

Section 1. Policy. Executive departments and agencies (agencies) have been among our Nation’s leaders as the United States works to build a clean energy economy that will sustain our prosperity and the health of our people and our environment for generations to come. Federal leadership in energy, environmental water, fleet, buildings, and acquisition management will continue to drive national greenhouse gas reductions and support preparations for the impacts of climate change. Through a combination of more efficient Federal operations such as those outlined in this Executive Order (order), we have the opportunity to reduce agency direct greenhouse gas emissions by at least 40 percent over the next decade while at the same time fostering innovation, reducing spending, and strengthening the communities in which our Federal facilities operate.

It therefore continues to be the policy of the United States that agencies shall increase efficiency and improve their environmental performance. Improved environmental performance will help us protect our planet for future generations and save taxpayer dollars through avoided energy costs and increased efficiency, while also making Federal facilities more resilient. To improve environmental performance and Federal sustainability, priority should first be placed on reducing energy use and cost, then on finding renewable or alternative energy solutions. Pursuing clean sources of energy will improve energy and water security, while ensuring that Federal facilities will continue to meet mission requirements and lead by example. Employing this strategy for the next decade calls for expanded and updated Federal environmental performance goals with a clear overarching objective of reducing greenhouse gas emissions across Federal operations and the Federal supply chain.

Sec. 2. Agency Greenhouse Gas Emission Reductions. In implementing the policy set forth in section 1 of this order, the head of each agency shall, within 90 days of the date of this order, propose to the Chair of the Council on Environmental Quality (CEQ) and the Director of the Office of Management and Budget (OMB) percentage reduction targets for agency-wide reductions of scope 1 and 2 and scope 3 greenhouse gas emissions in absolute terms by the end of fiscal year 2025 relative to a fiscal year 2008
baseline. Where appropriate, the target shall exclude direct emissions from excluded vehicles and equipment and from electric power produced and sold commercially to other parties as the primary business of the agency. The proposed targets shall be subject to the review and approval of the Chair of CEQ in coordination with the Director of OMB under section 4(b) of this order.

Sec. 3. Sustainability Goals for Agencies. In implementing the policy set forth in section 1 of this order and to achieve the goals of section 2 of this order, the head of each agency shall, where life-cycle cost-effective, beginning in fiscal year 2016, unless otherwise specified: (a) promote building energy conservation, efficiency, and management by: (i) reducing agency building energy intensity measured in British thermal units per gross square foot by 2.5 percent annually through the end of fiscal year 2025, relative to the baseline of the agency's building energy use in fiscal year 2015 and taking into account agency progress to date, except where revised pursuant to section 9(f) of this order, by implementing efficiency measures based on and using practices such as:

Sec. 4. Duties of the Chair of the Council on Environmental Quality. In implementing the policy set forth in section 1 of this order, the Chair of CEQ shall: (a) in coordination with the Director of OMB, establish a Federal Interagency Sustainability Steering Committee (Steering Committee) that shall advise the Director of OMB and the Chair of CEQ on the performance of agency responsibilities under sections 2 and 3 of this order and shall include the Federal Chief Sustainability Officer referenced in section 6 of this order and agency Chief Sustainability Officers designated under sections 7 and 8 of this order; (b) in coordination with the Director of OMB review and approve agency-wide scope 1 and 2 and scope 3 greenhouse gas emissions reduction targets developed under section 2 of this order; (c) in coordination with the Director of OMB, prepare streamlined reporting metrics to determine each agency's progress under sections 2 and 3 of this order; d) review and evaluate each agency's Plan prepared under section 14 of this order; (e) within 45 days of the date of this order and thereafter as necessary, after consultation with the Director of OMB, issue implementing instructions or other guidance to direct agency implementation of this order, other than instructions within the authority of the Director of OMB to issue under section 5 of this order; (f) within 150 days of the date of this order, prepare and issue revised Guiding Principles for both new and existing Federal buildings including consideration of climate change resilience and employee and visitor wellness; (g) revise, as necessary and
in coordination with the Director of OMB, existing CEQ guidance and implementing instructions on Sustainable Locations for Federal Facilities of September 15, 2011, Sustainable Practices for Designed Landscapes of October 31, 2011, as supplemented on October 22, 2014, Federal Greenhouse Gas Accounting and Reporting Guidance [Revision 1] of June 4, 2012, and Federal Agency Implementation of Water Efficiency and Management Provisions of Executive Order 13514 of July 10, 2013; (h) within 150 days of the date of this order, prepare and issue guidance to assist agencies in the implementation of section 13 of this order; (i) identify annually, based on total contract spending in the previous fiscal year as reported in the Federal Procurement Data System, the seven largest Federal procuring agencies responsible for implementation of section 15(b) of this order; (j) administer a Presidential leadership award program to recognize exceptional and outstanding performance and excellence in agency efforts to implement this order; and (k) establish and disband, as appropriate, temporary interagency working groups to provide recommendations to the Chair of CEQ associated with the goals of this order, including: grid-based green power; data quality, collection, and reporting; greenhouse gas emissions associated with the transportation of Federal freight and cargo; sustainability considerations in resilience planning; agency supply chain climate vulnerability; recycled content paper; green infrastructure; and carbon uptake accounting and wood products.

Sec. 5. Duties of the Director of the Office of Management and Budget. In implementing the policy set forth in section 1 of this order, the Director of OMB shall: (a) issue, after consultation with the Chair of CEQ, instructions to the heads of agencies concerning periodic performance evaluation of agency implementation of this order, including consideration of the results from section 4(c) of this order; (b) prepare scorecards providing periodic evaluation of Principal Agency performance in implementing this order and publish scorecard results on a publicly available website; and (c) review and approve each agency's Plan prepared under section 14 of this order.

Sec. 6. Duties of the Federal Chief Sustainability Officer. Henceforth, the Federal Environmental Executive is reestablished as the Federal Chief Sustainability Officer and the Office of the Federal Environmental Executive is reestablished as the Office of the Chief Sustainability Officer, for which the Environmental Protection Agency shall provide funding and administrative support and that shall be maintained at CEQ. In implementing the policy set forth in section 1 of this order, the Federal Chief Sustainability Officer shall: (a) monitor progress and advise the Chair of CEQ on agency
goals in sections 2 and 3 of this order; (b) chair, convene, and preside at quarterly meetings; determine the agenda; and direct the work of the Steering Committee; (c) lead the development of programs and policies to assist agencies in implementing the goals of this order in coordination with DOE, EPA, the General Services Administration (GSA), and other agencies as appropriate; (d) coordinate and provide direction to relevant existing workgroups through quarterly meetings to ensure that opportunities for improvement in implementation of this order are identified and addressed; and (e) advise the Chair of CEQ on the implementation of this order.

Sec. 7. Duties of Principal Agencies. To ensure successful implementation of the policy established in section 1 of this order, the head of each Principal Agency shall: (a) designate, within 45 days of the date of this order, an agency Chief Sustainability Officer, who shall be a senior civilian officer of the United States, compensated annually in an amount at or above the amount payable at level IV of the Executive Schedule, and report such designation to the Director of OMB and the Chair of CEQ; (b) assign the designated official the authority to represent the agency on the Steering Committee established under section 4 of this order and perform such other duties relating to the implementation of this order within the agency as the head of the agency deems appropriate; (c) prepare and distribute internally, where appropriate, performance evaluations of agency implementation of this order that reflect the contribution of agency services, components, bureaus, and operating divisions to the goals of this order; (d) ensure, as soon as practicable after the date of this order, that leases and contracts entered into after the date of this order for lessor or contractor operation of Government-owned buildings or vehicles facilitate the agency’s compliance with this order; (e) implement opportunities to improve agency fleet sustainability, including vehicle acquisitions as established in section 3(g) of this order, waiver authority, and fleet data management practices, by revising agency fleet management review and approval procedures to include the Chief Sustainability Officers designated under this section and section 8 of this order; (f) consider the development of policies to promote sustainable commuting and work-related travel practices for Federal employees that foster workplace vehicle charging, encourage telecommuting, teleconferencing, and reward carpooling and the use of public transportation, where consistent with agency authority and Federal appropriations law; (g) ensure regional agency actions consider and are consistent with, sustainability and climate preparedness priorities of States, local governments, and tribal communities where agency facilities are located; (h)
foster outstanding performance and excellence in agency efforts to implement this order through opportunities such as agency leadership award programs; (i) continue implementation of formal Environmental Management Systems (EMS) where those systems have proven effective and deploy new EMSs where appropriate; and (j) notwithstanding the limitations on implementation in section 17 of this order, apply, where feasible and appropriate, the strategies and plans to achieve the goals of this order in whole or in part with respect to fueling, operation, and management of tactical or emergency vehicles and to the activities and facilities of the agency that are not located within the United States.

Sec. 8. Duties of Contributing Agencies. Within 45 days of the date of this order, to ensure successful implementation of the policy established in section 1 of this order, the head of each contributing agency shall designate an agency Chief Sustainability Officer, who shall be a senior civilian officer of the United States, compensated annually in an amount at or above the amount payable at level IV of the Executive Schedule, and report such designation to the Director of OMB and the Chair of CEQ.

Sec. 9. Duties of the Agency Chief Sustainability Officers. The Chief Sustainability Officers designated under sections 7 and 8 of this order shall be responsible for: (a) ensuring agency policies, plans, and strategies implemented to achieve the goals of this order consider the role of agency regional facilities and personnel and are integrated into agency permitting and environmental review policies, programs, and planning; (b) developing and implementing an agency-wide strategic process that coordinates appropriate agency functions and programs to ensure that those functions and programs consider and address the goals of this order; (c) reporting annually to the Chair of CEQ and Director of OMB a comprehensive inventory of progress towards the greenhouse gas emissions goals established in section 2 of this order; (d) representing the agency on the Steering Committee; (e) convening quarterly meetings of agency bureaus, commands, or operating divisions that are responsible for the implementation of strategies necessary to meet the goals of this order; (f) representing the agency in any requests to the Chair of CEQ and Director of OMB to amend or normalize a baseline for goals established in this order due to change of greater than 5 percent as a result of agency space consolidation, a change in mission tempo, or improved data quality; (g) providing plans, including the Plan prepared under section 14 of this order, reports, information, and assistance necessary to implement this order, to the Director of OMB, the Chair of CEQ, and the Federal Chief Sustainability Officer; and (h) performing
such other duties relating to the implementation of this order as the head of the agency deems appropriate.

