E7.3 10585
CR-131901
21 May 1973

Type I Progress Report for the Period 14 February to 14 April 1973 for ERTS-1 Data User Investigation of the Use of ERTS Imagery in Reservoir Management and Operation - Proposal Number MMC 89

Mr. Saul Cooper - DE 002
Dr. Paul Bock - UN 017
- Co-Principal Investigators

The fifth 2-month period of our participation in the ERTS-1 program has been featured by:

a. A small increase in the size of our DCS network, with 20 of 27 planned field installations now fully operational.

b. Continued collection and entry of all DCS and ground truth data into our computer.

c. The first operational use of DCS for data relay during a significant flooding situation.

d. The development of plans for a 2-day DCS data users' workshop to be held at Wallops Station, Virginia which we are helping to organize.

e. Emphasis, in the study of ERTS imagery pictures, on interpretation of snow scenes.

f. Continued progress in the development of techniques for the processing and analysis of ERTS-1 imagery computer products.

A listing of the locations of our operating DCP's and proposed sites is inclosed. Note changes from the list submitted with our last report. Newly added DCP 6063 is assigned to the U.S. Geological Survey, Boston, Massachusetts and appears only in recognition of the fact that we are relaying data from this DCP to the USGS in near real time with the aid of our teletype link with

(E73-10585) THE USE OF ERTS IMAGERY IN RESERVOIR MANAGEMENT AND OPERATION Progress Report, 14 Feb. - 14 Apr. 1973 (Corps of Engineers, Waltham, Mass.) 12 p HC $3.00 CSCL 08H G3/13
N73-23445
Unclas 00585

NASA. Data handling and analysis for this DCP remain the responsibility of the U.S. Geological Survey. Data relay from NASA via our real time link continues to be timely, with a lag of approximately 45 minutes between ERTS-1 passover and arrival of the data at the New England Division. The increasing frequency of occurrence of broken or partially garbled teletype messages has been somewhat annoying. Analyses of the ERTS-1 DCP data remain preliminary because we do not have a sufficient mass of information to develop statistically significant performance results.

The ERTS-1 DCP hardware has performed well, with a very low incidence of failures. A few remaining problems concerning interfacing sensors to DCP's remain but these are, in all cases, due to our own lack of expertise with new equipment. However, we are learning rapidly, and as we do, our difficulties diminish.

Adverse winter weather conditions had no noticeable effects on the operating capabilities of our DCP's; it is noted, however, that special care should be taken in the handling of DCP antenna cables as these tend to become quite brittle during periods of exposure to extreme cold temperatures. The "Gel-Cell" batteries that power our DCP installations are exceeding all expectations of useful life. From literature supplied to us by the manufacturer, we calculated a life expectancy of 4 to 6 months. One set of batteries has been in continuous operation for 7 months, with no indication of impending failure.

As this report was being completed our five DCP's in the State of Maine were reporting near real time information on river stages during a significant flood event there (a copy of our press release is attached). This information is being used for guidance by Corps of Engineers experts here in Waltham, Massachusetts in coordinating flood emergency aid activities. The unique usefulness of ERTS DCS is quite apparent in this relay of data from remotely located rivers. The cost and time involved in establishing ground-based data relay facilities at these locations would have been large. The extension of our data collection capabilities to these remote points therefore had been precluded until the advent of ERTS.

Plans for a 2-day DCS data users' meeting on 30-31 May 1973 at Wallops Station, Virginia are proceeding smoothly. We are cooperating with several other Federal agencies to make this workshop on automatic collection of directly sensed earth resources

data a successful and important event.

Our ERTS-1 imagery studies continue to be divided between the pictorial and the computer products.

