

Benchmarks for Incorporating Adaptive Management into Water Project Designs, Operational Procedures, and Planning Strategies



Report 2

*Recommendations for Federal Agency
Implementation of Adaptive Management for
Climate Change Adaptation*

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Institute for Water Resources

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The Director of IWR is Mr. Robert A. Pietrowsky, who can be contacted at 703-428-8015, or via e-mail at: robert.a.pietrowsky@usace.army.mil. Additional information on IWR can be found at: <http://www.iwr.usace.army.mil>. IWR's NCR mailing address is:

U.S. Army Engineer Institute for Water Resources
7701 Telegraph Road, 2nd Floor Casey Building
Alexandria, VA 22315-3868

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Change Adaptation**

Prepared for:

Water Resources and Climate Change Adaptation Work group

of the

Interagency Climate Change Adaptation Task Force

In October 2011, the Interagency Climate Change Adaptation Task Force published the *National Action Plan (NAP) Priorities for Managing Freshwater Resources in a Changing Climate*. The plan provides an overview of the challenges that a changing climate presents for the management of the Nation's freshwater resources and recommends actions for Federal agencies to support water resource managers in understanding and reducing the risks of climate change.

The U.S. Army Corps of Engineers (USACE) is the lead agency for implementation of three actions in the NAP associated with the recommendation to support Integrated Water Resources Management (IWRM):

17. Work with States and interstate bodies (e.g., river basin commissions) to provide assistance needed to incorporate IWRM into their planning and programs, paying particular attention to climate change adaptation issues.
19. Working with States, review flood risk management and drought management planning to identify "best practices" to prepare for hydrologic extremes in a changing climate.
20. Develop benchmarks for incorporating adaptive management into water project designs, operational procedures, and planning strategies.

This report supports Action 20. It was prepared by a Federal interagency technical team.

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Participants on Interagency Technical Team

Adaptive Management for Freshwater Resources in a Changing Climate

Team Member	Agency	Email
Ken Barr	USACE-MVR	kenneth.a.barr@usace.army.mil
Andy Loschiavo	USACE-SAJ	andrew.j.loschiavo@usace.army.mil
Chuck Theiling	USACE-MVR	charles.h.theiling@usace.army.mil
Noel Gollehon	USDA-NRCS	Noel.Gollehon@wdc.usda.gov
Claudia Hoeft	USDA-NRCS	Claudia.Hoeft@wdc.usda.gov
Chris Carlson	USDA- USFS	ccarlson@fs.fed.us
Bernard Bormann	USDA-USFS	bbormann@fs.fed.us
Mike Muse	USEPA	muse.mike@epamail.epa.gov
Curt Baranowski	USEPA	baranowski.curt@epamail.epa.gov
Karen Metchis	USEPA	Metchis.Karen@epamail.epa.gov
Ken Williams	USGS	byron_ken_williams@usgs.gov
Roger Griffis	NOAA	roger.b.griffis@noaa.gov

Introduction ¹

Across the United States and the world, climate change is affecting communities, livelihoods, and the environment. In 2009, the White House convened the Interagency Climate Change Adaptation Task Force (ICCATF), co-chaired by the Council on Environmental Quality (CEQ), the Office of Science and Technology Policy (OSTP), and the National Oceanic and Atmospheric Administration (NOAA). It includes representatives from more than 20 Federal agencies. On October 5, 2009, the President signed an executive order directing the Task Force to make recommendations for how to strengthen policies and programs to adapt to climate change.

In October of 2010, the ICCATF published a Progress Report to the President describing Federal Agency actions needed to better prepare the Nation to respond to a changing climate. The Task Force called for a national action plan to improve management of freshwater resources. A Federal Water Resources and Climate Change Adaptation Work Group was formed and, working with stakeholders, developed the “National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate” to protect water supplies, water quality, human health, property, and aquatic ecosystems. This National Action Plan establishes the following national goal:

Government agencies and citizens collaboratively manage freshwater resources in response to a changing climate in order to assure adequate water supplies, to protect human life, health and property, and to protect water quality and aquatic ecosystems.

