

Landsat

DATA USERS NOTES



SUPPLEMENTAL ISSUE

JULY 1985

COLOR BALANCE FOR THEMATIC MAPPER: AN IMPROVED IMAGE ARCHIVE

The increased availability of Thematic Mapper (TM) data from Landsat 5 has resulted in multiple orders for TM color products using bands 2, 3, and 4. Since this combination is more compatible in spectral range to MSS bands 1, 2, and 4, the standard TM false-color composite provided by NOAA will now be made using TM bands 2, 3, and 4 with new photographic look-up tables. This report traces the evolution of the methods used to achieve the color products now available to Landsat users. Its purpose is to in-

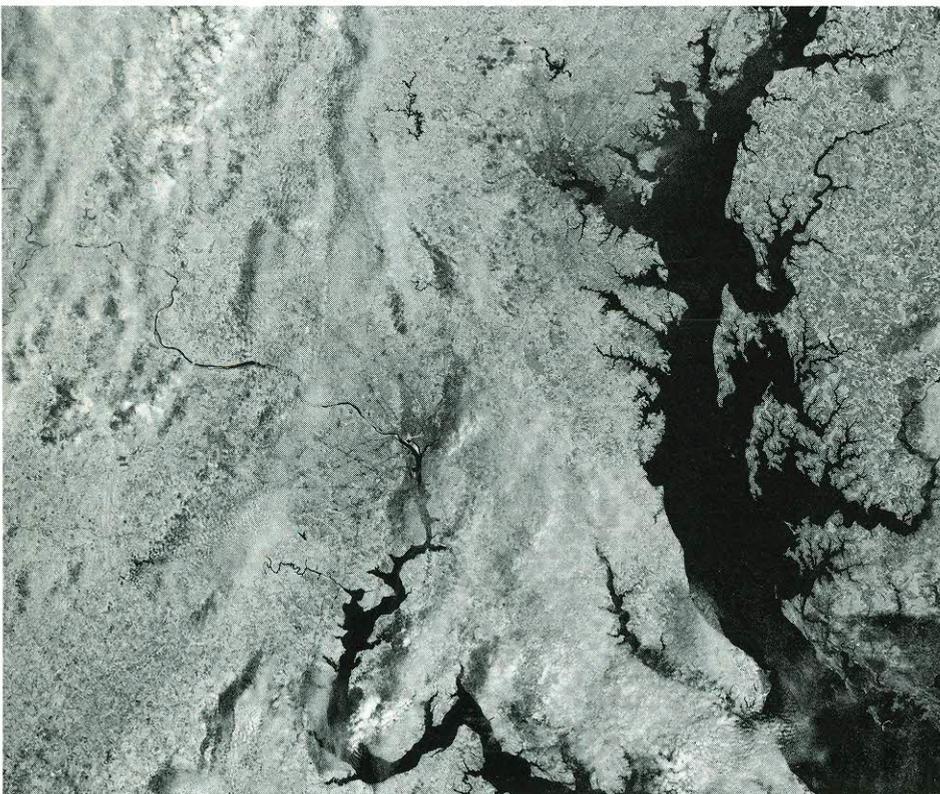
form TM data users of NOAA's progress in establishing a compatible TM/MSS color balance characterization. This color balance scheme will be applied to all archival photographic products produced after July 1, 1985.

Background

The TM was conceived by NASA as a second-generation instrument relative to the Multispectral Scanner System (MSS). As such it was principally designed to observe vegetation cover and provide a better measure of crop acreages in regions or countries with small fields. To aid in this assessment, a 30-meter spatial resolution was adopted along with some "sharpening" of the spectral bands.

The objective of early TM image evaluations using data acquired from Landsat 4 was designed to characterize sensor response and verify the utility of the TM for special applications. These studies were carried out by principal investigators funded by the NASA Science Office. Most principal investigators performed digital analyses using single scene data acquired over predetermined areas of the Earth's surface. Scientific results for each scene were categorized using digital data analysis techniques for the single acquisition received. A series of applications results were derived by these investigators. All results were taken from Landsat 4 acquisitions in the fall of 1982. When color composites were required to illustrate a point, they were generated through the use of special photoprocessing techniques to enhance specific features in each scene.

Multitemporal investigations were also planned and funded. However, the priority of these investigations was reduced when the Landsat 4 TM was effectively lost February 14, 1983 (approximately 7 months after launch) due to a combination of the loss of the X-band transmission capability and the eventual failure of two of the four solar array panels. Prior to this time, 11,000 TM scenes had been acquired worldwide. Approximately 8,000 of these covered the USA and were candidates for processing. However, due to the lack of a high volume production facility at the time of launch, the data on hand were processed on an alternate system capable of only one full scene each day of operation. This limitation resulted in very selective image processing. Furthermore, since there were no TM scenes available from Landsat 4 that were acquired during the spring and early summer growing seasons, the film look-up tables (see September 1983 Landsat Data



Landsat 5 Thematic Mapper scene of Washington, D.C. area generated using the new photographic look-up table (Band 4). Scale, approximately 1:1,500,000. Displayed is the central portion of scene 80099-18143 (Engineering roll 8811923), acquired in June 1984.

Users Notes) were applicable only to fall acquisitions.

Transition to NOAA

Landsat 5 was launched on March 1, 1984, at which time the NASA Thematic Mapper Image Processing System (TIPS) was in the final development phase and capable of only limited operation to support research and development. TIPS was to produce twelve full TM scenes per day for the archive, with this throughput volume of data to be increased significantly after the development phase was completed. Prior to the transition of TIPS to NOAA on September 1, 1984, all activities associated with ground processing were directed toward assuring that the complex of hardware and software required for TM operations met production throughput goals. As a result of these priorities, no attempt was made by NASA to optimize color balance.

Initial attempts by NOAA to make Landsat 5 MSS and TM photographic images look alike using TIPS were not totally successful for data acquired in any season other than fall. False-color composite images generated using black and white TIPS transparencies from bands 2, 3, and 4 were poorly suited for agronomic analysis. The images had an overall bluish cast; subtle vegetation stress signatures were not as evident, and the effects of soil moisture were more difficult to discern. Other users, accustomed to the MSS color scheme, also found the TM images unsuitable for their application when established interpretation criteria were applied to the photographic data. Subsequent analysis of the problem indicated that, with modification to the film production system, MSS and TM images from TIPS could be made to have similar color balance.

Color balance nearly identical to MSS "bench mark" images was achieved through the remapping of TM digital values. The remapping was based on a Landsat 5 data set consisting of several portions of a late June 1984 agricultural scene acquired simultaneously by MSS and TM. The scene included large fields, extensive forested areas, multiple cultural features and a variety of different vegetative cover types. Also, due to localized drought conditions and the presence of some irrigated fields, a wide range of crop conditions was evident. Sample sizes were selected from ten different

scene components to provide a wide range of spectral data. The sample sizes ranged from 400 MSS pixels for cultural features to over 22,000 pixels for forested areas. Data for each common area were extracted from computer-compatible tapes for both MSS and TM. These common data were remapped from TM to MSS equivalent digital values through using a linear regression.

Using these data, a new photographic look-up table for Landsat 5 data was created. This table (Table 2) should be contrasted with the earlier result (Table 1). Note that in Table 1, the look-up table values for bands 2 and 3 were the same at each step and bands 4 and 5 were equivalent in the same manner. In the current scheme, a single look-up table applies to

bands 1, 2, 3, and 4. Furthermore, in each of these bands, the photographic response curve shifted away from the original shape presented in 1983.

