Creation of GIS compatible, historic detailed soil data sets for the Collier and Miami-Dade Counties, Florida

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
mile, nautical (nmi)	1.852	kilometer (km)
yard (yd)	0.9144	meter (m)
Area		
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)
square foot (ft^2)	929.0	square centimeter (cm^2)
square foot (ft^2)	0.09290	square meter (m^2)
square inch (in^2)	6.452	square centimeter (cm^2)
section (640 acres or 1 square mile)	259.0	square hectometer (hm^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
Volume		
barrel (bbl), (petroleum, 1 barrel=42 gal)	0.1590	cubic meter (m^3)
ounce, fluid (fl. oz)	0.02957	liter (L)
pint (pt)	0.4732	liter (L)
quart (qt)	0.9464	liter (L)
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
gallon (gal)	3.785	cubic decimeter (dm^3)
million gallons (Mgal)	3,785	cubic meter (m^3)
cubic inch (in^3)	16.39	cubic centimeter (cm^3)
cubic inch (in^3)	0.01639	cubic decimeter (dm^3)
cubic inch (in^3)	0.01639	liter (L)

cubic foot (ft^3)	28.32	cubic decimeter (dm^3)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
cubic yard (yd^3)	0.7646	cubic meter (m^3)
cubic mile (mi^3)	4.168	cubic kilometer (km^3)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
Flow rate		
acre-foot per day (acre-ft/d)	0.01427	cubic meter per second (m^3/s)
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year (m^3/yr)
acre-foot per year (acre-ft/yr)	0.001233	cubic hectometer per year (hm^3/yr)
foot per second (ft/s)	0.3048	meter per second (m/s)
foot per minute (ft/min)	0.3048	meter per minute (m/min)
foot per hour (ft/hr)	0.3048	meter per hour (m/hr)
foot per day (ft/d)	0.3048	meter per day (m/d)
foot per year (ft/yr)	0.3048	meter per year (m/yr)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
cubic foot per day (ft^3/d)	0.02832	cubic meter per day (m^3/d)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
gallon per day per square mile [$(gal/d)/mi^2$]	0.001461	cubic meter per day per square kilometer [$(m^3/d)/km^2$]
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
million gallons per day per square mile [$(Mgal/d)/mi^2$]	1,461	cubic meter per day per square kilometer [$(m^3/d)/km^2$]
inch per hour (in/h)	0 .0254	meter per hour (m/h)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
mile per hour (mi/h)	1.609	kilometer per hour (km/h)
Mass		
ounce, avoirdupois (oz)	28.35	gram (g)
pound, avoirdupois (lb)	0.4536	kilogram (kg)
ton, short (2,000 lb)	0.9072	megagram (Mg)
ton, long (2,240 lb)	1.016	megagram (Mg)
ton per day (ton/d)	0.9072	metric ton per day
ton per day (ton/d)	0.9072	megagram per day (Mg/d)

ton per day per square mile [(ton/d)/mi^2]	0.3503	megagram per day per square kilometer [(Mg/d)/km^2]
ton per year (ton/yr)	0.9072	megagram per year (Mg/yr)
ton per year (ton/yr)	0.9072	metric ton per year
Pressure		
atmosphere, standard (atm)	101.3	kilopascal (kPa)
bar	100	kilopascal (kPa)
inch of mercury at 60ºF (in Hg)	3.377	kilopascal (kPa)
pound-force per square inch (lbf/in^2)	6.895	kilopascal (kPa)
pound per square foot (lb/ft^2)	0.04788	kilopascal (kPa)
pound per square inch (lb/in^2)	6.895	kilopascal (kPa)
Density		
pound per cubic foot (lb/ft^3)	16.02	kilogram per cubic meter (kg/m^3)
pound per cubic foot (lb/ft^3)	0.01602	gram per cubic centimeter (g/cm^3)
Energy		
kilowatthour (kWh)	3,600,000	joule (J)
Radioactivity		
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)
Specific capacity		
gallon per minute per foot [(gal/min)/ft)]	0.2070	liter per second per meter [(L/s)/m]
Hydraulic conductivity		
foot per day (ft/d)	0.3048	meter per day (m/d)
Hydraulic gradient		
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
Transmissivity*		
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)
Application rate		
pounds per acre per year [(lb/acre)/yr]	1.121	kilograms per hectare per year [(kg/ha)/yr]
Leakance		
foot per day per foot [(ft/d)/ft]	1	meter per day per meter
inch per year per foot [(in/yr)/ft]	83.33	millimeter per year per meter [(mm/yr)/m]