Considerable time has been spent during the reporting period assessing the usefulness of ERTS imagery photo products in the gathering of snow cover data. ERTS photos E-1204-15072 and E-1204-15074, dated 12 February 1973, and photos E-1203-15013 and E-1203-15020, dated 11 February 1973, covering all of Connecticut, Massachusetts, Rhode Island and most of Vermont and New Hampshire reveal extensive snow cover over much of the area. The MSS-4 band shows the greatest amount of contrast between snow-covered and snow-free areas, revealing snow-covered regions as highly illuminated while barren areas appear highly absorptive and poorly illuminated. The sharp white patches at first appear to delineate snow-covered from nonsnow-covered areas. However, examination of ERTS photos taken last summer over the same locations (E-1006-15061-1 & 2, E-1006-15063-1 & 2), reveal cleared or unforested areas delineated in almost identical patterns. These patterns also closely fit those of more recent USGS maps showing nonforested areas. The area around Northampton, Massachusetts in photo E-1204-15072 is illustrative of this phenomenon. For New England-type forests and terrain, imagery shows that tree cover interferes with the satellite observation of snow accumulation on the ground. This might have been expected, as one generally observes the winter landscape in forested regions of the Northeastern United States from a distance or from an aircraft as having a grayish hue even though snow may cover the ground. Probably the only time an area is likely to appear completely white would be immediately after heavy snowfall, provided wind has not already blown intercepted snow off the tree canopy.

The general outline of snow on the ground appears to reveal itself in a more subtle manner as an overall pattern of difference in illumination or scene brightness over a wide area. By itself, ERTS photo E-1204-15072 reveals little difference in illumination as it appears fairly uniform over that particular image frame. However, when photos E-1204-15072, E-1204-15074, E-1203-15013 and E-1203-15020 are assembled so as to approximate a single photo over the entire south-central and western New England area, a general contrast can be seen between the relatively highly illuminated northern and mountainous regions and the more poorly illuminated southern

coastal regions. When these photos are overlain with synoptic or near synoptic Corps of Engineers snow contour maps, the contours appear to fit the illumination pattern fairly well. So far no other snow parameters such as density, depth, or quality have been determined from the photos.

During the recent reporting period we also began experiments relating to the varying reflectivities observed in ERTS imagery products covering bodies of water. During the examination of ERTS computer output blow-ups of water bodies like Coventry Lake, Connecticut River, Lake Winnipesaukee, etc., it was observed that the response level of water has a very varied characteristic. The various response levels could be a function of depth of the water or the depth to which light can penetrate depending on the turbidity of the water, or it could also be a function of atmospheric haze. Sometimes all these factors together could be affecting reflectance. Dunham Pond in Connecticut, with a surface area of approximately one acre, was selected for the ground-truth experiments conducted on 6 and 7 April 1973 when ERTS passes occurred.

The aim of the experiment was to take measurements at various points on the pond which give an indication of the light penetration and water depth characteristics of the water body. The response levels of the water in the pond in the ERTS imagery are to be correlated to the actual ground truth measurements. These experiments on the pond are to be repeated on future days of ERTS coverage. If the results from Dunham Pond comparisons are encouraging, similar experiments are proposed for South Coventry Lake, Eagleville Pond and Mansfield Hollow Lake. Underflights by airplane may also be planned.

Regarding the hardware and software for processing of ERTS computer products, we have completed a program that permits printout of data from the MSS magnetic tapes. This computer program gives the same capabilities as the RBV print program developed previously. In brief, it permits the printing of sections of ERTS scenes at a particular band in terms of point brightness values stored on the tapes. Further details of these capabilities are contained in Appendix B of our Type II Report for the period June - December 1972. Sample computer printouts of selected scenes of the ERTS imagery are being produced for initial analysis. Orders of MSS magnetic tapes of recent data, including winter scenes such as snow cover, are being placed and will be used for finer analysis based on

the MSS print program. Work is continuing in the development of efficient means for handling MSS data that would combine the experiences and capabilities of man with the high speed computational power of a computer. This system is to be implemented on the IBM 360/65 computer, with a graphical terminal (2250) providing the interactive environment. A disk pack, for use in the development of this system, is being acquired by the computer for the exclusive use of this project.