Figures 1 through 16 have been prepared to illustrate the difference in black and white photographic products when the new look-up tables are applied. Each group of four figures contains two images and two plots. These figures were generated for a scene containing coverage of Kemmerer and Green River, Wyoming (southwest corner of state). This scene (path 37, row 31, from June 18, 1984) was selected for this analysis because of its wide variety of ground feature types. Each image pair illustrates the overall upgrade in image definition achieved by using the

| Digital Value | Linear Gray Scale Density | Band 1 Density | Bands 2 & 3 Density | Bands 4 & 5 Density | Band 6 Density | Band 7 Density |
|---------------|---------------------------|----------------|---------------------|---------------------|----------------|----------------|
| 0 | 2.20 | 2.20 | 2.20 | 2.20 | 2.20 | 2.20 |
| 16 | 2.07 | 2.17 | 1.55 | 1.69 | 2.20 | 1.32 |
| 34 | 1.93 | 2.02 | 0.98 | 1.35 | 2.16 | 0.88 |
| 50 | 1.80 | 1.56 | 0.64 | 1.12 | 2.01 | 0.66 |
| 68 | 1.67 | 1.12 | 0.41 | 0.90 | 1.76 | 0.50 |
| 84 | 1.53 | 0.87 | 0.32 | 0.75 | 1.50 | 0.41 |
| 102 | 1.40 | 0.65 | 0.28 | 0.60 | 1.20 | 0.34 |
| 118 | 1.27 | 0.50 | 0.26 | 0.50 | 0.95 | 0.30 |
| 136 | 1.13 | 0.39 | 0.25 | 0.40 | 0.70 | 0.27 |
| 152 | 1.00 | 0.33 | 0.24 | 0.34 | 0.49 | 0.25 |
| 170 | 0.87 | 0.30 | 0.23 | 0.30 | 0.32 | 0.23 |
| 186 | 0.73 | 0.27 | 0.22 | 0.26 | 0.24 | 0.22 |
| 204 | 0.60 | 0.25 | 0.21 | 0.24 | 0.22 | 0.21 |
| 220 | 0.47 | 0.23 | 0.20 | 0.22 | 0.20 | 0.20 |
| 238 | 0.33 | 0.21 | 0.20 | 0.21 | 0.20 | 0.20 |
| 255 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |

Table 1. Old TM Look-up Table, Showing Input Digital Value Versus Output Density. Published in September 1983 issue of Landsat Data Users Notes

| Digital Value | Linear Gray Scale Density | Bands 1, 2, 3, 4 Density | Band 5 Density | Band 6 Density | Band 7 Density |
|---------------|---------------------------|--------------------------|----------------|----------------|----------------|
| 0 | 2.20 | 2.30 | 2.20 | 2.20 | 2.20 |
| 16 | 2.07 | 1.67 | 1.69 | 2.20 | 1.32 |
| 34 | 1.93 | 1.43 | 1.35 | 2.16 | 0.88 |
| 50 | 1.80 | 1.26 | 1.12 | 2.01 | 0.66 |
| 68 | 1.67 | 1.10 | 0.90 | 1.76 | 0.50 |
| 84 | 1.53 | 0.97 | 0.75 | 1.50 | 0.41 |
| 102 | 1.40 | 0.85 | 0.60 | 1.20 | 0.34 |
| 118 | 1.27 | 0.75 | 0.50 | 0.95 | 0.30 |
| 136 | 1.13 | 0.65 | 0.40 | 0.70 | 0.27 |
| 152 | 1.00 | 0.57 | 0.34 | 0.49 | 0.25 |
| 170 | 0.87 | 0.49 | 0.30 | 0.32 | 0.23 |
| 186 | 0.73 | 0.43 | 0.26 | 0.24 | 0.22 |
| 204 | 0.60 | 0.37 | 0.24 | 0.22 | 0.21 |
| 220 | 0.47 | 0.33 | 0.22 | 0.20 | 0.20 |
| 238 | 0.33 | 0.28 | 0.21 | 0.20 | 0.20 |
| 255 | 0.20 | 0.24 | 0.20 | 0.20 | 0.20 |

Table 2. New TM Look-up Table, Showing Input Digital Value Versus Output Density

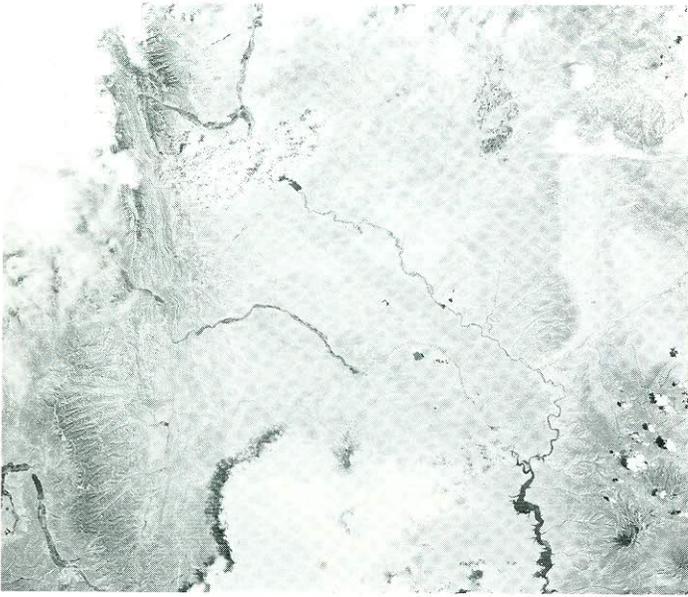


Figure 1 - Landsat 5 Thematic Mapper scene using old photographic look-up table (Band 1). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene Y50109-17295 (Archive roll 8420001).

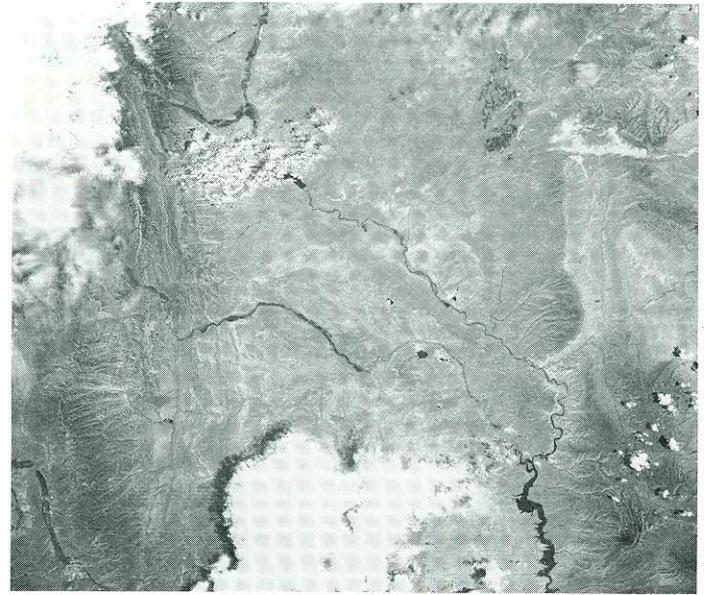


Figure 2 - Landsat 5 Thematic Mapper scene using new photographic look-up table (Band 1). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene 50109-17295 (Engineering roll 8511925).

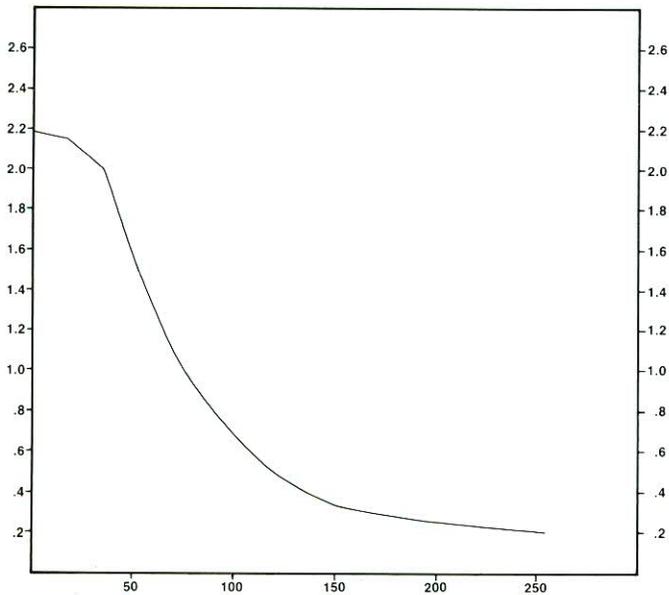


Figure 3 - Plot of TM Band 1-derived density transformation curve used to generate Figure 1, published in September 1983 issue of Landsat Data Users Notes.

