New Mexico Water Assessment: Surface-Water Inflow, Outflow, Gain, and Losses

USGS science for a changing world

In Cooperation with the New Mexico Water Resources Research Institute

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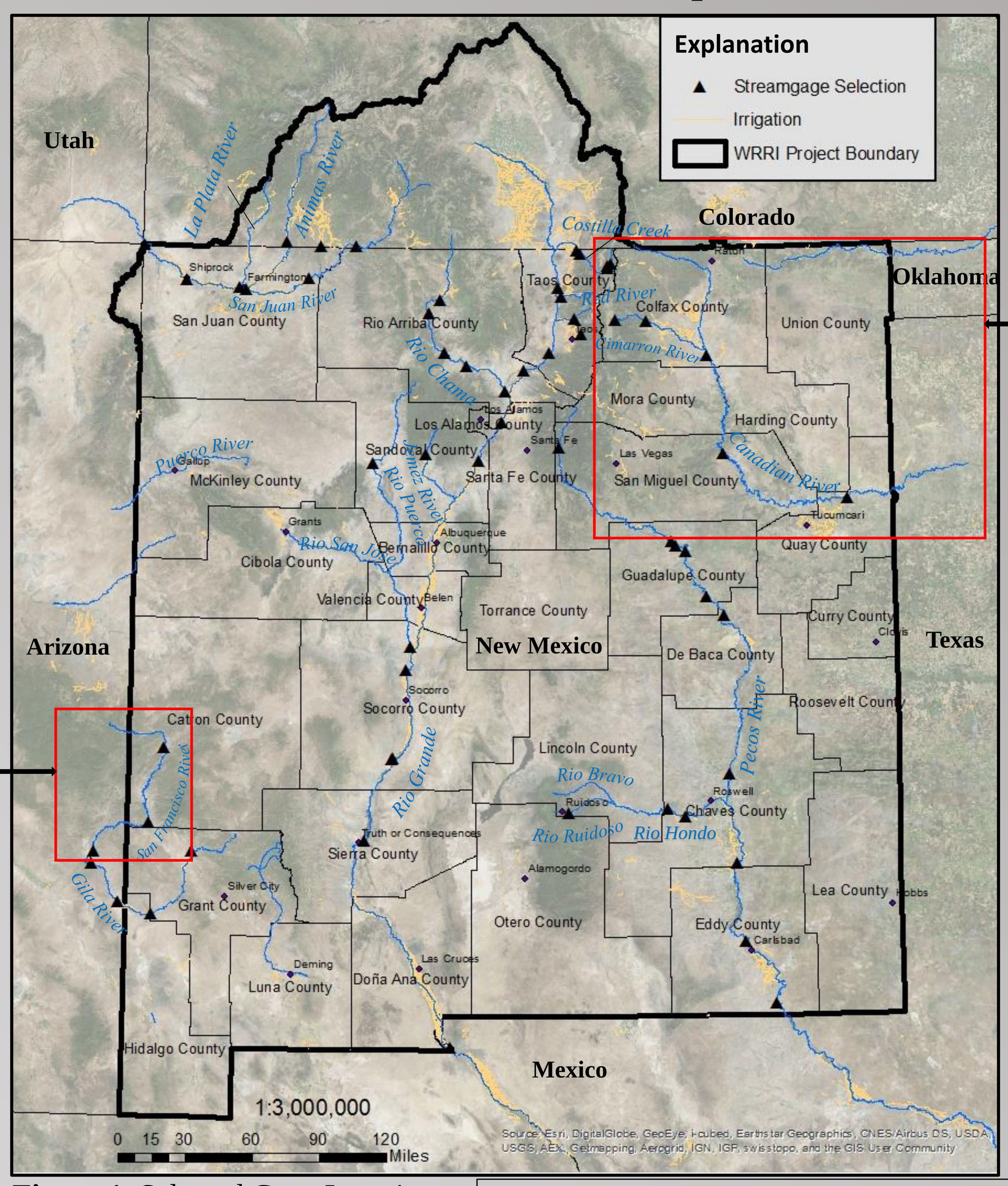
Background

Most of New Mexico is located within an arid to semi-arid climate zone. Surface water provides about 50 percent of the water supply (Longworth and others, 2008), but, under interstate compact regulations, the water in streams crossing New Mexico's borders must be shared with the bordering states and Mexico. Recent studies have shown that the timing and availability of spring runoff is changing (Clow, 2010; Dettinger, 2005; Hidalgo and others, 2009; Llewellyn and Vaddey, 2013; and Stewart and others, 2004), which may substantially affect the way surface water is managed in New Mexico. Lins (2005) has shown that changes in discharge can be abrupt and are not always predictable. Because changes in discharge are ongoing and dynamic and other changes may occur abruptly, New Mexico needs a flexible and up-to-date water-planning tool.

