U.S. Environmental Protection Agency

Climate Change Adaptation Plan

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Contributors

This document was produced by the Cross-EPA Work Group on Climate Change Adaptation Planning. The Work Group members include:

Chair Senior Advisor for Climate Adaptation Office of the Administrator/Office of Policy:	Joel D. Scheraga
Office of Administration and Resources Management (OARM):	Dan Amon
Office of Air and Radiation (OAR):	Bill Perkins, Erika Sasser, Lourdes Morales
Office of the Chief Financial Officer (OCFO):	Wyatt Boyd, Jason Bossie
Office of the Congressional and Intergovernmental Relations (OCIR):	Reynold Meni
Office of Chemical Safety and Pollution Prevention (OCSPP):	Richard Dumas
Office of Enforcement and Compliance Assurance (OECA):	Gerard C. Kraus, Melanie Shepherdson, Carol Holmes
Office of Environmental Justice (OECA/OEJ):	Victoria Robinson
Office of External Affairs and Environmental Education (OEAEE):	Cathy Milbourn, Enesta Jones
Office of General Council (OGC):	James Curtin, Daniel P. Schramm, Thomas Marshall
Office of Homeland Security (OHS):	Steve Williams

Office of International and Tribal Affairs (OITA):	David Guest, Anthony Socci
Office of Policy (OP)	Gerald Filbin, Catherine Allen
Office of Research and Development (ORD):	Andy Miller, Michael Slimak
Office of Solid Waste and Emergency Response (OSWER):	Brigid Lowery, Jennifer Brady
Office of Water (OW):	Karen Metchis, Joel Corona
Region 1:	Ken Moraff, Cynthia Greene
Region 2:	Paul Simon, Irene Nielson
Region 3:	Michael Dunn, Joe Piotrowski
Region 4:	Beverly Banister, Kenneth Mitchell
Region 5	Timothy Henry, Kate Balasa
Region 6:	Jim Brown, Jim Yarbrough
Region 7:	Rebecca Weber, Toni Gargas
Region 8:	Laura Farris
Region 9:	Karen Schwinn, Suzanne Marr
Region 10:	Joyce Kelly, Bruce Duncan

Staff Support: Leah Cohen (Office of Policy)

Part 1: Vision of the Future EPA

We live in a world in which the climate is changing. Changes in climate have occurred since the formation of the planet. But humans are now influencing Earth's climate and causing it to change in unprecedented ways.

It is in this rapidly changing world that EPA is working to fulfill its mission to protect human health and the environment. Many of the outcomes EPA is working to attain (e.g., clean air, safe drinking water) are sensitive to changes in weather and climate. Until now, EPA has been able to assume that climate is relatively stable and future climate will mirror past climate. However, with climate changing more rapidly than society has experienced in the past, the past is no longer a good predictor of the future. Climate change is posing new challenges to EPA's ability to fulfill its mission.

Vision

EPA continues to fulfill its mission of protecting human health and the environment even as the climate changes.

It is essential that EPA adapt to anticipate and plan for future changes in climate. It must integrate, or mainstream, considerations of climate change into its programs, policies, rules and operations to ensure they are effective under future climatic conditions. Through climate adaptation planning, EPA will continue to protect human health and the environment, but in a way that accounts for the effects of climate change.

EPA has not yet conducted a detailed quantitative assessment of the vulnerability of its mission to climate change. This Climate Change Adaptation Plan uses expert judgment, combined with information from peer-reviewed scientific literature on the impacts of climate change, to identify potential vulnerabilities. It then presents priority actions the Agency will take to begin integrating climate adaptation planning into its activities.

EPA's focus on climate adaptation is part of a larger federal effort to increase the nation's *adaptive capacity* and promote a healthy and prosperous nation that is resilient to a changing climate . A central element of EPA's efforts to adapt to a changing climate will be to strengthen the adaptive capacity of its own staff and its partners across the country. It will increase staff's awareness of ways that climate change may affect their ability to implement effective programs. It will empower staff to integrate climate adaptation into the work they do by providing them with the necessary data, information and tools.

Adaptive Capacity

Adaptive capacity is the ability of a human or natural system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

EPA will also strengthen the adaptive capacity of its partners across the country in ways that are critical to attaining the Agency's mission. States, tribes, and local communities share responsibility for protecting human health and the environment, and partnerships with EPA are at the heart of the country's environmental protection system. These partnerships will be critical for efficient, effective and equitable implementation of climate adaptation strategies. EPA's Regional and Program Offices will therefore work with their partners, engage local stakeholders, and use a diversity of approaches to build adaptive capacity and encourage climate adaptation planning depending upon state, local, and tribal needs and conditions. EPA will continue to work with other federal agencies and international partners to enhance understanding of climate change and will also leverage collective knowledge about climate adaptation planning.

EPA *Policy Statement on Climate-Change Adaptation*

EPA issued its first *Policy Statement on Climate-Change Adaptation* in June 2011.[1] The Policy Statement recognizes that climate change can pose significant challenges to EPA's ability to fulfill its mission. It calls for the Agency to anticipate and plan for future changes in climate and incorporate considerations of climate change into its activities.

"I skate to where the puck is going to be, not where it has been."
—Hockey great, Wayne Gretzky

The Policy Statement notes that many programs throughout the Agency have already begun to anticipate and address the implications of a changing climate. These efforts have laid a solid foundation on which to build climate adaptation planning into EPA's activities. Nevertheless, more needs to be done.

The *Policy Statement* calls for the development and implementation of this EPA Climate Change Adaptation Plan to integrate climate adaptation into the Agency's programs, policies, rules and operations. Priority activities are to be identified that will be undertaken by the Program and Regional Offices, and reflected in the EPA's annual budget submissions. This Plan lays out the priority actions to begin the long-term process of integrating climate adaptation into the Agency's activities.

The *Policy Statement* also directs every EPA Program and Regional Office to develop an Implementation Plan that provides more detail on how it will meet the priorities and carry out the work called for in the agency-wide plan. At the same time, the *Policy Statement* recognizes that each Office is best positioned to determine how to integrate climate adaptation into its own activities, and provides each Office with the flexibility to develop its Implementation Plan in a manner consistent and compatible with its own circumstances and objectives.

All of this work will be guided by principles representing EPA's core values. EPA's efforts to integrate climate adaptation into existing programs and activities will use the best available

science, protect populations and locations most vulnerable to climate change and with the least ability to adapt, and use sensible analytic methods and approaches for developing adaptation strategies. Partnerships will be forged that include multiple levels of government, as well as private and nongovernmental partners throughout the country and internationally.

The *Policy Statement* acknowledges that mainstreaming adaptation planning will be an ongoing, long-term activity. The effectiveness of the Agency's adaptation activities will be monitored and evaluated to continually assess the effectiveness of actions. Lessons will be learned and shared across the Agency and with its partners at home and abroad. Likewise, EPA will learn from the experiences of its international counterparts and partners. Adjustments to the Agency's approaches and plans will be made as necessary. These adjustments will be reflected in regular updates to this agency-wide Plan.[2]

Initial Strategic Measures

EPA has established initial goals for mainstreaming climate adaptation planning into its activities. The *FY 2011-2015 EPA Strategic Plan* contains the Agency's first "strategic performance measures" for integrating climate adaptation into its day-to-day operations.[3] Explicit commitments to attain the performance measures are now included in EPA's annual budget submissions to Congress.

The strategic performance measures contained in the *FY 2011-2015 Strategic Plan* commit the Agency to integrating adaptation planning into five major rulemaking processes and five major financial assistance mechanisms by 2015, using existing authorities. They also call for the integration of adaptation planning into five major scientific models or decision-support tools used in implementing Agency environmental management programs. These *Strategic Plan* commitments represent the Agency's best and most informed judgment about the most effective mechanisms for building adaptive capacity and promoting adaptive planning within EPA and by its partners. They also provide a set of measures for monitoring the Agency's progress on adaptation planning.

EPA emphasizes the importance of evaluating activities and acting on the lessons learned. EPA will seek to identify where its climate adaptation activities might have the greatest impact on protecting human health and the environment, replicate its successes, and identify areas needing improvement. It will be an ongoing challenge to measure the direct impact of EPA's adaptation planning activities on the resilience of its programs, and on the human health and environmental outcomes it is striving to attain. The Agency will continue to explore, test and evaluate other approaches for mainstreaming adaptation planning besides those already contained in the strategic performance measures. If necessary, it will develop improved strategic measures and annual performance measures. This ongoing process of evaluation and learning is consistent with EPA's commitment to transparency and accountability.

Contribution to a Healthy and Prosperous Nation

The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government. Federal agencies now recognize that climate change poses challenges to their missions, operations and programs. Ensuring the capacity of federal government agencies to maintain essential services and achieve their missions in the face of climate change is critical for successful adaptation by the entire nation. Federal agencies are working together to plan for climate change using approaches that no longer assume past conditions are good indicators of the future. Although there is no single planning approach appropriate for all agencies, the use of consistent, but flexible, frameworks facilitates coordination across agencies and allows them to leverage common tools and methods.[4]

The federal government has an important and unique role in climate change adaptation, but is only one part of a broader effort that must include public and private partners throughout the country and internationally. Partnerships with states, tribes, local communities, other governments and international organizations, many of which have already begun to implement adaptation measures, are essential.

EPA's leadership and commitment to help build the nation's adaptive capacity are vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Endnotes

[1] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation*, June 2, 2011, http://epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf.

[2] Executive Order 13514 resulted in a process that requires every federal agency to submit annual progress reports to its sustainability and climate change adaptation plans.

[3] U.S. Environmental Protection Agency, *FY 2011-2015 EPA Strategic Plan, Achieving Our Vision* (2011), http://epa.gov/planandbudget/strategicplan.html.

[4] White House Council on Environmental Quality, *Progress Report on the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy* (Washington, DC, October 5, 2010).

2. Known Vulnerabilities to EPA's Mission from Climate Change

2.1 Climate Change and Climate Impacts

The global climate is changing, and the impacts of this change are being felt across the United States and the world. These impacts pose new challenges to EPA as it strives to fulfill its mission of protecting human health and the environment. It is essential for the EPA to adapt if it is to reduce the vulnerability of its mission to climate change and continue fulfilling its statutory, regulatory and programmatic requirements. It is vital that the EPA anticipate and plan for future changes in climate and incorporate considerations of climate change into many of its programs, policies, rules, and operations to ensure they remain effective under future climatic conditions.

Vulnerability

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

During the past 50 years, average temperature across the United States has risen more than 2°F, while precipitation has increased an average of about 5 percent. Some extreme weather events, such as heat waves, intense precipitation events and regional droughts, have become more frequent and intense. One of the precipitation trends in the United States is the increasing frequency and intensity of heavy downpours (the types of events that cause runoff of pollutants and pathogens into our rivers and streams, and cause combined sewer systems to overflow in our cities). This change in heavy downpours was responsible for most of the observed increase in overall precipitation during the last 50 years.[1] Also, during the past 50 years, sea level has risen up to 8 inches or more along some coastal areas of the United States, and has fallen in other locations.[2]

These trends are expected to continue, partly due to past and future emissions of heat-trapping greenhouse gases from human activities, but will occur against a background of natural variations in climate.[3] In the United States, temperatures are projected to warm substantially over the 21st century under all projections of future climate change. These changes pose risks for a wide range of human and environmental systems, including public health, the quality of the air we breathe and the water we drink, freshwater resources, the coastal environment, wildlife and ecosystems, infrastructure, economic activity, cultural resources and social well-being. As such, the impacts of climate change introduce vulnerabilities across the mission and goals of EPA.

