Research Needs in Water Resources and Environment

Otto J. Helweg, Joseph Orlins, Dale Bucks, Regan Murray, David Truman, and Raymond Walton

Abstract

Periodically, there have been panels discussing research needs at ASCE and conferences; however, these panels are often made up of researchers from academia who discuss their research interests. At the recent World Water & Environmental Resources Congress of 2004, the Education and Research Council constituted a panel of research users in order to see what technical questions practitioners would like to see answered. This paper describes the results of a panel that consisted of representatives from three government agencies, USDA/ARS, USBR, EPA, plus one representative from the private sector, WEST Consultants.

Introduction

There is always the danger of answering questions no one is asking, or at least conducting research on questions of personal interest or areas funding agencies think are important. These research topics may not be the most important questions being asked by practicing engineers. The fields of water resources and environment are so broad, only a small slice of research users could be included. One of the panel members pointed out that the private sector was under represented. Hopefully, a future panel will correct this. The power point presentations may be accessed from the Education and Research Council's web site at:

http://engineering.rowan.edu/~orlins/EWRI/

The panel, which is included among the authors, was Dr. Dale Bucks from the U. S. Department of Agriculture, Agricultural Research Service (USDA/ARS), Regan Murray from the Environmental Protection Agency (EPA), David Truman from the U. S. Bureau of Reclamation (USBR), and Raymond Walton from WEST Consultants, a private consulting firm, specializing in water resources and environment. Panel members were asked to discuss several questions they would like to see researchers answer. Both Bucks and Murray were working in research areas, so they could respond to both sides of the issue, researchers and users. Walton had been on a university faculty, so he, also, was able to understand both sides of the research equation. Obviously, from the allotted time, each participant could only relate a small portion of their agency's interest; consequently, this report is not intended to by comprehensive, even for the various agencies.

There have been two papers published by the National Research Council on the research needs. The first, *Envisioning the Agenda for Water Resources Research in the 21st Century* (2001) and the second, *Confronting the Nation's Water Problems" The Role of Research* (2004). The latter gave the federal funding sources which is illustrated in Figure 1. Both of these sources may be accessed from the National Academy Press web site, www.nap.edu.

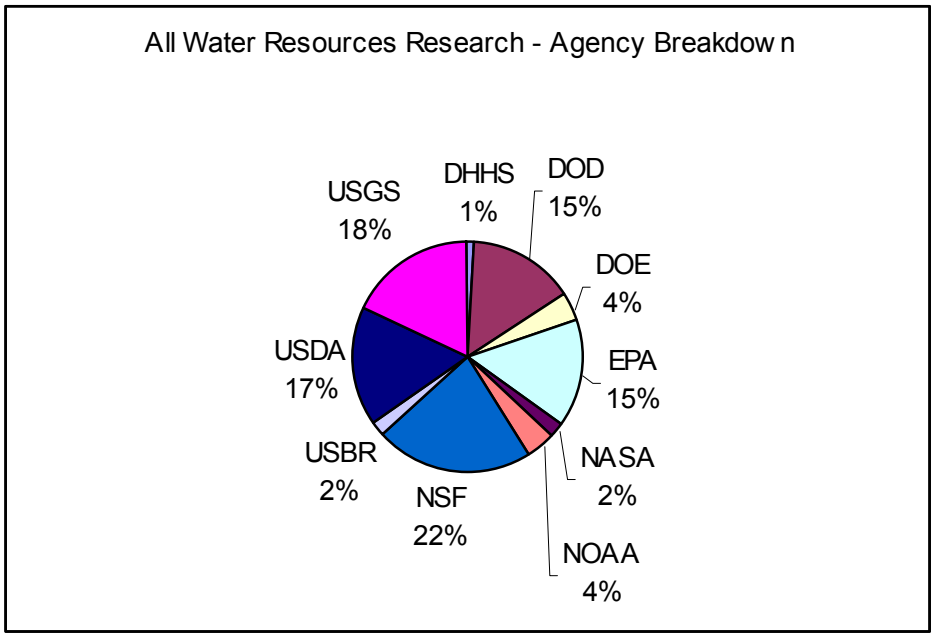

Figure 1, Agency contributions as a percentage of the total federal funding for water resources research in 2000

Research Interests of the USDA/ARS

Research Interests of EPA

The Office of Research and Development (ORD) is the scientific research branch of the Environmental Protection Agency (EPA), providing a solid underpinning for EPA's policies on protecting air, water, and land. ORD employs almost 2000 people in 13 labs

and facilities across the U. S. Of an annual budget of $700 million, more than $100 million funds extramural environmental research.

