Characterization of Shrubland-Atmosphere Interactions Through Use of the Eddy Covariance Method, Distributed Footprint Sampling, and Imagery from UAV's

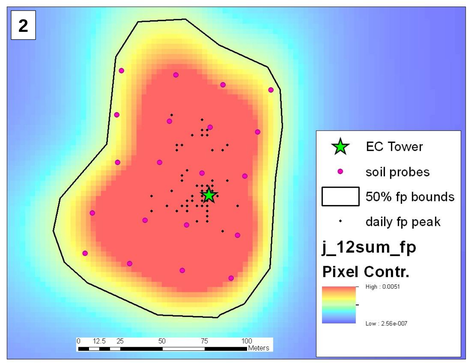
Cody Anderson[1], Enrique Vivoni[1], Albert Rango[2]
[1]Arizona State University SSEBE, [2]USDA-ARS Jornada Experimental Range

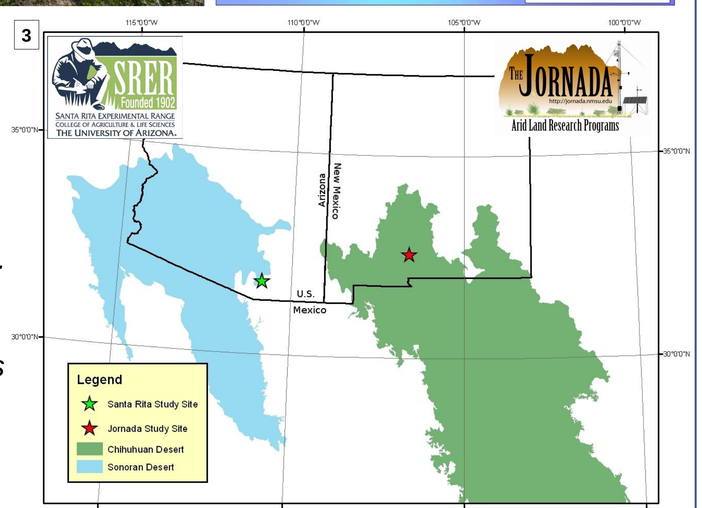
Professionals Dedicated To Arizona's Water

Background & Motivation:

- Eddy covariance (EC) tower: common scientific tool to measure ecosystem-scale evapotranspiration (ET) fluxes.
- Purpose of EC: connect land surface states with atmospheric fluxes.
- Traditional approach: use one soil moisture probe location and assume it represents EC footprint state.
- Problem: is this assumption reasonable in heterogeneous terrains (such as in the southwestern U.S.)?
- Goal of study: improve the implementation of the EC method, inform the EC results of previous studies, better model semiarid ecosystems for prediction of future land cover regimes and their consequent effects on water resources.

Experimental Design:

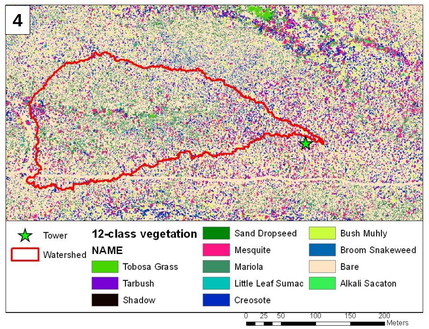


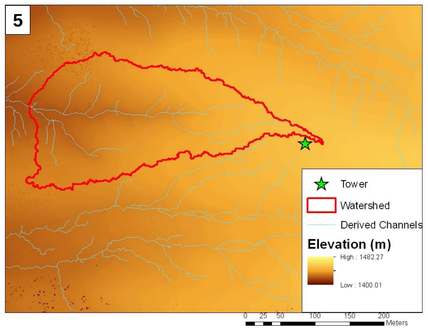


Figures: [1] Photograph of EC tower (background) and soil moisture transect (foreground) in field. [2] EC footprint for Summer 2012 with instrument locations [3] Geographical locations of the two study sites.

Environment characterization:

- Both sites are in semiarid shrublands that are typical of the Southwest's highly variable land cover and meteorological conditions.
- Dense sensor network allows for continuous measurements of rainfall, evapotranspiration, runoff, soil moisture storage, and energy components.
- UAV flights provide high-resolution (~10 cm) imagery, digital elevation models, and vegetation classifications.

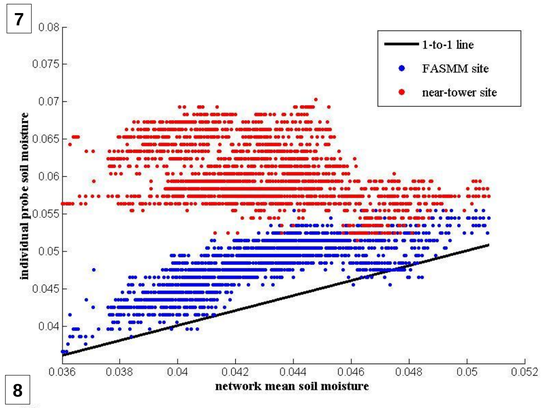




Figures: [4] 12-class land cover and [5] 10-cm digital elevation model maps derived from UAV flight in Summer 2011

Initial Findings (data since Dec '12):

- We begin to see heterogeneity within the footprint soil moisture (S) field. Larger differences are expected in the monsoon season.
- S fluctuations are greatest at 5 cm depth, especially on bare and grassy plots. Deeper soil is consistently dry.
- The near-tower moisture probe poorly represents the behavior of the probe network mean.
- Compared with the single-probe approach, the tower-view S (product of footprint and kriged soil moisture field) shows a slightly stronger connection to the daily change in S.



Figures: [6] Time series of S at 3 depths under different vegetation classes. [7] Single probe S vs. network mean S for site nearest tower and FASMM site. [8] ET vs. ΔS for site nearest tower and tower-viewed S