Long-term Patterns in Land Use and Soil Properties across the CAP LTER Ecosystem

Becky A. Ball[1], Sharon J. Hall[2], Hannah Heavenrich[2], Julie Ripplinger[2,3,4]

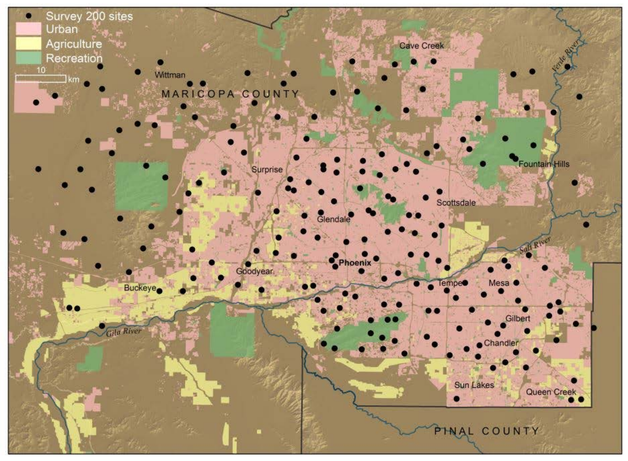
[1]School of Mathematical and Natural Sciences, Arizona State University – West Campus, Phoenix, AZ 85069; [2]School of Life Sciences, Arizona State University, Tempe, AZ 85287; [3]School of Geographical Sciences and Urban Planning, Arizona State University, Tempe, AZ 85287, [4]Department of Botany and Plant Sciences, University of California - Riverside, Riverside, CA 92507

Introduction:

- The Ecological Survey of Central Arizona (ESCA, née Survey 200) explores how soil properties and plant communities differ across land uses and socioeconomic indices in the CAP LTER ecosystem.
- Previous data show that urban, agricultural, and desert sites differ in soil nutrient content, black carbon, heavy metals, organic matter, and moisture, reflecting enhanced inputs under agricultural and urban land uses.
- Enhanced nutrient and irrigation inputs in urban and agricultural areas will alter important ecosystem processes such as rates of soil nutrient turnover and transformations.
- However, no studies have yet explored the rate of change in soil properties through time in this system, or linked long-term changes in soil properties to plant communities and climate.
- It is likely that changes in climate, plant community diversity, and land use over the last 15 years will have significant impacts on soil properties in the CAP LTER ecosystem.

Methods:

Sites: The ESCA inventory is conducted every 5 years at ~204 randomly located 30m x 30m plots using a probability based design.



Land use: From the original data, we reclassified sites as agricultural (active or fallow), desert, residential (with mesic, oasis, or xeric landscaping), urban and institutional, golf courses/parks, and vacant.

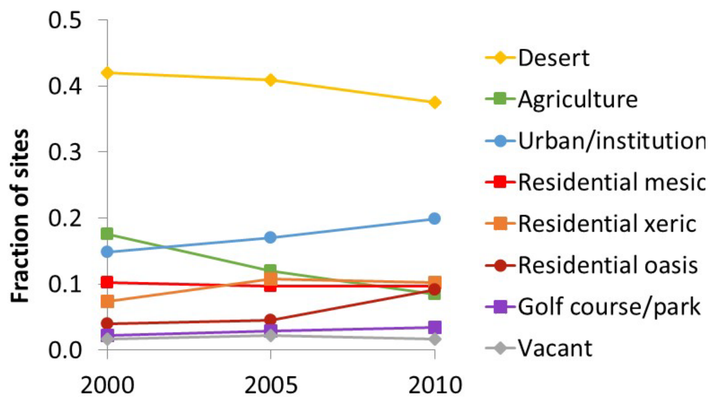
Soil properties: In 2000, 2005, and 2010 soil cores (0-30 cm) were collected from several locations in each plot and bulked into one composite per plot. Soils were analyzed for moisture, conductivity, inorganic N and P concentrations, pH, texture, and organic matter (SOM) using standard LTER protocols.

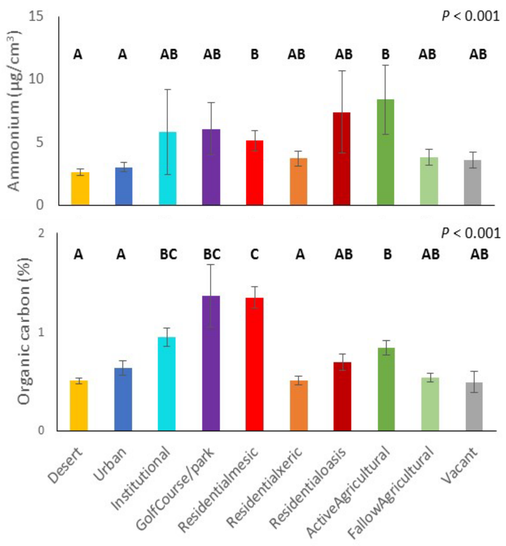
Research Questions and Hypotheses:

