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A New Sodicity Index for Improving Risk Assessment and Management of Saline and Sodic Soils

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Objective: The objective of this project was to develop a new sodicity index that is superior to existing sodicity indices for managing turfgrass.

Start Date: 2014

Project Duration: 3 years

Total Funding: $65,399

Summary text:

The sodium adsorption ratio (SAR) is a commonly used irrigation sodicity risk index based on the initial amount of dissolved sodium, magnesium and calcium in the water. In reality, the sodicity risk of water is affected by evaporation, leading to calcite precipitation and increasing the percentage of sodium on soil cation exchange sites. Existing methods to estimate the evaporation-adjusted SAR to account for calcite precipitation are unreliable or unnecessarily complex for routine sodicity risk assessment. Water sources differ substantially in their sodicity potential and their latent sodicity risk only becomes apparent at moderate and high salinity. This paper proposes a new sodicity risk index, which utilizes two limits, the Limiting Sodium Adsorption Ratio (LSAR), which computes an upper limit toward which the SAR converges as calcium carbonates precipitates as a result of evaporation; and the evaporation-adjusted SAR (ESAR) which computes a lower limit where no calcite precipitation occurs as salinity increases. We analyzed seven different river waters and set the upper and lower boundaries based on the most diluted condition of the river (where sodicity risk is not usually apparent). The upper boundary, LSAR, represents the worst-case scenario, where nearly all the calcium is removed by calcite precipitation; the lower boundary, ESAR, is the best-case scenario where evaporation concentrates the water but assumes no calcite precipitation. The SAR of waters solely influenced by evaporation were bounded by the LSAR and ESAR boundaries. Water where SAR fell outside of the boundaries were influenced by subsurface or surface discharge from saline sources and these waters could be readily identified by the trend in bicarbonate and calcium ratio. The new sodicity risk method represent here is a simple, accurate way to identify the potential sodicity risk of an irrigation water as it concentrates in the soil.

The LSAR and ESAR boundaries are relatively easy to calculate, and only require the initial EC of the irrigation water, the threshold EC for the particular turf species (in this work we used a threshold of 4 ds/m), and the sodium, calcium, and magnesium

concentration in the irrigation water. The Fc term is EC threshold concentration divided by the EC of the irrigation water. The equations are shown below:

$$\mathrm{LSAR} = \frac{\mathrm{F_c} \cdot \mathrm{Na_{iw}}}{\sqrt{\mathrm{F_c} \cdot \mathrm{Mg_{iw}}}} \qquad \mathrm{ESAR} = \frac{\mathrm{F_c} \cdot \mathrm{Na_{iw}}}{\sqrt{\mathrm{F_c} \cdot (\mathrm{Mg_{iw}} + \mathrm{Ca_{iw}})}}$$

The boundaries can then be plotted on a graph, and the user (golf course superintendent etc.) can see how the SAR is expected to change as the soil EC increases. If the EC threshold is crossed before the SAR reaches 15, then simply managing the EC below the threshold will be sufficient – no sodicity management would be required (i.e. applying gypsum, acid injecting, etc.). The method is conservative, and data points falling outside of the LSAR and ESAR boundaries were extremely rare.

Summary Points:

- Proper assessment of irrigation water quality is critical for the golf industry
- Current sodicity indices are flawed and likely produce inaccurate estimates of sodicity hazard
- After irrigation is applied, the solution concentrates which changes the SAR of the soil water solution. We developed equations for two boundaries (a best case and a worst case scenario) that describe how the SAR is expected to change as the EC of the soil water solution increases.
- We studied the SAR/EC relationships of several rivers and found that the majority were bounded by the LSAR and ESAR boundaries as the water concentrated. Waters high in alkalinity tended toward the LSAR boundary, while waters low in alkalinity tended toward the ESAR.
- The LSAR is a simple, accurate, conservative estimate of sodicity hazard and should be favored over all existing sodicity indices in turfgrass management and agricultural production. We developed a spreadsheet that irrigation water laboratories or end users could use to follow our method.

