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The National Integrated Drought Information System (NIDIS) in the Upper Colorado River Basin: A Progress Report

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Introduction

The goal of the National Integrated Drought Information System (NIDIS) is to improve the nation's capacity for management of drought-related risks through provision of best-available information and tools for monitoring, forecasting, impact assessment, preparedness and mitigation. NIDIS is being implemented through a series of pilot regional drought early warning systems, the first of which is focused on the Upper Colorado River Basin (UCRB). Central to the pilot is the development of collaborative processes among entities and individuals with a stake in drought risk management in the UCRB. There are also several supporting activities designed to enhance and improve available drought information for the UCRB. Other pilots have begun in the Apalachicola-Chattahoochee-Flint (ACF) Basin in the Southeast, and in California.

Geographic Scope

The Colorado River Basin was selected as the location for the first NIDIS pilot at an interagency federal planning workshop in Salt Lake City in May 2008. Since the basin covers a large area, the pilot has first focused on the Upper Colorado River Basin (UCRB). Additionally, to reflect the coordinated operations of

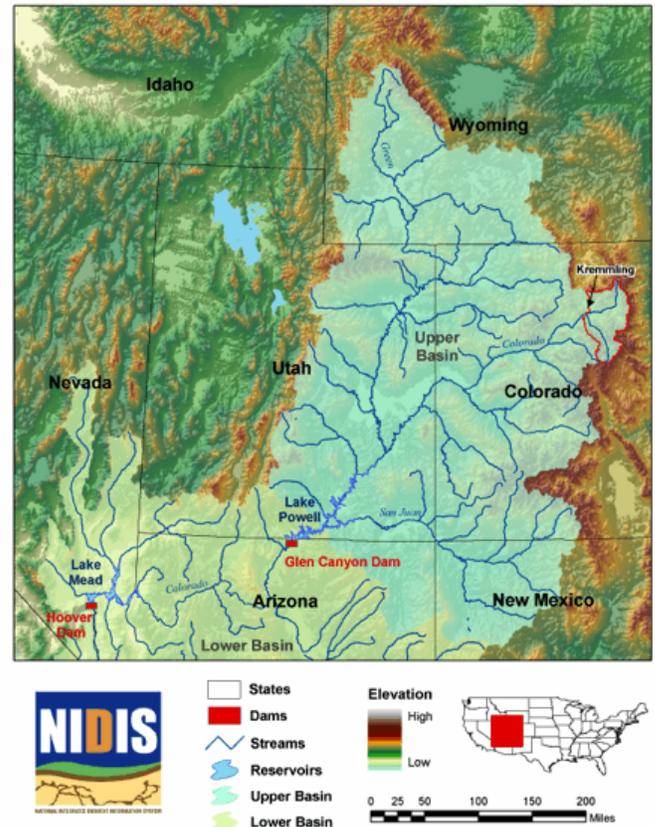


Figure 1. Map of the NIDIS UCRB Pilot area (blue shading) with the pilot subregion (above Kremmling) outlined in red.

Background on NIDIS

The federal legislation that authorized NIDIS in 2006 prescribes an interagency approach, led by NOAA, for the development and coordination of drought risk information to support proactive decision-making. The NIDIS goal, as stated in that legislation, is to "Enable the Nation to move from a reactive to a more proactive approach to managing drought risks and impacts." NIDIS was developed in partnership with the Western Governors Association, but is national in scope.

NIDIS has three general tasks:

- (I) Provide an effective drought early warning system that:
 - (a) collects and integrates information on the key indicators of drought and drought severity; and
 - (b) provides timely information that reflect state and regional differences in drought conditions
- (II) Coordinate Federal research in support of a drought early warning system; and
- (III) Build upon existing forecasting and assessment.

Lake Powell and Lake Mead by the Bureau of Reclamation, the NIDIS pilot area also includes Lake Mead and the main stem between Powell and Mead (Figure 1).

In addition to addressing the concerns of operators of large reservoirs, which requires understanding conditions over the UCRB as a whole, the pilot addressed concerns of two other important categories of drought information users: (1) water providers dependent on interbasin transfers out of the UCRB, and (2) ecosystem managers with responsibilities for forests, rangelands, and riparian habitat, including use of those lands for recreation and tourism. For the purposes of these two user groups, the pilot's scope is limited to the UCRB above Kremmling, Colorado (the area outlined in red in Figure 1).

