CV-SALTS Agronomist Salinity Expert Dialog
at International Salinity Forum 3
June 16, 2014

Attendees Included:

Don Barnett, Colorado River Salinity Control Forum	Karl Longley, CVRWQCB
Jeanne Chilcott, CVRWQCB	Heather du Vallon, Australia – Beef
Daniel Cozad, CVSC	Carl Walters, GB CMA Australia
John Dickey, CVSC	Kevin Minogue, Australia - Dairy
Peter Gibson, Australia – Dairy	Ahmad Moradi, UC Davis
Keith Knapp, UC Riverside	Helen Murdoch, GB CMA
Jessie Godfrey, UC Davis	Don Suarez, US Salinity Laboratory USDA
Juan Gonzalez, Cena University of Arizona, Tucson	Mark Potter, Murray Darling Basin Auth.
Stephen Grattan, UC Davis	Blake Sanden, UCCE Kern County
Daniel Isidoro, Spain	Maciej Zwieniecki, UC Davis
Daniel Hillel, World Food Prize Laureate, Author, Columbia University	Michelle Leinfelder-Miles, UCCE San Joaquin County

This description of the discussion and recommendations was supplied to all participants and all corrections and revisions were incorporated into this final version on July 14, 2014.

At the meeting, Daniel Cozad began with a brief overview of CV-SALTS. He described the large area and diverse complexity leading the questions for the evening. John Dickey added that the roots of questions are related to the core efforts in agriculture production, or how to keep growing crops and protect water quality. CV-SALTS focus on protecting water and soil resources within the regulatory context was explained, along with CV-SALTS need for guidance on technical concepts to help guide regulatory processes.

The Salinity Coalition is interested in these questions, created with support from Dennis Westcot, because CV-SALTS is working with stakeholders and the regulatory community to be able to rewrite regulation for the Central Valley that protects water quality for future use, while maintaining agriculture in the Central Valley in.

Notes were taken on discussion pertaining to questions 1 through 3, though much of this overlapped subject matter mentioned in later questions. Later questions received less explicit attention.

1. **During droughts and other times the target salinity values may be exceeded on an infrequent basis. How often can permanent crops endure salinity of the applied water exceeding the Mass and Hoffman threshold value by 10-50% during short periods for 1 or 2 years when a wet winter could follow the drought?**

    - Clarifying the questions, it was noted that water quality gets poorer when less water is available. The variety of crops that were identified in the Central Valley included trees, vines, almonds, walnuts, grapes, pistachios and stone fruits. Question is looking at water quality, significant loss of crop, and survival of the trees.

    - Mass-Hoffman numbers incorporate about 20 to 30% uncertainty in the yield response to root zone salinity (Suarez). Therefore, moving ECe 10% beyond a threshold for yield loss should not present any problem. However, concentrations 50% above the threshold are likely to have economic impacts. Crops could also tolerate a temporary boost in ECw above a threshold value without much increase in ECe due to the time lag of the effect of irrigation water salinity on soil salinity. You apply what you can or must to keep a crop alive during a drought; there are not really other options. In Australia, they use saline groundwater to keep crops alive during drought.

- Need to address specific ions too. Other key assumptions: 1) M-H assumes average 15% leaching fraction; since small reductions in ETc (during drought) dramatically change the LF (which is leaching water/(ETc+leaching water)), there is a built-in margin of safety; 2) With drip/microspray, the whole concept of LF changes. The root zone moves into the zone that is repeatedly wetted by the emitters. The LF is still defined as the % of water moving through this volume, but the frequent replenishment of water retains low salinity in the wetted volume. Temporal effects are important in this situation, and must be taken into account.

- If there is 20-30% uncertainty of the threshold value, how would you apply the 20-30% if you have to set water quality needed by irrigators growing sensitive crops with this water supply? Response: You need to look at specific crops and the specific information. Some crops have a lot of uncertainty in their response functions, some have varietal differences. Plants integrate soil salinity differently.

