AUSTRALIAN LANDSAT STATION OPEN FOR BUSINESS

The Australian Landsat Station has been operating since last October. This station has acquired data since late 1979, but it was not until recently that it began production of photographic and digital products for regular sale to the public. The product formats are similar to those made available by other Landsat distribution centers around the world.

Complete pricing information and other details are available from:

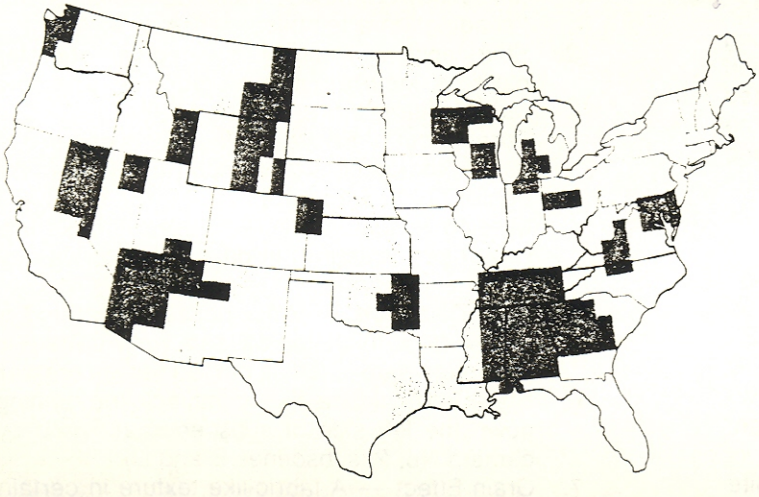
Australian Landsat Station
Data Processing Facility
P.O. Box 28
Belconnen, A.C.T. 2616, Australia
Telephone: (062)51 5411
Telex: 61510 (LANSAT)

HIGH-ALTITUDE PHOTOGRAPHY PROGRAM

During its first year in operation, the National High-Altitude Photography (NHAP) program has acquired over 200 rolls of both black-and-white and color-infrared photography. These data are part of a project established by the U.S. Geological Survey's National Mapping Division to acquire high-altitude photography of the contiguous United States for a national aerial photo data base.

The coverage obtained thus far falls over the areas indicated in gray on the accompanying map; acquisitions during 1981 will include the areas in blue.

All NHAP coverage is being encoded as geographically retrievable accessions in the Earth Resources Observation Systems (EROS) Data Center's main image file. In addition, microfiche reference aids have been prepared to facilitate manual selection and retrieval of the NHAP photographs. These consist of micrographic mapline plots indexed to the U.S. Geological Survey 1:1,000,000-scale map series.



Landsat Data Users NOTES

ISSUE NO. 16
JANUARY 1981

U.S. GEOLOGICAL SURVEY
EROS DATA CENTER
Sioux Falls, S. Dak. 57198

By noting an area of interest on the mapline plot and correlating it with the NHAP roll and frame number(s) that are also carried on each microfiche record, a user can easily obtain the necessary ordering information. Each microfiche record references a 2° by 6° geographic area (or half of a 1:1,000,000-scale map) for a single film type. The fiche will be updated on a continuing basis until completion of the NHAP program.

Orders for NHAP photographs and further information on any aspect of the NHAP program, including the microfiche reference aids, may be requested from the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605)594-6151.

ONBOARD TAPE RECORDER BACKUP PLAN

Early in 1980, the National Aeronautics and Space Administration (NASA) implemented a plan which will provide for the installation of ground-based tape recorders at several non-U.S. Landsat receiving stations. The recorders, to be capable of storing multispectral scanner (MSS) data in the format used by NASA's Image Processing Facility (IPF) at the Goddard Space Flight Center, were to provide a backup capability in the event that the Landsat 3 onboard recorders should fail.

Landsat 3 MSS data are no longer being received for reasons reported elsewhere in this newsletter. However, NASA will still proceed with the tape recorder backup plan, using the recorders to collect Landsat 2 data and, potentially, Landsat D data if necessary.

