Soil Suitability at the Arnold Arboretum

Overview
The Arnold Arboretum in Jamaica Plain, MA, cultivates a diverse range of plant species. Researchers recently collected data on over 100 soil properties. The goal of my project was to create a measurement of relative soil health using the following soil characteristics: nitrate concentration, pH, cation exchange capacity, organic matter fraction, phosphorus concentration, and potassium concentration. Additionally, comparing the maps shows which property is responsible for a plot's high or low score and can help determine what remediation effort would increase its suitability.

Methodology
I turned polygon data into raster layers and then used raster calculators, shown in the model builder below, to modify and combine the soil characteristics into several different health scores. Each raw data raster was modified by raster calculator into a measurement of how far each property was from the ideal amount. These “deficit” raster layers rate the soil plots from 0 to -1 with a calculation of: 
\[ \text{Deficit} = \left| \frac{X - X_{\text{ideal}}}{X_{\text{ideal}}} \right| \]
The health score maps to the right were created with different methods of weighting and combining the six properties into a single health score.

Discussion
Both the raw data maps and the combined health scores show that low nitrate concentrations and low pH values are the most influential negative factors on the final health scores. The differences between the different health score calculations show that the soil suitability for plant growth varies greatly by the requirements of the plant species. The algorithm for the score can be modified to be more accurate by prioritizing the most important needs of a particular species, the way that Score 2 is modified for a nitrogen-intensive species or Score 3 is modified for a pH-sensitive species.

Data Sources

Arnold Arboretum. Arnold Arboretum Office of the Curator of Living Collections. 125 Arborway, Boston, MA 02130-3500

Projection: NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001_Feet

Scores:

Score 1: Simple Additive Score
\[(DN + DP + DK) + DpH + DOrg = \text{Score}\]

Score 2: Double Nitrate Score
\[2*DN + DP + DK + DpH + DOrg = \text{Score}\]

Score 3: Low-pH Exclusive
\[(DN + DP + DK + DpH + DOrg) * (2 - DpH) = \text{Score}\]

Score 4: CEC Multiplied Score
\[\left(\frac{(DN + DP + DK) * 1}{\text{CEC}} + DpH + DOrg\right) = \text{Score}\]

This score takes into account the way that the CEC controls nutrient availability. Low nutrient areas can still have high scores if the CEC is high, because it assumes no nutrient leaching.