DID THE RIO GRANDE "ALWAYS GO DRY"? MUST IT?

Memo to the Middle Rio Grande ESA Collaborative Program-Steve Harris 4-15-05

Development and streamflow: Prior to the United States conquest of Mexico in 1848, the San Luis, Espanola, Albuquerque, Mesilla and Paso del Norte valleys, plus the *vallecitos* along mountain tributaries of the Rio Arriba had been opened by the Spanish for irrigation agriculture. At the time of the Anglo conquest, perhaps 200,000 acres cumulatively received irrigation waters, through numerous low river headings of rock and brush dams.

Vast headwaters forests were logged throughout the period to provide firewood and building materials. The timbering was localized and selective and drought year fires were frequent, the net effect of which was diversely structured forests. Spanish economies were built on subsistence gardening and grazing; markets were local and limited; national markets impossibly distant. High elevation grazing was limited by the short duration of the summer season, so that the preponderance of fodder was produced by irrigating pastures along the Rio Grande and its tributaries.

With the California Gold Rush, the Rio Grande was opened to Anglo settlement. Deserters from the Mormon Batallion, which accompanied Kearney through the region in 1849, "discovered" the San Luis Valley. During the 1850's, they opened almost 25,000 new acres to cultivation. Although the Civil War dampened immigration (only about 5,000 new acres were opened in the 1860's), the post-war period saw an explosion of Anglo immigration in every reach or the river. In the San Luis Valley, the decade of the 70's saw an increase in irrigated acreage of almost 70,000 acres, a virtual doubling of the previously irrigated acreage.

The Denver and Rio Grande Western Railroad reached the Alamosa in 1878 and at once commercial agriculture boomed. Previously, markets for valley produce were restricted to mining camps in the surrounding San Juans, now Denver and Chicago markets were accessible to Valley farms. New water development in the decade of the 70's approached 200,000 acre-feet.

In 1880 the DRGW railroad penetrated to Santa Fe,opening the *Rio Arriba* to the markets of the wider nation. By 1900, thousands of acres of Sangre de Cristo forests had been harvested and boomed down the Rio Grande to Embudo Station for use as ties. A result of this large-scale timber development, plus a policy of fire suppression was that the Rio Grande's high elevation watersheds were rapidly transformed. Snowmelt hydrographs in the Rio Grande's tributaries became more spiky, less attenuated into the summer season. Hydrologist Lee Wilson estimates that watershed production in its headwaters has reduced the volume of the Rio Grande's annual runoff by 10%.

The entry of the railroad also engendered a surge in traditional sheep grazing. Logging and grazing excesses aggravated the release of sediments into the river, impacting lands in the San Luis and Albuquerque (middle Rio Grande) valleys. Sediments aggraded river channels, which, with reduced peak flows, were less able to maintain themselves.

As this process promoted flooding, channel modifications were undertaken. For example, between 1945 and 1975, some 300,000 jetty jacks had been located along the middle Rio Grande to fix channels and hasten the removal of flood waters

Meanwhile, in the San Luis Valley irrigation continued to burgeon. By 1885, with the investment of British capital, five major canals were developed off the Rio Grande, with decreed rights to about 5,500 cfs, giving the valley the capacity to divert virtually all of the spring runoff. Consonant with its illusion of water supply abundance, the valley developed a custom of sub-irrigation, applying enough water to bring nearby shallow aquifers into the root zone of the crops. Soon, heated competition for Rio Grande water forced the state of Colorado to complete a general stream adjudication by the end of 1891. Valley farmers then began laying plans for a large storage reservoir at Wagon Wheel Gap.

The impact of this rapid and extensive development was soon felt by downstream water users. The middle valley, feeling the squeeze, often diverted what remained of a reduced Rio Grande. In the Juarez Valley, upstream diversions, coupled with the nine year drought which began in 1888, caused the region's famous vineyards to wither and die. At the same time and far downstream, steam navigation of the Rio Grande below Laredo ceased forever.

In response to vigorous protests from Mexico, the United States placed an embargo on dam building in the upper basin headwaters in 1896, a prohibition which was not lifted until the three states had agreed to enter negotiation of an interstate compact to equitably divide the waters of the Rio Grande in the late 1920's.