It is important that New Mexico water managers be able to plan for changes in the timing and availability of surface water and integrate knowledge of likely surface-water changes into a statewide water assessment and water budget because of the critical role of surface water in the state. Due to changes in discharge and precipitation, we can no longer assume that past patterns in discharge can reliably be projected into the future (Milly and others, 2008). It therefore should not be assumed that the development of a statewide water assessment and water budgeting tool is a one-time effort. This project, and others that contribute to the Statewide Water Assessment and water budget, are designed to feed a living GIS based database that should be updated and analyzed annually.

This project encompasses all major river's in New Mexico with two examples, the San Francisco River and the Canadian River, presented here.



Example 2: Canadian River

Example 1: San Francisco River

Figure 1. Selected Gage Locations

Base from ESRI
NAD 1983 StatePlane New Mexico Central FIPS 3002 (US Feet) projection
GCS North American Datum of 1983

Objectives

- Quantify the volume of discharge entering and leaving New Mexico
- Identify areas where discharge gains and losses occur
- Contribute, along with other projects, to the Statewide Water Assessment and Water Budget in the form of a living GIS based Database, to be updated annually

Methods

Daily mean discharge data were obtained from the network of USGS discharge gages in New Mexico and adjacent states. Gages selected for data analysis included the Rio Grande, Pecos, San Juan, Canadian, San Francisco, and Gila Rivers. Where major streams crossed state borders, a gage near the border, either in New Mexico or in the adjoining state, was included in the set of gages selected for analysis. Discharge data and derivative products will be stored in ArcGIS files that are compatible with others being prepared for the Statewide Water Assessment database.

Differences in monthly mean discharge at selected gages was analyzed for gains and losses in discharge. For visualization of patterns of discharge gains and losses, stream reaches between selected gages will be categorized on a seasonal basis as gaining, no gain/loss, and losing.

The annual status, in Water Years (W.Y.) (beginning Oct. 1 and continuing through Sept. 30 of the following year), of discharge conditions in New Mexico basins will be presented visually in a manner similar to that shown on the USGS Water Watch Regional Patterns map (http://waterwatch.usgs.gov/2013summary/#regional). The basin area upstream of gages with 28 or more years of record will be assigned a color based on an upstream/downstream comparison from annual discharge at a selected gage to the average discharge at that gage over a 30-year reference period.

