



U.S. Army Corps of Engineers Reservoir Operations

*Maria Placht, Institute for Water Resources, USACE*⁴⁹

Context

The U.S. Army Corps of Engineers (the Corps) is responsible for a variety of water resource-related missions in the United States, including coastal protection, disaster preparedness and response, environmental protection and restoration, flood protection, hydropower, navigable waters, recreational opportunities, regulatory oversight, and water supply.⁵⁰ The Corps also strives to be a good steward of the environment in these areas, especially through ensuring environmental flows for ecosystems.

This case will focus on the area of reservoir operations, which encompasses several of the above missions. Through its Civil Works program the Corps manages hundreds of reservoirs nationwide. Corps personnel focus the resources of these reservoirs to meet a wide variety of purposes, including navigation; flood storage; generating power for homes and businesses; supplying water for nearby communities; and providing recreational areas for camping, fishing, boating, and hiking.

⁴⁹ Views, opinions and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy or decision unless so designated by other official documentation.

⁵⁰ <http://www.corpsresults.us/>



Climate Change

According to the U.S. Global Change Research Program’s 2009 Report, “Global Climate Change Impacts in the U.S.,”⁵¹ climate-related changes observed in the United States include increases in heavy downpours, rising temperatures and sea levels, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the ocean and on lakes and rivers, earlier snowmelt, and alterations in river flows. Trends vary by region, with some areas, such as the Southwest, experiencing prolonged droughts. Other areas, including the Midwest and Southeast, have experienced an increase in total volume of precipitation, increase in heavy precipitation events, wetter springs, and drier autumns. Recent storm events (the 2008 Midwest floods; the 2011 Mississippi floods) show a shift toward summer flooding in these areas.

The effects of global climate change could extensively impact reservoir operations in the United States. Significant changes to reservoir inflows may lead to increased frequency of major floods as well as reservoir deficits in the traditional low-flow late summer period. Increased rainfall may have positive effects (reservoirs could store more water), but could also result in uncontrolled water release and downstream damage. With unpredictable precipitation it may be more difficult to balance the storage space in reservoirs, especially if there is a seasonal shift in rainfall. In other areas of the country, duration and severity of drought periods could result in an inability to maintain minimum release rates. The Corps is already seeing increased delivery of sediment to reservoirs from heavy rains. This results in loss of water storage area and makes it difficult to respond to floods and conservation needs.

Institutional Description and Response to Climate Change

The key instruments governing the operation of USACE reservoirs are Water Control Plans and Reservoir Regulation Schedules. Both are included in the reservoir’s Water Control Manual. These instruments outline how the project will meet the congressionally authorized purposes and other laws relating to the operation of federal facilities. The content, structure, and basic principles for the development and documentation of water control management strategies, rules (and changes to and deviations from adopted rules), and associated agreements are documented in the Water Control Manual. The Corps must periodically review (and approve in accordance with congressionally authorized purposes) its Water Control Manuals and update them according to evolving conditions in the watershed and riverine system and project purposes. However, funding is scarce for such reviews, and many manuals are decades old.

Climate change is one of many uncertainties affecting water resources management. Corps reservoir operations are being affected by land use changes that affect hydrology, and population increases and other demographic changes affect water demand. The presence of endangered species—and the associated legal requirements—and invasive species can also impact operations, given each reservoir’s impact on hydrologic variability. The Corps’ current understanding of climate change together with other global changes indicates that virtually all of its infrastructure will require adaptation.

51 <http://www.globalchange.gov/what-we-do/assessment/previous-assessments/global-climate-change-impacts-in-the-us-2009>



The Corps initiated its Responses to Climate Change (RCC) Program in 2008, formalizing a program that began in the 1990s. This program's mission is "to develop, implement, and assess adjustments or changes in operations and decision environments to enhance resilience or reduce vulnerability of USACE projects, systems, and programs to observed or expected changes in climate."⁵² The program is developing and beginning to implement approaches and policies to reduce potential vulnerabilities to the nation's existing water infrastructure that result from climate change and variability. This program's goal is that future infrastructure be sustainable and robust in a range of potential climate changes.

