

The Water Cycle Solutions Network

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Overview

Earth is a unique, living planet due to the abundance and vigorous cycling of water throughout the global environment. Water is essential to life and is the molecule that most directly impacts and constrains society's welfare, progress, and sustainable growth by serving as a resource for industry, agriculture, natural ecosystems, fisheries, aquaculture, hydroelectric power, recreation, and water supply. Therefore, it is a national priority to use advancements in science to develop solutions to society's water challenges.

Therefore, a *Water Cycle Solutions Network* is needed to establish pathways, partnerships, and interoperability between water and energy cycle research investments and decision support, as follows:

Actionable Database: We will develop this solutions network by engaging relevant water and energy cycle resources and community-of-practice organizations to develop what we term an "actionable database" that can be used to communicate and connect water and energy cycle research results towards the improvement of water-related Decision Support Tools (DSTs). An actionable database includes enough circumstances or facts about its nodes that connections and pathways between these nodes are identifiable and motivated.

Initial Focus on End Points: We will initially focus on identifying, collecting information about, and analyzing the two end points, these being the research results and water related decision support tools.

Connecting the Ends: We will develop strategies to connect these two end points via innovative communication strategies, improved user access to NASA resources, improved water cycle research community appreciation for DST requirements, improved policymaker, management and stakeholder knowledge of NASA research and application products, and identifying pathways for progress.

Metrics and Benchmarking: Finally, we will develop relevant benchmarking and metrics, to understand the network's characteristics, optimize its performance, and establish sustainability. This solutions network will deliver numerous pre-evaluation reports that will identify the pathways for improving the collective ability of water cycle scientists, managers and stakeholders to routinely harness recent research results to address water cycle assessment, prediction & management challenges.

Project Team: Our tightly-knit team is composed of the leading experts in cutting-edge water cycle research science, the water sector user community, and network design and optimization. The team represents a strategically placed set of national and international organizations that will partner to harness recent research results to characterize and improve networks that sustain solutions.

Partners: We have built numerous partnerships with a cross-section of individual and networked research results and decision tools from government, private, and academic domains, that will enable us to quickly establish an operational solutions network, entrain more partner nodes and networks, and foster the solutions network to self-sustainability.

Figure 3 illustrates our solutions network diagram, and Figure 4 illustrates generalized examples of the network design and wiring diagram -- our work focuses on the "bridge" domain of these figures, where we seek to extend research results into routine solutions.

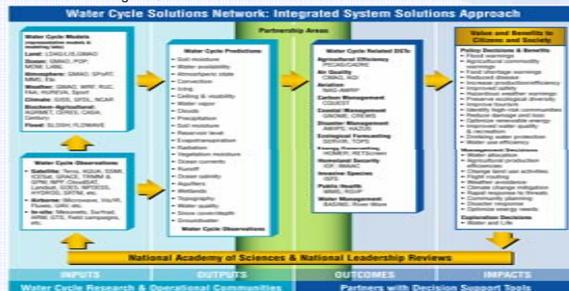


Figure 1: The water cycle solutions network approach.

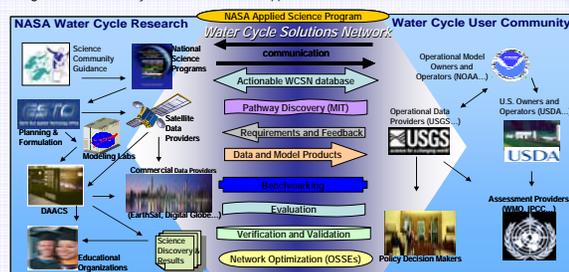


Figure 2: The Water Cycle Solution Network Diagram is a general outline of how the project will identify the nodes and the relationships between them during the period of performance.

NASA Applied Sciences Program

The objective for NASA Earth-Sun System Division, Applied Sciences Program (NASA, 2005) is the sustained use of recent research results to benefit society, through:

- Integrated Systems Solutions** that benchmark the performance resulting from recent science research result integration into decision support tools, and
- Solution Networks** that improve organizational networks of science institutions so society can harness recent science research results to meet national needs.

Solution networks are focused on optimizing the ability for science organizations (e.g., universities, industry, Government, laboratories, nonprofits) to interact, identify, access, and harness recent science research results to augment decision support tools and meet national needs. Activities include characterizing existing organizational networks, expanding networks and adding new connections, and mining the Earth Sun science results for capacities that may address applications of national priority. In this context, "networks" refers to organizational connections and communications rather than information technology. The program uses an "end-to-end" systems approach to extend research results as inputs to decision support tools, which features the use of systems engineering steps of evaluation, verification and validation, and benchmarking (NASA, 2005).

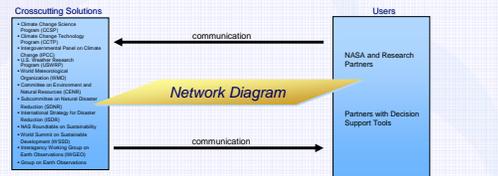


Figure 3: A conceptual solutions network diagram (NASA, 2005).

