Water Facts

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Drought conditions plague Australia's Lake Hume

Climate Change and Water Resource Management:

Adaptation Strategies for Protecting People and the Environment

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From urban and agricultural water supplies to flood management and aquatic ecosystem protection, global warming is affecting all aspects of water resource management in the United States. Rising temperatures, loss of snowpack, escalating size and frequency of flood events, and rising sea levels are just some of the impacts of climate change that have broad implications for the management of water resources. Reducing the emissions that cause climate change is a critical step we must take, but water resource managers and elected officials must act now to adapt to the effects of the warming that have already occurred or are unavoidable.

Global Warming is Already Affecting Water Resources

Many water supply sources (rivers, lakes, groundwater basins, etc.) are already over-allocated, suffer degraded water quality, and are often not in sufficient condition to support endangered species. Climate change will exacerbate these water challenges, leading to insufficient water for people and the environment and making it increasingly difficult to meet the needs of both.

Implementing actions now to improve water quality and supplies, protect aquatic ecosystems, and improve flood management not only makes sense, but early action will also help reduce future impacts related to climate change. Even if greenhouse gas emissions are reduced today, there is already warming "in the pipeline" that will create additional impacts. Adaptation is not a solution to climate change, but given the importance of our water resources, immediate action is needed to avert significant societal impacts.

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Manage For Droughts and Decreased Water Supplies

The past is no longer a reliable tool for predicting future precipitation patterns. Although droughts are nothing new, global warming is predicted to not only increase the frequency and intensity of droughts but also effectively create ongoing drought-like conditions in parts of the United States.[1] Some areas, particularly in the West and Southwest, are expected to get less precipitation. By elevating temperatures, increasing evaporation rates, and extending dry seasons, even existing rainfall patterns will yield less in terms of useable water supplies.

Ironically, global warming is also predicted to increase the frequency and intensity of storm events, which will in some cases provide more overall rainfall. However, intense rain events often deliver too much water at once, causing water to runoff instead of soaking into the ground, thereby making it harder to manage for water supply. These combined climate change related effects will decrease water supplies in regions across the country.

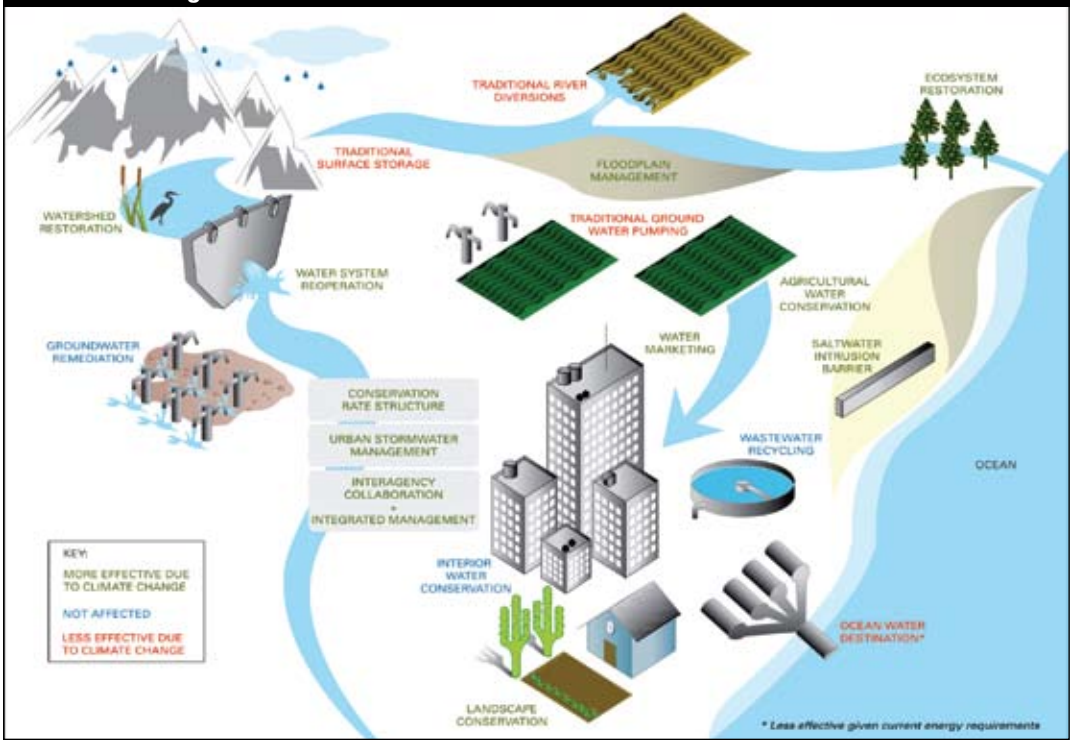
Figure 1: Predicted Changes in Water Flow Due to Climate Change