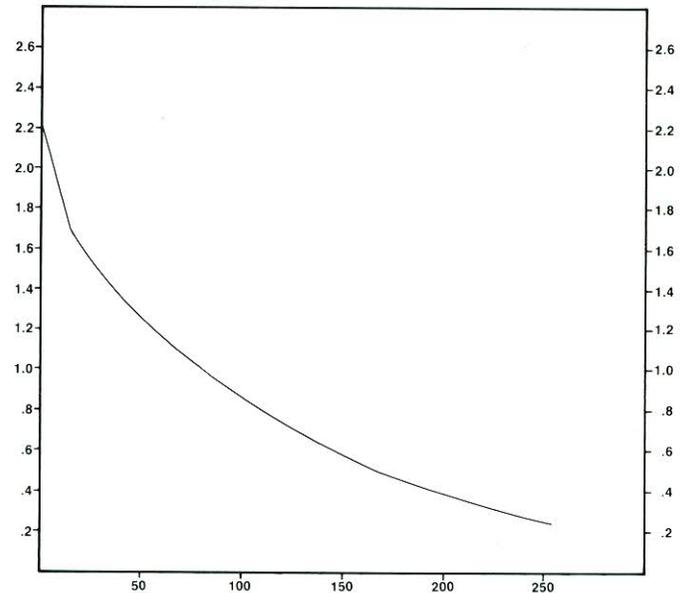


Figure 4 - Plot of TM Band 1 density transformation curve used to create Figure 2.

new look-up table. The photographic characteristic curve used to process each image has been plotted directly beneath its display. For example, Figure 3 is the curve used to generate Figure 1 and, similarly, Figure 4 is the curve used to generate Figure 2.

The transparencies used to produce these black and white products were used to produce the TM false-color composites presented as Figures

17 and 19. Figure 18 is the equivalent MSS false-color composite. The MSS data were acquired at the same time as the TM data and are representative of the data archived for this scene. Comparison of these figures illustrates that this more recent version of TM color is a close match to the MSS product.

In order to pursue this point, an expanded data set was considered. Figures 20, 21 and 22 are presented

to provide information relative to how these transformations improve data acquired over desert regions.

Multi-temporal and multi-satellite data are illustrated in Figures 23, 24, 25, and 26. These figures contain false-color composites for TM and MSS from Landsats 4 and 5. Figures 23 and 24 should be compared for TM to MSS color balance as should Figures 25 and 26. Though the match is not perfect, it is sufficient

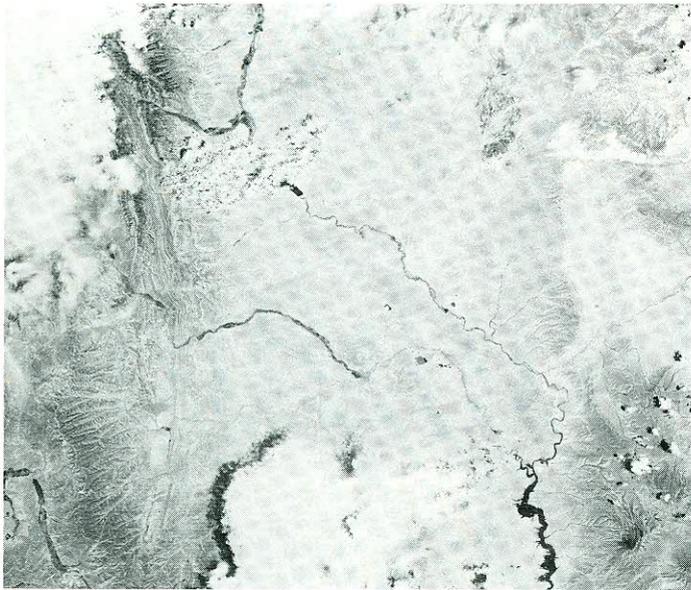


Figure 5 - Landsat 5 Thematic Mapper scene using old photographic look-up table (Band 2). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene Y50109-17295 (Archive roll 8420001).

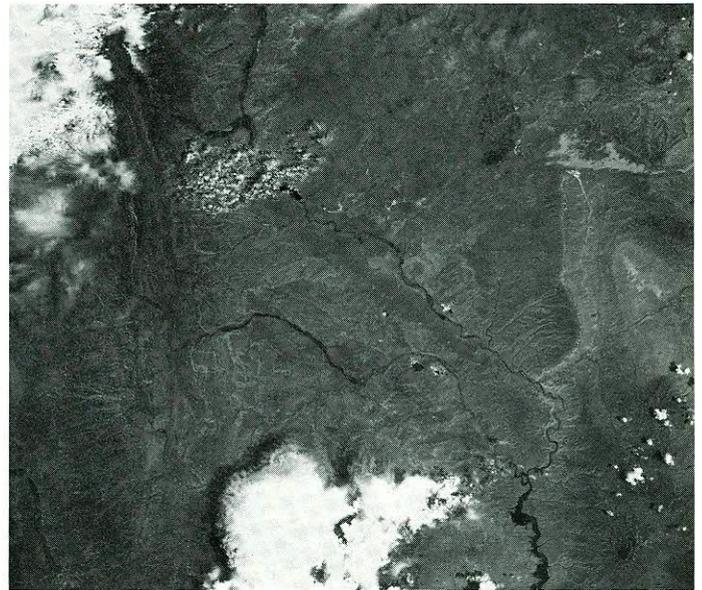


Figure 6 - Landsat 5 Thematic Mapper scene using new photographic look-up table (Band 2). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene 50109-17295 (Engineering roll 8511925).

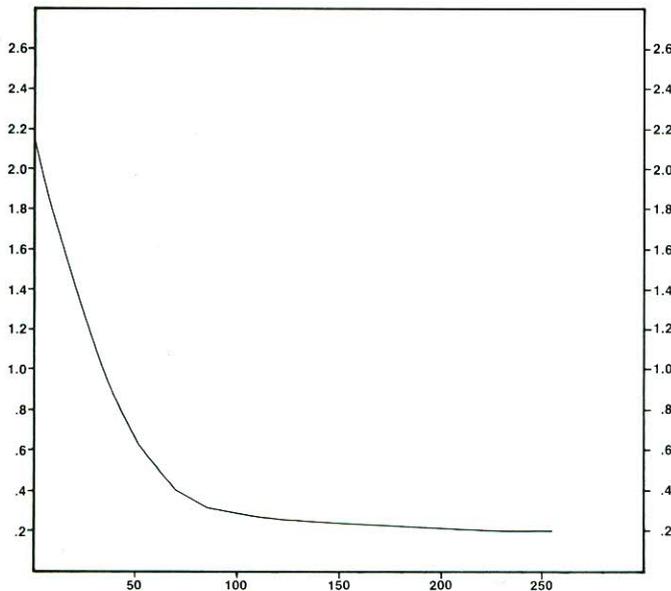


Figure 7 - Plot of TM Band 2-derived transformation curve used to generate Figure 5, published in September 1983 issue of Landsat Data Users Notes.

