CLIMATE CHANGE 101
Adaptation

The Earth's climate is rapidly changing. In the United States and other nations, people are seeing how the impacts of rising global temperatures affect their communities, their livelihoods, and the natural environment. Substantially reducing greenhouse gas emissions is essential to avoiding the worst impacts of climate change. But mitigation alone is not enough. Even with emission reductions, some warming will still occur. Adaptation planning at the local, state, and national levels can limit the damage caused by climate change, as well as the long-term costs of responding to climate-related impacts that are expected to grow in number and intensity in the decades to come.

CLIMATE CHANGE IMPACTS IN THE U.S.

For more than 50 years, the Earth's climate has been changing because of increasing greenhouse gas emissions from the burning of fossil fuels such as coal and oil, as well as deforestation and other human activities.[1] The warming of the Earth's atmosphere and waters, loss of land and sea ice, and rising global sea levels are not new phenomena. However, these global changes have been occurring at increasing rates in the last 30 years, particularly in the last decade. Science shows that climate change will continue, and accelerate, in the years ahead, with significant impacts on everything from our coastlines and our health to water supplies, ecosystems, and other natural resources.

Warming and impacts vary by location. If greenhouse gas emissions continue unabated, the continental United States is expected to warm one-third more than global averages,[2] meaning that Americans can expect an increase of 3–7ºC (5.4–12.6ºF), depending on where they live. For Alaska and the Arctic region as a whole, warming projections of 4–11ºC (7.2–19.8ºF) are at least *double* the mean increase for the world.[3] Already, the Arctic region is experiencing an array of impacts, including: severe winter storm surges and flooding; infrastructure damage and loss; land erosion; species loss; and the displacement of people and communities (see Figure 1).[4]

Figure 1. Shishmaref, AK. Erosion from winter storm surges required the village to be relocated. Source: Shishmaref Erosion & Relocation Coalition

In general, scientists expect the United States to see overall increases in precipitation (along with decreases in some areas, such as the Southwest), including increases in the intensity of hurricanes and more intense heavy rainfalls. Projections also indicate declines in snowpack, earlier snow and ice melt in areas including the West and Great Lakes regions, and more land areas affected by drought and wildfires (see Table 1).[5] Sea-level rise will affect the U.S. coastline to varying degrees, with the most severe impacts projected along the Gulf of Mexico and Atlantic coastlines,

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including potentially significant losses of coastal wetlands.[6] All of these impacts will affect food and water supplies, natural resources, ecosystems, and human life and property (see Table 2). Especially hard hit will be plants and animals, as they will have more difficulty adapting to large-scale, rapid changes in climate, compared to human societies. Where the climate changes at a rate or to a level beyond their ability to adapt, many species will not survive.[7] While models can project levels of drought, precipitation and severe weather events within very large regions, these models typically do not yet provide reliable projections at smaller scales, such as for individual towns or local ecosystems. As a result, the exact location and timing of these events cannot be forecasted with certainty.

THE CASE FOR ADAPTATION PLANNING

Limits on emissions will not be enough, or happen soon enough, to avoid all impacts of climate change. Reducing emissions will

Table 1. Sample of Projected U.S. Regional Climate Impacts[3,5]

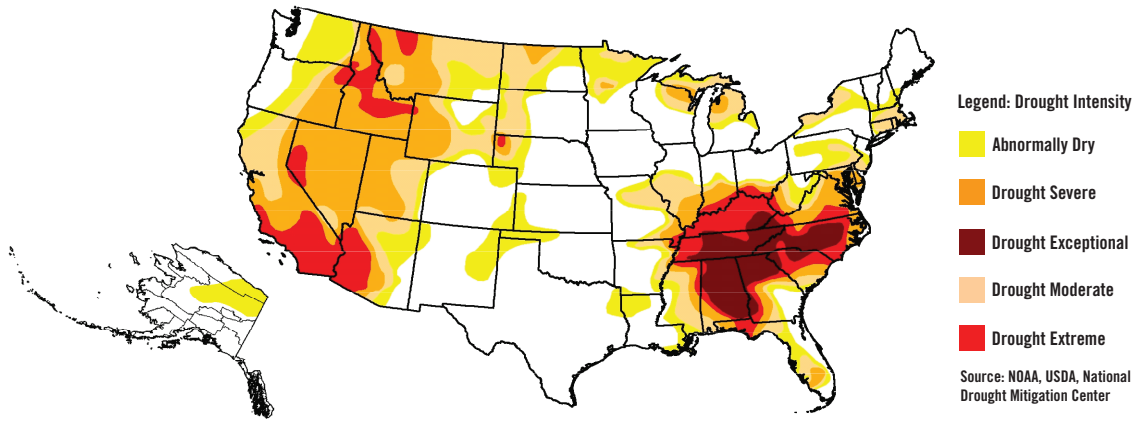
Impacts	Region
Coastal flooding/erosion[8]	South, Southeast, Mid-Atlantic, Northeast, Northwest, Alaska
Hurricanes	Atlantic and Gulf of Mexico coastal areas
Decreased snow cover and ice, more intense winter storms	Alaska, West, Great Lakes, Northeast
Flooding/intense precipitation	All regions, increasing with higher northern latitude
Sea-level rise	Atlantic and Gulf of Mexico coastal areas, San Francisco Bay/ Sacramento Delta region, Puget Sound, Alaska, Guam, Puerto Rico
Decreased precipitation and stream-flow	Southwest
Drought	Portions of the Southeast, Southwest (see Figure 2)
Wildfires[8]	West, Alaska
Intense heat waves[8]	All regions

