

CHAPTER ONE HUNDRED FIFTY SEVEN

LOW-PROFILE BARRIER ISLAND OVERWASH AND BREACHING IN THE GULF OF MEXICO

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ABSTRACT

An analysis of 17 tropical cyclone impacts along barrier islands in the Gulf of Mexico has led to the following conclusions: 1) tropical cyclones are the primary mechanism of barrier island overwash and breaching, 2) landward-directed and seaward-directed overwash flow can breach barrier islands, 3) storm track orientation to the shoreline controls the direction of barrier island breaching, 4) shore-normal and right-oblique hurricane impacts breach barrier islands by landward-directed overwash flow, and 5) left-oblique hurricane impacts breach barrier islands by seaward-directed overwash flow.

INTRODUCTION

The breaching of low-profile Gulf Coast barrier islands by hurricane impact is controlled by barrier island morphology, storm magnitude, and the type and intensity of other processes that operate on the system (Penland et al, 1980; Simpson and Reihl, 1981; Suter et al, 1982; Penland and Suter, 1984). Due to the asymmetry of the cyclonic wind field and the occurrence of the strongest winds in the northeast storm quadrant, orientation of the storm track to the shoreline controls the direction (landward or seaward) from which barrier island breaching occurs (Figure 1). Analysis of storm orientation and hurricane impacts using historical aerial photographs and tide gauge records of landfalls associated with hurricanes Flossy (1956), Audry (1957), Donna (1960), Carla (1961), Hilda (1963), Betsey (1965), Beulah (1967), Camille (1969), Celia (1970), Carmen (1974), and Eloise (1975) and field investigations of impacts associated with hurricanes Bob (1979), Claudette (1979), Frederic (1979), Allen (1980), Chris (1982) and Alicia (1983) leads to the development of three hurricane process-response models that explain the patterns of low-profile barrier island breaching identified on the Gulf

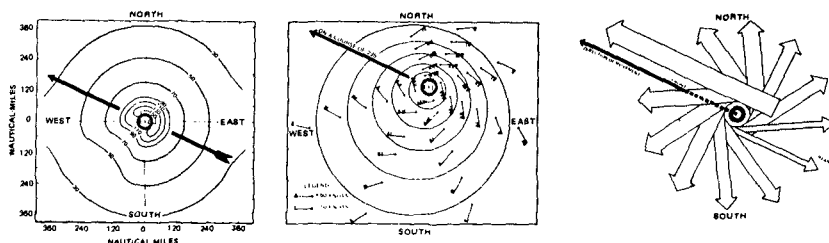


Figure 1. Distribution of pressure, surface winds, and waves within a typical northern tropical cyclone (Crutcher and Quayle, 1974).

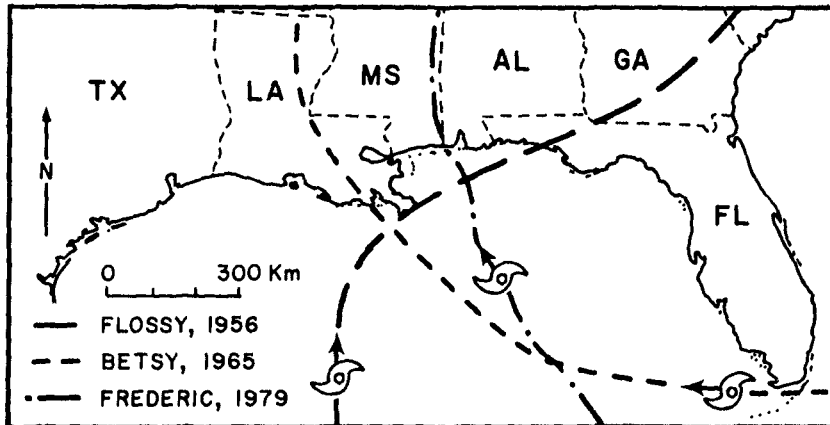


Figure 2. Hurricane Flossy represents a left-oblique impact, Hurricane Betsey represents a right-oblique impact and Hurricane Frederic represents a shore-normal impact.

Coast. These models are:

1. Shore-Normal Hurricane Impact.
2. Right-Oblique Hurricane Impact.
3. Left-Oblique Hurricane Impact.

Case studies for hurricanes Frederic 1979 (shore-normal impact), Flossy 1956 (left-oblique impact), and Betsey 1965 (right-oblique impact) are presented illustrating each type of hurricane impact (Figure 2).