Around the world all countries are expected to feel the effects of climate change, although the specific impacts will vary. The impacts, however, are expected to disproportionately affect developing countries and those already at risk.[4] Within the United States, certain parts of the

population may be especially vulnerable to climate change[5]. For example, EPA recognizes that climate change may have significant impacts on subsistence resources in rural communities, Alaskan Native villages, and Indian Country. EPA's efforts to anticipate and adapt to the effects of climate change on its core mission, therefore will include helping the most vulnerable people and places reduce their exposure to climate change and improving their capacity to predict, prepare for and avoid adverse impacts.[6]

2.2 Synthesis of EPA's Vulnerabilities

The best available science directs our attention to areas where EPA's mission, facilities, and operations may be adversely affected by climate change. EPA has not yet conducted a detailed quantitative assessment of the vulnerability of its mission to climate change. This Climate Change Adaptation Plan uses expert judgment, combined with information from peer-reviewed scientific literature on the impacts of climate change, to identify potential vulnerabilities.

The assessment of EPA's climate-related vulnerabilities is an ongoing process. This summary of known vulnerabilities should be viewed as a living document that will be updated as needed to account for new knowledge, data and scientific evidence.

This section summarizes the Agency's known mission, facility, and operational vulnerabilities. As scientific understanding increases, other vulnerabilities may join the list. This summary is organized by EPA's five strategic goals, which represent EPA's approach to its work and reflect the results it works to achieve on behalf of the American people:[7]

- Goal 1: Taking Action on Climate Change and Improving Air Quality
- Goal 2: Protecting America's Waters
- Goal 3: Cleaning Up Communities and Advancing Sustainable Development
- Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution
- Goal 5: Enforcing Environmental Laws

In addition to known vulnerabilities affecting each of the five goals, EPA has begun to assess the vulnerabilities of its facilities and operations to a changing climate. EPA must ensure the safety of its personnel, the safe and continued operation of its buildings and other critical assets (*e.g.,* vehicles), and the integrity of its grants and procurement systems. In the event of any catastrophic weather event, EPA's people, buildings and operations could be impacted. These vulnerabilities are summarized in this section. Finally, this section includes information on climate change impacts on the most vulnerable communities. For example, the Agency has a priority focus on children's environmental health and environmental justice, including minority, low-income, and indigenous populations, and these populations are discussed.

The assessment of EPA's climate change vulnerabilities is a dynamic process. The extent to which vulnerabilities have been identified and are understood varies across goals. The science of climate change will improve over time, providing greater weight of evidence to evaluate the consequences of existing and expected impacts. EPA will continue to identify new vulnerabilities and improve its understanding of known vulnerabilities as it undertakes more research, assessment, and monitoring activities, and fills in data gaps.

Examples of Data, Information, and Research Needs to Improve EPA's Assessment of its Vulnerabilities from Climate Change

Potential vulnerabilities remain difficult to assess in some areas because of limited scientific understanding of the potential impacts of climate change on some of EPA's programs. Examples of data, information, and/or research needs include:

- **Characterization of local impacts to precipitation and hydrology for use in planning long-lived water infrastructure.**
- **Monitoring shifts in water quality and aquatic ecosystems in watersheds, and methods for incorporating such changes into water quality programs.**
- **The potential impact of more intense weather events on EPA's disaster response planning efforts.**
- **The site-specific impacts of climate change on Brownfields, Corrective Action Facilities under the Resource Conservation and Recovery Act (RCRA), Superfund sites, RCRA Treatment, Storage and Disposal (TSD) facilities, non-hazardous solid waste facilities, and Leaking Underground Storage Tanks.**
- **The effect of climate change on energy efficiency programs given changes in energy demand and supply.**
- **The interactions between climate and the stratospheric ozone layer.**
- **The effects of climate change on multi-pollutant interactions in ecosystems.**
- **A characterization of climate-related trends in chemical use (*e.g.*, changing patterns of pesticide use and new chemical exposures to people and the environment), and implications for the review process for new chemicals or the registration process for new pesticides.**

2.3.1 Goal 1: Taking Action on Climate Change and Improving Air Quality

America's communities face health and environmental challenges from air pollution, some of which are exacerbated by the growing effects of climate change. EPA is working with its partners to protect public health and the environment with programs that address indoor and outdoor air quality, climate change, pollution prevention, energy efficiency, industrial air pollution, pollution from vehicles and engines, radon, acid rain, stratospheric ozone depletion, and radiation protection. Within this broad portfolio, several programmatic areas are vulnerable to future climate change, presenting challenges for EPA to continue to achieve its core mission.

The extent of vulnerability, however, differs across program areas and is tied to EPA's understanding of the science and projections of future climate change impacts. Some key areas of known vulnerability for EPA's air programs are:

Tropospheric ozone pollution is likely to increase in certain regions due to the effects of climate change. The relationship between temperature changes and tropospheric ozone formation is well understood. With climate change, higher temperatures and weaker air circulation in the United States will lead to more ozone formation even with the same level of emissions of ozone forming chemicals.[8] Studies project that climate change could increase tropospheric ozone levels over broad areas of the country, especially on the highest-ozone days.[9] Climate change also has the potential to lengthen the ozone season (the months of the year when weather conditions, along with pollutants in the air, can result in the formation of ground-level ozone in particular locations around the country), and may increase individuals' vulnerability to air pollution.[10]

EPA is working to reduce the number of areas in America that do not meet air quality standards. Increases in ozone due to climate change may make it more difficult to attain or maintain ozone standards. This will need to be taken into account when designing effective ozone precursor emission control programs.

Climate Change Impacts on Tropospheric Ozone Pollution

Studies project that climate change could increase tropospheric ozone levels over broad areas of the country. Climate change also has the potential to lengthen the ozone season, and may increase individuals' vulnerability to air pollution.

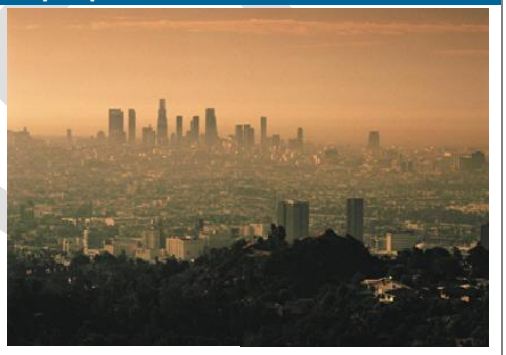


Photo: U.S. EPA

Sources: (1) U.S. EPA (2009). Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone. An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/094F. (2) K. Katsouyanni, et al., "Air Pollution and Health: A European and North American Approach (APHENA)," HEI Health Review Committee, Research Report #142 (Boston, MA: Health Effects Institute, October 2009), 5-90.

Increases in tropospheric ozone concentrations due to climate change would increase the public health burden from air pollution. The potential impacts on public health include more respiratory illnesses and increased risk of premature deaths.[11] This is a particular concern to sensitive subpopulations which are at risk for health effects from exposure to ozone. In order to better protect human health, Federal, state, tribal, and local governments will need to respond by improving the effectiveness of existing emissions control programs for ozone precursors or by implementing new control measures that will ensure attainment of the ozone National Ambient Air Quality Standards (NAAQS).

Particulate matter (PM) levels are likely to be affected through changes in the frequency or intensity of wildfires. While the impact of climate change on ambient PM levels remains somewhat uncertain, there is evidence indicating that climate change will affect PM levels through changes in the frequency or intensity of wildfires.[12] The Intergovernmental Panel on Climate Change (IPCC) has reported with very high confidence that in North America, disturbances such as wildfires are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons.[13] Forest fires are likely to increase in frequency, severity, distribution and duration in the Southeast, the Intermountain West and the West due to climate change. The potential increase in PM resulting from wildfires may increase the public health burden in affected areas, which may include sensitive subpopulations at risk for increased health effects from being exposed to PM pollution and also contribute to factors affecting attainment of the PM NAAQS and programs to address regional transport of air pollution.

Climate change may worsen the quality of indoor air. Climate change may worsen existing indoor environmental problems and introduce new ones as it alters the frequency or severity of adverse outdoor conditions. Some examples of potential indoor air quality impacts include:

- Heavy precipitation events may contribute to increases in indoor dampness and building deterioration, increasing occupants' exposure to mold and other biological contaminants and emissions from building materials, as well as outdoor environmental pollutants, due to breakdown of the protective building envelope.
- Temperature increases may affect the emergence, evolution and geographic ranges of pests, infectious agents and disease vectors. This may lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to new infestations.
- Warmer average temperatures may lead to changes in occupant behavior that may create health risks. For example, residents may spend more time indoors and in so doing, may become more prone to health risks from indoor environmental conditions. Moreover, residents may weatherize buildings to increase comfort and indoor environmental quality in addition to saving energy. Although in general, these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality.[14]

These impacts may increase public health risks, particularly to the young, the elderly, and other disproportionately impacted populations.

Climate change may alter the effects of and strategic priorities within EPA's regulatory and voluntary programs to help restore the stratospheric ozone layer. The interactions between the changing climate and ozone layer are complex. Climate change affects the ozone layer

through changes in chemical transport, atmospheric composition and temperature. In turn, changes in stratospheric ozone can have implications for the weather and climate of the troposphere. Stratospheric ozone depletion and increases in global tropospheric ozone that have occurred in recent decades have differing contributions to climate change. Additionally, climate change may exacerbate the health effects of ozone layer damage at some latitudes and mitigate them at others.[15] Ozone depletion and climate change are also linked because both ozone depleting substances and their principal substitutes are significant greenhouse gases. While the science continues to evolve, potential climate change impacts are included in the planning and implementation of the Agency's programs to protect stratospheric ozone.

Scientific understanding related to ways that climate change may affect the interactions of sulfur, nitrogen, and mercury deposition with ecosystems is evolving. While there is limited scientific evidence on this topic, additional research is underway to better understand how patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with projected changes in the climate and carbon cycle will affect ecosystem growth, species changes, surface water chemistry, and mercury methylation and bioaccumulation.[16] The potential impacts could have consequences for the effectiveness of ecosystem protection from Agency emissions reduction programs.

2.3.2 Goal 2: Protecting America's Waters

The nation's water is the lifeblood of our communities, supporting our economy and way of life, and is the basis of all ecosystems.

EPA works with its state, local and tribal partners to protect and restore the nation's waters. Together we protect public health by reducing human exposure to contaminants in drinking water, fish and shellfish, and recreational waters. We protect and restore watersheds and aquatic ecosystems by protecting the quality of rivers, lakes, streams, wetlands and coastal and ocean waters. EPA's programs include support for drinking water, wastewater and stormwater infrastructure; setting standards for protecting water quality and regulating municipal, and industrial discharges of pollutants to waters; working to control nonpoint sources of pollution; monitoring conditions of surface water, watersheds, beaches and coastal and ocean waters; and implementing programs to preserve healthy watersheds and to restore impaired waters.

Climate change alters the hydrological cycle, changing the background conditions in which natural and man-made systems function. Changes have already been observed and are expected to continue, such as warming air and water, changes in the location and amount of rain and snow, increased intensity of rainfall and tropical storms, sea level rise, changes in ocean chemistry, and indirect effects related to energy generation and fuel production.[17]

While there is relatively high confidence in our ability to project temperature increases due to climate change, projected changes in precipitation and its effects on hydrology at the local scale are less certain. Therefore, a key challenge will be how to help local decision makers understand potential local impacts, and how to make long-term plans under a new range of uncertainty about future hydrologic conditions. Water resource managers will also need to consider the local impacts of climate change as they grapple with other challenges– including population growth, land use changes, economic constraints, and a variety of stressors to the quality and quantity of our nations waters.

Climate Change Impacts on Water

Climate change impacts include too little water in some places, too much water in other places, and degraded water quality. Some locations will be subject to all of these conditions during different times of the year. Water cycle changes are expected to continue and will affect water infrastructure, energy production and use, human health, transportation, agriculture, and ecosystems.

Source: USGCRP, "Global Climate Change Impacts in the U.S."(2009), Water Sector, at: http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/water-resources

Photo: www.water.ky.gov

Protection of water quality, and restoration and protection of watersheds, wetlands, oceans, and aquatic ecosystems will be greatly challenged by changes in climate throughout the United States. EPA, working with its state, tribal, and local partners, is responsible for developing and implementing a portfolio of regulatory and non-regulatory programs to protect and improve water quality in the nation's watersheds and estuarine, coastal and ocean waters. As better information is developed for local decision making, changes may be needed in how EPA and our partners implement water quality programs, including Water Quality Standards, Total Maximum Daily Loads (TMDL), Effluent Guidelines, National Pollutant Discharge Elimination System (NPDES), nonpoint pollution control programs, and other watershed management programs.

