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Recovery of salt contaminated soils using halophytic plants for sustainable agriculture and water resources

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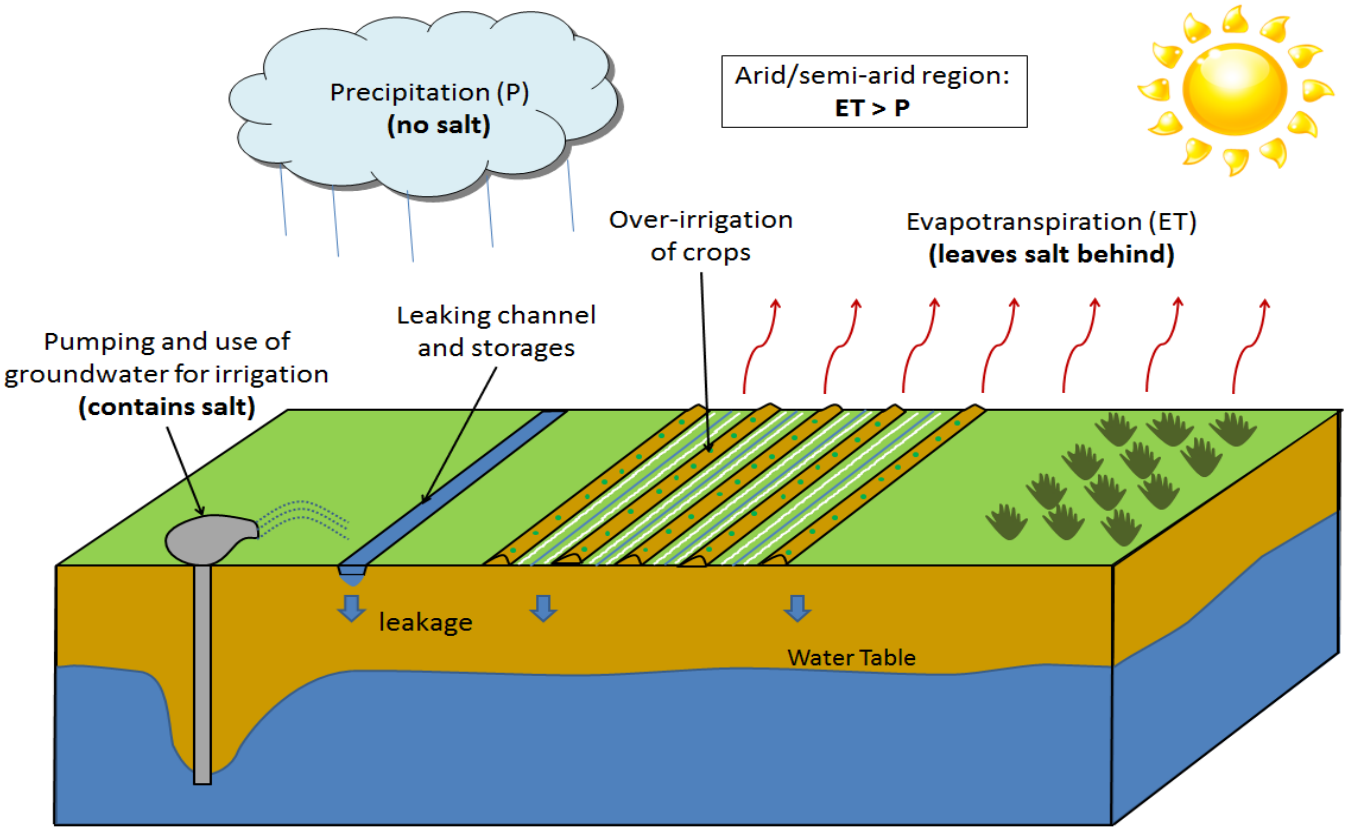
The Problem

- Human-induced
- Evaporation of saline irrigation water
- Leaching is a temporary solution