In the last several years, EPA has gained new responsibilities for protecting the homeland. Broadening its efforts to respond to and clean up hazardous material releases, EPA now has responsibility for responding to and cleaning up materials released during terrorist attacks. In addition, EPA has been named the lead federal agency for protecting the water supply. ORD is supporting these functions through its National Homeland Security Research Center (NHRSC) which performs and coordinates research related to building decontamination, rapid risk assessment, and water security.

In water security, EPA has two divisions that share responsibility. The Water Security Division (WSD) provides financial assistance and technical guidance to water utilities. The NHSRC's Water Security Team coordinates and carries out short-term applied research, and develops technologies and tools for the WSD, water utilities, and emergency responders.

Working with other federal agencies, and a large group of stakeholders, EPA formulated the *Water Security Research and Technical Assistance Action Plan* (Action Plan). The Action Plan is a comprehensive discussion of the short- and long-term research and technology developments necessary to improve the security of U. S. water systems. Some of the proposed research will be carried out by EPA or other federal partners, but

many of the research topics are well-suited for the private sector and academia. The National Academies reviewed the Action Plan in 2003, and a revised Action Plan was published. Beneficiaries of this research will include the water utilities, state, regional and local emergency response organizations, public health organizations, laboratories with water testing capabilities, public officials, and the general public.

The Action Plan describes research and technical activities in the following broad categories. EPA is working in all of these areas in a focused and applied manner. However, the topics are quite broad and often require long-term research, and thus, there is a great need for many other researchers from academia and the private industry to also work in these areas. It should also be noted that research in many of these areas, while focused on terrorism, could also serve multiple benefits, such as improving the general water quality of distribution systems, developing methods that simplify testing for regulatory purposes, etc.

Characterization and Detection

Research in this area focuses on detecting and characterizing contamination events in drinking water systems. Research can be broadly divided into two categories: laboratory methods and field detection methods. EPA is currently working on improving and standardizing analytical methods for potential water contaminants, developing screening protocols to analyze for “undetermined” water contaminants, and developing methods for concentrating biological samples. Preliminary work in this area resulted in the EPA Response Protocol Toolkit, guidance for responding to

contamination threats, see http://www.epa.gov/safewater/security. There is a broad interagency effort underway to develop “Early Warning Systems” for drinking water – integrated systems to detect, confirm, and warn of contamination in order to protect public health. EPA is evaluating broad spectrum and contaminant specific sensors, piloting syndromic surveillance efforts, developing computational models to design and evaluate early warning systems, and setting up early warning system testbeds.

Treatment and Containment

Research in this area is aimed at minimizing the impacts of drinking water contamination and quickly restoring a drinking water system to use. Hydraulic models are essential to predicting the flow paths of contaminants in distribution systems, and for designing and analyzing mitigation strategies, such as isolation of portions of the system, installing chlorine boosters, etc. In addition, there is a need to improve our basic understanding of the fate and transport of contaminants in drinking and source water; in particular, chemical reactions, degradation byproducts, interaction with biofilm and corrosion products, and biological transformations. EPA is also working on determining the efficacy of standard disinfection technologies against new contaminants of concern.

Decontamination and Disposal

Research in this area is focused on the removal of contaminant residue from pipes or other infrastructure, and the disposal of such contaminated materials.

Research is underway to determine which contaminants may pose a long-term decontamination challenge, as well as to develop and test standard methods for the decontamination of pipes made of various materials, home appliances, and other water infrastructure. An economic analysis of the costs of replacing pipes versus decontamination, as well as a socio-behavioral analysis of public acceptance of water distributed by decontaminated pipes, would be useful. Longer-term research is also needed to develop environmentally benign decontamination agents.

Risk Assessment

Research in this area focuses on adapting standard risk assessment methods for use during and immediately after terrorist attacks or other emergencies. Risk assessments for standard threat scenarios are being completed to predict the likely public health impacts of such scenarios, so that accurate estimates could be shared with the public immediately following an attack. EPA is working on PC-based rapid risk assessment tools for emergency responders that link GIS information with health data and modeling tools. Finally, methods for microbial risk assessment are needed in order to understand the impacts of bio-terrorism.