Table 2. Sample of U.S. Sectors and Projected Impacts

Sector	Impacts
Freshwater resource management[7,9,10,11]	Salination of freshwater; water table/aquifer depletion; increased runoff and pollution of freshwater sources; earlier runoff in snowpack-dominated areas.
Agriculture[7,9,10,11]	Changes in yields due to precipitation and temperature extremes; increases in pests and disease; salination of irrigation water; changes in timing of biological events.
Coastal resources[7,9,10,11]	Inundation of low-lying areas from storm surges, sea level rise, stronger hurricanes and tropical storms; infrastructure damage; wetland loss; saltwater intrusion; loss of habitat; human displacement.
Forestry[7,9,10,11]	Forest loss to drought, wildfires, infestation, diseases, species migration and loss.
Tourism and recreation[10]	Shorter winter recreation season due to reduced snowcover; longer summer season; loss of beaches to tropical storms, storm surges; loss of forest to wildfires.
Public health/health services[7,9,10]	Increased levels of heat stress, respiratory illness, chronic disease, human displacement (short-term and long-term), infectious disease, and premature death.
Transportation infrastructure[10]	Damage from sea-level rise, erosion, flooding and temperature extremes.

Figure 2

U.S. Drought Monitor for the week of October 16, 2007



decrease the magnitude of global warming and its related impacts. But carbon dioxide and other greenhouse gases can remain in the atmosphere for decades or centuries after they are produced. This means that today's emissions will affect the climate for years to come, just as the warming we are experiencing now is the result of emissions produced in the past. Because of this time lag, the Earth is committed to some additional warming no matter what happens now to reduce emissions. As a result, there are unavoidable impacts already built into the climate system. With worldwide emissions continuing to rise, adaptation efforts are necessary to reduce both the cost and severity of both mitigation and climate change impacts for decades to come.

Current model projections underestimated actual rates of climatic changes and impacts. Recent scientific research demonstrates that many aspects of climate change are happening earlier or more rapidly than climate models and experts projected.[12] The rate of change projected for global surface temperatures, and related impacts such as ice melt and sea-level rise, is unprecedented in modern human history. We now have nearly two decades of observations that overlap with model projections. Comparing the model projections to the observations shows the models underestimated the amount of change that has actually occurred. For instance, sea-level rise has occurred 50 percent faster than the projected rate, and the area of summer Arctic sea ice has decreased at three times the projected rate, while several other aspects of climate change have also been underestimated.[13,14] Adapting to climate change will become that much harder, and that much more expensive, to the extent that the changes happen faster, or on a larger scale, than we expect going forward.[15]

Glossary of Terms

Adaptation: Actions by individuals or systems to avoid, withstand, or take advantage of current and projected climate changes and impacts. Adaptation decreases a system's vulnerability, or increases its resilience to impacts.

Adaptive Capacity: A system's inherent ability to adapt to climate change impacts.

Impact: An effect of climate change on the structure or function of a system.

Mitigation: Actions to reduce greenhouse gas emissions.

Resilience: The ability of a system to withstand negative impacts without losing its basic functions.

System: A population or ecosystem; or a grouping of natural resources, species, infrastructure, or other assets.