Sec. 10. Regional Coordination. Within 180 days of the date of this order, each EPA and GSA Regional office shall in coordination with Federal Executive Boards established by the Presidential Memorandum of November 10, 1961 (The Need for Greater Coordination of Regional and Field Activities of the Government), DOD and other agencies as appropriate, convene regional interagency workgroups to identify and address: (a) sustainable operations of Federal fleet vehicles, including identification and implementation of opportunities to use and share fueling infrastructure and logistical resources to support the adoption and use of alternative fuel vehicles, including E-85 compatible vehicles, zero emission and plug-in hybrid vehicles, and compressed natural gas powered vehicles; (b) water resource management and drought response opportunities; (c) climate change preparedness and resilience planning in coordination with State, local, and tribal communities; and (d) opportunities for collective procurement of clean energy to satisfy energy demand for multiple agency buildings.

Sec. 11. Employee Education and Training. Within 180 days of the date of this order, the Office of Personnel Management, in coordination with DOE, GSA, EPA, and other agencies as appropriate, shall: (a) consider the establishment of a dedicated Federal occupational series for sustainability professionals and relevant positions that directly impact the achievement of Federal sustainability goals and if appropriate, prepare and issue such occupational series; and (b) initiate the inclusion of environmental sustainability and climate preparedness and resilience into Federal leadership and educational programs in courses and training, delivered through electronic learning, in classroom settings, and residential centers, particularly developmental training for Senior Executive Service and GS-15 personnel.

Sec. 12. Supporting the Federal Fleet. (a) GSA shall ensure that vehicles available to agencies for either lease or sale, at or below market cost, through its vehicle program include adequate variety and volume of alternative fuel vehicles, including zero emission and plug-in hybrid vehicles, to meet the fleet management goals of this order. (b) DOE shall assist the United States Postal Service (USPS) in evaluating the best alternative and advanced fuel technologies for the USPS fleet and report on such progress annually as part of the planning requirements of section 14 of this order.

Sec. 13. Supporting Federal Facility Climate Preparedness and Resilience. The head of each agency shall, consistent with Executive Order 13653 of November 1, 2013,
ensure that agency operations and facilities prepare for impacts of climate change as part of the planning requirements of section 14 of this order and consistent with planning required under section 5 of Executive Order 13653 by: (a) identifying and addressing projected impacts of climate change on mission critical water, energy, communication, and transportation demands and considering those climate impacts in operational preparedness planning for major agency facilities and operations; and (b) calculating the potential cost and risk to mission associated with agency operations that do not take into account the information collected in subsection (a) of this section and considering that cost in agency decision-making.

Sec. 14. Agency Strategic Sustainability Performance Plan. Beginning in June 2015, and continuing through fiscal year 2025, the head of each Principal Agency shall develop, implement, and annually update an integrated Strategic Sustainability Performance Plan (Plan) based on guidance prepared by the Chair of CEQ under section 4 of this order. Contributing agencies are encouraged to prepare a Plan but may limit content of the Plan to a summary of agency actions to meet the requirements of this order. Each Principal Agency Plan and update shall be provided to the Chair of CEQ and Director of OMB, shall be subject to approval by the Director under section 5 of this order, and shall be made publicly available on an agency website once approved.

Sec. 15. Supply Chain Greenhouse Gas Management. In implementing the greenhouse gas management policies in section 1 of this order and to better understand and manage the implications of Federal supply chain greenhouse gas emissions: (a) the Chair of CEQ shall, within 30 days of the date of this order and annually thereafter, identify and publicly release an inventory of major Federal suppliers using publicly available Federal procurement information, including information as to whether the supplier has accounted for and publicly disclosed, during the previous calendar year, annual scope 1 and 2 greenhouse gas emission data and publicly disclosed a greenhouse gas emission reductions target (or targets) for 2015 or beyond; and (b) the seven largest Federal procuring agencies shall each submit for consideration, in conjunction with the planning requirements of section 14 of this order, a plan to implement at least five new procurements annually in which the agency may include, as appropriate, contract requirements for vendors or evaluation criteria that consider contractor emissions and greenhouse gas emissions management practices. The plans submitted for consideration may include identification of evaluation criteria, performance period criteria, and contract clauses that will encourage suppliers to manage and reduce greenhouse
gas emissions, and shall be implemented as soon as practicable after any relevant administrative requirements have been met.

Sec. 16. Revocations and Conforming Provisions. (a) Pursuant to section 742(b) of Public Law 111-117, I have determined that this order will achieve equal or better environmental or energy efficiency results than Executive Order 13423. Therefore, Executive Order 13423 of January 24, 2007, is revoked. (b) Executive Order 13514 of October 5, 2009; Presidential Memorandum of December 2, 2011 (Implementation of Energy Savings Projects and Performance-Based Contracting for Energy Savings); section 1 of Presidential Memorandum of February 21, 2012 (Driving Innovation and Creating Jobs in Rural America through Biobased and Sustainable Product Procurement); and Presidential Memorandum of December 5, 2013 (Federal Leadership on Energy Management), are revoked. (c) Presidential Memorandum of May 24, 2011 (Federal Fleet Performance), is revoked as of October 1, 2015. (d) Section 3(b)(vi) of Executive Order 13327 of February 4, 2004, is amended by striking “Executive Order 13148 of April 21, 2000” and inserting in lieu thereof “other Executive Orders”. (e) Section 2(d) of Executive Order 13432 of May 14, 2007, is amended to read as follows: “greenhouse gases’ means carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, nitrogen triflouride, and sulfur hexafluoride;” (f) Section 5 of Executive Order 13653 of November 1, 2013, is amended by striking “Executive Order 13514” and inserting in lieu thereof “other Executive Orders”. (g) Section 1 of Executive Order 13677 of September 23, 2014, is amended by striking “Executive Order 13514 of October 5, 2009 (Federal Leadership in Environmental, Energy, and Economic Performance), and Executive Order 13653 of November 1, 2013 (Preparing the United States for the Impacts of Climate Change),” and inserting in lieu thereof “Several Executive Orders have”. BARACK OBAMA THE WHITE HOUSE, March 19, 2015.

Appendix C FACT SHEET: President Obama’s Climate Action Plan

We have a moral obligation to leave our children a planet that’s not polluted or damaged, and by taking an all-of-the-above approach to develop homegrown energy and steady, responsible steps to cut carbon pollution, we can protect our kids’ health and begin to slow the effects of climate change so we leave a cleaner, more stable environment for future generations. Building on efforts underway in states and communities across the country, the President’s plan cuts carbon pollution that causes climate change and threatens public health. Today, we have limits in place for arsenic, mercury and lead, but we let power plants release as much carbon pollution as they want – pollution that is contributing to higher rates of asthma attacks and more frequent and severe floods and heat waves.

Cutting carbon pollution will help keep our air and water clean and protect our kids. The President’s plan will also spark innovation across a wide variety of energy technologies, resulting in cleaner forms of American-made energy and cutting our dependence on foreign oil. Combined with the President’s other actions to increase the efficiency of our cars and household appliances, the President’s plan will help American families cut energy waste, lowering their gas and utility bills. In addition, the plan steps up our global efforts to lead on climate change and invests to strengthen our roads, bridges, and shorelines so we can better protect people’s homes, businesses, and way of life from severe weather.

While no single step can reverse the effects of climate change, we have a moral obligation to act on behalf of future generations. Climate change represents one of the major challenges of the 21st century, but as a nation of innovators, we can and will meet this challenge in a way that advances our economy, our environment, and public health all at the same time. That is why the President’s comprehensive plan takes action to:

Cuts Carbon Pollution in America. In 2012, U.S. carbon pollution from the energy sector fell to the lowest level in two decades even as the economy continued to grow. To build on this progress, the Obama Administration is putting in place tough new rules to cut carbon pollution—just like we have for other toxins like mercury and arsenic—so we protect the health of our children and move our economy toward American-made clean energy sources that will create good jobs and lower home energy bills.

Prepares the United States for the Impacts of Climate Change. Even as we take new
steps to cut carbon pollution, we must also prepare for the impacts of a changing climate that are already being felt across the country. Building on progress over the last four years, the plan:

- Directs agencies to support local climate-resilient investment by removing barriers or counterproductive policies and modernizing programs; and establishes a short-term task force of state, local, and tribal officials to advise on key actions the Federal government can take to help strengthen communities on the ground;
- Pilots innovative strategies in the Hurricane Sandy-affected region to strengthen communities against future extreme weather and other climate impacts; and building on a new, consistent flood risk reduction standard established for the Sandy-affected region, agencies will update flood-risk reduction standards for all federally funded projects;
- Launches an effort to create sustainable and resilient hospitals in the face of climate change through a public-private partnership with the healthcare industry;
- Maintains agricultural productivity by delivering tailored, science-based knowledge to farmers, ranchers, and landowners; and helps communities prepare for drought and wildfire by launching a National Drought Resilience Partnership and by expanding and prioritizing forest- and rangeland- restoration efforts to make areas less vulnerable to catastrophic fire; and
- Provides climate preparedness tools and information needed by state, local, and private-sector leaders through a centralized “toolkit” and a new Climate Data Initiative.