Computer programs being developed or planned are geared to the following:

a. Transcribing, with some modifications, MSS tapes to disk and printing sections of an image (these can be "enlargements" or closeups of parts of the scene).

b. Displaying the condensed image or sections of it on the graphics display. This includes the ability to obtain closeups or wide-angle shots, and to examine any desired section of the image. This will be accomplished through the use of a panel of control buttons and light pen.

c. Using the light pen to roughly outline events and describing by using the keyboard what has been outlined. The keyboard is then used to type in "ground truth" and associated information. When this interactive stage is completed, control is transferred to one or both of the following routines which are used for:

(1) Analyzing the data for all four bandwidths in detail and building the associated data trees.

(2) Analyzing the input data in terms of retrieved data sets and forming conclusions regarding current conditions.

During the reporting period, no changes were made in our ERTS standing order forms, and no data request forms were submitted.

A major one-day coordination meeting involving the New England Division, Corps of Engineers, U.S. Army Cold Regions Research & Engineering Laboratory and the University of Connecticut took place at the New England Division Headquarters on 13 April 1973 with 17 people in attendance. The meeting featured progress

reports and discussions of future plans for all aspects of this ERTS-1 investigation.

SAUL COOPER
Principal Investigator

2 Incl
As stated

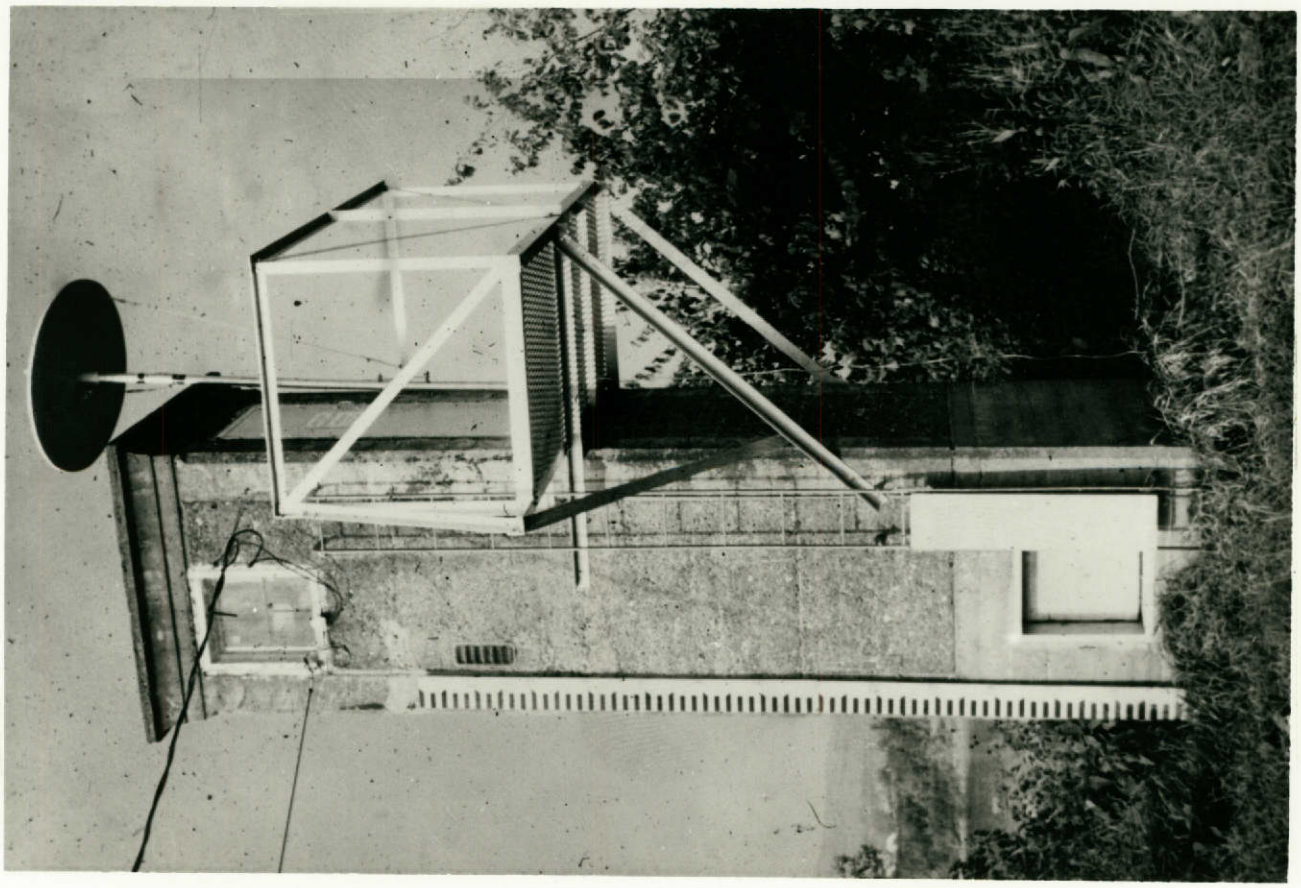
ERTS-1 - DCP INFORMATION SHEET

ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION — 5 APRIL, 1973

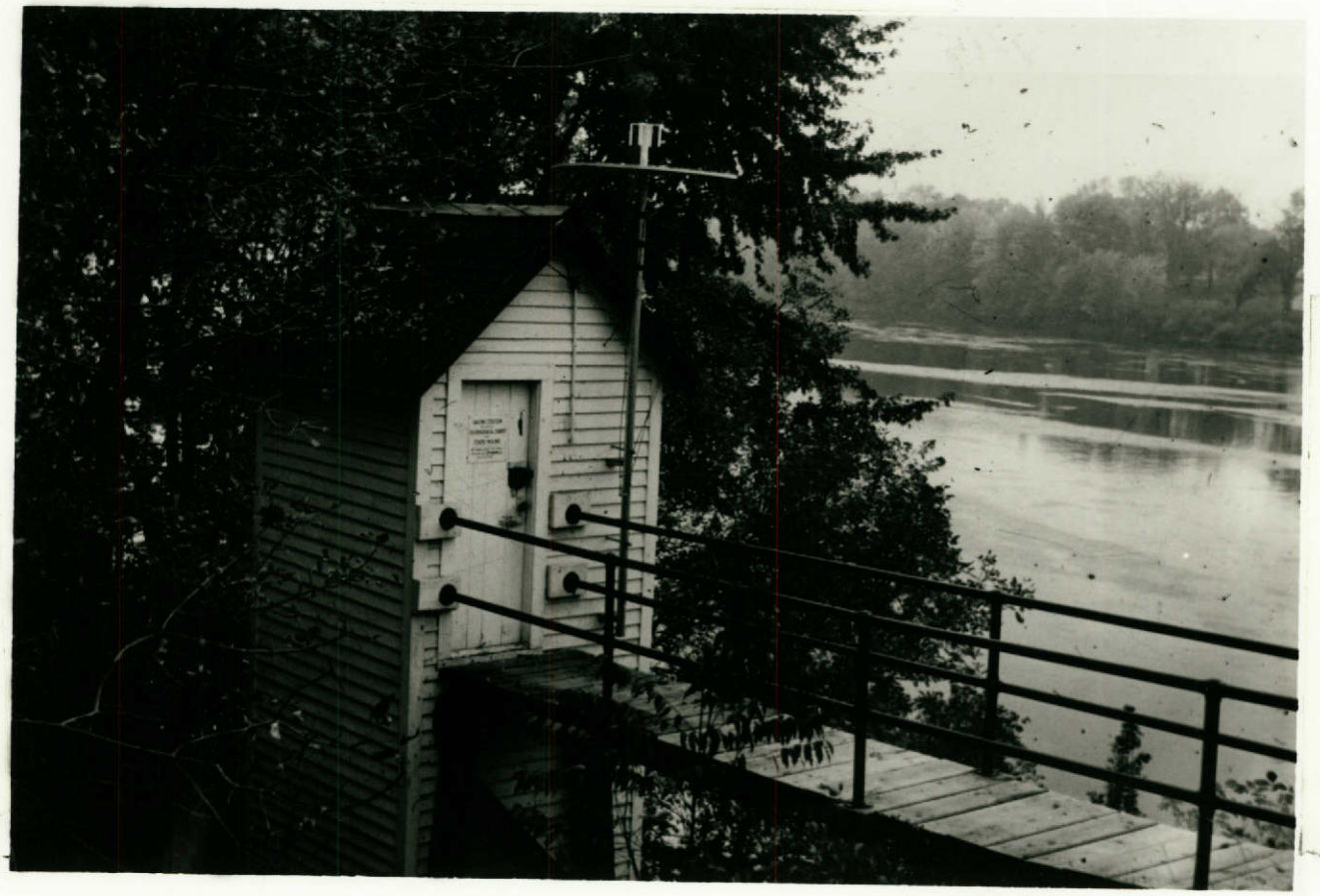
ID NO.	DCP NO.	TYPE*	STATION NAME	LAT	LONG	INSTALLED
1	6170	S	ST. JOHN RIVER AT FORT KENT, MAINE	47 15	68 35	091972
2	6071	S	PENOBSCOT RIVER AT WEST ENFIELD, MAINE	45 14	68 39	092072
3	6021	S	CARABASSETT RIVER AT NORTH ANSON, MAINE	44 52	69 57	100472
4	6304	S	ANDROSCOGGIN RIVER AT AUBURN, MAINE	44 04	70 12	112772
5	6171	S	SACO RIVER AT CORNISH, MAINE	43 48	70 47	112872
6	6271	S	PEMIGEWASSET RIVER AT PLYMOUTH, N.H.	43 45	71 41	112272
7	6246	S	MERRIMACK RIVER AT GOFFS FALLS, N.H.	42 57	71 28	032773
8		S	SOUHEGAN RIVER AT MERRIMACK, N.H.	42 51	71 31	