The October 2011 National Action Plan is available at:

http://www.whitehouse.gov/sites/default/files/microsites/ceq/2011_national_action_plan.pdf

To accomplish this goal, the Action Plan makes six recommendations; including Recommendation 5: Support Integrated Water Resource Management (IWRM). Four supporting actions have been identified for Recommendation 5 including:

Supporting Action 20: Develop benchmarks for incorporating adaptive management into water project designs, operational procedures, and planning strategies.

A planning strategy for climate change is to promote mid-course corrections in response to new information. As noted above, adaptive management is a key element of IWRM. According to the National Research Council, “Adaptive management promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood” (National Research Council, 2004). Federal agencies should develop benchmarks for incorporating adaptive management into their planning and operations and should allocate a portion of project funds for monitoring for adaptive management. (page 29).

¹ excerpts from CEQ Climate Change Adaptation Task Force Website :
<http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation>

This report provides recommendations to Federal agencies to develop benchmarks for incorporating adaptive management into planning and operations as a tool to address uncertainty and improve implementation of climate change adaptation.

Key Definitions

The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as:

Adjustment in natural or *human systems* in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

Anticipatory adaptation – Adaptation that takes place before impacts of *climate change* are observed. Also referred to as proactive adaptation.

Autonomous adaptation – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or *welfare* changes in *human systems*. Also referred to as spontaneous adaptation.

Planned adaptation – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

The National Research Council (2004) defined adaptive management as follows:

“Adaptive management promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a ‘trial and error’ process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.”

Other Important Definitions for this Report

Integrated Water Resources Management (IWRM) – A coordinated, goal-directed process for managing the development and use of river, lake, ocean, wetland, and other water assets (Rahaman and Varis, 2005) IWRM maximizes economic services and environmental quality and ensures public safety, while providing for the sustainability of vital ecosystems.

Socio-Ecological Systems – A coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner. The systems can be defined at several spatial, temporal, and organizational scales, which may be hierarchically linked. This term is used to emphasize the integrated concept of humans in nature and to stress that the delineation between social systems and ecological systems is artificial but can be useful in IWRM planning (Redman, et al., 2004). The term “ecosystem” is understood by scientists to include both the human and natural environment. However, for the purpose of this report, “socio-ecological systems” is used to reinforce the need to fully consider social and ecological factors.

Learning Objectives - Adaptive management needs to be formally structured to succeed. A key element to this structure is a formal set of learning objectives based on an understanding of management goals, potential uncertainties, and available planning and monitoring resources. Stating learning objectives as key questions is often useful in designing the learning process and linking to future decisions.

Governance – Governance is shared among those with power to make decisions, determines how other players make their voices heard and how account is rendered. Ultimately, the application of good governance serves to realize societal and organizational goals.

Purpose

An interagency technical team has been formed to assist the Water Resources and Climate Change Adaptation Work Group in developing benchmarks for incorporating adaptive management into freshwater resource stewardship and protection programs and projects (Supporting Action 20 for IWRM). The technical team is composed of staff from the U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and Forest Service (USFS), U.S. Environmental Protection Agency (USEPA), and National Oceanic and Atmospheric Administration (NOAA). Two tasks were assigned to the team in consultation with the Workgroup to address Action 20.

1. Provide an inventory of existing “adaptive management” practices and policies to Workgroup
2. Provide recommendations for wider application of adaptive management strategies to Workgroup

Report I: Summary of Existing Agency Adaptive Management Practices and Policies.

Report I addressed Task 1 by summarizing Federal adaptive management practices and policies. An attempt was made to include those practices and policies that are consistent with the principles of adaptive management. The Report is not an inventory of individual projects and programs but illustrates current uses of adaptive management.

