

## USGS Water Availability and Use Science Program

Melinda Dalton, U.S. Geological Survey

*Melinda Dalton is the Deputy Program Coordinator for the USGS Water Availability and Use Science Program (WAUSP). Her role in WAUSP focuses on promoting successful research related to components of the water budget as well as stakeholder engagement. In addition, she coordinates the USGS Water Use Data and Research program, a financial assistance program focused on the improvement of water use data and methodology development at the State level. Prior to WAUSP, she helped coordinate the USGS National Water Census, part of the Department of the Interior's WaterSMART initiative and has worked with the Department of the Interior's Climate Science Centers. Her USGS career began as a hydrologist at the Georgia Water Science Center and she still resides in Atlanta, GA with her husband Brendan, son Patrick, and dog Charlie.*



### ABSTRACT

A key part of achieving the US Department of the Interior's sustainability goals is informing the public and decision makers about the status and trends of the nation's water resources. To achieve these goals the USGS has implemented a National Water Census (NWC) to provide a more accurate picture of the quantity of the nation's water resources and improve forecasting of water availability for current and future economic, energy production, and environmental uses. In 2016, to streamline water sustainability activities, the USGS realigned all water availability and use oriented research, including the NWC, within a new Program - the Water Availability and Use Science Program (WAUSP).

WAUSP supports producing a current, comprehensive scientific assessment of the factors that influence water availability through development of nationally consistent datasets on the status and trends of water budget components (precipitation, streamflow, groundwater, and evapotranspiration), as well as human water use; improving the current understanding of flow requirements for ecological purposes; and evaluating water-resource conditions in selected river basins, or Focus Area Studies, where competition for water is a local concern.

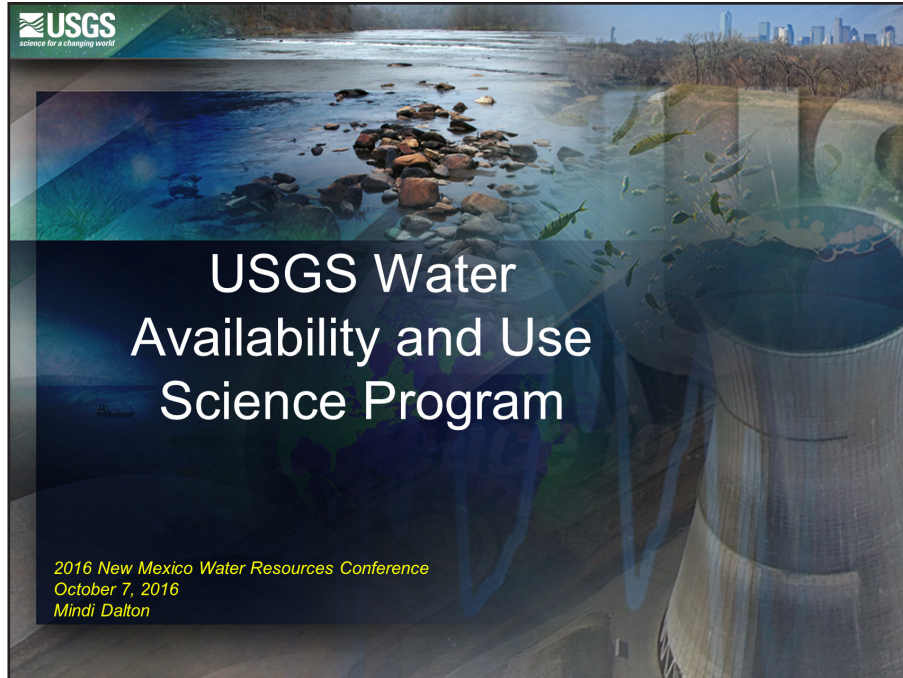


Figure 1. Introduction.

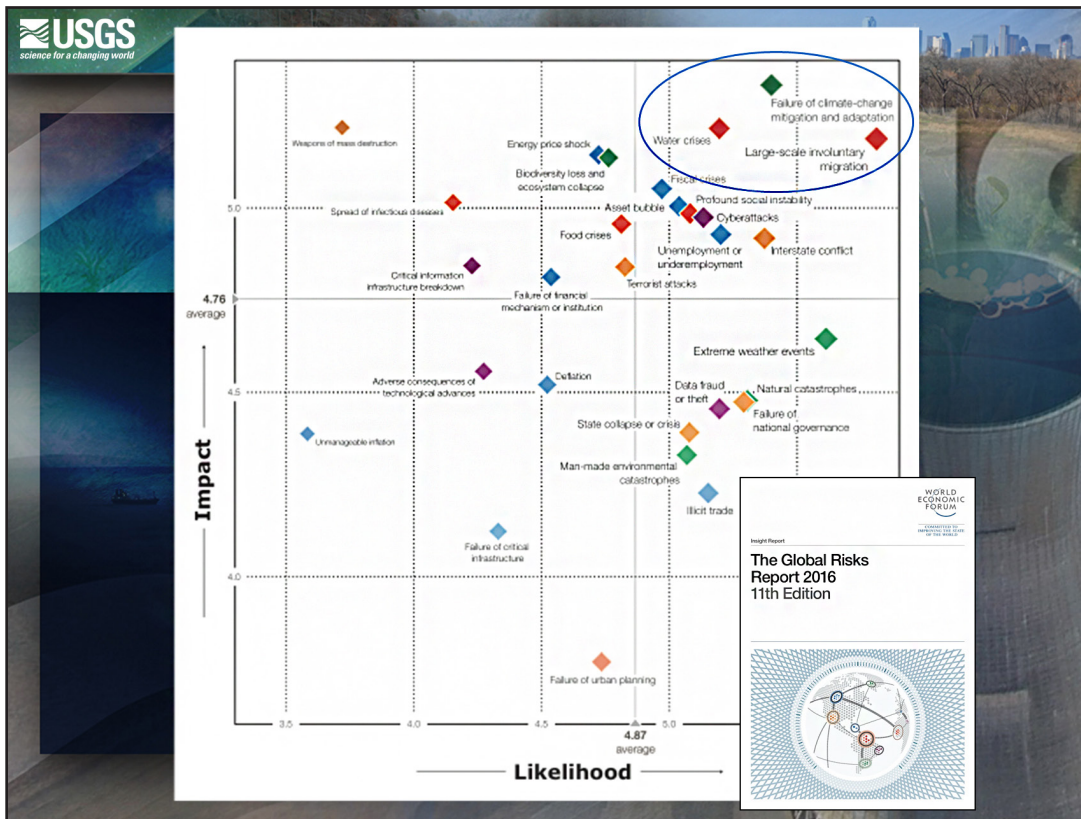


Figure 2. The World Economic Forum (WEF) identified water crises as one of the most likely and impactful world economic risks, intrinsically linked to the other two top rated risks that are directly influenced by water availability.

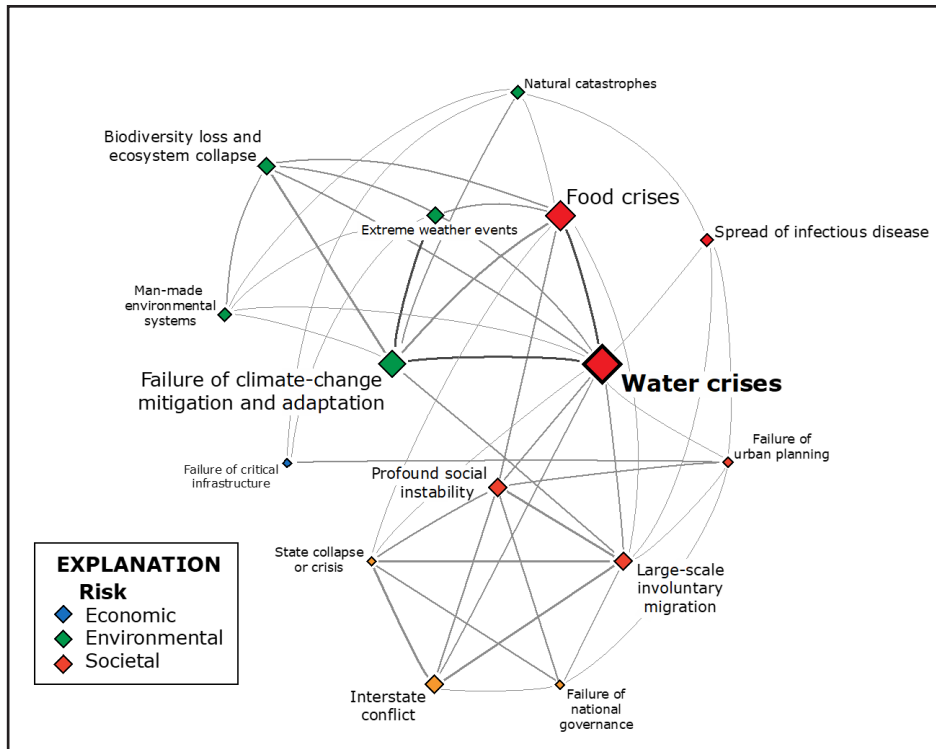


Figure 3. Water functions as the nexus of environmental and societal/economic concerns.