Lead International Efforts to Address Global Climate Change. Just as no country is immune from the impacts of climate change, no country can meet this challenge alone. That is why it is imperative for the United States to couple action at home with leadership internationally. America must help forge a truly global solution to this global challenge by galvanizing international action to significantly reduce emissions, prepare for climate impacts, and drive progress through the international negotiations. For example, the plan:

- Commits to expand major new and existing international initiatives, including bilateral initiatives with China, India, and other major emitting countries;
• Leads global sector public financing towards cleaner energy by calling for the end of U.S. government support for public financing of new coal-fired powers plants overseas, except for the most efficient coal technology available in the world's poorest countries, or facilities deploying carbon capture and sequestration technologies; and
• Strengthens global resilience to climate change by expanding government and local community planning and response capacities.

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Chapter 6

Climate Change Challenges of the Future

The Perils of Climate Change

Climate change is occurring rapidly and dramatically wreaking havoc across the globe. The impacts of climate change are more devastating as climate disasters grow in frequency and intensity. The assault on the Earth threatens natural and human systems with damage and loss that are often irreversible. As global warming intensifies, there will be increasing depletion of natural resources, sea level rise, melting of the polar ice caps, coral bleaching and disintegration, floods and droughts, risks of wildlife extinctions, population risks and forced migrations, disease and other health risks, economic and financial disaster, unsustainable lands and development, and more.

According to the United Nations Intergovernmental Panel on Climate Change (IPCC) much of the alarming rate of environmental degradation is due to human activities, especially the burning of fossil fuels. As the world forges ahead with industrial and urban development, it is depleting the natural resources and environment that aid the world’s progress. This untenable imbalance must be replaced with a rational balance between protecting the natural environment and resources and accelerating industrialization and urbanization.

Global efforts to respond to climate change have not halted rising carbon dioxide emissions which are now driven mainly by emerging economies such as China and
India. While world leaders have set a goal of keeping global warming to less than two degrees, the current trends are on track to deliver a world that is six degrees warmer. The window of opportunity to keep global warming below two degrees appears to be closing (Gilding, 2011; EPA, 2015; See also Appendix A).

As the opportunity to mitigate the impacts of global warming declines, the perils of climate change speed ahead in a multitude of ways across the globe. For example, migrating disease-carrying insects spread viruses in areas where people have not yet built immunity for them. Economic emergencies as well as health crises threaten nations. In the U.S., floods have caused over $25 billion in losses since 1993 alone. With increased global floods, droughts, and other climate disasters, the National Geographic Society reports that the cost of adaptation to a newer climate could result in at least 5 to 10 percent of a nation's gross domestic product (National Geographic, 2015). Worldwide competition over scarce resources is likely to ensue. The IPCC warns that in Africa where water is already a scarce commodity there will be less and less water with warmer temperatures and this could lead to even more conflict and war.

While the need for sustainable development is greater than ever, the impacts of climate change impinge on its achievement. In developing Asian countries, natural resources are used for the processes of heavy industrialization and urbanization. These processes create immense amounts of greenhouse gases (GHG) that further deplete the natural resources needed for sustainable development of countries. If new and more efficient ways to use energy are not found, there will be a depletion of natural resources that are essential for the planet to thrive. Studies conducted by the British government show that to avert potential disaster in relation to global warming, GHG emissions must be reduced by approximately 80 percent.

The environmental crisis the world faces demands global response. In his State of the Union Address on January 20, 2015, President Obama reaffirmed the U.S. commitment to cut GHG emissions by 26 to 28 percent from 2005 levels by the year 2025. The President declared that “No challenge poses a greater threat to future generations than climate change” (White House Press Release, January 20, 2015). Again in March 2015, the U.S. formally confirmed its commitment with the United Nations Framework Convention on Climate Change (UNFCCC). U.S. Secretary of State John Kerry called climate change the “defining challenge of our generation” (Gemen, 2015).
Climate Change: Challenges and Recommendations

Climate change poses global challenges never before faced by humankind. The threats to the survival of human and natural systems cannot be ignored. Some challenges and recommendations are:

1. Disaster and emergency situations epitomize the unpredictable, nonlinear aspects of human events. Holistic, creative, even unconventional and nonlinear mindsets may be more effective in analyzing and integrating the complexities of vulnerabilities, causes, and solutions. To manage response to climate disasters, thinking outside the parameters of current organizational protocol and systems can give decision-makers more options and flexibility to deal with instability and disorder.

2. The relatively high turnover and short tenure among elected and appointed officials at all levels of government responsible for climate change preparedness, response, and recovery create leadership gaps and inefficiency. Effective response hinges on knowledgeable and well-trained leaders and responders who have invested in response preparedness, developed engaged partnerships, and demonstrated ability to achieve shared objectives. While there is revolving climate change leadership in government positions there is still a need for consistent, concise, and common policies and procedures.

3. Engineering and scientific research is needed on the development of cost-effective energy use technologies (devices, systems, and control strategies) and energy supply technologies that produce little or no CO2 or other GHGs.

4. Better understanding of the relationship between GHG emissions and atmospheric GHG concentrations is needed to more accurately predict how the atmosphere and climate system will respond to mitigation measures.

5. Developing processes to control the land sink of carbon in the U.S. require additional research, including better monitoring and analysis of economic decision-making about the fate of land and how it is managed, as well as the inherent ecological processes and how they respond to the climate system.

6. Uncertainties in model-based projections of GHG emissions and of the effectiveness and costs of policy measures need to be better quantified.
Research is needed of the effects of different model structures, assumptions about model parameter values, and uncertainties of input data.

7. Social and behavioral science research is needed to inform the design of mitigation measures to maximize participation and to design a consistent framework for assessing cost effectiveness and benefits of both voluntary mitigation efforts and regulatory and subsidy programs.

8. More systematic incorporation and integration of disaster risk reduction, mitigation, and adaptation considerations into sustainable development policies, planning, and programming are needed. Better design and implementation of emergency preparedness, response, and recovery programs will be required. More comprehensive environmental and natural resource management and strategies, better management of risks associated with geological hazards, and more innovative work of planners, engineers, climate scientists, decision-makers, and others are needed.

9. In mobilizing resources to address climate change, states should mainstream disaster risk reduction measures appropriately into multilateral and bilateral development assistance programs including those related to poverty reduction, natural resource management, and urban development.

10. The development and strengthening of institutions, mechanisms, and capacities at all levels, in particular at the community level, should systematically contribute to building resilience to hazards.

Technology and Initiatives to Improve Climate Change Resilience

When climate disaster strikes, communities suffer devastating losses of people and property. Recovery can take months to years and with staggering public and private costs. The viability of communities depends upon strategies to increase resilience, withstand hazards, and recover efficiently in the aftermath of a disaster. Some new technologies and initiatives to achieve these goals follow: (See also Exercise A).

1. Local Government Self-Assessment Tool (LGSAT). The LGSAT, a Rockefeller Foundation funded innovation, was designed to enable local governments
to assess their climate risks in the context of urbanization, poverty, and vulnerability, and formulate and implement resilience strategies specifically tailored for the community. Targeted and tested for city governments’ use, the climate change resilience toolkit draws upon ICLEI ACCCRN - Asian Cities Climate Change Resilience Network (IAP) experience from the ten core ACCCRN cities and supplements this with models, approaches, and best practices of the ICLEI. It provides a simple yet rigorous process which can be implemented by the cities themselves, with only minimal need for external support. The goal is to build resilience to climate change across all urban systems and groups, in particular the poorest and most marginalized (Sunandan, 2014).

2. Community Resilience Planning Guide for Buildings and Infrastructure. The National Institute of Standards and Technology (NIST) issued the Community Resilience Planning Guide for Buildings and Infrastructure which is a collaborative effort of stakeholders and nine outside experts from multi-disciplines providing input at four regional meetings (NIST, 2015). It is a customizable tool that urban and rural communities can use proactively to craft a resilience strategy aligned with each community’s unique characteristics (e.g. geography, population composition, financial resources, age of infrastructures, etc.), circumstances, and priorities. It leads communities through a step-by-step process that helps them make informed long-term decisions about priorities, costs, and ways to effectively manage disaster risks. Planning for resilience focuses on the social functions that sustain a community, such as healthcare, public safety, education, business and employment. It also centers on the role that the built environment—buildings and infrastructure—play in supporting these functions. An effective community resilience strategy ensures that buildings and infrastructure, power, water, transportation, and wastewater systems will perform at levels needed to initiate and sustain recovery efforts.

3. The Coastal Flood Exposure Mapper. Originally developed by the National Oceanic and Atmospheric Administration (NOAA) for coastal management in the northeast, the Coastal Flood Exposure Mapper has been expanded to cover coastal areas along the entire U.S. East Coast and Gulf of Mexico. This NOAA tool provides users with maps, data, and information to assess risks
and vulnerabilities related to coastal flooding and hazards. Users select their location and the flood scenario of their choosing: FEMA flood designations, shallow coastal flooding associated with high tides, or flooding associated with sea level rise or storm surge. Flood maps are then overlaid with any of three exposure maps to show how floodwaters might impact area assets. All maps can be saved, printed, and shared. The societal exposure map provides information on population density and projected growth, poverty, the elderly, and employees. The ecosystem exposure map provides information about natural areas and open spaces—including their proximity to development—to help communities identify which areas can be conserved for future flood protection benefits. Pollution sources are also identified to show where natural resources could be affected during a flood. The infrastructure exposure map provides information on roads, bridges, water, and sewer systems (NOAA, 2015). With growing numbers of vulnerable coastal populations and increasing potential for floods, there is a critical need to protect and/or restore coastal communities’ infrastructures and environmental and economic assets. The Coastal Flood Exposure Mapper provides valuable information to do this with disaster risk reduction planning and resilience.

