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Paper M 1

SEASONAL CHANGES OF LITTORAL TRANSPORT AND BEACH WIDTH AND RESULTING EFFECT ON PROTECTIVE STRUCTURES

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ABSTRACT

The shorelines of Maryland's portion of the Chesapeake Bay exhibit seasonal changes in direction of littoral transport and resulting beach width. Observation and study of this process at selected locations emphasizes the necessity of study for a complete years seasonal cycle before stating erosion rates of an area to be protected by structures and the cyclincal presence or absence of beaches.

The purpose of this paper is to describe seasonal beach conditions at four selected sites and resulting physical changes to protective structures. The seasonal changes will be shown by 35mm slides of the sites and of ERTS-1 underflight photography of these sites. Through the use of ERTS-1 multi-spectral photography, it will be possible to make widespread predictions elsewhere in the Bay as a direct aid in protective structure design.

1. INTRODUCTION

Aerial photography is available to the public from the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, flown generally during warm weather months. The photography is panchromatic, showing all objects in varying shades of gray. The precise line of tide on the beach is not distinguishable, however, shallow offshore structural features are discernable. Littoral transport studies must necessarily include all seasons and the position of tide along the shoreline should be mapable from photography.

Seasonal ERTS-1 underflight color IR and color positive photography has established a geologic baseline reference of the shoreline environment of the Chesapeake Bay, and the Atlantic coast.

The purpose of this paper is to discuss in some detail one discipline application of the Maryland Geological Survey's Coastal-Estuarine Geology program, relating accumulated pre and current ground truth to ERTS-1 low altitude color IR and color positive film.

The Survey has been actively gathering physical data on the Chesapeake Bay nearshore environment since 1963. As a consequence, it has become apparent that littoral transport direction is seasonal, with a net direction and is related directly to seasonal prevailing winds, to intense local weather occurrences, and to the geographic location of the shore to prevailing wind direction. The geology of an eroding physiographic unit is vital to the total erosion-deposition budget of the unit, however, it becomes apparent that the nearshore shallow environment must contribute a share of the total E-R budget. To comprehend fully the offshore-onshore erosional depositional relationship, Mr. Randall T. Kerhin, geologist with the Maryland Survey, is studying in detail the offshore bar and trough structure and composition. The locations of areas to be described are shown in Figure 1.