Vulnerability: The potential for a system to be harmed by climate change, considering the impacts of climate change on the system as well as its capacity to adapt.

Acting now to limit the potential damage from climate change is often smarter—and costs less in the long run—than acting later. There is a human tendency to address current or near-term climate impacts in a just-in-time fashion (for example, water conservation measures to prevent droughts in some southeastern U.S. cities were started only after a severe shortage was evident).

This approach may work when: the impacts are predictable or slow in developing; solutions are available and can be implemented in time to save lives, property, or natural resources; and there is low risk of irreparable harm. Even under these conditions, however, people often overlook or delay solutions that reduce the ultimate risk of harm. "Proactive adaptation" requires assessing the vulnerability of natural and man-made systems (see Glossary of Terms), as well as the costs and benefits of action versus inaction, and planning alternatives accordingly. This approach recognizes the need to factor climate change into decisions that affect the long-term susceptibility of systems to the impacts of climate change. From the methods for building or repairing bridges, dams, and other infrastructure, to the rules and regulations governing coastal development and wetland protection, the decision whether to consider climate change now will have implications down the line.

Some systems and societies are more vulnerable to the impacts of climate change than others. Climate change will affect a wide array of systems including coastal settlements, agriculture, wetlands, crops, forests, water supply and treatment systems, and roads and bridges. The vulnerability of different systems varies widely. For example, the ability of natural systems to adapt to increasing rates of climate change is generally more limited than built systems.[16] Similarly, some countries or regions, such as the United States, may be better able to adapt to climate change, or have a greater "adaptive capacity," than others. By contrast, the adaptive capacity of many developing countries is often limited by a number of vital factors, such as economic or technological resources (See Table 3). Even within developed countries such as the United States, some areas have lower adaptive capacity than others. Smart planning ensures that governments and communities are paying attention to those systems that are most vulnerable, while laying the groundwork for actions to reduce the risk to human life, ecosystems, infrastructure, and the economy.

SUCCESSFUL APPROACHES TO ADAPTATION

Adaptation services are emerging as governments, businesses, and communities worldwide are recognizing the need to address current and potential climate change impacts (see Box 3: *Adaptation Planning Resources for U.S. State and Local Action*). Common elements in terms of methodology, or processes, for confronting climate change impacts include, but are not limited to:

Recognize that adaptation must happen at local and regional levels. Climate changes and their associated impacts vary greatly from location to location. Although national and international action is essential, many important decisions about how best to manage systems affected by climate change are made at local and regional levels. For example, states and localities have authority over land use planning decisions, including zoning and building codes, as well as transportation infrastructure. In some cases, state authority is extending to provide insurance coverage where the private market is retreating, exposing these states to larger financial risks. In exercising these authorities, managers, planners, and policy makers need to account for the potential outcomes of climate change. Yet systems such as water resources and species span city, county, and state lines. As a result, adaptation also requires planners from government, the private sector, and others to coordinate their activities across jurisdictions. Those engaged in planning need to share information, plan together, and collaboratively modify existing policies and procedures to ensure efficient and effective solutions. The exchange of information, resources, best practices, and lessons learned across jurisdictional lines and among different groups of stakeholders is a key element of successful adaptation planning.

Identify key vulnerabilities. Adaptation planning requires an understanding of those systems that are most at risk—and why. That means finding answers to questions in three key areas:

- **Exposure:** What types of climate changes and impacts can we expect, and which systems will be exposed? What is the plausible range of severity of exposure, including the duration, frequency, and magnitude of changes in average climate and extremes?
- **Sensitivity:** To what extent is the system (or systems) likely to be affected as a result of projected climate

Table 3. Key Factors for Adaptive Capacity[17]	
Factors	**Examples**
Economic resources	Wealth of individuals and localities.
Technology	Localized climate and impact modeling to predict climate change and variability; efficient irrigation systems to reduce water demand.
Information/awareness	Species, sector, and geographic-based climate research; population education and awareness programs.
Skills/human resources	Training and skill development in sectors and populations; knowledge-sharing tools and support.
Natural resources	Abundant levels of varied and resilient natural resources that can recover from climate change impacts; healthy and inter-connected ecosystems that support migration patterns, species development and sustainability.
Infrastructure	Systems that provide sufficient protection and enable efficient response (e.g., wireless communication, health systems, air-conditioned shelter).
Institutional support/governance	Governmental and non-governmental policies and resources to support climate change adaptation measures locally and nationally.

changes? For instance, will the impacts be irreversible (such as death, species extinction or ecosystem loss)? What other substantial impacts can be expected (such as extensive property damage or food or water shortages)?