The primary interbasin water transfer within the UCRB pilot area is Reclamation's Colorado-Big Thompson Project



(C-BT). As a practical matter, including interbasin transfers such as the C-BT extends the scope of the pilot into the Colorado Front Range, because demand for water from the UCRB for Front Range uses fluctuates with the native supply of water in the South Platte River Basin and drought status along the Front Range.

The land base of the UCRB above Kremmling is primarily managed by the US Forest Service, the Bureau of Land Management, and the National Park Service. Tourism, including fishing, rafting, and downhill skiing (Winter Park/Mary Jane and Sol Vista), is vital to the local economy.

Priority Pilot Activities

A scoping workshop for the UCRB Pilot in October 2008 brought together 56 people representing 22 state, local, and federal agencies. The discussions ranged widely, covering issues as diverse as bark-beetle infestations, paleoclimatology of the Colorado River, and insufficiency of environmental measurements at high-elevation sites. Workshop participants identified the following priorities for the pilot:

- (1) Development of a UCRB-specific drought monitor process to address the information needs of the pilot's three target categories of drought information user,
- (2) Inventory and evaluation of drought indicators and triggering criteria used by decision-makers in the basin,
- (3) Assessment of gaps in present monitoring and forecasting systems within the basin, and
- (4) Facilitation of web access to drought-related data and information products through integration of existing web resources with the NIDIS drought portal (<http://www.drought.gov>), to create a drought information clearinghouse for the UCRB.

The pilot began in earnest in spring 2009 and is planned to run through fall 2011. This timing relative to the exceptionally dry years of 2000 to 2004 is fortunate, as those years are still fresh in everyone's minds—but water managers are not currently working under severe drought conditions and can look back and reevaluate their data and information needs for those exceptionally dry years.

Where are we now? NIDIS-supported products and services in the Colorado Basin

NIDIS Early Warning and Water supply forecast webinars: UCRB Basin Drought Monitor

The principal collaborative process of the UCRB pilot is a series of webinars led by the Colorado Climate Center (CCC), home of the state climatologist at Colorado State University. The webinars consist of briefings on the latest observations, impact reports, and forecasts from individuals and organizations in Colorado, Wyoming, and Utah. They are held weekly in the period leading up to and during spring runoff (February—June), and monthly during the rest of the year. Formal contributions

to the briefing are made by scientists at CCC, USGS, the National Weather Service, and the Wyoming State Climate Office, while others are encouraged to join in on an *ad hoc* basis. Discussion of the material presented in the webinars informs the summary recommendations to the U.S. Drought Monitor lead author for the week. A summary narrative bulletin is prepared by CCC following the webinar for email and website circulation to drought information users throughout the basin. The webinar series was launched in April 2010, and the registered participants now include over 140 water, weather, climate and natural resources personnel from Utah, Colorado, and Wyoming. To register, go to http://climate.colostate.edu/drought_webinar_registration.php. See the Focus Article in the May 2010 IWCS for more information about the webinars.

In coordination with this new webinar series from CCC, the Colorado Basin River Forecast Center (CBRFC) is continuing its series of water supply forecast webinars begun in 2009. They are offered monthly from January through June, and as needed during the rest of the year. The sessions review water supply forecasts from NWS and NRCS, using output from CBRFC hydrological modeling runs that project total seasonal runoff. Model projections are tracked to see how they trend through the season in comparison with observed runoff, with discussion regarding how and why they differ until their ultimate convergence at the end of spring runoff.

Review of indicators, triggers, and other drought information needs

The Colorado Climate Center (CCC) has conducted interviews and focus group meetings with dozens of water providers, water users, and other stakeholders in the UCRB. These interviews have produced many valuable insights that have influenced the content of the UCRB drought monitor webinar series, the revision of the Colorado Surface Water Supply Index (SWSI) and the development of new tools for creation of custom, locally relevant drought indices. The findings also contributed to the Colorado Water Conservation Board's ongoing revision of the State Drought Response and Preparedness Plan.

Joint NRCS-NIDIS improvements to the Surface Water Supply Index (SWSI) for Colorado

The Surface Water Supply Index (SWSI) is a widely used drought indicator in the West that combines observations of reservoir levels, snowpack, precipitation, and streamflow. Following a NIDIS drought index workshop in August 2009, the NRCS Colorado Snow Survey Program opted to switch from the original SWSI (Shafer and Dezman 1982) to the revised SWSI (Garen 1993), which is based on sounder theoretical and statistical assumptions. (The revised SWSI is already used in Wyoming and Utah.) NRCS is also increasing the spatial detail of its calculations for Colorado, to provide monitoring for about 30 sub-basins instead of the seven major



basins previously covered. Conversion to the revised SWSI was completed by NRCS in April 2010 for sub-basins within the UCRB, while the rest of the state will be completed by March 2011. Figure 2 presents a side-by-side comparison of the old and new SWSI maps for western Colorado for April 2010.

