A coupled food-energy-water model for the Phoenix AMA

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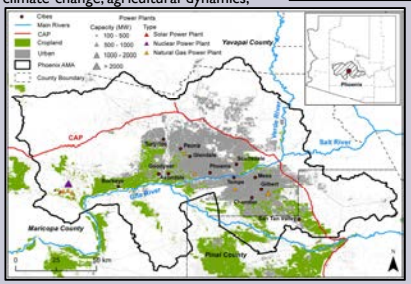
Project Design

- The food-energy-water (FEW) sectors (as networked material and energy flows) co-occur in the urban metabolism system (UM) along with 1) Governance networks, 2) Urban infrastructure and form, and 3) Socio-Economic drivers. This holistic representation of the FEW system provides a robust conceptual model
- Our team will focus on the FEW nexus as influenced by climate change, agricultural dynamics, growth, and the role of governance in the Phoenix Active Management Area (AMA)
- We are developing a FEW framework: a user interface & visualization tool coupled to a FEW model:
  - WEAP (plus MABIA)
  - LEAP
  - Statistical Crop Model (SCM)
- Scenarios (a few):
  - Cropping patterns, extent, & water use
  - Δ energy sectors and the impact on farming
  - Urban water dynamics, and population growth and efficiencies: regional water use



Software

Python.org
python
JavaScript
Octoparse.com

WEAP and LEAP:
Stockholm Environmental Institute

Simulations/ Analyses conducted for this poster

What We Simulated

AMA Agriculture
- 12 Irrigation Districts (ID)
- 14 Crops
- Ten years (calibration period)

Outputs We Examined

Agricultural Water
- Groundwater Pumped
- Crop Transpiration

Agricultural Energy Use
- Energy Used in Pumping

Empirical Data: Crops
- Relative Area and Value

Modeled Crops: Irrigation District Level

Crops
Alfalfa-hay
Alfalfa-haylage
Barley
Corn-grain
Corn-silage
Cotton
Durum Wheat
Other-hay
Potatoes
Sorghum-grain
Sorghum-silage
Sugarbeets
Vegetables/Fruit
Winter Wheat

Research Directions

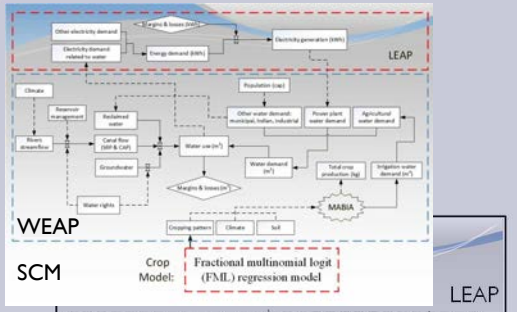
(1) We are using two off-the-shelf programs and one statistical model to create a credible, integrated model that captures the metropolitan-scale FEW interactions.

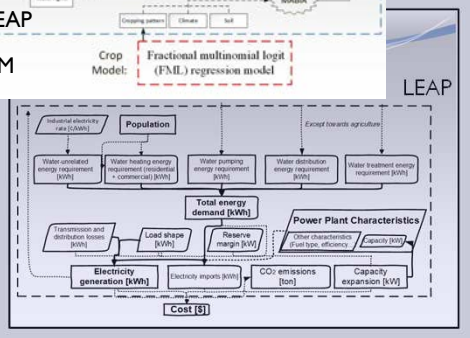
(2) We will explore the notion that integrative modeling can improve governance across food, energy, and water sectors.

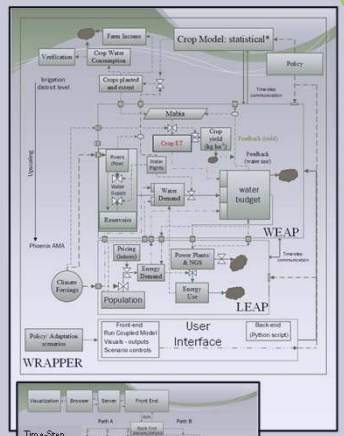
(3) Human-computer-interactions along with alternative visualizations will assess what technologies can best support sense making when analyzing the FEW nexus.