Adapted from De Oliveira et al. (2013)

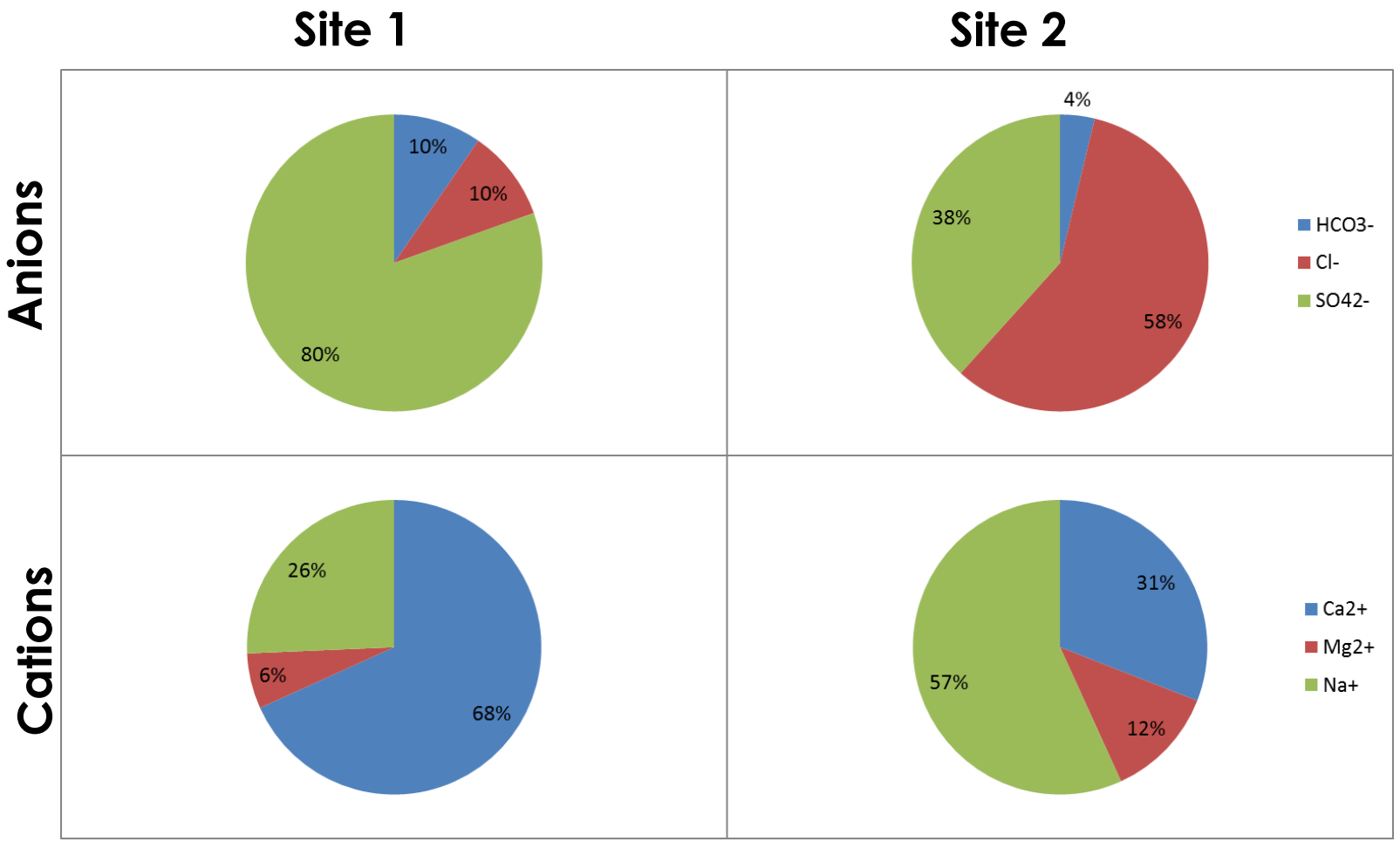
The Idea

- Big Idea: Cultivate halophytes
  - Human consumption
  - Animal consumption
  - Biofuel
  - Soil salt maintenance/reduction
- First Step: Develop a model
  - Model halophytes
  - Track salinity
  - Different management techniques