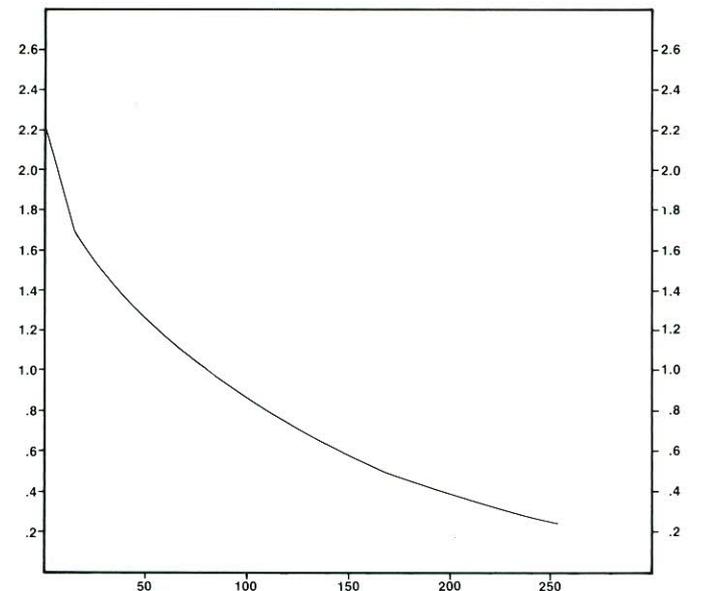


Figure 8 - Plot of TM Band 2 density transformation curve used to create Figure 6.

to provide a standard means of assessing the photographic data archive. Furthermore, comparison of Figures 23 and 25 illustrates the multi-temporal color change to be expected with TM. Figures 24 and 26 illustrate this same effect for MSS.

In summary, it can be stated that this set of look-up tables for TM bands 2, 3, and 4 produces both black and white and false-color composite images that have more defini-

tion than was possible using the old transformation. These tables will be applied to all photographic data processed after July 1, 1985. Computer search listings for these data will be marked with "NOAA RAD LOOK UP NO. 1."

On a related note, NOAA wishes to remind users that developmental work continues on black-and-white TM scenes over areas of very low or high reflectance. As pointed out in

the December, 1984 issue of this publication, there is concern over a lack of sufficient contrast in such TM scenes.

Questions, comments, or requests for further information can be directed to: NOAA Customer Services, Mundt Federal Building, Sioux Falls, SD 57198. Telephone: (605) 594-6151.

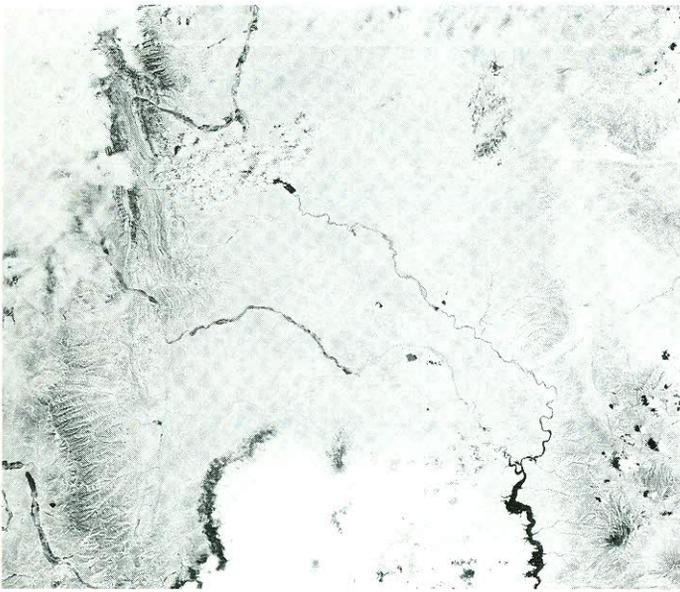


Figure 9 - Landsat 5 Thematic Mapper scene using old photographic look-up table (Band 3). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene Y50109-17295 (Archive roll 8420001).



Figure 10 - Landsat 5 Thematic Mapper scene using new photographic look-up table (Band 3). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene 50109-17295 (Engineering roll 8511925).

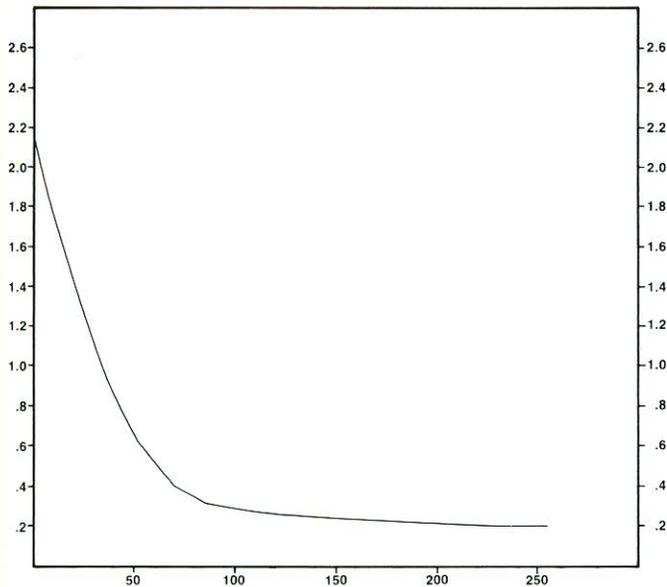


Figure 11 - Plot of TM Band 3-derived density transformation curve used to generate Figure 9, published in September 1983 issue of Landsat Users Notes.

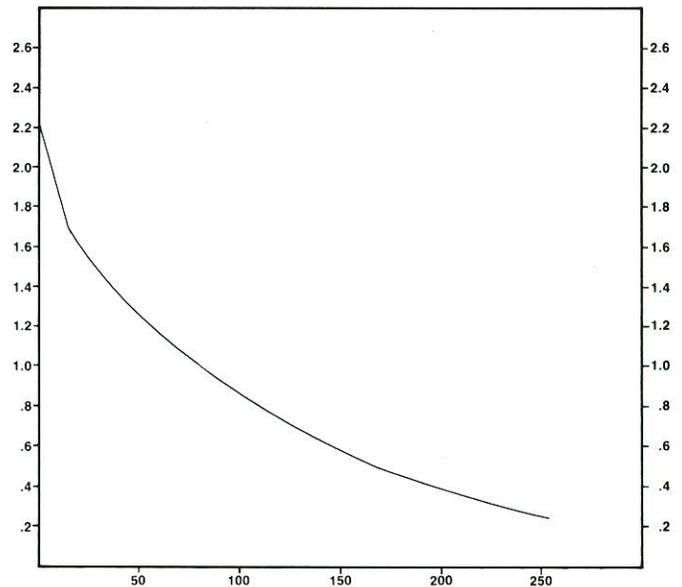


Figure 12 - Plot of TM Band 3 density transformation curve used to create Figure 10.

Details of the mathematical transformations used in the previous article will be presented at the 1985 ACSM-ASPRS convention to be held in Indianapolis, Indiana. The paper, co-authored by B.P. Clark and A.J. Johnson, has the title: **"Creation of an Optimized Color Balance for TM and MSS Imagery."**

NEW STANDARD TM COLOR COMPOSITE

As indicated in the lead article, the standard TM false-color composite indicator in the Landsat data base has been changed from Bands 1, 3, and 4 to Bands 2, 3, and 4. This change was made to assist the user community in comparing MSS and TM data. The choice of Bands 2, 3, and 4 from the TM sensor more closely

represents the spectral regions that MSS users are familiar with from MSS color composites of Bands 1, 2, and 4 (Bands 4, 5, and 7 for Landsats 1, 2, and 3). The flags of the existing Landsat 4 and 5 TM color composites have been changed in the data base to reflect this. In addition, the research or computer inquiry function has been modified to flag the existence of non-standard color composites as follows.

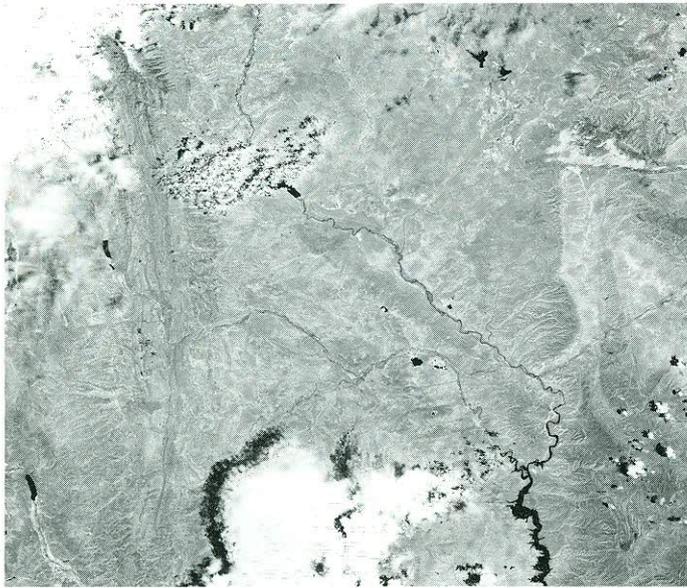


Figure 13 - Landsat 5 Thematic Mapper scene using old photographic look-up table (Band 4). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene Y50109-17295 (Archive roll 8420001).