9	6356	S	CHARLES R. AT CHARLES R. VILLAGE, MASS.	42 15	71 15	071772
10	6207	S	TOWN BROOK AT QUINCY, MASS.	42 15	71 00	090872
11	6010	S	PAWTUXET RIVER AT CRANSTON, R.I.	41 45	71 27	090672
12	6127	S	CONNECTICUT RIVER AT HARTFORD, CONN.	41 46	72 40	083072
20	6042	P	STINSON MOUNTAIN, N.H.	43 50	71 47	032273
21	6345	P	SOUTH MOUNTAIN, N.H.	42 59	71 35	120672
22		P	FRANKLIN FALLS DAM, N.H.	43 28	71 40	
23		P	BLACKWATER DAM, N.H.	43 19	71 44	
24		P	MACDOWELL DAM, N.H.	42 54	71 59	
25		P	MANSFIELD HOLLOW DAM, CONNECTICUT	41 46	72 11	
30	6101	C	STAMFORD BARRIER, STAMFORD, CONNECTICUT	41 02	73 32	011073
40	6254	Q	ASHUELOT RIVER AT WINCHESTER, N.H.	42 47	72 23	121272
41	6142	QS	NORTH NASHUA RIVER AT FITCHBURG, MASS.	42 34	71 47	110672
42	6355	Q	WESTFIELD R. AT WEST SPRINGFIELD, MASS.	42 06	72 38	092872
43	6242	Q	CHICOPEE RIVER AT CHICOPEE, MASS.	42 09	72 35	121472
50	6147	T	NED HEADQUARTERS, WALTHAM, MASS.	42 24	71 13	071772
51	6325	T	COLD REGIONS LAB AT HANOVER, N.H.	VARIABLE		
52	6216	T	COLD REGIONS LAB AT HANOVER, N.H.	VARIABLE		120572
53	6335	T	UNIV. OF CONN. AT STORRS, CONN.	VARIABLE		
54	6063	T	U.S. GEOLOGICAL SURVEY, BOSTON, MASS.	VARIABLE		032073