Example 1: San Francisco River

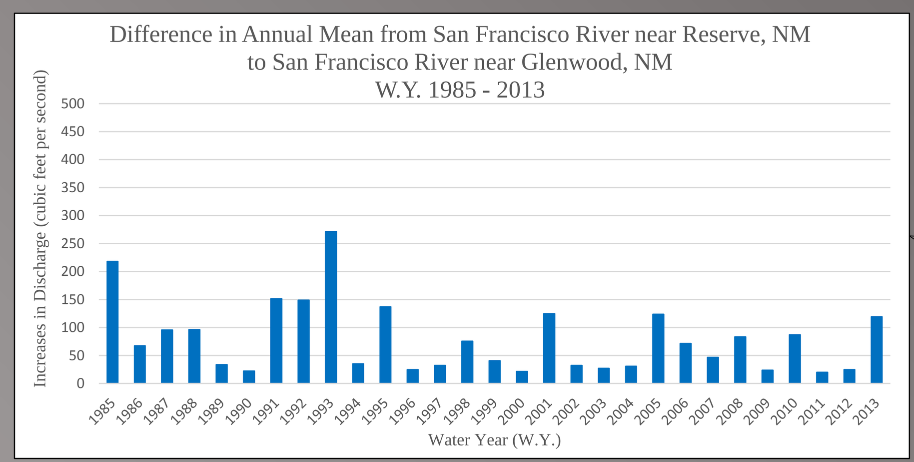


Figure 3. Reach 1 annual mean difference

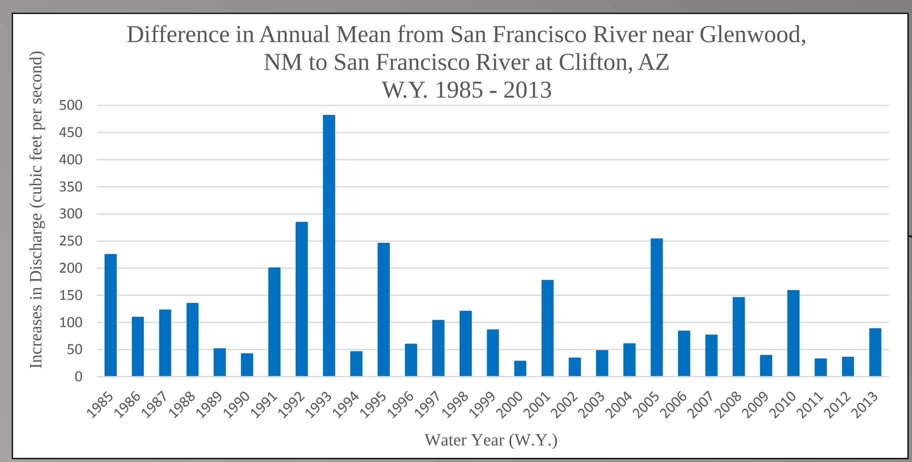


Figure 4. Reach 2 annual mean difference

Figure 2. San Francisco River

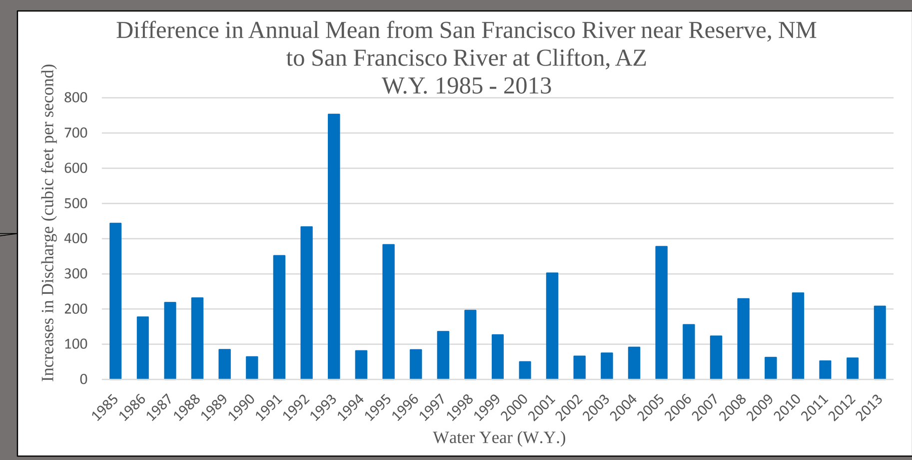


Figure 5. San Francisco River annual mean difference

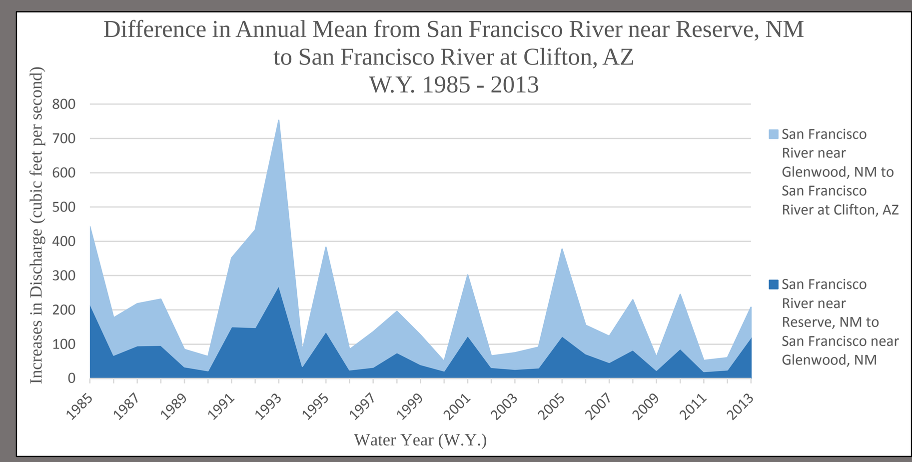


Figure 6. Total differences in annual mean discharge by reaches

The San Francisco River (fig. 2) is generally a gaining stream. The two reaches (figs. 3 and 4), show that the differences in annual mean discharge between the downstream and upstream gages are positive. Also, the annual mean differences between the first gage near Reserve, NM and the gage near Clifton, AZ is positive (fig. 5). It is apparent that most of the gain in discharge between San Francisco River near Reserve, NM and San Francisco River at Clifton, AZ occurs in Reach 2 of the river (fig. 6). Discharge gains most likely occur from tributary inflows, groundwater, and precipitation.