The RCC Program relies on a multitude of partnerships with other federal science and water management agencies and other stakeholders (both domestic and international). For example, the Corps works within the Climate Change and Water Working Group, an informal scientist-to-scientist confederation across federal agencies and the water management community. The Corps also participates in interagency work groups to develop a national strategy for climate change adaptation and in the Climate Change Adaptation Task Force, an interagency forum for discussing and monitoring the implementation of the federal government's adaptation approach.

The Corps translates the recommendations and research conclusions from its various partnership initiatives (and various guidance and instructions from the White House) into Engineering Technical Letters and Engineering Regulations. Corps district offices then follow this field-level project guidance in their planning and operations. If the guidance is not followed, the project may not be approved by USACE Headquarters.

The Corps addresses emerging issues that have not yet been incorporated into long-standing guidance with temporary guidance called Engineering Circulars (ECs). An example is the recent EC on "Incorporating Sea-level Change Considerations into Civil Works Programs." The Corps is constantly developing these types of guidance, yet thus far there has not been an EC related to addressing climate change considerations for reservoir operations.

Discussion of Most Important Climate-Adaptive Principles

Creativity and Learning

The RCC Program began sponsoring various climate change adaptation pilot studies in 2010. The goals of these initial studies are: 1) test and evaluate the Adaptation Process Framework proposed by the Council on Environmental Quality;⁵³ 2) develop and demonstrate innovative methods, strategies, policy, and technologies supporting climate change adaptation; and 3) build USACE district capacity in the professional and technical competencies important in climate change adaptation. Each pilot study concentrates on a central question to focus the participants

52 <http://corpsclimate.us/about.cfm>

53 In 2010 the Council on Environmental Quality proposed a flexible Adaptation Process Framework to help agencies identify climate-based vulnerabilities, reduce those vulnerabilities through adaptive actions, and build greater resilience to climate change throughout agency missions and operations. The proposed framework has three components: 1) a set of principles to guide agency adaptation and resilience activities, 2) a six-step approach to climate change adaptation and resilience, and 3) a proposed set of government-wide enabling investments to support the effective implementation of the framework. USACE is among four agencies currently testing the framework.



on a key knowledge gap that, it is hoped, will be applicable to other projects. These pilot studies are led by district staff and may include interagency, academic, and other expert participation.

Future pilot studies will focus on evaluating and testing approaches, frameworks, and guidance for incorporating climate change into USACE district life-cycle decision making. For example, one pilot study will focus on assessing the impact of climate change on the Coralville Reservoir. This is a multipurpose USACE reservoir on the Iowa River with authorized purposes of flood risk reduction, fish and wildlife management, water quality, low flow augmentation, and recreation. This study will identify potential strategies to assess and improve the robustness of reservoir operations in the context of climate change.

The pilot study approach exemplifies the ideas of experimentation, learning, and innovation. These studies will be invaluable for understanding how the Corps can continue to adapt to climate change, and will be incorporated into Corps guidance (including Engineering Regulations and Engineering Technical Letters) and also inform future updates to Water Control Manuals. Current pilot studies have already been useful in identifying issues that should be covered in future guidance.

Collaboration and Partnerships

As mentioned earlier, the Corps does much of its climate change work in partnership with other organizations. For instance, the foundational report that kicked off the four U.S. federal water management agencies' approach to climate change was an interagency report. "Climate Change and Water Resources Management: A Federal Perspective" was published as USGS Circular 1331 in 2009. The purpose of this report (prepared by the Corps, the U.S. Geological Survey, the Bureau of Reclamation, and the National Oceanic and Atmospheric Administration) was to explore collaborative strategies to improve water management by tracking, anticipating, and responding to climate change.

Partnerships with other agencies are critical because they allow the Corps to capitalize on interdisciplinary expertise, avoid duplication, and produce cutting-edge products that they do not have the resources to create on their own. Combining resources and leveraging expertise will enable the Corps to more effectively adapt to climate change.

Many stakeholders are interested in Corps reservoirs because of their specific preferences related to downstream flow, stages, and water quality. Reservoirs are usually constructed for multiple purposes, such as recreation, hydropower, and flood control. Therefore, if the Corps desires to change the operations of a reservoir (via an update to the Water Control Manual) for climate-related reasons, they must address various tradeoffs between these varied interests.