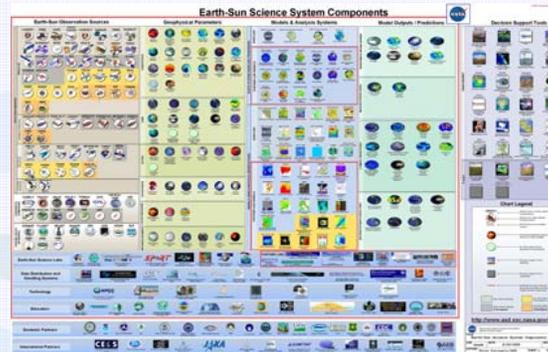


Figure 4: Network of partners identified by the NASA Applied Science Program (NASA, 2005).

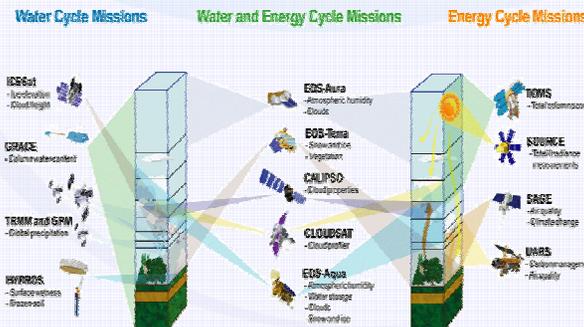


Figure 5: NASA water & energy cycle satellite missions.

Approach & Partners

Our approach is to evolve a network of water cycle partners to optimize Earth science-based solutions in support of the twelve national application priorities, as follows:

- Evaluate a network of water cycle partners:** identify and analyze water cycle community-of-practice organizations and their requirements, develop partnerships, and define collaboration pathways.
- Routinely identify, prioritize, mine and communicate relevant NASA (and other relevant) water cycle research results,** and develop operational pathways to provide timely user-community access.
- Optimize water cycle partner access to water cycle research results,** through developing prototypes, evaluation methods, verification procedures, and benchmarking standards.
- Analyze and document the networks' effectiveness** by developing metrics, standards, resource estimates and documentation procedures and guidelines.
- Engage in education and outreach** to help society understand the water cycle research results and their potential application for societal benefits.

Table 1: A selection of water-cycle relevant DSTs and the potential value of NASA water cycle research.

NPA	Water Cycle Relevance	Example DSTs	Value & Benefit to Citizens & Society
Agricultural Efficiency	Improved yield prediction through water availability, and improved weather, climate, and hazard prediction	Crop Assessment Data Retrieval and Evaluation (PCARD/CADE); Flood Drought	Reduction in production costs. Better seasonal yield estimates. Early warning of food shortages
Air Quality	Quantify atmospheric nitrogen deposition to water bodies as major contaminant. Provide accurate precipitation data	PCARD/CADE; Air Quality Modeling System (QMAQ); Air Quality Index (AQI); POC; Denver Noel	Reduction of the following long-range diseases, premature death, hospital admissions, etc. Improve crop yield/efficiency; pollution reports
Aviation	Turbulence; accurate convective weather, and congluibility; precipitation	National In-Route Aviation Weather Research Program (NAS-AIRWP); POC; Cirrus Kulkas	Improved Safety. Reduced Efficiency. Earlier warnings of hazardous weather. Reduction in the cost of flying
Carbon Mgmt	Provide accurate precipitation SM and ET for improved carbon sink estimation	Carbon Query and Evaluation Support Tools (CQUEST); POC; Dr. Christopher Fisher	Improved efficiency in crop production. Climate change mitigation. POC; Dr. Christopher Fisher
Coastal Mgmt	Providing water availability and stresses on these systems. Provide accurate precipitation, salinity, and runoff data. Providing water availability and stresses	Coastal Reef Early Warning System (CREWS); POC; Jim Hendrix; Coastal Reef Risk Modeling Environment (COMRE); POC; Jason Jackson	Alerting to coral bleaching conditions in the Florida Keys and the Great Barrier Reef. Increased & mitigate effects of and hazardous materials in waves and along coasts. Improve tourism
Disaster Mgmt	Prediction, assessment, and management of drought, wildfire, forest fires, debris, debris, and hazards by providing precipitation, runoff, soil moisture, and snow data	Advanced Weather System Interactive Warning System (AWIS); POC; Stephen Anderson; Hazardous Weather System (HWS); POC; Claire Dwyer	Disaster warnings including flood/fires/inflated, rapid, highly increased & mitigate effects of and hazardous materials in waves and along coasts. Improve disaster response. Community planning
Ecological Forecasting	Improve conservation and ecological sustainability, protected area management, and marine fisheries forecasting using soil moisture, precipitation and ET	Regional Visualization & Modeling System (RVM); POC; Dan Train; Terrestrial Observation & Prediction System (TOPS); POC; Richard Kiang	Predict the impact of changing land use patterns & climate on ecosystem development/ecological forecasts. Enhance management decisions related to floods, droughts, hurricanes, and agricultural production
Energy Mgmt	Energy production and efficiency using accurate global water radiation, precipitation, snow, soil moisture, and ET	Renewable Energy Technologies Screen (RETScreen); POC; Gregory J. Lind; Meteorological Optimization Mode (MOM); POC; Richard Kiang	Optimize renewable energy systems. Finds cost effective methods of energy distribution
Homeland Security	Water supply into enabling response, recovery and mitigation to threats, and military mobility prediction	Intelligence Modeling and Atmospheric Assessment Center (IMAC); POC; Stephen Anderson	Anticipate disaster-related damage. Improve response. Improve disaster response. Reduction in lives lost. Reduction in damage, cost and time to recover
Invasive Species	Primary factor controlling invasive species: is accurate precipitation data	Invasive Species Forecasting System (ISFS); POC; Michael Frame	Improvement in quality of health for man, animals and plants
Public Health	Disease, environmental health, and public health preparedness directly aided by precipitation and soil moisture	Rapid Response Validation Project (RRVP); POC; Dan Train; Integrated Modeling and Surveillance System (IMSS); POC; Richard Kiang	Provide early warnings for harmful exposures. Reduce environmental related diseases. Increase warning time. Reduce post-disaster response
Water Mgmt	Provide accurate precipitation, snow, soil moisture, ET, and runoff data for water management decision support	RiverWatch; POC; Terry H. Don Forest; Dave Matthews; Milja Bilby; Gregor Gregoric; National Science Foundation's Point & Nonpoint Source (NAPS); POC; R. Kinnison	Forecasting and long term water management planning. Water supply quantity and hydrologic runoff. Improved digital surface waters, storm water management. Hours drinking water protection. Monitoring of coastal area water