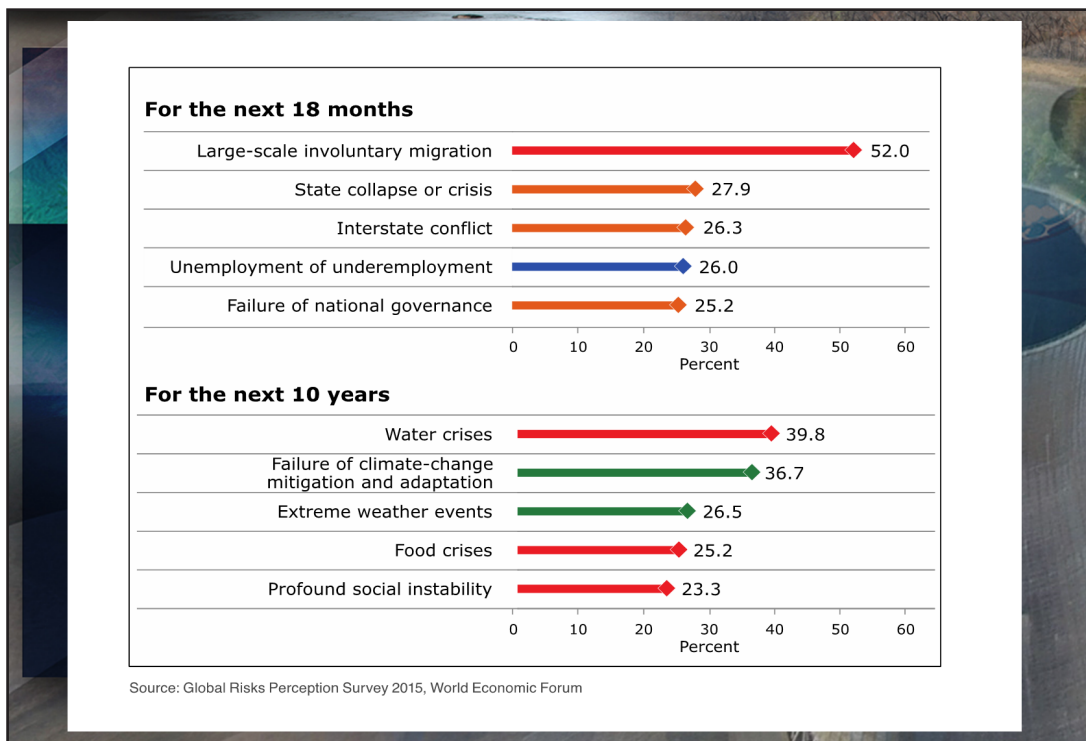


Figure 4. While over the next 18 months the WEF is mostly concerned about societal/governmental crises due to political unrest and terrorism, WEF identified water crises as one of the most likely and impactful world economic risks over the next 10 years.



## SECURE Water Act Public Law 111-11, § 9507 and 9508

- Recommended the creation of a Water Availability and Use Science Program
- Goal: To place technical information and tools in the hands of stakeholders, allowing them to answer questions they face about water availability:
  1. Does the Nation have enough freshwater to meet both human and ecological needs
  2. Will this water be present to meet future needs?

Figure 5. SECURE Water Act passed in 2009.

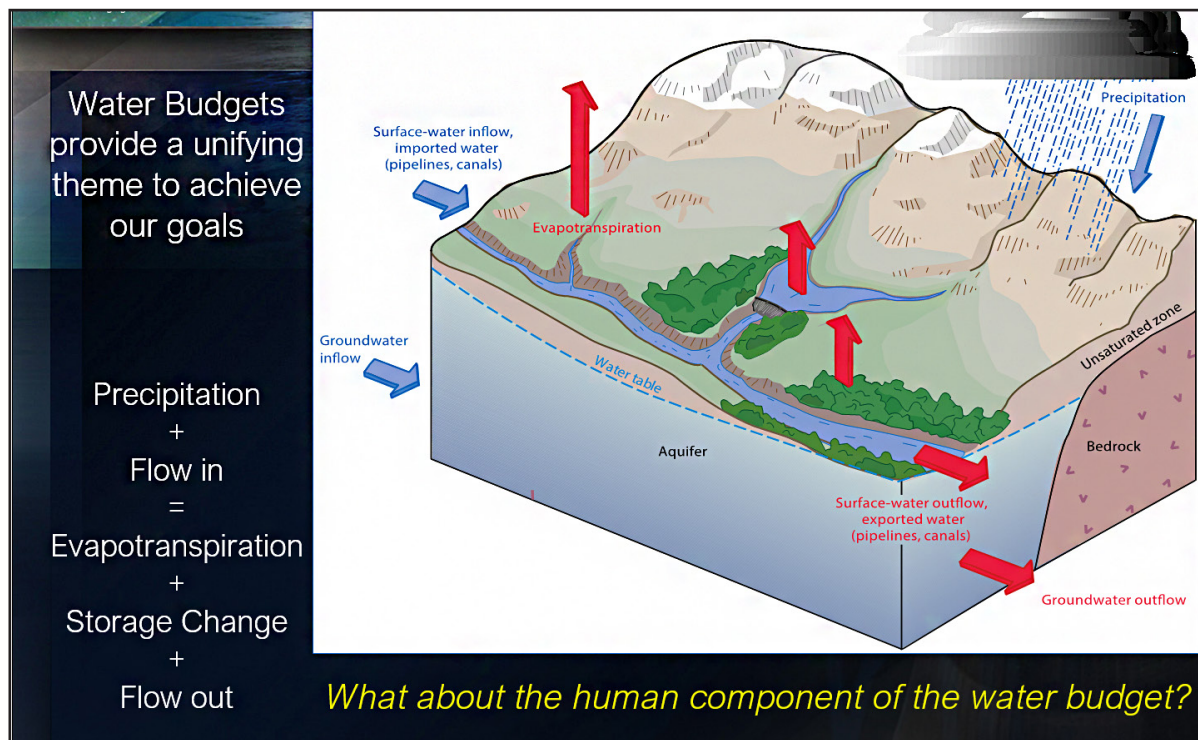



Figure 6. The Water Availability and Use Science Program (WAUSP) approach.






## Efforts to Improve Water Budget Components – *Nationally and Locally*

- Topical Studies - National scale
- Focus Area Studies - Stakeholder driven regional efforts

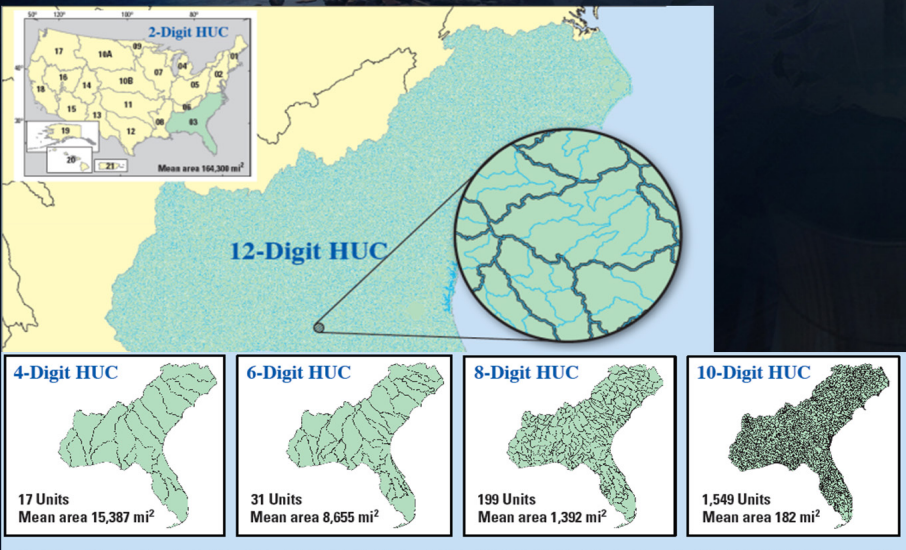
Collaboration with State and Federal Agencies

- Bureau of Reclamation
- Energy Information Agency
- Office of Science Technology and Policy
- EPA
- US Census Bureau
- All 50 States as well as Puerto Rico and Washington DC
- Many others

Figure 7. In WAUSP, we look to improve water budget components through topical studies and Focus Area Studies (FASs) in addition to collaborating with other USGS Mission Areas and other State and Federal Agencies.



