Irrigation Water Quality Standards and Salinity Management

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Effect of water evaporation on concentration of salts

1 L of Water
1 g of Salt

1 % Solution

2 % Solution

1/2 evaporated
Type of salinity problems

- Salinity hazard
- Sodium
- Saline soil conditions
- Plants
- Soils
- Sodic soil conditions
Terms used in salinity

**Total salinity**

- **EC**  Electrical conductivity  
  - mmhos/cm
  - μmhos/cm
  - dS/m

- **TDS**  Total dissolved solids  
  - mg/l
  - ppm

**Sodium hazard**

- **SAR**  Sodium Adsorption ratio  
  - ---

- **ESP**  Exchangeable sodium %  
  - ---
# Water Quality in selected wells in Far West Texas

<table>
<thead>
<tr>
<th>Location</th>
<th>EC</th>
<th>SAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Lawrence</td>
<td>4500-5800</td>
<td>6-7</td>
</tr>
<tr>
<td>Pecos E.S.</td>
<td>2330-2680</td>
<td>8-12</td>
</tr>
<tr>
<td>Coyonosa</td>
<td>2100-3810</td>
<td>4</td>
</tr>
<tr>
<td>El Paso AD</td>
<td>800</td>
<td>3-6.5</td>
</tr>
<tr>
<td>Paso-Hudspeth</td>
<td>900</td>
<td>4.2-11.6</td>
</tr>
<tr>
<td>Classes of water</td>
<td>EC $\mu$mhos/cm</td>
<td>TDS ppm</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------</td>
<td>---------</td>
</tr>
<tr>
<td>Excellent</td>
<td>250</td>
<td>175</td>
</tr>
<tr>
<td>Good</td>
<td>250-750</td>
<td>175-525</td>
</tr>
<tr>
<td>Permissible</td>
<td>750-2000</td>
<td>525-1400</td>
</tr>
<tr>
<td>Doubtful</td>
<td>2000-3000</td>
<td>1400-2100</td>
</tr>
<tr>
<td>Unsuitable</td>
<td>3000</td>
<td>2100</td>
</tr>
<tr>
<td>SAR values</td>
<td>Sodium hazard</td>
<td>Comments</td>
</tr>
<tr>
<td>------------</td>
<td>---------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>1-10</td>
<td>Low</td>
<td>Sensitive crops</td>
</tr>
<tr>
<td>10-18</td>
<td>Medium</td>
<td>Amendments and leaching</td>
</tr>
<tr>
<td>18-26</td>
<td>High</td>
<td>Unsuitable-continuous</td>
</tr>
<tr>
<td>&gt;26</td>
<td>Very high</td>
<td>Unsuitable</td>
</tr>
</tbody>
</table>
Classification salt affected soils

<table>
<thead>
<tr>
<th>SAR</th>
<th>Normal</th>
<th>Saline</th>
<th>Sodic</th>
<th>Saline-Sodic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>4</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>EC (mmhos/cm)</td>
<td>0</td>
<td>4</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

- Normal
- Saline
- Sodic
- Saline-Sodic
Salinity control

Leaching

Apply more water than the crop consume to push the salts below the root zone

at least......

at some time during the year
High Water Table

- Ground Line
- No Root Development
- Water-Logged Soil

Normal Root Zone
Drain - ditches, pipe

[Diagram showing lateral movement of water and drain pipe]
Drain pipe manufacturing
Socks for drain pipe
Extraction tubes
Lining canals

Reduce seepage

30 in deep

1 ft-w bottom

$100,000 mile
Sodicity control

Substitute Calcium for Sodium

And then leach the Sodium

Gypsum
Calcium Nitrate
Sulfur to solve calcium
Far West Texas
(Region E)

Figure 1. Nine major aquifers account for 96.3 percent of all groundwater withdrawals in Texas.
Figure 2. The 20 minor aquifers of Texas account for 3.7 percent of all groundwater withdrawals.
### Common constituents of irrigation water

