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LANDSAT Follow-on Investigation #22510
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The Use of LANDSAT DCS and Imagery in Reservoir Management and Operation

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1. ACCOMPLISHMENTS

The program continued with accomplishments during the reporting period as follows:

On 19-25 September, two snow pillows were interfaced to DCP's in the Saint John River basin area of northern Maine to obtain real time information on the water equivalent of the snowpack. Location listings of our operating DCP's as of 30 January 1976 are shown in Figure 1.

NED's direct LANDSAT DCS ground receive facility or Local User Terminal (LUT) was completely installed as of 15 September. A period of initial testing ensued, and the system was fully operational by mid-December. For the first three weeks antenna pointing angles were transferred to the tracking equipment via paper tape but within a short time this was circumvented by a direct interface to our NOVA mini computer. At the end of the reporting period the system was operable in an automatic mode, and could be left unattended over nights and during weekends.

Computer compatible tapes of LANDSAT imagery for the proposed Dickey-Lincoln reservoir area in northern Maine were ordered by CRREL to provide data for input to their study of hydrologic and related parameters depictable by the LANDSAT sensors.

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2. MAJOR PROBLEMS

Debugging of the LUT proceeded with little more than the expected minor difficulties such as blown fuses, improperly selected jumpers on interfaces and software encountering unforeseen situations. An inadequate signal/noise ratio was detected in the downlink receive system by NASA personnel (R. Snyder, H. Estep and E. Painter). The parametric preamp was returned to the factory for checking; and subsequently the antenna manufacturer, Scientific-Atlanta, found the cause to be a misaligned dielectric slab in the feed horn.

Another minor problem was that the NOVA mini computer does not keep time precisely enough for this system. The radio time standard we expected to use, WWVB, is not strong enough to be received clearly in this area. We are looking into other means of time code generation.

3. SIGNIFICANT RESULTS

The demonstration Local User Terminal at NED has already proven the hypothesis that a relatively inexpensive, automatic and easily maintained ground receive station for satellite relayed data is practicable for an operational use.

4. SIGNIFICANT CHANGES IN OPERATING PROCEDURES

We expanded our data acquisition activities to include both the teletype-relayed information from GSFC as well as that received directly by our Local User Terminal. This data is being studied to determine the relative performance of the two systems.

5. MEETINGS

A coordination meeting was held at CRREL on 10-11 September among representatives of NED and CRREL, with Dr. Paul Bock of the University of Connecticut also present. In addition, several visits to NED were made during the reporting period by members of the CRREL study team. On 20 November, Mr. Fred Gordon, our NASA Technical Monitor, visited the Division to see the facilities, including our LUT. Mr. Robert Snyder of NASA, Wallops Island was here on two separate occasions to install his DCS decoder and provide technical support during our downlink installation and debugging operations.

Mr. Jacob Kirimi from the Ministry of Water Development, Nairobi, Kenya spent two months as an intern in NED's Water Control Branch and participated in numerous discussions and demonstrations concerning LANDSAT. On 26 September, Mr. DeJong from Saudi Arabia was NED's guest for a briefing on satellite data collection. On 10 November, a representative of the Panama Canal Company, Mr. James L. McMillan, visited to learn about telecommunications hardware and software.

The following papers concerning our LANDSAT follow-on investigation were presented during the reporting period:

a. "The Use of LANDSAT DCS in Reservoir Management and Operation," by S. Cooper and J. Horowitz at the Tenth International Symposium on Remote Sensing of Environment, 6-10 October 1975 at Ann Arbor, Michigan (abstract inclosed).

b. "An Automated Local User Terminal for Data Collection," by T. Buckelew at the Eleventh Annual International Telemetering Conference, 14-16 October 1975 at Silver Spring, Maryland (abstract inclosed).

c. "Reservoir Management Employing Satellite Data Relay and Imagery," by S. Cooper and J. Horowitz at the Eleventh Annual Meeting of the American Water Resources Association, 9-14 November 1975 at Baton Rouge, Louisiana.

d. "The Use of LANDSAT DCS in Reservoir Management and Operation," by S. Cooper and J. Horowitz at a Seminar on Real Time Operation of Water Resource Projects at The Hydrologic Engineering Center, Davis, California on 17-19 November.