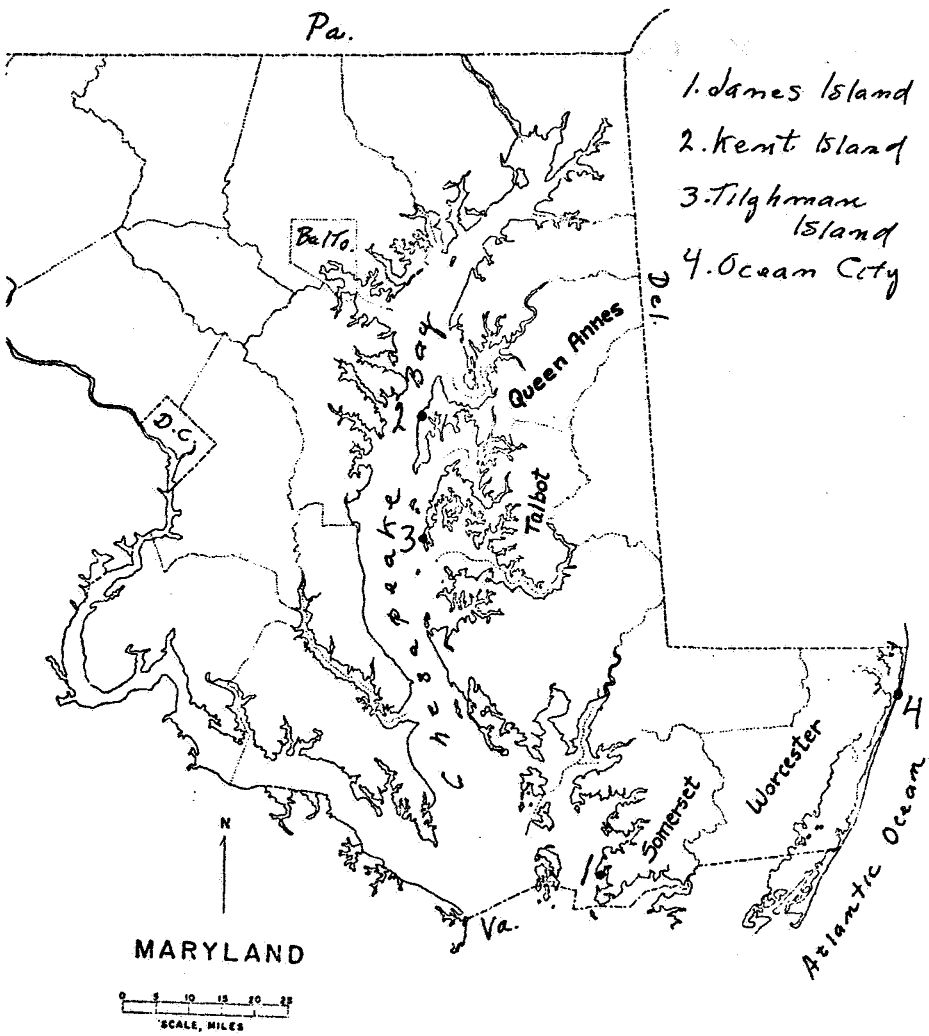


Figure 1. Locations of areas discussed

A study of the geomorphologic problem of a former spit that now serves as a barrier beach extending along the southern boundary of Janes Island State Park, Somerset County, extends slightly southeastward of Island Point a distance of 4,800 feet, disclosed two apparent but different types of littoral data. During the summer months, due to winds blowing from the southwest across Tangier Sound moved sand northward to a cove bordered by scrub size trees. There was no beach in front of the thick deep rooted organic marsh vegetation. Wave action would break chunks of the vegetation mass up and through them up on the shore. During the winter months the winds from the northwest would move the sand southward and by late spring there would be a sand beach completely covering and protecting the summertime eroding marsh shore edge. The erosion rate of this location is 1.5 feet a year, a relatively low rate, but understandably so. A time sequence of April and July, is shown by Figures 2, and 3.

Janes Island State Park - Island Point, - Looking North

Figure 2 April 29, 1971

Figure 3 July 22, 1969

Through the inspection of the ERTS-1 film, these facts are documented by Figures 4 and 5, which are photo copies of ERTS-1 underflight mission 16, October 20, 1972, and mission flight 226, January 16, 1973, respectively. Unfortunately flights earlier than October are not available. The fall-winter littoral transport direction southward began before October 20, as evidenced by mission 226 flight. The color IR film definitely delineates the sand shoreline separately out the ice, while the color positive film shows the offshore bar and trough structures which the color IR does not.