LANDWARD-DIRECTED OVERWASH FLOW

For shore-normal hurricane impacts, peak surge and strongest winds occur pre-landfall and are focused onshore to the right side of the storm track. Landward oriented overwash features and barrier island breaches are concentrated to the right of the storm. Left of the storm, somewhat weaker winds are directed offshore. If the lagoon is sufficiently wide and shallow, offshore wind set-up can pile water against the backbarrier, creating the potential for minor seaward overwash, evidence of which may be masked by subsequent landward overwash flow. The breaching associated with hurricane Frederic (1979) at Dauphin Island and Gulf Shores in Alabama and at Perdido Key and Santa Rosa Island in Florida is representative of a shore-normal impact (Figure 3).

For right-oblique hurricane impacts, the peak storm surge precedes the storm and the strongest winds are directed onshore. In this situation major landward overwash and barrier island breaching takes place right of the storm. Because of the orientation of the wind field, the potential exists for minor seaward breaching to occur to the left of the storm. Hurricane Betsey (1965) is representative of right-oblique impact (Figure 4).

SEAWARD-DIRECTED OVERWASH FLOW

For left-oblique hurricane impacts, the peak storm surge follows landfall. Due to the orientation of the storm track, the strongest winds are initially directed offshore. This results in a significant water level set-up against the backside of the barrier island and leads to major seaward overwash and breaching left of the storm track. With hurricane passage the direction of overwash switches onshore, enlarging the breaches generated by the earlier seaward overwash. Hurricane Flossy (1956) is representative of a left-oblique impact (Figure 5).

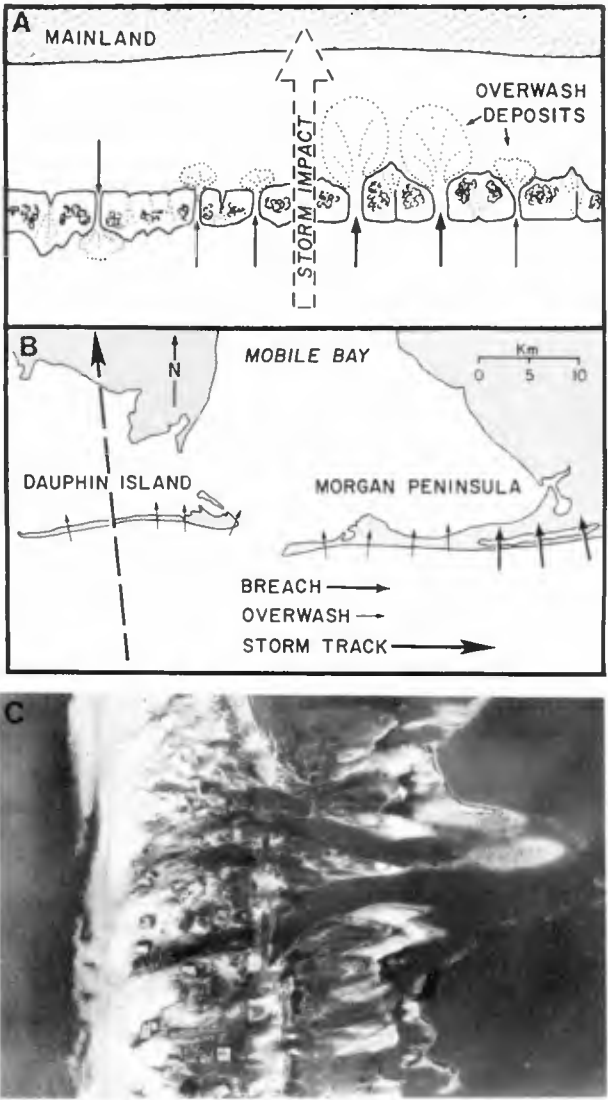


Figure 3. A) Shore-Normal Hurricane Impact Model. B) Hurricane Frederic impact in Alabama. C) An overwash channel associated with hurricane Frederic dissects washover fan spreading into the Mississippi Sound.