Also, Dr. Horowitz attended a symposium, entitled: Earth Resources: Space Applications to Northeastern Regional Problems, 18-19 November 1975 at the University of Connecticut, Storrs, Connecticut where he was also a member of the panel on Water Resources Applications. On 19-20 November, Mr. Buckelew attended a workshop on the LaBarge Convertible DCP at Tulsa, Oklahoma, where he presented a short briefing on NED's local user terminal.

6. RECOMMENDATIONS

The results of NED's investigation have been positive so far, and we recommend the continuation of the LANDSAT DCS program. We have forwarded a recommendation to our headquarters office in Washington, D.C. for consideration of a Corps-wide satellite data collection system.

7. FUTURE PLANS

We will continue analysis of the LANDSAT DCS with special emphasis on refining the software for the LUT. For the imagery portion of the experiment we will attempt to define hydrologic parameters using the computer compatible tapes of the MSS imagery.

8. ACCOUNTING

A tabulation of the dollar value of the imagery data ordered and received through 30 November 1975 for this investigation follows:

Type of Imagery	Value of Data Allowed	Value of Data Ordered	Value of Data Received
LANDSAT Prints and Transparencies (standing order)	A total of $8,900	Does not apply	$7,552
LANDSAT Prints and Transparencies (retrospective orders)		0	0
LANDSAT Computer Compatible Tapes	$4,800	0	0
Aircraft Imagery	$ 360	0	0

Total NASA funds expended on this investigation as of 30 November 1975 are $33,840.

SAUL COOPER
Principal Investigator

FIGURE 1. LANDSAT-2 - DCP INFORMATION SHEET
ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION   30 JAN. 1976

DCP NO.	STATION NAME	PARAMETER(S)*	LAT	LONG
7147	ST. JOHN RIVER AT NINEMILE BRIDGE, ME.	RS WES	46 42 [illegible]	[illegible]
7161	ST. JOHN RIVER AT DICKEY, ME.	RS [illegible]	47 [illegible] 48	[illegible]
7355	MICHAUD FARM AT ALLAGASH FALLS, ME.	WES	46 57 [illegible]	[illegible] 11 [illegible]
7220	ST. JOHN RIVER AT FORT KENT, ME.	RS	47 1[illegible] [illegible]	[illegible] 35 [illegible]
7071	PENOBSCOT RIVER AT WEST ENFIELD, ME.	RS	45 14 12	[illegible]
7272	CARRABASSETT RIVER NEAR NORTH ANSON, ME.	RS	44 52 29	69 [illegible]
7356	SACO RIVER AT CORNISH, ME.	RS	43 45 05	7[illegible] 4[illegible] [illegible]
7176	STINSON MOUNTAIN, N.H.	P	43 5[illegible] [illegible]	71 4[illegible] [illegible]
7127	SOUTH MOUNTAIN, N.H.	P	42 53 59	71 35 [illegible]1
7201	PEMIGEWASSET RIVER AT PLYMOUTH, N.H.	RS	43 45 33	71 41 17
7230	MERRIMACK RIVER NEAR GOFFS FALLS, N.H.	RS	42 56 54	71 27 52
7331	COLD REGIONS LAB, HANOVER, N.H.	T	VARIABLE	
7246	WACHUSETT MOUNTAIN, MA.	P	42 29 24	71 53 15
6962	IPSWICH RIVER NEAR IPSWICH, MA. (1)	RS	42 39 35	70 53 39
7106	NORTH NASHUA RIVER AT FITCHBURG, MA.	RS	42 34 34	71 47 10
7242	TOWN RIVER AT QUINCY, MA.	RS	42 14 5[illegible]	7[illegible] 5[illegible] 52
7142	CHICOPEE RIVER AT CHICOPEE FALLS, MA.	WQ	42 09 37	72 34 52
7021	WESTFIELD RIVER AT WEST SPRINGFIELD, MA.	WQ	42 05 59	72 33 20
7207	FRENCH RIVER AT WEBSTER, MA.	WQ	42 03 03	71 53 [illegible]
----	NED HEADQUARTERS, WALTHAM, MA.	T	42 23 46	71 1[illegible] 56
7304	BRANCH RIVER AT FORESTDALE, R.I.	RS	41 59 47	71 33 47
7345	PAWTUXET RIVER AT CRANSTON, R.I.	RS	41 45 03	71 26 44
7254	CONNECTICUT RIVER AT HARTFORD, CT.	RS	41 46 1[illegible]	72 40 34
7335	CONNECTICUT RIVER NEAR MIDDLETOWN, CT.	RS	41 33 40	72 36 45
7206	PORTER BROOK NEAR MANCHESTER, CT. (2)	RS	41 45 55	72 35 12
7124	UNALAKLEET WATER SUPPLY RES., ALASKA (3)	RL AT GST GT WP	63 54 30	160 45 10
6216	SUSITNA RIVER AT DEVIL CANYON DAMSITE, ALASKA (3)	WES AT GST WP	62 43 53	149 13 43
7042	(3, 4)			
7325	(3, 4)			