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
$°F=(1.8\times°C)+32$
Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:
$°C=(°F-32)/1.8$
Vertical coordinate information is referenced to the insert datum name (and abbreviation) here for instance, "North American Vertical Datum of 1988 (NAVD 88)."
Horizontal coordinate information is referenced to the insert datum name (and abbreviation) here for instance, "North American Datum of 1983 (NAD 83)."
Altitude, as used in this report, refers to distance above the vertical datum.
*Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness $[(ft^3/d)/ft^2]ft$. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.
Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).
Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).
NOTE TO USGS USERS: Use of hectare (ha) as an alternative name for square hectometer (hm^2) is restricted to the measurement of small land or water areas. Use of liter (L) as a special name for cubic decimeter (dm^3) is restricted to the measurement of liquids and gases. No prefix other than milli should be used with liter. Metric ton (t) as a name for megagram (Mg) should be restricted to commercial usage, and no prefixes should be used with it.

Creation of GIS-compatible, historic detailed soil data for Collier and Miami-Dade Counties, Florida

By John W. Jones

Introduction

When soils data are in digital format compatible with geographic information systems (GIS), a wide variety of analyses and display capabilities are afforded. Detailed information on soils that may be important to Everglades ecosystem restoration has been created in hardcopy form using traditional soils mapping techniques. However, accurate conversion of these analogue geographic data to GIS compatible information is a complicated process. Because detailed digital soils data for Southern Florida were not yet available from the US Department of Agriculture, the U.S. Geological Survey (USGS) Eastern Geographic Science Center (EGSC) developed a means for digitizing and attributing historic soil survey data for GIS analysis. This report documents that process and the two soil survey datasets created through it, one for Collier and one for Miami-Dade Counties in Florida. First, the sources for the soils data are described. Then the approach used to determine how data would be collected and organized is provided, followed by details of the spatial data collection and attribute data encoding.

Data Sources

Each detailed soil survey consists of a leaflet describing mapped soil characteristics in tabular form, numerous hardcopy soil maps covering the county, and a pamphlet that describes the characteristics and possible uses of delineated soil series. For Collier County, a single GIS data file was created from 8 individual soils maps included in the Soil Survey Detailed Reconnaissance for Collier County Florida (Series 1942, No. 8) issued in March 1954 by the U.S. Department of Agriculture, Soil Conservation Service in cooperation with the Florida Agricultural Experiment Station (USDA, 1954). While the maps are not fully described, it is assumed that aerial photography dating to before 1942 was used to produce these maps. For Miami-Dade County, a single GIS data file was created by scanning the 12 individual soils maps included in the Soil Survey Detailed Reconnaissance for Dade County Florida (Series 1947, No. 4) issued in April 1958 by the U.S. Department of Agriculture, Soil Conservation Service in cooperation with the Florida Agricultural Experiment Station (USDA, 1958). Again, while not specifically documented, it is assumed that aerial photography for these soil interpretations were collected during or before 1947. All original maps from both surveys are at 1:40,000 scale, and each covers 30 minutes of longitude by 15 minutes of latitude. But, as detailed in the next section, there are distinct differences in the standards applied in creating each County Soil Survey that led to the approach taken in creating the final digital data sets.

Approach

The process documented here results from the pursuit of several objectives. Developed methods had to be consistent within and across counties. Spatial data conversion methods had to be sufficiently precise to prevent any loss of information and had to be accurate enough to prevent introduction of additional error into the soil polygon’s spatial or attribute information. The spatial and attribute GIS data had to be structured so that as much information as possible was transferred from analogue data sheets and maps to digital form – preserving the important, but different types of information collected across soil surveys. Finally, methods of data capture and conversion had to be as efficient and cost effective as the previously stated objectives allow.

