Abstract

How does soil heterogeneity vary throughout the CAP-LTER region? To address this question we intensively sampled six patches, two agricultural, two native desert sites. At each patch, we used a dual-density spatially-stratified design covering an extent of 6400 m² and a minimum grain size of 5 m. At each sampling location we extracted a soil core (10cm depth) and determined its location using laser-based surveying. We analyzed each soil core to determine a suite of physical and biogeochemical variables including: mass of rock material, bulk density, water content, topography, and soil organic matter (OM), total nitrogen and stable isotope nitrogen ratios. We analyzed these data to assess three specific questions: 1) Are the means of each variable different between patches? 2) Are the variances of each variable different between patches? 3) Does the range of spatial dependency for each variable differ between patches? We discuss the answers to these questions as they pertain to scaling between individual patches and the Phoenix, AZ metropolitan region.

Research Questions

Are the pool sizes of physical and biological variables different between patches? Does the variation of physical and biological pool sizes vary between patches? Does the spatial pattern of physical and biological pool sizes vary between patches? How does the patch heterogeneity scale-up to the Phoenix, AZ metropolitan region?

Methods

An 8km² sampling grid was established in six patches.

The sampling grid was surveyed using a Total Station. A digital elevation model was constructed from the survey points and topographic variables, elevation and slope, were estimated.

Approximately 80 soil cores (10cm depth) were extracted from each sampling location. Soils were dried and stored. Soil samples were analyzed for the following: Soil Water Rock Content Soil Organic Matter Total Nitrogen Nitrogen Stable Isotope Ratios

Differences between mean values (ANOVA) and coefficients of variation (bootstrapping) were assessed.

Patch type differences were scaled to the entire Phoenix, AZ metropolitan region to estimate the net effect of urbanization on soil properties.

Patch Descriptions

Two Native Desert Patches
We sampled a patch within the urbanized core (Des1) and adjacent to the extent of urbanization (Des2) to characterize the soil properties of desert patch types. Des1 N = 94; Des2 N = 97.

Two Agricultural Patches
We sampled an alfalfa field (Af1) and a cotton field (Cot) to characterize the soil properties of agricultural fields. Both sites are located in the East valley. Alf N = 60; Cot N = 72.

Two Mesic Grass Patches
We sampled grass patches of urban parks to characterize the soil properties of mesic patch types. Mes1 was a old park (>30 years) in a lower income neighborhood. Mes2 was a new park (<5 years) in an upper income neighborhood. Mes1 N = 97; Mes2 N = 78.

Mean Differences For Physical and Biological Variables Between Different Patches

We computed the mean and standard error of all samples from each patch. Differences between patches were estimated using an ANOVA (p<0.05) with Bonferroni post-hoc tests; letters indicate significantly different groups.

Spatial Correlation of Physical and Biological Variables in Each Patch

We modeled semi-variogram patterns to estimate the strength of spatial dependence (1-Hugget/Sk), the range of spatial dependence, and the fit of the model to the data (0.0 = perfect agreement).

Coefficient of Variation Differences For Physical and Biological Variables Between Different Patches

We used bootstrapping to estimate 95% confidence intervals and to examine for differences (p<0.05; Bonferroni correction used for each variable) between sites of the coefficients of variation for each variable; letters indicate significantly different groups. For each analyst 100,000 bootstrapped samples were obtained.

Conclusions

1) The patches differ markedly in the mean, coefficients of variation, and spatial pattern for physical and biological variables.

2) There were similarities between patches of the same land use type. The desert patches had the least variable matter and nitrogen, but were the most variable. For many variables, mesic yards were similar to agricultural fields.

3) Urbanization has dramatically altered regional pools and patterns of variability in the Phoenix metropolitan area.

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