PEER Project Field Sites

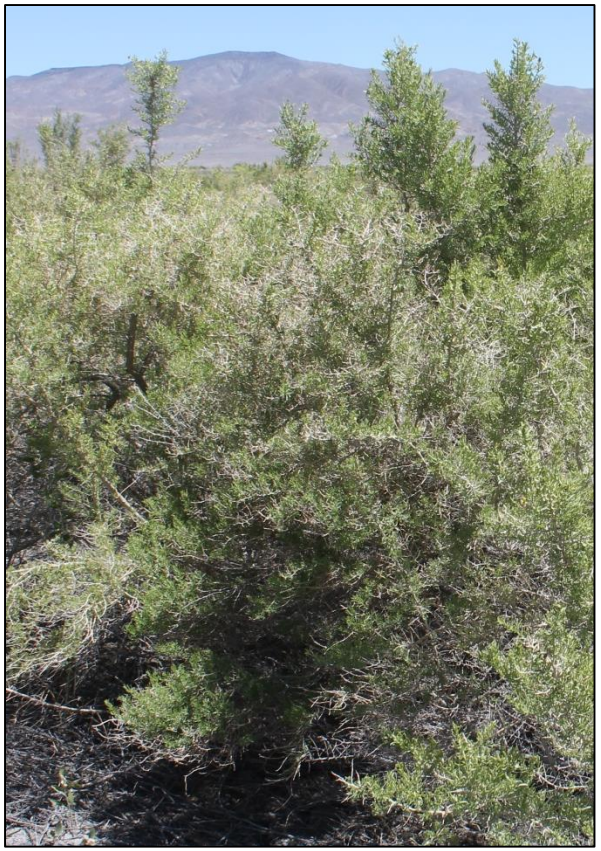
https://www.cia.gov/library/publications/the-world-factbook/geos/uz.html