Given these objectives, the resources available for this task, and the characteristics of each soil survey, no attempt was made to combine the two soil survey datasets into one. That is, while all maps within each survey were edge-matched and combined to create a single mosaic for each county, the resulting map mosaics for the two bordering counties were not combined. Even a brief glance at Figures 1 and 2 provides an indication of the between-survey differences in the classification schemes and minimum mapping unit criteria used. The measurements made on soil types and from aerial photographs also differed across surveys. Therefore two separate data files have been maintained so that categories of information not common to both were not lost. Also, by maintaining separate soils data files by county, differences in soil classifications across county boundaries needn’t be reconciled. Reconciliation of these differences through the development of a classification cross-walk or a new classification scheme is a task for future research.

Methods

Spatial Data Processing

For the most consistent capture of soil polygon boundaries, the individual maps from each survey (i.e., 8 maps for Collier County and 12 maps for Dade County) were scanned using an Ideal 48 inch pinch roller scanner that has a spatial resolution of 400 pixels per inch (ppi) and radiometric resolution of 24-bit color. The resulting digital files were rectified to a common map base and resampled to 200 ppi using ARC/INFO GIS and then converted to 8-bit color using Adobe Photoshop. The resampling yielded an effective ground resolution of approximately 16 feet for polygon boundaries. The conversion to 8-bit color reduced subtle, but potentially confusing, color differences among polygons of the same soil type and created an index color image for input to the raster-to-vector conversion process. Most of the polygons in the scanned images were surrounded by black. To make black boundaries and text distinguishable from all the other items on the scanned map, any gray pixels that should have been black were also converted at this time. Then, all the black line work and text were selected and changed to a color not found in the indexed color image and saved as a separate 200 ppi 8-bit color image. This file of boundaries and text only was visually overlain on the indexed color image. Text pixels were then deleted from this layer. ARC/INFO software was used for the raster-to-vector conversion as well. Once the soil polygon boundary file was converted to vector, the result was again displayed over the 8-bit raster file and any remaining sliver polygons were removed. Topology was created next. Then, again using the 8-bit color image as a backdrop and guide, each individual polygon was hand labeled with the appropriate soil symbol. Finally, all individual maps in each soil survey were digitally appended to all others from the same soil survey using GIS functionality to remove map edge boundaries. This completed the spatial data processing and created the foundation needed for soil polygon attribution.

Attribute Data Encoding

Each survey contains descriptive text and tabular information about each soil type. To create the attribute information associated with each soil polygon, the tabular information was manually typed into an Excel file to take advantage of Excel's forms completion capability. Notably, the original Collier County maps had suffixes on some soil symbols. After scouring the text for an explanation, it was determined that there is no discussion of these suffixes either in the text or tables supplied with the survey. Instead, they are listed only in the key provided on the first of the 8 map sheets and apparently represent observed land cover classes that are different from the vegetation cover documented in the table. Regardless, these soils suffixes were retained during the assignment of soil codes to polygons as previously described and the GIS was used to generate text files of all unique polygon identifiers or labels. These were used to hand edit the Excel files to make certain a record existed for every soil symbol/land cover class combination found in the digital soil map. Attribute information other than land cover class was copied from the table entry with the same soil symbol to each soil symbol/land cover combination with the same soil type.

The data in the Excel worksheets were exported to text files and edited to remove embedded Excel codes, insert delimiters, and place quotations around all character data. Then, within the INFO component of ARC/INFO, attribute file templates were created for each survey. Two templates were required because the types and formats of attribute information in each original table were different. The text files were then imported into INFO to create attribute data files. For the final processing step, the soils attribute data file was joined to the soils boundary data file using the "soils attribute field" (i.e., soil symbol and soil symbol/land cover combinations for Miami-Dade and Collier cases, respectively).

Data Distribution

All data are freely distributed through the South Florida Information Access website (***http://sofia.usgs.gov***) data exchange pages.

Acknowledgements

The original Soil Survey materials were provided by Thomas J. Smith, USGS Florida Integrated Science Center. Spatial data capture and conversion process was developed by Daniel Sechrist and Gregory Manual, USGS Cartographers. Funding for this work was provided by the USGS's Greater Everglades Priority Ecosystems Science Program, Geographic Analysis and Monitoring Program, and Eastern Geographic Science Center.