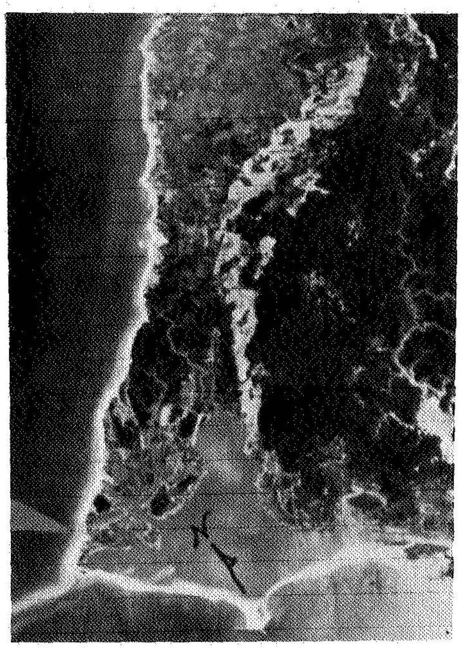


Figure 4. James Island
ERTS-1 Mission 16
Underflight Oct. 20, 1972

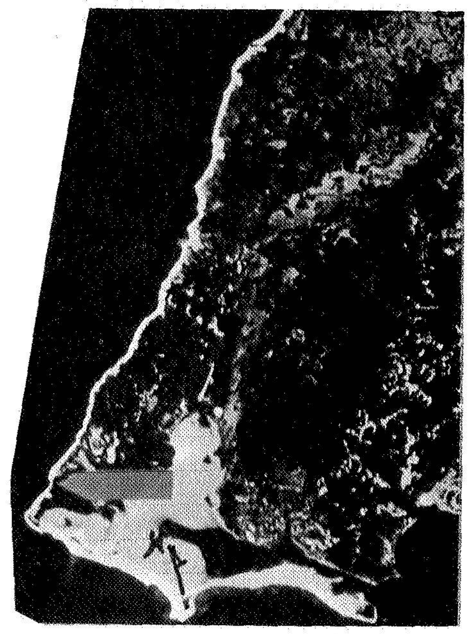


Figure 5. James Island
ERTS-1 Mission 226
Underflight Jan. 16, 1973

A second example area for which the Survey has pre and current ERTS-1 ground truth is the northern marker of a measured mile on Kent Island, Queen Annes County. During the summer months sand accumulates on the southern side of the groin to which the marker is attached, causing a starvation of the northern shoreline. The process is reversed in the winter; erosion rate is measured to be 5 feet a year. Figure 6 shows the summer starved condition and Figure 7 shows the winter buildup. This situation could be prevented by elimination of the groin. ERTS-1 underflight film mission 215 from an altitude of 10,000 feet dated September 23, 1972, is shown in Figure 8 and the January 16, 1973 flight is shown in Figure 9. The arrow points to the groin. The ERTS-1 film clearly shows this littoral reversal.

Figure 6. North Mile Marker - Kent Island - August 3, 1971

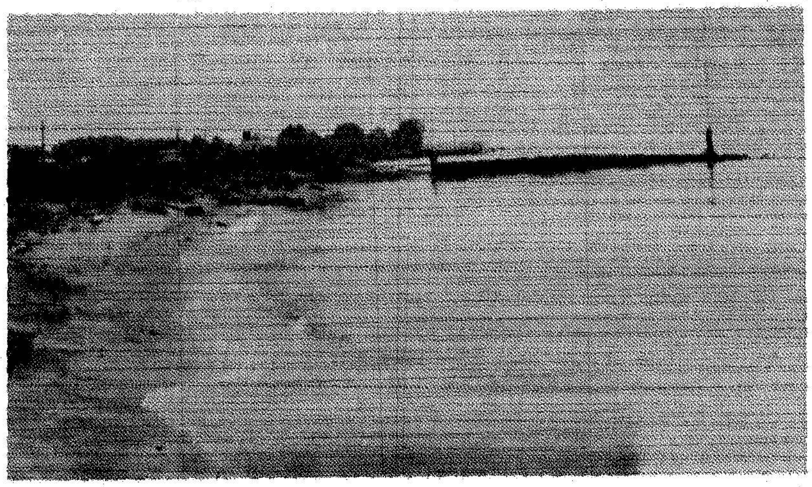
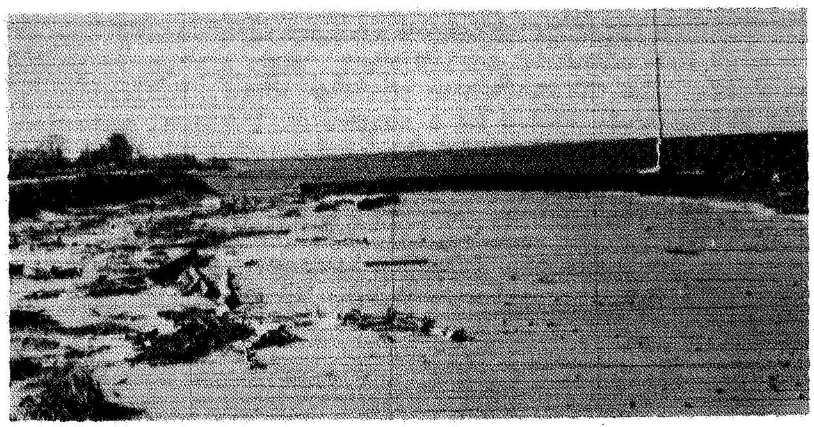