Anion-Cation Soil Comparison



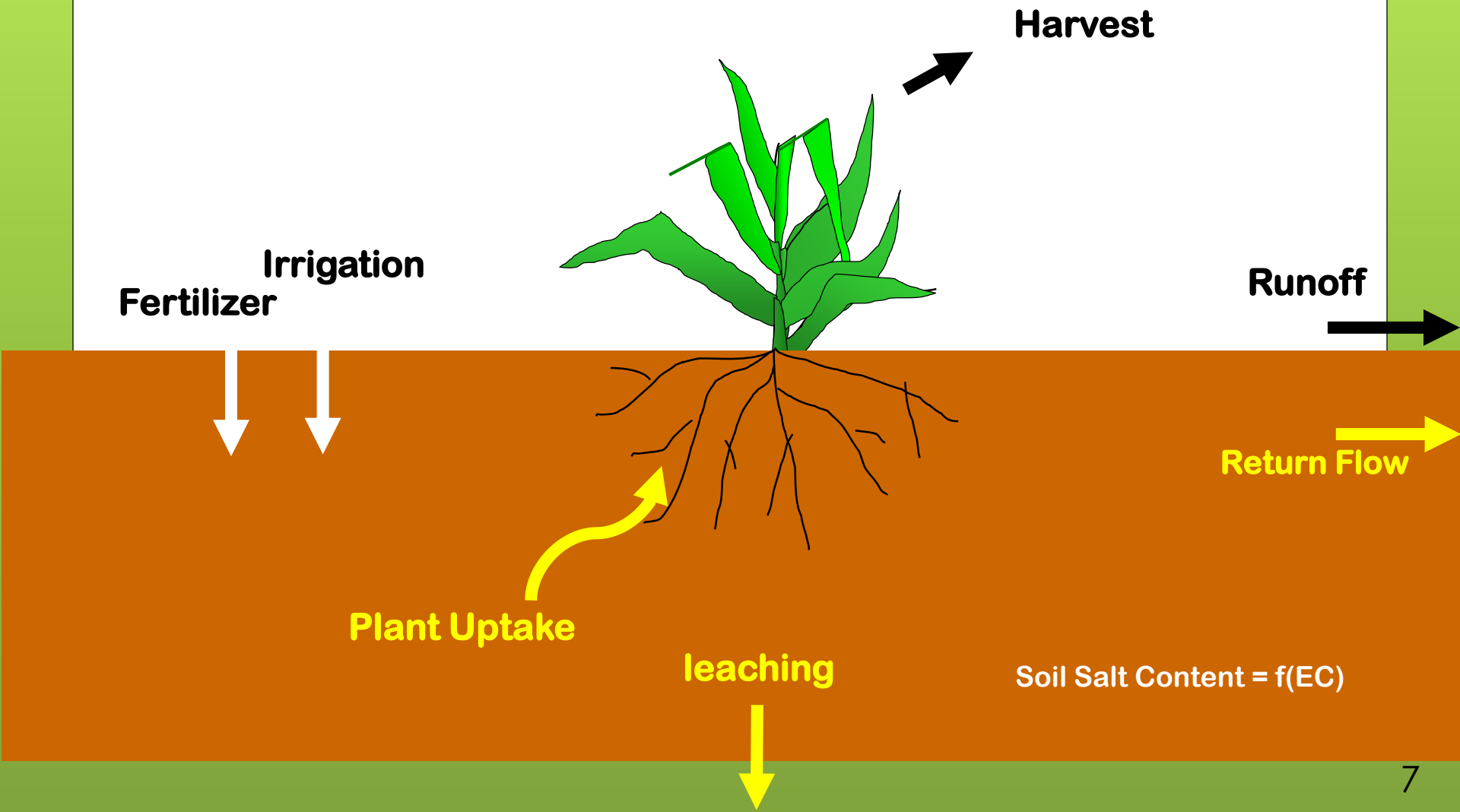
Model Selection

- Mechanistic
- Field scale
- Multi-year
- Irrigated crop growth
- Crop production
- Harvesting
- Distinguish ions



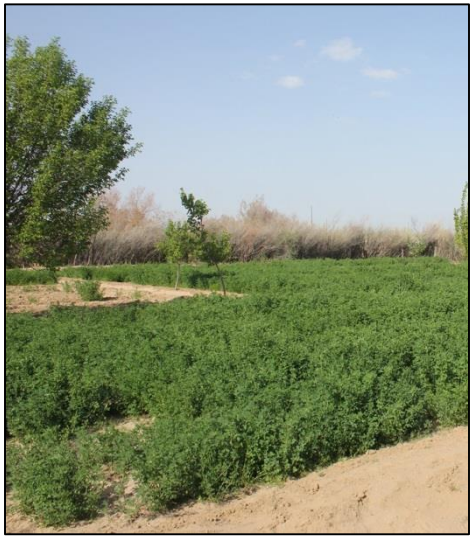
→ **APEX model**

Salinity Module in APEX



Chosen Plants

Climacoptera lanata



Alfalfa

Salicornia europaea

Atriplex nitens

Management File

Management for *A. nitens* and *C. lanata*

- *S. europeae* was not irrigated or fertilized
- Alfalfa continued same management for 10 years