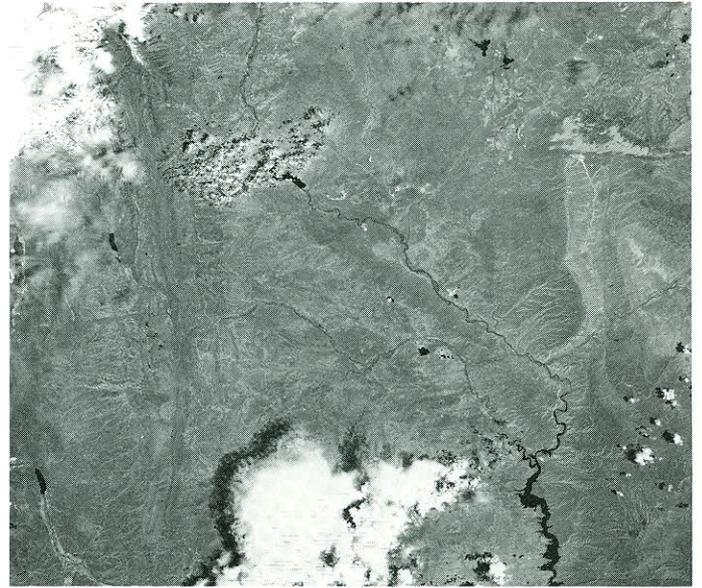


Figure 14 - Landsat 5 Thematic Mapper scene using new photographic look-up table (Band 4). Southwest Wyoming. Scale, approximately 1:2,000,000. Major portion of scene 50109-17295 (Engineering roll 8511925).

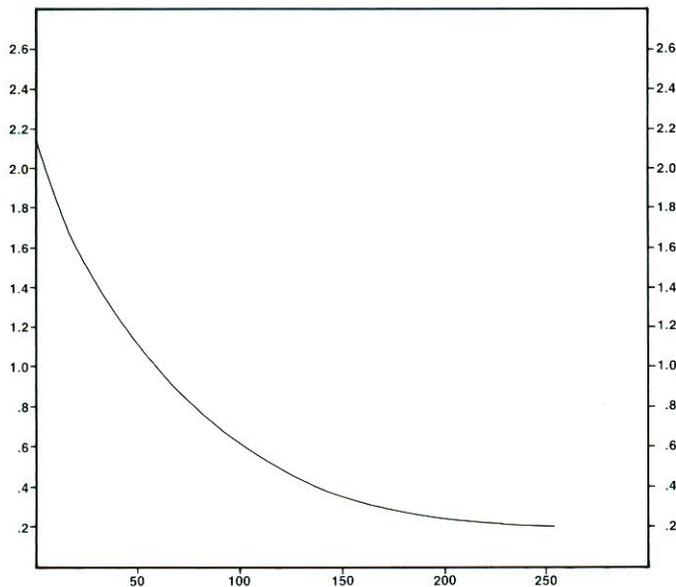


Figure 15 - Plot of TM Band 4-derived density transformation curve used to generate Figure 13, published in September 1983 Issue of Landsat Data Users Notes.

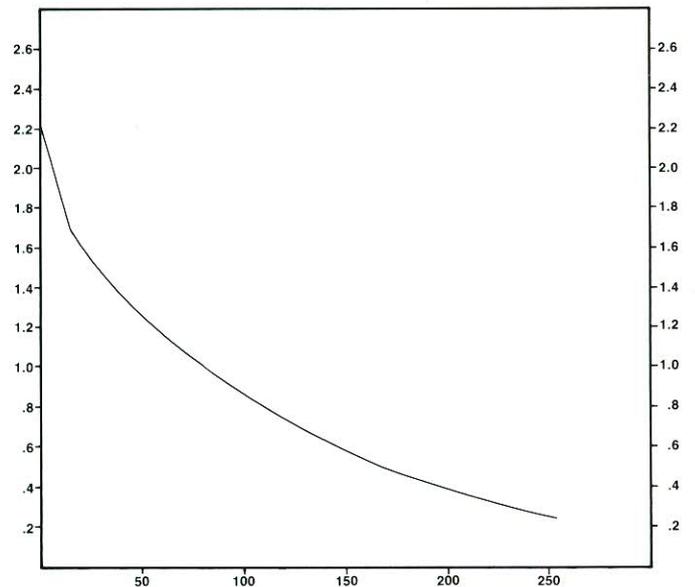


Figure 16 - Plot of TM Band 4 density transformation curve used to create Figure 14.

In the computer inquiry printout, the color composite field will contain a number if a standard composite exists; this number is an assigned color composite quality indicator. If the standard composite does not exist but a non-standard composite does, (for example, a Band 1, 2, 3 "natural color" composite), then the field will contain the character "U" for unique. If neither exists, the field will contain a "P" for possible; that is, no

color composite has been attempted, but could be. An "N" indicates that a color composite cannot be made.

NOAA expects that this change to the TM data base and the upgrade to the research capability will assist our TM customers.

TM PRODUCTION GOALS AND ARCHIVE HOLDINGS

NOAA has established the following production goals for the Thematic Mapper Image Processing System (TIPS): 25 film scenes and 10 CCT scenes per day, 7 days a week. The TM HDT-A archive at Goddard Space Flight Center contains approximately 50,000 scenes of Landsat 4 and Landsat 5 data at various levels

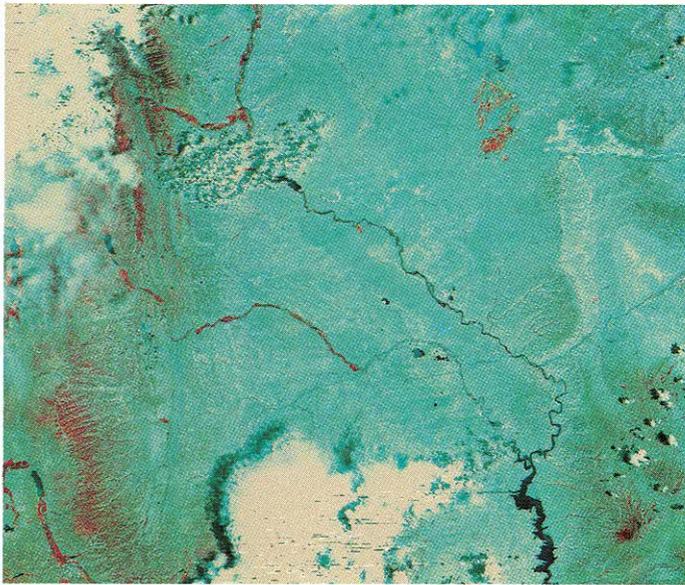


Figure 17 - TM false-color composite of Bands 2, 3, and 4 generated using the old look-up tables (Archive roll 8420001.)

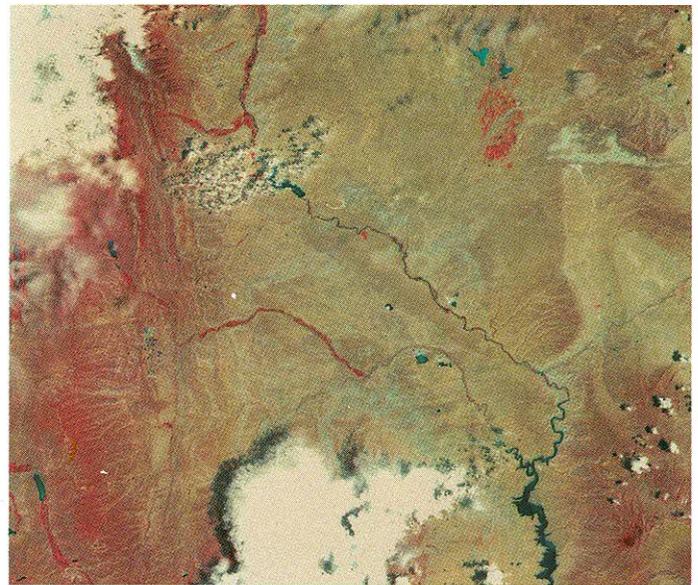


Figure 18 - Standard MSS false-color composite, Bands 1, 2, and 4. (Archive roll 5402.)

