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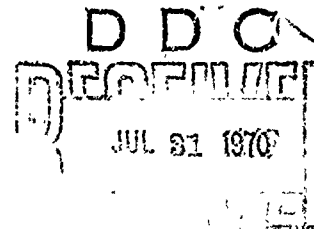
Technical Report 76

EFFECTS OF HURRICANE CAMILLE  
ON THE LANDSCAPE OF THE BRETON-CHANDELEUR ISLAND CHAIN  
AND THE EASTERN PORTION OF THE LOWER MISSISSIPPI DELTA

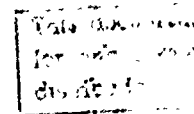
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## Technical Report 76

### EFFECTS OF HURRICANE CAMILLE ON THE LANDSCAPE OF THE BRETON-CHANDELEUR ISLAND CHAIN AND THE EASTERN PORTION OF THE LOWER MISSISSIPPI DELTA

L. D. Wright  
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#### ABSTRACT

Air and ground reconnaissance immediately following the passage of Hurricane Camille disclosed significant modifications to the natural landscape of the Breton-Chandeleur Island arc and to the eastern portion of the lower Mississippi Delta. Considerable dissection and redeposition was evident along beach and barrier formations, and total obliteration dominated numerous sections. Trends of redistributed beach material strongly reflected the final direction of hurricane-induced mass transport of water. In the lower delta damage was mainly to marsh vegetation and was attributable to high water and surge currents directed almost entirely from north to south.

#### INTRODUCTION

Most landforms—certainly most depositional landforms—are primarily the product of normally occurring processes which act with regularity and high frequency. However, occasional catastrophic events may modify a landscape to the extent that normal processes, once they resume, act upon a different set of "initial" conditions. In such a case form-process equilibrium will eventually be regained, but only after changes in the precatastrophy morphology have taken place.

The Mississippi Delta and its environs have suffered the impact of numerous hurricanes, and following each the natural resiliency of the area has, for the most part, shown itself to be superior to catastrophe. Nevertheless, each hurricane has wrought final changes which vary in both subtlety and significance, and never has the delta returned completely to its prehurricane configuration.

On August 17, 1969, Hurricane Camille passed immediately to the east of the Mississippi Delta "bird-foot" and proceeded northward up Breton and Chandeleur sounds to the Mississippi Gulf Coast. The general character of Camille and the destruction dealt by her have been treated elsewhere (Hsu, this Bulletin; ESSA, 1969). The purpose of this report is to describe generally some of the hurricane-induced changes which occurred in the natural landscape of the Chandeleur-Breton island arc and the eastern portion of the lower Mississippi River Delta following Camille. The descriptions and discussions presented herein are based upon an aerial reconnaissance flight and aerial photographs made by the writers on August 19, 2 days after Camille passed through the area; on an aerial reconnaissance flight and photographs made by J. M. Coleman on a Pan American Oil Company flight on August 21; and on ground reconnaissance trips carried out on September 1-3 and September 30-October 4.

Coastal destruction was the result of high winds, abnormally high water levels and associated currents, and wind-generated waves of high energy. The wave regime along the hurricane track is shown in Figure 1 of Sonu (this Bulletin). Approximate directions of dominant surge currents are indicated on Figure 1 of this report; maximum observed and estimated water levels are also shown. Tide gauge records from South and Southwest passes (the only two gauges to survive the storm) indicate that water levels first began to rise at about 1500 hours on August 16. The rate of rise continued to increase steadily as Camille approached the delta. The South Pass gauge ceased to function about noon on August 17; however, the gauge at Southwest Pass shows a rapid fall beginning in early afternoon of the 17th. This fall apparently heralded the seaward flow which dominated the delta in the hurricane's left semicircle. This inundation, together with the strong currents resulting from the steep hydrostatic gradient, appears to have provided most of the destructive energy.

#### BEACHES AND BARRIER ISLANDS

The morphological effects of Camille were most obviously manifest on the beaches and barrier islands fringing the southernmost and eastern portions of the delta. In the vicinity of Southwest Pass and westward therefrom, damage to beach and barrier formations appears to have been limited to occasional washovers and debris accumulations. The beach features most significantly affected include the spit which formerly connected the west jetty of South Pass with the mudlump 1 mile to the west, and Breton, Gosier, and Chandeleur islands, which together form an arc 52 miles in length north of Pass a Loutre.