The Mexican grievance over water supplies disrupted by *norteno* water development also led to negotiation of the 1906 Water Treaty, which guaranteed Mexico a firm supply of 60,000 acre-feet annually. The reduced condition of the river also provided strong impetus for construction of Elephant Butte Reservoir, which commenced in 1911.

By 1888, largely as a result of massive water development north of the Colorado state line, the middle Rio Grande began regularly to run dry when spring runoff receded in the Sangre de Cristo tributaries and the Rio Chama. It was not coincidence that the United States Geological Survey, under direction of John Wesley Powell, decided to construct its first stream flow gauge near the mouth of the Rio Embudo, in 1888.

Our modern attempts to reconstruct the Rio Grande's original stream flow condition are thus confounded by the absence of reliable data prior to full development of the San Luis Valley.

From the time of statehood in 1878, Colorado had asserted a sovereign right to appropriate the entire flow of the rivers which originated on its territory, a notion of which it was not disabused until a 1917 decision of the United States Supreme Court, *Wyoming v. Colorado,* held that senior water users in a downstream state had priority over a junior users residing in its upstream neighbor.

After *Wyoming v. Colorado* and the completion of Elephant Butte, a wet cycle returned to the river, which eased the crisis somewhat. Colorado completed a second adjudication which reduced the decree in its largest ditches and Rio Grande Project users now had a storage facility to smooth the variations in its supply.

Complaints in the politically less significant middle valley continued, however. When the present (second) Rio Grande Interstate Compact was executed in 1939 after ten years of negotiations, water uses in the three irrigation sections had been accurately catalogued and, it was hoped, protected.

Unfortunately, both Colorado and New Mexico found that they could not reliably comply with downstream delivery obligations undertaken by executing the compact. By the early 1950's, the New Mexico State Engineer and MRGCD found themselves before the US Supreme Court to answer for a debit that had exceeded its 200,000 limit allowed by the compact. The proximate cause of this action was Texas' assertion that MRGCD was storing water in El Vado each year, continuing even when the Article VII prohibitions were in effect.

New Mexico's debit would eventually grow to over 500,000 acre feet, before rehabilitation of waterlogged lands undertaken by the Middle Rio Grande Project could produce additional water flows. The Low Flow Conveyance Channel, which began operation in 1959, was an extension of the drainage concept in an attempt to make New Mexico's deliveries more reliable.

Other federal activities, like the San Juan Chama Project, helped New Mexico to become compact compliant. The annual importation of 96,200 acre –feet of water from the San Juan River basin into the Rio Grande system was approved by Congress in 1962. SJC project water helped ease the state's chronic non-compliance by offsetting river depletions caused by regional groundwater pumping and supplementing the MRGCD's overallocated supply.

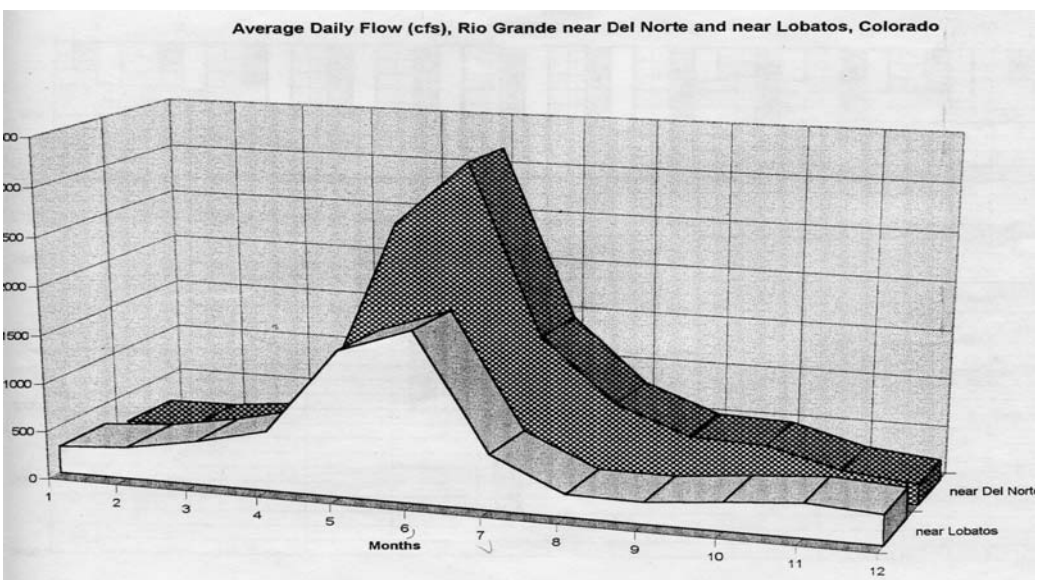
Meanwhile, Colorado's accrued debit swelled to almost 1,000,000 acre feet. New Mexico joined Texas in 1966 in a Supreme Court suit that resulted in an agreement by Colorado to begin to reduce its huge deficit. Across the board curtailment of valley irrigation supplies forced farmers to be more creative and conservative with their water applications. The federal Closed Basin Project, which began operations in 1984, was designed to reduce the state's accrued debit. Nevertheless, it was not until Elephant Butte Reservoir spilled in 1985 that Colorado's thirty year old water debt was forgiven.