## Scale Matters



4-Digit HUC	6-Digit HUC	8-Digit HUC	10-Digit HUC
17 Units Mean area 15,387 mi <sup>2</sup>	31 Units Mean area 8,655 mi <sup>2</sup>	199 Units Mean area 1,392 mi <sup>2</sup>	1,549 Units Mean area 182 mi <sup>2</sup>

Density of hydrologic unit codes (HUCs) at different levels illustrated by using the 2-digit HUC Region 03


Figure 8. Scale matters. The Water Census will be working at the HUC-12 scale, which is demonstrated on this figure. There are 103,400 HUC-12s in the US. On temporal scale, we will work on a daily time-step for components like streamflow, ET, precipitation, etc.



# Streamflow

- Estimation of streamflow at ungaged basins (HUC12)
- Remote sensing of streamflow
- Collaborative efforts include:
  - Working with EPA to improve calibration of the USGS national streamflow model
  - Working with the NWS to coordinate evaluation strategies for our respective models

Figure 9. In addition to the national network of streamgages, the USGS is working to develop models that provide estimates of streamflow when we don't have record or when we don't have monitoring capabilities. In remote areas, like Alaska, we are working on developing methods to use remote sensing to provide estimates of streamflow and using that data to develop watershed models. Several talks during the conference will be focused on these techniques specific to Alaska.



# Evapotranspiration

- Monthly and Annual ET estimates at MODIS and scales – spatial and the entire
- Improve remote sensing methods to estimate Irrigation Use for 2015
- Field testing and refinement part of NWC Focus Area Studies
- Collaborative efforts with Federal and State agencies to improve crop data layer and land use maps

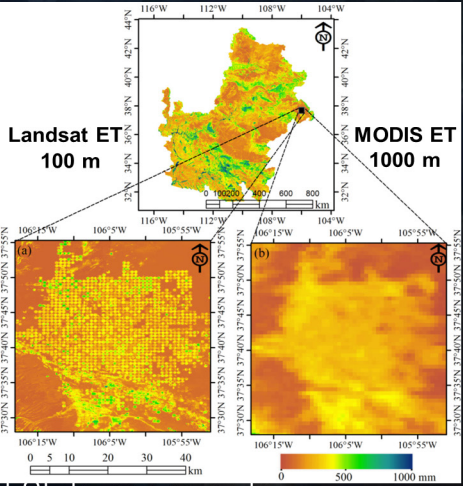


Figure 10. Evapotranspiration.



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# Groundwater

Quantitative assessments of groundwater availability in areas of critical importance

- document the effects of human activities on water levels, groundwater storage, and discharge to streams and other surface-water bodies;
- explore climate variability impacts on the regional water budget
- evaluate the adequacy of data networks to assess impacts at a regional scale

Multiple State and Federal Collaborators

Figure 11. Groundwater.

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# National Brackish Groundwater Assessment

“Significant brackish aquifers” to be studied:

- Contain dissolved-solids concentrations between 1,000 and 10,000 mg/L;
- Aquifers that have groundwater within 3,000 ft of land surface; and
- Can yield usable quantities of water.

\*Includes Alaska, Hawaii, and U.S. Caribbean

<http://water.usgs.gov/ogw/gwrp/brackishgw/>

Jennifer Stanton, Project Chief  
[jstanton@usgs.gov](mailto:jstanton@usgs.gov)

Figure 12. National Brackish Groundwater Assessment.



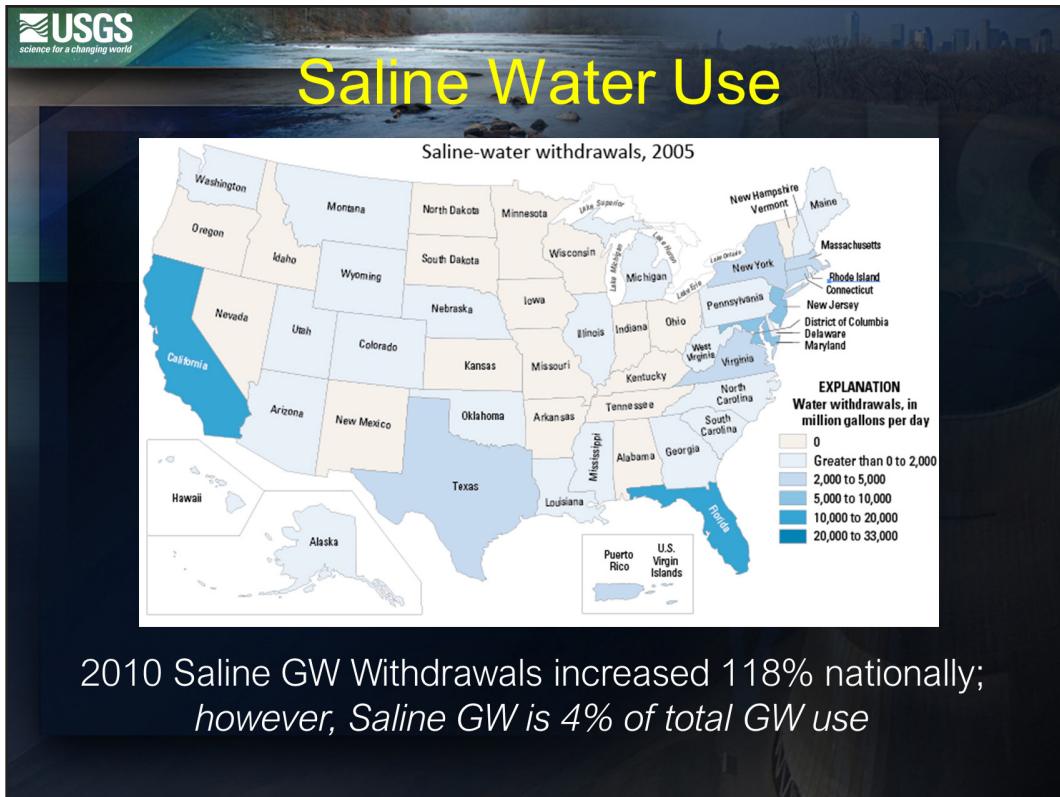


Figure 13. Saline water use.

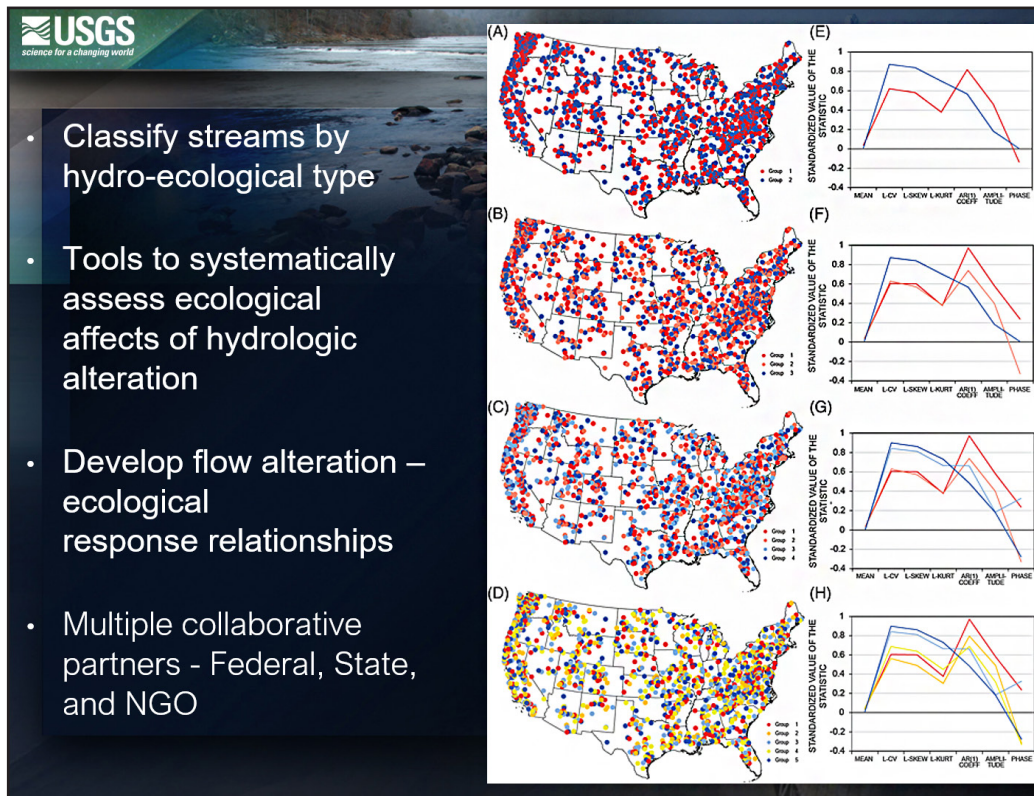


Figure 14. Ecoflows.

