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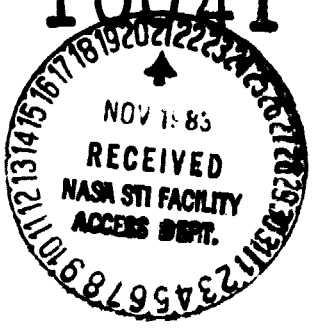

ANALYSIS OF THE QUALITY OF IMAGE DATA ACQUIRED BY THE LANDSAT-4 THEMATIC MAPPER (TM) OF THE BLACK HILLS AREA, SOUTH DAKOTA

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ANALYSIS OF THE QUALITY OF IMAGE DATA ACQUIRED BY THE LANDSAT-4 THEMATIC MAPPER (TM) OF THE BLACK HILLS AREA, SOUTH DAKOTA

Introduction

As investigators in the NASA-sponsored program (termed LIDQA) to analyze the initial data products received from the Landsat-4 spacecraft, our research team at the University of California is focusing on the analysis of Thematic Mapper (TM) and Multispectral Scanner (MSS) data in both film and digital tape format for the detection and identification of renewable resources. This preliminary study was designed as a "quick reaction" project to gain familiarity with the sensor specifications, format of the digital tape data, and characteristics of the film products during the early phase of the LIDQA investigation prior to Landsat-4 data acquisition over our California test sites. To meet our early results objectives this initial project was designed to evaluate Landsat-4 TM and MSS data acquired over the Black Hills area of South Dakota, an area composed of multiple renewable resources and within the range of the X-Band receiving station at NASA-Goddard Space Flight Center (GSFC).

Objectives

The two major objectives of this project were: (1) to gain familiarity with the structure, format, and quality of the Landsat-4 TM & MSS photographic and digital products for one scene covering the Black Hills area of South Dakota; and (2) to determine the extent to which major resource categories can be detected and identified on various photographic products generated from a subset of TM spectral bands and from all bands of the MSS.

Approach

1. To accomplish the first objective, both the photographic and digital products were studied by both resource analysts and computer systems analysts.

   Resource analysts were to gain familiarity with the high resolution film products by comparing the actual products (241mm B&W, Color Composties) with published specifications in terms of film type, film format, film mode, image dimensions, annotation line data, gray scale consistency, resolution pattern useability, registration mark accuracy, and compositing ability from individual B&W frames of each spectral band.

   Computer systems analysts with the resource analysts were to gain familiarity with the digital products (CCT) by comparing the CCT data of the Black Hills with the NASA-GSFC published tape format and

structure documents. This was to include a) gaining an understanding of the VAX, VMS-based tape format, b) reformating the CCT to comply with in-house image display hardware and software formats, c) displaying and photographing various combinations of bands, and b) determining potential image display and analysis problems due to Landsat-4 format and structure in comparison with existing in-house Landsat display and analysis algorithms.

2. To accomplish the second objective, our proposed research was to focus on the spectral and spatial characteristics of the Landsat-4 photographic products (photographic products received from GSFC and in-house generated photographic products from the digital data). A small set of examples from a number of major resource categories found in the Black Hills Area were to be selected for conducting photo-interpretation tests. The major resource categories selected were in forested, agricultural and urban environments.

Results and Discussion

For the first objective, resource analysts at our facility reviewed documentation made available by the Landsat Science Office at NASA-GSFC prior to receipt of any spectral data in photographic or digital form. These documents included the Landsat-D Assessment System (LAS) Computer Compatible Tape (CCT) format[1]; the Landsat-4 World Reference System (WRS) Users Guide[2]; the TM CCT-PT format and geometric correction system documentation[3,4], and the 241mm photographic film format document[5].

Once spectral data were received in film format, analysts gained familiarity with the black and white film products produced by the LAS high resolution laser beam film recorder by comparing published specifications with the characteristics evident on the film products. Useability of the resolution pattern was not evaluated as the film was produced without this pattern.

Familiarity with the digital products was accomplished by creating disk files on our interactive data analysis system and extracting the spectral statistics for selected agricultural features. By processing, reformatting, creating files, displaying and photographing various spectral band combinations for known areas on the ground, analysts gained a working knowledge of how best to manipulate the digital data with the large record size of the LAS-Scrounge CCT-PT, on a small mini-computer system.

To accomplish the second objective, we selected several sites representing a number of major resource categories in forested, agricultural, and urban environments from which to develop image interpretation keys. Development of the keys required a limited amount of field data collection in the study area. Collection of field data in the Black Hills relative to various categories of wildland, agricultural and urban/suburban resources was accomplished during the summer of 1982. This work centered on the selection of outstanding features which depict the test site and demonstrate the differences in local conditions. For each such feature, matched pairs of natural color and color

infrared photographs were taken, in stereogram form, both from the ground and from a light aircraft which was flown over the terrain at an altitude of approximately 1500 feet. Construction of the keys in preparation for testing has been accomplished as was described in our Interim Report.[6]

As Landsat-4 data from the Black Hills area could not be furnished by NASA for technical reasons, we completed our analysis under this purchase order by using the spectral data from the first acquisition of one of our agricultural test sites in California. This acquisition occurred on December 8, 1982 for WRS Path 43 Row 34. Our preliminary analysis of selected areas within this scene focused on the spectral characterization of agricultural crops, the results of which were reported at the Landsat-4 Early Results Symposium.[7]

Summary

This initial project provided us the opportunity to review existing documentation on the Landsat-4 system and to begin the analysis of both Landsat-4 TM and MSS data for selected resource features.

Based on this preliminary analysis we found the overall spectral, spatial and radiometric quality of the TM data to be excellent. Agricultural fields of variable shape, size, and orientation were detected with relative ease. The addition of the short-wave infrared band (TM5) has significantly improved our ability to detect and identify crop types on single date imagery. The TM data will be extremely valuable for estimating crop type and area proportions, updating agricultural land use survey maps, defining field boundaries and determining the size and location of individual farmsteads.

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