4. SafetyDatapaloozas and Civic Hardware Hackathons. Released by the White House in 2014 as part the Innovation of Disaster Response and Recovery Initiative, SafetyDatapaloozas and Civic Hardware Hackathons were developed to find effective ways to use technology to empower disaster survivors, first responders, communities, and all levels of government with critical disaster information and collaboration resources. These new apps and tools are now available on data.gov. Building upon these tools and services showcased at the White House Demo Day and the launch of the Initiative's first major online presence, disasters.data.gov, public and private sector technology and innovation teams are continuing to support America’s PrepareAthon and each year’s National Day of Action for disaster preparedness. A host of new technology and innovation commitments were shared in 2015, and included work on new interactive mapping tools, free and open source hardware designs, improved smartphone alerts, and a series of disaster resilience technology exhibits in anticipation of the National Maker Faire, during a dedicated ‘Week of Making’ in June 2015. From free platforms that connect
more than 59,000 neighborhoods and 750 local agencies across the country to a network of 3,000 volunteers that has made over 14 million changes and additions to OpenStreetMap data in Ebola-affected regions, the numbers show this community’s dedication and collaborative spirit (Dickerson and Appelgate, 2015; See also Exercise A).

5. Asian Innovations: Fujitsu’s Supercomputer, K in Japan and a House that Rises with Water in Thailand. Since Japan’s massive earthquake and tsunami in 2011, reducing disaster risk has become a major focus for government and industry. Tohoku University and Fujitsu Laboratories jointly developed a real-time flood analysis system using Fujitsu’s supercomputer, K. Its simulation model swiftly calculates the estimated arrival time of tsunamis, how far inland will be affected, and the probability and extent of building damage within 10 minutes of an earthquake (NAR, 2015). Municipalities can potentially use the information to provide advance warning to residents. However, regulatory hurdles stand in the way, as only the Meteorological Agency has the authority to release tsunami-related information (NAR, 2015). In Thailand, the devastating floods in 2011 causing billions of dollars of damage and leaving more than 360 people dead, spawned a host of disaster innovations, including a house that rises with water designed by a Thai architect in May 2015 (BBC, 2015).

6. Online Climate and Disaster Risk Screening Tools. Recognizing the impediments to sustainable development that climate change imposes especially on poor nations, the International Development Association of the World Bank introduced a new set of Online Climate and Disaster Risk Screening Tools to provide a systematic and consistent means of assessing short and long-term climate and disaster risks at an early-stage of project and national or sector planning processes. Screening is a first and essential step to assure that these risks are assessed and managed in sustainable development planning. The tools are based upon the approaches used by the IPCC and the United States Agency for International Development (USAID) and are linked with the World Bank’s Climate Change Knowledge Portal which distils and presents climate information at the country level for more than 100 countries based on the most recent IPCC report (Rigaud, 2015). These open source, self-paced screening tools are universally applicable, and do not require
one to be a climate expert. However, the tools take into account the type of technical expertise of the user (e.g. road or water engineers, agriculturists, health practitioners, policy level planners, etc.), and their understanding of the local context. There are national level tools that target planning processes, sector-wide strategies, development policy reforms, and institutional strengthening at national and sector levels. There are also project level tools that target investments in a range of key sectors including agriculture, water, roads, energy, health, coastal flood protection, natural resource management, education, financial management, non-road transport, urban, social and community development, and more. The screening process provides users with an overview of risks for key aspects of their project or program. Early screening results can inform consultations, dialogue, and form the basis for follow-up work including detailed technical assessments and feasibility studies. In addition, users have the opportunity to collaborate during the screening process, thus tapping into the collective knowledge of multiple teams working on projects.

7. National Disaster Mitigation Program (NDMP). Introduced in May 2015 by the Canadian Ministry of Public Safety and Emergency Preparedness of Canada as part of the Government’s commitment to build safer and more resilient communities, this five year cost sharing program provides provinces and territories the opportunity to apply for cost-sharing for flood prevention and mitigation projects. The Canadian government will cost-share up to 50 percent of eligible provincial project costs and up to 75 percent of eligible project costs in the territories that could include both non-structural projects such as flood-mapping and forecasting, and small-scale structural projects such as retrofitting or modernizing existing buildings to improve resiliency. Public Safety Canada will work with provinces, territories, and other partners on the assessment criteria for projects funded by the NDMP (UNISDR, 2015). The NDMP reflects the Canadian government’s shift towards a proactive disaster relief model that will better protect Canadians and their communities from the costs and heartache associated with recurring flooding. The NDMP will increase awareness of the disaster risks across the country and contribute to building resilient communities (UNISDR, 2015).

8. Micro Insurance and Pooling Disaster Risk Financing. In May 2015, finance stakeholders in the Asia Pacific region agreed to develop a viable micro
insurance strategy for the region and create a regional risk pool mechanism to reduce risk of individual countries when there are disasters (PIA, 2015). Micro insurance is at the household level focusing on how to build resilience for individuals, while risk financing deals with ensuring government access to funding in a timely manner after a disaster strikes. Risk pooling refers to different countries joining together to share disaster risk and then taking their agreement to the global reinsurance markets to achieve a better level premium than if they were to go individually to the markets (PIA, 2015).

Asia-Pacific Economic Cooperation (APEC) has expressed interest in this strategy, considering that it is modeled on risk pools already established in different parts of the world; for example, in the Caribbean with its Caribbean Risk and Catastrophe Facility and in the Pacific region with its Pacific Risk Financing Initiative. Prerequisites include cooperation among the members of the countries involved and providing sufficient standardized data across all the countries within the pool which can be depended on in a risk transfer mechanism. Going forward, the pool members will consider if risk pooling can also be a part of a broader risk financing strategy (PIA, 2015).

9. Japan-World Bank Program for Mainstreaming Disaster Risk Management in Developing Countries. Japan’s Global Facility for Disaster Reduction and Recovery (GFDRR) and the World Bank Program for mainstreaming disaster risk management in developing countries established a partnership in February 2014 between the Ministry of Finance of Japan (MoF) and the World Bank (GFDRR and WB, 2015). The objective of the partnership is to support developing countries in mainstreaming disaster risk management in national development planning and investment programs through technical assistance and pilot projects. Thematic initiatives focused on:

- risk identification: the production, communication, and use of risk information.
- risk reduction: land use planning, building standards, and institutional strengthening.
- preparedness: forecasting and service delivery, early warning systems, and contingency planning.
financial protection: sovereign disaster risk financing, risk retention, and transfer strategies.

knowledge mobilization and exchange: knowledge development and dissemination, capacity building, and outreach.

The program strives to connect Japanese and global expertise in disaster risk management with developing countries (GFDRR and WB, 2015).

10. Kampala Declaration. In April 2015, the World Meteorological Organization (WMO), Uganda's Ministry of Water and Environment and Ministry of Agriculture, and other partners co-sponsored a workshop for farmers and experts through the USAID-funded project “Laying the Foundation for Establishing Networks Linking Farmers in Africa and South Asia for Demand-driven Climate Services” (WMO, 2015). Agriculture is one of the four priority areas of the WMO-led Global Framework on Climate Services (GFCS) which is promoting operational climate services at the national and regional levels. The workshop attendees adopted the Kampala Declaration which established the Regional Network of Farmers of Africa and South Asia (RENOFASA) to develop an implementation plan to promote cross regional cooperation; disseminate weather and climate information, products, and services to farmers in a timely manner through modern communications technologies; organize training seminars; and establish advisory teams to interact with farmers to improve weather and climate services. The Kampala Declaration's contribution to climate change adaptation and resilience has been recognized by the parties to the United Nations Framework Convention on Climate Change (UNFCCC).

11. The Resilient Lands and Waters Initiative. In April 2015, the Department of the Interior (DOI), Environmental Protection Agency (EPA), and NOAA announced the Resilient Lands and Waters Initiative to prepare natural resources for climate change (USDOI, 2015). Building on existing collaborations, sites in southwest Florida, Hawaii, Washington, and the Great Lakes region were selected to showcase climate resilience approaches. With these four regional collaborative landscape partners, federal agencies work to conserve and restore important lands and waters and make them more resilient to a changing climate. This initiative helps build resilience in regions vulnerable to climate change and related challenges (USDOI, 2015).
The selected lands and waters face a wide range of climate impacts and other ecological stressors related to climate change, including sea level rise, drought, wildfire, and invasive species. At each location, federal agencies work closely with state, tribal, and local partners to prepare for and prevent these and other threats, and ensure that long-term conservation efforts take climate change into account. The initiative also focuses on conserving coastal wetlands and marine conservation areas, protecting drinking water for urban areas, and providing habitat for wildlife. These collaborative efforts include the use of existing tools and the development of new tools to benefit the entire landscape. For example, in the Great Lakes partners are developing a coastal wetland prioritization tool that will help determine where restoration efforts are most needed. Also in the He'eia watershed on the island of O'ahu, organizations are using NOAA's Sea Level Rise Viewer to examine maps of the potential impacts of sea level rise on the region. In each region climate resilience approaches that address the needs of the entire landscape are used. Federal, state, local, and tribal partners work together in these landscapes to develop more effective strategies and maps to facilitate their work. These strategies will benefit wildfire management, mitigation investments, restoration efforts, water and air quality, carbon storage, and the communities that depend upon natural systems for their own resilience (USDOI, 2015). For example, southwest Florida is home to large tracts of open and working lands with diverse ownership where partners in the region are working to identify and apply incentives to meet important conservation targets. In Washington, as part of efforts in the Puget Sound, partners are collaborating on several projects that affect the entire Snohomish River watershed, including the restoration of important tidal wetland habitats which will have major climate mitigation benefits. The landscape-scale approach demonstrated through this initiative enables agencies and partners to identify shared priorities and improve their future conservation efforts. Additionally, by tracking successes and sharing lessons learned, the initiative will encourage the development of similar resilience efforts in other areas across the country. The Resilient Lands and Waters Initiative is a key part of the Administration's Climate and Natural Resources Priority Agenda, a first of its kind, comprehensive commitment across the federal government to support resilience of America's vital natural resources (USDOI, 2015).
Health Effects of Climate Change in the Future

In 2014, the World Health Organization (WHO) published 'Quantitative Risk Assessment of the Effects of Climate Change on Selected Causes of Death, 2030s and 2050s'. It is an update and expansion of the assessment conducted by the WHO for the year 2000 (WHO, 2014). The 2014 report includes a wider range of health impacts and projections for future years. It provides a quantitative assessment of the health impacts of climate change and takes into account a subset of the possible health impacts while assuming continued economic growth and health progress. Under these conditions it concludes that worldwide, climate change is expected to cause approximately 250,000 additional deaths per year between 2030 and 2050: 38,000 due to heat exposure in elderly people, 48,000 due to diarrhea, 60,000 due to malaria, and 95,000 due to childhood under-nutrition. In the future, the burden of disease will continue to fall mainly on children in developing countries, but other population groups will be increasingly affected (WHO, 2014).