Table 2: A selection of existing water-cycle related science and stakeholder networks.

Network	Description
CIAMS	The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CIAMS) is a corporation of 100 university member institutions founded in 2001 to develop and enable a research agenda for the hydrologic science community. CIAMS's program calls for research to be carried out at much larger spatial scales than has been done in the past, to integrate all parts of the terrestrial hydrologic cycle in addressing research questions, such as the hydrologic, chemical, and biological processes. CIAMS's program in Hydrologic Information Systems (HIS) will create comprehensive hydrologic data models consisting of an information database coupled with tools for acquiring, analyzing, visualizing, and modeling
CBP	Columbia Basin Project is a multi-state MT, WA, ID, OR that involves a network of 175 irrigation districts, Grand Coulee Dam, and related storage facilities on the Columbia River and tributaries that produce large quantities of hydroponic agricultural products, and also the riverine ecosystem of this region. The project is managed by the Washington Department of Ecology in conjunction with the Bonneville Power Administration, British Columbia Power, Canada, and state and local entities. DSS is used in the operation and planning of water resources management in this area
CVP	Central Valley Project of California, operated by the California Department of Water Resources, Reclamation, US Army Corps of Engineers, and a network of irrigation and power companies. The Central Valley Operators (CVO) uses a variety of DSTs for operational decision-making on the 150 reservoirs and basins throughout the Central Valley
URCOM	Upper Rio Grande Water Operators Model and network of users including the USACE, USGS, Reclamation, and the irrigation districts and municipalities that draw water from the Rio Grande Basin. This DST and user network provide water management solutions to this water scarce region which has headwaters in the San Juan Mountains of Colorado and involves NM, TX, and Mexico, and the Colorado River Basin downstream
GMS	GMS is a joint initiative of the European Commission and the European Space Agency, designed to establish a European capacity for the provision and use of operational information for Global Monitoring of Environment and Security (GMS)
PUB	The UNIS Decade on Predictions in Ungauged Basins (PUB) is aimed at formulating and implementing appropriate science programs to engage and emerge the scientific community in a coordinated manner, towards achieving major advances in the capacity to make predictions in ungauged basins
GWSP	The Global Water System Project (GWSP) will undertake key cross-cutting activities such as generating an information database on the global water system, facilitating a discussion on water resources in the social and natural sciences, and developing scenario models for the global water system
HELP	Hydrology in the Environment, Life and Policy (HELP) is designed to establish a global network of catchments to improve the links between hydrology and the needs of society. As a cross-cutting programme of the UNESCO International Hydrological Programme, HELP is expected to contribute to the World Water Assessment Programme (WWAP), and the Hydrology and Water Resources Programme at UNU (IHPAP)
AWARE	Available Water Forecasting in the Mountain Environment an EU project involving Austria, Switzerland, Italy, Slovenia, and Spain, and 6 research hubs and universities to establish a geo-service for tailoring models, and data assimilation systems to improve forecasting and management of snowpack, floods, avalanches, and related water cycle processes
EFFS	European Flood Forecast System - a consortium of EU nations studying methods to improve flood predictions and warnings in central and southern Europe

The project's success hinges on building a community of engaged research, end-user, industry, government, non-profit, networks, and academic partners. If you are interested in becoming a water cycle solutions network partner, please contact us.

Literature cited

NASA Applied Sciences Program: Extending NASA Earth-Sun System Research Results through a Systems Engineering Capacity, 2005

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More information

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