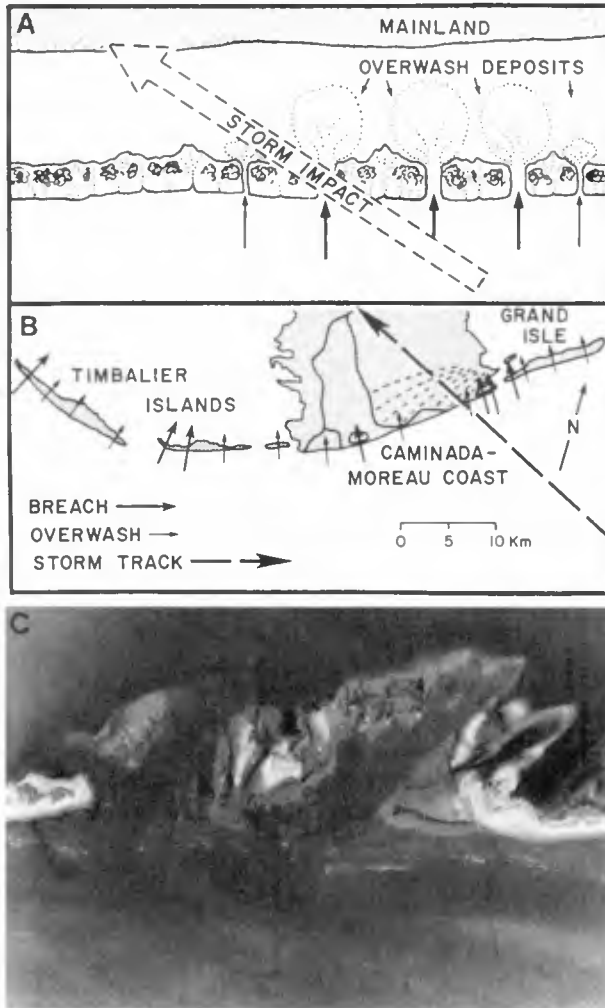


Figure 4. A) Left-Oblique Hurricane Impact Model. B) Hurricane Betsey impact in Louisiana. C) a land-ward oriented beach through Caminada Pass spit. Multiple wash-over fans are deposited in Caminada Bay.

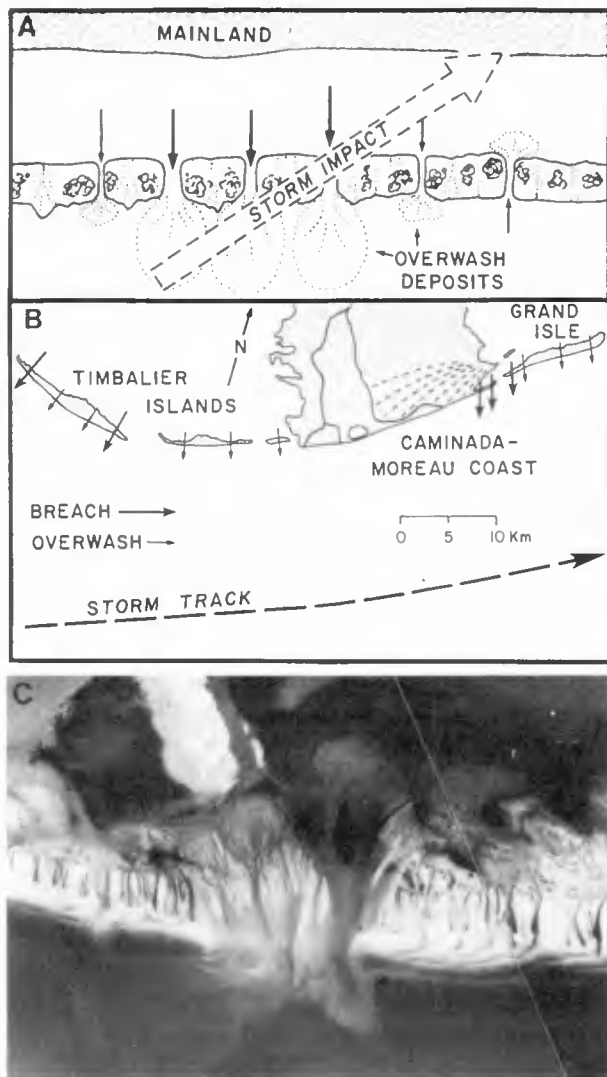


Figure 5. A) Right-Oblique Hurricane Impact Model. B) Hurricane Flossy impact in Louisiana. C) a seaward oriented breach through the western end of Timbalier Island. Note the seaward oriented washover fan spreading across the surf zone into the Gulf of Mexico.

CONCLUSIONS

The analysis of 17 hurricane and tropical storm impacts along barrier islands on the U.S. Gulf Coast leads to the following conclusions:

1. Storm overwash associated with tropical cyclone impact is the primary mechanism of Gulf Coast barrier island breaching.
2. Barrier islands can be breached by landward-directed or seaward-directed overwash flow.
3. Storm track orientation to the shoreline controls the direction from which barrier island breaching occurs through overwash flow.
4. Shore-normal and right-oblique hurricane impacts breach barrier islands by landward directed overwash flow.
5. Left-oblique hurricane impacts breach barrier islands by seaward directed overwash flow.

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