The potential vulnerabilities of EPA's water quality programs to climate change include:

- Higher air and water temperatures will increase pollutant concentrations and lower dissolved oxygen levels, potentially resulting in additional water bodies not meeting water quality standards and being listed as impaired.
- Higher air and water temperatures combined with nutrient pollution will increase the incidence of Harmful Algal Blooms, threatening ecosystems and public health.

- Warmer waters and other ecological shifts will threaten aquatic habitats and aquatic species, such as cold water fisheries, with the potential for significant impacts on subsistence fishing tribes.
- Increased intensity of rainfall events and storms will cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams.
- Increased intensity of rainfall events and storms will cause increased pollutant loads in runoff, and the velocity of runoff will scour and erode creek beds.
- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge will result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. Competition will be exacerbated for limited water supplies for municipal, industrial, energy, agricultural, and ecological uses.
- Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of wetlands and watersheds.
- Sea-level rise combined with coastal development will challenge the ability of coastal wetlands to migrate.
- Ocean acidification resulting from the absorption of CO_2 will continue to stress coral reefs.
- As the nation pursues alternative strategies for producing energy and fuel, both to reduce greenhouse gases and to increase energy independence, local or regional demand for limited water supplies for energy and fuel production may increase, placing additional pressures on water quality programs.
- The ecological effects of climate change, such as shifts in aquatic species and their habitats or the quality of snowpack, are likely to affect the economic and cultural practices of tribal communities.
- Sea level rise and coastal surges increase erosion that can affect coastal zones that support aquatic species.

Climate change will have a significant impact on water infrastructure. In most of the United States, we enjoy the benefits of clean and safe water resulting from an extensive network of drinking water, wastewater and stormwater infrastructure. EPA recognizes that this infrastructure is aging and is being further taxed by the impacts of climate change. Additionally, as state, tribal and local governments face more demands for increasingly limited resources, the ability to respond to these growing infrastructure pressures becomes more complicated. Climate change will create vulnerabilities in the nation's infrastructure system in the following ways:

- Changes in rainfall patterns beyond the design capacity of drinking water, wastewater and stormwater infrastructure, or flooding due to increased intensity of storms, could overwhelm and damage infrastructure.

- Sea-level rise could affect water infrastructure, including drinking water intakes and wastewater outfalls, and could push saline water into coastal aquifers. Combined with tropical storms and associated storm surges, the integrity of coastal water infrastructure systems may be at increased risk.
- Drinking water and wastewater utilities need to take an "all hazards" approach to planning for emergencies and extreme weather events, which may be impacted by climate change. In order to support the efforts of such utilities, it is important for EPA guidance, tools, and technical support to also support this all hazards approach.
- Vulnerable and economically deprived communities may be particularly at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events.

Climate change will affect the quality and availability of drinking water supplies. More than 290 million people living in the United States rely on the safety of tap water provided by public water systems that are subject to national drinking water standards. EPA ensures that these water systems are sustainable and secure by developing and revising water standards, ensuring compliance with these standards, and protecting sources of drinking water from contamination.

EPA's role in drinking water is solely to protect the quality of what Americans consume. EPA does not have a direct role in ensuring adequate water supplies. However, changes in water quantity may affect water quality. The issue of water quantity is a significant issue for many communities, and will be increasingly so especially in the west and southeast. We can expect increasing numbers of communities grappling with increased drought, reduced snow pack, and challenges to water supplies. Such communities will be faced with managing competition between municipal supplies, energy production, industrial use, agricultural use, and ecological needs, and it is likely that EPA and our partners will be called on to address water quality issues in this context.

EPA has identified a number of areas where its programs designed to protect drinking water are vulnerable to climate change. These vulnerabilities include:

- Higher air and water temperatures will promote increased growth of algae and microbes, which will increase the need for drinking water treatment.
- Changes in water temperature can lead to increased risk from invasive species that can disrupt water and waste water systems.
- Increased stormwater runoff will wash sediment and other contaminants into drinking water sources, requiring additional treatment.

- Sea-level rise could increase the salinity of both surface water and ground water through saltwater intrusion, encroaching upon coastal drinking water supplies.
- Reduced annual precipitation or increased intensity and duration of drought in some regions will affect water supplies, causing drinking water providers to reassess supply plans and consider alternative pricing, allocation and water conservation options.
- Warming temperatures will cause precipitation in some areas to increasingly fall as rain rather than snow. Combined with seasonal shifts in springtime snowmelt, areas relying on snowpack to serve as a water 'reservoir' may need to develop new plans for ensuring water supplies.
- In areas with loss of snowpack or less precipitation, water demand may shift to underground aquifers or prompt development of underground storage of treated water, which will require EPA to assure the safety of such underground sources of drinking water.

2.3.3 Goal 3: Cleaning Up Communities and Advancing Sustainable Development

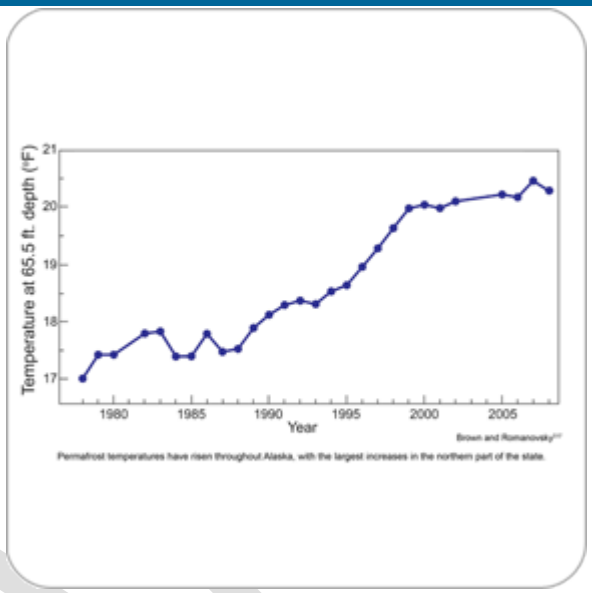
EPA's highest priorities under this goal are to prevent and reduce exposure to contaminants and accelerate the pace of cleanups across contaminated sites and properties, including Brownfields, Resource Conservation and Recovery Act (RCRA) Corrective Action Facilities, Superfund sites and Leaking Underground Storage Tanks.[18]

A range of major climate change stressors may affect contaminated sites, which in turn could affect how EPA addresses contamination and manages cleanups. In order to understand the potential impacts to these sites, EPA has begun to use broad screening analysis mapping to identify the sites most likely threatened by climate change impacts. EPA has a general understanding of the potential vulnerabilities at these sites. Key vulnerabilities identified by EPA include:

Flooding from more intense and frequent storms and sea-level rise may lead to contaminant releases from Corrective Action sites, Superfund sites, Brownfield sites and landfills.
Inundation and flooding may lead to transport of contaminants through surface soils, ground water, surface waters and/or coastal waters. Saltwater intrusion and increased ground water salinity in coastal aquifers may also increase the permeability of clay liners installed at waste sites, such as landfills, allowing contaminants to spread to nearby properties. These contaminant releases may pose an increased risk of adverse health and environmental impacts.

Changes in precipitation patterns and temperature may adversely affect the performance of the cleanup remedy and alter the efficacy of cleanups. To the extent that climate change leads to more prolonged droughts, water-intensive remedies may be impacted and the risk of wildfires spreading to contaminated sites may increase. Changes in precipitation may affect the rate at which vegetation grows at various sites and may affect phytoremediation and ecological revitalization efforts. The impacts may be positive or negative, depending on conditions at each site. Ground water processes may also be altered, resulting in potential adverse impacts on the performance and cost of remediation. To the extent that temperatures increase with climate change, contaminants at cleanup sites may become more volatile, increasing risks for local populations. The extent of this effect will depend on the contaminants at individual sites.

Increased Temperatures May Represent a Significant Risk for Waste Sites in Alaska



Temperature increases associated with climate change may lead to the melting of permafrost – which acts as a barrier to the transport of contaminants – in northern latitudes. With increased temperatures, thawing could allow contaminants to migrate more freely to adjoining areas. Source: Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf .

Climate change may also affect the ability of EPA's emergency management workforce to respond to natural disasters. If contamination occurs because of climate change, OSWER has significant capabilities to respond and minimize exposure to human populations and ecosystems. Several of EPA's programs perform these functions, including the Oil Spill Response Program and Superfund Emergency Response. These programs provide an institutional framework to use and build upon when responding to climate change impacts. When responding to emergencies, EPA often coordinates with other Federal agencies, as well as state, tribal and local organizations. These organizations will be important partners in EPA's work responding to natural disasters of increased severity and frequency.

Flooding from more intense and frequent storms and sea-level rise may disrupt existing waste management networks Flooding from sea level rise or severe storms may disrupt the transportation system in place to handle waste. For example, flooding may disrupt the pick-up of waste in neighborhoods and business or the work performed at transfer stations. Cities with transfer stations along waterways are at particular risk. A major storm event may increase the amount of solid waste generated and lead to the release of fuel or hazardous materials. Smaller entities with hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event. Changes in precipitation may impact waste management practices such as composting by affecting biological processes.

2.3.4 Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

A major component of EPA's mission is ensuring the safety of chemicals. Increasingly, the chemicals used to make our products, build our homes, and support our way of life end up in the environment and in our bodies. A changing climate can affect exposures to a wide range of chemicals. Exposures may change because of changing environmental conditions or changing use patterns. EPA's efforts to reduce exposures may be affected.

Impact of Climate Change on Pesticide Exposure Models

Many of EPA's tools and models for examining exposure to chemicals rely on inputs that are sensitive to climate data (*e.g.*, changing weather patterns, temperatures, stream flow rates, air currents and precipitation rates). EPA is in the early stages of examining the vulnerability of its models to climate change, beginning with a review of its pesticide exposure models.

Photo: U.S. EPA

Source: U.S. EPA, Memorandum: Transmittal of Meeting Minutes of the FIFRA Scientific Advisory Panel (SAP) held December 7, 2010, on Pesticide Exposure Modeling and Climate Change, March 3, 2011. SAP minutes, No. 2011-01.

EPA relies heavily on tools and models to help estimate exposures to chemicals when monitoring data are unavailable. The Agency is in the early stages of examining the ways in which its models may have to be updated to account for climate change. It has begun with a review of the potential implications of climate change for its current approaches to evaluating pesticide exposures to people and the environment.[19] These approaches are currently and will continue to be used to assess exposures to the general population, as well as children, agricultural workers and other groups who may be disproportionally affected.

EPA consulted with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP) to provide guidance on its model review and preliminary conclusions, and on sources of information that may help fill knowledge gaps. The SAP concluded that climate change is likely to affect future decisions because of its impact on pest pressure, how and where pesticides are used, and the quantity of pesticides used. Since EPA reviews pesticide registrations every 15 years using assessment methodologies that are conservative and protective of human health and the environment, it is expected that the assessments, and decisions based on them, will remain protective. However, the SAP also concluded that weather data used in models that estimate pesticide exposure are becoming dated, and thus may not adequately reflect recent changes in climate. Some of EPA's exposure models that contain climate-related variables may have to be updated as weather patterns, temperatures, stream flow rates, air currents, precipitation rates, and other climate variables continue to change.

Climate Change and FIFRA

An increase in the frequency of emergency pest problems could lead to an increase in the need for emergency exemptions under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) if currently registered pesticides are ineffective. This would allow for the use of chemicals which are not registered.

The Agency has not yet conducted vulnerability assessments of the potential impacts of climate change on exposures of people and the environment to other types of chemicals. For example, there may be increased risk of exposure to lead and asbestos as homes, buildings, and other community infrastructure are damaged by fires, high winds, and flood events. Similarly, climate change may lead to the development of new chemicals submitted for Agency review that have uses for water purification and desalinization, wastewater treatment, antimicrobial disinfection, and disease prevention. EPA will explore the need for future assessments that evaluate potential impacts like these.

