The Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) was founded in 1986 to research and develop decision support systems (DSS) that are used by government agencies and others to improve the management of finite natural resources, particularly water. Funded primarily by the U.S. Bureau of Reclamation, the Tennessee Valley Authority, and the U.S. Army Corps of Engineers, CADSWES has developed DSS tools that are now widely used to provide a foundation for long-term resource planning that supports water conservation, ecosystem health, and balanced natural resource management. CADSWES research focuses on areas such as climate change adaptation, modeling of multi-objective water resource systems, improved short and long term forecasting under hydrologic variability, and hydropower optimization. The Center’s research and development emphasis also includes a strong platform for graduate student education – building the next generation of sustainability focused natural resource researchers and practitioners. CADSWES technologies, including the widely adopted RiverWare basin modeling tool, are licensed through the CU Office of Technology Transfer and incorporate regular training and user group meetings for water resource professionals. CADSWES endeavors to contribute significantly to improved sustainability and management of our natural systems by:

- Working closely with resource management agencies to understand and respond to decision support needs as those needs arise;
- Pursuing strategic research to advance the science of sustainable and integrated water resources management;
- Applying powerful and appropriate information technologies to advance the results of research to useful decision support tools;
- Serving as a university center for education and collaboration among researchers, agencies, faculty and students in the development and application of the DSS tools and the issues and methods of sustainable resource management;
- Maintaining, supporting, and teaching the use of the decision support tools to facilitate improved resource management by government agencies and others.

**CADSWES Director: Edith Zagona**

Edie Zagona joined CADSWES in 1988 and has been the director since 2001. She is a Research Professor in the Civil, Environmental, and Architectural Engineering Department. She received her PhD in Civil and Environmental Engineering from CU-Boulder, MS and BS degrees in Civil Engineering from Colorado State University and the University of Arizona, and spent eight years with the Bureau of Reclamation planning and designing water development projects. Zagona has led a multi-disciplinary team at CADSWES in the research and development of RiverWare since its inception in 1993; the model-based decision support tool for multi-objective river, reservoir and hydropower planning and management is now widely used by water managers, agencies, utilities, researchers and consultants.

She continues to provide technology transfer and extend the DSS tools while also leading research projects in the areas of sustainable water resources planning and management under uncertainty, simulation and optimization modeling of hydrologic and hydraulic systems, multi-objective reservoir operations, reliability of environmental flows, hydropower optimization and adaptation to climate change. She serves on various advisory and review boards including the DOE’s Wind and Water Power Peer Review Team and is a technical advisor to the Nile Basin Initiative’s Decision Support System development.

**Recent Highlights**

- CADSWES is partnering with the National Renewable Energy Laboratory (NREL) to improve hydropower modeling with wind energy integration. Through this collaboration, CADSWES will be bridging gaps in knowledge and energy forecasting to provide more realistic modeling scenarios that focus on renewable energy synthesis and efficiencies.
- CADSWES recently launched the initial release of RiverSMART, the RiverWare Study Manager and Research Tools. This new suite of software facilitates climate change assessments and other long-term planning studies. Included are components for generating stochastic hydrologic ensembles based on historic, paleo, and climate change data and for generating alternative demand projections based on sectors and population. These are combined with a scenario manager that can execute thousands of simulations and organize the outputs for statistical analysis. The software was developed under a recently completed Reclamation WaterSMART project (Zagona and Rajagopalan).
- In 2012, CADSWES was a winner of the Partners in Conservation Award from the U.S. Department of Interior, as a contributor to the Colorado River Basin Water Supply and Demand Study, which was nominated as a model of collaboration for future watershed planning across the country. The seven Colorado River Basin States, the Bureau of Reclamation, and water users worked together to establish a common factual and technical foundation for resolving future water supply and demand imbalances. Reclamation technical staff who spearheaded this study are stationed at CADSWES and utilized some of the CADSWES decision support tools to accomplish the study.

