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IMPACT OF ERTS-1 IMAGES ON MANAGEMENT OF NEW JERSEY'S COASTAL ZONE

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ABSTRACT

The thrust of New Jersey's ERTS investigation is development of procedures for operational use of ERTS-1 data by the Department of Environmental Protection (DEP) in the management of the State's coastal zone. Four major areas of concern were investigated: detection of land use changes in the coastal zone; monitoring of offshore waste disposal; siting of ocean outfalls; and allocation of funds for shore protection.

ERTS imagery was not useful for shore protection purposes; it was of limited practical value in the evaluation of offshore waste disposal and ocean outfall siting. However, ERTS imagery shows great promise for operational detection of land use changes in the coastal zone. Some constraints for practical change detection have been identified.

INTRODUCTION

The New Jersey Department of Environmental Protection (DEP) is a regulatory agency charged by law with protecting and enhancing the State's total environment. The Department is oriented toward implementing and enforcing environmental statutes. While DEP is not a research organization, we do pursue mission oriented research when that research offers good prospects for successful application to practical problems. Remote sensing research has played and will continue to play an important role in DEP programs. Our wetlands and coastal zone statutes could not have been implemented without remote sensing tools.

New Jersey's ERTS-1 investigation, which is being conducted in conjunction with Earth Satellite Corporation, is aimed at developing procedures for operational use of ERTS data by DEP

in managing the State's coastal zone. Four significant problem areas have been identified as potentially benefiting from information derived from ERTS data:

1. Monitoring of offshore waste disposal;
2. Siting of ocean outfalls for regional sewage treatment plants;
3. Allocation of funds for shore protection;
4. Detection of land use changes in the coastal zone.

OFFSHORE WASTE DISPOSAL

The offshore waste disposal problem is important because of proximity to New Jersey's coastline of two major Federally regulated marine waste disposal sites--one off Sandy Hook near the New York Bight and the other off Cape May near Delaware Bay. DEP is concerned with the effects this waste disposal will have on future recreational use of waters and beaches, fish resources, and public health.

The Federal Environmental Protection Agency has designated five dumping areas within the New York Bight site for the disposal of the following waste materials: industrial acid, sewage sludge, dredge spoil, construction debris and wrecks. ERTS imagery primarily records acid and dredge spoil. We are monitoring the dumping with each ERTS overpass to determine geographical extent and generalized dispersion characteristics. These analyses are helping the Department to better understand the extent of the problem; they will also help to support a case with EPA for possible alternate disposal sites, if the data demonstrate this need. However, the long delay in receiving ERTS imagery has caused it to be useless in helping to monitor impacts of individual dumpings, even for the limited use of guiding water quality sampling by DEP inspectors.

OCEAN OUTFALLS

The Department presently is engaged in a long term program of converting New Jersey sewage waste disposal from hundreds of local, often improperly operated, primary and secondary treatment plants to a small number of regional secondary treatment plants with long ocean outfalls. While ocean discharge of sewage effluent is not the ideal solution to the problem,it poses much less hazard to the environment than

the alternatives available to New Jersey, e.g., discharging into ground water and estuarine areas, which have been traditional recipients of these wastes.

A review of the outfall design criteria found in engineering reports indicates that little or no systematic use has been made of nearshore circulation of surface dispersion information derived from remote sensing techniques. Furthermore, effectiveness of ocean outfall systems rarely has been confirmed after construction. Using ERTS data, repetitive black and white aircraft photography dating back to 1940, and other historical data, we have developed tidal and wind driven surface current information for direct input into the design of New Jersey's sixteen proposed ocean outfalls. These data have been received enthusiastically by the sewage authorities and their environmental consultants, but it is still too early to tell if, of themselves, the data will be definitive.

The Department must determine if outfall design specifications are being met and must insure that effluents have a minimal impact on nearshore waters and beaches. Federally imposed standards also must be attained. These determinations can best be made with aircraft photography and collateral ground truth data. We are planning to verify the models from which most outfalls presently are designed by injecting dye at the treatment plant, photographing the outfall site, contouring areas of equal density on the photography and relating in situ measurements of dye concentration to film density. In this way, we hope to confirm the initial dilution ratio of the outfall from the sea bottom to the ocean surface.

ERTS still may be of benefit in these analyses. The capacities of the proposed outfalls are much greater than all but one outfall now in operation, and this outfall presently is operating far below design capacity. We intend to conduct a dye study at this outfall (when it begins operating at capacity) in conjunction with an ERTS overpass. To date ERTS imagery of dye studies has not provided useful information, however, the larger outfalls may be detectable with ERTS. If this proves to be the case, repetitive coverage will be of great value in demonstrating the effectiveness (or lack of effectiveness) of the outfall design.

SHORE PROTECTION

New Jersey (through DEP) annually spends several million dollars of State funds for construction and maintenance of shore protection structures. These expenditures are in the

form of matching grants to local municipalities (on a seventy five percent State--twenty five percent local basis) and represent only ten percent of the total requests for aid.

New Jersey is probably one of the best (or worst) examples of beach preservation structures in the United States. The Atlantic shoreline consists of groin upon groin all the way down the coast. Over the years, the State has been building and repairing these structures and/or replenishing the sand-eroded areas without a clear understanding of the effectiveness of these measures. Only recently, the United States Park Service decided to abandon completely shore protection measures on their lands and let the beaches return to a natural condition.

ERTS proved to have insufficient resulution to address this problem, both directly in measuring beach erosion rates and indirectly in measuring nearshore currents. Perhaps, with an increase in resolution to tens of feet or even feet, repetitive ERTS coverage will be valuable in monitoring impacts and effectiveness of shore protection structures, but the imagery from ERTS-1 is not useful for this purpose.