- At 50% stone fruit would be destroyed but it would not be at 10%

- Karl Longley asked if routinely flushing the salts out of the root zone is the assumption, what is the impact of that for modeling? Mass-Hoffman is defined as terms of the EC of the soil saturation extract, as a weighted average of root-zone water uptake. So in better years do you have to maintain lower EC? Yes, you maintain within the 10% threshold. Some of the best management practices suggest that you maintain the nutrients in the root zone by controlling leaching to a lower level, but this also can maintain salts in the root zone.

- When you leach, you run the risk of leaching nutrients as well as salt. Assumption these are average annual things root zone salinity is influenced by leaching whether it happens in January, March, or August. It is possible to leach at a time when you don't have much mobile nitrogen. Leaching doesn't always imply pushing nitrogen past the root zone; it depends on when/how you leach.

- Michelle Leinfelder-Miles mentioned that a 15% leaching fraction is not a good assumption as there are places in the Delta region that do not see a 15% LF. The Delta area is not, in large part, dealing with trees or vines, but rather mostly perennial alfalfa or annual field crops and vegetables. Shallow groundwater and low porosity soils contribute to the challenge in achieving a 15% LF.

- Under a drip irrigation concept of leaching, you are not talking about some uniform process, but rather pockets of soil that are wetted, with volumes of soil between the critical zones that remain saline or unaffected. The roots concentrate in that wetted zone under the drip. We lose the concept of uniformity and deal with these microzones and roots that concentrate within them. For Drip the entire wetted volume is called the root zone.

2. **Most crop tolerance modeling has used annual averages for determining the plan responses to soil salinity or salinity in the irrigation water. Are there periods/stages in the crop growth cycle that are more critical and should therefore be a focus, in developing water quality protection criteria? How can the temporal variability be captured and use for regulatory limits?**
   - For annuals, sensitive periods are generally early in the crop cycle. In permanent crops, these periods are less well known. Perhaps flowering/fruit set? On regulatory standard setting: Defaulting to any number is perhaps less useful than looking at more flexible, creative regulatory approaches that allow farming to adjust to water type and timing. For example, in the Murray-Darling, programs were developed to improve water quality. It was more practical than regulating everything. Benefit-cost ratios associated with standards tend to drop exponentially as standards become increasingly stringent. For example, compliance with a standard like 0.7 dS/m in drainage water could be very costly, but deliver far less benefit. Australia did not so much reference plant sensitivity as the requirement. Rather, they co-designed a program where farmers & watershed authorities worked to meet attainable goals. They dealt with drought years, having a buffer for these. They developed, implemented, re-evaluated, and then adjusted the program. This resulted in actual water quality improvement.

   - Yes, there are stages in the crop growth cycle that are more critical. Focus on lower salinity water for early germination, early period growth, setting of fruit. For tomatoes after initial growth they can take a lot more salt, but it has to be leached out of the soils. There hasn't been a lot of work done on specific periods of sensitivity and salinization process to allow their use for standard setting. Additionally there are some crops that are more sensitive, so if you have a year where there are higher levels of salt, then you should not assume everyone will plant the salt sensitive crops during that year. Editorial note: clearly relevant to annuals.

   - The 0.7 dS/m EC in the FAO was intended for use to protect irrigated agricultural in developing countries, to protect irrigators from too much salt in the water. Dischargers are regulated by Board to this number as it is embedded into regulation from the scientific community, and it is the only number that is universal that we have at this time. Dischargers, including agriculture, are regulated by the Regional Water Board. This impacts economics of agriculture as a discharger of water. We (the Regional Board) are asking for help to determine what the best approach or number should be, and this may not be the most conservative number. How do we adjust thresholds by the crop, season, drought scenario? What do we use as guidelines to determine these numbers?

   - Colorado looked at what the current levels were in the water bodies and what quality farmers were using today, and then tried to regulate water to stay at or below the current levels, and to stop degradation. Colorado Basin states must equal existing annual flow concentrations. Thresholds are developed from averages over many years. Definition of the standard is not just a numeric value, but rather a numeric value and a plan for implementation. Both the number and plan are reviewed and approved every three years.
   - In the Murray River (Australia), the standard was set at 0.9 dS/m EC annual average, as an achievable goal, and trading credits were allowed as tools to meet the standard. This annual average standard allowed trading and progressive improvement of water quality. The standard works to protect perennial crops (not annuals).