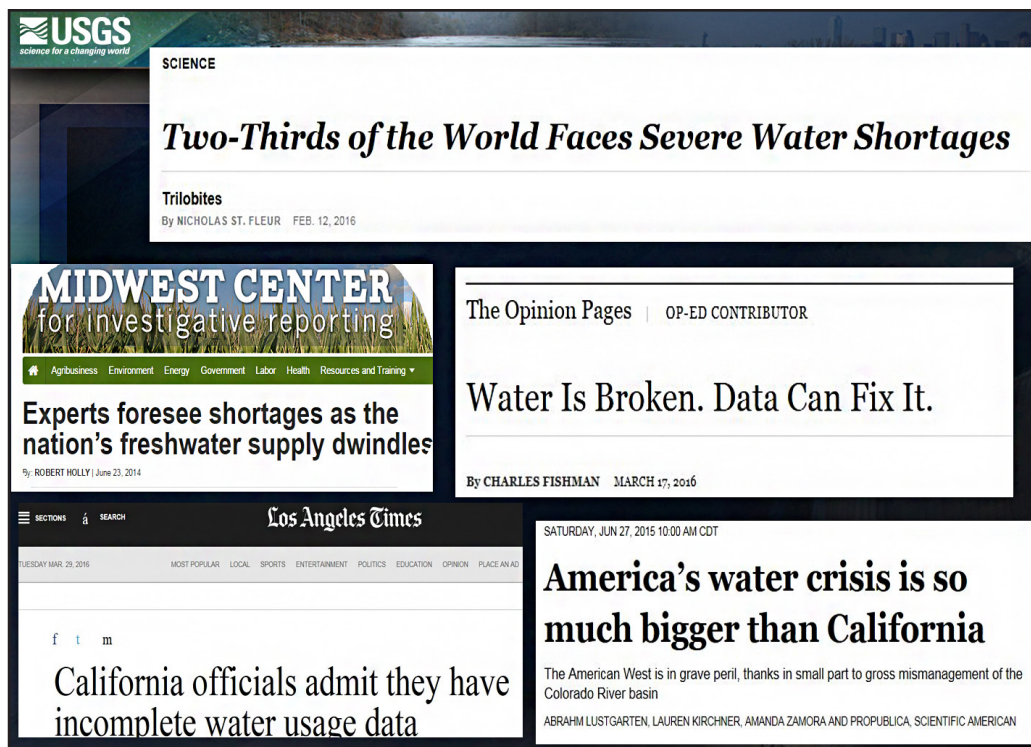


Figure 15. Why water use?

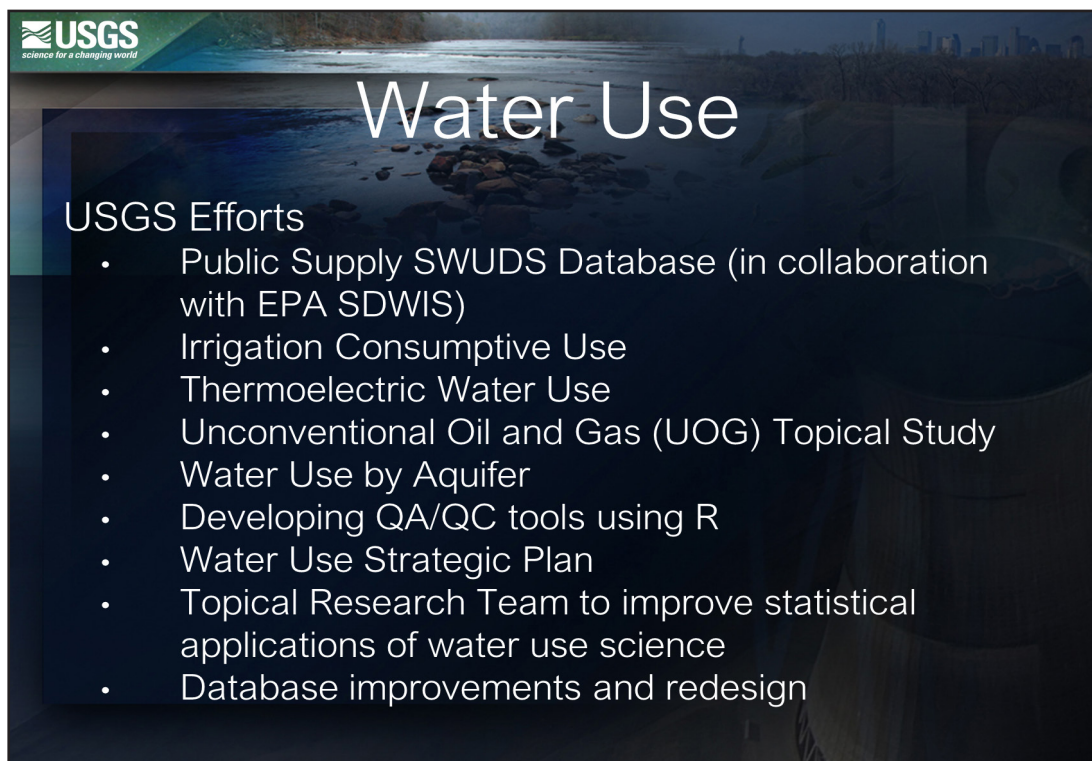



Figure 16. USGS efforts on water use.





# Water Use

## External Collaboration

- Comparison of water use reporting and collecting activities with Bureau of Reclamation
- Improving estimates of Thermoelectric Water Use and Consumptive Use with Energy Information Agency
- Bakken Environmental Status and Trends report (BEST report)
- Water Use Conservation policy with Vanderbilt University
- Reinstating industrial/mining water use with US Census Bureau
- Working with Brazilian National Water Agency (ANA) to help design national water use program

Figure 17. External collaboration on water use.

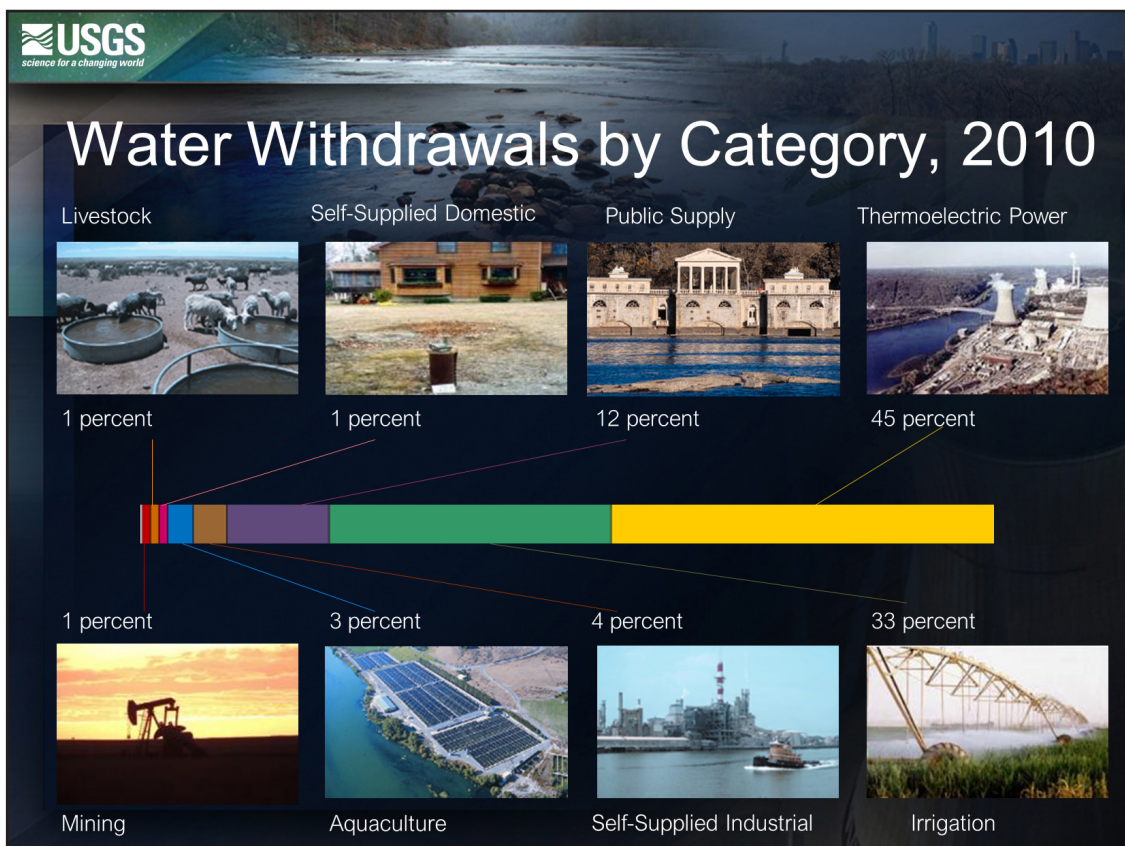


Figure 18. Water withdrawals by category, 2010.



