Publications

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Flow, Salts, and Trace Elements in the Rio Grande: A Review

S. Miyamoto, L. B. Fenn, D. Swietlik

- Full Text

There are increasing concerns that water quality of the Rio Grande (or Rio Bravo) may be deteriorating mainly due to the recent expansion of the maquilas program and associated population relocation into the Border area. This review was conducted to assess the state of flow, salts, and trace elements in the Texas/Mexico portion of the Rio Grande and its tributaries. The data used included published and unpublished reports by federal, state, and some local sources.

The total inflow into the Texas/Mexico portion of the Rio Grande (El Paso to

Brownsville) since 1969 has averaged 4.51 billion m3 (3.65 million acre-ft) annually. Approximately 60 percent of the inflow is estimated to originate from the Mexican side. The largest flow of the Rio Grande occurs below Falcon Dam at an annual rate of 3.0 billion m3 (2.43 million acre-ft). No significant yearly trend of annual flow was detected either by a linear regression or the autocorrelation analysis for the last 21 years. The Rio Conchos, the Rio San Juan, and the Rio Salado are the major tributaries from the Mexican side and account, respectively, for 20, 10, and 10 percent of the total inflow into the Rio Grande. The Devils River and the Pecos River are two of the major tributaries from Texas and account, respectively, for 7.8 and 6.1 percent of the total inflow into the Rio Grande.

The highest salinity of the Rio Grande occurs in the section from Fort Quitman to Presidio (2000 to 5000 mg L-1) and at the Pecos River (2000 to 4000 mg L-1). Salinity of the Rio Grande decreases below Presidio due to the confluence of the Rio Conchos, and it currently averages 860 mg L-1 at Amistad International Reservoir. However, salinity in this segment of the Rio Grande is increasing at an annual rate of 15 to 18 mg L-1. If these trends continue, salinity at Amistad Reservoir will exceed 1000 mg L-1 by the year 2000 or will become twice the salinity level of 1969 by 2004. Salinity below Amistad has been increasing at lower rates (9 to 10 mg L-1). Salinity of the Rio Conchos, the Rio San Juan, and the Pecos River has also been increasing at an annual rate of 8.5, 21, and 38 mg L-1, respectively. Salinity is flow-dependent at the upper reach and at Brownsville. Elsewhere, salinity is largely independent of the annual flow and has not yet attained the steady state.

Sodicity of the main flow of the Rio Grande is at the range where soil particle dispersion begins (SAR of 3 to 4), and that of saline tail water below Fort Quitman and the Pecos River well exceeds the stability guideline. The sodicity

of the Rio Grande water usually increases with increasing salinity, and the sodium adsorption ratio reaches close to 10.

The annual salt inflow into the Rio Grande between Fort Quitman and Amistad Dam is estimated at 1.84 million tons, and that between Amistad and Falcon Dam at 1.17 million tons. Saline tail water of the Federal Middle Rio Grande project and the Pecos River contributes 48 percent of the salt load to the Rio Grande above Amistad Dam, while contributing only 21 percent to the flow. These two streams plus the Rio Salado contribute 50 percent of the salt load of the Rio Grande above Falcon Dam, while contributing 26 percent to the flow of the Rio Grande. Salts have been accumulating, especially in the segments above Amistad Dam.

Existing database for trace elements is rather sketchy and is often inaccurate for some elements (e.g., Hg, Ag, and Cd). Nonetheless, most data indicate that dissolved concentrations of trace elements measured for the last 10 years at six monitoring stations along the main flow of the Rio Grande are low enough to meet the EPA primary drinking water standard, the proposed EPA criteria for livestock water supply, as well as guidelines for irrigation uses. However, dissolved concentrations of Cu, Pb, Hg and Ag often exceed the EPA chronic criteria for aquatic species protection, which are considerably more stringent than those for drinking water. Elevated levels of dissolved Hg concentrations are found in the upper reach (Elephant Butte down to Presidio) and elevated levels of dissolved Cu, Pb and V in salt marshes of the Lower Rio Grande. The concentrations of Cd, Cu, and Cr in pore water of the sediments in the upper reach appear to be many times higher than those in free water. The concentrations of many metals in fish samples collected from various locations along the Rio Grande often exceed the 85th national percentile established by the U.S. Fish and Wildlife Service. There is, however, no indications of Se

problems along the Rio Grande.

With few exceptions, the concentrations of total recoverable metals found in the sediment samples from the Rio Grande main stream are below or at the average values established for soil samples from the western states, except for Hg and Pb. Acid digestible contents of metals in sediments appear to be poorly correlated with dissolved metals or the metal concentrations in fish. The concentration of acid-digestible trace elements (Zn, Cu, Cd, Pb, Ni, Cr, and V) in soil samples from irrigated fields in the El Paso and the Juarez Valleys show some indications of Cu, Pb, and Zn accumulation. Even so, the levels of these metals are well below toxic levels for plant growth or for animal health concerns. The alkaline nature of the Rio Grande seems to help maintain relatively low dissolved concentrations of metals in water, but metals are probably accumulating in soils and sediments.

Overall, this review indicates salts to be the major constraint for full utilization of water resources in the Rio Grande and that salinity is steadily increasing, especially above Amistad Dam. In these areas, salinity of the Rio Grande already exceeds the primary drinking water standard as well as the guidelines for production of high value horticultural crops. The continuing increase in salinity of Amistad Reservoir is of a special concern, as it may exceed the primary drinking water standard by as early as the year 2000 and could adversely affect high value crop production in the Lower Rio Grande. Trace element problems in the Rio Grande are sporadic and do not seem to be wide-spread at present, except from the view of aquatic species protection. There is a need to carry out a detailed salinity projection analysis, and to improve the accuracy of trace element monitoring and assessment of bioavailability indices for various ecosystems, especially in aquatic systems. Future research should also include water management options which target reuse of saline drainage

water and disposal of wastewater away from the primary waterway of the Rio Grande to curtail salinization and trace element accumulation.