Attempting to update a Water Control Manual can result in a long process fraught with conflict among the interest groups impacted by the reservoir's operations. There are usually competing desires associated with these purposes, and each interest group would prefer a different pattern of storage and stream flow regulation. The recent effort to update the Missouri River's Water Control Manual took 15 years and cost millions of dollars, in part due to an inability to reach agreement among the various stakeholders. This kind of conflict could keep the Corps from rapidly adapting to climate change.



A more successful “re-operation” (regulation schedule change) was undertaken with a significant Corps stakeholder, The Nature Conservancy (TNC), for Green River Lake and Dam in Kentucky. TNC worked closely with the Corps to alter the regulation schedule for the dam to better accommodate downstream ecological functioning. While the re-operation was for environmental reasons, it is an example of how such a collaborative process could work for climate change reasons. More details are in the following section.

External Regime

The ability of the Corps to alter its reservoir operations and adapt to changing and unexpected conditions is governed by the congressionally authorized purposes of the reservoir, the Water Supply Act, the Rivers and Harbors Act, the National Environmental Policy Act (NEPA), and the Flood Control Act. Changes or deviations from published regulation schedules—whether emergency, short-term, or long-term—are possible with appropriate studies and approvals. Some examples of reservoir operation modifications that could occur to adapt to climate change are modification of storage allocation within the reservoir (seasonal or permanent), modification of the reservoir release schedule, and expanded use of forecast tools in reservoir operation.⁵⁴ The significance of the change to be made and the context in which it is made dictate the regulatory process the Corps must follow.

For significant changes in allocation of water storage, the Water Supply Act of 1958 provides the basic authority for USACE to reallocate storage for water supply, allowing each Corps reservoir to meet present or anticipated future demand for municipal and industrial water supply. The Corps must receive congressional approval in the form of legislation to undertake such reallocation. The Corps may also seek major changes via a project modification study, as provided for by the Rivers and Harbors and Flood Control Act of 1970. This authority allows a new feasibility study of an existing project based on observed changed watershed hydrologic conditions; new needs; or the need to add, drop, or revise existing authorized purposes. This type of study requires public consultation and an environmental impact statement, but can result in a revised water control plan. Additional guidance for changing water control plans during times of water shortage is contained in Corps guidance regarding drought contingency plans. Drought contingency plans are easier to update than Water Control Manuals and can address future droughts, but they may also require NEPA documentation.

Minor changes to reservoir operations can be implemented in the context of existing authorities. Obtaining a temporary deviation is possible if NEPA documentation is completed, there are no significant adverse impacts, and there are no state and federal disagreements. One example, mentioned above, was the TNC-Corps 2002-2006 partnership to alter the regulation schedule for the Green River Lake and Dam to better accommodate downstream ecological functioning. The regulation change, which was implemented via an interim arrangement mechanism called a “deviation,” included altering the storage and release schedules to partially mimic the historic natural flow pattern. After three years of testing and vetting with the public and stakeholders, the interim regulation schedule was made permanent. After implementing some innovative solutions,

54 Expanded use of forecast tools could be problematic because current regulation plans were not designed to employ modern forecast products. Reservoirs are usually regulated for “water on the ground or in the system,” a principle that is followed to control operations that might otherwise be based on speculation or uncertain forecasts.



the regulation changes adopted had no negative impact—and even had some positive impact—on the authorized purposes of flood damage reduction, recreation, and water supply.⁵⁵

The external regime negatively affects the Corps' ability to quickly alter its reservoir operations in response to climate change. The quickest way to change a reservoir's operations would be a series of adaptive measures requiring minor regulation changes that have no negative impact on the authorized purposes of the reservoir and no significant adverse impacts per NEPA. Thus the changes would not entail a contentious process and would require little involvement of external institutional factors. In such a case, the required documentation and approvals would be straightforward and achievable in less than five years, as was the case of the Green River Lake and Dam. Drought contingency plan updates could also be a quicker, cheaper process. If, on the other hand, the required adaptive measures that would necessitate a change in reservoir operations are significant, would have a negative impact on the authorized purposes, and have detrimental environmental impacts, the process would be highly controversial and involve various external institutional factors. In this case it could take many years and a considerable amount of money to produce the required documentation and internal and external approvals. Such funding may be hard to come by in times of limited budgets and competing priorities.

55 A Call to Enhance the Resiliency of the Nation's Water Management http://ascelibrary.org/wro/resource/1/jwrmd5/v137/i4/p305_s1?view=fulltext&bypassSSO=1