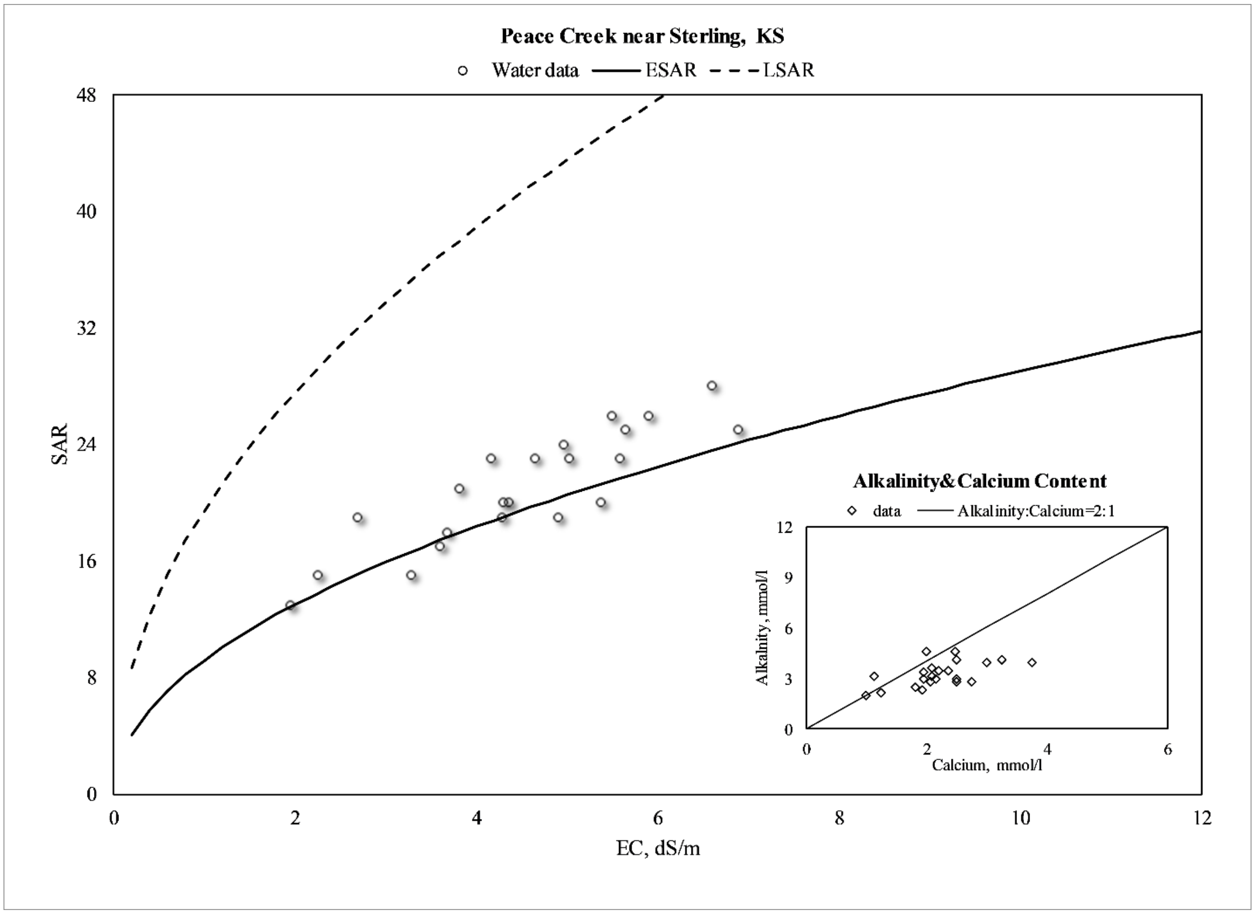

Figure 1. The SAR and EC relationship for the water in Peace Creek, near Sterling, KS. This water is low in alkalinity (alkalinity: Ca ratio <2) and therefore the water tends toward the ESAR boundary as the water concentrates from evaporation.

