The POWER of DATA –
Sensor data-induced cultural change within the Grassland Basin

Nigel W.T. Quinn
Berkeley National Laboratory
US Bureau of Reclamation

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Early years—when not in a ditch
Early years – when not in a ditch

Some things never change – 2009
Basic premise:

- Easy to get enthralled by our technology – models, decision support systems etc.
- Can elicit a type of intellectual laziness – “thinking within the box”
- We forget the power of mental models (i.e. the instincts, perceptions built from experience and making mistakes)
- Can cause us to miss soft technology solutions to problems
- Hard to spend as much time as we should in the field with our client stakeholders
In support of my hypothesis – four anecdotes:

• Tim and the MACE flow sensor readout button
• Dave and flow QA in the Volta Cross Channel
• Grassland Water District – sensor network data visualization
• Water table elevation sensors in Panoche WD – soft police power
Grassland Ecological Area sensor network

Grasslands Bypass Project Area

Grasslands Drainage Basin
1. Tim and the MACE flow sensor readout button

- Tim – wetland water master with more than 30 years of experience. Technology skeptic. Weir stick + Myron EC tester + labrador in pickup

- Missteps during real-time sensor deployment
  - V-notch weirs
  - Metal sheds - Campbell logging systems
  - MACE sensor data processing – decimal point error
• **What we did right!**
  
  - YSI-Econet – web based data access + Google maps
  
  - YSI data interface – designed by CDFG biologist
  
  - Cycled CDFG employees to perform sensor network maintenance and QA – gained exposure to system
  
  - Public relations – provided tours of sensor network
• Tim’s new mental model
  - Push-button access to flow data
  - Interrogates system while still at home – prepare for troubleshooting and repair before go to field
  - Minimizes pond disturbance when taking flow and EC measurements
  - Has had profound impact on acceptance of sensor data among landowners
  - Happy wife
Dave and data QA in the Volta Cross Channel

- District Manager and Governmental Affairs specialist – focus on water supply
- Tolerated water quality projects – grants helped pay bills
- Saw little connection between sensor network and water acquisition and conservation activities until.....
Cross channel monitoring station
- GWD delivery from SLDMA
- Sontek acoustic Doppler sensor

Monitoring station located in north-west corner of Volta Refuge
Flow rating after installation showed discrepancy

- District slow rating showed 30% less flow than rating used by Water Authority – District being overbilled!
- District manager instantly acquired “new” water supply
- Complete change in attitude toward utility of real-time monitoring
- District manager became a vocal advocate – promoted biologist to lead District environmental program
- District found utility in real-time monitoring network for water conservation operations and planning
Grassland WD – real-time salinity management

Initial modeling approach

• Develop flood-up and drainage maps within GIS

• Develop daily water and salinity balances based on monthly WETMANSIM – wetland salinity management simulation model

• Use real-time inflow data, pond depth objective data (outflow) and weather station records to track salinity

• Calibrate against District outflow data from 5 real-time monitoring stations

• Use current pond salinity/salt load/remaining volume as basis for District drainage drawdown decisions
Grassland Water District – reservations

- Model attempting to predict conditions beyond the capability of the District to understand or measure
- Insufficient data to fully support proposed modeling
- District reluctant to appear too prominent in vanguard of real-time salinity management
- Suggested a less ambitious approach that would allow better salt load characterization and promote system understanding
- Address limitations of existing web-based sensor network
Grassland Water District – sensor data visualization

Limitations of YSI-EcoNET sensor network reporting system

• Provides data and time series plots of flow or EC for one site at a time - can’t visualize output for channels within entire district

• Can’t calculate salt load – reports only measured parameter values – no QA capability

• Provides limited support for real-time salt export decision making – can’t combine data to view daily, weekly or monthly salt exports to Mud Slough and SJR

• Inability to share portions of data with public or State and Federal refuges – all of site is either public or private (username and password protected)
Soft police power - water table elevation sensors in Panoche WD

- Grassland Bypass Project sets monthly and annual limits on selenium loading to Mud Slough (and SJR)
- Complexity and heterogeneity of system beyond model decision support capabilities
- Selenium loading not well correlated with salinity. Selenium monitoring expensive – analyzed in Lab.
- Policy decision – ensure equitable selenium load allocation among six participating water districts
Drainage sump pumps in Panoche Water District
Simulated water table depth monitor
Data-driven selenium load management system

- Panoche Water District assumed responsibility for GBP subarea
- Installed totalizing meters and EC monitors at every drainage sump discharge – data downloaded weekly
- Developed flow - selenium load relationship for each sump
- District-level drainage reuse system developed
- Installed color-banded water table elevation monitors visible from the road in each tile drained field
Program results

• Grassland Bypass Project – highly effective. Project has met all monthly and annual selenium load objectives for past 13 years
• Water table color-banded monitors effective in improving selenium load management
• Simple accounting system used to forecast end-of month totals and determine percent of selenium load reused
• Internal police power has allowed adaptive approach that improved selenium load management capability over time
Summary

• Models don’t always provide the best decision support solution
• However our clients may need help developing the “mental” model of their own decision space to arrive at a solution
• Four instances have been described where data, signature events and modeling alternatives have provided cost effective environmental decision support and changed attitudes
• We need to be adaptive, listen to our clients and be willing to think “outside the box”