Designing Sustainable Landscapes:

Soil available water supply, Soil depth to restrictive layer, and Soil pH settings variables

A project of the University of Massachusetts Landscape Ecology Lab

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- North Atlantic Landscape Conservation Cooperative (US Fish and Wildlife Service, Northeast Region)
- Northeast Climate Science Center (USGS)
- University of Massachusetts, Amherst

Reference:

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2017. Designing sustainable landscapes: soils settings variables. Report to the North Atlantic Conservation Cooperative, US Fish and Wildlife Service, Northeast Region.

General description

These three soils variables are among several ecological settings variables that collectively characterize the biophysical setting of each 30 m cell at a given point in time (McGarigal et al 2017). Soils are important drivers of natural communities. We picked three soil attributes that represent the most important factors: depth, chemistry, and water-holding capacity.

Depth to resistant layer measures the depth of soils to a restrictive layer (e.g., bedrock) that limits root depth (**Fig. 1a**). Areas with shallow soils (usually on steep slopes or ridgetops) can't support deep-rooted plants.

Soil pH strongly affects nutrient uptake by plants (**Fig. 1b**). In the east, soils with higher pH (e.g., in areas with limestone bedrock) tend to support a greater diversity of plants, including a number of species that typically grow only in sweet soils. Conversely, some groups of plants (such as members of Ericaceae) are specialized to acidic soils, where generalist species grow poorly at best.

Available water supply (AWS) measures the water-holding capacity of soils (**Fig. 1c**). It is measured as the total volume of water that available to plants when the soil, inclusive of rock fragments, is at field capacity. Soils with a high AWS are more drought-resistant, supporting plant growth through periods without rain—for instance, good agricultural soils have a high AWS. AWS is calculated as the available water capacity times the thickness of each soil horizon to a specified depth (25 cm in this case). Note that AWS is distinct from our topographic wetness settings variable, which estimates the amount of water delivered to the soil at each point.

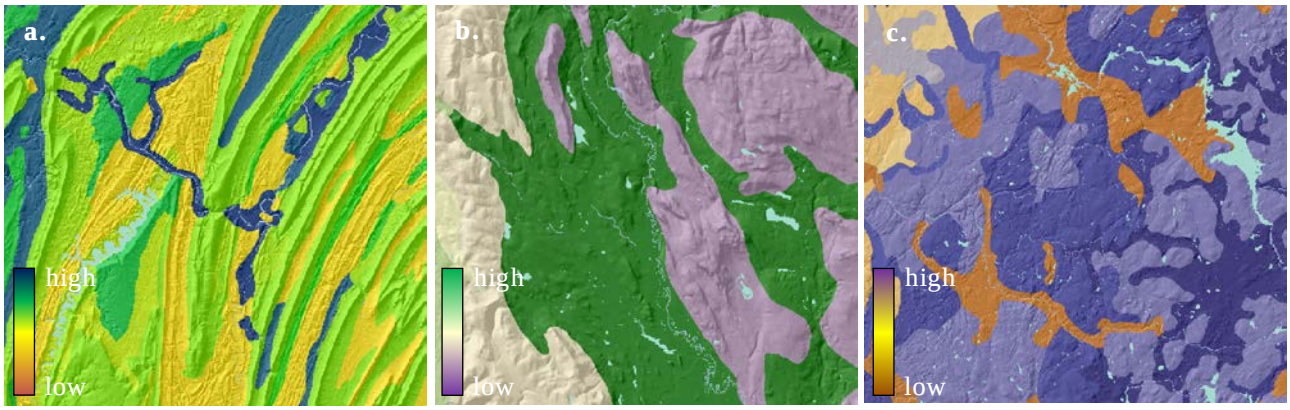

Figure 1. Examples of soils settings variables: (a) depth to resistant layer in south-central Pennsylvania, (b) soil pH in the calcareous valleys and granitic highlands of Berkshire County, Massachusetts, (c) available water supply in the Adirondacks of New York.

Use and interpretation of this layer

These three ecological settings variables are used for the similarity and connectedness ecological integrity metrics. These layer carry the following assumptions:

- Soil units are mapped accurately, and the attributes are correctly assigned. Soils data from NRCS were especially problematic. The large-scale soils data (SSURGO, varying from 12,000 to 1:63,360) were mapped separately within each state, with (apparently) minimal attention to differences across state boundaries. As a result, these data show often extreme discontinuities at state lines. After much exploration, we decided that these data were unsuitable for our regional analyses, and fell back to the smaller-scale STATSGO2 soils data (1:250,000). These data show much larger mapping units, and thus are less accurate at local scales, but they lack the discontinuities at state lines found in SSURGO data. This solution is far from optimal, as small-scale patterns in soils are lost, but it seemed to be the best option available.

Derivation of this layer

Data source

- NRCS STATSGO2 1:250,000 soils map (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629).

Algorithm

We downloaded STATSGO2 data using the NRCS Soil Data Viewer, and converted the shapefiles to grids aligning with the rest of our data. Soils data are not reported for open water; available water supply and soil pH used 0 to indicate missing data for water, and depth to resistant layer used 202 for water. We set all values corresponding to open water in our landcover to no data. We replaced missing values where NRCS had mapped water but our landcover maps otherwise with a focal mean of the neighborhood.

GIS metadata

These data products are distributed as geoTIFF rasters (30 m cells) and can be found at McGarigal et al (2017):

- **Available water supply** (units: cm, range: 1.12 to 9.46)
- **Depth to resistant layer** (units: cm, range: 0 to 202 cm)
- **Soil pH** (units: pH, range: 4.3 to 6.9)