- **Adaptive Capacity:** To what extent can the system adapt to plausible scenarios of climate change and/or cope with projected impacts?[18] What is feasible in terms of repair, relocation, or restoration of the system? Can the system be made less vulnerable or more resilient?

Involve all key stakeholders. Successful adaptation planning relies on input from, and the alignment of, all key stakeholders. This means broadening the participants involved in identifying problems and solutions. Because the impacts of climate change span entire regions, adaptation planning should involve representatives from federal, state, and local government; science and academia; the private sector (see Box 1: *Industry Adaptation Planning*); and local communities. Successful planning will require creativity, compromise, and collaboration across agencies, sectors, and traditional geographic and jurisdictional boundaries. It also requires the involvement of experts who can help participants understand historical and current climate and other trends affecting various sectors, and who can provide completed impact assessments for other locations with similar sectors and/or projected impacts.[19]

Set priorities for action based on projected and observed impacts. For vulnerable systems, prioritizing adaptive measures based on the nature of the projected or observed impacts is vital. The Intergovernmental Panel on Climate Change published a list of criteria to aid in identifying key vulnerabilities. Some of these criteria include:

- **Magnitude:** Impacts are of large scale (high number of people or species affected) and/or high-intensity (catastrophic degree of damage caused such as loss of life, loss of biodiversity).
- **Timing:** Impacts are expected in the short term and/or are unavoidable in the long term if not addressed. Consider also those impacts with variable and unpredictable timing.
- **Persistence/Reversibility:** Impacts result in persistent damage (e.g., near permanent water shortage) or irreversible damage (e.g., disintegration of major ice sheets, species extinction).
- **Likelihood/Certainty:** Projected impacts or outcomes are likely, with a high degree of confidence (e.g., damage or harm that is clearly caused by rising temperatures or sea-level). The higher the likelihood, the more urgent the need for adaptation.
- **Importance:** Systems at risk are of great importance or value to society, such as a city or a major cultural or natural resource.

- **Equity:** The poor and vulnerable will likely be hurt the most by climate change, and are the least likely to be able to adapt. Pay special attention to those systems that lack the capacity and resources to adapt.

Choose adaptation options based on a careful assessment of efficacy, risks, and costs. Due to uncertainties in projected climate changes and in how systems will respond to those changes, adaptation options carry varying degrees of uncertainty, or risk, as well. Timing, priority setting, economic and political costs, availability of resources and skills, and the efficacy of various solutions all should be a part of the discussion. The range of options includes but is not limited to:

- **No-regret:** Actions that make sense or are worthwhile regardless of additional or exacerbated impacts from climate change. Example: protecting/restoring systems that are already vulnerable or of urgent concern for other reasons.[20]
- **Profit/opportunity:** Actions that capitalize on observed or projected climatic changes. Example: a farmer is able to shift to different crops that are better suited to changing climatic conditions.
- **"Win-win":** Actions that provide adaptation benefits while meeting other social, environmental, or economic objectives, including climate change mitigation. Example: improving the cooling capacity of buildings through improved shading or other low-energy cooling solutions.[21]
- **Low-regret:** Measures with relatively low costs for which benefits under climate change scenarios are high.[22,23] Example: incorporating climate change into forestry, water, and other public land management practices and policies, or long-term capital investment planning.

Box 1. Industry Adaptation Planning

To date, business action on climate change has primarily focused on managing the risks and opportunities associated with emerging regulations and changing market demands. But as recognition grows that some climate impacts are already occurring, and many more are likely inevitable, companies are beginning to develop adaptation plans to complement existing climate strategies.

Many of the projected impacts of climate change, such as sea level rise, increased incidence and severity of extreme weather events, and prolonged heat waves and droughts, could have serious consequences for businesses. Disruptions may include: damage to core operations, such as factories and office buildings; diminished quality and quantity of key inputs, such as water resources and forestry products; restricted access to the broader supply and demand infrastructure, such as electric utilities and transport networks; and sudden (or gradual) changes in demand for products and services.

Specific impacts will likely vary by sector. For example, higher demand for air conditioning during prolonged heat waves could stress and possibly overwhelm the electric grid. Longer and more intense rains could restrict access to construction sites and slow productivity in the buildings sector. Meanwhile, the agriculture industry is at risk of extreme drought that could render large swaths of previously arable land unusable.