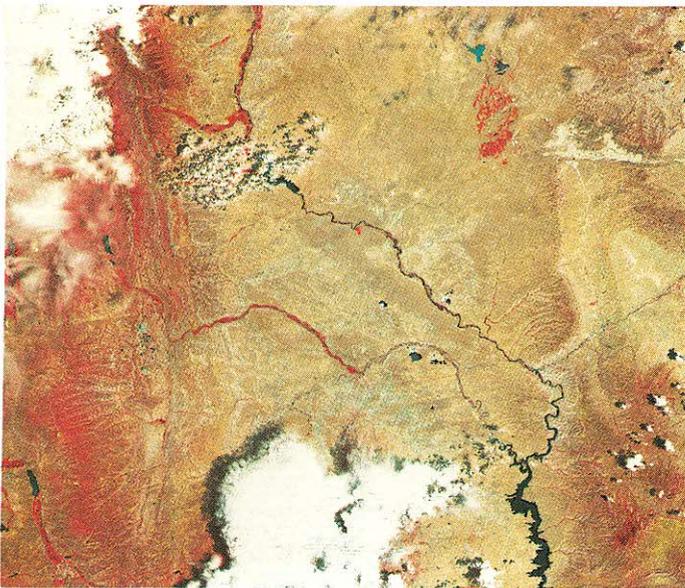


Figure 19 - TM false-color composite of Bands 2, 3, and 4 generated using the new look-up tables (Engineering roll 8511925).

LEGEND

- Figures 17 and 19 represent false-color products before and after using the new look-up table.
- Figures 17 and 18 illustrate the lack of comparison between MSS and TM prior to the transformation.
- Figures 18 and 19 illustrate the color relationship achieved between MSS and TM with the new look-up table.
- Figures 17, 18 and 19 are images from the southwest corner of Wyoming. Scale, approximately 1:2,000,000. The prints are major portions of scene 50109-17295 (acquired 6-18-84).

of cloud cover. Production of TM data for customers and the film archive has resulted in 6948 TM scenes produced by April 30, 1985. These products are archived at Sioux Falls as follows:

TM Film Scenes

| | |
|-----------|-------|
| Landsat 4 | 1,176 |
| Landsat 5 | 5,772 |

Total Film Scenes: 6,948

TM CCT Quads

| | Corrected (P data) | Uncorrected (A data) |
|-----------------------------|-----------------------|-------------------------|
| Landsat 4 | 971 | 136 |
| Landsat 5 | 6,151 | 643 |
| TOTAL CCT QUADS: | 7,122 | 779 |

As NOAA has gained production experience, certain timelines have emerged. For acquisition data, the timeline from satellite passage to the entry of archive data at Sioux Falls has been about 20 days. This is a reasonably acceptable timeline based

on the data collection and distribution system in place. For retrospective orders, turnaround performance is somewhat higher for two reasons. First, TIPS is structured to process data in continuous swaths rather than as single scenes. Secondly, older data, especially those acquired before September 1, 1984, have proven difficult to recover and process. NOAA management intends to continue to refine the system so that customers can receive data in the quickest possible time.



Figure 20 - TM false-color composite of bands 2, 3, and 4, generated using old look-up table. (Archive roll 8503641.)



Figure 21 - Standard MSS false-color composite. (Archive roll 6170.)

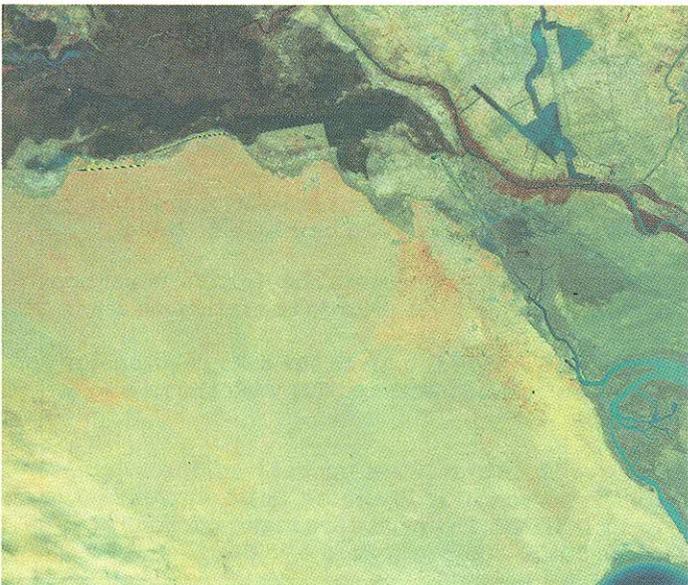


Figure 22 - TM false-color composite of bands 2, 3, and 4, generated using new look-up table. (Engineering roll 8511924.)

LEGEND

- Figures 20, 21, and 22 are images from the Middle East. Scale, approximately 1:2,000,000. The prints are major portions of scene 50325-06522 (acquired 1-20-85).
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LANDSAT IMAGE DATA QUALITY ANALYSIS

The LIDQA Final Symposium, concerning **Utilization of Landsat 4 and 5 TM and MSS Data**, jointly sponsored by NASA and the American Society of Photogrammetry and Remote Sensing (ASPRS), will be part of the fall 1985 ACSM/ASPRS Convention to be held in Indianapolis, Indiana, September 9-11, 1985. Topics to be addressed include:

- | | | | |
|------------------------|---------------------------|-------------------------|---------------------|
| •TM Sensor Performance | •TM Image Product Quality | •Information Extraction | •Data Applications |
| -Radiometric | -Radiometric | Techniques for TM Data | -TM |
| -Geometric | -Geometric | | -TM relative to MSS |

For further information contact:

Brian L. Markham, Code 623, NASA/GSFC, Greenbelt, MD 20771, 301-344-5240

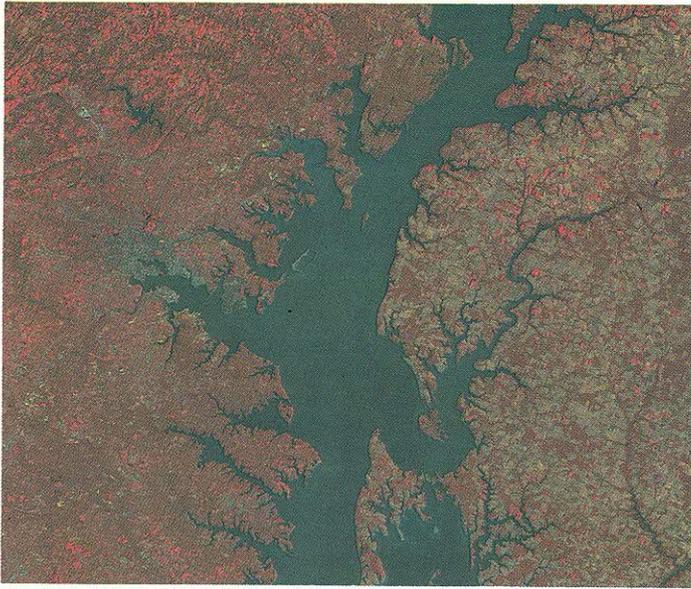


Figure 23 - A segment of quadrant 2 of the Baltimore/Chesapeake Bay area. Scale, 1:1,000,000. TM scene acquired in November 1982 by Landsat 4. Scene 40109-15135. (Engineering roll 8511922.)

