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Soil and Water Science
Research Brief
University of Florida Institute of Food and Agricultural Sciences

GIS MEETS SOIL AND WATER SCIENCE

S. Grunwald

A geographic information system (GIS) is a powerful set of tools for collecting, storing, transforming and displaying spatial data. The spatial data represent phenomena from the real world in terms of (i) their position with respect to a known coordinate system, (ii) their attributes that are unrelated to position (e.g. pH, soil texture), and (iii) their spatial interrelationship with each other which describe how they are linked together (topology).

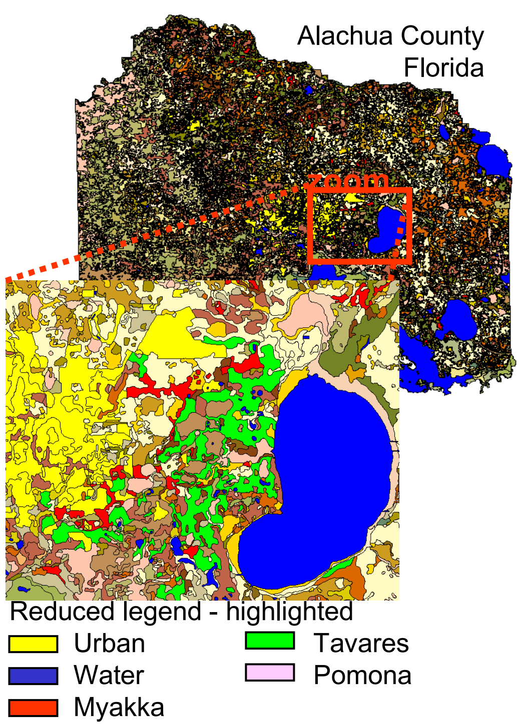

Fig.1. Soil Series derived from SSURGO, Alachua County, Florida.

Digital Soil Data

The Natural Resources Conservation Service (NRCS) USDA has the federal responsibility for the National Cooperative Soil Survey (NCSS) and federal leadership for collecting, storing, maintaining, and distributing soils information in the United States. NRCS has established 3 digital soil geographic databases (NATSGO, STATSGO, and SSURGO) representing different intensities of soil mapping. Three types of information are included in soil information systems: (i) Soil maps (polygons, data points), (ii) Soil attribute tables, and (iii) Metadata.

The soil GIS layers use the entity data model based on the vector polygon as the geographical primitive. Polygons are defined in terms of their soil class, which by implication is homogeneous over the unit. This data model is practical, however, it ignores spatial variation in both soil-forming processes and in the resulting soils. An alternative to the discrete polygon data model for soil is to assume that soil properties vary gradually over the landscape. Commonly, continuous soil maps are created using: (1) Interpolation methods (e.g. splines, ordinary kriging); both the area (or volume) of the samples (i.e., the support) and their density in space relative to the spatial variation of the attribute concerned are important for the quality of the resulting interpolations.

(2) Fuzzy set methods, which allow the matching of soil individuals to be determined on a continuous scale via membership functions instead on a Boolean binary scale (either 0 or 1) used for crisp soil classification.

Digital Hydrology Data

The simple entity vector data model of points (e.g. wells), lines (e.g. rivers), and areas (e.g. lakes) is most often used to represent hydrologic features. Changing water levels due to flooding in rivers, reservoirs and lakes may change the geometry and location of water bodies, which poses problems of realistic representation of hydrologic features (Fig. 2).

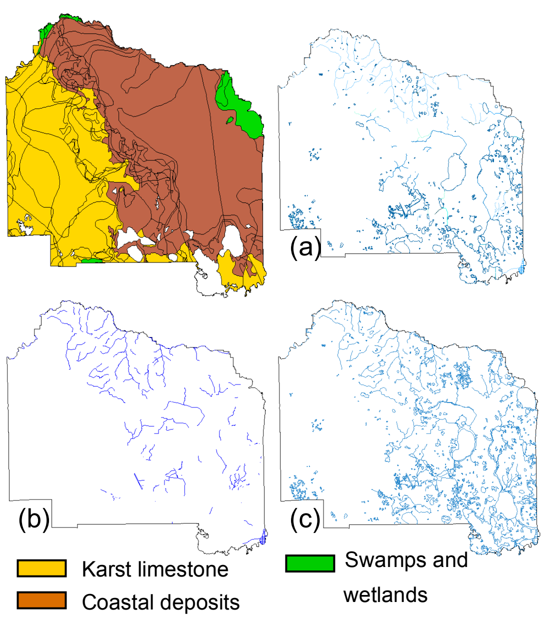

Fig. 2. Hydrologic features in Alachua County, Florida. Data sources: (a) United States Bureau of Census, TIGER hydrologic line file 1:100,000 (b) U.S. Geological Survey & Florida DEP, stream file 1:100,000 (c) U.S. EPA, USGS DLG3 1:100,000 and USGS UC boundaries 1:2,000,000.

Hydrological and transport modeling of materials (nutrients, suspended sediment, pesticides) over space and time require changes to be signaled in attributes, location, and form of critical patterns (e.g. water bodies). Digital elevation models (DEM) can be used to derive hydrologic GIS layers (Fig. 3) and other primary and secondary topographic data layers (e.g. slope, profile curvature, wetness index).

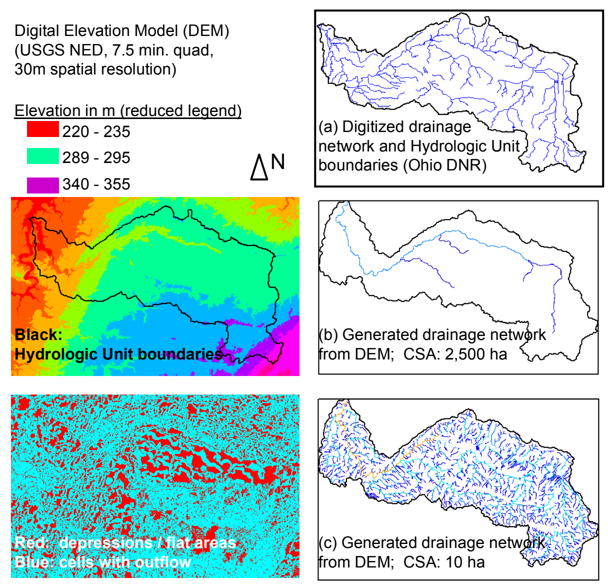

Fig. 3. TOPAZ software (D8 method) was used to generate drainage network maps with varying critical source area (CSA) values (b) and (c). These maps were compared to a readily available drainage network map (a) in Honey Creek Watershed, Ohio (386 km^2).

Author: Sabine Grunwald, Assistant Professor and GIS Research Laboratory Manager,
Soil and Water Science Dept., University of Florida, 2169 McCarty Hall, PO Box 110290
Gainesville, FL 32611;
SGrunwald@mail.ifas.ufl.edu