Companies are beginning to recognize and act on these risks. Entergy, the New Orleans-based utility, which suffered $2 billion in losses from Hurricanes Katrina and Rita, has begun relocating important business operations to areas less vulnerable to severe weather events. Mining giant Rio Tinto is using high-resolution climate modeling to conduct detailed site assessments and gauge risks to high-priority assets. Additionally, Travelers, a major insurance company, is exploring new pricing strategies to encourage adaptive actions from its commercial and personal customers.

For more information on business approaches to adaptation, see Frances Sussman and J. Randall Freed. Forthcoming. *Adapting to Climate Change: A Business Approach.* Pew Center on Global Climate Change: Arlington, VA.

- **Avoiding unsustainable investments:** Policies or other measures that prevent new investment in areas already at high risk from current climatic events, where climate change is projected to exacerbate the impacts.[24] Example: prohibiting new development in flood-prone areas where sea-level rise is increasing and protective measures are not cost effective.
- **Averting catastrophic risk:** Policies or measures intended to avert potential or eventual catastrophic events—i.e., events so severe or intolerable that they require action in advance based on available risk assessment information. Example: relocating Alaskan villages in areas at or near sea-level with projected sea-level rise and increasing severe weather events.

U.S. STATES AND CITIES ARE BEGINNING ADAPTATION EFFORTS

Comprehensive, proactive adaptation planning is still in the early stages in the United States. As of January 2008, more than 20 bills had been introduced in Congress that addressed some aspect of adaptation. Many of the bills address mitigating impacts to fish and wildlife, natural resources, oceans or marine life. Others provide research or support to states on vital issues such as water resources or coastal impacts. A number call for both national and regional adaptation cost assessments. One bill focuses on potential conflicts over resources and environmental refugee concerns stemming from climate change. Taken together, these bills address many key adaptation challenges; increasing recognition of the need for a comprehensive approach to identifying or assessing at-risk systems, and the need to address the scope of funding and responsibility that will be required at both national and state levels to prepare for the full breadth of climate change. In the absence of current federal legislation on adaptation, and recognizing the importance of state and local action, states and localities are beginning to plan and act to address the unavoidable impacts that will occur in the decades to come.

State Actions. State governments are recognizing the need for broad-scale adaptation planning, and have started taking steps toward this goal. Five states—Arizona, Colorado, North Carolina, Utah and Vermont—acknowledge adaptation within their climate action plans addressing greenhouse gas mitigation; recommending that comprehensive state adaptation plans be created. Six other states have already started their adaptation planning efforts, in parallel with their mitigation activities; these states include Alaska, California, Florida, Maryland, Oregon and Washington (see Figure 3).

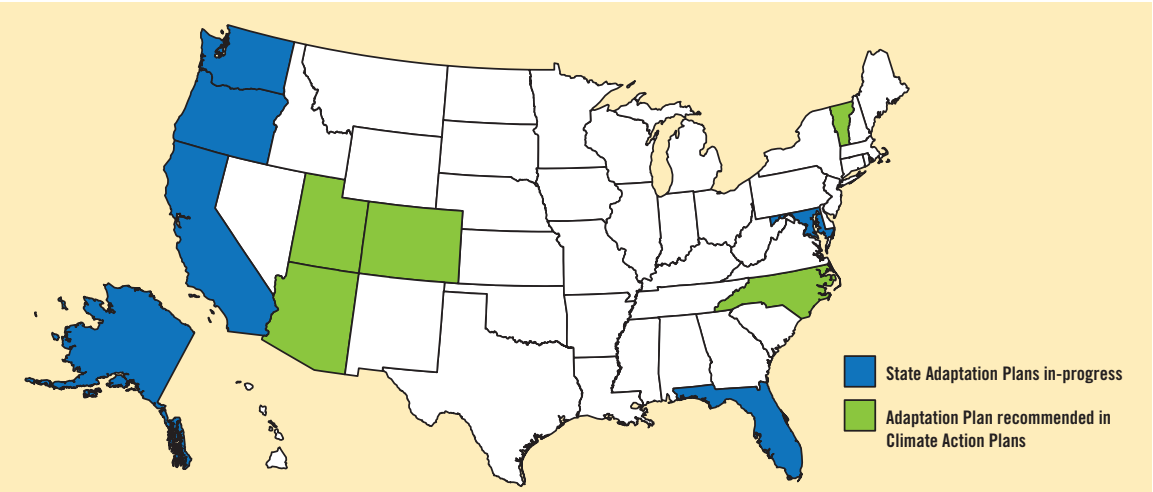
In California, political leaders recognize that climate change is having a wide range of impacts on the state's natural resources, ecosystems, infrastructure, health systems and economy. In June 2005, California Governor Arnold Schwarzenegger signed an executive order calling for biannual updates on global warming impacts facing California, as well as adaptation plans to address these impacts. As climate change continues and accelerates, it will strain these and other sectors further—bringing hotter, drier summers; increased risk of drought and wildfires; and expanded water resource needs. Through the California Energy Commission's Public Interest Energy Research program (PIER), research is under way to identify effective adaptation methods for agriculture, water resources and supply management, forest resources and wildfire management, and public health.[25]