The ground-based tape recorders will be essential to the continued receipt of worldwide MSS coverage for key U.S. agricultural programs. In the absence of an onboard recording capability, they will permit real-time reception and storage of data in IPF-compatible format when the satellite is out of range of its U.S. receiving stations. The non-U.S. stations acquiring these data will thus be able to produce wideband video tapes which could be shipped to the United States for processing. The effect would be the same as if the satellite's onboard recorders had continued to operate, although the worldwide coverage would be more limited and the turnaround times would be slightly slower.

Currently under procurement with operation scheduled by mid-1981, the ground-based tape recorders will be capable of handling Landsat 2 MSS data and could be upgraded to handle Landsat D thematic mapper data if necessary. NASA plans to provide recorders to Australia, Brazil, and Sweden. Japan, a fourth country which will participate, is already equipped with IPF-compatible recorders. Site selection was based on agricultural requirements.

Interested readers may obtain further details on the MSS onboard tape recorder backup plan from Mr. James Welch, Resource Observation Division, NASA Headquarters, Code ER-2, 600 Independence Ave., S.W., Washington, D.C. 20546.

ONBOARD TAPE RECORDER EXPERIENCE

Recorder	Design Life	Status
Landsat 1		
Recorder 1	500 hr	Failed at 849 hr
Recorder 2	500 hr	Failed at 50 hr
Landsat 2		
Recorder 1	500 hr	Failed at 644 hr
Recorder 2	500 hr	Failed at 1,500 hr
Landsat 3		
Recorder 1	1,000 hr	RBV Only, - 425 hr*
Recorder 2	1,000 hr	Operational, - 760 hr*

*As of Dec. 12, 1980

RBV IMAGE DEFECTS

On September 1, 1980, the NASA Goddard Space Flight Center began processing Landsat 3 return-beam vidicon (RBV) data in a digital mode. These data are now being radiometrically and geometrically corrected and then sent via Domsat to the EROS Data Center (EDC) where they are converted to photographic and digital products. This is the same production operation that has been in effect for MSS data since February 1979.

Several visible anomalies have been identified in these RBV data, all of which are attributable to sensor characteristics. The anomalies sometimes result in loss of image data or in poor image quality, and, to complicate matters, they tend to appear randomly. Those discovered to date include:

1. Shading — A manifestation of differences in response to scene brightness across each camera lens. The two cameras additionally differ from one another in their overall sensitivity to scene brightness, although this is not "shading" in a technical sense.
2. Stairsteps — Anomalously regular stairstep patterns incurred in high-radiance and low-radiance areas of an image.
3. Corners out of Focus — Poorly focused image data in the corners as compared to data in the center of the subscene.
4. Missing Reseau Marks — Reseau marks that have been obscured in dark areas or washed out in bright areas.
5. Data Distortion — Minor horizontal shifting of image data which can cause a wavy pattern in the image data (such as curved reseau marks).
6. Black Vertical Line — A thin black line running down the left side of subscenes acquired by camera No. 2 (subscenes B and D).
7. Grain Effect — A fabric-like texture in certain areas of the subscene.

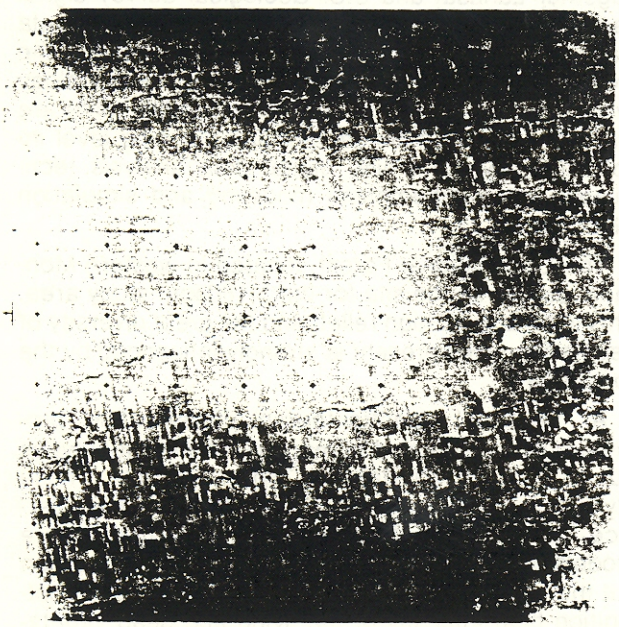
8. Faceplate Contamination — Dust specks or "burn-in" areas on the photoconductive layer of the camera.
9. Geometric Anomalies — Spatial distortion characterized by parallel lines in the left one-third of some subscenes.