Example 2: Canadian River

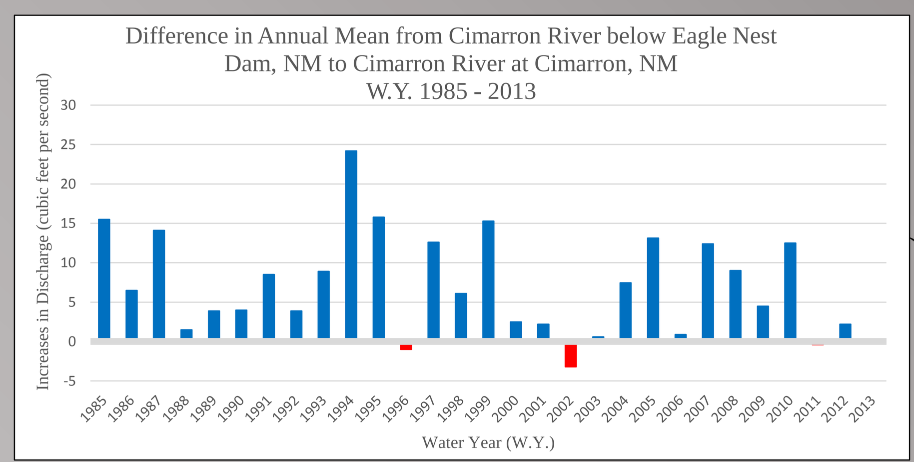


Figure 8. CIM- 1 annual mean difference

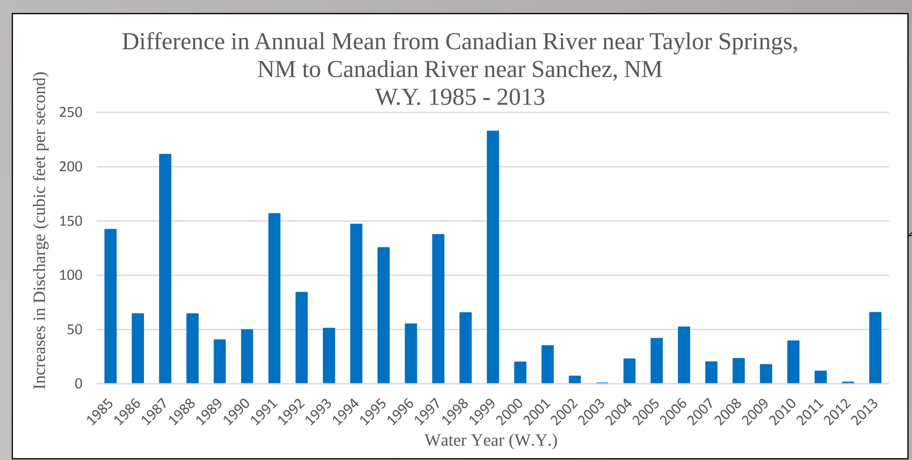


Figure 9. CAN-1 annual mean difference

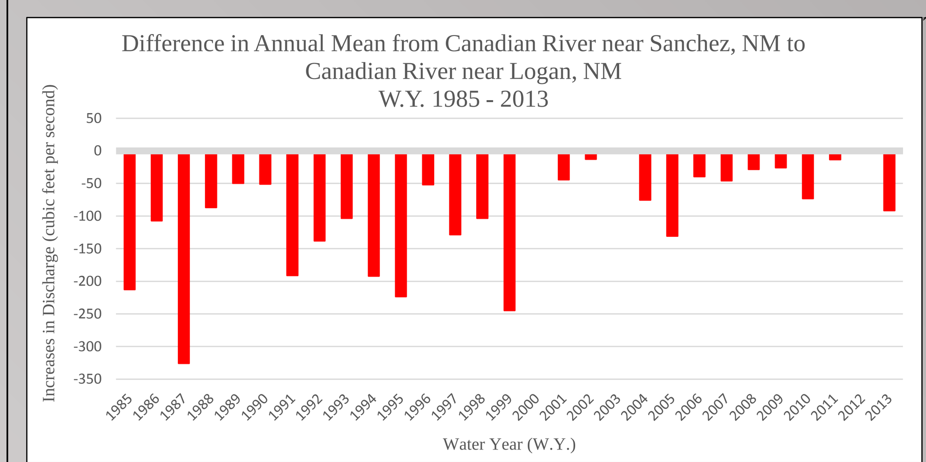


Figure 10. CAN-2 annual mean difference

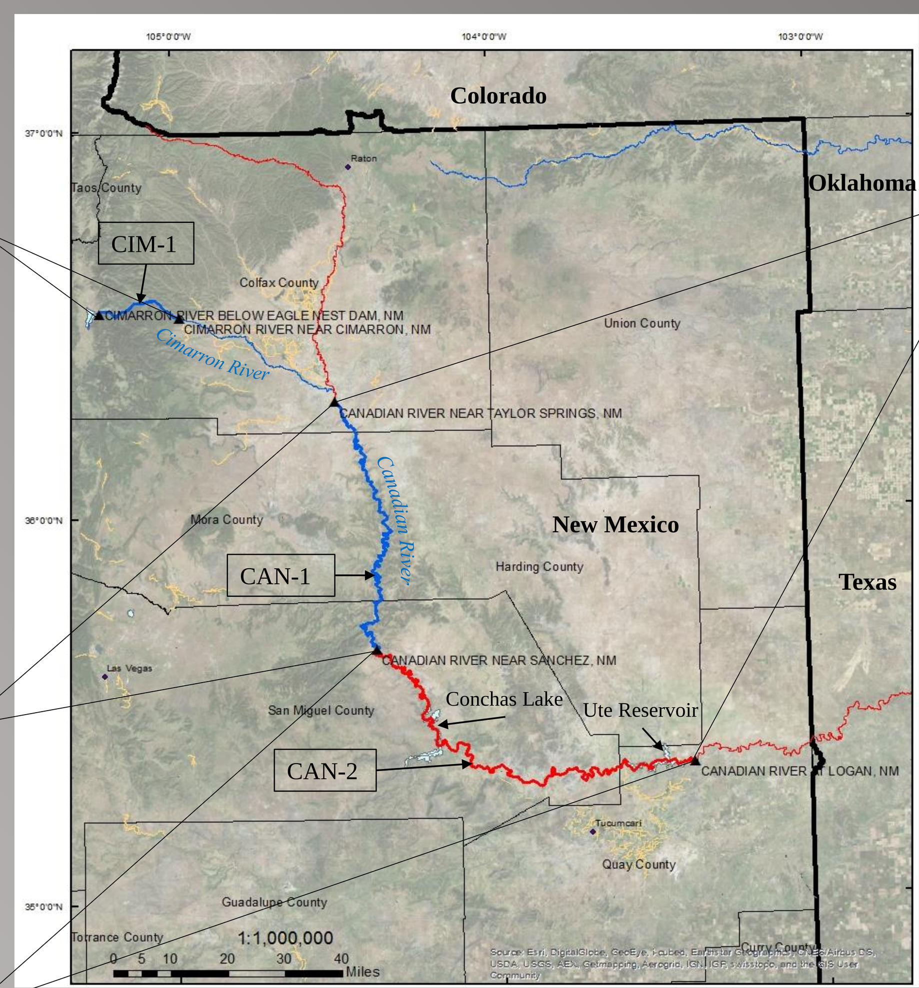


Figure 7. Canadian River and Cimarron River Tributary

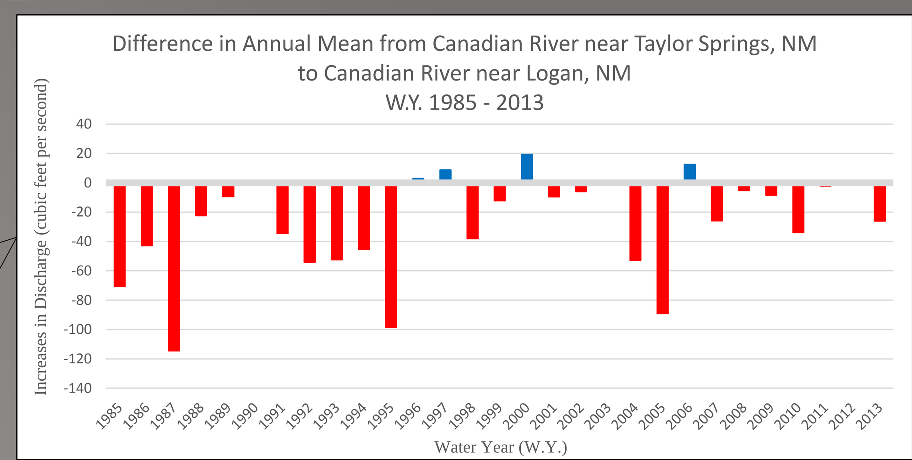


Figure 11. Canadian River annual mean difference

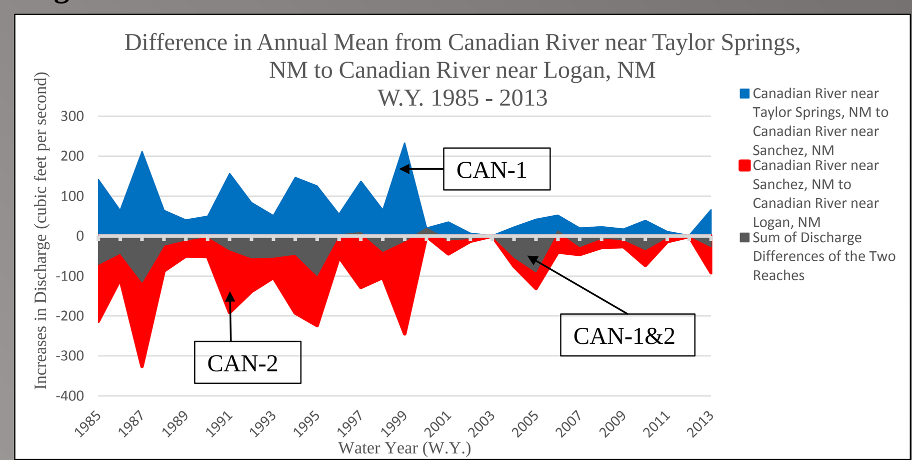


Figure 12. Canadian River differences in annual mean by reach

The Canadian River and its tributary, the Cimarron River (fig. 7), have both gaining and losing reaches. Reach 1 of the Cimarron River (CIM-1), has generally been a gaining reach since water year 1985 (fig. 8). Reach 1 of the Canadian River (CAN-1) has been a gaining reach (fig. 9), while Reach 2 of the Canadian River (CAN-2) has been a losing reach (fig. 10). Overall, the Canadian River has been a losing river (fig. 11 & 12), because CAN-2 losses exceed CAN-1 gains (fig. 9 & 10). Discharge gains could result from inflows from tributaries, groundwater, and precipitation. Discharge losses could be the results from evaporation, transpiration, irrigation diversions, and outflow to groundwater. Losses exceed gains when there is no inflow from tributaries, no groundwater recharge, and evaporation. Reservoir's could be one of the causes of losses in Reach 2 due to evaporation and groundwater seepage.

Future Work

- Contribute, along with other projects, to the Statewide Water Assessment and Water Budget in the form of a living GIS database.
- Analyze differences in monthly mean discharge for gains and losses in discharge at all locations.

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