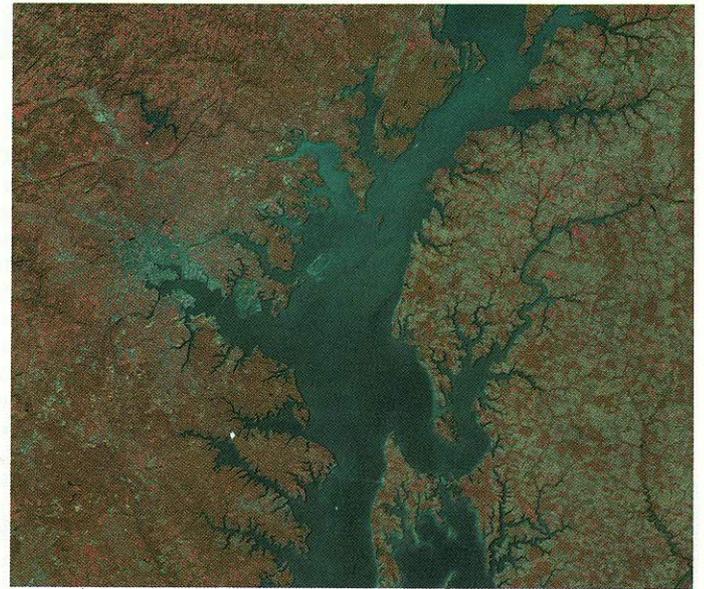


Figure 24 - A segment of quadrant 2 of the Baltimore/Chesapeake Bay area. Scale, 1:1,000,000. MSS scene acquired in November, 1982 by Landsat 4. Scene 840109-15140. (Archive roll 3847.)

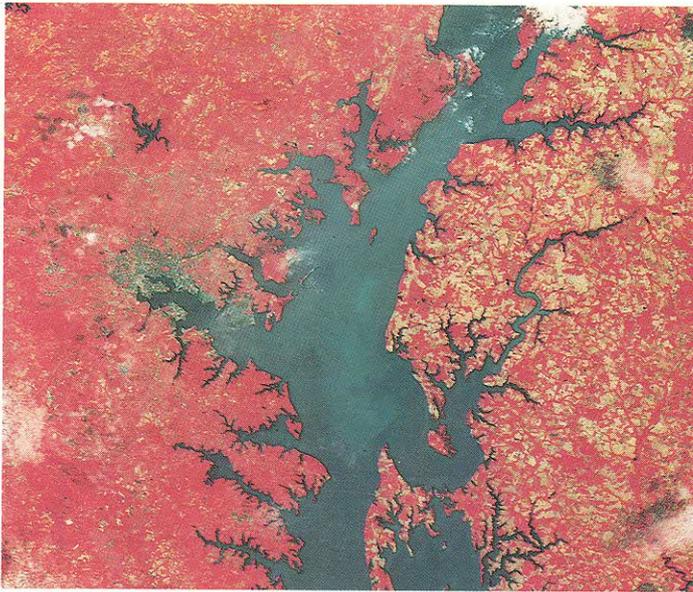


Figure 25 - A segment of quadrant 2 of the Baltimore/Chesapeake Bay area. Scale, 1:1,000,000. TM scene acquired in June, 1984 by Landsat 5. Scene 50099-15143. (Engineering roll 8511923.)



Figure 26 - A segment of quadrant 2 of the Baltimore/Chesapeake Bay area. Scale, 1:1,000,000. MSS scene acquired in June, 1984 by Landsat 5. Scene 850099-15143. (Archive roll 5372.)

LEGEND

- Sensor Comparisons: Comparison of Figure 23 with Figure 24 illustrates the match achieved between Landsat 4 MSS and TM data.
- Comparison of Figures 23 and 25 illustrates the type of seasonal variation expected from TM data.
- Comparison of Figures 25 and 26 illustrates the match between Landsat 5 MSS and TM data.
- Comparison of Figures 24 and 26 illustrates the seasonal variation to be expected from MSS data.

LANDSAT MICROFICHE

To better support Landsat customers, NOAA is offering a new format for the Landsat microform image reference system. Microfiche will replace the standard 16mm B&W roll microfilm. The change is being made for TM and MSS data processed after January 1, 1985. The new format will be less expensive (\$20 per set of 1200 scenes versus \$60 for a microfilm cassette of 1200 scenes) and it will be delivered much sooner than the roll microfilm has been. The microfiche image reference system will not change — scenes will continue to be randomly packed on the microfiche and be retrievable only through an INORAC or microCATALOG inquiry. The new microfiche references will be distinguishable from the roll film microform locations within the inquiry listings by a "D" prefix

(D7902310808, for example) instead of the roll film "B" prefix.

The range of microfiche locations for each image is noted in the upper left-hand corner. Each fiche holds 60 images. Each set is exclusive to one sensor type (MSS or TM) and has a uniquely-colored header (fiche title strip) throughout the set. Sequence numbers are in the upper right-hand corner to minimize filing problems (1 of 20; 2 of 20; etc.). In Figure 1, the microfiche image set number is D790231 and the frame or location is 0808 which will be on card 14, column 8, row 3. (See Figure 2).

The microfiche image sets are available in two forms: as a single set (20 cards/1200 scenes) and by calendar year subscription, January through December (20 cards/1200 scenes and as many sets as are pro-

duced in the calendar year). The cost for a single MSS or TM set is \$20.00. The cost for a calendar year subscription of MSS data is \$500.00. The calendar year subscription cost for TM is \$100.00. The MSS microfiche images are Band 2. Microfiche TM images are Band 3 or 6 (night-time data).

Regardless of order date, all subscriptions will run from January through December, ensuring receipt of a full year's data. Single microfiche image cards are not available for sale or distribution.

For more information regarding microfiche image reference data and other microfiche accession aids for Landsat, contact Landsat Customer Services, Mundt Federal Building, Sioux Falls, SD 57198. Telephone: (605) 594-6151.

