Estimating Rangeland Runoff, Soil Erosion, and Salt Mobility and Transport Processes
Salinity Research Team

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Background

• The Colorado River provides water to about 36 million people and irrigation water to nearly 4.5 million acres of land in the United States and Mexico

• Damages within the United States from salts are estimated to be $385 million per year

• About 55% of the salt loading comes from rangelands

• Potential to reduce dissolved-solids loading to the Colorado River through land management activities on rangelands
Background

- **Worldwide Literature review and synthesis of knowledge.** The primary objective of this completed phase of the project was to compile a body of easily accessible knowledge learned from past studies on the sources and transport of dissolved solids to streams in rangelands around the world.

Approach/Objectives

• Use rainfall simulation techniques, Walnut Gulch Simulator, to quantify salt transport processes on upland rangeland hillslopes in upper Colorado Basin.

• Assess the Rangeland Hydrology and Erosion Model (RHEM) ability to predict runoff, sediment yield, and total dissolved solids on saline rangelands.

Price, Utah experimental site

Ferron, Utah experimental site
Location of Sites

Major Land Resource Area 34B
Warm Central Desertic Basins; Mountains; and Plateaus

Physical Classification of Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Price, Utah</th>
<th>Ferron, Utah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological site</td>
<td>Desert loamy clay (shadscale)</td>
<td>Desert shallow clay (mat saltbush)</td>
</tr>
<tr>
<td>Canopy cover %</td>
<td>8.4 %</td>
<td>21.7 %</td>
</tr>
<tr>
<td>Bare Soil %</td>
<td>89.3 %</td>
<td>74.7 %</td>
</tr>
<tr>
<td>Soil Series</td>
<td>Persayo loam</td>
<td>Chipeta-Badland complex</td>
</tr>
<tr>
<td>Surface texture</td>
<td>Silt Loam</td>
<td>Silt Loam</td>
</tr>
<tr>
<td>Slope %</td>
<td>6.3 %</td>
<td>18.9 %</td>
</tr>
</tbody>
</table>
Experimental Design

• Select 2 Ecological Sites for evaluation of salinity transport processes
• 4 rainfall intensities / return periods evaluated
  – 2 year (50 mm/hr)
  – 10 year (90 mm/hr)
  – 25 year (114 mm/hr)
  – 50 year (140 mm/hr)
• 3 replicates per rainfall intensity
• 12 plots per site evaluated (Plot 2 m by 6 m)
Experimental Measurements

• Hydrologic measurements
  – Rainfall volume and intensity
  – Runoff
  – Concentrated flow path evolution
  – Rill formation and evolution
  – Sediment deposition

• Water Quality
  – Anions (NO2, NO3, S04, CL)
  – Cations (C, Mg, K, Na)
  – Electrical Conductivity
  – Cation Exchange Capacity
  – pH
  – Sodium Absorption Ratio
  – Total Dissolved Solids
  – Sediment load

• Soil sampled at:
  0-5 mm, 6 - 50 mm, 51 - 100 mm
  – Texture
  – Bulk Density
  – Electrical Conductivity
  – Cation Exchange Capacity
  – pH
  – Anions
  – Cations
  – Soil water content
  – Sodium Absorption Ratio
Rainfall Simulator System

Walnut Gulch Simulator

Super critical flume-Pressure transducers

Electrical resistance sensors & temperature sensor

Electrical Resistance Sensors
Fig. 1. Runoff (L/S) as a Function of Precipitation Intensity (mm/hr) at Price, Utah
Fig. 2. Observed vs. RHEM Predicted Runoff (mm/hr)
Observed Sediment Yield (g) vs. RHEM Predicted Sediment Yield (g)

\[ y = 16439 \ln(x) - 74714 \]

\[ R^2 = 0.52 \]

Fig. 3. Observed Sediment Yield (g) vs. RHEM Predicted Sediment Yield (g)
Future Work

List of sample sites, sample numbers, and status of the analysis for rainfall simulation project to understand and predict salinity transport process on rangelands.

<table>
<thead>
<tr>
<th>Year</th>
<th>Location by nearest city</th>
<th>Number of Plots</th>
<th>Sampling Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>Price, UT</td>
<td>12</td>
<td>Completed</td>
</tr>
<tr>
<td>2014</td>
<td>Ferron 1, UT</td>
<td>12</td>
<td>Completed</td>
</tr>
<tr>
<td>2015</td>
<td>Ferron 2, UT</td>
<td>12</td>
<td>Completed</td>
</tr>
<tr>
<td>2016</td>
<td>Moab 1, UT</td>
<td>12</td>
<td>Field sample complete</td>
</tr>
<tr>
<td>2016</td>
<td>Moab 2, UT</td>
<td>12</td>
<td>Field sample complete</td>
</tr>
<tr>
<td>2016</td>
<td>Grand Junction 1, CO</td>
<td>12</td>
<td>Sample August 2016</td>
</tr>
<tr>
<td>2016</td>
<td>Grand Junction 2, CO</td>
<td>12</td>
<td>Sample August 2016</td>
</tr>
<tr>
<td>2017</td>
<td>Eagle Valley, CO</td>
<td>12</td>
<td>Sample May 2017</td>
</tr>
<tr>
<td>2017</td>
<td>Montrose, CO</td>
<td>12</td>
<td>Sample June 2017</td>
</tr>
<tr>
<td>2017</td>
<td>Farmington, NM</td>
<td>12</td>
<td>Sample July 2017</td>
</tr>
<tr>
<td>2017</td>
<td>Farmington, NM</td>
<td>12</td>
<td>Sample August 2017</td>
</tr>
</tbody>
</table>
Conclusion

Data from Rainfall simulation are useful for documenting:

• Infiltration and Runoff rates on saline soils
• Soil erosion rates
• Sediment concentration and yield
• Salt transport processes
• Water quality as expressed as total dissolved solids for rangelands
Conclusion

• Data from Rainfall simulation are useful for validating the RHEM ability to predict runoff, sediment yield, and total dissolved solids on saline rangelands.

• RHEM assessment tool used to quantify reductions in total dissolved solids derived from implementing revegetation practices as a function of plant density and canopy and ground cover.
Thank You