2.3.5 Goal 5: Enforcing Environmental Laws

EPA protects human health and the environment through vigorous and targeted civil and criminal enforcement and by ensuring compliance with environmental laws. Climate change may affect decisions related to the enforcement of environmental laws. For example:

- The risks posed by climate change may affect decisions by EPA about where resources should be allocated to ensure compliance with rules or regulations it believes to be priorities. These enforcement priorities may be derived from a variety of sources, ranging from the Administrator's identified goals for EPA, to program-specific guidance memoranda to assist enforcement personnel in selecting appropriate enforcement mechanisms depending on site-specific circumstances.

- A flood, hurricane or wildfire can swiftly divert the Agency's focus.[20] If climate change leads to more intense weather events and increases EPA's involvement in disaster response and remediation, then enforcement efforts (as well as efforts in other EPA programs) could be affected due to a scarcity of available staff and resources.

2.3.6 EPA's Facilities and Operations

EPA must ensure the security of its personnel, the safe and continued operation of its buildings and other critical assets (*e.g.,* vehicles), and the integrity of its grants and procurement systems. In the event of any catastrophic weather event, EPA's people, buildings and operations could be affected. Based on the potential for climate change to alter water supplies and increase the frequency and severity of extreme weather events, EPA has identified the following vulnerabilities to the Agency's continued safe and efficient operations:

EPA's Gulf Ecology Division Laboratory

When Hurricane Ivan tore through Florida's Gulf Coast in September 2004, it served as a powerful reminder to EPA's Gulf Ecology Division Laboratory facilities that intelligent facility design in the 21st century requires the highest standards for safety and durability, as well as sustainability. Located on Sabine Island, a 16-acre patch of land off the coast of the Florida Panhandle, the laboratory campus was especially vulnerable to the hurricane's devastating winds and rain. In the wake of the storm, six of the 40 buildings at the campus were destroyed and had to be temporarily replaced with modular structures.

In 2008, these buildings were permanently replaced with a new Computational and Geospatial Sciences Building. This facility was designed to meet the Florida Building Code, which requires stringent hurricane mitigation techniques. It has also earned the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Silver 2.2 certification for New Construction. This building meets the demands of its environment in a sustainable manner.

(Source: "Sustainable Facilities at EPA: Computational and Geospatial Science Building, Gulf Breeze, Florida," U.S. Environmental Protection Agency, EPA-200-F-09-002, Washington, DC, 2009.)

Increased frequency and severity of extreme weather events may affect Agency facilities, personnel safety, physical security and emergency communications. Some extreme weather events are expected to become more commonplace as the climate changes, increasing the occurrence of flooding, heat waves, lightning and high winds. An increase in these events would increase the risk to EPA's personnel in the field and EPA facilities. EPA has begun to assess these vulnerabilities and has identified the following areas of potential impact:

- Severe weather and flooding could cause damage to EPA facilities, especially in coastal areas. The Agency has already seen such damage to its Gulf Ecology Division Laboratory in

Florida. Sea Level rise could also impact low lying coastal facilities and their access roads, especially when coupled with storm surges and flooding.

- Extreme weather events, including severe winds and lightning could cause damage to EPA's long-term environmental monitoring assets, particularly in coastal and flood prone areas. The Agency has already seen such damage to equipment at sites in the Clean Air Status and Trends Network and the National Atmospheric Deposition Program.
- Seasonal temperature changes and changing weather patterns can affect air quality and the general comfort of outdoor activities. Extreme heat, bad air quality or other weather conditions exacerbated by climate change may increase the health risks of EPA employees and contractors engaged in field work, such as sampling, remediation and inspections.
- Severe winds, lightning and other extreme weather events could cause power outages that disrupt EPA's security systems, outdoor lighting and emergency communication systems. Some of these systems are not linked to an uninterruptible power supply or backup generators. Outdoor lighting and security cameras are also vulnerable to direct impacts from high winds and other severe weather.

An increase in the number of extreme weather events could affect planning and management of emergency operations. During and after extreme weather events, EPA employees and contractors are dispatched to assess impacts to the environment and human health. The Agency also awards acquisitions and grants to support stakeholder emergency response. An increase in extreme weather events could result in the following impacts:

- An increase in the occurrence of extreme weather events may affect the availability of the Agency's personnel and resources to support the dispatch of emergency management personnel to assess environmental damage and test sites for air quality, water quality and other human health and environmental threats. At the same time, EPA personnel would increasingly be drawn away from their normal day-to-day activities to respond to extreme weather events or emergencies.
- Changing weather patterns and weather events may increase the demand for protective gear and appropriate vehicles and vessels to meet the demands of extreme working conditions during research, field work, and emergency management.
- EPA continues to award and manage acquisitions and grants during severe weather events; both those that are required for ongoing needs and those required for emergencies. An increase in such events could affect EPA's ability to assess contractor readiness and capabilities, process and award contracts, provide financial assistance, enter into interagency agreements and train essential personnel.

Changing water supplies may compromise the quality of water used at EPA facilities. Shifts in snowpack in some regions of the country could mean a change in the disposition of water supplies and potentially compromise the quality of water available to the Agency. EPA laboratories require water to conduct experiments and meet building cooling requirements. Water shortages and quality issues could have significant impacts on the Agency's ability to manage its facilities and conduct important research, particularly in drought-prone regions.

2.4 Climate Change Impacts on the Most Vulnerable Communities

Climate change will have a disproportionate effect on particular geographic locations, communities, and demographic groups.

The impacts of climate change raise environmental justice issues. Environmental justice focuses on the health of and environmental conditions affecting minority, low-income, and indigenous populations. EPA places emphasis on these populations because they have historically been exposed to a combination of physical, chemical, biological, social, and cultural factors that have imposed greater environmental burdens on them than those imposed on the general population. Climate change is likely to exacerbate existing and introduce new environmental burdens and associated health impacts in communities dealing with environmental justice challenges across the nation.[21] EPA's *Policy Statement on Climate Change Adaptation* calls on the Agency to focus on incorporating consideration of environmental justice into the design and evaluation of adaptation strategies.

The populations most vulnerable to climate change often include, but are not limited to, the communities that are the focus of EPA's environmental justice program. Children, the elderly, the poor, the infirm, and tribal and indigenous populations are among the most vulnerable.[22] For example, children living and playing outdoors in regions with higher ozone levels resulting from increased temperature will be at higher risk for experiencing asthma symptoms and exacerbations. The elderly are more vulnerable to heat stress because they are often in poorer health, have debilitating chronic diseases and are less able to regulate their body temperature during periods of extreme heat. They may also be taking medications that increase risk for dehydration and may live alone or have fewer social contacts, which may further exacerbate their vulnerabilities.[23] Economic constraints can also place low-income households at disproportionate risk to extreme heat events due to lack of air conditioning or failure to use air-conditioning to cut down on associated energy costs.[24]

EPA has a special obligation to work consultatively with the tribes to help them as sovereign governments address their climate adaptation concerns. EPA's 1984 *Policy for the Administration of Environmental Programs on Indian Reservations* directs the Agency to work

"in a manner consistent with the overall Federal position in support of Tribal 'self-government' and 'government-to-government' relations between Federal and Tribal Governments."

EPA is committed to integrating environmental justice and climate adaptation into its programs, policies, rules and operations in such a way that to the extent possible, it effectively protects all demographic groups, geographic locations and communities, and natural resources that are most vulnerable to climate change. The Agency will place special emphasis on overburdened populations that are least able to help themselves, and work in partnership with them to empower them to effectively adapt to climate change.

Coastal Climate Change Impacts on Low-Income Minority Communities

Climate change will affect certain groups of people more than others, depending on where they live and their ability to cope with different climate hazards. For example, a combination of sea level rise and land subsidence in coastal Louisiana has increased the area's vulnerability to storm surge and hurricane damage.[1,2] Hurricane Katrina , though not necessarily directly a result of climate change, provides an illustrative example of how storm surges can result in catastrophic effects for coastal communities and how social vulnerabilities can manifest in the form of unequal access to resources and of vulnerabilities. Barriers for the community to respond to Katrina included the lack of material resources, such as cash and access to transportation, for evacuation purposes.[3,4,5] These factors contributed to disproportionate impacts on minority and low-income communities in New Orleans. For example, African Americans were overrepresented in mortality rates in all age categories compared to their proportion of the pre-Katrina population.[6] The impacts of Hurricane Katrina were devastating and highlight the environmental as well as social vulnerabilities of coastline communities.

1. Sources:USGCRP (2009). *Global Climate Change Impacts in the United States* . Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.
2. CCSP (2008). *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Savonis, M. J., V.R. Burkett, and J.R. Potter (eds.). Department of Transportation, Washington, DC, USA, 445 pp.
3. Elliott, James R. and Jeremy Pais. 2006. "Race, class, and Hurricane Katrina: Social Differences in Human Responses to Disaster," Social Science Research, 35: 295-321.
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5. Berube, A., and B. Katz. 2005 "Katrina's Window: Confronting Concentrated Poverty Across America." The Brookings Institution Special Analysis in Metropolitan Policy.
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Climate Change Impacts on Tribal Communities

Indigenous people are among the most vulnerable communities in North America.[1] Tribes are more vulnerable to climate change impacts because of their dependence upon a specific geographic area for their livelihoods, the degree to which those geographic areas embody climate-sensitive environments, and their unique cultural, economic, or political characteristics and contexts. Also, tribes generally have fewer resources to prepare for, respond to, and recover from natural hazards, including those related to climate change.[2] The disproportionate vulnerability of tribes to climate change affects EPA's mission to protect human health and the environment in Indian country.

Examples of the impacts climate change is already having on tribes include:

- **The coastal Inupiat village of Shismaref Alaska is one of many coastal villages in Alaska facing relocation due to threats from flooding and erosion related to a rise in sea level and a decrease in sea ice. Sea walls have been broken and homes washed away. Residents have decided to relocate farther inland for safety, giving up their traditional fishing, sealing, and home-building sites.[3]**
- **Drought is perhaps the most pervasive climate-induced weather impact on tribes. Water is at the heart of many tribal cultures and the foundation of their livelihoods, economies, subsistence, and treaty rights. Water is essential to the sustainability of the fish, wildlife, and plants on which tribes rely. The recent trend toward more severe and frequent droughts, especially in the American Southwest, threatens the very underpinnings of tribal communities. The Southwest is already in the midst of a 10-15 year drought, and climate projections suggest the Southwest may transition to a more arid climate on a permanent basis over the next century and beyond.[4] In fact, climate observations indicate that this transition may have already begun.[5]**
- **Moose, a species important to many tribes in the Great Lakes region, are suffering the impacts of warmer weather. In a recent study of moose at the southern edge of their range in northwest Minnesota, researchers found that over the past 40 years, declines in the moose population are related to increases in mean temperature with winter and summer temperatures increasing by an average of 12°F and 4°F, respectively, over this period. Lack of food resources and increased exposure to deer parasites associated with warmer summer temperatures appear to be the primary causes of more decline.[6]**

Sources:

1. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds). Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. "Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability." *Cambridge University Press*, Cambridge, United Kingdom and New York, NY, USA, 2007.

2. Cutter, S.L. and C. Finch. 2008. "Temporal and spatial changes in social vulnerability to natural hazards." *Proceedings of the National Academy of Science* 105(7): 2301-2306.

3. National Research Council, *Adapting to the Impacts of Climate Change*, America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, The National Academies Press, Washington, DC, 2010.

4. Solomon, S., G-K Plattner, R. Knutti, and P. Friedlingstein, 2009. Irreversible climate change due to carbon dioxide emissions. *Proceedings of the National Academy of Sciences*, 106(6): 1,704-1,709. DOI: 10.1073/pnas.0812721106; Johanson, C.M., and Q. Fu, 2009: Hadley Cell Widening: Model Simulations versus Observations. *Journal of Climate*, 22:2,713–2,725.