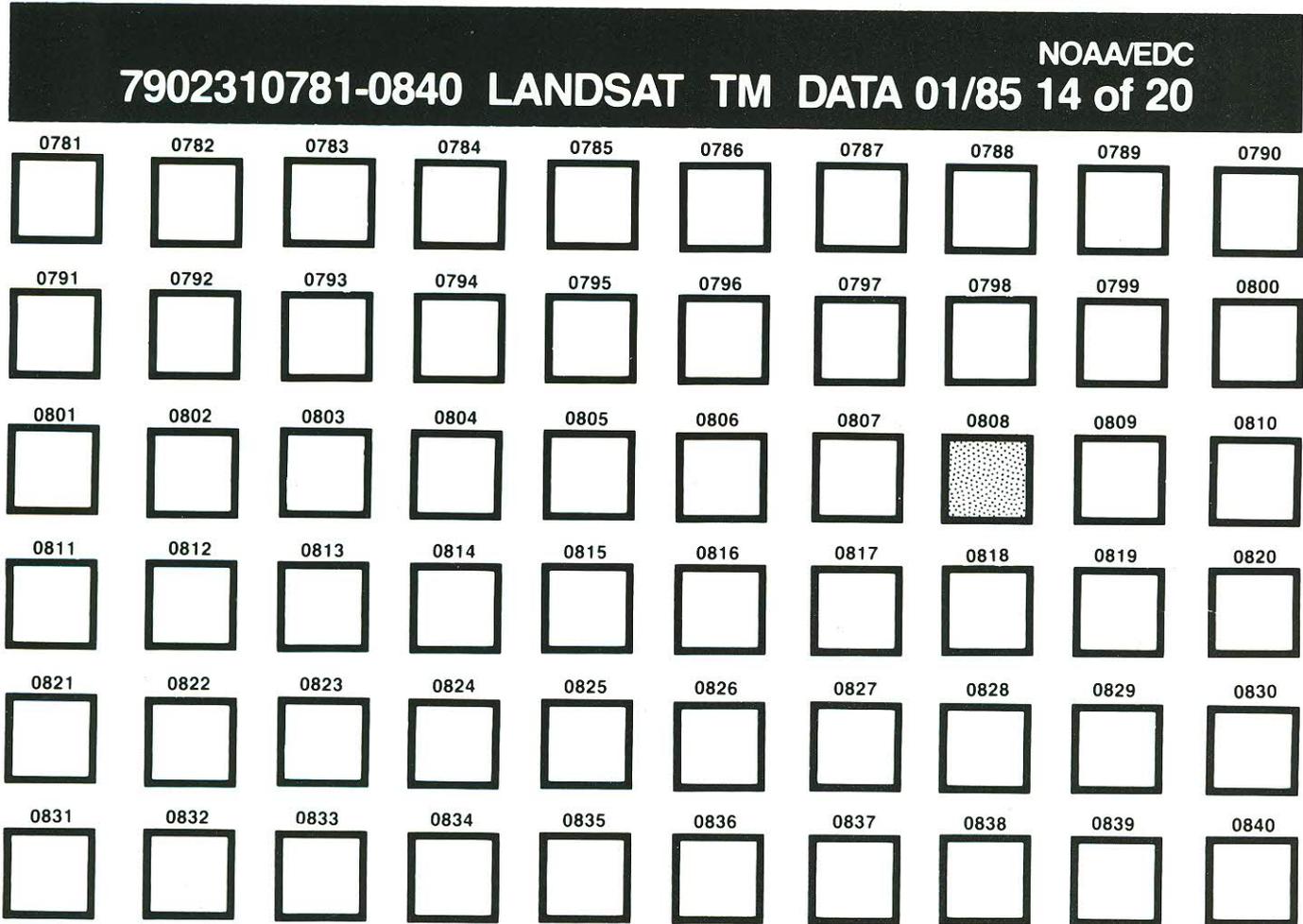
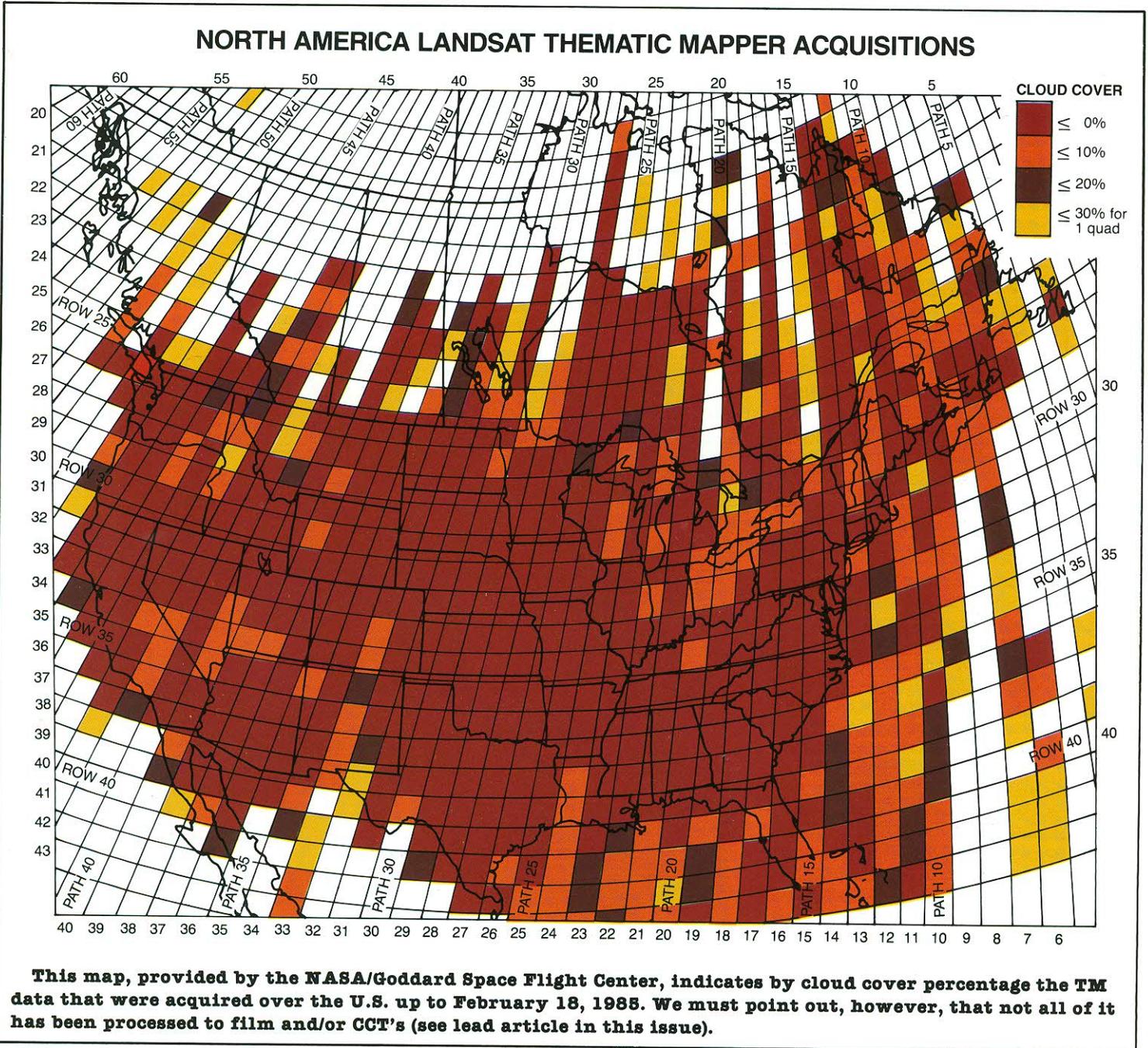


Figure 2.

| IMAGERY-TYPE | SCENE ID | FILM-SOURCE | QUALITY | CLOUD | EXPO-DATE | SCENE-CENTER-POINT | SCENE-SCALE | MICROFORM | COL | IN | DE | CCT |
|------------------------------|---------------|-------------|-------------|------------|-------------|------------------------|-------------|-------------|-----|------------|------------|-----|
| PATH= 17 ROW= 38 LANDSAT | ====> | ENG | RADIOMETRIC | CAL | DATA | <==== | | | | | | |
| LANDSAT-5 (TM) | Y5020915305XJ | 3&W=06.7" | 5565358 | 00X | 09726734 | N31046M005 W082003M005 | 131,000/000 | D7902310808 | P | * | * | 3 |
| CORNER POINT COORDINATES=#1: | N32D20M10S | W08D05M28S | #2: | N32D38M15S | W08D051M28S | #3: | N31D11M50S | W08D016M39S | #4: | N30D53M45S | W08D25M22S | |

Figure 1.- Example of computer printout for the scene in microfiche location D7902310808.





Pecora 10

The Tenth William T. Pecora Memorial Remote Sensing Symposium
August 20, 21, 22, 1985. Student Center, Colorado State University,
Fort Collins, Colorado

REMOTE SENSING IN FOREST AND RANGE RESOURCE MANAGEMENT

The Pecora Symposium will focus on research and development in remote sensing of forest and rangeland resources and related fields. The meeting will cover basic research as well as operational uses of sensor technology. Topics will include:

- INTEGRATED RESOURCE INVENTORY
- GEOGRAPHIC INFORMATION SYSTEMS APPLICATIONS
- LAND USE AND LAND COVER MAPPING
- CHANGE DETECTION AND MONITORING
- VEGETATION DAMAGE ASSESSMENT
- MAPPING SOIL AND WATER RESOURCES
- FIRE FUELS MAPPING
- MAPPING AND MONITORING WILDLIFE HABITAT
- GLOBAL RESOURCE ASSESSMENT
- NEW AND EMERGING TECHNOLOGY—DATA ACQUISITION
- NEW AND EMERGING TECHNOLOGY—DATA PROCESSING

Technology and scientific developments will determine how effectively remote sensing will be used in forest and range resource management. The symposium goal is to bring together managers, technologists, and scientists from private, government, and university sectors to display, present, and discuss the most recent research and application developments.

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