Report II: Benchmarks for Incorporating Adaptive Management Into Fresh Water Resource Assessment, Stewardship, Protection, Management and Project Planning, Design and Operations

For the purposes of this document, the functions of Federal freshwater management include 1) actions taken to develop project plans, design, and operations to manage freshwater resources; and 2) Federal efforts to work across Federal agencies, states, local governments, Tribes, industry, and non-governmental organizations to develop and implement plans to conserve, protect, and/or enhance freshwater resources. Report I outlined the laws, regulations, policies, and best practices implemented by a number of Federal Agencies to implement adaptive management strategies to address uncertainty associated with water resources management. This second report builds on that baseline. In order to develop benchmarks for incorporating adaptive management into water resources management at multiple scales, several premises were identified to help frame the scope of the second report and its recommendations.

Key Premises

1. *Resiliency to Climate Change*: Achieving or retaining resiliency of human and natural (socio-ecological) systems to climate change is one of the primary goals of developing adaptation plans. Water resource system resiliency would help ensure “adequate water supplies, to protect human life, health and property, and to protect water quality and aquatic ecosystems”, as expressed in the National Action Plan.
2. *Varying Spatial and Temporal Scale*: Climate change impacts will vary across the nation at different spatial and temporal scales. Climate change can affect regional rainfall patterns, snowmelt, evapotranspiration rates, air and water temperature, and biogeochemical processes that affect the quality and quantity, and timing and distribution of water that yields benefits to human and natural systems. Adaptive management strategies applied in one biogeographic system may not work as well or at all in other systems because all sites have unique local characteristics. Strategies to test actions and policies need to be developed with consideration of the balance between scientific specificity and opportunities to inform actions at multiple geographic locations or at other spatial-temporal scales that accounts for hydrologic, bio-physical, and ecological interactions at different scales.
3. *Role of Science*: Adaptive management strategies employ science based approaches to learn from implementation of actions or policies under high-levels of uncertainty. The new information is used to not only update scientific understanding of the system and the effects of actions and policies, but to also inform managers on potential options to improve implementation and better achieve program or project goals. Coordinated monitoring and research efforts are necessary in order to effectively and efficiently address key climate change questions related to particular water resource program or project goals. Ultimately, goal directed learning should be a key objective of any climate change adaptation plan.
4. *Disparate Governance Authority*: Climate change effects will transcend multiple governmental jurisdictions, laws, and regulations that provide the decision-making authority to develop and implement adaptive management strategies and policies. The recommendations in this document are intended to guide Federal actions to consider adaptive management strategies that help address climate change impacts to freshwater resources and project success. However, the authority to implement many adaptive management strategies and policies also reside at other levels of government and Federal agencies have limited influence over Tribal, local, and state governing bodies or their advisory committees and infrastructure management entities. Considering this, the adaptive management benchmark recommendations are intended to help the Federal government facilitate collaborative efforts across governance levels (e.g., state, counties, Tribes) and geographic scales of political jurisdiction (e.g., counties) to implement joint adaptive management strategies and policies.
5. *Integrated Water Resource Management (IWRM)*: Frameworks and forums that integrate adaptive management strategies and science both vertically and horizontally across multiple layers of governance and geographic scales are necessary to maintain and/or achieve systems that are more resilient to climate change effects. Collaboration at multiple levels also helps legitimize the process, so that agencies and their representatives will actively participate and support improvement of policies and actions based on shared learning about their outcomes. These collaborative efforts are likely the only way to gain

enough momentum at multiple scales to achieve goals for resilient natural and human systems.

6. *Climate Change Variability*: The primary reason for uncertainty about climate change impacts and best solutions is that our understanding of climate and hydrologic dynamics is relatively short term and spatially constrained. Recent climate monitoring reveals many indicators of change, but we have not monitored the natural potential range of many parameters, and we may be missing cycles that become apparent at greater intervals. Thus, we are faced with uncertainty regarding long term trajectory and magnitude of climatological events, and we are not certain the recent past is a reasonable predictor of the future anymore. In other words, predictive models and/or management approaches based on the record of climate variability and effects on freshwater resources may not work because variability in key factors could be different. In addition, socio-ecological system states are changing in response to climate change.