SPARE DCP'S.... 7010, 7012, 7171, 7271, 7273

* P - PRECIPITATION
WES - WATER EQUIVALENT OF SNOWPACK
RS - RIVER STAGE
RL - RESERVOIR LEVEL
WQ - WATER QUALITY (TEMPERATURE, CONDUCTIVITY, PH AND DISSOLVED OXYGEN)
AT - AIR TEMPERATURE(S)
GST - GROUND SURFACE TEMPERATURE
GT - GROUND TEMPERATURE(S)
WP - WIND PASSAGE
PV - PARAMETERS VARIABLE
T - TEST SET

(1) DCP BELONGS TO U.S. GEOLOGICAL SURVEY, BOSTON, MA.
(2) DCP ON LOAN TO U.S. GEOLOGICAL SURVEY, HARTFORD, CT.- -ON DEMONSTRATION AT THE MANCHESTER NATURE CENTER
(3) DCP ON LOAN TO U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LAB, HANOVER, N.H.
(4) NOT YET INSTALLED

ABSTRACT

THE USE OF ERTS DCS IN RESERVOIR MANAGEMENT AND OPERATION

The New England Division, Corps of Engineers (NED) participated in the Earth Resources Technology Satellite (ERTS-1) experiment to assess the possible future usefulness of satellites such as ERTS in the operation of its water resource systems used to control floods.

Based on two years' experience with a 26-station network in New England, NED has found real time data collection by orbiting satellite relay to be both reliable and feasible. Orbiting satellite systems can be designed that are more flexible, easily maintained and less expensive than conventional ground-based means. The only drawback with the ERTS-1 Data Collection System (DCS) for NED operational purposes is the frequency of data reports (four to six times daily). However, it should be understood that the ERTS system is experimental, to test the feasibility of data collection by orbiting satellite. An operational system could be designed involving more than one satellite, to increase the frequency of data reporting.

Based on its ERTS-1 experience, NED endorses the institution of a satellite data collection system on a Corps-wide basis or a nationwide system with other Federal and State agencies, whether it be of the orbiting type with which we have experimented, or the geostationary kind, for which evaluation is not yet available. Any operational satellite configuration should include ground receive stations at all major user locales for direct receipt of satellite information, rather than the present relay of data from NASA. Therefore NED, with NASA support, is constructing an inexpensive, semiautomatic and easily maintained ground receive station as a follow-up to its present investigation. This is expected to further demonstrate the utility of satellite data relay by testing a system in a quasi-operational mode.

Since the technological feasibility of the use of satellites has been demonstrated by ERTS, the next stage of system development should be initiated; namely, pilot project test and evaluation demonstrations under quasi-operational conditions. This subject will be addressed by the NED ERTS-B follow-on experiment and a cooperative demonstration study with NASA of a user-operated ground receive station for direct acquisition of DCS data.

AN AUTOMATED LOCAL USER TERMINAL FOR DATA COLLECTION

GIVEN AT INTERNATIONAL TELEMETERING CONFERENCE
SILVER SPRINGS, MARYLAND
OCTOBER 14, 15, 16, 1975
BY TIMOTHY D. BUCKELEW

ABSTRACT: The need for real time hydrologic data for flood control reservoir regulation puts special demands on a data collection system, especially during storms when it is most needed. In an experiment to test the use of the LANDSAT satellite for flood control activities, New England Division, U.S. Army Corps of Engineers in cooperation with NASA is constructing a local user terminal for direct receipt of satellite-relayed data at Waltham, Massachusetts. This station, consisting of a 15-foot dish, tracking and receiving equipment, and a mini-computer, will be relatively simple, automatic, capable of running unattended 2 to 3 days, and will be protected against power failures by software restart features. Early operation will depend on predicting the satellite's position but software autotracking may be developed.