Comparison of Changes in Dissolved-Solids Loads Estimated from Streamflow and Water-Quality Data to Estimates from Changing Irrigation Methods, Uinta Basin Area, Utah

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Background

• Dissolved solids from the Green River affect the suitability of Colorado River water for downstream uses.

• Agricultural activities were estimated to contribute 43% of dissolved-solids load in Colorado River at Lees Ferry, Arizona.

• Study done in cooperation with the Colorado River Basin Salinity Control Forum to assess trends in dissolved-solids load in Uinta Basin.
Objectives

- Estimate annual dissolved-solids load at selected sites in the basin that drain either natural land, agricultural land, or both
- Determine trends in dissolved-solids load at these sites
- Compare changes in dissolved-solids load to estimates made by the Natural Resources Conservation Service and Bureau of Reclamation
Mean daily streamflow at selected gaging stations in the Uinta Basin study area, water years 1989 through 2013
Dissolved-Solids Load

Load = (Concentration) x (Flow) x (CF)

Where

- Load is estimated dissolved-solid load, in tons per unit time
- Concentration is dissolved-solids concentration, in milligrams per liter
- Flow is streamflow, in cubic feet per second
- CF is conversion factor (0.002697 for tons per day)

LOADEST Regression Models

Regression equation relates dissolved-solids load to explanatory variables

- Flow (Q) and/or quadratic flow
- Time (t) and/or quadratic time
- Seasonal terms (k2πT)

\[
\ln L = a + b_1 (\ln Q - \ln Q^*) + b_2 (\ln Q - \ln Q^*)^2 \\
+ b_3 (t - t^*) + b_4 (t - t^*)^2 \\
+ b_5 [\sin(k2\pi T)] + b_6 [\cos(k2\pi T)] + e
\]

where

- \(a\) = regression equation intercept
- \(b\) = coefficient on the regression variable
Dissolved-Solids Loads in Duchesne River Basin

Strawberry River near Duchesne, UT

Duchesne River Basin, Utah
Duchesne River near Randlett, UT, (gaging station 09302000)
Duchesne River Basin, Utah

Gaging station or area description

- Duchesne River near Tabinia, UT
- Monitored tributaries (inflow)
- Unmonitored discharge load added to Duchesne River between Tabinia and Myton gaging stations
- Duchesne River at Myton, UT
- Monitored tributaries (inflow)
- Unmonitored discharge load added to Duchesne River between Myton and Randlett gaging stations
- Duchesne River near Randlett, UT

Duchesne River Basin

Sprinkler
Flood

1989 flow-normalized load determined from mean daily flow, water years 1989-2013
2013 flow-normalized load determined from mean daily flow, water years 1989-2013
Mean annual load determined from daily mean flow, water years 1989-2013
Dissolved-Solids Loads in Middle Part of Green River Basin

Green River near Jensen, UT
Percentage of net decrease in flow-normalized load at Green River at Green River, UT

- Green River near Greendale, UT 45%
- Duchesne River near Randlett, UT 19%
- White River near Watson, UT 16%
- Remaining 20% from Yampa and Price River Basins, Vernal and other areas

Green River at Green River, UT
## Estimating Change in Dissolved-Solids Load from Sprinkler-Irrigated Area

\[
\Delta \text{Load} = \text{Sprinkler area} \times \text{Pre-project yield} \times \text{Irrigation method efficiency}
\]

Where

- \(\Delta \text{Load}\) = load reduction from conversion from flood to sprinkler irrigation, in tons per acre
- Sprinkler area = sprinkler-irrigated area, in acres
- Yield = estimated pre-salinity control project dissolved-solids yield from flood-irrigated land, in tons per acre
- Irrigation method efficiency = 84% for wheel-line sprinklers and 90% for center pivot sprinklers

### Estimated Change in Dissolved-Solids Load from Sprinkler Irrigated Areas

<table>
<thead>
<tr>
<th>USGS gaging station name or area description</th>
<th>2012 sprinkler-irrigated area, in acres</th>
<th>Estimated 2012 dissolved-solids load from sprinkler-irrigated area, in tons</th>
<th>Estimated 2012 dissolved-solids load from flood-irrigated area, in tons</th>
<th>Estimated 2012 dissolved-solids load from total irrigated area, in tons</th>
<th>Estimated change in 2012 dissolved-solids load based on sprinkler-irrigated area, in tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duchesne River near Randlett, UT (total irrigated land in the Duchesne River Basin)</td>
<td>72,447</td>
<td>12,100</td>
<td>68,895</td>
<td>71,600</td>
<td>83,700</td>
</tr>
<tr>
<td>Unmonitored load added to Green River between Jensen and Green River, UT, gaging stations (total of irrigated land, excluding the Duchesne River Basin, draining to this reach)</td>
<td>56,777</td>
<td>14,400</td>
<td>22,330</td>
<td>35,800</td>
<td>70,100</td>
</tr>
<tr>
<td>Total for the Duchesne River Basin and unmonitored load added to Green River between Jensen and Green River, UT, gaging stations (total of irrigated land draining to this reach)</td>
<td>129,224</td>
<td>26,500</td>
<td>91,225</td>
<td>127,400</td>
<td>154,000</td>
</tr>
</tbody>
</table>
Summary

• Most of the studied gaging stations upstream of agricultural activities had no trend in flow-normalized dissolved-solids loads (FNLS).

• WY 1989-2013 FNLS decreased at studied sites with agricultural land in the drainage area.

• Net decrease in 2013 FNLS compared to 1989 FNLS at Duchesne River near Randlett site and unaccounted inflow to the Green River between Jensen and Green River sites is 132,000 tons.

• Total change in 2012 load estimated from conversion from flood to sprinkler irrigation in the Uinta and Price River Basins is -136,000 tons.

• NRCS-BOR estimate of change in 1989-2013 load for the Uinta and Price River Basins is -200,000 tons.
Questions?
Contact Susan Thiros at sthiros@usgs.gov