High waves and storm surge currents appear to have played the major role in modifying the sand formations. Areal variations in intensity of erosion and net direction of transport of the eroded material are generally explicable in terms of Figure 1. It is evident from an inspection of these diagrams that destructive forces were most intense in the vicinity of Breton and Gosier islands, between which the eye of Camille passed shortly after 1900 hours CDT on August 17. Westward, and especially in the vicinity of the aforementioned spit at South Pass, wind intensities were somewhat lower and were directed predominantly offshore rather than onshore, so that wave energy would necessarily have been considerably lower. To the right of the eye, along the arc of Gosier and Chandeleur islands, intensities diminished less rapidly, and surging effects appear to have been more complicated, perhaps because of impoundment of water in Breton and Chandeleur sounds.

#### South Pass Spit

Prior to Hurricane Camille a continuous sand spit 1 mile in length and with a maximum width of 300 yards extended from the west jetty of South Pass to a mudlump 1 mile to the west. Figures 2 and 3 show this feature as it appeared before and after Camille, respectively. Observations of the consequences of previous hurricanes affecting the Mississippi Delta have disclosed that surging effects and destruction are much less severe in the left semicircle (or area west of the eye) (Morgan *et al.*, 1958; Goudeau and Conner, 1968). Alterations by Camille at South Pass were characteristically less dramatic than those farther to the east.

