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Integrated Water Resources Science and Services (IWRSS)

An Integrated and Adaptive Roadmap for Operational Implementation

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Executive Summary

Water resources are widely considered to be one of the most significant challenges facing this nation in the 21st century. Managers and decision-makers in all sectors of water resources require new and more integrated information and services as they strive to adapt to uncertainty, change and increasing stresses on limited resources. The scope of water resources is polydisciplinary; as federal agencies with significant responsibilities and authorities in this area, the information needs of the broad scope of stakeholders must be considered and addressed in an integrative fashion.

This roadmap responds to the demand for additional operational water resources information and integrated services. Through a consortium of federal agencies with operational missions in water science, observation, prediction and management, the Integrated Water Resources Science and Services (IWRSS) project has been started to integrate service and service delivery, improve river forecasts, and provide new "summit-to-sea" high-resolution water resources information and forecasts. Collaboration and innovation are paramount. Together, the IWRSS Consortium seeks to be the most useful government organization for stakeholders of our nation's water resources and an unbiased, trusted broker of water resources information.

Objectives and Goals

With this vision, the overarching objective of the IWRSS project is to demonstrate a broad integrative *national water resources information system* to serve as a reliable and authoritative basis for adaptive water-related planning, preparedness and response activities from national to local levels. The project seeks to make intersections between relevant systems more seamless, synthesize information better across systems to improve services and service delivery and improve the overall quality of information, and provide new information and services to better support the needs of water resources stakeholders.

Three operational goals (right) guide the IWRSS design. These goals reflect agency missions and goals, programmatic plans and objectives, and other drivers. The first goal has an inward component concerned with developing a Common Operating Picture (COP) by improving interoperability between systems, exchanging data and information seamlessly between systems and actors in the consortium, and making a significant leap-forward in the realm of geospatial information accessibility, visualization and interpretation. It also has an outward component that seeks a similar COP experience for IWRSS consumers by providing a transparent front for water resources information, i.e. "one-stop-shopping" for well-integrated water resources information.

Operational Goal 1
Integrate Services and Service Delivery

Operational Goal 2
Increase Accuracy and Lead Time of River Forecasts

Operational Goal 3
Provide New "Summit-to-Sea" High-resolution Water Resources Information and Forecasts

The second goal is aimed at strengthening collaboration to improve several key themes important to river forecasting and management. These include flow forecasting and water management (including low flows in particular), flood forecasting, levee and dam failures, river ice, climate and

drought mitigation, water supply, coastal environments, geo-intelligence, and research and development. Improved data access and modeling capability are common denominators for all of these themes. Here the project exploits the fundamental systems-level capabilities gained in Goal 1 within the workflow of specific forecast systems and modeling tools used by the agencies to perform their missions.

The third goal is at the core of the envisioned national water resources information system and is the grand synthesis challenge for the IWRSS project. This goal is concerned with putting together the development and implementation of high-resolution models, interoperable tools and collaborative workflow that together enable comprehensive description and prediction of the water resources environment at all locations, from the mountain summits to the sea, coasts and estuaries. This goal is to 1) provide stream-flow forecasts throughout the river and stream network from headwaters all the way to the coasts and estuaries, advancing the current capability in which forecasts are only available at selected locations and generally stop short of the coasts, and 2) provide consistent and seamless high-resolution GIS-ready geospatial data and information describing past, current and future soil moisture, snowpack, evapotranspiration, groundwater, runoff and flood inundation conditions, and the uncertainty associated with this information. This goal exploits the efficiencies and information access gained in Goal 1 and the enhanced forecast tools and workflow gained in Goal 2. Marshalling the intellectual resources of the consortium partners and implementing new subject-matter expertise within the consortium is essential to achieve the desired level of synthesis and integration.

Integrated Approach

The IWRSS project will demonstrate a new integrated interagency operations approach for the end-to-end water resources forecast process and service delivery. This type of water resources prediction is a new business area and IWRSS is a new model for the way we do business together. Part of this model is to strengthen and enhance the numerous intersections that exist between the three operational goals of IWRSS. The IWRSS project design focuses on three crosscutting collaboration themes focused directly on key intersections (right).

The first theme is concerned with establishing and maintaining a strong participatory process for IWRSS and building the social capital necessary for success. It involves all aspects of stakeholder interactions and communications at both national and regional levels, including internal and external communications strategies, outreach, and the development and implementation of social science strategies for stakeholder engagement.

The second theme is concerned with information services and involves all technical aspects of the national water resources information system, including system interoperability and data exchanges, eGIS and geo-Intelligence, integrated information delivery, the acquisition and management of observations and surveillance, and technological research and development. In particular it is concerned with the intersections between these focal areas, and emphasizes the implementation of sound information technology (IT) engineering practices to promote the coordination, integration and facilitation of interagency activities to pursue common goals in water resource management.

