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Letters

A Potential Global Soils Data Base

ERIC R. STONER, ARMOND T. JOYCE, AND HOWARD C. HOGG

Abstract—A general procedure is outlined for refining the existing world soil maps from the existing 1:1 million scale to 1:250 000 through the interpretation of Landsat MSS and TM images, and the use of a Geographic Information System to relate the soils maps to available information on climate, topography, geology, and vegetation.

Keywords—Soils, remote sensing, Landsat, predictive modeling.

INTRODUCTION

Reliable soils information is needed for productivity assessments, climate modeling, modeling of geochemical cycling, the assessment of land resource degradation, and determination of land suitability. The ability to make these assessments on a global basis depends on the availability of soil maps at an adequate scale, within the framework of a comprehensive soil classification system.

GLOBAL SOIL MAPS

The Soil Survey of the United States Department of Agriculture initiated a World Soil Map Project in 1945 [1]. Dr. Marline G. Cline headed the project and devised the system that was used, which followed the 1938 USDA soil classification system [2]. The project was made possible through work that the Soil Survey was asked to do for the Military Geology Branch of the U.S. Geological Survey. Under the administration of Dr. Charles E. Kellogg, the World Soil Geography Unit in the Soil Survey, SCS/USDA completed maps covering all the world at 1:1 million except for the United States, Australia, and a few African countries [3]. None of the maps have been published. Originals are retained at the Soil Geography Unit.

Soils were mapped at 1:1 million on Operational Navigation Charts (ONC’s) at the great group level with phase separations based on terrain type and parent material. Where no soil maps were available, kinds of soils were predicted from inferences from genetic factors.

The World Soil Maps continue to be updated, particularly for use by the Foreign Agricultural Service’s Crop Condition Asses-

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SOIL TAXONOMY

Soil taxonomy, the comprehensive soil classification system now in use in the United States, has been recognized as a basic international system of references for making and interpreting soil surveys [7]. Soil surveys made within the framework of soil taxonomy permit the orderly transfer of knowledge gained through research and experience from one tract of land to another. A soil survey consists of 1) determining important characteristics of soil, 2) classifying the soil into defined units, 3) locating and plotting their boundaries on maps, and 4) predicting their suitability/productivity for various uses. Remote sensing techniques have been used and are being refined in this third area, that of delineating soil mapping units, while the capabilities of modern computerized geographic information systems are appropriate as a means for storage and retrieval of the information that pertains to soil suitability/productivity.

Soil taxonomy contains six defined levels or categories of soil detail. These are listed below with the number of definable classes for each level found in the United States.

<table>
<thead>
<tr>
<th>Order</th>
<th>Suborder</th>
<th>Great Group</th>
<th>Subgroup</th>
<th>Family</th>
<th>Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>47</td>
<td>185</td>
<td>970</td>
<td>4500</td>
<td>10500</td>
</tr>
</tbody>
</table>

To address issues or problems related to soil productivity or land degradation, the specificity represented by soil family is needed. Soil families in soil taxonomy contain information pertaining to soil properties that affect water movement and retention, aeration, and the production of plants. These qualities make a family-level soil delineation desirable from the point of view of predictive modeling of land suitability.

REFINING GLOBAL SOILS DATA

Large-scale soil maps at scales of 1:12,000 to 1:31,680 are commonly published as part of county-level soil surveys in the United States and contain the level of cartographic and categoric detail which is needed for far, ranch, and woodland management, and urban development.

Soil information that would be appropriate for a global inventory of land use change would not have to possess the level of detail needed for county-level soil surveys, but must still retain map fidelity and follow the hierarchy of soil taxonomy. Existing world soil maps at 1:1 million need cartographic refinement and taxonomic translation from the 1938 USDA soil classification system with which they were prepared. Large-area applications require a map scale of 1:250,000 which is compatible with Landsat MSS and TM resolution. Map boundary sharpening at 1:250,000 could be done with either Landsat image products or computer digital display within the context of a geographically referenced digital information system.

The attributes that make up soil families can, in part, be inferred from other map sources and can be used to refine and further subdivide soil subgroup boundaries. These attributes and possible sources of collateral information are: 1) soil temperature regime as measured by mean annual subsoil temperature, but easily inferred from mean annual air temperature and thus readily accessible from meteorological station data; 2) soil mineralogy in the subsoil as can frequently be inferred from parent material geology; 3) particle-size distribution in the subsoil, which again can be inferred from parent material geology; and 4) thickness of soil penetrable by roots, which can be inferred to some extent from topography and native plant adaptation on soils of variable thickness. A geographic information system could be employed to merge the soils information with climatic, topographic, geologic, and vegetative information as available and as required.
Soil subgroup maps enlarged from 1:1 million to 1:250 000 with boundary refinement approaching the soil family level would be an appropriate base for descriptive applications and predictive modeling of soil/plant response on a regional scale.

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