Figure 7. North Mile Marker - Kent Island - March 5, 1971



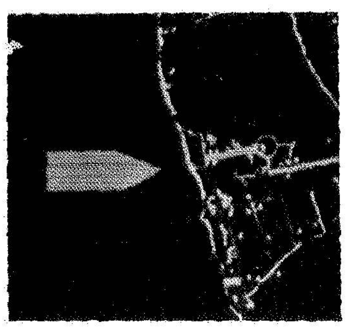


Figure 8.

Kent Island
ERTS-1 Mission 215
Underflight Sept. 23, 1972

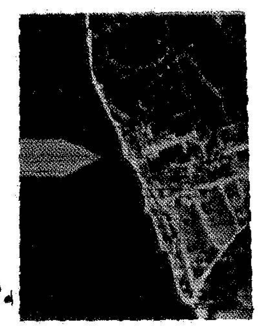


Figure 9.

Kent Island
ERTS-1 Mission 226
Underflight Jan. 16, 1973

Another area of interest is located immediately north of the U. S. Navy Research Laboratory tower, south Tilghman Island, Talbot County. Although the property is now privately owned, the State of Maryland acquired shore property having 3,800 feet of shoreline in 1963. Erosion at the rate of 16 feet per year of the area north of the protected Navy property was endangering a county road paralleling the shoreline. As a consequence the State provided in 1965, a sum of $50,000 to be used in construction of approximately 1,100 feet of protective structures which were considered as a "show case test site".

Construction was begun in April, 1966 and completed in September, 1967. The first section of structure was keyed to the northern end of the Navy steel bulkhead and consists of 270 feet of timber bulkheading, reinforced at the toe with 1/4 ton rip-rap. The remaining 730 feet was protected by a sloped revetment of interlocking concrete blocks. The use of concrete blocks in revetment design has been documented by Hall, J. V. and Jachowski, R. A. (1964) and Hall, J. V. (1967). The revetment at Tilghman has been described by Mohl, E. V. and Brown, J. D. (1967) and Slaughter, T. H. (1967).

Background knowledge of offshore and onshore conditions of the area indicated a high hydrodynamic environment, with little or no beach during most of the year. The offshore was shallow cored, indicating a predominent sandy bottom which could serve as a source of littoral material, especially during the winter months. By the spring of 1971 it was apparent that for a number of reasons, the northern 200 feet of the concrete block revetment was in trouble, the toe of the structure was being undermined. As a result of toe undermining, the structure failed along this section. (Figure 10 shows the northern end of the structure on September 26, 1967 shortly after completion. Figure 11 shows the same location on October 4, 1972.)