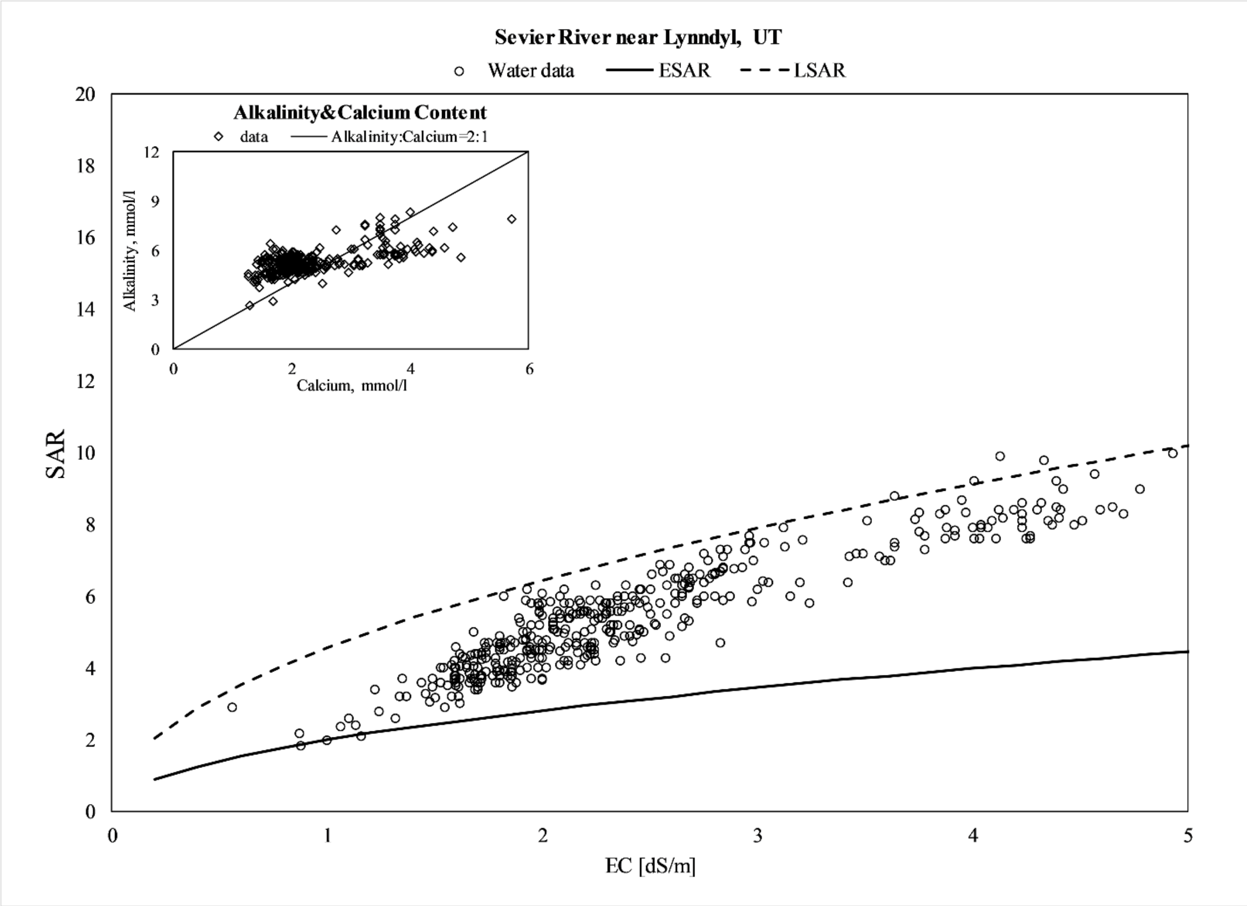

Figure 2. The SAR and EC relationship for the water in the Sevier River, near Lynndyl, UT. This water is high in alkalinity (alkalinity: Ca ratio often >2) and therefore the water tends toward the LSAR boundary as the water concentrates from evaporation.

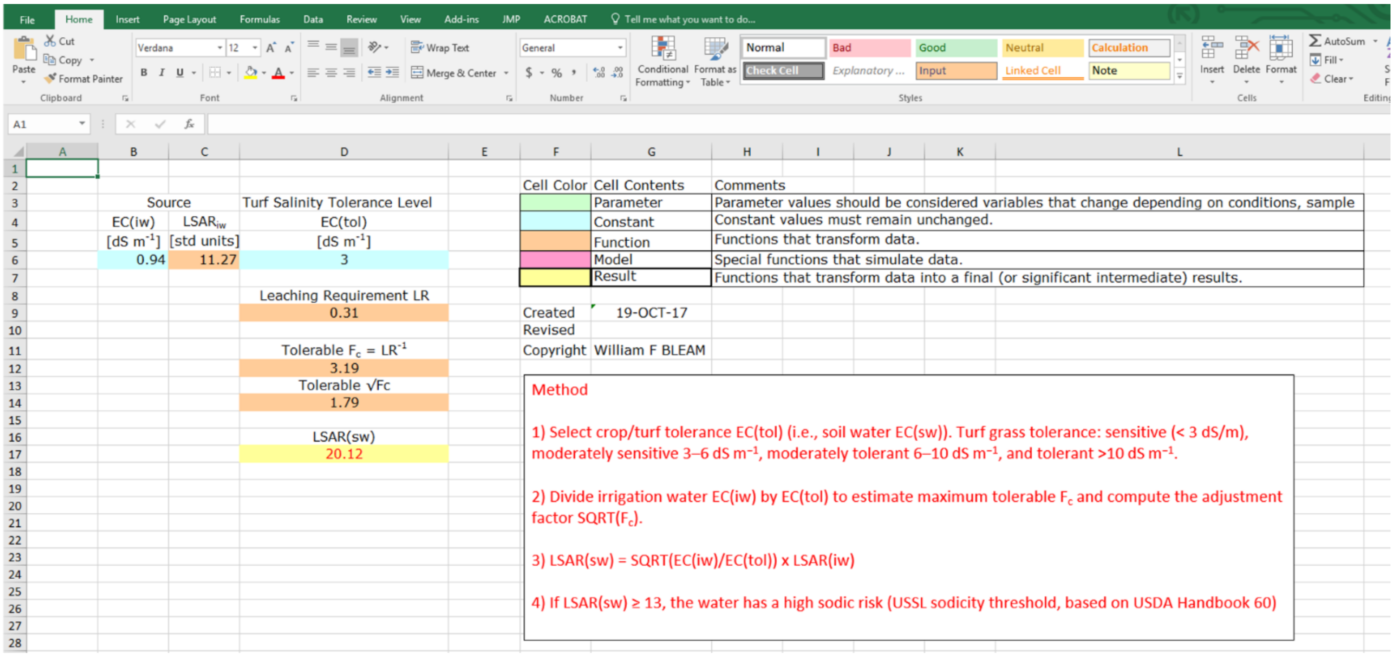

Figure 3. Screenshot of spreadsheet that predicts LSAR and ESAR for laboratories of end users.