Scientists and emergency managers recognize that climate change impacts are becoming more severe. They see the effects of climate change in storms, wildfires, heat waves, higher sea levels, extreme rainfall, windstorms, and diseases spreading to new areas (DHS, 2010). For example, the projected increases in heat waves and disease transmitted by food, water, and insects affect how communities respond to these emergencies (NIEHS, 2010). Research performed by the U.S. Global Change Research Program (USGCRP) on the implications of climate change on the U.S. shows how it will affect emergency management. In the U.S. the percentage of population over age 65 is currently 12 percent and is projected to be 21 percent, over 86 million people, by 2050 (USGCRP, 2009). The elderly are expected to need different types of emergency services and supplies, particularly in environments presenting extreme weather conditions. Heat is already the leading cause of weather-related deaths in the U.S. with more than 3,400 deaths between 1999 and 2003 reported as a result of excessive heat exposure (USGCRP, 2009).

The effects of climate change on health becomes particularly challenging when considered in combination with other drivers such as increased urban populations and aging infrastructure. The burden on already strained budgets becomes even heavier. The international impacts of climate change that are likely to affect the U.S. include shifting disease patterns, increased conflict over resources, and migration due to climate issues.
These threats minimally will require better coordination of emergency management and public health services (USGCRP, 2009).

**Future Effects of Climate Change on Migration**

Scientists say that one of the more disturbing aspects of climate change-related disruptions is the looming climate-induced migration crisis. Extreme weather disasters, sea level rise, and environmental degradation are factors which could trigger mass migrations, disrupting populations and destabilizing governments. “We now know,” said Mary Robinson, the UN Special Envoy for Climate Change and former president of Ireland, “that climate change is a driver of migrations, and is expected to increase the displacement of populations” (Rahman, 2015). The Nansen Initiative, a study sponsored primarily by the governments of Switzerland and Norway, found that an estimated 144 million people were at least temporarily displaced between 2008 and 2012 due to climate related disasters (Kyte, 2015). An objective of the Nansen Initiative is to build consensus among states to address cross-border displacement in the context of sudden and slow onset disasters.

The United Nations IPCC warned that a failure to deal with the issue of climate change will only result in disarray (Rahman, 2015). "Because climate change is expected to increase the frequency and intensity of weather-related disasters, the total number of climate change migrants will rise in the years ahead,” Anika Rahman writes in the Huffington Post (Rahman, 2015). Estimates of the number of “environmental migrants,” or those displaced by the effects of climate change vary with different researchers using different methodologies and different time scales. There are no exact predictions, but some forecasts place the number from 50 million to 1 billion people over the coming decades (Brookings, 2015).

Most researchers agree that most people will move within their countries but they are unsure how many will cross national borders. There exists no reliable source or estimate on how many people have already moved because of the effects of climate change. There are anecdotal accounts of people who crossed from one country to another in Central America after Hurricane Mitch in 1998 and of Bangladeshis fleeing into India (and being turned back) after cyclones and floods. There are reliable reports by the Brazilian government which extended humanitarian visas to hundreds of Haitians fleeing the
devastating 2010 earthquake (Brookings, 2015). Although there are some reliable reports on the number displaced within national borders because of sudden-onset disasters, there is no systematic data collection for those who have crossed international borders because of disasters and environmental factors. The estimates are often so wide-ranging because of the unforeseen links between climate change and migration - links which are not always direct. For instance, climate change may exacerbate a natural disaster that would have occurred anyway, or may lead to a secondary impact such as a landslide or flooding, or pollute water sources.

According to the IPCC, by 2050 as much as 42 percent of the world's population (nearly half of a projected 10 billion or more) may live in countries with insufficient freshwater stocks to meet the combined needs of agriculture, industry, and domestic use (Gilman et al., 2007). Based on the National Intelligence Assessment of National Security Implications of Global Climate Change to 2030, the most significant impact for the U.S. will be indirect, linked to the outcomes of climate change effects on other countries and their potential to seriously affect U.S. national security interests (DHS, 2010). As a result, the U.S. can expect to deal with large groups of "climate migrants" from varying regions around the world fleeing water scarcity and perhaps conflicts waged because of significant water shortages (Brookings, 2015).

There are multiple factors surrounding migration and displacement of populations. Mapping the risk of displacement because of disasters or the effects of climate change is complex because migration is multi-causal in nature. People decide to move for many reasons including environmental, economic, and personal (e.g. family ties and tolerance of risk). Some people will migrate before they have to leave, while others will be forced from their homes by a sudden onset climate disaster. Some will have to be relocated by their governments to places where they will be safer. Most of this movement of people will be within the borders of their country where they are considered internally displaced persons (Brookings, 2015). However, in the future disasters, environmental degradation, or the effects of climate change will force people to leave their countries.

Under present international law, there is no special provision to admit those leaving their countries for these reasons. Instead, they are dealt with through normal immigration channels. Therefore, if residents from a Pacific island country have to leave their country because of sea-level rise or if a cyclone forces people to cross an international border, governments are under no obligation to treat them differently than any other economic migrant asking for admission. Although the term 'climate change refugee' is used in the media to depict these people, they are not refugees
under international law (Brookings, 2015). The term ‘refugee’ is well-established in international law and applies only to those fleeing persecution on the basis of five clearly specified criteria: race, religion, nationality, political opinion, or membership in a social group. It does not apply to those forced to leave their countries because of disasters or environmental degradation or the effects of climate change. In the summer of 2014, a New Zealand court explicitly rejected the request for refugee status by citizens of Tuvalu arguing that they could no longer remain in their country because of the effects of climate change (Brookings, 2015).

The Nansen Initiative addressed this gap in international law to build consensus addressing the needs of people displaced across borders by disasters or the effects of climate change. People do not want to be forced out of their country because of disasters or the effects of climate change. However, if a home government of a migrant refuses to adopt policies to curb GHG emissions to halt global warming which is leading to sea level rise, drought, and heat waves that will make certain parts of the world uninhabitable, then should another government be prepared to accept those who turn up at its borders because they can no longer survive in their communities?

The fourth edition of the International Organization for Migration (IOM) annual publication focused on unraveling the complex links of sudden and slow onset of natural disasters and human mobility. It reviews case studies considering concepts such as community resilience and social vulnerability as aspects of disaster risk reduction, and how resilience and vulnerability impact migration strategies (IOM, 2014). It provides examples of policy responses regarding issues such as resettlement, national adaptation strategies, and disaster risk reduction at the individual, community, national, and regional levels. Analysis of many different types of migration such as pastoralist movements, displacement due to natural disasters or cross-border displacement are conducted in the context of a diversity of natural disasters. The publication raises awareness of the effects of climate change on the livelihoods of vulnerable populations, facilitates voluntary migration, and works to prevent forced forms of migration when a massive displacement is likely to occur (IOM, 2014).

More and ongoing research is needed to begin to understand the ways in which climate change will contribute to new patterns of both internal and cross-border movements of people. The Nansen Initiative has made an impressive start by raising poignant migration issues with governments, civil society, and experts from many disciplines and many countries (Brookings, 2015). Now and in the future affected
communities, experts, and policy-makers must address cross-border, disaster-induced displacement and develop policies and mechanisms that respond to the needs of those who can no longer survive in their countries and will need to seek entrance into another country.

**Future Climate Change Impact on Insurance**

Developing and investing in flood-prone areas represent a tradeoff between the location's economic and other benefits and the exposure to a flood hazard. Storm Sandy in 2012, Midwest flooding in 2011 and 2008, Hurricane Ike in 2008, and Hurricanes Katrina and Rita in 2005 renewed interest in the array of tools available to improve flood resiliency. In addition to oversight and funding of emergency response activities, the issue for Congress is deciding on whether and how to enact and implement feasible and affordable flood policies and programs to reduce flood risk. The challenge is how to structure federal actions and programs so they provide incentives to reduce flood risk without unduly infringing on private property rights or usurping local decision making. Addressing this challenge would require adjustments in the flood insurance program, disaster aid policies and practices, and programs for structural and nonstructural flood risk reduction measures and actions (CRS, 2012).

Anticipated climate change impacts such as more intense storms and rising sea levels will demand more elaborate and extensive emergency response. More frequent and heavier downpours and floods in urban and coastal areas will cause greater personal injuries and property damage, thus creating a heavier burden on emergency responders and a growing financial toll on businesses and homeowners. Flood insurance program policies will need to be reevaluated. Emergency managers must be ready to preposition more stocks to be responsive to potentially catastrophic events. The emergency management community may be required to reevaluate how services are provided to accommodate the hazardous impacts of climate change and implement comprehensive changes to strategic plans.

