Changing salinity in the Upper Colorado River Basin during the 20th century, 1929-2019

Christine Rumsey, Olivia Miller, Dan Jones, Annie Putman, Robert Hirsch, and David Susong

U.S. Geological Survey, Utah and National Science Centers

UTWSC All Hand’s Meeting
February 4, 2020
Value of the Colorado River

- The Southwestern US relies on Colorado River water to sustain ecosystems, communities, and economies
  - Economic benefit exceeds $1.4 trillion/year
  - Used by over 40 million people
  - Provides water for ag, municipalities, and industry
Salinity in the Colorado River

- Salinity is a major threat to water users
  - Quantified damages to U.S. users are ~$400 million/year
  - Decreased crop yields
  - Increased water treatment costs
- Water quality obligation to Mexico

---

English Text of Minute 242

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

Mexico, D.F.
August 30, 1973

MINUTE NO. 242

PERMANENT AND DEFINITIVE SOLUTION TO THE INTERNATIONAL PROBLEM OF THE SALINITY OF THE COLORADO RIVER

The Commission met at the Secretariat of Foreign Relations, at Mexico, D.F., at 5:00 p.m. on August 30, 1973, pursuant to the instructions received by the two Commissioners from their respective Governments, in order to incorporate in a Minute of the Commission the joint recommendations which were made to their
Colorado River Salinity Control Forum

- 1973 - Colorado River Salinity Control Program was created to enhance and protect water quality in the Colorado River
  - Members include the 7 basin states; federal, state, and local agencies; public and private entities
  - Implement salinity control efforts
    - Irrigation upgrades
    - Vegetation management
    - Infrastructure improvements
COLORADO RIVER NEAR CISCO, UT  Total dissolved solids
Water Year *
Flux Estimates (dots) & Flow Normalized Flux (line)

Long-term trends
Salinity in the 20th and 21st centuries

• What are the long-term trends in salinity?
  – Calculate 50+ years of dissolved-solids trends
  – Understand how trends vary spatially across the UCRB
• What were salinity patterns prior to control projects?
• What are major forces driving long-term trends?
  – Correlate dissolved-solids trends to land-cover and land-use change
• Can these processes help us understand how salinity will behave in the future?
USGS long-term records

• This work is possible because of the availability of long-term discharge and water quality data collected by USGS
  – Data from pre-1960 to present
Widespread decreasing salinity trends across the UCRB during the 20th century
Substantial declines in load: Mainstem rivers

- CR - CISCO: -39%
- GR - GREEN R., UT: -31%
- SJ - BLUFF: -51%

FN load (10^3 mT/yr)

1940 1960 1980 2000

[Map showing river systems and data points]
Substantial declines in load: Mainstem rivers

-1.6 million tons

-0.7 million tons +25%

-0.5 million tons +3%

-29%

1940 1960 1980 2000
Temporal patterns of change help understand drivers
Major findings

- Widespread declines in salinity loads and concentrations during the 20th century
- Decreases observed as early as the 1940s
- Unparalleled rates of decline were observed during the 1980s and 1990s
- The pace and extent of decrease began to decline in the early 2000s
What are drivers of multi-decadal changes in salinity?

• Changes in vegetation
  – recovery from grazing, fire, logging, climate, etc.

• Streamflow processes
  – arroyo cutting, dams, water use, climate

• Land use
  – resource extraction, grazing, agriculture, logging

• Salinity control projects
  – irrigation improvements, point-source mitigation
Questions/ideas?

Christine Rumsey
crumsey@usgs.gov