SPATIAL PATTERNS OF SOIL ORGANIC MATTER IN CENTRAL ARIZONA

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Abstract

Soil organic matter (SOM) measurements were obtained from 200 sampling sites in central Arizona. The samples were distributed in a spatially stratified random design that encompassed an area of 6387 km^2. The study area includes the urbanized, suburbanized, and agricultural areas of metropolitan Phoenix and the surrounding native desert ecosystem. The objective of this study was to determine the spatial pattern of SOM content and then to scale-up the point measurements to generate a regional SOM estimate. We hypothesized that land cover would be an important factor explaining the variability of SOM content. In addition, we also hypothesized that the multiple stressors associated with urbanization would be manifested as an urban to wildland gradient in SOM content. Three alternative methods will be used to estimate regional SOM content. 1) We will use regression analysis to predict SOM content as a function of other spatially distributed variables. 2) We will estimate a patch specific SOM content by overlaying a classified TM satellite image with the sample locations, and generated a regional estimate by integrating field measures with remotely sensed data. 3) We will identified spatial correlations in the data and then interpolated with a Kriging algorithm. Preliminary results showed that patch type alone was not an adequate predictor of SOM content. A significant ($p<.05$) second-order spatial trend in SOM content was observed centered on the urbanized region. Understanding SOM patterns is a necessary first step in understanding the biogeochemical controls in this region.

Soil Organic Matter in Urban Ecosystems

Soil Organic Matter (SOM) is an important component of terrestrial ecosystems. Energy for microbial and decomposer organisms as well as nutrients, such as nitrogen and phosphorus, are stored within the pool of SOM. Understanding the patterns and dynamics of SOM provides critical information on many different ecosystem functions including nutrient cycling, loss, and accumulation rates, and productivity. Urbanization can impact SOM content through various processes including land cover change, nutrient and water changes, and disturbance regime changes. It is the purpose of this study to understand the patterns and the controls of SOM in the greater Phoenix, AZ region.

OBJECTIVES

Understanding the Pattern

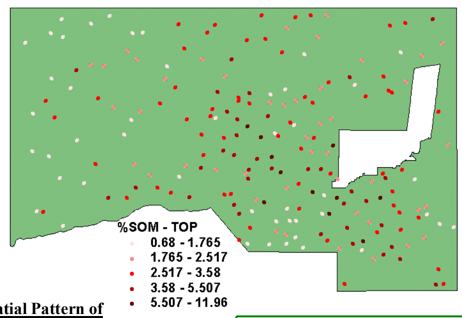
- Is there a 'linear' or concentric decrease in SOM away from the urban center? If so, is this the same in every direction?
- Is there some distance from the urban center beyond which there are no discernible changes in SOM? If so, does this correspond with previous findings on landscape pattern and patch size?
- Which variable(s) best explain any pattern/variation in SOM?
- Is the human created discrete patch structure evident in SOM?

Extrapolation to CAP Study Area

- What is the total SOM?
- What is the spatial pattern of SOM?
- What are the stores of carbon in the various patch types?

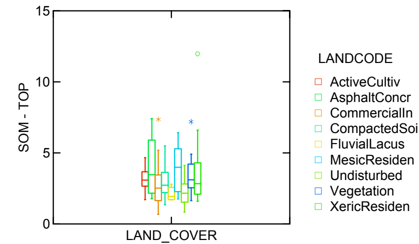
DATABASE

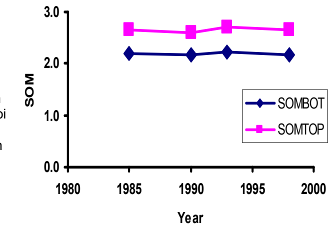
- Spatially Explicit SOM Samples
  Soil cores from the 200 Point Sampling Program were analyzed for SOM and other ecological variables.
- Satellite Remote Sensing Data
  Thematic Mapper satellite data has been obtained from 1985 through the present at regular intervals. These data have been processed to generate both land cover and vegetation patterns.
- Other GIS Data
  Additional GIS data from various sources will also be used. These include topographic, ecological, geological, and sociological data layers.



Spatial Pattern of Sampled SOM

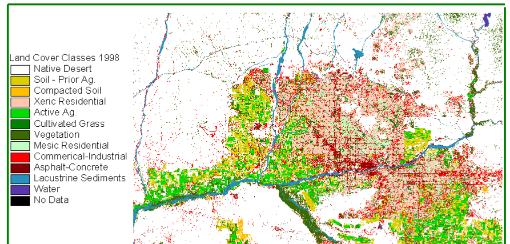
A randomized spatial stratification sampling design was generated to locate the sample points. This figure shows the spatial pattern of SOM from the top 10cm of soil cores at each sample location. Evident here is the increased levels of SOM in the center of the study area compared to the outside of the study region. This is further corroborated by a significant ($p<0.05$) second order spatial trend (hyperbolic function) in the data.

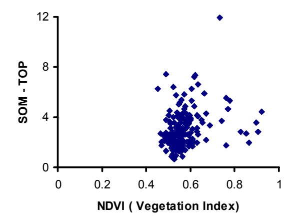


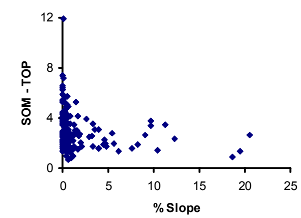


Patch specific SOM contents can be derived by identifying the land cove at each sample point by geographic overlays of the sample locations and land cover map (above left - Box Plot of distribution within each land use class). This can then be extrapolated to generate current and historical estimate of regional SOM content. Future work will be directed at reducing the unaccounted for variance within land cover classes.

Correlations between a satellite derived vegetation index (below left) and topography can be similarly obtained with geographic overlays of data. While no easily apparent relationship between SOM and the vegetation index is observed, a complex relationship between SOM and slope can be identified.





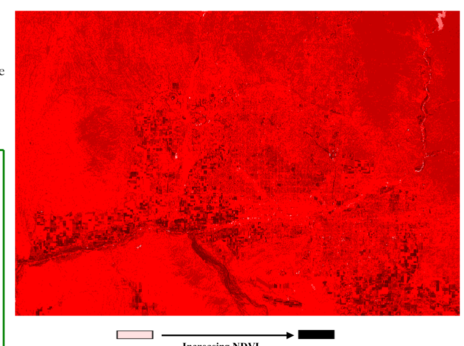


Spatial Pattern of Satellite Derived Potential Correlates of SOM

Land cover patterns (above) and vegetation index (right) are two data sets that are hypothesized to correlate with SOM. Because of their spatial coverage, better regional estimates of SOM can be generated by extrapolating the relationship between SOM and these variables.

Sampling for the 200 Point Project

Field crews located each sample point with a geographic positioning system (GPS) and sampled for a suite of ecological variables. Soil cores were taken and the top (0-10 cm) and bottom (10-30cm). SOM was estimated through loss-on-ignition at 550° C. Independent tests showed that inorganic carbon was not released at this temperature.



Conclusions

- The spatial patterns of SOM suggest that urbanization increases the SOM content in this region. SOM content is generally greater in the center of the study region.
- However, the human generated patch structure as observed in classified remotely sensed imagery does not seem to reflect distinct classes of SOM. The variance within each patch type is similar to the variance between patch types.
- SOM maybe related to environmental variables such as vegetation and topography in complicated ways. Simple relationships between SOM and these other variables do not exist for the study site. However, within particular patch types these relationships might become stronger.
- By generating a more robust understanding of SOM, mechanistic ecosystem models can be developed to simulate alternative landscape configurations.

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