The National Flood Insurance Program (NFIP) within FEMA faces dual challenges of maintaining affordable flood insurance premiums for property owners and ensuring that revenues from premiums and fees cover claims and program expenses over time. In March 2015, a congressionally mandated report from the National Research Council (NRC), the operating arm of the National Academy of Sciences, found that these objectives are often incompatible and may conflict with one another. The report
includes measures that could make insurance more affordable for all policy holders and provides a framework for policymakers to use in designing targeted assistance programs (NRC, 2015).

Still, even the most adaptive models can sometimes fall short. Maxine Burkett, Associate Professor of Law at the University of Hawai‘i at Manoa who specializes in climate justice and vulnerability, explained that in instances where destruction is so great that it lies beyond the possibility of mitigation or adaptation, an insurance-based, risk and loss approach becomes necessary (ESCP, 2015). In these scenarios, aid cannot fully provide for the rehabilitation needed following disasters, such as the devastation caused by the November 2013 Typhoon Haiyan, known as “Yolanda” in the Philippines, and the March 2015 Tropical Cyclone Pam on the island of Vanuatu. Determining how to pay for loss and damage is a “new frontier” for climate negotiations, Burkett said, and islands are “policy pioneers” (ESCP, 2015).

In 2007, the Caribbean Catastrophe Insurance Facility was founded as the first ever multi-country risk pool, allowing for lower insurance premiums by transferring risk across 16 countries. Islands in the Pacific and Indian Ocean are now seeking to replicate its success (ESCP, 2015). The Alliance of Small Island States, a coalition of 44 small-island and low-lying coastal countries, has strongly advocated for an effective loss and damage mechanism that formalizes insurance and risk transfer strategies at the international level. One of the Alliance objectives includes finance-specific language in the climate treaty to be negotiated in December 2015, with action points on how to design and introduce a structure for international funding that acknowledges shared liability, responsibility, and compensation between the Global North and South (ESCP, 2015). According to Burkett, “Supporting institutions will be key to assist in their efforts to have a more novel and ambitious policy that will aid islanders first but of course will aid us all over time because these are policies that we need for all of our communities” (ESCP, 2015).

**Future Climate Change Impact on Infrastructure and Government Budgets**

Projecting future sea levels and predicting their impact on the environment present special challenges because sea level processes are not well understood. Based on the state of science in 2007, the IPCC conservatively projected that the world’s ocean levels
would rise from 8 inches to 2 feet by the end of this century (USGCRP, 2009). Research published in May 2015 in Nature Climate Change reported satellite estimates showing that total sea level rise is lower than previous estimates, but rates of sea level rise are speeding up. Some cities such as Baltimore and Honolulu have already experienced coastal flooding 10 times more than it was in 1930, and by the 2050s sea level rise is projected to cause flooding on a moderate level for 26 major U.S. cities. Extreme flooding and super storms like Sandy in the Northeast in October 2013 will become more frequent and intense. Climate Central researchers found that sea level rise caused an estimated $2 billion of the $9.6 billion in flooding damage from Sandy (Khan, 2015). The National Association of Clean Water Agencies estimates that adaptation to climate change will cost water utilities between $500 billion and $1 trillion over the next 35 years (Zients and Golfuss, 2015).

As of May 2015, more than 1 billion people lived along shorelines around the world and $11 trillion in assets were vulnerable to flooding because they are below the 100-year flood mark (Khan 2015). These coastal areas will face increasing risk from sea level rise and storm surges that threaten personal property and infrastructure including water, sewer, roads, bridges, dams, levees, electrical grids, transportation, and communication systems. The NRC and other climate groups warned of the destructive impacts that changes in sea levels, precipitation, and other extreme weather events can have on the infrastructure of communities struck with disaster (GAO, 2014). Much of the country’s existing infrastructure is decades old and thus vulnerable to extreme weather events. The destructive impact of climate change on aging infrastructures is compounded by the stress of other potential threats such as unchecked population growth, and rapid urbanization and industrialization.

According to the NRC and the U.S. Government Accounting Office (GAO), the nation’s infrastructure and NASA centers are vulnerable to changes in the climate (GAO, 2014). With climate change, infrastructure typically designed to operate under past climate conditions may not operate as well or for as long as planned, leading to damaging economic, environmental, and social impacts. For example, NOAA estimates that within 15 years segments of Louisiana State Highway 1, providing the only road access to a port servicing 18 percent of the nation’s oil supply, will be inundated by tides an average of 30 times annually due to relative sea level rise causing this port to close (GAO, 2013). However, reports from GAO site visits in 2014 point to key factors which enabled some local decision makers to integrate climate change into infrastructure
planning. These factors included (1) having local circumstances such as weather-related crises that spurred action, (2) learning how to use available information, (3) having access to local expertise, and (4) considering climate change impacts within existing planning processes (GAO, 2014). Generally, decision makers have not systematically considered climate change in infrastructure planning because of more immediate priorities, such as managing aging infrastructure and limited resources (GAO, 2014).

As of May 2015, forecasts projected critical shortfalls in funding requirements vital to climate change initiatives, strategies, and investments for non-government and private organizations, local, state, and federal budgets (Zients and Golfuss, 2015). Addressing aged infrastructure and disaster recovery efforts will be resource intensive, and efforts such as cap-and-trade or the imposition of a carbon tax may not generate adequate revenue to fund such efforts (Zients and Golfuss, 2015). However, some initiatives are being developed to mitigate the impacts of climate change on infrastructure. For example, in May 2015, the White House convened the nation's leading thinkers on infrastructure planning and design to highlight how projects like new roads and transit lines can be designed to foster economic opportunity and increase resilience to the impacts of climate change. Also a Federal Guide to Infrastructure Planning and Design was developed to help communities seeking to expand their pipelines of well-designed projects. This community resource guide incorporates programs and opportunities from eight federal agencies and lays out a new set of principles to inform the work of local and state governments, public and private utilities, planners, and other stakeholders around the U.S. (Zients and Golfuss, 2015). The guide is part of the Build America Investment Initiative and a federal government wide effort to help communities design and finance more and better infrastructure projects.

As dozens of studies have suggested, the U.S. is currently underinvesting in the nation's infrastructure by hundreds of billions of dollars per year. By 2045, the U.S. population will grow by 70 million people and the demands on the nation's infrastructure systems will grow respectively. For example, in 2015, the U.S. moved more than 60 tons of freight per person per year which by 2045 will grow by 45 percent. The Build America Investment Initiative and other investment programs anticipate the pressure climate change, along with population and economic growth will place on U.S. infrastructure (Zients and Golfuss, 2015).

The ominous threat of climate change impact on infrastructure and government
budgets looms large. The dire forecasts for the future approach faster and faster in the present. Communities are challenged to act now to build smarter by anticipating impending future climate disasters. This calls for integrating new technologies and design methods; utilizing the efforts of the President’s Task Force on Climate Preparedness and Resilience and Partnership for Sustainable Communities; and seeking input from the nation’s governors, mayors, and tribal leaders on how the federal government can modernize grant programs and offer better incentives for disaster resilient infrastructure (Zients and Golfuss, 2015).

**Concluding Remarks**

There are now many observed, well-documented harmful impacts of climate change on natural resources and ecosystems in many regions of the U.S. and the world. The unremitting emission of heat trapping GHGs spiking global temperatures that in turn set off the chain of devastating extreme weather events will continue into the future without swift and deliberate intervention. The litany of observed extreme climate related hazards – rising sea levels, heat waves, storms, hurricanes, floods, droughts, windstorms, wildfires, infectious diseases, and more - are projected to continue during the current century and to grow in both number and magnitude (CRS, 2012). Projections from the USGRP are that “greenhouse gas concentrations in the atmosphere will continue to increase unless the billions of tons of our annual emissions decrease substantially and that even if emissions stopped increasing, atmospheric greenhouse gas concentrations would continue to increase and remain elevated for hundreds of years” (USGRP, 2009 and 2015; See also Appendix A).

Climate change and its effects present serious challenges for all leaders and communities worldwide, especially those who are involved in disaster preparedness and emergency management. The urgent need for world leaders to move climate change challenges to the forefront of global attention and action is imperative. In 2007, when Ban Ki-moon took office as the eighth Secretary-General of the UN, he made climate change one of his top five priorities. Ban pushed the issue with governmental leaders, the private sector, NGOs, and the general public (UN, 2014). He intervened in a 2007 Climate Change Conference in Bali which was about to collapse, warning that climate change prevention was a “moral challenge.” Ban turned the conference around and continued to press for climate change initiatives. He led delegations to the Arctic, Antarctic, and the Amazon Basin to view the negative effects of climate change
first-hand (UN, 2014). With leaders like Ban the UN has continued in sponsoring major international conferences on environment and sustainable development, two of the most important earlier ones in Rio de Janeiro and Stockholm. The UN’s Intergovernmental Panel on Climate Change (IPCC) is one the most important international organizations providing a forum for climate change discussion, securing scientific information, conducting assessments and evaluations, and publishing major reports on the critical and often contentious issue of climate change. The IPCC reviews the scientific literature that has been published by scientists, governmental agencies and other groups, and then draws its conclusions and makes recommendations. The work of the IPCC is invaluable to disaster risk researchers and practitioners. It is one of the most credible entities in the scientific community (Miller, 2013).

Building on past research and the experience of climate affected communities, the work of scientists and emergency managers move on with glimmers of optimism. Recognizing the staggering and increasing economic losses and human fatalities due to global flooding, still the National Academy of Sciences (NAS) scientists claim that with concerted resilience and adaptation efforts in the most flood-prone countries, the potential economic costs could be cut by 96 percent and global fatalities reduced by 69 percent (Pidcock, 2015). In 2015, a USGRP report on mitigation found that although global emissions of GHGs have risen to unprecedented levels, technological measures and behavioral changes could limit the increase in global mean temperature to two degrees Celsius above pre-industrial levels (USGRP, 2015). And in contrast to the common narrative of small-island states being among the most vulnerable to climate change, their growing experience in climate-compatible development, disaster prevention, and coordinating information and aid in new ways are valuable strengths and assets (ESCP, 2015). Some sustainable development and adaptation efforts in island communities are leading the globe in terms of innovation, but support from the international community is necessary to fulfil the potential of these projects (ESCP, 2015).

