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APPLICATION OF ECOLOGICAL, GEOLOGICAL  
AND OCEANOGRAPHIC ERTS-1 IMAGERY  
TO DELAWARE'S COASTAL RESOURCES  
PLANNING

E73-10426) APPLICATION OF ECOLOGICAL,  
GEOLOGICAL AND OCEANOGRAPHIC ERTS-1  
IMAGERY TO DELAWARE'S COASTAL RESOURCES  
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for period January - February 1973

Prepared for  
GODDARD SPACE FLIGHT CENTER  
GREENBELT, MD. 20771

## A. Problems

ERTS-1 satellite imagery was slow in reaching our team. However, this problem has been corrected since the latter part of February.

## B. Accomplishments

### a) Applicability of ERTS-1 Imagery to the Study of Suspended Sediment and Aquatic Fronts.

Imagery from four successful ERTS-1 passes over the Delaware Bay and Atlantic Coastal Region have been evaluated to determine visibility of aquatic features. The overpasses took place on August 16, October 10, December 3, 1972, and January 26, 1973. (I.D. Nos. 1024-15073, 1078-15075, 1133-15141, and 1187-15140 respectively). Visual inspection, density slicing and multispectral analysis of the imagery revealed strong suspended sediment patterns and several distinct types of aquatic interfaces or frontal systems. Measurements from boats and photography from low altitude aircraft, performed before and during the satellite overpasses, permitted a limited degree of correlation between satellite and ground data on the type and quantity of suspended matter. In the upper and middle bay the interfaces tended to align along the flow axis of the river or parallel to the shoreline. At the mouth of the bay there were fronts which were oriented at right angles to the flow axis and were strongly influenced by tidal conditions. The first type of interface tended to persist over most of the tidal cycle and could usually be associated with a strong change in color and turbidity, with Secchi depths changing from 0.6 - 1.2 meters to 1.4 - 2.2 meters as one crossed it. The second type of interface was primarily a salt water intrusion during incipient flood tide, with associated discontinuities in salinity and temperature. The water samples contained sand particles in shallow areas while silt was predominantly present in deeper waters. Multispectral scanner band 5 (0.6 - 0.7 microns) gave the sharpest definition of interfaces between waters of differing turbidity. Band 4 (0.5 - 0.6 microns), due to its deeper water penetration, was more sensitive to patterns having lower turbidity, yet was veiled by a uniform blanket of atmospheric scattering making identification of sediment patterns more difficult.

### b) Identification of Coastal Vegetation Species in ERTS-1 Imagery.

Coastal vegetation species appearing in the ERTS-1 images taken of Delaware Bay on August 16, and October 10, 1972 (Observation I.D. Nos. 1024-15073 and 1079-15133) have been correlated with ground truth vegetation maps, and imagery obtained from high altitude

altitude RB-57 and U-2 overflights. The vegetation maps of the entire Delaware Coast were prepared during the month of August and September, including the day of the August satellite overpass, using data collected on foot, in small boats, and from low altitude aircraft. Multispectral analysis of high altitude RB-57 and U-2 photographs indicated that five vegetation communities could be clearly discriminated from 60,000 feet altitude including, 1) salt marsh cord grass (Spartina alterniflora), 2) salt marsh hay and spike grass (Spartina patens and Distichlis spicata), 3) reed grass (Phragmites communis), 4) high tide bush and sea myrtle (Iva species and Baccharis halimifolia), and 5) a group of fresh water fowl. All of these species are shown in fifteen overlay maps, covering all of Delaware's wetlands prepared to match the USGS topographic map size of 1:24,000.

Major communities of 1) Spartina alterniflora, 2) Spartina patens and Distichlis spicata, and 3) Iva frutescens and Baccharis halimifolia can be distinguished from each other and from surrounding uplands in ERTS-1 scanner bands #6 and #7. Similarly, major impounded areas, built to attract water fowl, can be identified. Mosquito control drainage ditches and plant species such as Phragmites communis which naturally occur in small, dispersed patches are impossible to discriminate within the resolution capability of the ERTS-1 scanner. In disturbed marshes of northern Delaware Bay, Phragmites communis, does occupy large enough expanses of marsh to be detected. In summary, it appears from preliminary analysis that spectral discrimination capabilities of ERTS-1 imagery compare favorably with those of aerial infrared photography and that spatial resolution is the dominant factor limiting the potential for detailed vegetation mapping using ERTS-1 imagery.

c). Three more papers have been presented and are being prepared for publication in journals and proceedings. (See Section D of this report).

d). Ground truth has been collected during two more satellite overpasses and two aircraft overflights (See Attached Tables).