Recommendations for Adaptive Management Benchmarks to Support Climate Change Adaptation Planning and Establishing a Learning Environment in Support of Adaptive Management

1. **Collaborative Governance**: Create opportunities for more Local/State/Tribal/Regional/Federal collaboration and learning to maintain cohesion and participation across different groups towards shared water resources management goals with climate change pressures. Coordinated governance of adaptive management strategies and policies must work both vertically and laterally from local government up to Federal governance levels as well as across the geographic jurisdictions that affect a watershed or aquifer.
 - a. Forums and Frameworks: Establish intergovernmental and non-governmental forums and frameworks to collaboratively assess and characterize risk and uncertainty, develop adaptation plans, resolve cross-purpose policy issues, and develop adaptive management strategies and policies. Adaptive management strategies would be implemented by different agencies and local jurisdictions at different government levels to reduce climate risk, address uncertainty related to magnitude of effects, and provide new information to update management plans and actions.
 - b. Science Platform for Decision-Making: Adaptive management leads to new science/technical information (conceptual models, literature review/synthesis, analytic protocols, hypothesis tests monitoring/assessment) integrated within governance structures to link new science and information back to decision-making. Collaborative governance forums and agency specific governance structures must begin with and repeatedly return to deliberation on recent scientific findings and updates to local assessments to inform and update adaptation plans, policies, and actions to address climate change. The scientist and management dialogue must inform learning objectives and prioritize monitoring, to assure the most up to date science is used to develop adaptive management strategies.
 - c. Shared Goals, and Objectives: Collaborative forums help set overarching goals for climate change adaptation. These forums allow for exchange between stakeholders affected by water resources issues and policy makers. Goals should maintain or improve socio-ecological system resilience. Shared goals can aid coordination of intergovernmental actions, adaptive strategies, and the development of measures of

success. The expressed desire to learn about stakeholder values, and their preferred alternatives encourages them to participate in the planning process, and recommend and support adaptive management approaches.

2. **Scientific Coordination Forums:** Collaborative scientific forums can help build shared understanding and learning about the science describing socio-ecological systems from a water resources perspective. Examples of existing forums include but are not limited to the following: Landscape Conservation Cooperatives, South Florida Ecosystem Restoration Task Force Science Coordination Group, Gulf of Mexico Ecosystem Restoration Task Force, Missouri River Recovery Implementation Committee; Columbia River Adaptive Management Working Group.
 - a. Describe Socio-Ecological Systems: These forums will need to operate at different scales, ideally maximize use of existing forums to avoid additional bureaucracy, and include technical information from different disciplines to fully describe socio-ecological systems (i.e., conceptual models as a framework to understand system structure and functions and link agency efforts at multiple scales).
 - b. Characterize Uncertainty, Risk, and Vulnerability: In addition, these forums help identify climate change effects, characterize risk and vulnerability, and develop appropriate tests to address alternative views on climate change effects or strategies to address them. Scientific results from research and monitoring specific actions would be shared by individual agencies to provide a better understanding of, and perhaps reduce, key uncertainties related to the effects of climate change.
 - c. Modeling, Monitoring and Assessment: Scientific coordinating forums can support development, improvements, and use of models used to help evaluate water resource policies, projects, and actions. These models can help identify hypotheses about the potential effects of climate change and potential outcomes of specific agency actions. Scientists can also use models to help prioritize and implement monitoring and research and collaboratively discuss how to test the hypotheses, evaluate system status, and inform the effectiveness of various individual agency adaptive management strategies as part of more holistic assessment of socio-ecological system status at different scales. An important role of such forums is to define what is known in order to better understand what is unknown.
3. **Risk and Uncertainty Management:** After establishing collaborative scientific, advisory and governance forums and defining shared goals, the risk, uncertainty, and vulnerability of a water resource system's socio-ecological structure, functions, and benefits provided to society and nature must be assessed. Climate change ultimately will affect the ability to maintain or achieve a particular desired water resource system state in the future. Collaborative frameworks that apply adaptive management must understand whether these affected system states are reversible or unstable and irreversible. Understanding the risk and uncertainty associated with a particular socio-ecological system will help guide planning towards a flexible, resilient strategy. Those parts of the system that are most vulnerable should be evaluated to determine whether water resource plans, projects, protection and stewardship efforts can achieve or maintain resiliency. If changing system states are likely or potentially reversible, then agencies should implement adaptive management strategies to help manage risk. In the climate change adaptation planning context, adaptive management strategies test hypotheses about the best management policies, plans, and actions to address uncertainty associated with