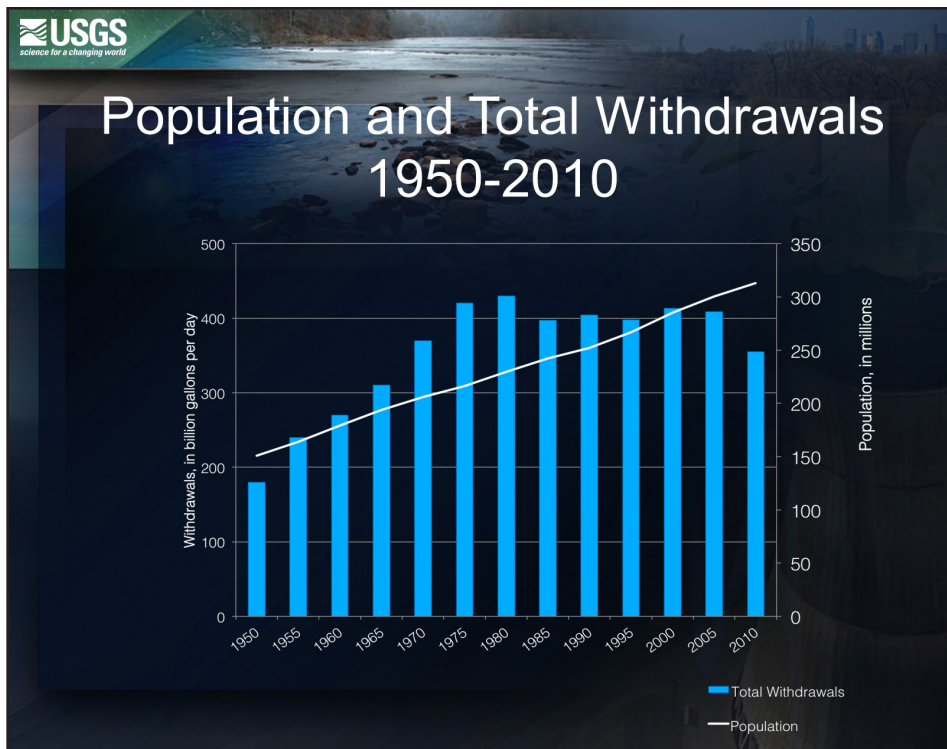


Figure 19. Population and total withdrawals: 1950-2010.

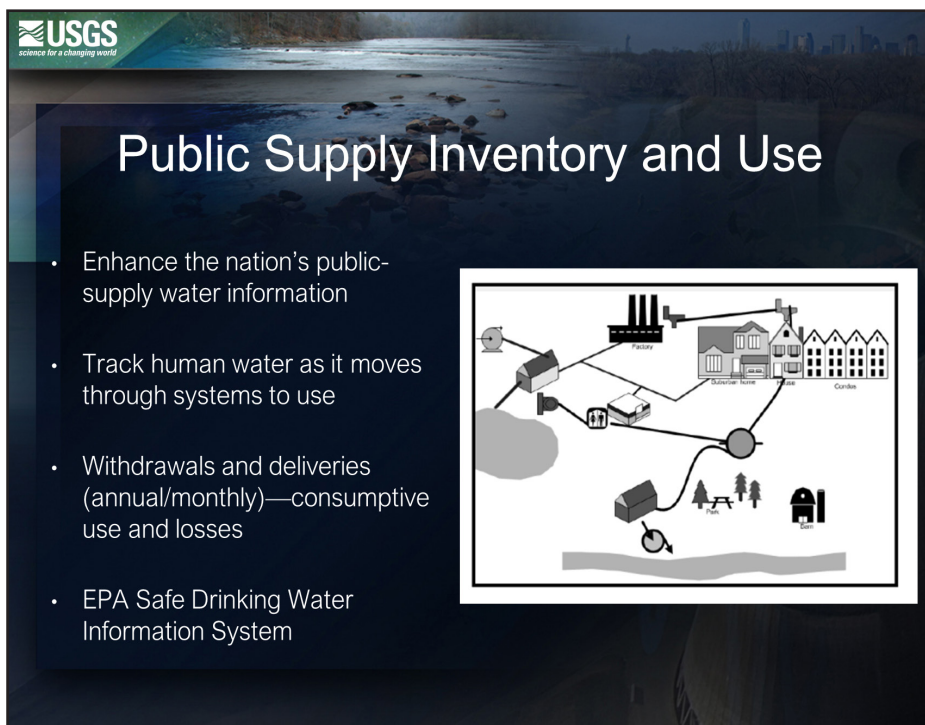


Figure 20. Public supply inventory and use.

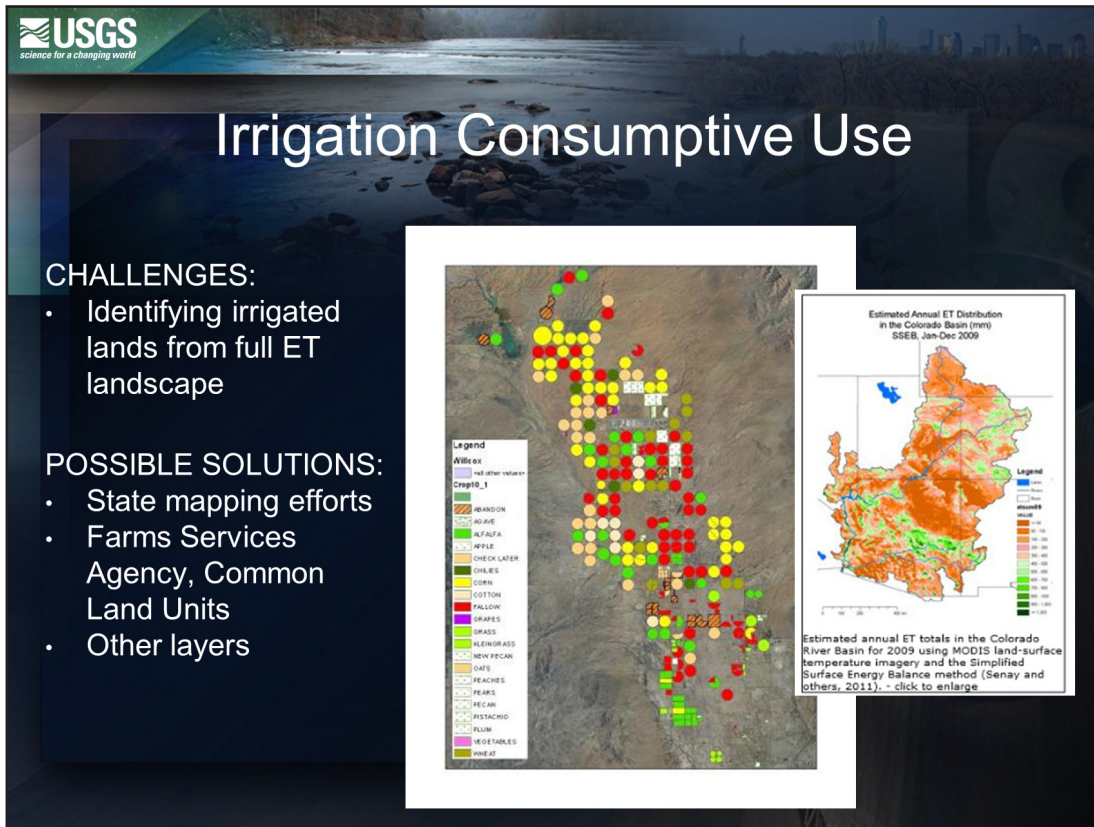


Figure 21. Irrigation consumptive use.



Figure 22. Unconventional oil and gas.