* S-RIVER STAGE
P-PRECIPITATION
C-COASTAL(WIND DIRECTION, VELOCITY AND TIDE)
Q-WATER QUALITY(TEMPERATURE, CONDUCTIVITY, PH AND DISSOLVED OXYGEN)
T-TEST SET(SENSORS VARIABLE)

Battery powered radio equipment located in the river gaging station on the Carabassett River at North Anson, Maine, transmits river stages to the orbiting Earth Resources Technology Satellite via the saucer shaped antenna in the picture. These signals are received at the Corps of Engineers, New England Division headquarters in Waltham, Mass., and are used to coordinate their flood emergency activities.



Battery powered radio equipment located in the river gaging station on the St. John River at Fort Kent, Maine, transmits river stages to the orbiting Earth Resources Technology Satellite via the saucer shaped antenna in the picture. These signals are received at the Corps of Engineers, New England Division headquarters in Waltham, Mass., and are used to coordinate their flood emergency activities.



Battery powered radio equipment located in the river gaging station on the Penobscot River at West Enfield, Maine, transmits river stages to the orbiting Earth Resources Technology Satellite via the saucer shaped antenna in the picture. These signals are received at the Corps of Engineers, New England Division headquarters in Waltham, Mass., and are used to coordinate their flood emergency activities.

NEWS RELEASE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

ENVIRONMENT

RIVER SYSTEMS

RECREATION

FLOOD CONTROL

NAVIGATION

SHORE PROTECTION

2 May 1973

"EYE IN SKY" TRACKED MAINE'S FLOODING RIVERS FOR ARMY ENGINEERS

FOR RELEASE UPON RECEIPT

WALTHAM, MASSACHUSETTS -- The U. S. Army Corps of Engineers report that the "eye in the sky", the Earth Resources Technology Satellite (ERTS), proved its worth beyond any doubt these past few days, monitoring flooding Maine rivers.

"ERTS has been relaying data from five river points in Maine up to six times a day to aid the New England Division in coordination of flood emergency activities," Colonel Charles J. Osterndorf, Acting Division Engineer said. "From a near polar orbit 500 miles above the earth's surface, ERTS picks up radioed reports from automatic self-powered, transmitting stations at five key points in Maine as it passes over the region," he said. The Maine stations are part of a 27-station network being installed in New England, in an experimental program being carried on by the Corps of Engineers in cooperation with the National Aeronautics and Space Administration.

The information is received at NASA's Goddard Space Flight Center in Maryland and relayed to Waltham. A battery powered transmitter at the gaging site, the satellite, and the receiving station at the Space Flight Center combine to provide readings to the Corps' Waltham headquarters within 45 minutes.

// more

Of the 27 sites in New England the five stations in Maine are located on the St. John River at Fort Kent, the Penobscot River at West Enfield, the Carabassett at North Anson, the Androscoggin at Auburn, and the Saco River at Cornish.

"The Maine experience goes far toward proving the viability of the satellite in the future of data collection systems," Colonel Osterndorf said. "Corps offices throughout the country are carefully watching the experiment for possible application of such a system in their areas."

The Division has dispatched 10 engineers to Maine in response to a request from the Office of Emergency Preparedness to make preliminary damage surveys in three counties north of Bangor, where swollen rivers inundated many areas including Fort Kent and Indian Island, Old Town.

-30-