As climate adaptation gains greater attention and resources, states will have much to learn from each other, as well as from other countries and localities where adaptation is already occurring. Additional resources to assist states and localities are available at the end of this brief (see Box 3: *Adaptation Planning Resources for U.S. State and Local Action*).

Local Actions. Hundreds of cities have created climate action plans, with more cities completing their plans every week. Although most plans are principally focused on achieving reductions in greenhouse gas emissions, communities across the United States are already taking action to address specific climate impacts. These city actions include: desalinating freshwater sources; protecting infrastructure and communities from flooding, erosion and more severe weather events; and preparing for more severe water shortages and droughts. These initiatives and others may be privately funded or managed, or they may be the responsibility of municipal, emergency response or other agencies. Currently, there is no formal process for sharing information across jurisdictions about their adaptation activities.

Figure 3

State-level Adaptation Planning



Source: Pew Center on Global Climate Change. 2007. "Adaptation: What States and Localities are Doing."

In addition to addressing specific impacts now, more localities are recognizing the need for comprehensive adaptation planning. For example, Seattle's climate action plan calls for an inter-departmental team to prioritize climate change-related issues and to make recommendations on adaptive measures and timing. The plan calls for the evaluation of impacts in several areas, including: sea-level rise, storm water management, urban forestry, building codes, and heat waves. At the same time, Seattle already is engaged in water-supply planning based on projected climate change impacts. In April 2007, New York Mayor Michael Bloomberg released his PLANYC: A Greener, Greater New York. In this plan, the mayor addresses adaptation, recognizing that the results of climate modeling indicate that New York faces significant economic and human health risks from storm surges, hurricanes and flooding, in addition to heat waves, wind storms and water contamination. While adaptation actions are already being taken to protect the city's water supply and sewage and wastewater treatment systems, in PLANYC, the Mayor calls for the city to conduct adaptation planning to protect critical infrastructure and specific communities at high risk from climate change. The plan also calls for an overall adaptation planning process.

An adaptation planning leader in the United States is King County, Washington, home to the city of Seattle. In 2006, this county formed its own inter-departmental climate change adaptation team, building scientific expertise within county departments to ensure that climate change factors were considered in policy, planning, and capital investment decisions. The county has considered climate in the development of emergency response plans, water supply planning processes, and all county plans (e.g., river and floodplain management plans). Most recently, King County and the University of Washington's Climate Impact Group co-authored a guidebook, *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments,* in association with the International Council for Local Environmental Initiatives: Local Governments for Sustainability.[26]

THE FEDERAL ROLE

Much investment is needed to help state and local governments, municipalities, private businesses, and individuals manage the impacts of climate change. At the moment, resources are lacking for adaptation planning and related activities, even though proactive approaches to reducing risks and limiting impacts can result in significant cost savings in the decades ahead, while protecting critical systems and human life.

Box 2. Adaptation: A Global Perspective

Adaptation to climate change is a challenge for all countries. Some other industrialized countries, such as the United Kingdom, Netherlands, Germany, Australia, and Canada, are ahead of the United States in planning for climate change impacts, and their experiences provide valuable lessons for U.S. policymakers (see Box 3: *Adaptation Planning Resources for State and Local Action* at the end of this brief).

From a global perspective, the adaptation challenge is probably greatest for developing countries. They are generally more vulnerable to climate change by virtue of being at lower latitudes, where impacts such as increased disease and extreme heat and drought will be more pronounced, and because their economies are more dependent on climate-sensitive sectors such as agriculture, fishing, and tourism. What's more, with lower per capita incomes, weaker institutions, and limited access to technology, developing countries have less adaptive capacity.