## Thermoelectric Water Use

- Method based on linked heat and water budgets constrained by power plant generation, cooling system technologies, and environmental variables such as air temperature, water temperature, and wind speed

USGS National Water Census and National Streamflow Information Program  
Methods for Estimating Water Consumption for Thermoelectric Power Plants in the United States  
Scientific Investigations Report 2013-5188  
U.S. Department of the Interior  
U.S. Geological Survey

USGS National Water Census and the USGS National Streamflow Information Program  
Withdrawal and Consumption of Water by Thermoelectric Power Plants in the United States, 2010  
Scientific Investigations Report 2014-5184  
U.S. Department of the Interior  
U.S. Geological Survey

Figure 23. Thermoelectric water use.

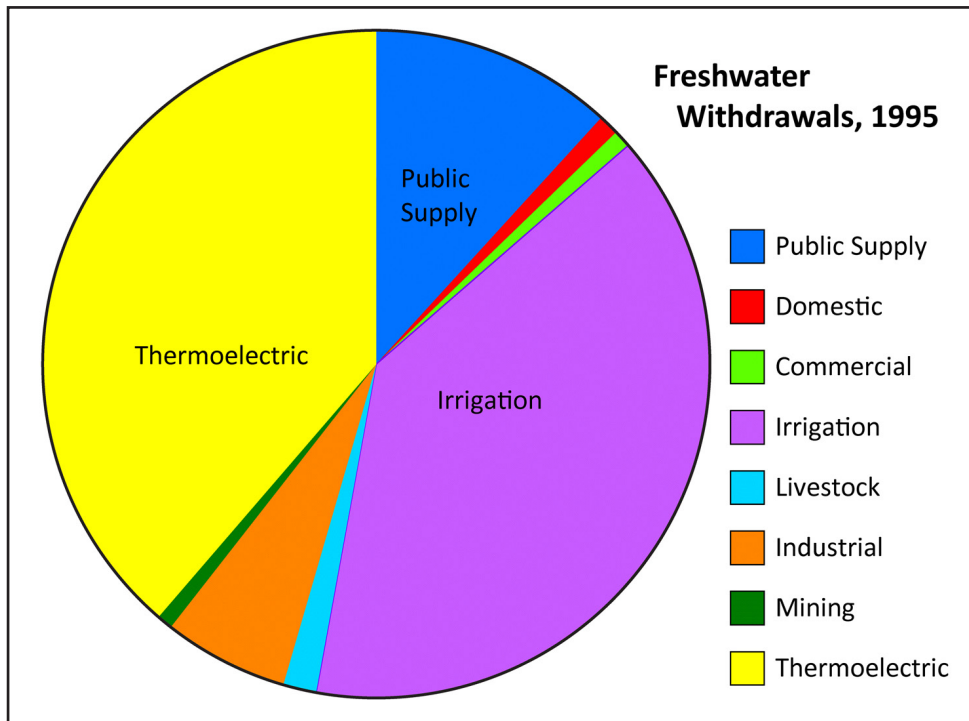


Figure 24. Freshwater withdrawals, 1995.



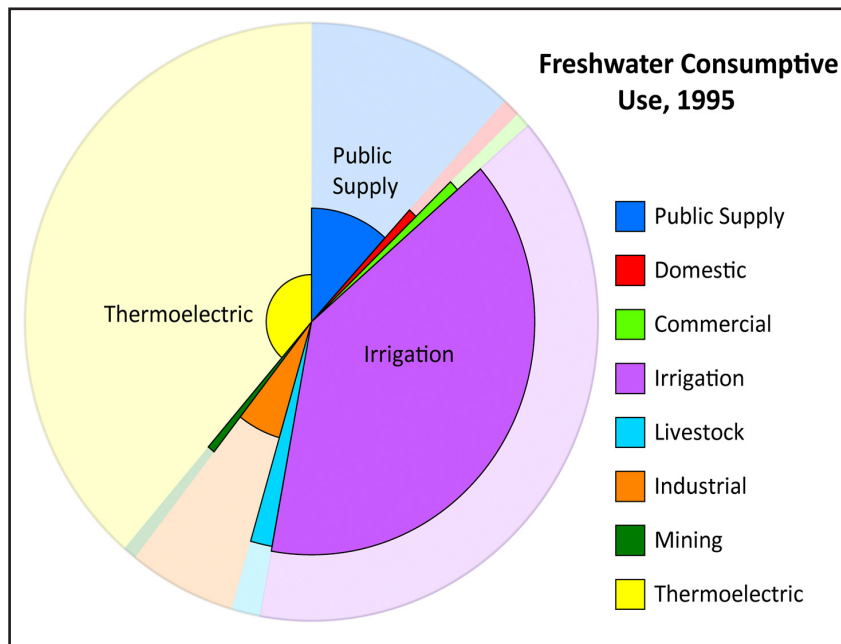


Figure 25. Freshwater consumptive use, 1995.

## Water Use Data and Research Program (aka State Water Use Grants)

- \$12,500,000 authorized in 2009 as part of SECURE Water Act, each State can receive a maximum of \$250,000, cumulatively
- Developing and/or improving State water use and availability datasets that are integrated into USGS databases
- 44 States have received funds to develop workplan
- 26 proposals received for FY16 Competitive Announcement – list of selected projects will be released soon
- Monthly Water Use Open Forum

<http://water.usgs.gov/wausp/wudr/index.html>

Figure 26. Water Use Data and Research Program.

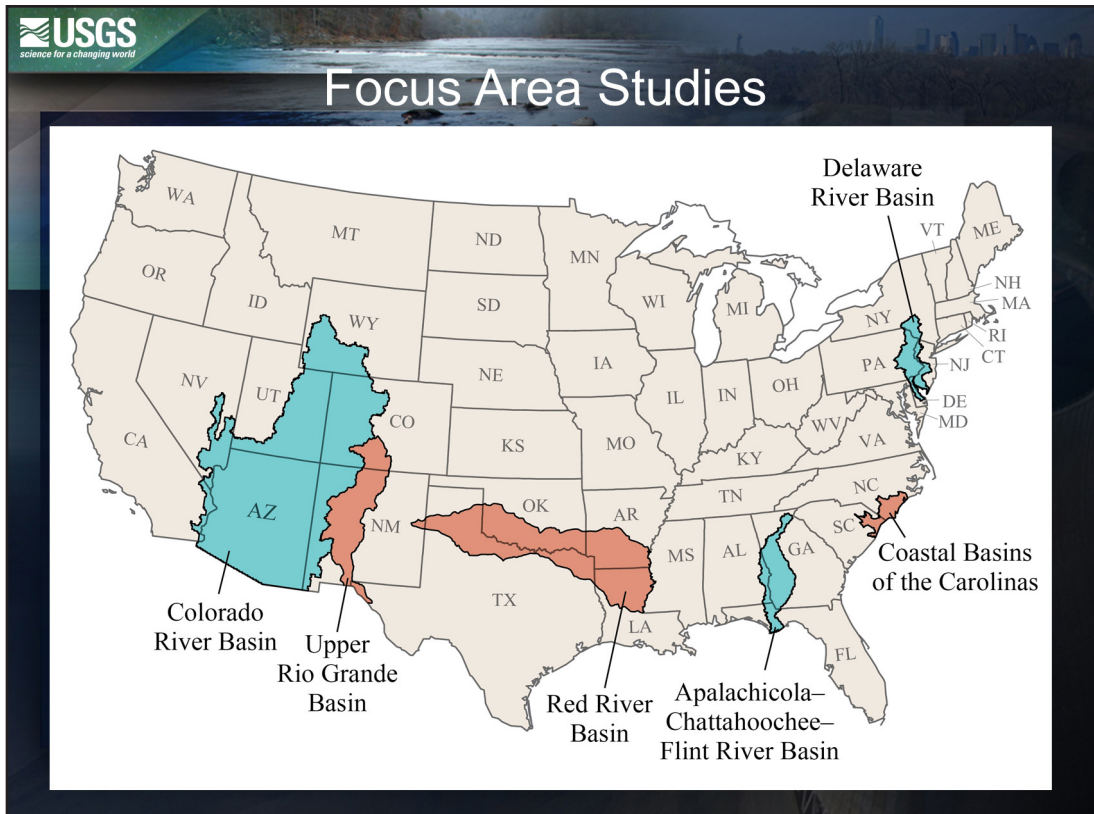


Figure 27. Focus area studies.