In the final analysis, given the observed and measured harmful effects of climate change it is impossible to deny its evidence and irresponsible to ignore its dangers. Although human conflicts dominate the news in the U.S. and many other countries of the world, climate change still remains “the #1 problem and challenge because it affects all 7.2 billion people on the Earth” (Miller, 2013). Bill Miller, reporter for the UN, warns that “The challenge is to be aware that a changing climate is like a slow-motion car wreck. When the final impact is felt, it will be too late “(Miller, 2013).
Questions for Review

1. What are in your view the 5 most important climate change challenges facing the United States in the future? Explain and provide examples. What are the best ways to meet each of 5 challenges you selected. Provide at least 2 ways for each of the 5 challenges with examples.

2. What are in your view the 3 climate related disasters that are the greatest challenge to the United States? Explain and provide examples. Provide the 2 best ways to prepare for, respond to, and recover from each of 3 the climate related disasters you selected.

3. What are in your view the 2 climate related disasters that are the greatest challenge to your community? Provide the 2 best ways to prepare for, respond to, and recover from the 2 climate related disasters you selected.

4. Thinking back over your reading and response to questions for review, exercises, and assignments for this course, what are the 5 most important things you have learned? How have your perspectives and opinions changed about climate change since the beginning of this course (if they have)?

Exercise A. Initiatives Empowering America's Communities to Prepare for the Effects of Climate Change

Assignment: Read and review carefully the list of commitments by public sector agencies and private sector organizations. Select one public commitment and two private sector commitments which you believe will do the most to prepare your community for the impacts of climate change. Explain and provide reasons for each of the three commitments you selected. (8-10 pages using all sources, including those referenced in this chapter).


“Climate change is a fact. And when our children’s children look us in the eye and ask if we did all we could to leave them a safer, more stable world, with new
sources of energy, I want us to be able to say yes, we did."—President Barack Obama, State of the Union Address, January 28, 2014.

In June, 2014 President Obama announced a Climate Action Plan to cut carbon pollution, prepare communities for the impacts of climate change, and lead international efforts to address these global challenges. The plan noted that government agencies act to curb the carbon pollution that is driving climate change, must also prepare our citizens and communities for the climate impacts that are already underway across the country. Delivering on a commitment in the President’s Climate Action Plan of 2014, in March of 2015, the Obama Administration launched the Climate Data Initiative—a broad effort to leverage the federal government’s extensive, freely-available climate-relevant data resources to stimulate innovation and private sector entrepreneurship in support of national climate change preparedness.

President Obama reaffirmed his commitment to ensuring that communities across America have access to the information and tools they need to protect themselves from harm today and potential damage in the future. This means connecting regional and city planners, resource managers, farmers, hospitals, and businesses with data-driven tools to help them better understand, manage, and prepare for the real-world impacts associated with climate change. Maps of future sea-level rise, for instance, can help builders decide where to break ground out of harm’s way, and other online tools can help water utility operators identify potential threats to the local water supply. Resulting insights gathered from data can help communities and businesses better understand and manage the risks associated with climate change. Using data about climate change that are collected by satellites and scientific equipment and turning them into easy-to-use information and tools require analysis, innovation, and cutting-edge technological expertise. Through the Climate Data Initiative, the Obama Administration urged America’s top private-sector innovators to leverage open government data resources and other datasets to build tools that will make America’s communities more resilient to climate change and to forge cross-sector partnerships to make those tools as useful as possible. Response to this call to action resulted in a number of commitments by Federal agencies and private-sector partners:
Administration Commitments:

The Climate Data Initiative builds on two significant Administration commitments: (1) to strengthen America's resilience to climate change, and (2) to make government-held data more accessible to the public, entrepreneurs, researchers, and others as fuel for innovation and economic growth. New steps taken by the Administration include:

- Launch of climate.data.gov. With leadership from the National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA), the Administration launched climate.data.gov—a new climate-focused section of Data.gov, the federal government's open data platform hosted by the General Services Administration, that will make federal data about our climate more open, accessible, and useful to citizens, researchers, entrepreneurs, and innovators. Climate.data.gov will initially focus on coastal flooding and sea level rise and already includes more than 100 curated, high-quality datasets, web services, and tools that can be leveraged by innovators to help communities prepare for the future. Over time, these data and resources will expand to provide information on other climate-relevant threats, such as to human health, energy infrastructure, and our food supply.

- Release of New Infrastructure and Geographic Map Data Relevant to Climate-Preparedness. Commitment to help communities and citizens plan for the risks of coastal flooding and other climate-change-related impacts, the U.S. Geological Survey, U.S. Department of Homeland Security (DHS), U.S. Department of Defense (DoD), and National Geospatial-Intelligence Agency (NGA) released a collection of datasets containing mapping information about hundreds of thousands of the nation’s infrastructure units and geographical features, including bridges, roads, railroad tunnels, canals, and river gauges. Providing wider access to these data to mission partners and the general public can advance preparedness for climate change impacts and other disasters. These data, which have been reviewed by DHS, DoD, USGS, and NGA and deemed non-sensitive, are being made available via user-friendly mapping services on Geoplatform.gov and Climate.data.gov.

- Support for Climate Data & Tools in the President's Budget. Recognizing the critical importance of information needed to meet the challenge of climate change, the President’s proposed FY15 Budget support for State, local, and tribal preparedness efforts, analysis of vulnerabilities of critical infrastructure,
and development and dissemination of better information and planning tools, including the Climate Resilience Toolkit and Climate Data Initiative. The Budget also includes a new $ billion Climate Resilience Fund. Opportunity, Growth, and Security Initiative, that expands on existing climate-change preparedness programs to ensure we are doing everything we can to support the safety and security of our communities and resources. The Fund will help us better understand and prepare for climate change by investing in research and unlocking data and information, including new sea-level rise analyses.

**Private Sector Commitments:**

Esri (Environmental Systems Research Institute): Providing Communities with Map-Based Planning Tools and Collaboration Platforms. Esri is an international supplier of Geographic Information System (GIS) software, web GIS and geo data base management applications. Esri revealed a new two-part initiative to help communities more effectively build climate resilience. First, Esri will develop and publish a series of free and open “maps and apps” developed in partnership with 12 cities that help address the most urgent climate-relevant needs shared among thousands of users of Esri's ArcGIS platform—such as preparing for droughts, heat waves, or flooding. Second, Esri announced a climate-focused geo-collaboration portal, an online destination to discover, contribute, and share resources critical to confronting the impacts of climate change.

- CartoDB: Announcing New Grants Program to Support Creation of Data-Driven Tools. CartoDB is a Software as a Service (SaaS) cloud computing platform that provides GIS and web mapping tools for display in a web browser. CartoDB will launch a grants program to support foundations and nonprofits in creating data-driven tools or efforts with respect to helping communities, companies, or citizens with resilience and preparedness for climate change impacts such as flooding, drought, and heat waves. The company will solicit grant applications and offer between $50 and $3500 for successful applications to be used on CartoDB infrastructure to help make climate resilience apps or projects possible. The money is to be spent in a year, and funded projects are free to reapply in the future.
• Climate Central: Releasing New Web Tools to Assess Local-Scale Sea Level Rise. Climate Central is a non-profit news organization that analyzes and reports on climate science. Climate Central will release a free web tool providing local projections, maps, and assessments of exposure to sea level rise and coastal flooding tabulated for every coastal zip code, municipality, county, and state in the U.S., along with planning, legislative, and other geographic districts. Exposure assessments will cover more than 100 demographic, economic, infrastructure, and environmental variables using data drawn mainly from federal sources, including NOAA, USGS, FEMA, DOT, DOE, DOI, EPA, FCC and the Census. Climate Central has already developed its Surging Seas Risk Finder tool for Florida, New Jersey, and New York, which is geared toward city, state, and federal planners, and commits to completing the balance of coastal states this year.

• Microsoft Research: Providing Climate Scientists with New Tools and Computing Resources. Microsoft Research announced a new program to provide climate change scientists and decision-makers free access to cloud computing resources to conduct research and analysis of climate data. Microsoft also announced a new, free climate data resource, FetchClimate, for retrieving past and present observations and for future climate-prediction information. FetchClimate will continue to be available as a free intelligent environmental information retrieval service and will now be adaptable as a cloud-based system that can be re-implemented and adapted to the specific needs of new projects.

• The World Bank: Launching New Initiative for Global Use of Open Data for Climate and Disaster Resilience. The World Bank launched a new Field Guide that serves as a model for how communities around the globe can best leverage open data for resilience to disasters and climate change impacts. As part of the World Bank's Open Data for Resilience Initiative (OpenDRI), the Field Guide builds on work across more than 20 countries to map millions of buildings and urban infrastructure; open more than 1,000 geospatial datasets to the public; and spur the development of innovative applications based on those data. The OpenDRI Field Guide will be presented at stakeholder workshops and events across the globe. Additionally, to establish a versatile framework for free access to risk data, the World Bank will share the Field Guide and other resources with at least 24 partner countries by 2016.
• MIT Climate CoLab: Crowdsourcing Solutions to Global Climate Change Preparedness. The Massachusetts Institute for Technology (MIT) Center for Collective Intelligence runs the Climate CoLab, an online platform to crowdsource solutions for what to do about global climate change. Over 10,000 people from around the world have registered as members and have submitted more than 400 proposals in contests ranging from how to generate electricity with fewer harmful emissions, to how to increase public understanding about climate change. The MIT Climate CoLab recently launched two global crowdsourcing contests in line with the White House Climate Data Initiative to generate solutions to climate change preparedness and resilience: (1) What can be done to adapt to the impacts of climate change? and (2) How can crowdsourcing provide more efficient disaster risk management? To help the public understand the potential impacts of climate change, MIT Climate CoLab’s platform also includes computer simulation models to predict phenomena such as temperature change and sea level rise.