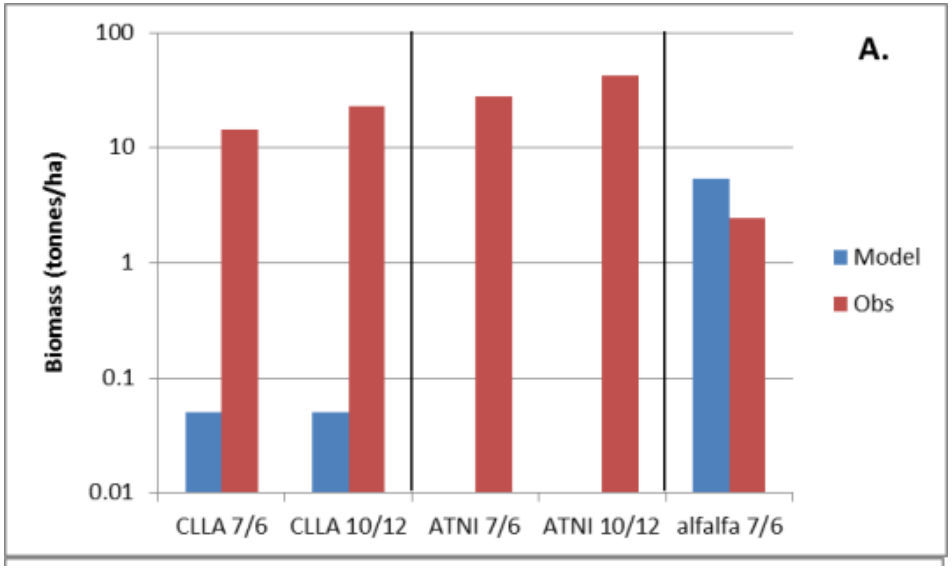
Management	Operation	Date applied	Type applied	Rate
Irrigate	Irrigation, furrow, gated pipe, 75% efficiency*	3/1/2013*		86mm
Plant	Handsowing (custom)	3/22/2013		
Irrigate	Irrigation, furrow, gated pipe, 75% efficiency*	4/1/2013*		86mm
Fertilize		5/29/2013	N_{15}:P_6:K_6	80kg/ha
Irrigate	Irrigation, furrow, gated pipe, 75% efficiency*	6/1/2013*		86mm
Fertilize		7/15/2013	N_{15}:P_6:K_6	100kg/ha
Irrigate	Irrigation, furrow, gated pipe, 75% efficiency*	9/1/2013*		86mm
Harvest	Handharvest (custom)	9/10/2013		
Kill	Kill (stop growing plant permanently)	12/30/2013		

*not recorded, best estimation

Calibration

- Randomly varied sensitive parameters 500 times for each site
  - Ranges constrained to sensitive range
- RMSE, R^2, and %bias calculated for metrics
  - Biomass
  - Soil EC
  - Crop height
- "Best fit" models determined for each metric and best overall
- Dotty plots created to look at relationship between parameter values and RMSE