5. Seager, R., et al., 2007. Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. *Science*, 316: 1,181-1,184.

6. U.S. Fish and Wildlife Service. *Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change* http://www.fws.gov/home/climatechange/pdf/CCStrategicPlan.pdf

2.5 Summary of Key Areas of Known Vulnerability

The current list of known vulnerabilities of EPA's programs to climate change are summarized in the table at the end of this report. The vulnerabilities listed in the table help to guide the Agency in identifying areas to focus its adaptation planning efforts. For several of the vulnerabilities, current scientific understanding is that the climate impact is likely or very likely to occur and EPA's best judgment is that there is a high likelihood the program will be affected. The Agency, as part of its efforts to mainstream adaptation into its programs (addressed in Part 3 of this document), will conduct a more comprehensive vulnerability assessment to determine which programs and areas are most suitable to initiate action.

This qualitative assessment has been done at a national level. It identifies vulnerabilities to entire programs within EPA to help focus the Agency's climate adaptation efforts. However, there is a "regional texture" to the impacts of climate change. The severity and importance of known vulnerabilities will vary across regions. The forthcoming *Implementation Plans* that will be produced by every EPA Regional Office will capture the regional differences and identify the vulnerabilities of greatest importance, including identifying the most vulnerable people and places within these programs. They will then describe how climate change adaptation will be integrated into their planning and work in a manner consistent and compatible with their own circumstances and objectives.

Endnotes

[1] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[2] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[3] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[4] *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Parry, M.L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., et. al., contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change 2007, "Summary for Policy Makers" (2007), 11-12.

[5] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[6] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation*, June 2, 2011, http://epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf.

[7] While the discussion of vulnerabilities is organized by goal, some of the impacts of climate change are expected to cut across goals. For example, climate change may increase the number of weather-related emergencies to which the Agency is called to respond, potentially drawing staff from multiple locations and program areas. Staff participating in emergency response work would be unavailable to complete their normal program responsibilities. Climate change is also expected to affect many of the models that EPA programs and the states use to make environmental decisions.

[8] Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[9] U.S. EPA (2009). Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone. An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/094F.

[10] Katsouyanni, K., et al.; HEI Health Review Committee (2009). Air pollution and health: a European and North American approach (APHENA). Research Report Health Effects Institute. 2009 Oct;(142):5-90.

[11] U.S. EPA. Air Quality Criteria for Ozone and Related Photochemical Oxidants (2006 Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-05/004aF-cF, 2006.

[12] Committee on Environment and Natural Resources, "Scientific Assessment of the Effects of Global Change on the United States" (Committee on Environment and Natural Resources of the National Science and Technology Council, U.S. Climate Change Science Program, 2008), http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf.

[13] C.B. Field et al., "North America," Chapter 14 in *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

[14] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

[15] World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2010*, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011).

[16] Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, 114 p.

[17] "Global Climate Change Impacts in the U.S."(2009), Water Sector, at: http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/water-resources.

[18] There may be additional sites not included in this list that occur as a result of emergency response activities or unanticipated events.

[19] Conclusions from EPA consultations with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP), a panel of external experts established under FIFRA to provide the Agency with advice on pesticide-related science matters.

[20] U.S. Environmental Protection Agency, "FY 2011-2015 EPA Strategic Plan, Achieving our Vision" (2011), 43, http://epa.gov/planandbudget/strategicplan.html.

[21] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[22] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[23] G. Luber et al., "Climate Change and Extreme Heat Events," *Am J Prev Med* 35(5), August 2008.

[24] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

Part 3: Mainstreaming Climate Change Adaptation in EPA

3.1 Building Adaptive Capacity

EPA's *Policy Statement on Climate-Change Adaptation* acknowledges the importance of adapting to climate change if the Agency is to continue fulfilling its statutory, regulatory and programmatic requirements. It is vital that the EPA anticipate and plan for future changes in climate and incorporate considerations of climate change into many of its programs, policies, rules and operations to ensure they remain effective under future climatic conditions.[1]

EPA will continue to protect human health and the environment, but in a way that accounts for the effects of climate change.

Climate change is one of many factors that can influence the effectiveness of EPA's activities over time. It is essential the Agency account for climate change as it designs its programs, policies and rules, in the same way other factors such as population growth and economic development are regularly considered. EPA will integrate, or mainstream, climate change adaptation by strengthening the adaptive capacity of its own staff. EPA will empower them to account for climate change in the normal course of doing business. It will increase staff's awareness of ways that climate change may affect their ability to implement effective programs, and provide them with the necessary data, information and tools to integrate climate adaptation into the work they do.

EPA will work to strengthen partners' adaptive capacities. The Agency will work with its state, tribal and local partners and will strive to ensure that to the greatest extent possible, their human health and environmental protection programs become resilient as the climate changes. This is particularly important since the Agency authorizes many states and tribes to implement various environmental programs. Also, EPA's efforts to help communities become more environmentally and economically sustainable could be affected by climate change. EPA will need to ensure that its tools, research, and technical assistance evolve to help communities and other entities take projected climate changes into account as they plan development. International partnerships and collaboration on adaptation will also be important to address the transboundary impacts of climate change.

The Agency's investment in building adaptive capacity is an ongoing effort. It will require a sustained, long-term commitment to empower EPA's workforce and partners by providing the information and tools necessary to account for climate change.

3.2 Guiding Principles for Adaptation at EPA

EPA has adopted a set of principles to guide all of its efforts to integrate climate adaptation into its programs, policies and rules. The principles affirm EPA's approach of integrating climate adaptation into existing programs and activities to ensure their effectiveness as the climate changes. They uphold EPA's core values of using the best available science, protecting populations and locations most vulnerable to climate change, and using sensible analytic methods and approaches for developing and implementing adaptation strategies. EPA has an important and unique role in climate adaptation, but is only one partner in a broader effort that must include multiple levels of government, as well as private, nongovernmental, and international partners. The principles call for ongoing evaluation of the effectiveness of climate change adaptation approaches, recognizing that the Agency will continue to learn how to adapt effectively over time.

Guiding Principles for Adaptation

- **Adopt integrated approaches:** **Adaptation should be incorporated into core policies, planning, practices and programs whenever possible.**
- **Prioritize the most vulnerable:** **Adaptation plans should prioritize helping people, places and infrastructure that are most vulnerable to climate impacts and be designed and implemented with meaningful involvement from all parts of society.**
- **Use best-available science:** **Adaptation should be grounded in the best-available scientific understanding of climate change risks, impacts and vulnerabilities.**
- **Build strong partnerships:** **Adaptation requires coordination across multiple sectors and scales and should build on the existing efforts and knowledge of a wide range of public and private stakeholders.**
- **Apply risk-management methods and tools:** **Adaptation planning should incorporate risk-management methods and tools to help identify, assess and prioritize options to reduce vulnerability to potential environmental, social and economic implications of climate change.**
- **Apply ecosystem-based approaches:** **Adaptation should, where relevant, take into account strategies to increase ecosystem resilience and protect critical ecosystem services on which humans depend to reduce vulnerability of human and natural systems to climate change.**
- **Maximize mutual benefits:** **Adaptation should, where possible, use strategies that complement or directly support other related climate or environmental initiatives, such as efforts to improve disaster preparedness, promote sustainable resource management, and reduce greenhouse gas emissions including the development of cost-effective technologies.**
- **Continuously evaluate performance:** **Adaptation plans should include measureable goals and performance metrics to continuously assess whether adaptive actions are achieving desired outcomes.**

(Source: The White House Council on Environmental Quality, "Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy," October 5, 2010, http://www.whitehouse.gov/sites/default/files/microsites/ceq/Interagency-Climate-Change-Adaptation-Progress-Report.pdf.)

3.3 Agency-wide Priorities

EPA has identified priority actions it will take to begin integrating climate change adaptation into its programs, policies, rules and operations. These priorities represent EPA's commitment to address the known vulnerabilities of its mission to climate change, and to continue to identify other vulnerabilities its programs may have to climate change.

Agency-wide Priorities

- **Fulfill Strategic Measures in *FY 2011–2015 EPA Strategic Plan***
- **Protect Agency facilities and operations**
- **Factor legal considerations into adaptation efforts**
- **Strengthen adaptive capacity of EPA staff and partners through training**
- **Develop decision-support tools that enable EPA staff and partners to integrate climate adaptation planning into their work**
- **Identify cross-EPA science needs related to climate adaptation**
- **Partner with tribes to increase adaptive capacity**
- **Focus on most vulnerable people and places**
- **Measure and evaluate performance**
- **Develop Program and Regional Office *Implementation Plans***

3.3.1 *Priority:* Fulfill Strategic Measures in *FY 2011-2015 EPA Strategic Plan*

EPA expects that its understanding of how to integrate climate adaptation into its programs, policies, rules and operations will improve over time. The FY 2011–2015 EPA *Strategic Plan* identified three initial mechanisms through which the Agency will begin mainstreaming climate adaptation by 2015:[2]

Strategic Measures in *FY 2011-2015 EPA Strategic Plan*

By 2015:

1. **Integrate climate change adaptation into rulemaking processes.**
2. **Integrate climate adaptation into financial mechanisms.**
3. **Develop decision-support tools.**

1. **Integration of climate change adaptation into rulemaking processes:** EPA will integrate climate change trend and scenario information into five rulemaking processes to further EPA's mission, consistent with existing authorities. The integration of climate adaptation

into Agency rulemaking processes will help ensure the rules are effective as the climate changes.[3] A variety of "entry points" can be considered, including the development of the rule itself; related policy and guidance development; and post-rule permitting, monitoring and enforcement.

EPA will enhance the ability of rule makers to address the implications of climate change through updates to the Action Development Process (ADP). This process was developed by EPA to guide the Agency's rulemaking activities from the start of the rulemaking process through the analysis of regulatory options to the final publication of a regulation. EPA will integrate climate adaptation into the ADP by:

- **Identifying process points where climate change adaptation considerations need to be identified, analyzed and discussed.** The rulemaking process[4] includes opportunities to discuss climate change adaptation considerations, both internally and with stakeholders. An Analytic Blueprint spells out a workgroup's plan for data collection and analyses to support development of a specific action. The development of an Analytic Blueprint provides an early opportunity to articulate any climate change adaptation issues that need analysis.
- **Developing guidance documents and training rule writers to understand the implications of climate change impacts.** EPA has guidance on addressing children's health and environmental justice for all of its rulemakings. EPA will develop a similar guide for climate change adaptation, and provide training. This will improve the regulatory work groups' understanding of climate change adaptation and how to consider it in rulemaking, when appropriate.

Progress is already being made to fulfill the Strategic Measures

EPA is already making progress to fulfill the three Strategic Measures. For example, the Agency issued guidance in October 2011 encouraging all Offices to include climate adaptation evaluation criteria into announcements of competitive funding opportunities. The guidance is relevant to announcements in which the outcomes to be supported by the awards are sensitive to changes in climate (*e.g.,* ability to attain air quality standards; effectiveness of water infrastructure), or the projects being solicited would be more effective if they addressed climate change adaptation issues (*e.g.,* development of models and tools to support decision making).

EPA is also already developing tools to support climate adaptation planning. For example, the BASINS tool that is designed for use by regional, state, and local agencies in performing watershed and water quality-based studies now includes a Climate Assessment Tool (CAT). CAT provides a capability for understanding how water resources could be affected by a range of potential changes in climate, and the possible effectiveness of management practices for increasing resilience of water resources to climate change.

- **Tracking and monitoring rulemakings where climate change adaptation may be an important consideration.** To help identify rulemakings where climate change adaptation may be relevant, EPA will use its internal regulatory tracking databases to manage and

report on regulatory development. This will allow EPA workgroups and stakeholders to plan and allow for integration of climate change considerations when identified in the critical process points described above.

2. **Integration of Climate Change into financial assistance mechanisms:** EPA will integrate considerations of climate change impacts and adaptive measures into five major grant, loan, contract or technical assistance programs. This will further EPA's mission, consistent with existing authorities. The integration of "climate adaptation criteria" into financial mechanisms will encourage recipients to account for climate change.