maintaining resiliency or improving conditions under different climate scenarios. If current socio-ecological system states are likely or could change and cannot be reversed, agencies should test policies, plans, and actions that allow the system to adapt to a more resilient state. Ultimately, these strategies will need to be tested at the scales manifested by the hydrologic and ecologic changes expected to be most vulnerable. Understanding how socio-ecological systems work, their current, desired, and potential states, and the uncertainty and related risk is a prerequisite for developing goals and effective strategies in managing freshwater resources.

4. **Planning/Design/Implementation Flexibility:** After vulnerabilities have been prioritized and adaptive management strategies identified, agencies need to consider ways to incorporate flexibility into water resource project plans, designs, and implementation, as well as flexibility in implementing water resource stewardship activities. Flexibility is the structural and/or operational capacity to adjust if monitoring indicates the need. Flexibility can be incorporated into an alternative as a design parameter to make it robust with respect to uncertain future conditions. Flexibility varies with the scale of implementing specific water resource projects. For example, building a reservoir by itself may not provide much flexibility in preserving water for multiple uses in a changing climate. However, if the reservoir is one phase of multiple storage, recovery, and conservation actions in a watershed plan, then the plan may have more flexibility in adjusting implementation based on demonstration of successful projects across the larger watershed to best achieve a more resilient system.
5. **Cost-Effective Adaptive Management:** The range of climate change uncertainties will increasingly challenge the wise allocation of public resources to address climate change impacts in the face of great uncertainty. We need to prioritize adaptive management that reduces uncertainty that poses the highest risk, most socio-economic cost, or affects the most vulnerable parts of the system. In addition, the opportunity to test agency strategies must exist (i.e. flexibility, performance directed monitoring, and agency/stakeholder willingness to test plans, policies and actions) to determine whether adaptive management should be applied at all. However, specific analytical methods for prioritizing adaptive management efforts may need to be developed for each agency to ensure adequate funding can be devoted to necessary adaptive management strategies and associated monitoring and assessment efforts. For example, it may help agencies to consider valuing learning as a water resource project or stewardship objective in order to prioritize adaptive management efforts and monitor returns on investment.

Articulating the probability of achieving the benefits of various climate change adaptation actions could also be helpful to explain the associated risk and how it can be reduced through adaptive management activities using Bayesian, Monte Carlo, and/or other statistical analyses. Ideally, analytical methods need to be developed to help quantify projections of climate change impacts on watershed hydrology, ecology, and the economic/social costs and implications of those impacts. In addition, the cost, time-line, and steps associated with adaptive management strategies and monitoring need to be described. In addition, Federal Office of Management and Budget may need a performance measure to help evaluate adaptive management activities across programs, even if qualitative. Ultimately, Federal agencies need to explain why adaptive management activities that cost money are necessary and what value they produce in addressing climate change effects.

Summary

This second report identifies 5 key benchmarks to incorporate adaptive management into water resource project planning, design, operations and overall implementation, as well as water resource stewardship, at hydrologic/ecologic scales commensurate with the scale of climate change effects. This report provides a broad framework for agencies regarding what they can do to use adaptive management as part of climate change adaptation planning. One key take-home message is that collaborative governance and scientific forums are needed for multiple governance levels to work together with stakeholders at scales that can truly address the effects of climate change.

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