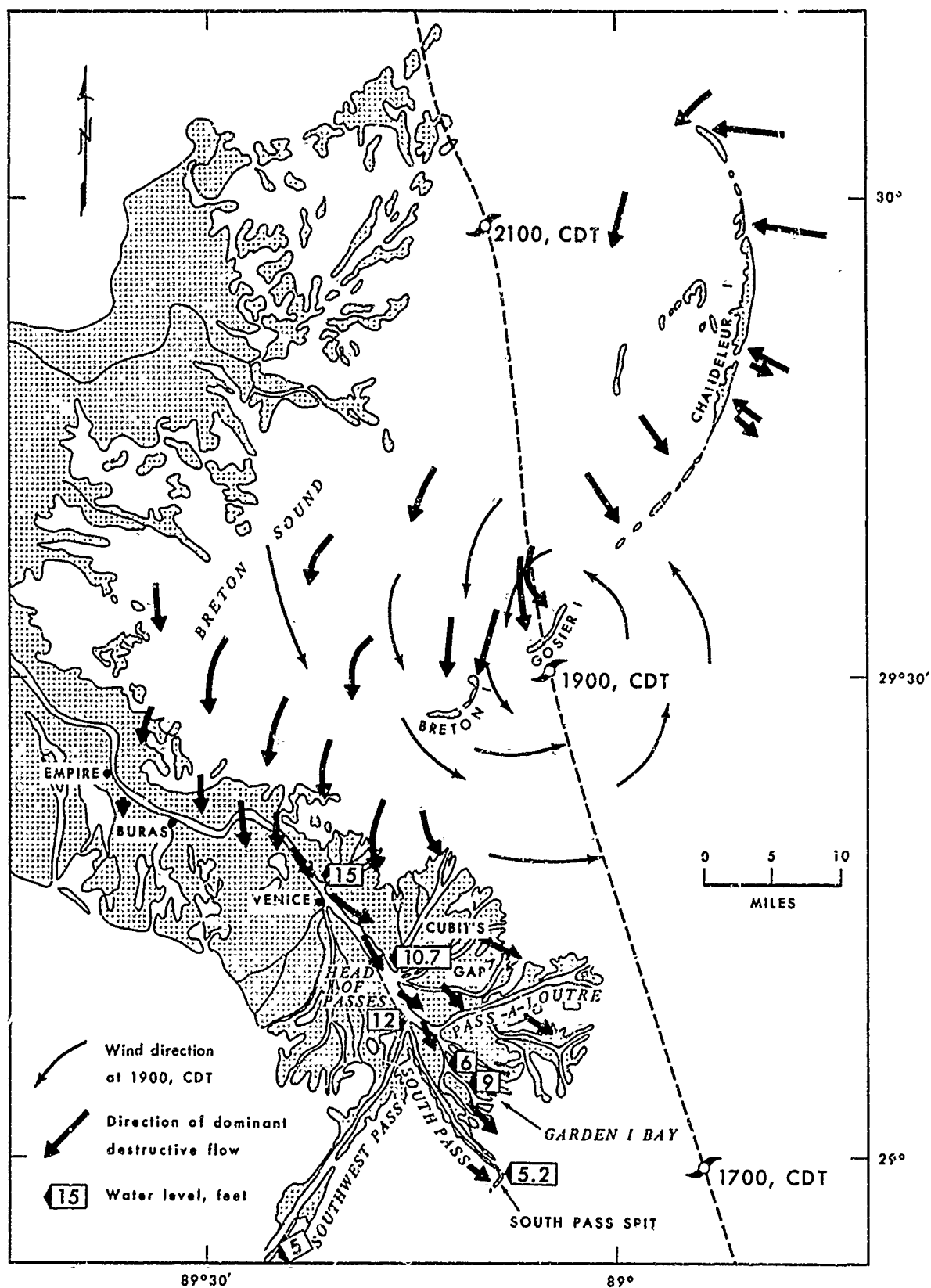


Figure 1. Index map; dominant surge currents; maximum observed and estimated water levels.

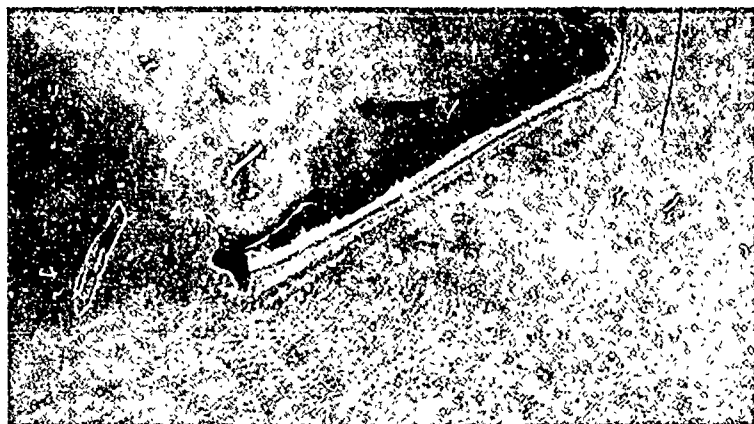


Figure 2. South Pass spit prior to Camille.



Figure 3. South Pass and spit after Camille.

On the basis of observations of water marks on the walls of structures in this area, the writers estimate that the water level did not exceed 5 to 6 feet above normal. (The U.S. Army Corps of Engineers officially estimates 5.18 feet at Port Eads.) This fact suggests a water surface sufficient to inundate completely the spit under consideration but a hydrostatic head and resultant energy considerably lower than that nearer to and eastward of the eye.

With the exception of a few sand patches at the extreme eastern end of the spit, the active subaerial beach was completely removed and the sands were redistributed (Fig. 3). The remaining subaerial portion of the formation tapers westward to a termination at a point less than 0.5 mile west of the eastern end. Farther to the west, the width and offshore situation of the breaker zone suggest that the sediments which formerly gave subaerial expression to the spit have merely been redistributed to form a broad, shallow shoal continuous with the main trend of the spit. There is no evidence of channeling across the spit or of deep dissection. That sediments eroded from the feature were deposited primarily in the inshore zone immediately seaward of the original shoreline is evidenced by the fact that the breaker zone is wider and farther seaward than it was previously and by the lack of sand accumulations on or bayward of the remaining subaerial surface. It may be postulated that rapid reclamation of the spit will be favored by the inshore accumulation of eroded sand at depths shallow enough to enable constructive waves to reform the beach.

