Salt Dynamics in Non-Riparian Freshwater Wetlands

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We have investigated the salinity dynamics of seasonal wetlands in the San Joaquin River basin, with an emphasis on salinity exchange with wetland soils and how different flooding strategies influence the long-term salinity of the wetlands. The role of year-over-year storage of salts in the soil column has been explored using a combination of field, laboratory and numerical analysis.

We have investigated the salinity dynamics of seasonal wetlands in the San Joaquin River basin, with an emphasis on salinity exchange with wetland soils and how different flooding strategies influence the long-term salinity of the wetlands. Over the two years of this grant, we performed both field and laboratory experiments and developed a numerical analysis to simulate the laboratory experiments.

The field data collection consisted of time series of conductivity (EC), temperature and depth at multiple locations in the wetland under study, plus velocity measurements at two locations in a channel that bisects the wetland (Figure 1). These time series spanned the entire flooded period, and were supplemented by several spatial surveys of EC and temperature collected by towing a conductivity-temperature probe on a floating raft around the wetland. Several interesting features have emerged from the analysis of this data. As would be expected, the dynamics of the wetland are dominated by wind forcing and heating and cooling at the surface. At the same time, however, the salinity dynamics are strongly influenced by management decisions involving the draw-down of the wetland (Figure 2).

Figure 1. Deployment of field instruments in Curlew Flat wetland. Graduate student Kate Huckelbridge is shown.

The laboratory experiments we performed focused on how flood-up and draw-down strategies, as well as vegetation types, affect the retention of salts in the soil column. We used four different flood-up and draw-down protocols to span the management strategies typically pursued (Table 1). In each case, the flooding and draining of the soil column was performed on multiple soil columns characterized by a range of vegetation types representative of the actual field site. Between the flood-up and draw-down stages, the water column was replaced with high EC waters to simulate the effects of evaporation in the field. Data recorded in each experiment included detailed time series of EC and temperature at three elevations in the soil-water column.

Exp	Flood-Up	Draw-Down
1	Fast (2-3 days)	Fast (2-3 days)
2	Fast (2-3 days)	Slow (10-12 days)
3	Slow (10-12 days)	Fast (2-3 days)
4	Slow (10-12 days)	Slow (10-12 days)

Table 1: Laboratory Experiment Summary

To aid in the interpretation of the laboratory results, and to extend them to an estimate of the flux of salt from the soil column into the water column, we pursued a numerical model of the soil-water columns studied in the laboratory. A one-dimensional advection-diffusion model that allows a spatially-variable diffusion to be specified was developed and driven by the laboratory observations. We found that the observations were internally consistent and the numerical calculations could easily match the observed trajectories. As a result, we used the numerical simulations to extend the observations spatially to the soil-water interface and calculate the flux of salts between the soils and the water column (Figure 3). Although many of these results are still being analyzed, it is already clear that the details of wetland flood-up and draw-down play a part in establishing the year-over-year salinity dynamics.

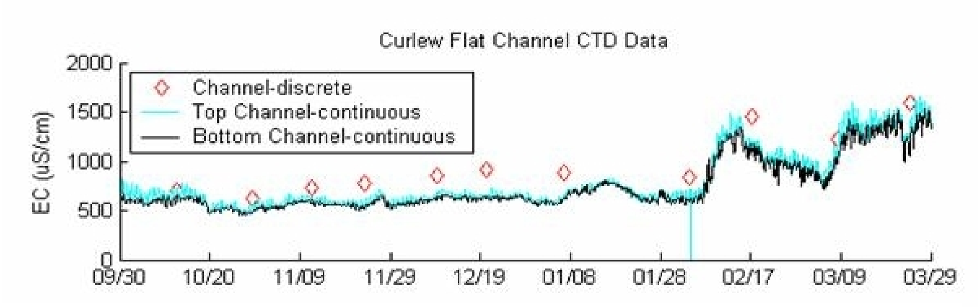

Figure 2. Seasonable variability of electrical conductivity (as surrogate for salinity) during flooded period. Increase in conductivity in early February followed a rapid draw-down of the wetland by managers.

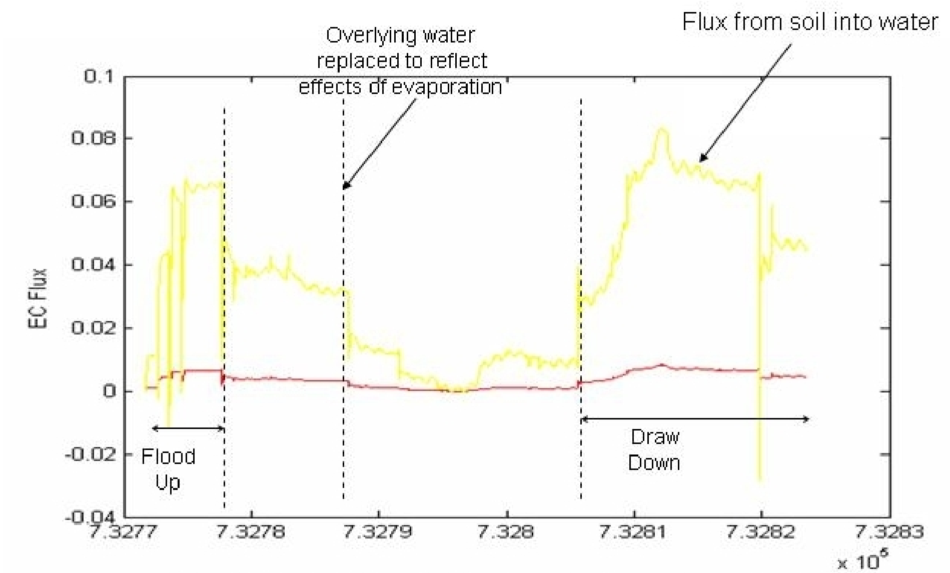

Figure 3. Numerical flux calculations based on laboratory experiment for fast flood-up, slow draw-down.

Professional Presentations

Huckelbridge, K., Salt Dynamics in Freshwater Wetlands, UC Davis, Civil & Environmental Engineering, May, 2007.

Collaborative Efforts

The PI's research group includes two PhD students pursuing research related to the restoration of wetlands on the perimeter of San Francisco Bay. Many of the properties to be restored are currently salt ponds (as in the case of the South Bay Salt Pond Restoration Project, SBSPRP). An open question for many of these activities is what role the exchange of constituents between the soil column and the water column will play in determining the state of the restoration project. In most of these cases, the flooding and drying of the area will be on the tidal timescale, which is considerably faster than the flooding and drying being analyzed in this work, but the concepts may prove to be transferable.

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