3. **The steady-state model used by Ayers and Westcot assumed standard surface applied irrigations with a 2-3 week interval between irrigations which was standard irrigation practice 40 years ago. Is the present crop tolerance data (Mass and Hoffman) applicable under present irrigation practices? How important is irrigation timing in modeling crop tolerance under field conditions? Would levels of sensitivity to salinity in applied water differ significantly for drip and microspray, relative to surface irrigated fields?**

   - Spatial (intra-field) variability is substantial, and must be considered. Perhaps it is best dealt with at the farm or management zone level. Use conservative, but not crippling (e.g., 0.7 dS/m) assumptions to allow some flexibility along with protection. Again, the marginal benefit of such a rigid, 0.7 dS/m EC standard would approach zero. You need to somehow consider soil quality (especially texture, structure, and drainage). Transient models handle this better than steady-state models, but some of the steady-state models could be enhanced to consider the system more fully. This might be more achievable for planning-level analyses. For example, precipitation's contribution to leaching, irrigation method, and water uptake decrease leading to more drainage (leaching) under saline stress and should be accurately reflected in modeling yield loss. Suarez' slides showed the effect of not taking rainfall and other critical factors into account, attached.
   - You may want to consider Letey's steady-state model as it incorporates more factors. "No drainage can meet 0.7 dS/m." If you limit discharge salinity to very low values, then this incites reduced water use efficiencies as dischargers seek to dilute (or not to concentrate) drainage to meet standard, consuming more water as they do. Modeling may be less productive than a negotiation that considers practicalities. In the real world, life is complicated.
   - Quality of the soil is important. It is important to look at the quality of the soil: is it sandy, clay, well structured, layered? Does it have a tendency to disperse?. Most models do not consider spatial and temporal variability, or irrigation timing and frequency.

4. **Most modeling of plant responses has used steady-state models for analysis. How good are the transient models? Is the amount of data needed for their analysis better suited to a smaller plot of land where the variables can be measured and recorded or can they be applied to widespread areas with variable field conditions? When data is available should CV-SALTS prefer transient models?**

   - Need to inject realism relative to a balance between interaction among salinity management, nitrate leaching, and water use efficiency (this also relates to Question 5). Transient models account for variables known to be important. Steady-state models can be modified to account for these, including consideration of some spatial and temporal variability, as well as irrigation timing/frequency. Other approaches could be considered to be equally valid as modeling conditions such as 0.5 dS/m EC above the source/natural water salinity as a limit. Alternatively, you could pick a salinity threshold two or three times natural/ambient level.

5. **Based on your practical experience, which factors are most critical for developing models for determining crop tolerance criteria under field condition present today in areas similar to the Central Valley of California and how would you suggest these be used to make regulatory decisions?**

- Practical experience: In Australia we define this experience as the fact that practical decisions dictate whether I (the farmer) am going to make a living or not? Blake Sandon, talks to farmers about how they can best farm, asking them what kind of water are you dealing with, and reminding them to look at the dirt. You need to consider the architecture of how the dirt comes together and how irrigation will water that particular field. If they are ahead of the curve, they may have time for leaching before they get nailed with warmer temperatures and water logging that can cause problems at bloom. Then focus on optimizing root zone conditions, as possible.

- SBX7-7 process mandated water use efficiency reporting by irrigation districts – setting efficiency standards for approval of allocations. Eventually water rights may be impacted, but concentrations of salinity will go up if water use is reduced.

- Australia in 2005-06 had allocations of environmental water, and regularly dropped below 60% of the expected yield. They have now adjusted the program because they are government funded programs. They recommend you "Don't make it complicated".

- Make a living. Groundwater regulation will improve use and management of water; not controlling water use makes salinity almost impossible to deal with. Water use efficiency makes the assessment and implementation more difficult. Planning must include the source of water, consider end-of-basin standards. Support efforts to promote resource sharing.