References Cited

USDA, 1954. Soil survey (detailed reconnaissance) of Collier County, Florida. Soil Conservation Service Series 1942, No. 8.

USDA, 1958, Soil survey (detailed reconnaissance) of Dade County, Florida. Soil Conservation Service Series 1947, No. 4.

Figure 1. The result of digitizing, rectifying, attributing, and merging 8 soil survey maps covering the area of Collier County.

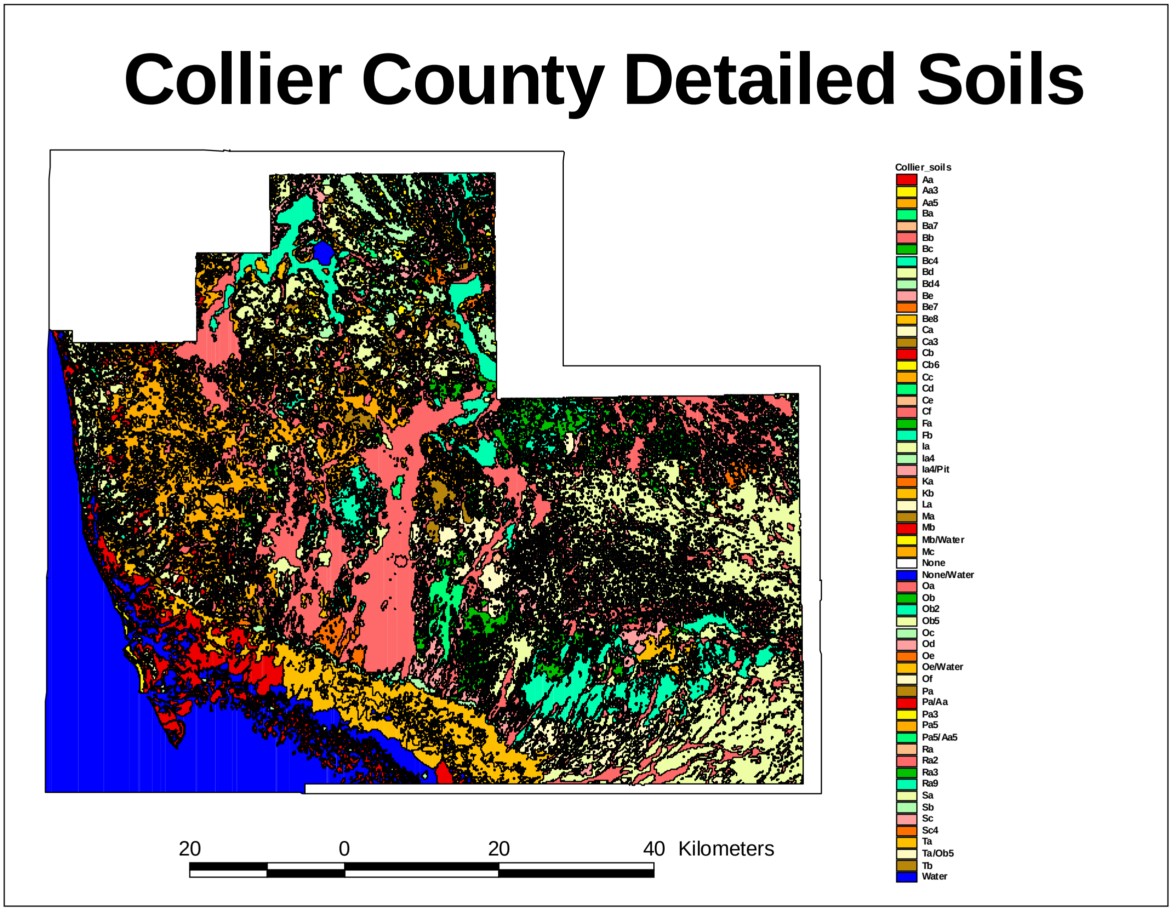

Figure 2. The result of digitizing, rectifying, merging, and attributing 12 soil maps covering the area of Miami-Dade County. Note the much larger minimum mapping unit employed compared to that for Collier County.