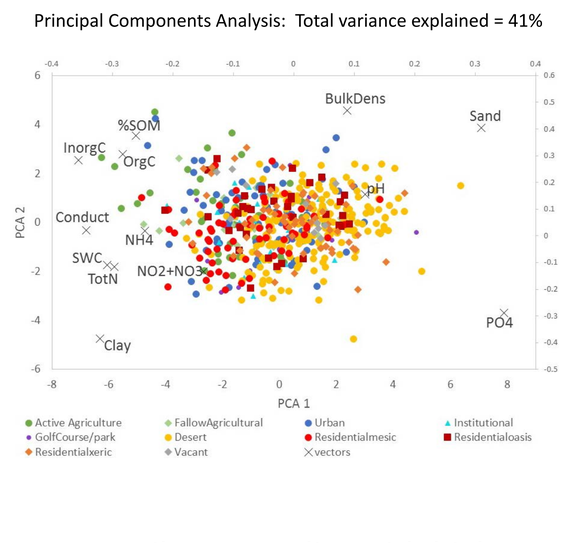
- How do soil physical properties and soil chemistry change over time across different land uses in the CAP LTER ecosystem?
- We hypothesize that nutrient content of agricultural and urban soils will exhibit high temporal variability between the three survey years compared to unmanaged desert soils, reflecting shifts in human decisions about land management.

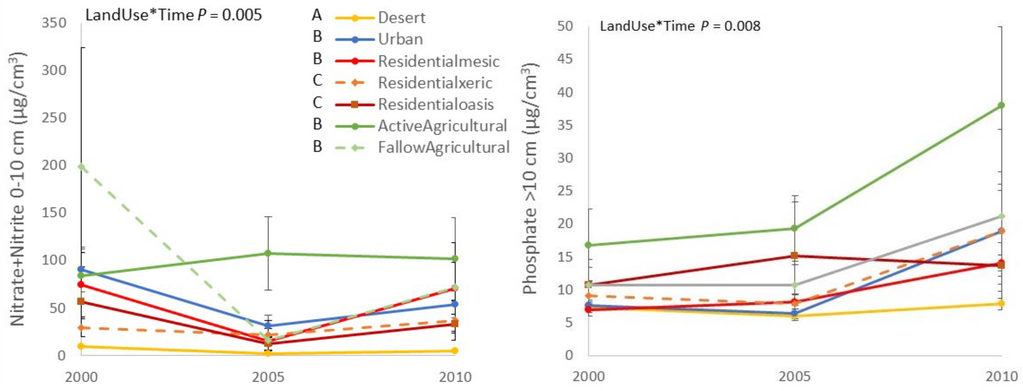
Initial Results and Discussion:

Since 2000, metro Phoenix has lost desert and agricultural land, while urban and residential land uses (xeric and oasis) have increased.







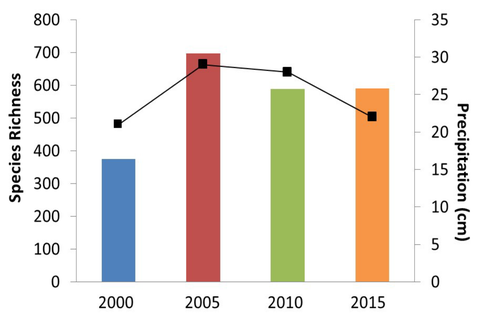


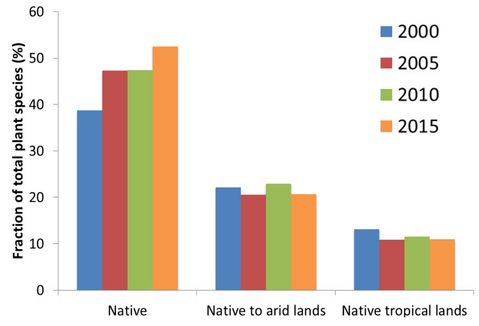
Soil nitrate and phosphate changed over time in some land uses but not others. These data support our hypothesis that soil properties in desert lands vary less over time compared to managed ecosystems that experience human decision-making.

Soil properties also differed across land use types, and most changed over time.

Desert soils are sandier with higher pH and PO_4 (right on PC1) while agricultural soils are higher in soil N, moisture, and C (left on PC1).

Notably, plant communities have also shifted since 2000.





Conclusions:

Land use and land cover has a significant impact on all of the measured soil properties, suggesting that the replacement of desert and agriculture by urban and residential land covers since 2000 is associated with fundamental changes in the biophysical functioning of the CAP LTER ecosystem. However, land use alone does not explain all of the variation in soil properties, and we will next explore the relationship between soil properties, land use, and vegetation communities that have also shifted since 2000.

Acknowledgements: This material is based upon work supported by the National Science Foundation under grant number DEB-1026865, CAP LTER. We thank the team of field technicians and analytical chemists at the Goldwater Environmental Lab for their efforts to collect and process samples, the Information Management team for data archiving, and the efforts of Mechell Frazier to collect and document data.