Best Fit Model Results - Biomass

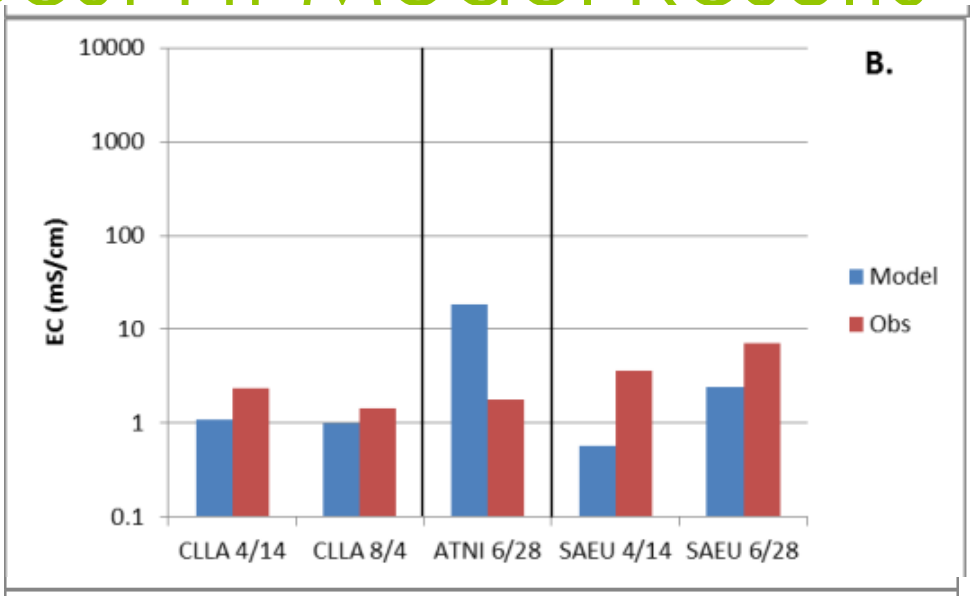


- RMSE = 23.02 tonnes/ha
- % bias = -53%
- N = 5

CLLA = *Climacoptera lanata*
ATNI = *Atriplex nitens*

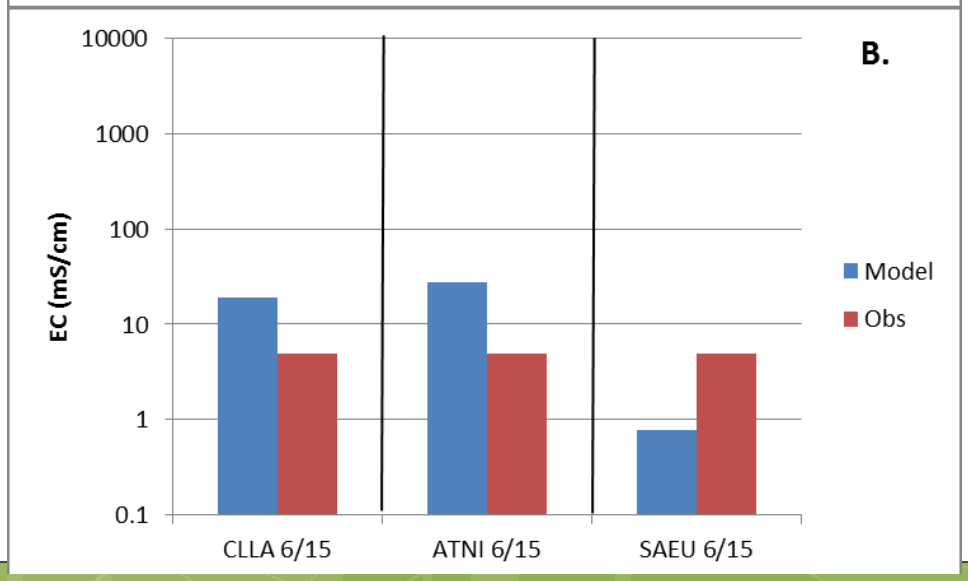
Best Fit Model Results – Soil EC

Kyzylkezek



- RMSE = 4.01 mS/cm
- % bias = -29%
- N = 11

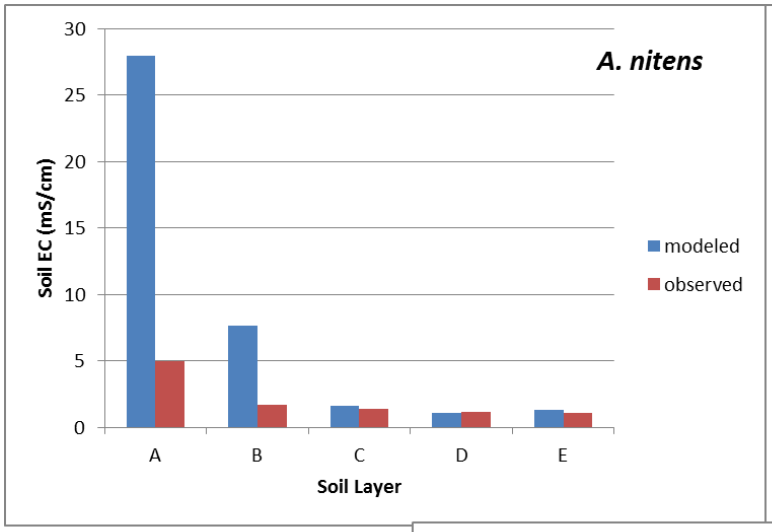
Khorezm

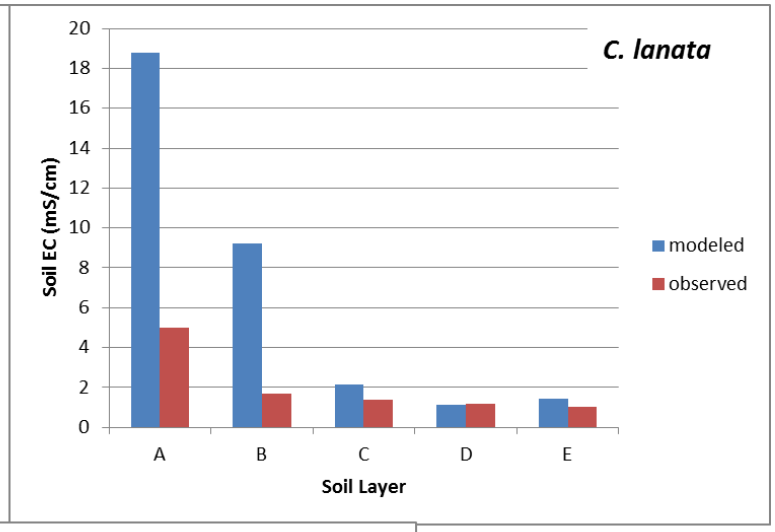


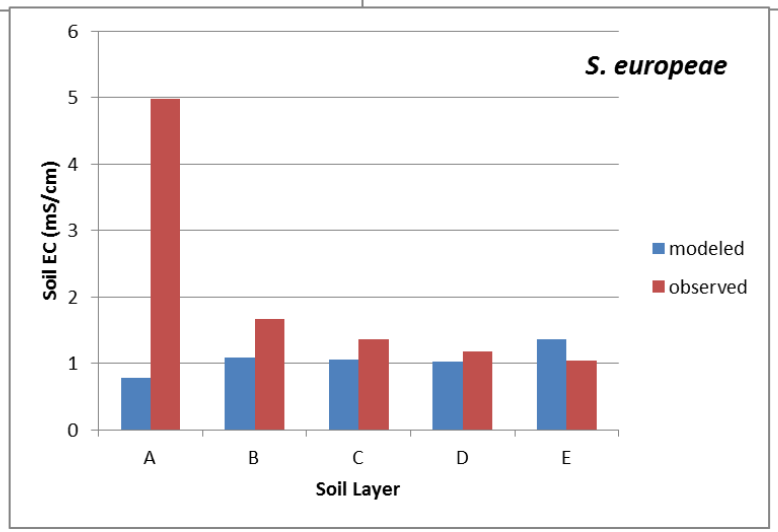
- RMSE = 7.11 mS/cm
- % bias = 155%
- N =11

CLLA = *Climacoptera lanata*
ATNI = *Atriplex nitens*
SAEU = *Salicornia europeae*

Soil Salinity (Khorezm)







Soil Layers
A: 0 – 20 cm
B: 20 – 40 cm
C: 40 – 60 cm
D: 60 – 80 cm
E: 80 – 100 cm

Conclusions

- Halophytes have promise to help with salinity management in irrigated agriculture
- APEX salinity module needs further refinement
- More field data are needed
- Check all APEX variables for sensitivity
- Model needs to be improved before it is adequate to assess the potential of halophytic plants

Acknowledgements

- Nevada Agricultural Experiment Station for Hatch grant
- NSF-USAID PEER funding for field research

Next step..

- A proposal entitled "Using halophytic plants to improve food security in irrigated arid and semi-arid ecosystems" has been submitted to USDA-NIFA Agricultural and Food Research Initiative Program