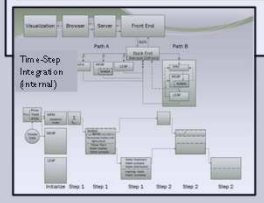
(4) The potential role of climate change impacts on land shares under different crops in the Phoenix metropolitan region will be examined.

Conceptual Models





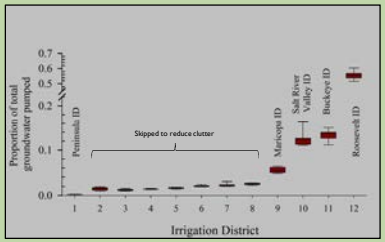




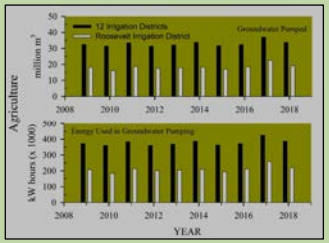
Preliminary Results & Discussion

Simulated

Groundwater Pumped by ID

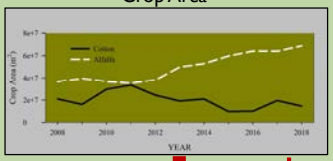


Water & Energy Pumped/ Used

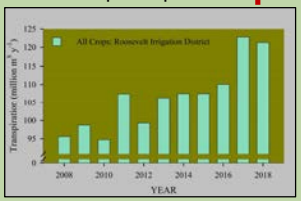


Roosevelt Irrigation District

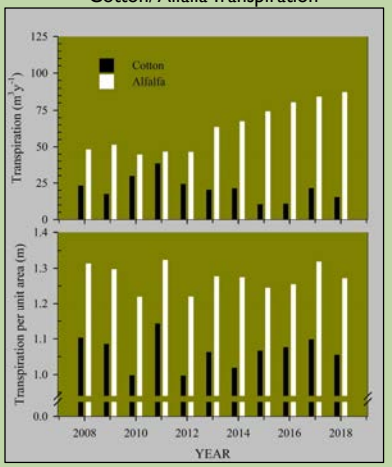
Crop Area



Crop Transpiration

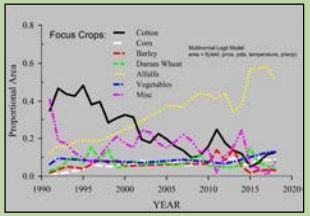


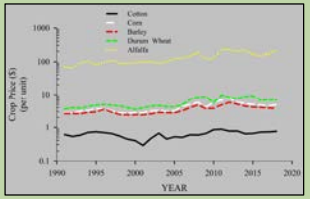
Cotton/ Alfalfa Transpiration



Empirical

"Modeled" Crops-AMA Level*





*Available Empirical Data

Discussion

1) Four irrigation districts dominate the AMA (for groundwater): Roosevelt ID
2) Cotton plantings are declining
3) Alfalfa plantings are increasing
4) In general, increased transpiration rates across all crops (dominated by alfalfa)
5) Differences in the transpiration rate per unit area between cotton and alfalfa
6) Alfalfa uses more water on a per unit basis
7) We will conduct scenarios to look at various policies/ management (such as cropping patterns and water use)

Acknowledgment

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Publications

Guan, Xin, Giuseppe Mascaro, David Sampson, Ross Maciejewski 2019.A Metropolitan Scale Water Management Analysis of the Food-Energy-Water Nexus.Accepted: Science of the Total Environment, 701, 20 January 2020, 134478.

Mounir, A., G. Mascaro, D.D.White. A metropolitan scale analysis of the impacts of future electricity mix alternatives on the water-energy nexus. Appl. Energy, 256 (2019), Article 113870, 10.1016/j.apenergy.2019.113870