Attempts to correct these problems through existing ground processing techniques have so far been unsuccessful.

Because the defects are sensor-caused, EDC Quality Assurance personnel are *not* downgrading image quality when they occur. The policy has been to assign a poor quality rating to an RBV image if a significant amount of image content has been lost. This ensures that RBV images which have defects, but which still retain their scientific usefulness, will remain available to the user public.

It should be noted that a sizable portion (up to 40 percent) of the RBV data now being processed are free of these defects or are affected in only a minor way.

Complete details on the current situation are contained in a handout which is being mailed to the Landsat Data Users NOTES readership. If after receiving it you have questions or desire additional copies, simply contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605)594-6151.



An RBV subscene exhibiting shading differences across the camera faceplate.

HURRICANE ALLEN

EDC has received two rolls of aerial photography taken over the Texas Gulf Coast soon after Hurricane Allen struck last summer. The coverage extends from Sabine Pass on the Texas-Louisiana border to the Rio Grande River, taking in a strip from 1 to 2 miles offshore to about 10 miles inland. Two flight lines were photographed, designed to focus on the barrier islands, lagoons, and bays. The photographs were taken on August 20, 1980, at an altitude of 60,000 feet. The mission number is 429, and both black-and-white (roll 1) and color-infrared photography (roll 2) at scales of 1:18,000 and 1:62,000, respectively, were acquired.

The eye of the storm hit South Padre Island about 48 km north of Laguna Beach, Port Isabel, Tex. The most vivid examples of breached beaches, highway destruction, and sand washover are contained on the color-infrared roll, frames 88-100. Further information on this aerial coverage may be obtained from the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6151.

LANDSAT 3 MSS PROBLEM

On December 17, 1980, an anomaly appeared in the data being returned from the Landsat 3 MSS. This anomaly has been traced to the electronic components which convert the analog detector voltages into the 64-level digital signal which is transmitted to the ground. The anomaly is such that the three least significant bits (level 1, 2, and 4) are absent (set to zero) whenever the fifth bit (level 16) is zero. When the fifth bit is set to one, the first three significant bits are normal. This results in output data which are accurate over some ranges of values and inaccurate by up to 7 levels in other output ranges as shown in the table below. This occurs in all bands.

Correct Data Level (normal)	Output Data Level (anomalous)
0-7	0
8-15	8
16-31	16-31
32-39	32
40-47	40
48-63	48-63

Because of this anomaly, NASA has decided not to operate the MSS on Landsat 3. (RBV operations on Landsat 3 will not be affected.) However, there are instances where even these anomalous MSS data may be useful for some purposes; in these cases NASA would consider operating the MSS and making the data available to the users. Examples where the data could be useful are for discrimination of surface classes of high contrast such as surface water and snow cover and in applications where the expected data levels will fall in the accurate parts of the digital scale, i.e., 16-31 and/or 48-63, in one or more of the bands of interest.

It should be noted that these data also still suffer from the late line start problem which eliminates about 30 percent of the left-hand edge of each scene.

If you have a need for these nonstandard Landsat 3 MSS data, you should send your request with a specific justification explaining the applications of the degraded data to:

Dr. Stanley C. Freden
NASA/Goddard Space Flight Center
Code 902
Greenbelt, MD 20771
Telephone: 301-344-5818

These data will be distributed through the EROS Data Center as nonstandard Landsat products.

EDC REMOTE TERMINAL NETWORK

The EDC computerized main image file is accessed by 44 remote terminal sites located nationwide. These non-EDC users represent Federal and State Government agencies as well as private industry. Through their real-time data communications link with the EDC computer, they are able to interrogate the main image file and receive up-to-date information on more than 6 million frames of aircraft and satellite imagery held at EDC. Records of the Landsat holdings of various non-U.S. receiving stations can also be accessed.

