The U.S. national cooperative soil characterization database

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Abstract
The National Cooperative Soil Survey (NCSS) is a partnership of federal, state, county, and private entities with the common goal of producing and maintaining a useful soil survey of public and private lands in the USA. Soil characterization data have been analysed by the cooperative laboratories using common, standard methods. The data have been used to support soil survey including assigning classification, estimating soil properties for map unit components, and developing predictions of soil behaviour. These data have been published in printed reports and electronic files and databases. Current demands to utilize the data for validating soil properties, evaluating soil variability, and improving applications are difficult with the data in their current forms. Aggregating the soil characterization data from various sources will improve the ability to meet these demands.

The measured characterization data for 36 pedons samples as the Miami soil series showed a significant difference between these data for clay content and soil organic-carbon content. Estimated and measured values for cation exchange capacity (CEC, pH 7) are comparable.

Key Words
Characterization data, Miami, soil organic carbon, clay, CEC, SSURGO

Introduction

Soil characterization data are essential to a strong soil survey program. As the soil survey program progresses, there is greater demand for evaluation of horizon properties from multiple pedons to evaluate variability, statistical confidence and to develop new and more reliable interpretations. A complete inventory of available data is needed to ensure maximum data collection efficiency.

The United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS) Soil Survey Laboratory and university laboratories associated with the NCSS have measured horizon properties using common, standard methods. These data have been gathered for more than 50 years but have been published independently by each laboratory.

Because these data are difficult to access, a program was initiated with the objective of consolidating soil characterization data and associated soil profile descriptions from various laboratories into a single easily accessible and searchable database. The database is available online at http://ssldata.nrcs.usda.gov/. A secondary objective of this paper is to illustrate the utility of the consolidated database by comparing estimated properties to measured data for the Miami soil that has been analysed by several laboratories.

Methods

A database was developed to store the analytical results from various sources. The sample preparation techniques, analytical methods, instrument utilized, size fractions analyzed, and the reporting basis were identified and catalogued for each measurement. The sampling site, pedon, horizons, and associated information were also stored. The associated morphological descriptions were entered in the National Soil Information System (NASIS) and appropriate links between the description and analytical data established. Conversion routines were written as needed to map and convert existing electronic files and databases to a common database. Data entry routines were developed for information stored in paper archives (Fig.1).

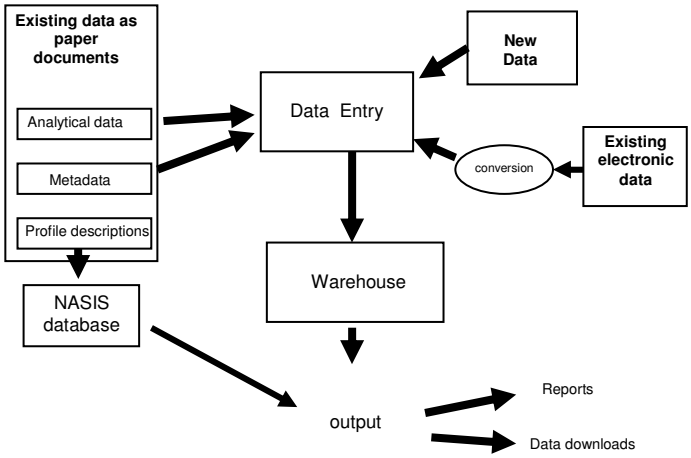

Figure 1. Soil characterization data flow.

The Miami soil series is classified as a member of the family of fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs (Soil Survey Staff, 1999). These soils formed in a thin mantle of loess over till. Approximated 500,000 hectares have been identified and mapped in the United States. Cultivation of commodity crops, such as corn and soybeans, is the primary use of the soil. The soils were analysed by the USDA-NRCS, the University of Illinois, Purdue University, and the Ohio State University soil characterization laboratories at 69 different sites. The data were collected between 1954 and 1990. Particle-size distribution and CEC, pH 7 were measured using standard NCSS methods (Burt, 2004). Soil organic carbon content was measured by the NCSS Walkley-Black method. Estimated soil properties were obtained from the Soil Survey Geographic (SSURGO) Database (Soil Survey Staff, 2009). The estimated soil properties are reported as the representative (RV), high, and low value. The RV value is not defined statistically as the median or mean. The SSURGO spatial data were also used to determine if the sampled sites correlated as the Miami series were coincidentally located in a mapped polygon of the same name. The U.S. General Soil Map (STATSGO2), (Soil Survey Staff, 2009) was used to illustrate the geospatial distribution of the Miami series. The Miami polygons were selected if the Miami components comprised more than 20 percent of the composition in the map unit.