#### Breton, Gosier, and the Chandeleur Islands

Breton, Gosier, and the Chandeleur islands comprise a discontinuous convex-seaward arc of barrier islands seaward of the extinct and subsiding St. Bernard Delta (Russell, 1936; Treadwell, 1955), from which they are separated by the shallow Breton and Chandeleur sounds. Destructive energy was more intense in the vicinity of Breton and Gosier islands than in any other part of the delta. By means of the formula suggested by Conner *et al.* (1957), the writers estimate an extratidal increase in water level of over 21 feet around Breton and Gosier islands and slightly lower values along the Chandeleur arc. Considering that water level heights were estimated as high as 30 feet just east of the storm center on the Mississippi coast, the minimum estimate of 21 feet for Breton and Gosier islands is probably conservative. With winds as high as 200+ miles per hour along their coasts and 175+ miles per hour along the Chandeles, tremendous wind waves must certainly have accompanied the surge, though the short fetch consequent on the small diameter of the storm undoubtedly exerted a tempering influence on wave generation. Using Bretschneider's (1957) empirical methods, Sonu (this Bulletin) estimates a deep-water wave height of 16 meters (52 feet) near the eye of the storm at 1800 CDT. Assuming a 21-foot increase in water level, the writers estimate a maximum breaker height of about 17 feet (5 meters) over and in immediate proximity to Gosier Island. This value is based on a wave height/depth ratio of 0.78 (Munk, 1949).

Breton Island, at the southernmost limit of the chain, is the most

stable of the group—it has retained its shape and position for at least the last 100 years (Shepard, 1960). Prior to Hurricane Camille the active beach on Breton Island was backed by stabilized relict beach ridges and by dunes ranging up to 12 feet in elevation (Treadwell, 1955; Kolb and Van Lopik, 1958). Borings indicate that sands extend beneath the island to depths of at least 30 feet (Shepard, 1960).

Figure 4 shows the southern part of Breton Island after Hurricane Camille passed immediately to the east. It is apparent that the island has been almost completely leveled. The eroded sand now constitutes a broad flat along the seaward side of the island and testifies to the significance of seaward return flow following the initial onshore surge. The alignment of runnels and small depositional fans further indicates the direction of net transport.

On the northern part of Breton Island, a crescentic recurve convex to the north, the situation was somewhat more complex, and vestiges of bidirectional transport are apparent. Figure 5 shows this area after the passage of Camille. The large patch of sand on the north side of the circular structure was absent prior to the storm; it appears to owe its existence to washover from the beach which formerly fringed the island's northern side. Such washover could be attributable to flow directed to the

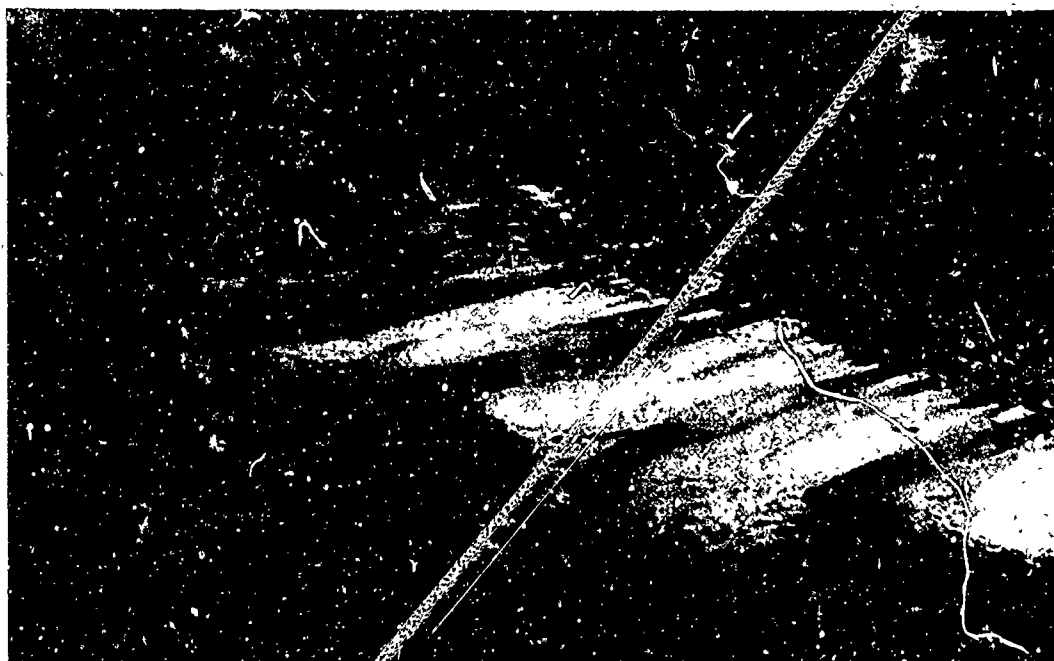


Figure 4. Breton Island; southern part, seaward side in foreground.

southeast (i.e., return flow) or to onshore waves refracted around the northern tip of the island. The sand waves and partially submerged sand plumes in the lower right-hand corner are indicative of flow in the opposite direction. If features as sensitive as the latter had been formed by the initial surge, they would surely have been obliterated by the return flow. They could be associated with a secondary surge (or resurge) such as that postulated by Redfield and Miller (1957) or with conventional tidal flow following the hurricane.