Of the remote terminal sites that are currently part of the network, 63 percent are operated by agencies of the Federal Government, 15 percent belong to State Governments, and 22 percent are run by private-sector users. In general, these are large-volume users of Landsat and other remote sensing data. Their requirements for frequent inquiries to establish data availability are best met by a direct computer interface. The accompanying map gives an indication of the distribution of the remote sites around the country.

Access to the main image file via remote terminal is relatively simple to establish. Each site provides its own equipment, usually consisting of teletype-compatible terminals capable of character-mode transmission at 300 or 1,200 bits per second. The private-sector organizations are assessed a charge based on a comparison of the amount of terminal activity with the volume of orders placed for data products.

Organizations interested in the specifics of this service may obtain additional information by contacting the Remote Terminal Coordinator, User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6158.

FOREST FUELS MAPPING PROJECT

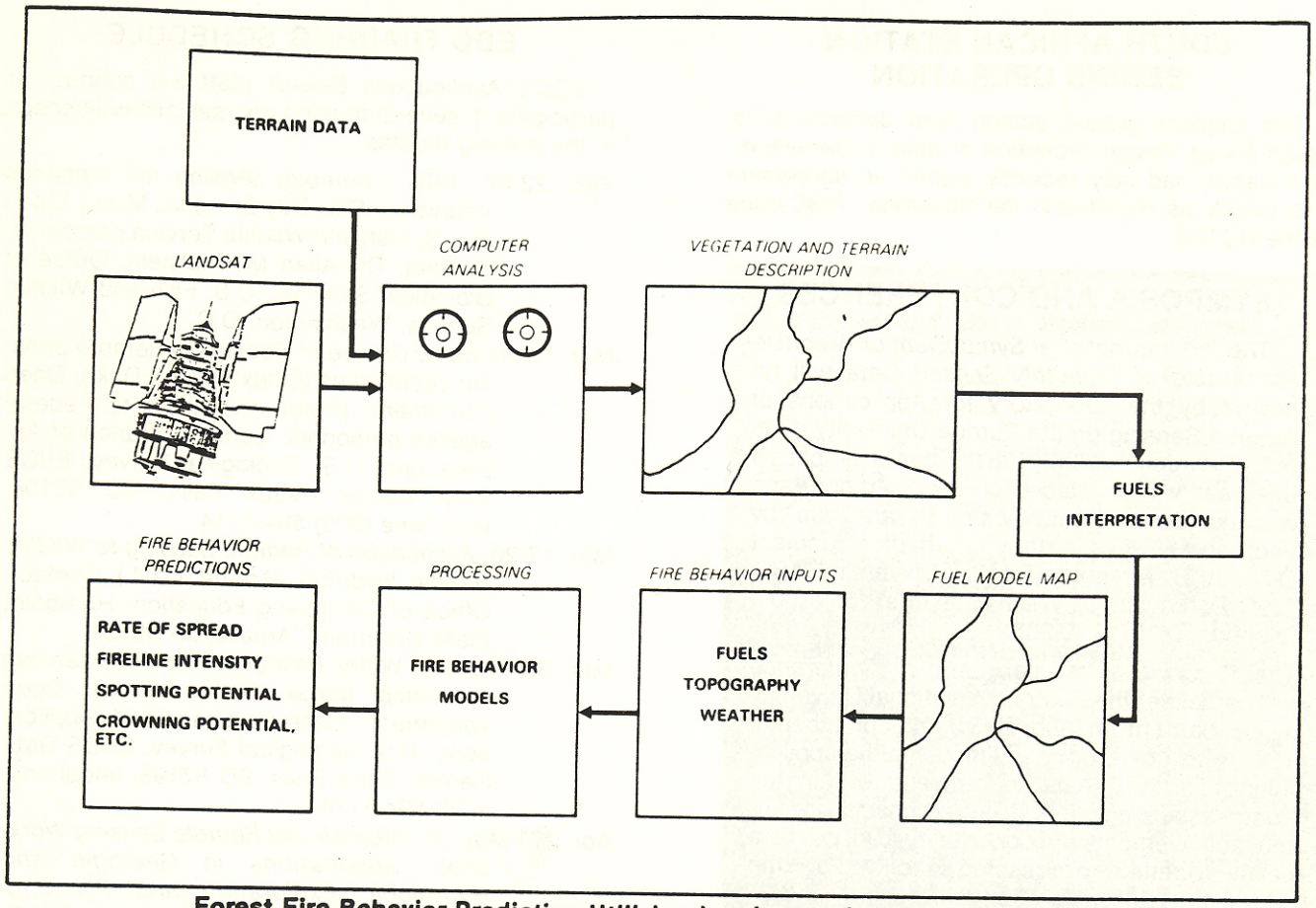
The EDC Applications Branch recently carried out a cooperative demonstration project with the U.S. Forest Service's Northern Forest Fire Laboratory in Missoula, Mont. The purpose of the study was to develop a digital data base of forest fuels and topographic data to serve as input in mathematical fire simulation models. The fire simulation models integrate fuels and topographic data with weather information to provide site specific estimates of fire behavior. The behavior model is a relatively new tool which provides Forest Service fire managers with a consistent method for predicting the behavior of forest and rangeland fires. Applications of the estimates provided by this model range from real-time, site-specific predictions of the probable rate of spread of a flaming front to broad-scale regional planning efforts aimed at identifying seasonal manpower requirements.