**Sponsors and Funding**

CADSWES receives about $1.5M per year in research contracts and grants. Recent sponsors and collaborators include:

- Bureau of Reclamation
- U.S. Army Corps of Engineers
- Tennessee Valley Authority
- Joint Institute for Strategic Energy Analysis
- National Renewable Energy Laboratory

[cadswes.colorado.edu](http://cadswes.colorado.edu)
RiverWare is a river system and hydropower simulation and optimization modeling tool researched and developed by CADSWES and sponsored by the Tennessee Valley Authority, the U.S. Bureau of Reclamation and the U.S. Army Corp of Engineers. It is an ideal platform for operational decision-making, responsive forecasting, operational policy evaluation, system optimization, water accounting, water rights administration, and long-term resource planning. Users construct a river basin network model that incorporates the best methods for simulating processes such as flow routing, evaporation, hydropower generation, consumptive use, and groundwater interaction. Additionally, operational policies are entered as prioritized rules or goals in RiverWare’s interpreted policy language. The intuitive graphical interface, efficient data management, object-based topology, and customized spreadsheet views allow quick and meaningful results for decision makers and stakeholders.

RiverWare is used by numerous federal, state and local water management agencies, utilities, research institutes and consultants, and is available to the public through the CU Office of Technology Transfer. As CADSWES continues to maintain and enhance RiverWare, emphasis is also placed on the development of other complementary DSS tools. The Center provides training classes, technical support and annual user group meetings for sponsors and commercial users. RiverWare is also used as a teaching tool for academic water resources classes and as a research tool for graduate students. Learn more at http://cadswes.colorado.edu/riverware.

Principal Research Areas

Climate Change and Adaptation
Effects of climate and hydrologic variability and change on performance of river and reservoir systems and adaptive measures to adjust operations to these changes. Development of new analysis and DSS tools to assist in identifying and evaluating strategies for adaptation. Projects sponsored by Reclamation.

Improved Modeling and Operations of River Systems
Development of new techniques for modeling, formulating and evaluating operational policies; conducting yield analysis; integrating models, data and analysis tools; simulating ensembles for risk and uncertainty analysis; and communicating with stakeholders. Projects funded by Reclamation, Corps of Engineers, TVA and other utilities and water management agencies.

Hydropower Optimization and Renewable Energy Research
Development of improved hydropower optimization techniques; assessment of potential for integrating hydropower with wind generation considering operational constraints, e.g., water supply, environmental flows, total dissolved gas in releases. Projects sponsored by Tennessee Valley Authority, the Department of Energy, the Joint Institute for Energy Analysis, NREL and other power utilities.

DSS Modeling Tools for Water Rights and Accounting
Projects on the Rio Grande, Snake River, Truckee-Carson, Lower Colorado (Texas), Uinta River, sponsored by Reclamation, Corps of Engineers, state water agencies.

Environmental Flows
Assessing future reliability of environmental flows and new approaches to modeling environmental flow metrics in basin-scale policy models. Projects sponsored by Reclamation, the U.S. Army Corps of Engineers and NGOs (Environmental Defense and The Nature Conservancy).

Forecasting and Stochastic Streamflow Simulation
Development of methods of Stochastic Streamflow Simulation that capture novel information from large-scale climate signals which improves on data provided by the historic record; and use of these simulations to improve water management. These have been applied on the Gunnison, San Juan, Pecos, Truckee-Carson and Colorado River Basins. Projects sponsored by Reclamation, NOAA.

Research and Development Team

Mitch Clement
Professional Research Assistant: water resources, integration of hydropower with renewables, tech transfer.

Timothy Magee
Research Associate: operations research analyst, hydropower optimization.

David Neumann
Senior Professional Research Assistant: water resources, water rights, tech transfer and outreach.

Balaji Rajagopalan
Professor, Civil, Environmental and Architectural Engineering: hydrology, data analysis; climate change.

Edith Zagona
Research Professor, Civil, Environmental and Architectural Engineering: water resources, decision support.

Computer Scientists

Bureau of Reclamation’s Colorado River Climate Change and Modeling Team in permanent residence at CADSWES
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More Information

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