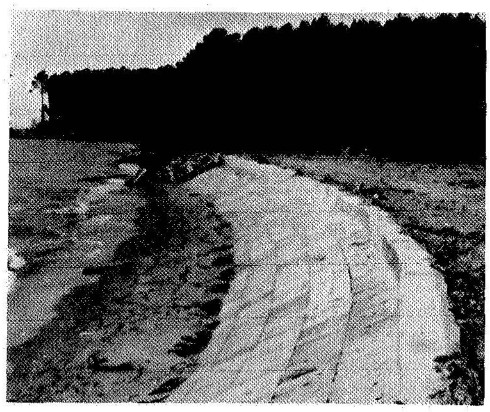


Figure 10. S. Tilghman Island Sept. 26, 1967

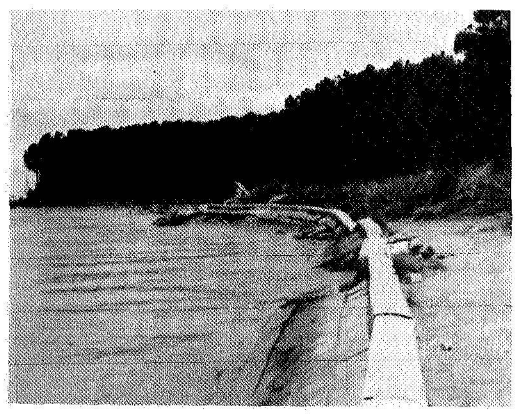


Figure 11. S. Tilghman Island Oct. 4, 1972

Inspection of ERTS-1 low altitude flight film, Color IR of October 20, 1972, Figure 12 and January 16, 1973, Figure 13, and color positives of January 16, 1973, does not show any beach for the 3,800 feet under consideration. The lack of winter sand accumulation as shown by the January 16, 1973 flight may not be the usual situation as sometimes is the case, but it emphasizes the fact that there is very little beach sand to be counted on to protect the toe of the revetment.

Figure 12.

S. Tilghman Island
ERTS-1 Mission 16
Underflight
Oct. 20, 1972

Figure 13.

S. Tilghman Island
ERTS-1 Mission 226
Underflight
Jan. 16, 1973

The last area to be described is the beach at Ocean City, Maryland, specifically the beach between 12th and 27th Streets, and 73rd and 78th Streets. These are two areas of Ocean City beach groin field systems. The groins in the southern field were erected over the period 1938 to 1961. The northern groin field was erected in 1961.

Of concern is the effectiveness or non-effectiveness of the groin fields and individual groins. Winter northeast winds take their toll of the beach and in some cases the dune is under extreme high tide attack. (Figure 14 dated February 7, 1973, shows weak beach conditions at the 75th Street groin.

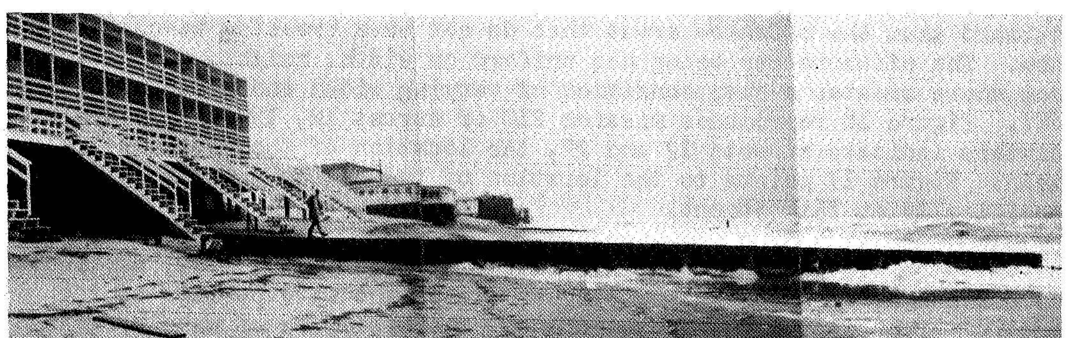


Figure 14. Ocean City, 75th Street February 7, 1973

Figure 15 shows the beach conditions at 13th Street on October 17, 1972. The groin in the foreground is completely exposed and high tide reached under the base of the boardwalk.