Credit: U.S. Climate Change Science Program

Fortunately, because western communities have been adapting for decades to meet the needs of growing populations in an arid landscape, a wide array of management tools are already well-established, such as water recycling, conservation, and improved groundwater management. However, given the scale and scope of the impacts climate change will have across the entire country, it will be essential to identify solutions that are cost-effective, quickly implementable, and environmentally beneficial—and that are effective in the face of additional warming. For example, water conservation and wastewater recycling will be more resistant to the impacts of climate change than tools such as new surface storage facilities and river diversions, which will be affected by increased evaporation and, in areas, reductions in total precipitation. It is also important that solutions provide multiple benefits, such as where increased water use efficiency also reduces the amount of energy used (and carbon emissions) because less water is transported, heated, and treated. The following recommendations are intended to guide the development of water supply response measures:

- ***Implement water use efficiency first.*** Maximizing water use efficiency is one of the most cost-effective measures communities can quickly implement to protect water supplies while also reducing energy use and global warming pollution.[2]
- ***Use climate-smart water management tools.*** Tools such as groundwater banking and water recycling may perform better in a warmer future, while those that rely on historical hydrology (e.g., river diversions and surface storage) are likely to perform less effectively in the future.[3]
- ***Prioritize multi-beneficial approaches.*** Adaptation measures that address multiple impacts, such as source water protection, smart growth, and low impact development can benefit not only water supply, but also interrelated issues including water quality, fish and wildlife habitat, flood management, reduced energy consumption, and reduced global warming pollution.
- ***Integrated regional water management.*** Employing a regional planning approach can capitalize on solutions that benefit a broad range of issues, stakeholders, and agencies and therefore will probably have wide support and the ability to broadly distribute implementation costs.[4]
- ***Factor in energy use.*** Each component of water use, from transport and treatment through distribution, can require energy. Energy consumption and efficiency need to be considered in response planning to ensure solutions are not exacerbating the basic problem of carbon emissions.[5]
- ***Water system reoperation.*** Regional water supply systems are often interconnected by tributary rivers and canals. Reoperating water supply systems for improved flood control and stormwater management can buffer climate-related impacts by distributing the effect of changes in hydrology over a wider area.
- ***Factor climate change into feasibility analyses and project design.*** Evaluations of potential surface storage and other facilities should take into account the effects of climate change on likely future hydrology, demand, economic analyses of alternatives, and potential environmental impacts.
- ***Incorporate the need for flood management.*** Because most dams serve both water supply and flood management roles, increasing downstream flood protection can enable existing dams to be operated for increased water supply. Improved flood management should be incorporated as a multi-beneficial tool for water supply management.[6]

Figure 2: Performance of Water Management Strategies After Considering Global Warming Effects



Protect Aquatic Ecosystems

Global warming threatens to permanently alter wetland and riverine ecosystems through fundamental changes in hydrology and temperature. Already stressed by decades of habitat loss, water supply diversions, and polluting runoff, climate change may be the final straw imperiling many fish and wildlife populations. Increases in temperature alone will drastically reduce cold water habitat for salmon and trout species, threatening the extinction of fish populations throughout the United States.[7] Failure to restore and protect aquatic habitats will result in declining wildlife populations and lead to new listings under the Endangered Species Act. This will in turn result in a new wave of water resource conflicts pitting protection of species against the need for water supplies, thereby undermining water resource management in general. Taking the following steps to restore and support aquatic ecosystems will help mitigate the impacts of climate change and reduce the conflicts between water supply and wildlife protection:[8]

- Provide for at least the minimum flows, as well as temperatures, necessary to support basic ecosystem functions in water resource planning.
- Plant trees and reduce hardscape in cities to cool urban waterways.
- Remove barriers to upstream migration and provide the necessary flows to enable fish access to the upper watersheds where temperatures are cooler.
- Restore degraded rivers and floodplain habitats to provide wildlife corridors through urbanized areas and critical habitat for sensitive species.
- Protect existing wetlands, headwaters, and forests from development and degradation and restore previously existing wetlands where possible to provide habitat and improve stream hydrology.