Custom drought index server

To further meet the need for custom, local drought information and indices, a cooperative agreement has been set up between NIDIS and Utah State University (USU) to implement a web server using technology developed by the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI). Using a single GIS-based form, the CUAHSI software provides user-friendly access, to multiple datasets at United States Geological Survey, NRCS, and NOAA for streamflow, snowpack, precipitation, and temperature. USU is developing software around this capability so that users can interactively identify stations of interest using GIS tools, and then compose their own locally-relevant drought indices.

Coordination with the Colorado Water Conservation Board (CWCB) drought plan revision

The CWCB is currently revising the Colorado Drought Mitigation and Response Plan to meet the standards of the Federal Emergency Management Agency (FEMA) and the Emergency Management Accreditation Program. As part of the drought plan revision, the CWCB is supporting the development of a compatible drought early warning system based on the conceptual model, methods and personnel already engaged in the NIDIS UCRB pilot. The activity includes a review of indicators and triggers that activate statewide responses. NIDIS is coordinating its actions with CWCB to ensure that the needs of the State have been factored into the NRCS SWSI and Utah State CUAHSI activities described above.

Snow model plotting tool on the web

To supplement direct snowpack monitoring at NRCS SNOTEL sites, the NWS National Operational Remote Sensing Center (NOHRSC) is developing a database of daily modeled snow water equivalent (SWE) values for 8-, 10-, and 12-digit hydrologic units across the mountain West. NOHRSC staff are working with NOAA's National Climatic Data Center (NCDC) to develop an interactive web utility allowing users to produce plots that trace the accumulation and depletion of seasonal SWE through the water year. The utility will be ready in fall 2010.

Monitoring gaps assessment

A NIDIS team is preparing a monitoring gaps assessment for the UCRB that identifies gaps in observational instrument networks, gaps in the understanding of drought processes, and gaps in the availability of analytical products and tools. So far, information on needs in stream gaging, reservoir monitoring,

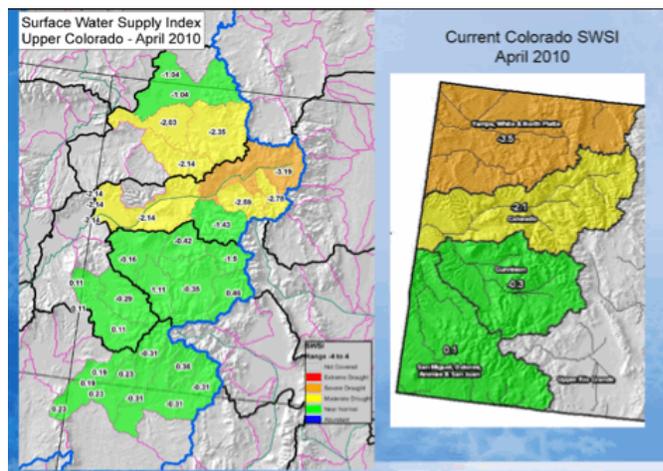


Figure 2. Maps of the revised SWSI (left) for western Colorado at the 8-digit hydrologic unit code (HUC) level, and the original Colorado SWSI (right) at the 4-digit HUC level.

SNOTEL sites, and snow modeling have been compiled, including general cost estimates to address those needs. Additional information gathering and synthesis is needed to complete the report and publish it as a USGS Circular later this year.

UCRB Basin Drought Portal

At the request of NIDIS partners in the basin, the US Drought Portal office at NCDC is developing a clearinghouse on the U.S. Drought Portal (<http://www.drought.gov>) to address the needs of UCRB drought information users and to maintain interim data sources for the early warning and information system development. Access to the drought data and information products most commonly used in the basin will be facilitated and streamlined.

Spatial analysis of water demand

NIDIS has engaged the National Center for Atmospheric Research (NCAR) Geographic Information System (GIS) group to develop a spatial database of water demand data for the UCRB above Kremmling to illustrate the benefits of capturing the topological relationships among water users and their respective sources of supply. Such information will support early identification of potential drought impacts related to insufficient water supply (especially due to changes in severity during a drought) as anomalies in supply are detected through monitoring of water deliveries.