The third theme is concerned with the physical and social science aspects of developing a well-integrated national water resources information system that is responsive to the needs of stakeholders. It includes the physical science aspects necessary to advance operations in five focal areas: 1) develop and implement the summit-to-sea modeling and prediction framework, 2) provide the historical context and trend information necessary to understand the present and the future, 3) advance water flow and management capabilities, 4) improve the use of observations, and 5) quantify uncertainties and validate analyses and forecasts. A sixth focal area includes the social science aspects necessary to identify and understand specific information needs, relate these needs to the design and function of operational tools that provide the information, and to effectively communicate this information back to the stakeholder. This theme recognizes that there is a large resource of mature science capability available; it focuses more on science implementation and integration than on science development. Thus IWRSS is not a research instrument; it is principally an instrument for operational implementation that aggressively mines and assembles existing capability.

Strategies

The IWRSS project takes a program approach to delivering capability and outcomes. Its aim is to improve the delivery of capability by aggregating related projects and associated lines of development and manage their delivery coherently and jointly. In this way interdependencies, risks and opportunities can be managed more effectively to focus on achieving outcomes with good value. This approach embraces the strengths of all actors at all scales in each agency, and seeks to draw the best solutions from the mix. This greatly increases flexibility, which is essential for IWRSS because water resources stakeholders are themselves working to become more flexible and adaptable, and IWRSS must be positioned to adapt with them.

Therefore the project design uses adaptive strategies for operational development and implementation. A spiral development model provides the high-level strategic framework for the project, and agile development methods form the low-level tactical approach. The comprehensive vision and design for integration and collaboration positions IWRSS to take advantage of opportunities, both large and small.

The cross-cutting human dimensions theme and the spiral development model are designed to engage stakeholders early and often to improve understanding of needs, planning and operations, and to update this knowledge regularly. In this way IWRSS can better anticipate emerging needs, target high-value and high-impact opportunities, manage resources to sustain high-value functions and guide investments in new capabilities. By participating more closely with stakeholders, it's likely that it will be easier to recognize important opportunities.

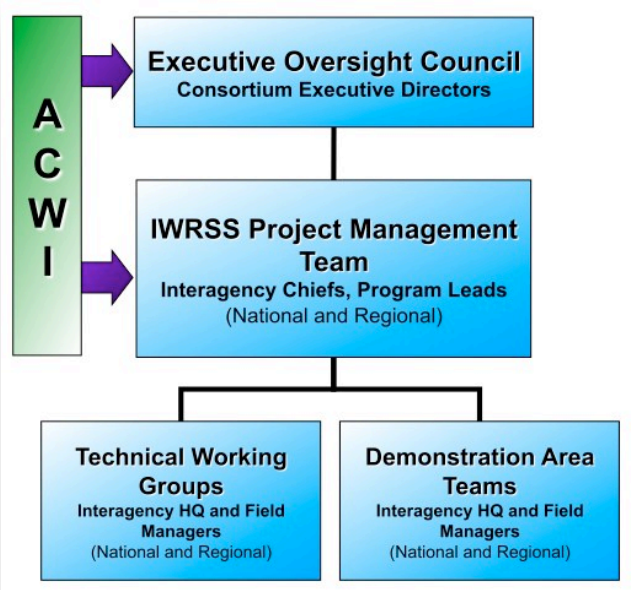
The program approach is manifest throughout the IWRSS design; integration, interoperability, trans-boundary data synchronization and workflow are all aspects of this approach. Research and development is another important aspect of this approach. By considering the wide array of water-related research and development activities across multiple agencies as a virtual, integrated program, R&D assets can be managed more effectively with limited resources. In particular, by adopting a common framework for characterizing the readiness of science and technical capabilities, IWRSS can more readily identify capability sources and focus resources on advancing needed capability to operational levels.

National, Regional and Local Framework

The IWRSS project design is regionally focused. Regional demonstration projects will be the venue for implementing and operationally proving many IWRSS capabilities. To enable broad, trans-boundary integration and synthesis, an innovative national IWRSS operational support center is planned. This facility will provide a number of centralized shared services and place staff in regions to support demonstrations. It will operationally and interactively produce national high-resolution water budget analyses and forecasts to provide a contextual backdrop for regional products and services. Together, with regional and local facilities providing focused services and a national facility providing integrative "glue", the national integrated water resources information system is designed to provide information, products and services that transcend geographic and organizational boundaries. With interoperable systems and data services, national coverage and sharper regional coverage, some aspects of the IWRSS design consider the combined offices of the three agencies as nodes on a mesh-like communications network, and exploit this abstraction to broaden intersections and improve the flow and integration of information across boundaries.