Technology Verification

EPA has five Verification Centers for homeland security technologies: advanced monitoring, water treatment, containment/filtration, decontamination, and wastewater. These centers verify the performance of technologies through public and private testing

partnerships overseen by stakeholder groups. New technologies can be voluntarily submitted for testing. For more information, see http://www.epa.gov/etv.

Physical Security

EPA is also working to improve the physical security of water systems. Work is underway to develop guidance on protection from explosives, procedures to enhance cyber-security, and tools to understand the interdependency of water systems with other critical infrastructure (power supply, telecommunications, etc.). EPA is working with ASCE and other organizations to develop "Design Standards and Protocols for Enhanced Security," minimum standards for incorporating security into the design and building of new infrastructure.

Research Interest of USBR

In order for a research project to be approved, it is reviewed by two committees, one for relevancy to USBR's goals and objectives and the other for technical merit. These two committees submit their evaluations to the Program Review and Funding Board. This board then prioritizes the proposals which are then funded in order of preference until the research budget is exhausted. Figure ?? illustrated this process.

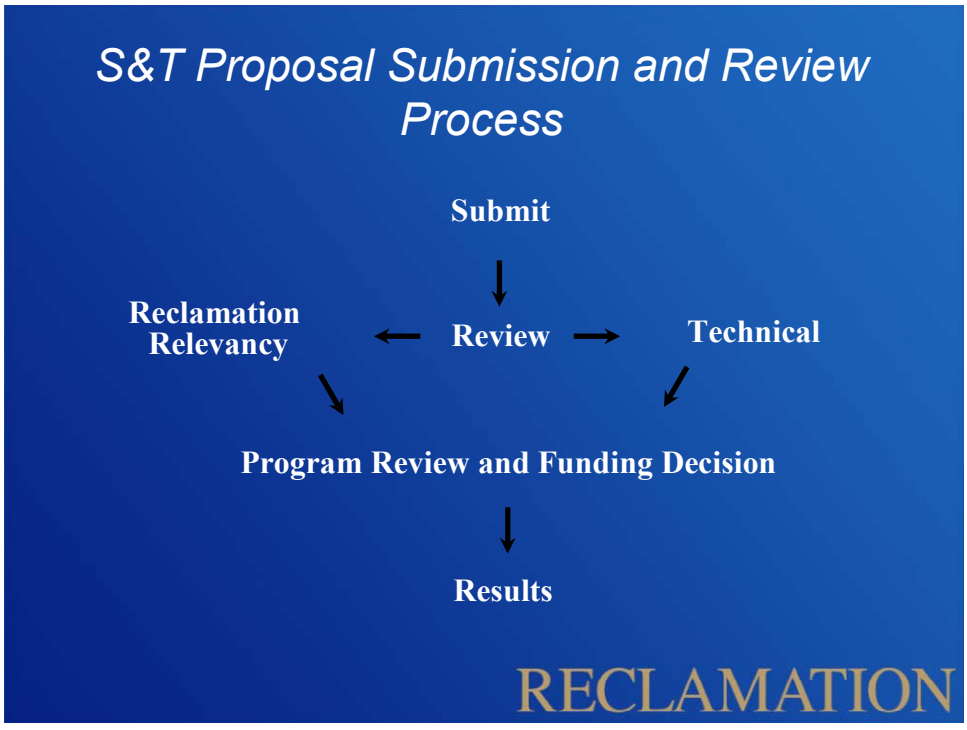

Figure ?? BUREC Research proposal evaluation process.

The upper Colorado regional office of BUREC conducted a survey of two groups to gain insight into what the pressing research needs are. One group was a steering

team constituted to answer that question and the other group was a region-wide survey. Figure ?? shows the results. It is fascinated to see the difference of opinion between the two groups. For example the steering team thought integrating water research into management along with desalinization and water purification were the top research priorities. In contrast, the region as a whole felt that reducing water quality impacts on the various water districts was most important. Other projects the region thought were important centered on the water districts. It appears that those more in contact with the water districts see projects effecting the districts as more important than projects that might have a broader administrative interest. Figure ?? shows a comparison of the survey.