At present fuels and topographic data of the nature required to drive the simulation model are available to fire managers only on a limited basis. Thus, this project was designed to identify techniques for bringing together Landsat and U.S. Geological Survey digital terrain data to develop the fuels and topographic data base and meet a very real information need. The overall intent was to demonstrate a methodology where digital Landsat MSS and topographic data are transformed into management and planning level information by combining digital data analysis techniques with mathematical modeling and simulation algorithms.

The Lolo National Forest, located in western Montana, served as the site for the 1,180-km² study area. This is an area of high relief, and the great diversity of vegetation types present is strongly influenced by the topography.

A "layered" spectral-terrain classification procedure was developed to map six different fuel types out of a set of 20 standard types available. These stylized fuel types were designed by the Forest Service to be used directly with mathematical fire models; each described not just a type of vegetation but the quantity, size, depth, combustibility, and post-ignition heat intensity of the living and dead vegetation material present.

The project began with registration of digital Landsat and terrain elevation data to a 60-m universal transverse mercator (UTM) grid. Eighteen 30-by-30-pixel cluster blocks were selected for controlled clustering and to serve as sample blocks for the



Forest Fire Behavior Prediction Utilizing Landsat and Digital Terrain Data

development of a ground-acquired vegetation-terrain training data base. The ground data were then merged with the Landsat and terrain data, on the same grid, for the generation of classification training statistics.

A maximum-likelihood 2-layered classification approach was then employed. Utilizing the statistical information gathered during the clustering process, the four bands of Landsat MSS data covering the study were classified into 48 spectral classes. These were analyzed to determine the relationship of each spectral class to the six forest fuel types selected for the study. Where spectral clusters were identified as representing more than one fuel type, a second classification was performed using four components of terrain data (consisting of elevation, slope, and two slope-vs-aspect variables). At this point, each cluster was handled as an individual data set, for which discriminant analysis had led to the identification of clear vegetation-terrain relationships.

The final classified image comprised eight cover classes representing the six fuel types and two others — barren and nonforest. To this image the principle road network was added following digitizing from Forest Service engineering maps. The fuels-road network data base was then merged with the elevation, slope, and aspect data to provide the Forest Service with the necessary information to feed the fire behavior model. From this data base numerous map products and tabular summaries were generated to satisfy stated objectives and to demonstrate the utility of the data when combined with some basic geoprocessing and graphic display capabilities.

In evaluating the classification accuracy achieved in this study, a random sample of 205 pixels from eight classes were chosen for field verification. Overall accuracy was estimated to be 68.2 percent with a standard error of 3.6 percent. Without the digital terrain data, the accuracy of Landsat alone was estimated to be no better than 52.2 percent.

This project has taken a significant step towards integrating Landsat and digital terrain data directly into the management information system process. By entering the data provided by this study into the mathematical fire model to simulate wildland fires and by varying other input variables such as meteorological data, a whole scenario of fire behavior patterns and planning regimes can be generated and evaluated. The preliminary technical report on this project is available from the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605)594-6151.

SOUTH AFRICAN STATION BEGINS OPERATION

The Landsat ground station near Johannesburg, South Africa, began reception of data in December. The station had only recently signed an agreement with NASA, as reported in the November 1980 issue of the NOTES.