Over the past 20 years, many of which were surplus water years, both Colorado and New Mexico have been in compact compliance. For Colorado, it has been a one hundred year battle to balance its Rio Grande water budget. The state's work on the problem has not yet concluded. Today, it is attempting to implement policy proposals which may include creating underground water sub-districts and retiring pumping rights which are in excess of recharge.

New Mexico, too, has made substantial progress, but it is still far from water supply stability. Claims to water in the middle Rio Grande outstrip the ordinarily available supply. The region's rapidly growing principal city proposes development of its San Juan Chama project water, more than half of which has been flowing down the river to help ring the compact bell. Since, 1994, the state water users have borne virtually the entire burden of endangered species recovery. Water reallocation is taking place in an administrative vacuum. Its work has just begun.

A few conclusions:

- The "natural condition of the Rio Grande" has been profoundly impacted by water management in Colorado, and New Mexico as well. The altered conditions of the past 125 years have knocked the peak off of peak flows and collapsed the falling limb of the annual hydrograph (July-September).
- River drying certainly occurred prior to irrigation development. But it is the massive scale of water diversions that made drying such a common occurrence that we are tempted to think that "the river always went dry".
- It is possible to reconstruct pre-Conquest hydrologic conditions by evaluating the Del Norte stream gauge, which is located above the San Luis Valley diversions. Such an evaluation argues against intermittency as the base condition of the river below. (see chart, next page.)



- There is evidence that Texas reluctantly consented to the construction of El Vado Reservoir with the assurance that it would store water only in times of abundance and that its operation would assist in meeting compact deliveries. When channel deterioration in the mid-1940s and MRGCD's apparent willingness to store water in violation of Article VII restrictions during the 1949-58 drought, Texas screamed foul.

- Writes Ira Clark, in his exhaustive Water in New Mexico: A History of Its Management and Use, “It [the compact] had not afforded to downstream water users a proportionate share during critically dry periods, and they [RG Project user] were convinced that the excessive accrued debits by New Mexico were due almost entirely to flagrant flaunting of the terms of the compact by the Middle Rio Grande Conservancy District. That district had been unquestionably been guilty of violations…”
- Drainage works undertaken with federal money under the Middle Rio Grande Project, did result in water salvage to the benefit of RG Project users, but this occurred at a time when substantial debits had accrued. Texas logically viewed the increases as “payback” for a decade of intercepted supplies. Evidence that the projects resulted in permanent improvement is rather sketchy.

Streamflow and ecology: No one disputes the fact that society has profoundly transformed the middle Rio Grande, altered its form, its water and sediment flow regimes, its chemical components, its connective relationship to its watershed. What we’re contending over is the degree to which we are stuck with the changes middle valley society has imposed on the river over the centuries, what conditions are most desirable for the river in the future and what it is possible to do to realize improvements.

Few would doubt that our water use regimes are clearly implicated in the Rio Grande “mystery”. On the average, only about 10% of the water produced by the upper Rio Grande basin watersheds arrives at Ft. Quitman. Just a visit to the Forgotten River section would convince anyone that ten per-cent of its watershed production is clearly not sufficient to support ecological viability. In this “ten percent zone” the ecosystem is highly simplified: channels are obliterated, soil salinities are through the roof, non-native species dominate the landscape, farm economies have been wiped out. Ft Quitman flows are erratic, unpredictable, accidental; they are not synchronized with snowmelt runoff. The channels do not even convey the water. It is a river in perpetual, man-made drought. Although this was not society’s intention, it could not have designed a more thorough ecological disaster than the 200 mile Rio Grande segment known as the Forgotten River.