COASTAL ZONE LAND USE

The New Jersey Wetlands Act, which took effect in November, 1970, requires that the Department map the wetlands and regulate their use. Approximately 938 maps are being prepared, over 500 of which have already been completed, at a scale of 1:2400. These maps show the upper wetlands boundary and an inventory of wetlands vegetation down to five acre units, for approximately 450 square miles of wetlands. In preparing these maps, stereo aerial photography was taken, in both natural color and color infrared, for over 1300 square miles of New Jersey's coastal area. This photography is at a scale of 1:12000.

The New Jersey Coastal Area Facility Review Act took effect in September, 1973. This Act regulates use of lands adjacent to the wetlands and extends DEP responsibility to approximately 1750 square miles. The Coastal Area Act defined the boundaries of the area in terms of roads and railroads and listed the facilities to be regulated. The Act also required that the DEP prepare an environmental inventory for the coastal area. Since the Act contained a grandfather clause for facilities already under construction on the effective date, the Department obtained stereo color infrared aerial photography on that date throughout the coastal area for legal documentation. This photography, at a scale of 1:35000, also will be used to help prepare the environmental inventory.

DEP, by virtue of these two statutes, has the authority to control major development within the coastal area of New Jersey. This area constitutes approximately twenty-five percent of the State. Enforcement of these laws must deal with two basic situations:

1. Monitoring authorized development projects to ensure compliance with permit conditions.

2. Detecting clandestine or unauthorized major land use modifications.

In the past, the Department has approached the enforcement problem by using ground inspectors, supplemented by occasional observations from light aircraft and helicoptors. Hand held photography was obtained frequently for legal evidence, both on the ground and in the air. This approach was satisfactory when the areas over which DEP had enforcement powers were more limited; however, it is far too costly and slow a method to adequately cover twenty-five percent of the State.

The wetlands and coastal area photography, referred to previously, have demonstrated clearly the value of systematic aerial photography in monitoring the coastal area. These photographs are scanned to detect land use changes and to direct a limited number of inspectors to the precise locations of changes. This leads to far more effective

utilization of the inspectors' time. Simultaneously, the photographs provide a legal record of changes. Periodic aerial photographic coverage (three to four times a year) would provide cost effective surviellance, but there would be several months interval between observations. With modern construction equipment, extreme destruction of land can occur rapidly. More frequent observations are needed, but the cost for frequent aerial coverage of the entire coastal area would be prohibitive. For this reason, the Department has turned to ERTS as a potential surviellance tool for detecting land use changes.

Comparisons of ERTS images for the period 10 October 72 through 7 July 73 have detected two hundred seventy-six changes. These changes are plotted on 1:24000 scale photomaps, which are used to guide field inspectors. We have successfully detected changes as small as two to three acres. At present we are refining our interpretation techniques to distinguish developmental changes from agricultural and seasonal changes.

DISCUSSION

For the first three problem areas -- offshore waste disposal, ocean outfalls and shore protection -- we have concluded that repetitive high-altitude aerial photography provides for more useful information than does ERTS. The resolution of ERTS-1 is insufficient for addressing these problems. An increase in resolution to tens of feet or feet may provide the needed information.

We believe that repetitive ERTS coverage has great potential value to the State for the fourth problem area -- operational detection of land use changes in the coastal area. A responsive change detection system initially would be used to enforce our coastal zone and wetlands statutes. Specifically, it would guide on-ground inspections, help us plan intelligently for local aircraft surveillance, and establish legal records for court use. All of these promote efficiency in management of our coastal zone and are cost effective in terms of time and personnel.

To realize this potential in change detection, certain limitations of the present ERTS system must be overcome:

1. Change detection must be automated (digital tapes should be used for analysis in conjunction with imagery);

2. Approximately one acre resolution must be achieved;

3. The repetitive coverage interval of 18 days should be reduced (this is highly desirable but not limiting);

4. Thirty to sixty day imagery delivery times from NASA for standing orders are shortened substantially (to four to seven days);

5. Requests for additional data are met in a timely fashion (rather than six months or longer as at present).

The Department is prepared to initiate an operational test of change detection utilizing ERTS-1 imagery. This test requires rapid delivery of imagery by NASA. We will analyze the imagery rapidly and immediately provide the information to DEP inspectors. Timeliness of the information is most important in motivating our inspectors to use it. With timely information, our inspectors can halt unauthorized land use changes before great environmental damage has occurred. Stale information is of historical interest only, and will have no meaningful impact on operational management of our coastal zone. To conduct this test, we have requested that imagery be made available within five working days after each ERTS overpass, for five consecutive overpasses. The number of overpasses requested will allow for possible cloud cover. This test, using visual interpretive techniques, will provide detailed data on the effectiveness of ERTS in operational change detection.

DEP also will propose to NASA an extension of our ERTS investigation to improve the timeliness and accuracy of our change detection capability by shifting to automatic data processing of ERTS digital tapes. We hope that NASA will act favorably on this proposal. It represents a major step toward a fully operational change detection system.

RECOMMENDATIONS

In dealing with the real world problems of a regulatory agency, our work indicates that ERTS data coupled with repetitive aircraft coverage will be most productive and cost effective. We recommend that NASA take into account these kinds of needs and fund either in whole or in part worthwhile aircraft and ERTS supporting programs that are aimed at specific operational problems of state and local governmental agencies. The success of our ERTS investigation in addressing these real world problems has convinced the State of New Jersey to include in its next budget fifty thousand dollars to participate in the kinds of activities mentioned above.

We appreciate the opportunity to participate in the ERTS program with NASA.