   Although this Strategic Measure is limited to a goal of five major financial assistance mechanisms by 2015, the ultimate goal is to integrate climate adaptation into all financial assistance agreements, where appropriate.

3. **Development and use of decision-support tools:** EPA will integrate climate change trend and scenario information into five major scientific models or decision-support tools used to implement Agency environmental management programs. The development of decision-support tools will help build the adaptive capacity of the Agency's workforce and its partners.

These three mechanisms represent different pathways through which the Agency can integrate climate change into ongoing programs and priorities, to attain desired environmental and human health outcomes and sustain them as the climate changes. EPA will continue to explore more pathways through which the resilience of the Agency's mission can be enhanced.

3.3.2 *Priority:* Protect Agency facilities and operations

EPA is committed to the safety of its personnel, the integrity of its buildings, and the efficiency of its operations, but the increasing frequency and severity of extreme weather events poses risks to meeting these objectives. Climate change could disrupt the operation of the Agency's programs, compromise the safety of its staff, or affect the integrity of its physical infrastructure. Adaptation planning to protect EPA's workforce, operations and underlying infrastructure is crucial.

EPA will develop and implement measures to protect its workforce and increase the resilience of its facilities and operations to climate change. For example, where possible, EPA will enhance the resilience of existing facilities in coastal areas to protect them from severe weather, flood damage, and sea level rise. The Agency will also work with other government agencies, particularly the General Services Administration, to account for climate change in the design and construction of new facilities, or when new buildings are leased.

3.3.3 *Priority:* Factor legal considerations into adaptation efforts

In appropriate circumstances, EPA should account for climate change in its programs, policies, rules, and operations, to maintain their effectiveness under conditions of environmental change and uncertainty. As a general matter, the Agency's broad mandates to protect human health and the environment afford a large reservoir of legal authority to support adaptation work. However, specific legal questions that may arise in the course of adaptation programming cannot be answered in the abstract.

As a federal agency, EPA derives its authority to act from the U.S. Constitution and the laws passed by Congress. The Agency is committed to ensuring that its actions are constitutional, authorized by statute, consistent with Congress's vision and intent, and otherwise legally supported. The 2011 EPA *Policy Statement on Climate-Change Adaptation* called on the Agency to "identify for the Office of General Counsel areas where legal analysis is needed to carry out agency actions called for in this policy statement." Because the legality of its actions is such a high priority for EPA, program managers and staff are encouraged to freely and frequently consult with the appropriate attorneys in the Office of General Counsel (OGC), Offices of Regional Counsel (ORC), and the Office of Enforcement and Compliance Assurance (OECA) as they conduct their adaptation work.

Important variation exists among the statutes EPA administers, as well as the regulatory programs EPA designs, implements, and enforces under those laws. Some of these laws, like the Clean Air Act and the Clean Water Act, give EPA regulatory powers, such as the authority to write regulations, set standards, issue permits, ensure compliance, and authorize state and tribal environmental programs. Other laws govern EPA actions in a variety of areas essential to its mission, such as research and development, budget and personnel management, contracts, and the award of financial assistance. Still other laws impose obligations on EPA, such as responsibilities to evaluate the effect of its activities on state and local governments, overburdened communities, small businesses, and endangered species, among others.

Each of these laws, whether granting EPA authority or imposing an obligation, may deserve special attention and analysis in resolving legal questions related to adaptation work. For example, EPA may need to determine the extent of its authority to incorporate adaptation measures into the terms and conditions of financial assistance mechanisms; evaluate the legal basis for considering climate change impacts in setting standards or issuing permits under the Clean Air Act and Clean Water Act; or review the adequacy of its emergency response authorities in the context of more frequent natural disasters. These examples are merely illustrative of the diversity of ways in which legal issues may arise for EPA as it mainstreams climate adaptation.

Important variation also exists in the level of scientific understanding of climate change impacts and the sensitivity of EPA programs to those impacts. These variations inform the analysis of

EPA's legal authority and responsibilities. For instance, under the Administrative Procedure Act, federal agencies like EPA have a basic obligation to act transparently and rationally. This is generally demonstrated through an administrative record that documents the analysis and reasoning leading to a final decision and responds appropriately to concerns raised by interested parties and the public, using the information available to the Agency at the time of its decision. The relative weight climate change considerations should be given in evaluating options for EPA action may depend on factors such as the time and geographic scale of the potentially relevant climate impacts compared to the temporal and spatial scale of the proposed EPA action; the strength of the scientific understanding of the climate impacts; and the environmental and economic consequences estimated to result from including or choosing not to include climate change adaptation measures or considerations in the EPA action.

Considerations such as these are by definition case specific. Over time, however, EPA anticipates that more detailed policy principles and legal precedents will emerge to further guide and inform EPA's adaptation efforts.

3.3.4 *Priority:* Strengthen adaptive capacity of EPA staff and partners through training

An organization with adaptive capacity has the ability to craft and adopt new means to achieve its goals as circumstances change. EPA needs its personnel and partners in states, tribes, and local communities to have adaptive capacity if it is to achieve its mission in the midst of climate change. EPA will build adaptive capacity through ongoing education and training. Equipped with an understanding of expected climate-related changes and adaptation approaches, and provided with and trained on how to use new decision-support tools, EPA and its partners will be able to incorporate climate change adaptation into their plans and decisions.

EPA's training, education and outreach programs that are focused on climate adaptation will evolve over time. As an initial step, EPA will design and implement a training program for its staff and its partners focused on topics relevant to EPA's mission. One goal is to increase awareness about the importance of climate change adaptation, and to encourage all EPA staff and partners to consider the changing climate in the normal course of business. A second goal of EPA's training will be to expose its staff and partners to specific approaches and tools for integrating climate adaptation into decision-making processes.

3.3.5 *Priority:* Develop decision-support tools that enable EPA staff and partners to integrate climate adaptation planning into their work

The fact that the climate is no longer relatively stable, but will continue to change in new ways, presents a major challenge for decision makers working to protect human health and the environment. Many standard practices may no longer be effective unless they account for climate change. For example, standard methods used for estimating the probability and expected frequency of floods for flood plain mapping, designing infrastructure systems, and estimating runoff of pollutants and sediments into rivers and streams are based on the assumption of climate stationarity.[5] The end of climate stationarity means that EPA and its partners need to alter their standard practices and decision routines to account for a continuously changing climate.

The assumption of stationarity

Until now, EPA (for those programs not explicitly focused on climate change) has been able to assume stationarity of climate; that is, climate is relatively stable and future climate will mirror past climate. But the past is no longer a good predictor of the future.

The development of decision-support tools plays a central role in EPA's overall efforts to adapt to climate change. Following the recommendations of the National Research Council, EPA is committed to developing decision-support tools to improve the quality and efficacy of decisions related to outcomes that are sensitive to changes in climate.[6] These tools will empower staff to consider climate, as well as changes in social and economic conditions that are influenced by climate change. They will enable staff to integrate climate adaptation planning into their work and decision-making processes. Priority will be given to the development of tools that would benefit end-users in multiple areas of EPA.

Decision Support Tools

"The effectiveness of any decision support tool depends on whether it provides information that is relevant to decision makers. Tools need to be useful at space and time scales that are meaningful and relevant for specific decisions and decision makers, and they also need to be based on up-to-date and reliable information"

(Source: National Research Council, *Informing an Effective Response to Climate Change*, America's Climate Choices: Panel on Informing Effective Decisions and Actions Related to Climate Change, The National Academies Press, Washington, DC, 2010.)

EPA will also support capacity-building for state, tribal, local, and international partners by working with them to develop and use effective decision-support tools. EPA will coordinate with other Federal agencies on developing decision-support tools with partners, when appropriate.

3.3.6 *Priority:* Identify cross-EPA science needs related to climate adaptation

Implementing effective strategies to adapt to the changing climate requires that decisions be grounded in the best available science on climate change risks, impacts and vulnerabilities, and adaptive management practices. Throughout EPA, there is a growing need for up-to-date information on the existing models, tools, data and information relevant to climate change adaptation.

EPA has made great progress in climate-related research and with the development of models and tools. However, the complex interactions of climate change impacts mean that uncertainties and data gaps persist and that multiple Agency stakeholders have a role to play in developing a research agenda. In order to identify the most pressing science needs for improved adaptation decision making, *priority* research needs related to climate change adaptation will be identified and periodically updated for the *entire* Agency through a coordinated approach. This approach is designed to produce research results that benefit end-users in multiple areas of EPA.

EPA will advance a rigorous basic and applied science program that will inform, enable and deliver innovative and sustainable solutions to environmental problems in a changing climate. The EPA Office of Research and Development (ORD) has the primary responsibility of coordinating with the Program and Regional Offices to identify the priority science needs of the Agency and its partners. This coordination is essential since some of the priority science needs will be met by ORD's research program, and some by scientists in Program and Regional Offices. In cases where other agencies could produce the scientific information needed, ORD will play a major role representing EPA's needs to other federal agencies. For example, ORD is EPA's primary representative to the U.S. Global Change Research Program (USGCRP), which coordinates and integrates climate change research across 13 federal departments and agencies.

Available data, tools, and information will be shared across the Agency and with its partners to avoid redundancy given the Agency's limited resources. To facilitate the ongoing sharing of information, EPA will establish a central repository of data (and associated metadata), models, tools and information related to climate adaptation that are produced by the Agency. The repository will also include information ("lessons learned") about methods for mainstreaming climate adaptation that have been used by particular EPA Offices that may be applicable to other users across the Agency. Where relevant to the adaptation efforts of EPA and its partners, the repository will be linked to other databases and repositories of information within EPA, as well as those produced by other federal agencies and non-federal entities.

3.3.7 *Priority:* Partner with tribes to increase adaptive capacity

EPA is committed to strengthening its partnerships with tribes on their priorities related to climate change adaptation. A unique government-to-government relationship exists between the U.S. Government and the 565 federally recognized tribes. EPA gives special consideration to tribes in developing policies that may affect their interests. EPA recognizes that tribes will likely be disproportionately vulnerable to climate change. This disproportionate vulnerability is partly due to their dependence on specific geographic areas for their livelihood; unique cultural, economic and political characteristics; and limited resources to prepare for, respond to and recover from climate-related hazards (*i.e.*, limited adaptive capacity).[7]

EPA is committed to an ongoing partnership with tribes to build their adaptive capacity and address their adaptation-related priorities.

Each Program and Regional Office Implementation Plan will support the development of adaptive capacity in the tribes and identify clear steps for ongoing collaboration with tribal governments where appropriate. These efforts will include increasing tribal capacity to identify vulnerabilities in order to adapt to a changing climate. EPA will work with tribes to support the effectiveness of national climate change adaptation programs in Indian country. The Agency will support the development of climate science to meet priority research needs and decision-support tools useful to the tribes. EPA will also work with the tribes to identify and support the use of climate change relevant traditional ecological knowledge (TEK) in decision making. EPA recognizes that TEK, as an expression of key information that links historical, cultural and local ecological conditions, may help tribes choose how they adapt to climate change while also protecting resources and resource uses important to their culture and livelihood. These efforts will leverage existing EPA partnerships with the tribes and tribal networks.

On a national level, EPA will work with other Federal agencies to collectively support tribes as they assess their vulnerabilities to climate change and plan and implement adaptation actions. Regional Offices will seek opportunities to work together with other Federal agencies' regional offices to provide strong support to tribes on their particular climate change challenges.

3.3.8: *Priority:* Focus on most vulnerable people and places

The Agency places special emphasis on, and works in partnership with, overburdened populations. As discussed in Part 2 of this report, certain parts of the population, such as children, the elderly, the poor, Tribes and indigenous people can be especially vulnerable to the impacts of climate change. This may be due to susceptibility to health impacts of environmental contaminants, economic status, health status, education or access to

information. Also, certain communities will be particularly vulnerable, such as those that are in low-lying coastal areas or subsistence fishing tribal communities. EPA's efforts to anticipate and adapt to the effects of climate change on its core mission, therefore, will include helping the most vulnerable people and places reduce their exposure to climate change and improving their capacity to predict, prepare for and avoid adverse impacts. For example, Program and Regional implementation plans will include a focus on understanding the environmental-justice implications of climate change impacts, identifying populations and communities vulnerable to climate change and with limited ability to adapt, and incorporating consideration of environmental justice issues into the design and evaluation of adaptation strategies.