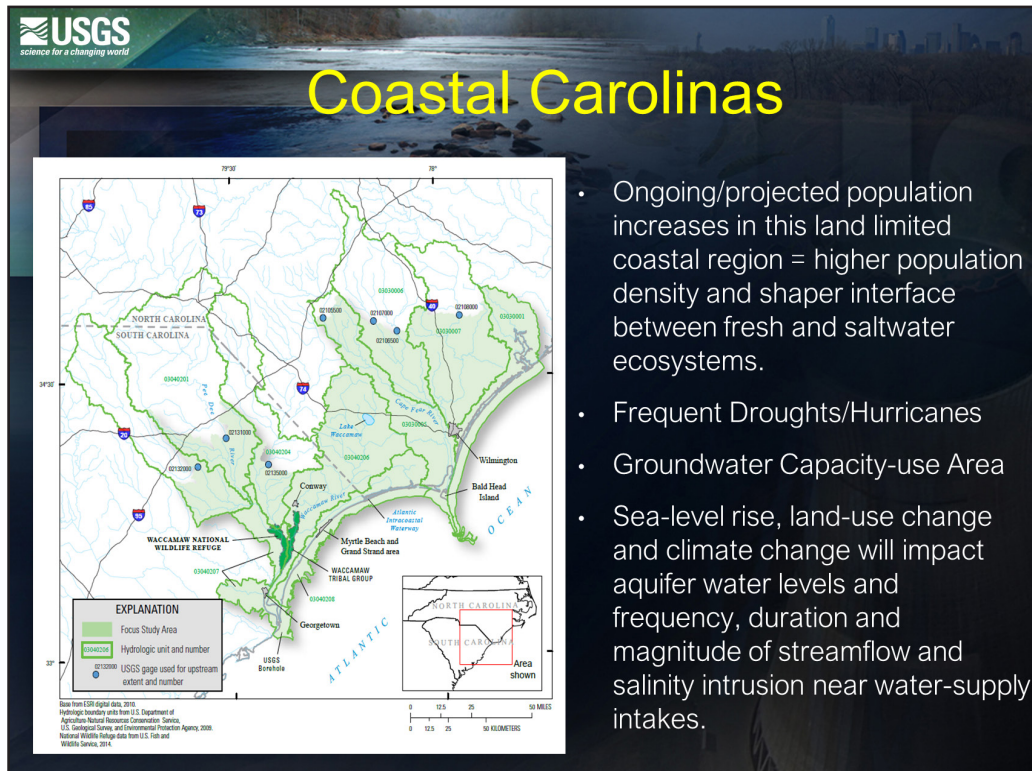


Figure 28. Coastal Carolinas.



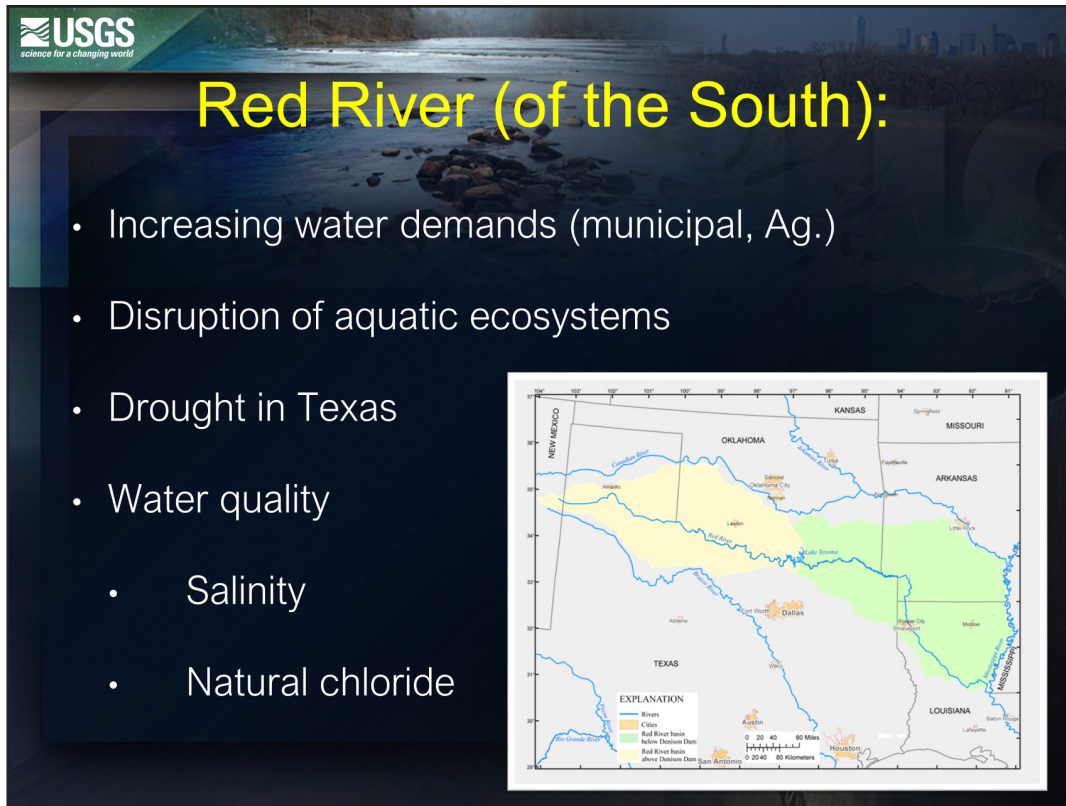


Figure 29. Red River of the South.

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### Upper Rio Grande Basin Focus Area Study

**Background:**  
The Upper Rio Grande Basin (URGB) of Colorado, New Mexico, Texas, and northern Mexico was chosen as a focus area study (FAS) for the USGS National Water Census. The conjunctive use of water in the URGB takes place under a myriad of legal constraints including the Rio Grande Compact agreement between the States, an international treaty with Mexico, and several federal water projects. Development of estimates of the selected water-budget components for the URGB FAS will support current and on-going local, state, and Federal efforts to advance the understanding of the hydrologic system of the Upper Rio Grande and improve management of the conjunctive use of surface-water and groundwater resources.

**Approach:**

- Compile and evaluate water use by major category at the HUC-8 spatial scale;
- Estimate actual evapotranspiration using the Simplified Surface Energy Balance method;
- Simulate snowmelt processes, including estimation of sublimation loss, in the headwaters of the URGB; and
- Develop a basin-scale hydrogeologic framework and water-level surface and change maps.

**Objectives:**  
Develop a consistent set of indicators that reflect the status and trends of major water budget components, and provide information and tools that allow users to better understand water availability and use in the URGB.

**Administrative Details:**  
Timeline – FY2016 – FY2018  
Project Chief – Kyle Douglas-Mankin ([kdouglas-mankin@usgs.gov](mailto:kdouglas-mankin@usgs.gov))  
Status – Active  
Cooperator – USGS Water Availability and Use Science Program  
Deliverables and Other Details –  
USGS Scientific Investigations Reports  
USGS Scientific Investigations Map

**water SMART**

Figure 30. Upper Rio Grande Basin Focus Area Study.





Figure 31. TAAP: Transboundary Aquifer Assessment Project.



Figure 32. Rio Grande Transboundary Integrated Hydrologic Model: modeling conjunctive use to support resource management.



**Background:**  
The Tri-County Resource Management Plan/Environmental Impact Statement (RMP/EIS) "decision area" (the public lands and resources that are managed by the Bureau of Land Management in Sierra, Doña Ana, and Otero Counties) is a large (4,375 square miles) and varied landscape. The decision area contains both connected and closed surface-water and groundwater basins, some of which cross state and international boundaries, with competing water demands and both remote and populated areas. Some portions of the decision area are multiple-use lands, while others have varying levels of resource protections, including areas of critical environmental concern (ACECs) and wilderness study areas (WSAs).

**Objectives:**

- Improve the existing characterization of surface-water and groundwater resources across the Tri-County area.
- provide hydrologic information related to potential future oil and gas development.

Study results can be used to guide the sustainable preservation and management of water resources.

**Approach:**

- Summarize the current understanding of the hydrologic resources of the Tri-County area, and identify critical data gaps in evaluating those resources;
- Assess the vulnerability of hydrologic resources to potential effects of oil and gas development within the Tri-County area; and
- Develop a plan of study to identify specific areas needing additional assessment and monitoring.

**Administrative Details:**  
Timeline – FY2016 – FY2017  
Project Chief – Johanna Blake ([jmtblake@usgs.gov](mailto:jmtblake@usgs.gov))  
Status – Active  
Cooperator(s) – U.S. Bureau of Land Management  
Deliverables and Other Details – USGS Scientific Investigations Report, Geodatabase

*U.S. Geological Survey New Mexico Water Science Center*

Figure 33. Assessment of hydrologic resources and the potential effects from oil and gas development in the U.S. Bureau of Land Management Tri-County Planning Area, Sierra, Doña Ana, and Otero Counties, New Mexico.