Governance

The governance structure planned for IWRSS consists of an Executive Oversight Council, a Project Management Team, Technical Working Groups, and teams for each selected regional demonstration area. The Executive Oversight Committee will provide high-level agency oversight and programmatic authority for the IWRSS Project. Its members will consist of senior executive service leadership representing water resources programmatic interests from each agency, who will meet twice annually to discuss IWRSS agenda. The Council will engage the Federal Advisory Committee for Water Information (ACWI) as a source of guidance and direction for the IWRSS project.



The Project Management Team will be responsible for overall strategic planning, integration and operations of the Project. Consisting of national and regional chiefs and program leads from each agency, this team will be the primary planning and decision-making body for IWRSS operations, services, science and technology. Technical Working Groups consisting of national and regional managers will be formed to focus on specific topical areas identified for the human, technical and science themes of IWRSS.

Business Concept

The project's outcomes are expected to include:

1. **Integrated Water Resources Services.** IWRSS will result in improved internal and external communication and better, more productive engagement with stakeholders. Delivery of water resources data, services and products will be more integrated to provide stakeholders with an experience that appears to be one-stop shopping. Communication of risk and uncertainties will be improved, both in terms of quantitative measures and through the efforts of enhanced training and outreach.
2. **System Interoperability, Collaborative Tools and Workflow.** Major systems in use across multiple agencies will be made interoperable, meaning data and information will be able to flow between them more seamlessly and models, tools and other applications will be cross functional across systems. Models used nationally will be made available regionally, and new models will be made accessible. Toolkits will be provided to improve access and analysis of information and improve collaborative workflow.
3. **Common Operating Picture.** Several elements of the IWRSS project will work in combination to provide a common operating picture across multiple agencies, enabling river forecasters in one agency using their system to see the same information as river managers in another agency using a different system, and external stakeholders to see much of the same information through common web services. The Common Operating Picture will be dominantly geospatial, meaning enterprise GIS and geo-Intelligence will be ubiquitous within agency systems.
4. **Integrated, Sustainable Consistent Water Resources Modeling and Forecasts.** The centerpiece of IWRSS for IWRSS stakeholders will be a new national suite of integrated high-resolution water resources analyses and forecasts. Analyses will include historical water budget studies going back as long as records permit, current conditions for immediate situational awareness, and forecasts of future water budget conditions. This suite will include basic short-term ensemble water budget forecasts at 1 km^2 resolution for the U.S., advanced modeling in selected regional demonstration areas with mechanisms to transition best practices to other regions, and advanced regional river and flood forecasting and water management models, including linkages between terrestrial and coastal/estuarine environments, surface water and groundwater, and water quality.

The project has been designed to ensure that IWRSS is sustainable and well aligned with water resources business areas of the Consortium agencies. The legal authority for these agencies to engage in the scope of activities planned for IWRSS is well documented. The IWRSS project design has drawn from an extensive array of agency planning instruments to identify and align with broadly held goals and objectives. The Consortium is open, and it is expected that other agencies will join in this activity as it begins and evolves.

The stakeholders for the IWRSS project are consumers of water resources information who can benefit from the new and improved information and integrated service delivery that IWRSS will provide. They require data and information to develop knowledge necessary to make decisions and take actions. IWRSS stakeholders include decision makers who manipulate water, water and environmental resource managers and planners, emergency managers and responders, public-sector information consumers with a wide variety of commercial and private interests, and "internal"

stakeholders involved in the enterprise collection, analysis, prediction and delivery of water information and services.

Budget and Implementation

The IWRSS project design builds on existing capabilities by focusing on elements that support and foster integration, and develops new capabilities through implementation and regional demonstration. The design strategy is deliberately flexible and adaptable to allow the project to be opportunistically driven and executed. For planning purposes, multiple budget options ranging from $100M to $500M per year are being prepared to develop the scope of elements and capabilities to be addressed by the project, including: 1) interoperability and data synchronization capabilities, 2) eGIS and geo-intelligence capabilities, 3) national high-resolution water budget modeling and prediction, 4) the national IWRSS operational support center, and 5) regional demonstration projects. The resulting design provides a comprehensive programmatic approach to delivering a national integrated water resources information system.

There are five fundamental steps necessary to demonstrate a baseline summit-to-sea modeling and prediction framework. The first is to start bringing the right people together. Workshops and a series of technical working groups are planned to work on details of major design components, and early stakeholder engagement is a key element. The second step is to assemble key science components and make necessary connections. Third is to begin early production to provide experience and examples. Fourth is to begin developing the workflow between actors. The fifth step is to engage more stakeholders in the process to begin refining product and service, following the spiral development strategy.

Structure of the Report

The first three chapters introduce the project, describe the vision, objective and goals, and discuss the approach for the project design and implementation. The next three chapters describe each of the three crosscutting themes in detail; here are found the specific elements and capabilities that IWRSS will focus on. The next two chapters describe the plans for the national IWRSS operational support center and the regional demonstration projects. The concept of operations is summarized from a system or user point of view in Chapter 9, and the business concept is discussed in Chapter 10.