The system here may once have been able to tolerate some episodes of drying, elevated salinity, sediment choking etc. but since the closing of the Butte in 1916, there has been too little variation, too little “relief” for the organisms the river once supported.

So, let us consider that there may be hydrologic thresholds below which the ecological process of aquatic/riparian ecosystems break down. Forgotten River is clearly below that threshold.

If 10% of watershed production is not enough to sustain the benefits we derive from river systems, what proportion is enough? According to the Compact, when the San Luis Valley receives a 500,000 acre-foot supply, it must provide 120,000 acre-feet to New Mexico; when supply is one million acre-feet, it provides 350,000 acre-feet. That’s 24% and 35% respectively. One might argue that the segment below the state line seems pretty healthy (certainly looks better than the Forgotten River) but consider that a 1987 sample turned up only 13 fish species, only 5 of which are native to the system. Another 6 natives are more or less confirmed to have been extirpated in the last century. But then, when you add in the 300,000 acre-feet from uncontrolled, partially exploited Sangre de Cristo tributaries (along with substantial groundwater inflows in the gorge section of approximately 150 cfs), the fish diversity in the Taos segment improves dramatically. So maybe 35% hydrology is insufficient, too.

In this little exercise, we assume that fish abundance and diversity are indicators of ecosystem health. Obviously, ecosystems are a good deal more complex than fish surveys reveal, but they're useful indicators. And gross supplies (like gross diversions in an irrigation district) are not as significant as flow regimes, a simplified annualization, versus daily and momentary supplies. For flow-dependent biology, timing is, if not "everything", at least something very important. (For confirmation of this principle, ask the farmer who waited too long for a bolt of irrigation water).

Present thinking (actual experts, not just me) is that, because keystone organisms in aquatic and riparian ecosystems evolved in response to long term cycles of runoff and recession, the flow processes: timing, magnitude, duration, recurrence intervals, rates of change help determine the functioning of these systems. Hence, the concept of "mimicking the natural hydrograph". For example, if you deliver in November volumes of water which, in eons past flowed in June, then flow-related biological processes may become uncoupled from processes related to other factors like length of day, temperature, turbidity of the water, food availability, etc., etc., etc. The risk is that the altered conditions don't work to sustain the organism.

In the middle valley, our Compact obligations require passing something like 60% of the Otowi index flow, which computes out to about 45% of watershed production (70% if Colorado wasn't part of the system). I submit that if we are reliably giving the RG Project its 790,000 average supply, then the gross delivery should be adequate to sustain ecosystem. All we need to do is attend to the appropriate timing of flows. This actually bodes favorably for our (and the minnow's) future. The really significant challenges, in my view, are:

- Preventing the escalation of river depletions, especially challenging as Albuquerque starts to pull an additional 45 kaf out of the river.
- Achieving control over the late season hydrograph, when we have been taking as much as 90% of flows. That is, preventing desiccation.
- Offsetting increased depletions from making a greater proportion of deliveries in-season, rather than during the winter.
- Controlling or offsetting new depletions associated with physical habitat improvement (widening channels, increasing flooded areas).

These measures will require that some volume of water be devoted to these purposes. Ideally, we would have some cooperation above (Colorado) and below (RG Project) our little valley. Presently, the MRG water budget does not support the most desirable (45%?) flow regime. We are in gross deficit. I'd suggest that we have four viable, but costly and/or risky alternatives, all of which we must pursue:

- Continue MRGCD's excellent delivery efficiency improvement projects and use them to maintain water in storage to extend the irrigation season.
- Reduce riparian Et losses through bosque thinning, salt cedar conversion.
- Reduce the impacts of the City's new Drinking Water Project by requiring it to absorb a greater share of conveyance losses, adaptive administration of required releases to offset past, present and future aquifer pumping (based on improving understanding of the relationship of all pumping to the river) and so forth.
- Appeal to all willing sellers/lessors to forbear water use at agreeable times and store net savings in Abiquiu for later release to account to help meet the above mentioned challenges.

(Note that the 2003 silvery minnow Biological Opinion aprescribes flows that don't necessarily address middle Rio Grande water budget issues, the acceptable range of variability or most desirable timing of flows).