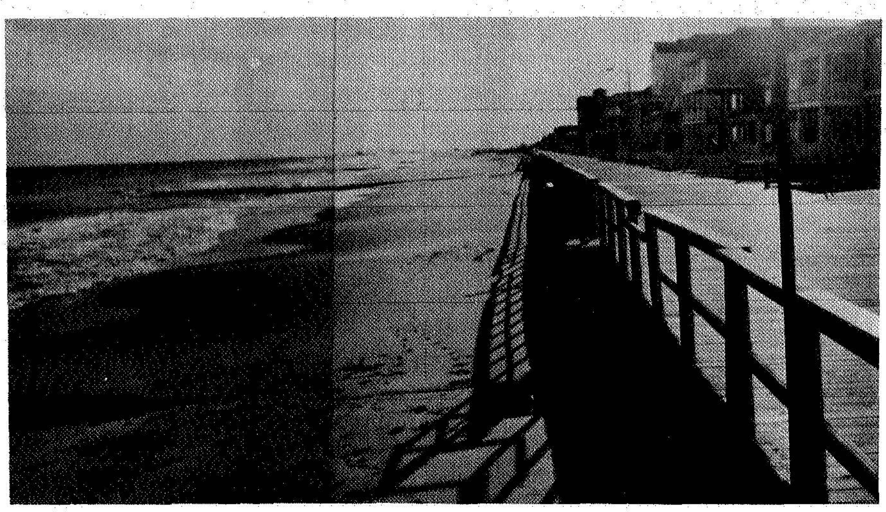


Figure 15. Ocean City, 13th Street October 17, 1972

Available offshore profiled data obtained by the U. S. Army Corps of Engineers along Ocean City beach show the nearshore bar to vary in width and height and distance from shore. Personal knowledge of Ocean City summer beach swimming conditions, documents the existence of rip currents, when along shore currents are increased. ERTS-1 underflight low altitude film of mission 210 on August 12, 1972, disclosed very clearly, the apparent relationship of the offshore bar to the beach. The day was a fairly normal summer day weather-wise, winds started off in the morning from the north and swung around to the southeast later in the day. Maximum wind was 6 to 10 mph. The minimal offshore wave breaking pattern of the day disclosed that where the waves break the shoreline is farther eastward than the offshore areas that do not have breaking waves facing them. The offshore bar being non uniform on width, height, and distance from shore creates a cusp condition of varying width and depth of enlargement. Figure 16 reproduces mission 210 of August 12, 1972. The numbered pointers indicate streets 12 and 27, the location of the southern groin field. Figure 17 points to the location of the northern groin field, specifically at 75th Street.

Mission 226 low altitude underflight of January 16, 1973, duplicates the essence of August 12, 1972 flight, except the wave pattern of the January flight is a little more intense, therefore, exact wave breaking patterns are not discernable.

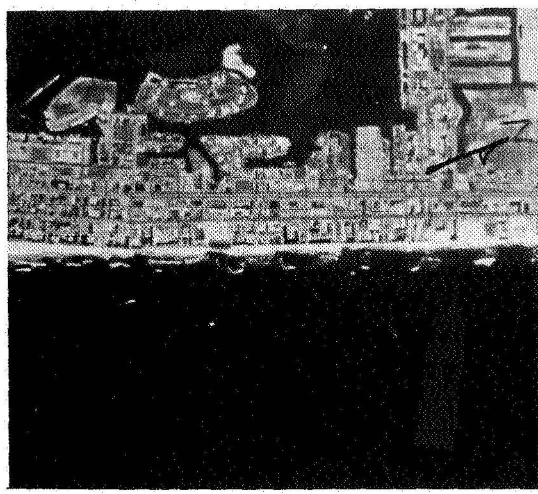


Figure 16. South Ocean City
ERTS-1 Mission 210
Underflight August 12, 1972

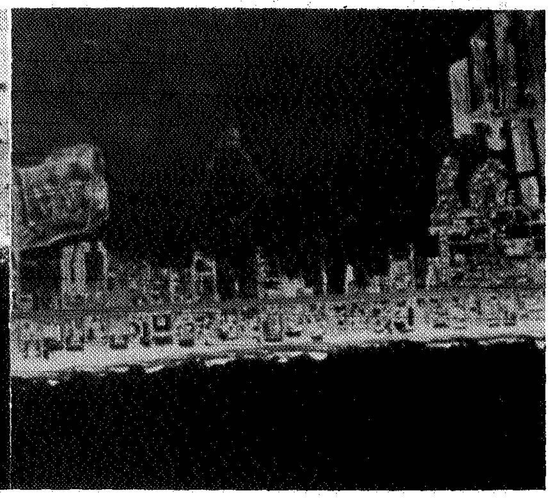


Figure 17. South Ocean City
ERTS-1 Mission 210
Underflight August 12, 1972

ERTS-1 low level underflight multi-spectral photography has proven to be a most productive aid in study of littoral transport of selected areas within the Chesapeake Bay, and of geohydrodynamic processes along Maryland's Atlantic Coast.

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