Gosier Island is situated directly on the position at which the eye of Camille was located about 1920 hours CDT on August 17. Aerial photographs taken in April 1969 show Gosier Island as continuous, with a length of about 4.5 miles and a width of about 400 yards. According to Treadwell (1955), the island had elevations varying between 4 and 10 feet. In 1917 the island was merely a shoal area with a few small island patches (*ibid.*). Since that time it has had a history of consolidating under normal conditions and of being dissected by storms (*ibid.*). Just prior to Camille, a continuous sand beach on the seaward side of the island was backed by mangroves and marsh segmented by tidal channels which terminated at the beach.

The severe destruction wrought by Camille is immediately evident from Figure 6. Except for five small subaerial patches, the island has



Figure 5. Breton Island; northern end, sound in foreground.

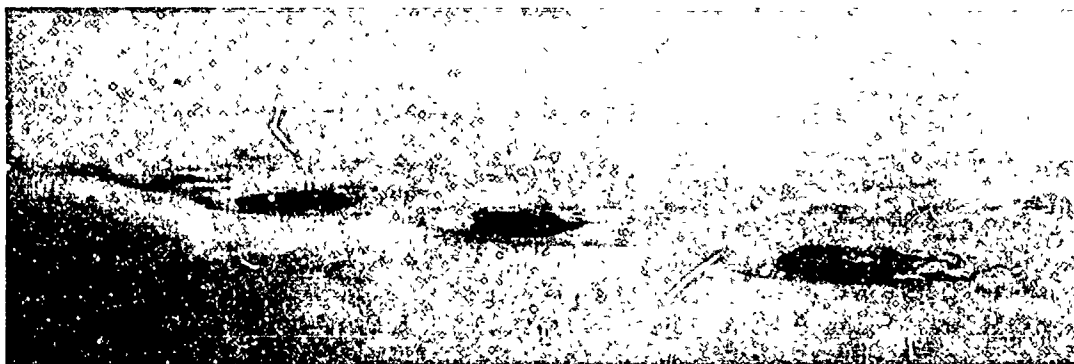


Figure 6. Gosier Island; sound side in foreground.

been reduced to a broad shoal. Figure 6 is oriented facing seaward, and it is interesting to note that nearly all the sediment has accumulated on the seaward (right) side of the residual islands, in spite of Gosier's situation in the hurricane's right semicircle. It is, of course, reasonable to assume that high onshore waves and surge components were significant in destroying the beach and effecting the dissection. However, it is apparent that any patterns inherited from the initial surge have been completely superseded by transport associated with the final event (return flow).

The pattern of dissection of Gosier Island seems to have been influenced to a large degree by the patterns of tidal channels and marsh segmentation which existed prior to the storm. Though it is not clearly evident from Figure 6, the residual islands tend for the most part to be triangular, with their apexes pointing southward. This corresponds to the shape of the marsh segments which existed previously. It would appear that flow and resultant erosion were channelized and were most strongly concentrated in the tidal channels and small embayments which originally crenulated the soundward side of the island.

Numerous elongate sandy islands, including the Curlew Islands, which were formerly present along a 10-mile stretch of coastline northeast of Gosier Island were completely destroyed by Camille. A patch of inundated marsh in what was formerly the Stake Islands, off the southern tip of the Chandeleurs, constitutes the first emergent feature north of Gosier Island.

Compositely, the Chandeleurs are by far the largest of the barrier formations considered, having a total length (prehurricane) of over 25 miles. The Chandeleurs lack the stability which characterizes Breton Island and are retreating soundward at an average rate of 0.25 mile per century (Kwon, 1969). In further contrast to Breton Island, the Chandeleur chain is normally fringed by a sand beach only a few feet thick which is backed by mangrove and marsh and underlain by relict marsh

deposits (Russell, 1936; Treadwell, 1955). Normally, as these islands retreat, beach sands on the seaward side encroach upon and bury the mangrove and marsh immediately behind the islands, while dead marsh deposits and mangrove stumps are exhumed along the foreshore (Russell, 1936; Treadwell, 1955).