**Background:**  
Water resources in the Rio San Jose Basin are limited, and development for public supply, mining, agriculture, and commercial activities have the potential to affect the water availability and quality at a basin-wide scale. This study is designed to provide water-resource managers with better information to plan for potential effects of increased or shifting demands and changes of climatic conditions, to fairly administer water rights, and to support sustainable development. To provide these tools and information, it is necessary to understand what surface-water and groundwater resources are available, how these resources are interconnected, and how the resources might be affected by changing stresses.

**Objectives:**

- Characterize the hydrogeologic framework and water resources of the Rio San Jose Basin
- Create a watershed management tool to evaluate the possible regional effects of different water-use and climate scenarios on the basin's water-resources.

**Approach:**

- Collect and compile hydrologic information, including groundwater-level measurements, streamflow data, well log information, and aqueous geochemical analysis;
- Construct hydrogeologic framework, potentiometric-surface maps, sources of recharge, groundwater flow paths, and groundwater/surface water exchange;
- Develop coupled groundwater/surface-water flow model (GSFLOW) to investigate aquifer-stream interactions, provide water budgets, and simulate effects of current and potential groundwater and surface-water management and changing climatic conditions.

**Administrative Details:**  
Timeline – FY2015 to 2019  
Project Chief – Andrew Robertson ([ajrobert@usgs.gov](mailto:ajrobert@usgs.gov))  
Status – Active  
Cooperator(s) – Pueblo of Acoma, Pueblo of Laguna, Bureau of Reclamation  
Data and Other Details available at – [http://nm.water.usgs.gov/projects/rio\\_san\\_jose](http://nm.water.usgs.gov/projects/rio_san_jose)

*U.S. Geological Survey New Mexico Water Science Center*

Figure 34. Water resource assessment of the Rio San Jose Basin, West-Central New Mexico.





### Mesilla Basin Monitoring Network

**Background:**  
The Mesilla Basin monitoring program was established in 1987 to document the hydrologic conditions of New Mexico's southern-most, Rio Grande rift basin. The program's data collection and reporting is conducted by the U.S. Geological Survey in cooperation with local, state, and federal agencies. Hydrologic data collected as part of the monitoring program provide valuable information to better understand the geohydrologic system and to support efforts to update, revise, and calibrate basin hydrologic models.

**Approach:**  
Maintain a monitoring program including:

- annual groundwater-level measurements at more than 150 wells;
- real-time and monthly monitoring of groundwater levels in nested wells near the Rio Grande;
- hourly measurement of water-quality parameters in the shallow alluvial aquifer; and
- a microgravity survey to estimate groundwater storage changes.

Discharge measurements were made along the Rio Grande to determine gaining and losing reaches until 2015.

**Objectives:**  
Document hydrologic conditions within the Mesilla Basin and establish a long-term continuous data record to permit the quantitative evaluation of the groundwater flow system and stream-aquifer relations.



**Administrative Details:**  
Timeline – Since 1987  
Project Chief – Andrew Robertson ([ajrobert@usgs.gov](mailto:ajrobert@usgs.gov))  
Status – Active  
Cooperator(s) – Las Cruces Utilities, New Mexico State University, NM Office of State Engineer, Bureau of Reclamation, NM Environment Department, International Boundary and Water Commission  
Deliverables and Other Details – Data Collection



U.S. Geological Survey New Mexico Water Science Center

Figure 35. Mesilla Basin monitoring network.



### Simulation of Pre- and Post-Fire Streamflow in the Upper Rio Hondo Basin, NM

**Background:**  
The 2012 Little Bear Fire burned 44,000 acres in the upper Rio Hondo Basin in south-central New Mexico. Landscape in the Basin ranges from mixed conifer forests at higher elevations (12,000 ft) to desert shrubland at lower (5,200 ft) elevations. Burned areas are at risk of substantial post-wildfire erosion and flash floods. USGS post-wildfire analysis estimated 70% of the burned area had a high probability of debris flow. USGS scientists have developed the Precipitation-Runoff Modeling System (PRMS) to simulate hydrologic responses to changes in climate, vegetation, soil, and management. This hydrologic model could be used to help us understand how watersheds respond to fire.

**Approach:**

- Develop and calibrate a PRMS model for the Rio Hondo Basin from the headwaters to the Rio Hondo above Chavez Canyon streamgauge (USGS ID: 08390020); and
- Develop scenarios for post-wildfire changes to vegetation, soil, and management, apply to model sub-watershed areas, and simulate hydrologic responses.



**Objectives:**  
Improve understanding of the effects of fire on watershed hydrologic response by:

- developing a calibrated PRMS model, and
- simulating hydrologic response to landscape changes in the wildfire burn area.



Little Bear Fire burn area (orange) in the upper Rio Hondo Basin.

**Administrative Details:**  
Timeline – FY2015 – FY2017  
Project Chief – Kyle Douglas-Mankin ([kdouglas-mankin@usgs.gov](mailto:kdouglas-mankin@usgs.gov))  
Status – Active  
Cooperator(s) – NM Department of Homeland Security and Emergency Management  
Deliverables and Other Details – USGS Scientific Investigations Report



U.S. Geological Survey New Mexico Water Science Center

Figure 36. Simulation of pre- and post-fire streamflow in the Upper Rio Hondo Basin, NM.





### Hydrologic Studies in the East Mountain Area of Bernalillo County, NM

**Background:**  
Recent expansion of suburban development and population growth in the Sandia Mountains of eastern Bernalillo County, NM (East Mountain Area, EMA), has led to increased residential and commercial construction and increased demands on available water resources. Information about the spatial and temporal variability of water resources is needed for continued population and economic growth.

USGS scientists have developed the Operational Simplified Surface Energy Balance (SSEBop) evapotranspiration (ET) estimation model. ET estimation enables the quantification of other components of the water budget, such as recharge, which is critical to understanding sustainable water use.

**Approach:**

- Collect precipitation and snow survey data (2001-present);
- Collect micrometeorological and soil data (2013-present);
- Collect continuous data from wells and springs (2005-present);
- Make data available in ADAPS;
- Collect and analyze remote-sensing ET data, calibrate SSEBop model, and use SSEBop to create ET mapping products for the EMA.

**Objectives:**  
Improve understanding of the amount and spatio-temporal variability of water resources in the EMA by:

- monitoring precipitation, micrometeorological data, snowpack depths, and groundwater data; and
- developing regional ET estimates.

**Administrative Details:**  
Timeline – Since FY2002. Current FY2014 – FY2016.

Project Chiefs – Lauren Sherson ([lsherson@usgs.gov](mailto:lsherson@usgs.gov)) and Kyle Douglas-Mankin ([kdouglas-mankin@usgs.gov](mailto:kdouglas-mankin@usgs.gov))

Status – Active

Cooperator(s) – Bernalillo County: Public Works Division


Deliverables and Other Details –  
USGS Data Series Report  
USGS Scientific Investigations Report






U.S. Geological Survey New Mexico Water Science Center

Figure 37. Hydrologic studies in the East Mountain Area of Bernalillo County, NM.



### Implementing a Web-based Streamflow Statistics Tool for New Mexico (StreamStats)

**Background:**  
Estimates of streamflow are needed for a wide variety of applications, including water-resources planning and management, flood-plain mapping, and instream flow determinations. Surface water is the primary source of water for irrigators along major stream corridors in New Mexico and is increasingly being utilized by large municipalities. While streamflow statistics for gaged sites are readily available from existing sources, streamflow statistics are needed for ungaged sites where no observed flow data are available. Quantification of streamflow at ungaged locations will provide information that State and local water planners and managers need to insure a secure water future for New Mexico.

**Approach:**

- Compile a streamflow statistics database;
- Develop digital map-base layers; and
- Construct the web-based Geographic Information Systems (GIS) hydrologic framework.

**Objectives:**  
Provide an interactive web-based tool for determining streamflow statistics (low-flow and peak-flow frequency) for any stream location within New Mexico for which applicable streamflow regression equations have been published.

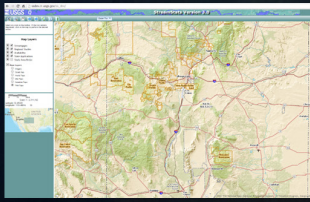

**Administrative Details:**  
Timeline – FY2016


Project Chief – Nathan Myers ([nmyers@usgs.gov](mailto:nmyers@usgs.gov))

Status – Active

Cooperator – U.S. Forest Service, New Mexico  
Department of Transportation, New Mexico  
Water Resources Research Institute, New Mexico  
Environment Department

Deliverables and Other Details – Interactive web-based tool and integrated hydrologic GIS datasets for the State  
(<http://water.usgs.gov/osw/streamstat/>)



U.S. Geological Survey New Mexico Water Science Center

Figure 38. Implementing a web-based streamflow statistics tool for New Mexico (StreamStats).