Results

The sampled sites are distributed in Illinois, Indiana, Michigan, and Ohio. Figure 2 shows the geospatial relation of the sampled sites to the geospatial distribution of the mapped Miami series. The geospatial distribution appears to be represented by the sampled sites except for those located in Michigan. Only 36 pedon locations were coincident with the Miami polygons. Measured characterization data from these 36 sites were compared to the estimated soil properties.

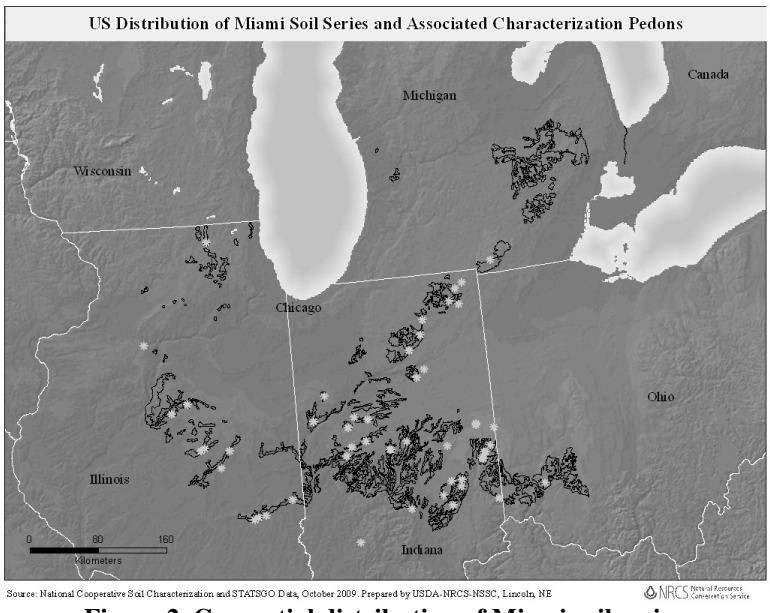

Figure 2. Geospatial distribution of Miami soil series.

The soil properties were partitioned into Ap horizons with no depth greater than 25 cm and Bt horizons with no depth greater than 1 m. These partitions represent the diagnostic surface (ochric epipedon) and subsurface horizons (argillic horizon) and include the particle-size control section. Descriptive statistics were calculated for the measured and estimated soil properties for each partition (Table 1). The soil property observations for each horizon are not available from every site, and these pedons were omitted from the analyses. Estimated CEC values were not available for the low and high estimates. There was no significant difference between measurements from the 4 laboratories for the selected properties therefore the results were combined for comparison with the estimated soil property data. The RV value is used to compare to the measured property mean even though the RV value does not statistically represent the mean of the estimated soil property.

Significant differences were observed between measured and estimated values for the clay content and soil organic carbon content (SOC) for the Ap and Bt horizons. The percent measured and estimated clay contents are both within the fine-loamy particle-size class. There were no significant differences observed between measured and estimated CEC. Potential sources of the differences in clay and SOC include: 1) estimated soil properties were assigned when an insufficient number of measured values were available to evaluate and underpin the values; 2) the selected soils were not current in their correlation to the Miami series; or 3) land use or agricultural management differs between estimated and measured values.

Table 1. Descriptive statistics of selected measured and estimated soil properties.

Combined Characterization Data	Clay %		CEC – pH 7 cmol(+)/kg		SOC %	
	Ap	Bt	Ap	Bt	Ap	Bt
Mean	18.98	30.37	13.33	15.85	1.22	0.46
Median	18.90	30.40	13.90	15.80	1.09	0.45
Standard Error	0.81	0.84	0.63	0.62	0.10	0.02
Minimum	12.40	21.30	10.40	7.20	0.81	0.89
Maximum	25.80	42.30	15.00	19.60	3.12	1.11
n	21	35	7	13	24	55
25th percentile	16.90	27.25	12.50	14.00	0.94	0.35
75th percentile	21.75	33.60	14.50	17.30	1.22	0.54
SSURGO Data						
Mean of RV	22.88	26.69	13.61	15.61	0.80	0.33
Standard Error	0.66	0.16	0.33	0.22	0.02	0.06
n	125	1380	125	1380	125	1380
Mean low	17.77	21.64			0.45	0.20
Mean high	28.92	31.47			1.19	0.46
Significant difference between measured and estimated value (α=.05)	*	*			*	*

Conclusion

The estimated and measured soil properties were compared for the Miami series. The number of available measured soil properties was increased by including values from several NCSS soil characterization laboratories. Based on this one example, significant differences exist between measured and estimated soil properties for the Miami series. There remain several tasks to fully utilize the measured soil data. These tasks include 1) assigning the sample pedons to the appropriate representative soils; 2) verifying the spatial location and associated map unit polygon; and 3) evaluating the estimated soil properties and updating them as needed. The aggregation of soil characterization data from all sources improves the reliability and population of estimated soil properties in a soil survey database. The quality of the aggregated data is highest when known standard methodologies were used.

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