In the 1992 UN Framework Convention on Climate Change, the United States and other developed countries committed generally to help "particularly vulnerable" countries adapt to climate change. In coming decades, adaptation in developing countries is estimated to require tens of billions of dollars annually.[27] To date, $279 million in multilateral support has been pledged. Additional funds are now being generated through a levy on emissions credits generated through the Kyoto Protocol's Clean Development Mechanism (CDM). Under the Bali Roadmap, which launched talks on a post-2012 international climate agreement, stronger adaptation support is one of the core issues to be negotiated.

Effective international support will likely require stronger efforts both within and outside the UN climate change regime. Within the regime, options include support for comprehensive national adaptation strategies and for implementation of high-priority projects. Other support can be provided through multilateral and bilateral assistance programs to better integrate climate adaptation into the development process.

For more information on international adaptation, see Burton, I., Diringer, E., Smith, J. *Adaptation to Climate Change: International Policy Options*. The Pew Center on Global Climate Change, Arlington, VA, November 2006.

Just as the federal government must act to reduce U.S. emissions and take other steps to mitigate climate change, it must also take action on adaptation. Although not an exhaustive list, ways in which the federal government can enable efficient and effective adaptation strategies across the U.S. include:

Intellectual leadership, research and development

- Provide ongoing climate science research, with a focus on impacts, sensitivity, and adaptive capacity.
- Provide improved modeling to project climatic changes at smaller scales and better forecast state and local impacts.

Policy and regulation

- Require states to include climate change impact projections in infrastructure projects requesting federal funding.
- Require climate change adaptation screening in Environmental Impact Assessments.
- Update Federal Emergency Preparedness Plans to include potential climate change impacts and set guidelines for state preparedness plans.
- Review and update federal agency regulations and procedures where climate change impacts and adaptation are relevant, such as in the Departments of Interior and Agriculture, EPA and FEMA.

Coordination

- Support coordination and collaboration among state and local agencies, governments, and private-sector entities, particularly for cross-state or cross-jurisdictional impacts and adaptation plans (e.g., integrated or consistent response plans, interstate stakeholder agreements, species or resource management).

- Develop policies to mitigate interstate impact and adaptation issues.
- Help ensure efficiency in adaptation resource planning and implementation.

Sharing of best practices

- Acquire knowledge from nations that are ahead in adaptation planning and action.
- Leverage knowledge, skills, resources, and technologies that are available in other countries to help state and local governments efficiently implement solutions as cost-effectively as possible (See Box 2: *Adaptation—A Global Perspective*).
- Support cataloguing of state and global solutions and other forms of knowledge sharing, and oversee nationwide communication and information systems for efficient dissemination of knowledge across locales and jurisdictions.

Models and planning tools

- Provide affordable modeling and adaptation planning tools to states, municipalities, private sector entities, and communities without sufficient funding, to help identify sectors at risk and assess vulnerable systems.

Education and awareness

- Help citizens, communities, and industries understand the risks of climate change impacts and their role in local and regional adaptation efforts, incorporate climate change adaptation into their way of operating, and increase participation and support for necessary actions.
- Fund education, training, and awareness programs to ensure citizens are fully informed and participating in viable adaptation solutions.

Funding

- Provide additional resources to states and localities lacking sufficient funding for proactive adaptation planning, in order to avert more costly reactive responses in the future.
- Provide support for updated impact assessments at state and regional levels.
- Provide bilateral and multilateral assistance for adaptation planning and measures in developing countries.

Federal Lands

- Consider the impacts of climate change on federal landholdings (e.g., National Parks, Forest Service, Bureau of Land Management lands) and infrastructure (e.g., naval facilities).

PREPARING FOR THE FUTURE

While governments at all levels must begin acting to reduce greenhouse gas emissions, some degree of climate change is already inevitable. Climatic changes are happening now and are projected to increase in both frequency and severity before the benefits of emission reductions will be realized. Although mitigation is critical in addressing climate change, the need for both adaptation planning and action is also critical. The federal, state, and local governments, as well as resource managers, industry, and community leaders, all have a role to play in assessing the climate vulnerability of both natural and man-made systems, and taking action to help these systems adapt. Citizens and public and private entities can all contribute toward a common goal of averting dangerous climate risk and adequately preparing for those changes that are already unavoidable.