The Agency will make special efforts to connect with populations that have been historically underrepresented in decision-making in order to support the development of adaptation plans that are culturally sensitive and that improve their capacity to predict, prepare for, and avoid climate change impacts. The Agency will also continue to focus on life stages vulnerable to climate change.[8] The development of effective adaptation plans and strategies will also be improved by examining the interaction of multiple stressors, including climate change, on communities and populations.

3.3.9 *Priority:* Measure and Evaluate Performance

Evaluation is a systematic way to learn from experiences. In its *Strategic Plan*, EPA emphasizes the importance of evaluating activities and acting on the lessons learned. Through systematic evaluation, the Agency can identify where activities have the greatest impact on protecting human health and the environment; provide the roadmap needed to replicate successes; and conversely, identify areas needing improvement.

EPA will evaluate its climate change adaptation actions on an ongoing basis to assess the Agency's progress toward attaining the desired long-term outcome of mainstreaming climate change adaptation into the Agency's programs, policies, rules and operations. Based on lessons learned about the most effective climate change adaptation strategies, EPA can make adjustments to the way adaptation is integrated into its activities.

EPA's commitment to measuring and evaluating the progress it is making to integrate climate adaptation into its programs, policies, rules, and operations is discussed in greater detail in Part 4.

3.3.10 *Priority:* Develop Program and Regional Office *Implementation Plans*

EPA includes National Environmental Program Offices and National Support Offices headquartered in Washington, D.C., and 10 Regional Offices around the country. The EPA *Policy Statement on Climate-Change Adaptation* directs the development of programmatic Implementation Plans. EPA National Environmental Program Offices[9] and Regional Offices will develop their own Implementation Plans providing more detail on how they will integrate climate adaptation into their planning and work, and help address the cross-EPA priorities identified in this agency-wide plan. The National Environmental Program and Regional Offices will have flexibility to develop their Implementation Plans in a manner consistent with their own circumstances and objectives. Support Offices will assist with the implementation of the Agency-wide Plan and National Environmental Program and Regional Office Plans as they do for other initiatives. The ultimate goal of the Implementation Plans is to focus on the core missions and priorities of the Program and Regional Offices, and to ensure that their programs and operations are resilient and effective in a changing climate.

The Implementation Plans will be completed by June 28, 2013. While flexibility is essential to produce Implementation Plans that are effective and responsive in meeting each specific organization's needs, Environmental Program and Regional Offices will cooperate as they develop their respective plans, share experiences and lessons learned, and coordinate on issues that cut across Agency programs and regions. The EPA National Water Program has already developed the second iteration of its National Water Program Strategy: Response to Climate Change. The 2008 Strategy and the forthcoming 2012 revision provides opportunities for lessons learned and examples of how other EPA programs may approach development of their plans.[10]

The Cross-EPA Work Group on Climate Adaptation Planning will oversee the development of the Implementation Plans and identify required interim products (*e.g.,* comprehensive vulnerability assessments) that will facilitate the development of the Plans.

Common Areas of Focus for Implementation Plans

1. **Vulnerability assessments**
2. **Priority actions on climate adaptation**
3. **Agency-wide Strategic Measures on climate adaptation**
4. **Legal and enforcement issues**
5. **Training and outreach**
6. **Partnerships with tribes**
7. **Vulnerable Populations and Places**
8. **Evaluation and cross-Office pilot projects**

Annual highlights of progress from each Environmental Program and Region will be included in updates to the agency-wide Climate Change Adaptation Plan that will be submitted on an annual basis with the Agency's Sustainability Plan. The Implementation Plans will also be used to provide input to the Agency's annual planning and budgeting process, where appropriate.

In order to promote consistency, the Implementation Plans for all Environmental Program and Regional Offices will have several common areas of focus, as outlined in the table below. There will be diversity among the plans and some offices may have a broader scope in some areas than others. For instance, Regional Offices may be able to focus their efforts on particular geographic locations more than National Program Offices.

1. **Vulnerability assessments:** Each Implementation Plan (Office or Region) will contain an initial assessment of the implications of climate change for the organization's priorities and objectives. This assessment will build on the work presented in Part 2 of this document. Program and Regional Offices are at different stages of understanding and addressing the ways climate change may affect their respective missions. Some Implementation Plans will therefore have more detailed information on vulnerabilities than others.

2. **Priority actions for climate adaptation:** Each Implementation Plan will describe the organization-specific priorities related to climate change adaptation. At the core of each Implementation Plan will be a description of the activities that the Program or Regional Office will pursue over time to integrate climate change adaptation into its programs, policies and operations. The Plan will describe how these activities address both organization-specific priorities and the cross-Agency priorities. In addition, Implementation Plans will describe how Program and Regional Offices will work together on actions that are most effectively accomplished by more than one Office or Region.

   For each action, the Implementation Plan will identify the organization's key partners at the international, federal, state, tribal, local, public and private sector levels. Attention will be given to engaging those partners who have been historically under-represented.

   Activities will include both short- and long-term actions. Short-term activities may include actions that are readily achievable, such as specific training needed to begin building adaptive capacity. Short-term activities may also focus on areas where the organization has relative certainty about climate impacts, and therefore feels that action cannot be delayed. The more immediate actions will enable the organization to learn what works. Armed with the lessons learned, the organization can move forward with insights and information as it begins to tackle additional issues. Longer-term activities will focus on building resilient, healthy communities that have the knowledge and tools needed to inform decisions.

3. Agency-wide Strategic Measures on climate adaptation: At a minimum, the Implementation Plans will consider activities that address the three existing Agency-wide Strategic Measures (discussed in Section 3.3.1 and in Part 4), to the extent they are applicable to the organization.

4. Legal and enforcement issues: Specific legal questions may arise as each Program and Regional Office integrates adaptation planning into its programs, policies, and rules. Each Office will describe how its program managers and staff will consult with the appropriate attorneys in the Office of General Counsel (OGC), Offices of Regional Counsel (ORC), and the Office of Enforcement and Compliance Assurance (OECA), as they conduct their adaptation work.

5. Training and outreach: All Program and Regional Offices will benefit from Agency-wide training activities that they will work together to develop and implement under the auspices of the Cross-EPA Work Group on Climate Change Adaptation. Each Implementation Plan will describe the ways in which the organization will use the Agency-wide training resources to educate its staff. Each Implementation Plan will also indicate how the organization will then, over time, integrate climate adaptation where appropriate into *existing* Office-specific training programs used by its workforce and external partners. Regional Offices, working in coordination with HQ Program Offices as needed, may also choose to take the lead on cross-media training and awareness-building among states and other external partners.

6. Partnerships with tribes: Each Program and Regional Office Implementation Plan will include actions to address the tribes' adaptation issues relevant to the Office. The Implementation Plans will identify how the Office will work collaboratively with tribes to increase the adaptive capacity of the tribes. This partnership will help ensure that priority tribal adaptation needs are addressed, and efforts to build adaptive capacity within tribes are effective. The Office of International and Tribal Affairs (OITA) will support the efforts of all Offices to consult and partner with the tribes to develop and implement the actions. Also, OITA will help coordinate the interactions of EPA Offices with tribes to promote unified EPA consultations with individual tribes.

7. Vulnerable populations and places. Each implementation plan will describe how the Program or Regional office will identify vulnerable populations and places to climate change. The process of conducting vulnerability assessments and determining priority actions for climate adaptation should consider how each Program and Regional Office can help vulnerable populations and places reduce their exposure to climate change and how to improve their capacity to predict, prepare for, and avoid adverse impacts. The plans are a useful tool to account for the regional variability in how climate change will impact people and places already overburdened by environmental pollution or other stressors.

8. Evaluation and cross-organization pilot projects: Each Implementation Plan will include a process for measuring and evaluating the effectiveness over time. Program and Regional Offices are encouraged to partner with each other to conduct pilot projects that test climate adaptation approaches that are broadly applicable. Relevant Implementation Plans will describe these joint efforts, as well as Office-specific pilot projects. The goal is to learn what approaches work and why. The Implementation Plans will periodically be adjusted to improve the organization's efforts to integrate climate adaptation into its activities.

3.4 Importance of Partnerships

EPA believes strong partnerships are critical to fulfilling its mission of protecting human health and the environment. As stated in the EPA *Strategic Plan*, successful partnerships make the most effective use of partners' respective bodies of knowledge, resources and talents. Partnerships are keys to effective integration of climate change adaptation considerations into the protection of human health and the environment. In general, EPA will focus adaptation work on existing geographic-based partnerships with the goal of increasing effectiveness in climate change adaptation efforts.

States, tribes, and local communities share responsibility for protecting human health and the environment, and partnerships with EPA are at the heart of the country's environmental protection system. These partnerships will be critical for efficient, effective and equitable implementation of climate adaptation strategies. EPA's Regional and Program Offices will therefore work with their partners, engage local stakeholders, and use a diversity of approaches to form the development of adaptive capacity and encourage climate adaptation planning depending upon state, tribal, and local needs and conditions.

Cross-cutting national strategies relevant to adaptation planning at EPA

- *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*
- *Draft National Fish, Wildlife and Plants Climate Adaptation Strategy*
- *Draft National Ocean Policy Implementation Plan*

(For more information: http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation)

EPA will continue to build and maintain strong partnerships with other federal agencies. For example, EPA will continue to actively participate in the Interagency Climate Change Adaptation Task Force and related working groups, including the Task Force's Agency Adaptation Working Group, the Freshwater Adaptation Working Group, the Fish, Wildlife and Plants Working Group, and the National Ocean Council. EPA will be part of the Federal Agency Climate Change

Adaptation Community of Practice, which is a forum that allows agency staff working on adaptation to share knowledge and experience on adaptation planning, implementation and evaluation. The Program and Regional Office Implementation Plans will identify specific areas of collaboration with other federal agencies where appropriate, such as in delivering support to tribes.

Finally, climate change impacts do not stop at our borders, but instead can pose risks globally. EPA is committed to working with our partners internationally to share expertise, practical experiences, information and data to address adaptation issues.

Endnotes

[1] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation*, June 2, 2011, http://epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf.

[2] U.S. Environmental Protection Agency, "FY 2011-2015 EPA Strategic Plan, Achieving Our Vision" (2011), 43, http://epa.gov/planandbudget/strategicplan.html.

[3] It will also be important, as EPA moves forward, to examine what impact rules being developed now could have in the future, taking climate into consideration.

[4] ICF Incorporated, "The Reg Map: Informal Rulemaking," 2003, http://www.reginfo.gov/public/reginfo/Regmap/regmap.pdf.

[5] National Research Council, *Informing Decisions in a Changing Climate*, Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education (Washington, DC: The National Academies Press, 2009).

[6] National Research Council, *Informing Decisions in a Changing Climate*, Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education (Washington, DC: The National Academies Press, 2009).

[7] S.L. Cutter and C. Finch, "Temporal and Spatial Changes in Social Vulnerability to Natural Hazards," *Proceedings of the National Academy of Science* 105(7) (2008), 2301-2306.

[8] In 2005 EPA started using the term life stages to refer to age-defined groups. The term life stage refers to a distinguishable time frame in an individual's life characterized by unique and relatively stable behavioral and/or physiological characteristics that are associated with development and growth. For example, EPA views childhood as a sequence of lifestages. There are other lifestages that may be important to consider when assessing human exposure and risk including, pregnancy, nursing, and middle and later years.

[9] This includes the Office of Air and Radiation (OAR), Office of Water (OW), Office of Research and Development (ORD), Office of Solid Waste and Emergency Response (OSWER), Office of Enforcement and Compliance Assurance (OECA), Office of Chemical Safety and Pollution Prevention (OCSPP) and the Office of International and Tribal Affairs (OITA).