SYMPOSIA AND CONFERENCES

The *7th International Symposium on Machine Processing of Remotely Sensed Data* will be hosted by the Laboratory for Applications of Remote Sensing on the Purdue University campus from June 23-26, 1981. Special emphasis this year will be placed on forest, range, and wetland assessment. Abstracts are due by February 13. For further information, contact Douglas B. Morrison, Purdue University/LARS, 1220 Potter Drive, West Lafayette, IN 47906, telephone (317) 749-2052.

The *Second Australasian Landsat Conference* will be held at the Australian National University in Canberra from August 31 to September 4, 1981. This conference will focus on the application of Landsat data to problems within the Australasian region, with an emphasis on current achievements. An opportunity to inspect the newly opened processing facility of the Australian Landsat Station will be provided. A circular containing the call for papers and details on registration can be obtained by writing to: LANDSAT '81, P.O. Box 783, Canberra City, A.C.T. 2601, Australia.

The *7th Canadian Symposium on Remote Sensing* will be held in Winnipeg, Manitoba, from September 8-11, 1981; the theme will be "Down to Earth Management." Abstracts are due by May 15. Please write Mr. W.G. Best, Chairman, c/o Department of Natural Resources, Manitoba Centre for Remote Sensing, 1007 Century Street, Winnipeg, Manitoba R3H 0W4, Canada, for further information.

A *Conference on Remote Sensing Education* will be held at Purdue University from May 19-21, 1981. Cosponsored by NASA and the National Oceanic and Atmospheric Administration (NOAA), this conference will be conducted by the Laboratory for Applications of Remote Sensing to bring together remote sensing educators for the purpose of information exchange and the improvement of curricula for colleges and universities. Inquiries may be addressed to Shirley Davis, Purdue University/LARS, 1220 Potter Drive, West Lafayette, IN 47906, telephone (317) 749-2052.

EDC TRAINING SCHEDULE

EDC's Applications Branch staff will conduct or participate in several training courses and workshops in the coming months.

Feb. 23-27, 1981 *Remote Sensing for Wetlands Analysis* (NSTL, Bay St. Louis, Miss.). Open to U.S. Fish and Wildlife Service personnel. Contact: Dr. Allan Marmelstein, Office of Biological Services, U.S. Fish and Wildlife Service, Washington, D.C.

Mar. 16-20 *Basic Course in Geological Remote Sensing Techniques* (Sioux Falls, S.Dak.). Open enrollment, preference given to Federal agency personnel. Contact: Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone (605) 594-6114.

Mar. 17-20 *Application of Remote Sensing to Wildlife Habitat Inventory* (Arcata, Calif.). Contact: Office of Continuing Education, Humboldt State University, Arcata, CA 95521.

Mar. 30 - Apr. 3 *Water Resources Remote Sensing Workshop* (Sioux Falls, S.Dak.). Open enrollment. Contact: Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

Apr. 28 - May 29 *International Remote Sensing Workshop: Applications in Geologic and Hydrologic Exploration and Planning.* (Sioux Falls, S.Dak.). Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092.

June 1-5 *Digital Remote Sensing Techniques in Geology* (Sioux Falls, S.Dak.). Open enrollment. Contact: Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605)594-6114.

June 15-19 *Terrain Analysis: Interpretation of Aerial Photographs and Images* (Sioux Falls, S.Dak.). Contact: Coordinator, Continuing Education Program, Harvard Graduate School of Design, Gund Hall L-37, Harvard University, Cambridge, MA 02138, telephone: (617) 495-2578.

Aug. 31 - Oct. 21 *International Remote Sensing Workshop: Applications in Vegetation Assessment and Land-Use Planning* (Sioux Falls, S.Dak.). Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092.

ADDITIONAL TRAINING IN REMOTE SENSING

Feb. 9 - Mar. 6, 1981 *Digital Image Processing* (Flagstaff, Ariz.). Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092.

Feb. 9-13 *Aerial Photography/Aerial Photo Interpretation* (Moscow, Idaho). Contact: Dr. Joseph J. Ulliman, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, ID 83843, telephone: (208) 885-7016.