### C. Significant Results

As described in Section B, communities containing four different coastal vegetation species, developed marshlands and fresh water impoundments have been identified in ERTS-1 images. Ground measurements of suspended sediment load have been correlated with tonal variations in band 5.

#### D. List of Publications

1. "Application of Automated Multispectral Analysis to Delaware's Coastal Vegetation Mapping" American Society of Photogrammetry, 1973 Convention, Washington, D. C., March 11-16, 1973.
2. Klemas, V., Daiber, F., Bartlett, D., Identification of Coastal Vegetation Species in ERTS-1 Imagery, NASA ERTS Symposium on Significant Results, Washington, D. C., March 5-9, 1973.
3. Klemas, V., Treasure, W., and Srna, R., Applicability of ERTS-1 Imagery to the Study of Suspended Sediment and Aquatic Fronts. NASA ERTS-1 Symposium on Significant Results, Washington D. C., March 5-9, 1973.
4. Kupferman, S., Klemas, V., Polis, D., and Szekiolda, K., Dynamics of Aquatic Frontal Systems in Delaware Bay, A.G.U. Annual Meeting, Washington, D. C., April 16-20, 1973.

#### E. Conformance to Schedule

Measured from the date of ERTS-1 imagery delivery, we are on schedule.

#### F. Work Progress Evaluation

As described in Sections B, C, and D, of this report, the massive ground truth collection effort is paying off, enabling our team to interpret and correlate any ERTS - imagery of this region that we can get our hands on. Federal and State agencies are quite impressed by our results and have offered key personnel as co-investigators.

#### G. Adequacy of Funds

If NASA supplies all the funding specified in our contract, all work will be completed on schedule with results exceeding our original expectations.

#### H. Personnel Changes

None

#### I. Future Planned Work

1. The coastal vegetation studies are being expanded to include other types of land use, i.e., industrial, commercial, recreational, etc.

2. An in-depth study of coastal processes is being conducted correlating ERTS-1 imagery with more detailed measurements, including salinity, sediment concentration, turbidity, chlorophyll, phytoplankton, etc..

3. More dye studies will be conducted during the next ERTS-1 overpasses to determine dye visibility and also to test the environmental impact of an off-shore oil terminal just outside the Delaware Bay. Sludge dumping and acid disposal from barges in the Atlantic, 10 to 40 miles off-shore, is being coordinated with ERTS-1 overpasses.

IMAGERY FROM  
 DELAWARE BAY REGION  
 ERTS-1 SATELLITE OVERPASSES\*

<u>Date of Pass</u>	<u>Region</u>	<u>I. D. Number</u>	<u>Center Point Coordinates</u>	<u>Bands</u>	<u>Format</u>
8/16/72	DO	1024-15073	38.926N 73.925W	M	MSTP9
9/3/72	DO	1024-15074	38.752N 73.998W	M	MSTP
10/9/72	DB	1078-15075	38.915N 73.955W	M	MSTP9
10/10/72	DO	1079-15133	38.883N 75.346W	M	MSTP
10/27/72	DO	1096-15081	38.794N 74.016W	M	MSTP
12/2/72	DO	1132-15083	38.786 74.036W	M	MSTP
12/3/72	DB	1133-15141	38.798N 75.474W	5,6,7	MSTP9
1/26/73	DB	1187-15140	38.883N 75.346W	M	MSTP9

Bands M = 4, 5, 6, and 7 (Multispectral Scanner)

Format M = 70 mm negative transparency  
 S = 70 mm positive transparency  
 T = 9.5 in positive transparency  
 P = 9.5 in paper print  
 9 = 9-track tape 800 (bpi)

Region DB = Delaware Bay  
 DO = Delmarva Coast

\* This list shows only imagery containing less than 60% cloud cover.

ERTS AND SKYLAB AIRCRAFT OVERFLIGHTS  
OF DELAWARE BAY TEST SITE

<u>DATE</u>	<u>AIRCRAFT AND ALTITUDE</u>
September 14, 1970	RB-57 at 60,000 ft. altitude
November 4, 1971	U-2 at 65,000 ft. altitude
August 26, 1971	9 Inch Color IR at 11,500 ft.
September 15, 1972	U-2 at 65,000 ft. altitude
October 28, 1972	C-130 at 10,000 ft. altitude
March 24, 1973	U-2 at 65,000 ft.
April, 1973	C-130 at 10,000 ft.
April, 1973 - August, 1973	Sidelooking Radar Overflights
Summer, 1973	Laser Wave Profiling Overflights
Summer, 1973	Laser Chlorophyll and Oil Detection Overflights
Fall, 1973	RB-57 at 60,000 ft.