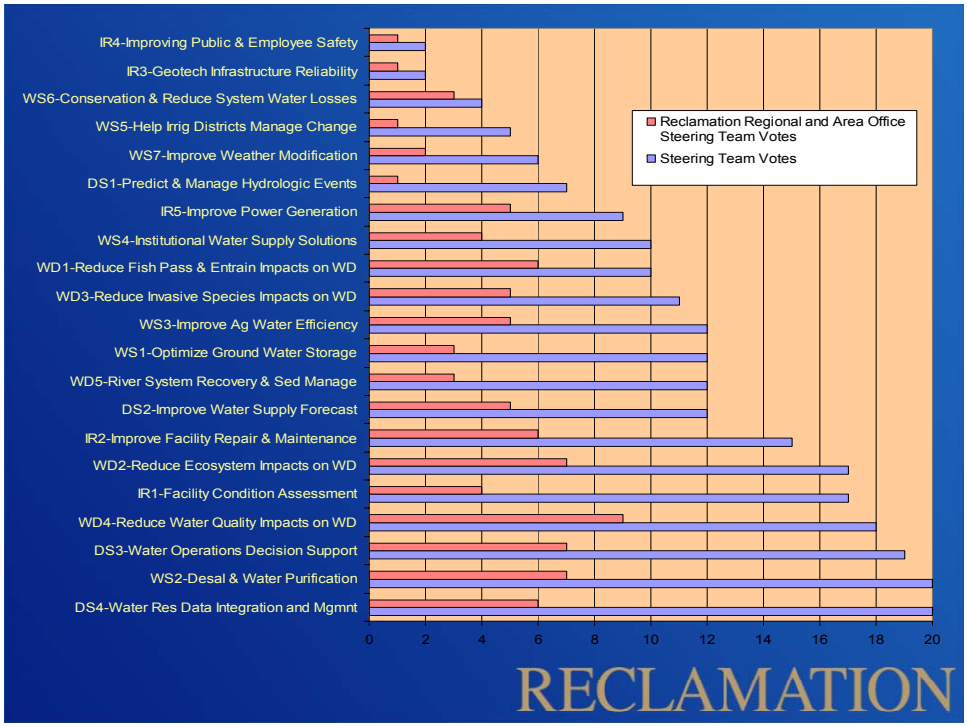

Figure ??, Comparison of polling two groups concerning research needs in the Upper Colorado Region of USBR

In the opinion of Truman, there are seven present research needs in the region. These are listed in Table 1. Tamarisk and Salt Cedar trees are phreatophytes that evapotranspire a large amount of water from the river. They have become prolific along the river banks and have displaced the original vegetation that was in place before the dams decreased the natural floods. There are, of course, concerns by some environmentalists that merely eliminating these trees would damage important bird and animal habitat. How to replace them with less water-using trees and shrubs is a major question. Also, what impact would doing this have on the environment? What would be the effect of eliminating them?

Table 1, Major USBR Research Needs in the Upper Colorado Region

Tamarisk/Cedar Controls

Crop Consumptive Use – Remote Sensing

Runoff Forecasting

Desalination

Decision Support – Modeling Tools

Extreme Hydrologic Events

Geophysical Tools – Soil Density

The second item deals with estimating the crop consumptive use (evapotranspiration, ET) by remote sensing. This is an important input for both planning and managing water distribution to the water districts and individual irrigators. Runoff forecasting deals, not only with estimating the effect of precipitation, but the impact of

snow cover on stream flow. The depth of snow and water content can be, and has been, measured for many years. Being able to do this by remote sensing with improved ET models will greatly enhance water use efficiency.

Improving desalination continues to be an important research area. Much has been done with both reverse osmosis (RO) and distillation plants. The city of Tampa Bay has constructed the largest RO plants for Municipal and Industrial (M&I) use; however, there has been considerable problems along with law suits along the way. We are a long way from desalting water for agricultural use. Better modeling tools aid decision support systems. The U. S. Army Corps of Engineers (COE) has developed an extensive simulation model for the Missouri river to show the impacts of various reservoir operating policies on energy, navigation, water supply, and the environment. As one can imagine, with these completing uses, sophisticated models are required.

Extreme hydrologic events need to be anticipated. Often with reservoirs reach rear record lows, people think the system has failed with these lows show that the system is working by supplying water during droughts. However, knowledge of the probabilities of these extreme events is critical to reservoir operation policies. Finally geophysical tools to measure soil density and other properties aid in both irrigation planning and management as well as run-off planning and watershed management.

Research Interests of the Private Sector

References

Water Science and Technology Board of the National Research Council (2001) *Envisioning the Agenda for Water Resources Research I the 21st Century*, National Academy Press, Washington, D.C.

Water Science and Technology Board of the National Research Council (2004) *Confronting the Nation's Water Problems: The Role of Research*, National Academy Press, Washington, D.C.