<table>
<thead>
<tr>
<th>Cations</th>
<th>Anions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amonium $\text{NH}_4$</td>
<td>Bicarbonate $\text{HCO}_3$</td>
</tr>
<tr>
<td>Calcium $\text{Ca}$</td>
<td>Carbonate $\text{CO}_3$</td>
</tr>
<tr>
<td>Hidrogen $\text{H}$</td>
<td>Nitrate $\text{NO}_3$</td>
</tr>
<tr>
<td>Magnesium $\text{Mg}$</td>
<td>Phosphate $\text{PO}_4$</td>
</tr>
<tr>
<td>Sodium $\text{Na}$</td>
<td>Sulfate $\text{SO}_4$</td>
</tr>
<tr>
<td>Potassium $\text{K}$</td>
<td></td>
</tr>
</tbody>
</table>
Water Testing

Routine analysis $20

- Conductivity, pH, Na, Ca, Mg, K, CO₃,
- HCO₃, SO₄, Cl, B, Nitrate, Hardness and SAR

R+ Metals $30

- Zn, Fe, Cu Mn, and P

R+ Metals+ Heavy Metals $50

- As, Ba, Cd, Pb, Cr, and Flouride
Soil Testing

Routine analysis $10

pH, NO₃, P, K, Ca, Mg, Na, S, and Conductivity

R+ Micro-nutrients $20

Z, Fe, Cu, Mn

R+ Detailed Salinity $25
<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Poor</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humans</td>
<td>0-800</td>
<td>2,500-4,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Cattle</td>
<td>0-1,000</td>
<td>4,000-6,000</td>
<td>10,000</td>
</tr>
</tbody>
</table>
Toxicity

Boron
Chloride
Sodium
Salt Tolerance

More

Forage corps

Field crops

Vegetables

Fruits

Less
<table>
<thead>
<tr>
<th>Crop</th>
<th>100%</th>
<th>90%</th>
<th>75%</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall wheat grass</td>
<td>5.0</td>
<td>6.6</td>
<td>9.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Wheat grass</td>
<td>5.0</td>
<td>6.0</td>
<td>7.4</td>
<td>9.8</td>
</tr>
<tr>
<td>Bermuda grass</td>
<td>4.0</td>
<td>5.7</td>
<td>7.2</td>
<td>9.8</td>
</tr>
<tr>
<td>Barely hay</td>
<td>4.0</td>
<td>4.9</td>
<td>6.3</td>
<td>8.7</td>
</tr>
</tbody>
</table>

More Yield
Less Salinity

Less Yield
More Salinity
<table>
<thead>
<tr>
<th>Crop</th>
<th>100%</th>
<th>90%</th>
<th>75%</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bermuda grass</td>
<td>6.9</td>
<td>8.5</td>
<td>10.8</td>
<td>14.7</td>
</tr>
<tr>
<td>Corn forage</td>
<td>1.8</td>
<td>3.2</td>
<td>5.2</td>
<td>8.6</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2.0</td>
<td>3.4</td>
<td>5.4</td>
<td>8.8</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>2.2</td>
<td>3.6</td>
<td>5.7</td>
<td>9.1</td>
</tr>
</tbody>
</table>
Salt accumulation

Very high    high    moderate    low
Salt build-up as a function of seed placement

ECw 4

Single row bed

ECw 8

Salt accumulation

ECw 16

Double row bed

Seeds fail to germinate
5000 acres of SDI per year in District 6

Furrow - 35 lbs/ac-in
SDI - 55 lbs/ac-in
Excellent - 65 lbs/ac-in
Drip spacing

40"

80"
Overlapping is important - Uniformity

Foliar injury:
cotton (resistant)
Alfalfa (medium)
Center pivot more than 400 GPM

Cost per 1/4 mile

New: $40,000

$320/ac

not included: supply line and pump, electricity
Surface irrigation - Need to level the land
Size of the borders

Percent slope

soil texture

(a) GRADED BORDER
Border irrigation
End