Appendix A Future Climate Change (Related to Continued Greenhouse Gas Emissions)

Continued emissions of greenhouse gases will lead to further climate changes. Future changes are expected to include a warmer atmosphere, a warmer and more acidic ocean, higher sea levels, and larger changes in precipitation patterns. The extent of future climate change depends on what we do now to reduce greenhouse gas emissions. The more we emit, the larger future changes will be.

Increasing greenhouse gas concentrations will have many effects: Greenhouse gas concentrations in the atmosphere will continue to increase unless the billions of tons of our annual emissions decrease substantially. Increased concentrations are expected to:
  • Increase Earth’s average temperature
  • Influence the patterns and amounts of precipitation
  • Reduce ice and snow cover, as well as permafrost
  • Raise sea level
  • Increase the acidity of the oceans

These changes will impact our food supply, water resources, infrastructure, ecosystems, and even our own health. Future changes will depend on many factors:
The magnitude and rate of future climate change will primarily depend on the following factors:

- The rate at which levels of greenhouse gas concentrations in our atmosphere continue to increase
- How strongly features of the climate (e.g., temperature, precipitation, and sea level) respond to the expected increase in greenhouse gas concentrations
- Natural influences on climate (e.g., from volcanic activity and changes in the sun’s intensity) and natural processes within the climate system (e.g., changes in ocean circulation patterns)

Scientists use computer models of the climate system to better understand these issues and project future climate changes.

Past and present-day greenhouse gas emissions will affect climate far into the future: Many greenhouse gases stay in the atmosphere for long periods of time. As a result, even if emissions stopped increasing, atmospheric greenhouse gas concentrations would continue to increase and remain elevated for hundreds of years. Moreover, if we stabilized concentrations and the composition of today’s atmosphere remained steady (which would require a dramatic reduction in current greenhouse gas emissions), surface air temperatures would continue to warm. This is because the oceans, which store heat, take many decades to fully respond to higher greenhouse gas concentrations. The ocean’s response to higher greenhouse gas concentrations and higher temperatures will continue to impact climate over the next several decades to hundreds of years. [1] [2]

Future Temperature Changes: Future temperatures are expected to change further. Climate models project the following key temperature-related changes.

**Key Global Projections**

- Average global temperatures are expected to increase by 2°F to 11.5°F by 2100, depending on the level of future greenhouse gas emissions, and the outcomes from various climate models. [3]
- By 2100, global average temperature is expected to warm at least twice as much as it has during the last 100 years. [2]
- Ground-level air temperatures are expected to continue to warm more rapidly over land than oceans. [2]
- Some parts of the world are projected to see larger temperature increases than
the global average. [2]

- Key U.S. Projections
- By 2100, the average U.S. temperature is projected to increase by about 4°F to 11°F, depending on emissions scenario and climate model. [1]
- An increase in average temperatures worldwide implies more frequent and intense extreme heat events, or heat waves. The number of days with high temperatures above 90°F is expected to increase throughout the United States, especially in areas that already experience heat waves. For example, areas of the Southeast and Southwest currently experience an average of 60 days per year with a high temperature above 90°F. These areas are projected to experience 150 or more days a year above 90°F by the end of the century, under a higher emissions scenario. In addition to occurring more frequently, these very hot days are projected to be about 10°F hotter at the end of this century than they are today, under a higher emissions scenario. [1]

Future Precipitation and Storm Events: Patterns of precipitation and storm events, including both rain and snowfall are also likely to change. However, some of these changes are less certain than the changes associated with temperature. Projections show that future precipitation and storm changes will vary by season and region. Some regions may have less precipitation, some may have more precipitation, and some may have little or no change. The amount of rain falling in heavy precipitation events is likely to increase in most regions, while storm tracks are projected to shift poleward. [4] Climate models project the following precipitation and storm changes.

**Key Global Projections**

- Global average annual precipitation through the end of the century is expected to increase, although changes in the amount and intensity of precipitation will vary by region. [4]
- The intensity of precipitation events will likely increase on average. This will be particularly pronounced in tropical and high-latitude regions, which are also expected to experience overall increases in precipitation. [4]
- The strength of the winds associated with tropical storms is likely to increase. The amount of precipitation falling in tropical storms is also likely to increase. [5]
- Annual average precipitation is projected to increase in some areas and decrease in others. [6]
• Key U.S. Projections
• Northern areas are projected to become wetter, especially in the winter and spring. Southern areas, especially in the West, are projected to become drier. [1]
• Heavy precipitation events will likely be more frequent. Heavy downpours that currently occur about once every 20 years are projected to occur about every four to 15 years by 2100, depending on location. [1]
• More precipitation is expected to fall as rain rather than snow, particularly in some northern areas. [1]
• The intensity of Atlantic hurricanes is likely to increase as the ocean warms. Climate models project that for each 1.8°F increase in tropical sea surface temperatures, the rainfall rates of hurricanes could increase by 6-18% and the wind speeds of the strongest hurricanes could increase by about 1-8%. [1]
  There is less confidence in projections of the frequency of hurricanes, but the global frequency of tropical hurricanes is likely to decrease or remain essentially unchanged. [5]
• Cold-season storm tracks are expected to continue to shift northward. The strongest cold-season storms are projected to become stronger and more frequent. [1]
• Future Ice, Snowpack, and Permafrost: Arctic sea ice is already declining. [7] The area of snow cover in the Northern Hemisphere has decreased since about 1970. [7] Permafrost temperature has increased over the last century. [7] Over the next century, it is expected that sea ice will continue to decline, glaciers will continue to shrink, snow cover will continue to decrease, and permafrost will continue to thaw.

**Key Global Projections**

• For every 2°F of warming, models project about a 15% decrease in the extent of annually averaged sea ice and a 25% decrease in September Arctic sea ice. [7]
• The coastal sections of the Greenland and Antarctic ice sheets are expected to continue to melt or slide into the ocean. If the rate of this ice melting increases in the 21st century, the ice sheets could add significantly to global sea level rise. [7]
• Glaciers are expected to continue to decrease in size. The rate of melting is expected to continue to increase, which will contribute to sea level rise. [7]
• Key U.S. Projections
• Northern Hemisphere snow cover is expected to decrease by approximately 15% by 2100. [7]

• Models project the snow season will continue to shorten, with snow accumulation beginning later and melting starting earlier. Snowpack is expected to decrease in many regions. [7]

• Permafrost is expected to continue to thaw in northern latitudes. This would have large impacts in Alaska. [7]

• Future Sea Level Change: Melt water flowing from the Greenland ice sheet
Source: NASA, Warming temperatures contribute to sea level rise by: expanding ocean water; melting mountain glaciers and ice caps; and causing portions of the Greenland and Antarctic ice sheets to melt or flow into the ocean. [7] Since 1870, global sea level has risen by about 8 inches. [5] Estimates of future sea level rise vary for different regions, but global sea level for the next century is expected to rise at a greater rate than during the past 50 years. [8]

The contribution of thermal expansion, ice caps, and small glaciers to sea level rise is relatively well-studied, but the impacts of climate change on ice sheets are less understood and represent an active area of research. Thus it is more difficult to predict how much changes in ice sheets will contribute to sea level rise. [7] Ice loss from the Greenland and Antarctic ice sheets could contribute an additional 1 foot of sea level rise, depending on how the ice sheets respond. [7]

Regional and local factors will influence future relative sea level rise for specific coastlines around the world. For example, relative sea level rise depends on land elevation changes that occur as a result of subsidence (sinking) or uplift (rising).

Assuming that these historical geological forces continue, a 2-foot rise in global sea level by 2100 would result in the following relative sea level rise: [1]

- 2.3 feet at New York City
- 2.9 feet at Hampton Roads, Virginia
- 3.5 feet at Galveston, Texas
- 1 foot at Neah Bay in Washington state

Relative sea level rise also depends on local changes in currents, winds, salinity, and water temperatures, as well as proximity to thinning ice sheets. [1]

Corals require the right combination of temperature, light, and the presence of calcium carbonate (which they use to build their skeletons). As atmospheric carbon dioxide (CO2) levels rise, some of the excess CO2 dissolves into ocean water, reducing its calcium carbonate saturation. Calcium carbonate saturation has already been
reduced considerably from its pre-industrial level, and model projections suggest much greater reductions in the future. In projections for the future, it is very unlikely that calcium carbonate saturation levels will be adequate to support coral reefs in any U.S. waters. Source: USGCRP 2009. Oceans become more acidic as carbon dioxide (CO2) emissions in the atmosphere dissolve in the ocean.

This change is measured on the pH scale, with lower values being more acidic. The pH level of the oceans has decreased by approximately 0.1 pH units since pre-industrial times, which is equivalent to a 25% increase in acidity. The pH level of the oceans is projected to decrease even more by the end of the century as CO2 concentrations are expected to increase for the foreseeable future. [1] [3] Ocean acidification adversely affects many marine species, including plankton, mollusks, shellfish, and corals. As ocean acidification increases, the availability of calcium carbonate will decline. Calcium carbonate is a key building block for the shells and skeletons of many marine organisms. If atmospheric CO2 concentrations double, coral calcification rates are projected to decline by more than 30%. If CO2 concentrations continue to rise at their current rate, corals could become rare on tropical and subtropical reefs by 2050. [1] [3] [9] (See also, EPA Website Future Climate Change, 2015) Sources cited in Appendix A are as follows:


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