Low-flow impacts database

Under NIDIS, the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln has compiled a database of low-flow/low-stage impacts for 164 NWS forecast points in the UCRB. Based on extensive interviews and data collection at the local level, NDMC staff cataloged and recorded specific impacts of low flows on instream water quality, pumping station operations, and other activities. This information will be integrated into the Advanced Hydrologic Prediction System



(AHPS) to facilitate the inclusion of low-flow/drought warning and trigger information with river forecasts from the CBRFC.

Linking climate and streamflow modeling

NIDIS is supporting research by NOAA's Climate Prediction Center (CPC) and the CBRFC through the NOAA Climate Test Bed. The goal is to improve ensemble water supply forecasts through better use of CPC seasonal climate forecasts from atmospheric models, and improved treatment of evapotranspiration in the CBRFC hydrologic model. The work should also permit CBRFC to generate probabilistic forecasts for the Bureau of Reclamation regarding the need to apply equalization procedures in the operation of Lakes Powell and Mead, a critical goal of the NIDIS pilot.

Reconciling estimates of 21st century flows

The NOAA Earth System Research Laboratory (ESRL) is coordinating an activity by four RISA programs (Western Water Assessment, California Applications Program, Climate Assessment for the Southwest, and the Climate Impacts Group) to reconcile the widely divergent projections of 21st century Colorado River flows that have been published in recent years. Initial findings indicate a narrower range of projected changes in mean annual flow by 2050, from roughly -10% to -20%, rather than the range from +5% to -45% that was in circulation at the outset of the study. The sensitivity of the UCRB to climate variability has been estimated at a 2% reduction in annual streamflow for each 1% reduction in annual precipitation.

Four Corners Workshop on Drought Preparedness for Tribes

As a first step to expand the UCRB Pilot into the Lower Colorado River Basin, NIDIS, in partnership with WWA, Climate Assessment for the Southwest (CLIMAS) and the Department of the Interior, conducted a workshop on impacts assessment and information needs on Native American Lands in the Four Corners region at the USGS Flagstaff Science Center, Flagstaff, Arizona, April 8-9, 2010. The workshop was a direct response to drought- and climate-related issues and concerns raised among Native Nations in the Four Corners region of the Southwest. Native leaders and natural resource managers who are responsible for making decisions related to climate and drought for their communities participated in the workshop alongside federal and academic climate researchers. The purpose of the workshop was twofold: to identify critical needs for improved drought-sensitive decision-making in the region, and to begin the process of engaging Native Nations as partners in the NIDIS drought early warning network for the Colorado River Basin. The workshop webpage, hosted by WWA, is here:

http://wwa.colorado.edu/climate_change/nidis_drought_flagstaff_tribes_april10.html.

Data mining for water availability, ecosystem change, and societal needs

In cooperation with NOAA, USGS has begun assembling data and information resources from the many science projects conducted over past decades in the UCRB to form a comprehensive resource to inform future research and resource management decision making. The project is motivated by predictions for change in the ecosystems of the UCRB due to land use and climate change. To accomplish this task, USGS is assembling a small group of data miners and catalogers to assemble metadata about projects and subsequent databases, online applications, and scientific publications of import to the region. The work will focus on projects that address three main questions:

- 1) Water availability: How will interactions among climate change, land use, and management practices affect the timing, quality, and quantity of water resources in the UCRB?
- 2) Ecosystem changes: How will interactions among climate change, land use, and management practices affect ecosystems and the services they deliver across the UCRB?
- 3) Societal Needs: How will interactions among climate change, land use, and management practices affect human communities and decision making in the UCRB?

Summary

Water Year 2010 has seen the NIDIS UCRB pilot gain significant momentum. The principal collaborative process, the CCC webinar series, was implemented through one full runoff season, with significant insights gained along the way. These insights will help improve the webinar series for the 2011 runoff season. A dozen or so supporting activities aimed at improving the quality and availability of drought information in the UCRB are also well under way. These will provide new tools and information products to the UCRB drought risk management community.

The challenge in the coming year will be to bring these various elements of the UCRB pilot together into a cohesive whole. Given the high level of enthusiasm, cooperative spirit, and professionalism of those implementing the pilot, we are optimistic about achieving this outcome. That said, the UCRB pilot should not be seen as a program being implemented by a small, closed team. Contributions and feedback from drought information users throughout the UCRB are welcome and valued. Consistent with this outlook, a stakeholder workshop will be organized for fall 2010 to solicit more vital input from the UCRB community. Please contact Jim Verdin at the NIDIS program office (verdin@usgs.gov) to be put on the mailing list for that workshop, or provide other input on the pilot activities.

References

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