A SELECTED BIBLIOGRAPHY OF REMOTE SENSING

APPLICATIONS TO SOIL SCIENCE

U.S. GEOLOGICAL SURVEY

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UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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By Thomas R. Loveland, Daniel B. Carter, and William C. Draeger

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ABSTRACT

The bibliography contains approximately 200 references dealing with the application of remote sensing technology to the identification and analysis of soils. The scientific papers and reports listed describe procedures and methods used in data collection and include specific applications of those data to soil studies. Most citations discuss current work from 1970 to 1978 and all references are categorized according to the type of remotely sensed data used and their application.

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INTRODUCTION

The world's soil resources for the production of food and fiber that are required to meet the needs of an expanding population are decreasing in quantity and quality. Some of the best arable lands are being removed from agricultural production as a result of degradation and by conversion to nonagricultural uses such as highways, subdivisions and shopping centers. To aid the wise use and conservation of our soil resources, new tools that enable proper inventorying, planning, and monitoring of soil use are needed. One such tool, remote sensing, involves the use of aerial and space remotely sensed data to survey the type, use, quality, and distribution of soil resources. Remotely sensed data can be used to ascertain and interpret a variety of soil characteristics and together with ancillary data and field checks can be used to investigate physical and chemical properties of soils and determine how these properties affect land utilization.

The study of soils using remotely sensed data is fundamentally the same as field investigation of soils in that one must consciously consider the soil-forming factors such as climate, parent material, organisms, relief, and time. The difference is that the perspective has changed from which the effects of these factors are viewed; the effects are observed from the air or space and as a result, only surface characteristics are seen. The soil profile characteristics must be initially inferred based on the soil surface properties and later must be checked through actual field investigations to verify soil characteristics and conditions.

Remotely sensed data have several attributes that contribute to their utility in soils analysis. The synoptic view allows the analyst to see regional characteristics and patterns and to make inferences based on visible and known soil relationships. Remotely sensed imagery can record reflected or emitted energy from both the visible and invisible regions of the electromagnetic spectrum. This can yield soils information not interpretable from conventional visible light imagery. Finally, the image is a temporal benchmark that permanently records surface conditions and thus can be used for soils mapping and for monitoring land use changes which affect soils. These characteristics combine to make remotely sensed data a valuable soil survey and inventory tool. While this technology will not eliminate traditional field survey methods, it can improve the efficiency and accuracy of soils inventory and analysis.

This bibliography contains approximately 200 references to papers describing the use of remote sensing in the analysis of soils. It is organized by imagery type (black-and-white photography, multispectral scanner, thermal infrared, etc.) and, where applicable, is subdivided into sections dealing with different applications using that specific type of imagery. The bibliography lists many but not all significant papers dealing with remote sensing and soil science. Most citations span the period from 1970 to 1978 with some important references before that time also listed.

The authors gratefully acknowledge the bibliographic contributions and thorough review provided by Dr. Chris J. Johannsen, State Extension Specialist--Land Use, University of Missouri, Columbia.

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The following citations discuss the fundamentals and terminology of soil science. They cover topics ranging from soil genesis and morphology to soil classification and taxonomy. Because the quality of an interpretation is based on the analyst's understanding of the soil forming factors and their interrelationships, these references may be helpful in determining how soil bodies will appear on remotely sensed imagery.

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Remote Sensing of Soils: Background Information

These references contain discussions of the basic properties and appearances of soils on remotely sensed imagery. The citations deal with inventory techniques, information extraction and mapping procedures, and methods for examining or locating areas having specific soil properties. In addition, various types of images (black and white, color, etc.) are discussed to familiarize the analyst with general image characteristics that are associated with each image type. More specific discussions of image characteristics are contained in the sections that follow.

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Color and color infrared photography have been used with increasing frequency for soils studies; as they often facilitate the separation of different soil properties because of subtle changes in soil colors. Uses of color and color infrared imagery for the preparation of soil surveys, for mapping soil limitations, and for monitoring soil erosion are among the important topics referenced in this section. As the large number of studies utilizing this type of imagery precludes a complete listing of available articles, only the most recent or important studies are identified.

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Microwave and radar remote sensing activities deal principally with the assessment of soil moisture conditions. Citations covering this topic discuss primarily the affects of surface roughness of soils and how this affects moisture properties. A less prevalent but promising application is the use of microwave and radar imagery for reconnaissance soil surveys. Relationships between soil moisture content, vegetative cover and soil classifications can sometimes be inferred from this type of imagery. The importance of sensor calibration for obtaining reliable soils information is a theme covered in many of the items listed.

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Multispectral Scanner (MSS) Data

The use of multispectral scanner data for soils studies has increased dramatically since the launch of Landsat 1 in 1972. Relatively limited use of aircraft-based MSS data for the collection of soil information was made prior to that time. The most common use of MSS data in the field of soil science has been for reconnaissance soil surveys. Investigators have used MSS imagery to detect and infer such soil properties as soil moisture, salinity, and clay and organic matter content. Landsat MSS imagery has been used to measure the extent of erosion and to monitor erosional sequences. The uses of MSS data are many and the volume of literature covering these topics is immense. Hence, only the most recent and readily available materials are listed.

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Digital Analysis Techniques

This section contains primarily studies dealing with digital analysis of MSS data, however a few articles discuss digital analysis of color and color infrared photography. Scientists have found that digital analysis of Landsat MSS data can reduce compilation time and increase the accuracy of soil surveys. Others have shown the utility of digital analysis techniques in identifying soil properties, limitations, and capabilities. The use of digital analysis techniques by soil scientists is relatively recent.

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