Additional Adaptation reports available from the Pew Center on Global Climate Change (www.pewclimate.org) include:

Coping with Climate Change—The Role of Adaptation in the United States (2004)—This report provides an in-depth analysis of the need for adaptation action and strategies in the United States, with implications and recommendations for both natural and man-made systems.

Adaptation to Climate Change: International Policy Options (2006)—This report examines options for future international efforts to help vulnerable countries adapt to the impacts of climate change both within and outside the climate framework.

Adaptation—What U.S. States and Localities are Doing (2007)—This report provides an account of states and localities that have begun adaptation planning, as well as a state level inventory of adaptation planning in state climate action plans.

Box 3. Adaptation Planning Resources for U.S. State and Local Action

U.S. Climate Change Science Program (CCSP): The Climate Change Science Program integrates federal research on climate and global change from agencies such as the Departments of Agriculture, Energy, Interior, and Transportation. Two CCSP adaptation reports currently available for review include:

- *The Impacts of Climate Variability and Change on Transportation Systems and Infrastructure*—This study looks at how climate change could affect roads, airports, rail, transit systems, pipelines, ports, and waterways for a region of the U.S. Central Gulf Coast, and ways to support transportation planning processes. http://www.climatescience.gov/Library/sap/sap4-7/sap4-7-draft3.pdf
- *Synthesis Assessment Product 4.4: Adaptation for Climate Sensitive Ecosystems and Resources* focuses on federally owned and managed lands and water, including national parks, forests, wildlife refuges, rivers, estuaries and marine protected areas. This report provides resource managers with adaptation options and processes for identifying vulnerabilities, and offers recommendations for federal roles and policies. http://www.climatescience.gov/Library/sap/sap4-4/public-review-draft/default.htm

The Convention on Biological Diversity: The Convention has created an Adaptation Planning Database and links to scientific studies and other resources, specifically for biodiversity-related climate change adaptation. The database includes data for: identifying vulnerable systems, assessing threats and impacts, identifying and evaluating options, and implementing adaptive measures. http://adaptation.cbd.int/

Eldis—Community-Based Adaptation Exchange Program: Eldis is a global services organization specializing in adaptation services in high-risk countries. It offers a database of donors, implementing agencies, academia, and policy organizations involved in adaptation. http://www.cba-exchange.org

ICLEI Local Governments for Sustainability: ICLEI is a global services organization specializing in both mitigation and adaptation support to local governments in the U.S. and globally. Through their Sustainable Cities program, ICLEI works with local governments to build resiliency to climate impacts. http://www.iclei.org

Queensland Climate Change Center of Excellence (QCCCE): Based in Australia, the QCCCE is a new unit within the state's Office of Climate Change, providing policy advice, information, and scientific data on climate change and impacts. ClimateSmart Adaptation 2007-12 (put title in italics) is the government's action plan to increase resilience to climate change impacts in key sectors including: water planning, agriculture, emergency services, human health, tourism, finance, and insurance. http://www.climatechange.qld.gov.au/

University of Washington's Center for Science in the Earth System, Climate Impacts Group (CIG): CIG is an interdisciplinary research group studying the impacts of natural climate variability and global climate change on the U.S. Pacific Northwest. Its research focuses on four key sectors: water resources, aquatic ecosystems, forests, and coasts. CIG performs fundamental research on climate impacts and works with planners and policy makers to apply this information to regional decision-making processes. http://www.cses.washington.edu/cig/

UK Climate Impact Program (UKCIP): UKCIP provides tools and data to support climate change risk assessments and develop adaptation strategies. The program offers climate change and socio-economic scenarios, a framework for making decisions in the face of climate risk and uncertainty, and a methodology for costing the impacts of climate change. Although specific to the United Kingdom, UKCIP's tools and databases of climate change adaptation case studies and adaptation options are relevant and useful for the U.S. http://www.ukcip.org.uk/

USAID: Through their Global Climate Change Program, USAID helps developing countries and countries in transition address climate-related concerns. In 2007, USAID published a guidance manual for development planning, *Adapting to Climate Variability and Change*. This manual provides guidance on how to assess vulnerability to climate variability and change, as well as how to design or adapt projects so that they are more resilient to a range of climatic conditions. Specific cases on water, flood, and agricultural management impacts and adaptation options are included. http://www.usaid.gov/our_work/environment/climate/docs/reports/cc_vamanual.pdf

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