Feb. 23-27 *Air and Space Technology in the Planning Process* (Trinidad, Calif.). Also to be held March 23-27 and April 27 to May 1. Contact: STAR, Inc., P.O. Box 833, Trinidad, CA 95570, telephone: (707) 677-3011.

Apr. 18-19 *Remote Sensing Workshop* (Los Angeles, Calif.). Held in conjunction with the 71st Annual Meeting of the Association of American Geographers. Contact: Ronald A. Weinkauf, Dept. of Geography and Earth Science, University of Wisconsin, LaCrosse, WI 54601, telephone: (608)785-8340.

June 2 - July 3 *Advanced Training in Geologic Interpretation* (Flagstaff, Ariz.). Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092.

Aug. 25 *Postgraduate Diploma Programme in Remote Sensing* (Tamil Nadu, India). Duration: 1 year. Contact: Prof. R. Palanivelu, Head, Division of Photogrammetry and Remote Sensing, Pararignar Anna University of Technology, Madras 600 025, Tamil Nadu, India.

Oct. 5 - Nov. 6 *Advanced Training in Land Use Planning and Environmental Applications* (Flagstaff, Ariz.). Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092.

Oct. 13-24 *International Geologic Correlation Programme (IGCP) Workshop on Remote Sensing and Mineral Exploration* (Nairobi, Kenya). Contact: W.D. Carter or L.C. Rowan, U.S. Geological Survey, National Center, Mail Stop 730, Reston, VA 22092.

Monthly: *Short Courses on Numerical Analysis of Remote Sensing Data* (West Lafayette, Ind.). Contact: Douglas B. Morrison, Purdue/LARS, 1220 Potter Drive, West Lafayette, IN 47906, telephone: (317) 749-2052.

Continuing: *Training in Remote Sensing* (Brookings, S.Dak.). Long-term (3-12 months) detailed training in technical and administrative techniques of remote sensing technology. Contact: Dr. Donald G. Moore, Remote Sensing Institute, South Dakota State University, Brookings, SD 57006.

NOTE:
If you are planning a training course in remote sensing, please let us know well in advance so that we can list it in this newsletter. Contact the Chief, Training and Assistance, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, phone (605) 594-6114, concerning all training-related activities.

Landsat Production Statistics

	June '80 MSS	June '80 RBV	July '80 MSS	July '80 RBV	Aug. '80 MSS	Aug. '80 RBV	Sept. '80 MSS	Sept. '80 RBV	Oct. '80 MSS	Oct. '80 RBV	Nov. '80 MSS	Nov. '80 RBV	6-Month Total MSS	6-Month Total RBV
Landsat scenes acquired (satellite acquisition)	3,084	1,209	3,999	1,648	2,145	1,433	3,394	1,676	3,759	1,958	2,576	1,007	18,957	8,931
Landsat scenes received at EDC*	3,712	-	4,037	-	1,166	-	2,667	-	1,440	2,258	1,620	6,875	14,642	9,133
Average time in days from acquisition to EDC receipt (by month of EDC receipt)	65.5	-	90.1	-	41.2	-	19.7	-	20.7	-	37.8	-	-	-
Average time in days from EDC receipt to archive availability	2.6	-	4.0	-	2.0	-	2.4	-	4.2	-	3.1	-	-	-
Average delivery time in days from receipt of order at EDC to shipment:														
Standard photographic products	12		13		13		16		20		19		-	
Standard digital products	11		9		9		8		13		9		-	
Landsat photographic frames sold	12,480		8,216		8,302		7,817		19,470		7,741		64,026	
Landsat digital scenes sold	505		564		333		295		404		364		2,465	
Total Landsat dollar volume	$259,884		$232,182		$172,730		$156,987		$294,194		$175,305		$1,291,282	

*September, October, and November include some reprocessed data.

The Landsat Data Users NOTES is published bi-monthly in order to present information of interest to the user community regarding Landsat products, systems, and related remote sensing developments. There is no subscription charge; individuals and organizations wishing to receive the NOTES should contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota 57198, U.S.A., telephone: (605)594-6151.

Comments, corrections, and other inquiries should be directed to:

Editor, Landsat NOTES
U.S. Geological Survey
EROS Data Center
Sioux Falls, South Dakota 57198