[10] National Water Program Strategy: Response to Climate Change. 2008 and draft 2012. Available at: http://www.epa.gov/water/climatechange

Part 4: Measuring and Evaluating Performance

4.1 Existing Strategic Performance Measures

The *FY 2011-2015 EPA Strategic Plan* outlines the Agency's long-term goals, objectives, and strategic measures, which are the measurable human health and environmental results the Agency is working to achieve.[1] The *EPA Strategic Plan* acknowledges that the ability of communities to respond to changes in climate over the coming decades is critical to achieving many of the environmental outcomes the Agency is working towards. Consequently, the *EPA Strategic Plan* contains three strategic measures intended to promote the integration of climate adaptation planning into the Agency's activities.[2] The three strategic measures are focused on core Agency activities that influence its ability to fulfill its mission: (1) rule-making processes; (2) the distribution of financial resources and technical assistance; and (3) the development of science models and decision-support tools.

FY 2011-2015 Strategic Measures on Climate Adaptation

By 2015, EPA will account for climate change by integrating climate change science trend and scenario information into five rule-making processes to further EPA's mission, consistent with existing authorities (preference for one related to air quality, water quality, cleanup programs, and chemical safety.)

By 2015, EPA will build resilience to climate change by integrating considerations of climate change impacts and adaptive measures into five major grants, loan, contract, or technical assistance programs to further EPA's mission, consistent with existing authorities (preference for one related to air quality, water quality, cleanup programs, and scientific research).

By 2015, EPA will integrate climate change science trend and scenario information into five major scientific models and/or decision-support tools used in implementing Agency environmental management programs to further EPA's mission, consistent with existing authorities (preference for one related to air quality, water quality, cleanup programs, and chemical safety.)

The strategic measures are used by the Agency to design annual performance measures that are presented in EPA's *Annual Plans and Budgets*, and to establish priorities in the annual National Program Manager (NPM) Guidance. The Agency then reports on its performance against these annual measures in the *Annual Performance Reports*.

[1] U.S. Environmental Protection Agency, "FY 2011-2015 EPA Strategic Plan, Achieving Our Vision" (2011), 43, http://epa.gov/planandbudget/strategicplan.html.

[2] Performance measures can be used to provide accountability, as well as to guide decisions about program refinement and prioritization. They can be used to provide program managers and staff, and other external stakeholders, with valuable information about whether a project or program is meeting the desired goals. Measures can help identify when program goals are not being met and whether changes need to be made to meet those goals.

In its *FY 2011-2015 Strategic Plan*, EPA emphasizes the importance of continuously evaluating activities based on their progress and performance, and acting on lessons learned. EPA is already using the three strategic measures pertaining to climate change adaptation to begin evaluating its actions on an ongoing basis. Through ongoing evaluation, the Agency will learn how to effectively mainstream climate adaptation planning into its activities. EPA will evaluate what worked and why, as well as what didn't work and why not. Based on the lessons, EPA will make adjustments to the way adaptation is integrated into its activities.

Importance of Program Evaluation

Because EPA programs and regions will be learning by experience as we integrate climate change adaptation into regulation, financial mechanisms and information tools, it will be essential to apply evaluation as a tool to better understand how well approaches work and how they can be improved upon.

4.2 New Performance Measures

Over time, the Agency will identify where its adaptation activities have or can have the greatest impact on protecting human health and the environment. However, it will be an ongoing challenge to measure the direct impact of EPA's adaptation planning activities on the resilience of its programs, and on the human health and environmental outcomes it is striving to attain. Metrics that enable one to attribute changes in resilience of environmental and human health outcomes to EPA's adaptation efforts, where this is possible, do not yet exist. Such metrics need to be developed over time.

Although the three existing strategic measures do not directly attribute changes in resilience of environmental and human health outcomes to EPA's adaptation efforts, they are focused on essential processes and outcomes (*e.g.,* increased adaptive capacity gained through changes in knowledge and changes in behavior) that are important steps toward achieving the long-term goal of resilience to climate change.

As the Agency works to fulfill each of the three existing strategic measures, it might be possible to identify additional actions that must be taken to successfully attain the measures. For example, as EPA Program Offices integrate climate change adaptation into major rulemaking processes, they may discover that an effective approach is through the development of guidance for states and tribes authorized to implement Federal environmental programs. Identification of key steps like this might lead to the development of additional measures (*e.g.,* numbers of states applying climate-related aspects of EPA guidance) for evaluating EPA's progress.

As EPA works with interested states and tribes to consider climate adaptation as they implement environmental programs, it could work with them to explore ways to measure changes in their adaptive capacity. Metrics could reflect *changes in knowledge* (*e.g.,* number of partners taking formal

training to increase their awareness of the importance of adaptation planning), *changes in behavior* (*e.g.,* increases in the use of decision support tools to integrate climate adaptation planning into state and local planning activities such as infrastructure planning decisions), and *changes in state/condition* (*e.g.,* changes in the ability of communities to withstand more frequent and intense storm events and avoid, for example, combined sewer overflow events).

Some of the pilot projects that will appear in Program and Regional Office Implementation Plans may also explore innovative ways for measuring changes in adaptive capacity through changes in knowledge, changes in behavior, or changes in state/condition. These will also inform the development of future Agency strategic measures.

EPA recognizes that the integration of climate adaptation planning into its programs, policies, rules, and operations will occur over time. This change will happen in stages and measures should reflect this evolution. The earliest changes in many programs will be changes in knowledge and awareness (*e.g.,* increase in the awareness of EPA staff and their external partners of the relevance of adaptation planning to their programs). Building on this knowledge, they then will begin to change their behavior (*e.g.,* increase their use of available decision support tools to integrate adaptation planning into their work). As programs mature, there will be evidence of more projects implemented as a result of increased attention to climate-related programmatic issues. Finally, in the long-term, adaptation planning efforts will lead to changes in condition (*e.g.,* percentage of flood-prone communities that have increased their resilience to storm events) to directly support EPA's mission to protect human health and the environment.

Summary of Program Vulnerabilities to Climate Change Impacts by EPA Strategic Goal

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
Goal 1: Taking Action on Climate Change and Improving Air Quality	• Increased tropospheric ozone pollution in certain regions	• Likely[1]	• Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• High	• Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems
	• Increased frequency or intensity of wildfires	• Likely[2]	• Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• Medium	• Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires
	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very Likely[3] • Likely[3]	• Protect public health by promoting healthy indoor environments through voluntary programs and guidance	• Medium	• Could increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations
	• Effects on the stratospheric ozone layer	• Likely[4]	• Restoring the stratospheric ozone layer • Preventing UV-related disease • Providing a smooth transition to safer alternatives	• High	• Unable to restore ozone concentrations to benchmark levels as quickly at some latitudes
	• Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	• Likely[5]	• Ecosystem protections from Agency emissions reduction programs	• Low	• Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Increasing intensity of hurricanes • Increasing flood risk	• Likely[3] • Likely[3] • Very likely[6] • Likely[3] • Likely[7]	• Drinking water, wastewater and stormwater infrastructure	• High	• Water infrastructure could be overwhelmed or damaged. • Drinking water intakes and wastewater outfalls could be affected. • Integrity of coastal water infrastructure systems could be put at increased risk. • Drinking water and wastewater utilities will need an 'all hazards' approach to planning for emergencies and extreme weather events. • Problems of safety as well as access to clean and safe water will be exacerbated for vulnerable and economically deprived communities.
	• Increased water temperatures • Increasing heavy precipitation events • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Loss of snowpack	• Very likely[9] • Likely[3] • Very likely[6] • Likely[7] • Very likely[10]	• The quality and availability of safe drinking water	• Medium	• High water temperatures and increased stormwater runoff will increase the need for drinking water treatment, raising costs. • May cause saltwater intrusion in surface water and ground water, placing increased demands on drinking water treatment. • Water supplies may be affected, forcing communities to seek alternative sources. • Water demand may shift to underground aquifers or prompt development of reservoirs or underground storage of treated water, requiring EPA to ensure safety.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Sea Level Rise • Increasing heavy precipitation events • Increasing risk of floods • Changes in temperature	• Very likely[6] • Likely[7] • Likely[7] • Very likely[3]	• Cleaning up Contaminated Sites and Waste Management	• Low	• Increased risk of contaminate release from EPA Sites • May need to alter selected remedies to ensure protection.
	• Melting permafrost in Northern Regions	• Likely[10]	• Cleaning up Contaminated Sites and Waste Management	• High	• Increased risk of contaminant release at sites and potential impact to drinking water where permafrost was utilized as a containment remedy. • May need to implement new remedies to contain contaminants at sites previously protected by permafrost. •
	• Increasing intensity of hurricanes • Increasing heavy precipitation events • Increasing risk of floods	• Likely[3] • Likely[3] • Likely[7]	• Emergency Response	• High	• Increased need for emergency response. • Possible limitations to response capability due to staff and financial resource constraints.
Goal 4: Ensuring Safety of Chemicals & Preventing Pollution	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very likely[3] • Likely[3]	• Protecting human health and ecosystems from chemical risks.	• Low	• Assure that chemical exposure models reflect changes in the environment • Changing in planting timing or location may affect the volume and timing of agricultural chemical use which could impact the appropriate risk management decisions.
Facilities and Operations	• Increased Water Temperatures • Decreasing precipitation days and increasing drought intensity	• Very likely[9] • Likely[7]	• Water usage at EPA facilities	• High	• Water temperatures impact research activities or cooling requirements. • Facilities could be located in areas with water shortages

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
	• Increasing risk of floods • Increasing intensity of hurricanes • Sea level rise • Increasing extreme temperatures	• Likely [7] • Likely [3] • Very likely [6] • Very likely [3]	• Operations of Agency facilities, personnel safety, physical security, and emergency communications • Emergency management mission support (protective gear and acquisition)	• Medium	• Facilities in coastal or flood-prone areas • Personnel engaged in field work and vulnerable to extreme temperatures or events • Security, lighting and communication systems without backup power • Personnel and real property supporting emergency response and management

Footnotes for Summary of Climate Change Vulnerabilities to Climate Change Impacts by EPA Goal Table

[a]This table summarizes vulnerabilities by goal for four of the five goals in EPA's Strategic Plan. Goal 5 "Enforcing Environmental Laws" is not included in this table. Please note that the table also summarizes vulnerabilities to EPA facilities and operations; this is not part of the EPA Strategic Plan goal structure but is an important element of EPA's vulnerability assessment. Please see Section 2 of this document for a fuller discussion of impacts.

[b]Climate Change Impacts are based upon peer-reviewed scientific literature

[c] Programmatic Impacts are based upon EPA best professional judgment at this time.

[d] Impacts can vary by season and location.

[e] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, additional discussion on the likelihood term is provided in the associated footnote.

[f] **High** assumes the program will be affected by the impact; **Medium** assumes the program could be affected under some conditions by the impact; **Low** assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within EPA at this time. Please note, this column does not reflect several important considerations. For example it does not distinguish timeframes (current, near-term, long-term). It does not account for regional and local variations. And it does not reflect the priority of actions the agency may undertake now or in the future.

1) Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

2) C.B. Field et al., "North America," Chapter 14 in *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

3) IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea,K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

4) World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2010*, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011). Note: the word "expected" is used in the report to characterize projected climate change impacts on the stratospheric ozone layer. For purposes of this table the word "likely" has been used as a proxy for "expected."

5) Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, p. 114.

6) IPCC, 2012: "It is very likely that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future."

7) USGCRP, 2009: *Global Climate Change Impacts in the United States* . Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

8) NRC, 2010: National Research Council of the National Academies, America's Climate Choices: Panel on Advancing the Science of Climate Change, 2010. p 41. "One of the most certain outcomes from increasing CO_2 concentrations in the atmosphere is the acidification of the world's oceans." For purposes of this table, the term "certain" is used.

9) USGCRP, 2009: p. 46. [In the case of freshwater] "Increased air temperatures lead to higher water temperatures, which have already been detected in many streams, especially during low-flow periods." For the purposes of this table "very likely" is used.

10) Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, p. 130