



National Risk Management  
Research Laboratory

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## Water Resource Adaptation Program

*Addressing the Multi-front Challenge Through Holistic Adaptations*

### Introduction

The Water Resource Adaptation Program (WRAP) contributes to the U.S. Environmental Protection Agency's (U.S. EPA) efforts to provide water resource managers and decision makers with the tools needed to adapt water resources to demographic and economic development, and future climate change. WRAP's research also supplements the U.S. EPA's Sustainable Water Infrastructure Initiative goal to ensure our nation's water and wastewater infrastructure meets future needs.

WRAP research results are used to identify infrastructure and watershed engineering and management needs, and to help ensure that our water supply is of high quality and that water demand from human consumption and economic activity is met. WRAP researchers consider uncertainties in future predictions and the adaptability of existing infrastructure and water programs. This information is used to establish adaptation measures for specific regions and watershed basins.

### Facing the Challenge

Climate change, land use, and socioeconomic development, collectively referred as global change, pose a daunting challenge to water resource programs and water infrastructure. Water adaptability is a key element for sustainable water resource development and utilization. The earth's climate changes in response to climate forcings — when an alteration in the global energy balance “forces”

the climate to change. Climate-forcing mechanisms working in concert with other forcings in the earth's orbit, ocean circulation, and atmospheric compositional changes, produce hydrological variations we have already observed and the variations that may occur in the future. Even when atmospheric greenhouse gas levels are reduced and the excessive radiative forcing is mitigated, the inertia of the hydrologic changes can continue into the foreseeable future.

The WRAP research approach has three basic elements to face these challenges:

- To investigate the hydrologic effects of climatic change and define the water resource needs of future socioeconomic conditions. The researchers use a variety of investigating tools, such as climate modeling, statistical data mining, and water availability forecasting.
- To develop adaptation methods, many focused on advanced and innovative engineering techniques and solutions to increase the resilience of water engineering systems and water programs.
- To develop and provide end users with the tools needed for water resource adaptation.

### Research Areas

WRAP research supports the EPA's Sustainable Water Infrastructure Initiative to ensure that our nation's water infrastructure meets future needs of

demographic and economic development. WRAP researchers collaborate with academic institutions, water utilities, and other internal and external stakeholders, to provide the science that offers timely and useful information and tools for water resource managers to respond to global change and to develop engineering and management adaptation solutions. The program currently has four areas of research:

**Water Demand and Demographic Changes** – Factors such as population migration, urbanization, and economic development drive changes in the lifespan of the nation's water infrastructure. WRAP researchers are helping to ensure our water infrastructure is adapted—within its natural service time—to future water demand.

**Adaptive Engineering** – Engineering measures, such as alternative water resource development, are designed according to specific types of watershed and regional climate conditions. In this context, WRAP researchers are developing adaptive engineering tools and management methods for sustainable watershed and infrastructure development. WRAP is undertaking four areas of adaptive engineering development:

- **Water Reuse** – Identifying regions where potable and nonpotable water and wastewater can be reused under future climatic conditions.
- **Water Conservation** – Developing and applying advanced technologies

for detecting leaking pipes buried in the ground to minimize water quality deterioration and loss during distribution from water facilities to consumers' taps.

- **Watershed Adaptation** – Integrating watershed management principles and practices to future climatic and socioeconomic conditions. Current research centers on two areas of best management practices: soil carbon sequestration and nonpoint source pollution prevention.
- **Smart Water Systems** – Application of smart growth principles, such as adopting water conservation policies and maintaining an energy-efficient water infrastructure, to meet the growing demand for clean drinking water, lower water infrastructure costs, and high-efficiency water delivery.

#### **Climate Mitigation Sustainability** –

WRAP researchers develop technical solutions for sustaining our water resources and generate scientific data on climate mitigation measures in alternative energy production, geological carbon sequestration, and soil carbon sequestration. WRAP-developed mitigation measures help to reduce greenhouse gases and also address the impact of the mitigation measures themselves on water resources.

**Water Availability** – In response to regional environmental issues involving the balance between water availability and water demand, the White House launched a new “Water Availability and Sustainability” science initiative. WRAP scientists and engineers have developed a water availability forecasting platform for use in the United States. The first tool employs hydroclimatic periodicity (cyclic variations in frequency and magnitude) to forecast long-term (i.e., decades or millennia) variations or trends in precipitation and stream flows. The second tool is the newly developed water availability index (WAI) used to forecast water availability in the short term (i.e.,



days). Integrated together in a platform, the periodicity-based and WAI-based tools could provide timely information for water program planning and operations.

#### **Outcomes**

Benchmarks have been established to ensure the WRAP's success:

- A national infrastructure condition and adaptability assessment report by 2008
- Infrastructure adaptation program outcome assessment by October 2013
- Infrastructure and Water Program Adaptation Symposium for Global Changes in early 2009
- A collection of publications, including recent conference proceedings, journal articles, and books

#### **Collaboration**

The purpose of collaboration is to capitalize on the strengths of different organizations in a multi-disciplinary approach. These partnerships and cooperative efforts enhance our ability to ensure that our nation's water programs and infrastructure adapts to meet future needs of demographic and economic development. In short, collaboration is an integral part of WRAP research. The WRAP collaborators include EPA program offices and regional offices; other federal agencies; state and local governments; the

American Tribal Council; water planning agencies and utilities; NGOs; private industry, corporations, and consultants; international organizations; and academic institutions.

WRAP stakeholder involvement:

- Cooperative research
- Stakeholder panel workshops
- Comprehensive assessment of water utilities for their considerations of climate change in water resource planning
- Selection of a water district representative in charge of case studies on global change

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#### **RESOURCES**

Water Resource Adaptation Program (WRAP)  
<http://www.epa.gov/nrmrl/wswrd/wqm/wrap/>

Global Climate Change Research Program  
<http://www.epa.gov/ORD/npd/globalresearch-intro.htm>

U.S. EPA (2002). “The Clean Water and Drinking Water Infrastructure Gap Analysis” (EPA/816/R-02/020) <http://www.epa.gov/nrmrl/wswrd/wqm/wrap/pdf/816r02020.pdf>

Sustainable Infrastructure for Water & Wastewater  
<http://www.epa.gov/waterinfrastructure/>



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