Improve Flood Management and Public Safety

Experts predict that global warming will increase the frequency and intensity of flood events. Today, flood managers must consider challenging issues such as the potential loss of life from floods, the skyrocketing cost of flood damages, the massive pollution and waste generated by damaging floods, and the competition between operating dams for flood safety and water supply. Climate change will only increase these challenges. Across the nation, land use development in floodplains has put millions of people and billons of dollars in infrastructure at risk. To date, state and federal agencies have been slow to react to these challenges and to provide guidance to change floodplain management. However, events like Hurricanes Katrina and Rita and recent floods in the Midwest are forcing elected officials and agencies to recognize the need for action and to begin discussing major policy changes. The following adaptation recommendations can improve public safety while providing additional benefits to water supply and wildlife:[9]

- Require the Army Corps of Engineers and the Federal Emergency Management Agency (FEMA) to incorporate the effects of climate change in analyses of future flood risk, including the ongoing national effort to revise the 100-year flood maps.
- Pass federal legislation increasing the requirements for flood insurance for development using federally backed loans from the current 100-year level to a 200-year or greater level of protection.
- Overhaul the federal flood insurance program to strongly discourage development in the 100-year floodplain.

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- Reduce stormwater runoff by requiring low impact development measures for new developments, and create incentives for retrofitting existing developments to capture and retain surface flows.
- Reoperate existing reservoirs factoring in the likely changes in hydrology due to climate change to reduce or mitigate flood management impacts.
- Improve monitoring, forecasting, and early warning systems for storm events.
- Require the National Flood Insurance Program (NFIP), administered by FEMA, to assess its insurance program and minimize the impacts it has on water supplies, aquatic ecosystems, and listed species.
- Preserve and restore wetlands, flood plains, dunes, and other natural barriers to reduce impacts of storms.

Protect Water Quality

Changes in precipitation, flow, and temperature associated with global warming will exacerbate water quality problems. For instance, longer dry seasons and loss of snowpack will reduce instream summer base flows, resulting in the concentration and increased residence time of pollutants. Conversely, the increase in the frequency and intensity of rainfall events related to global warming will overload the capacity of sewer systems and wastewater treatment plants, resulting in more combined sewer overflows and stormwater runoff, which increase water pollution from sediments, nutrients, pathogens, pesticides, and other pollutants. Sea-level rise will adversely affect groundwater aquifers by causing an increase in the intrusion of salt water into coastal aquifers and making less freshwater available for human use.[10] Taking the following steps will help protect water quality and water supplies and provide additional wildlife and flood protection benefits:

- Adopt low impact development (LID) measures such as permeable surfaces and vegetated infiltration basins for new developments, and retrofit existing developments to reduce storm flow runoff and increase infiltration of rainfall.[11]

- Protect and restore streamside vegetation buffers, wetlands, and headwaters to help filter pollutants and reduce the inflow of urban and agriculture runoff.[12] And pass the Clean Water Restoration Act, which would restore pollution protections under the Clean Water Act to many of these same resources.
- Restore and improve environmental and public health monitoring and surveillance systems in order to evaluate climate-health baseline relationships.
- Upgrade stormwater and combined stormwater and sewage systems to prepare for more frequent and heavier rainfall events and investigate opportunities for the beneficial reuse of stormwater and wastewater.
- Adopt minimum stream flow water quality standards to protect aquatic ecosystems.

Looking Ahead, Acting Now

As climate change continues to affect our water resources and elevate threats to public health, water resource managers and policymakers must act quickly to enact well-informed, environmentally sound policies that address the threats we already face while preparing for the predicted challenges of tomorrow. Pursuing the comprehensive solutions offered here will bring wide-ranging and cost-efficient benefits that protect both our health and the planet.

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