The shallowness and small volume of the beach along the Chandeleurs undoubtedly favored its obliteration, and, as might be expected, beach erosion was more complete at the southern end of the Chandeleurs than on Breton Island, which was several miles closer to the eye of the storm. Removal of sands was probably further enhanced by the numerous inlets which could have served to concentrate flow. Thus, at the southern end of the island chain only the tenacious marsh deposits survived to render subaerial expression following Camille.

Northward along the arc there is an increase in the amount of sand remaining near or above the water surface, but this is mainly in the form of shoals on either side of the remaining land surface and very thin sheets scattered over the marsh. In the vicinity of Figure 7, about 3 miles north of the southern end of the Chandeleur chain where the island attains its maximum width, the sand has been pushed a short distance landward, and a strip of relict marsh along the seaward margins has been exhumed; but the coastline has apparently resisted dissection and severe erosion. Here the greater width of the marsh probably absorbed much of the energy of the return flow.

Still farther north, in the central portion of the island, dissection again prevails. Pre-Camille photographs (April 1969) indicate an unbroken stretch of beach, but there are numerous tidal channels through the marsh and mangroves behind it. For the most part these channels were aligned transverse to the trend of the island and terminated abruptly at the backshore of the beach. It is clear from Figure 8 that the channels have dominated in controlling dissection patterns. The beach, which formerly had a width here of about 50 feet, was for the most part completely eroded. Figure 8 suggests that most of the beach sand accumulated as shoals on the sound side of the island. It was also evident from color slides and visual observations that a thin film of sand covered most of the marsh area. This trend is, of course, in contrast to those observed farther to the southwest, around Breton, Gosier, and southern Chandeleur islands, and implies a less consequential role for return flow. Figure 9, taken 1 mile north of Figure 8, shows definite but small-scale seaward transport. In this particular case, seaward transport is apparently a secondary effect and may simply indicate that final breaching did not occur until water level in the sound was falling. Certainly, soundward transport was dominant in the vicinity, as the photograph of the area adjacent, to the north (Fig. 10), demonstrates.

Aside from that on the extreme southern end, the most severe



Figure 7. Chandeleur Islands, near south end; sea side in foreground.



Figure 8. Chandeleur Islands, central part; sea side in foreground.



Figure 9. Chandeleur Islands, central part; sea side in foreground.



Figure 10. Chandeleur Islands, central part; sound side to the left.

erosion on Chandeleur Island took place along a 1.5 - 2 mile section 10 miles south of the northern tip. Figure 10 is oriented facing north along this section. All that remains above the high-tide surface are a few small patches of mangrove and marsh. Again, the prehurricane topography appears to have exerted the major control. Prior to Camille, large washover fans of beach sand buried the greater portion of the marsh and extended across the entire width of the island. Consequently, the storm was able to erode and redistribute the mobile, unstabilized sands without hindrance from more resistant marsh or mangroves. Though sand has been deposited predominantly on the sound side of the island, locally there is evidence of seaward transport. Overall, the shallow shoals which now comprise the greater portion of the area are reminiscent of sand flats in areas of high tidal range, where there is strong bidirectional flow. Of course, the area in question is one of comparatively low tidal range, but in this area hurricane surge and return flow may have attained a balance that produced a tidelike effect.

The northern 8 miles of Chandeleur Island formerly consisted of an unbroken sand beach 250 feet wide which was backed intermittently by mangroves. As elsewhere in the chain, erosion and dissection were significant. However, beach removal was much less complete, and moderately wide strips of beach remained intact except where a breach occurred. Breaches were relatively narrow and, again, seem to have occupied previously existing tidal channels. Eroded sediments were deposited entirely in the lee of the island, as Figure 11, which shows the extreme northern end of the island around Chandeleur Light, suggests. Sand washed through breaches by the surge accumulated immediately soundward of the breach in spectacular fan-shaped deposits.

#### General Conclusions Regarding the Beaches and Barriers

It is apparent overall that waves and currents both played a part in eroding and redistributing the sediments composing the features just described. However, it may be concluded from the patterns exhibited that waves played the minor role in producing the final effects. Currents associated with the onshore surge and subsequent return flow were of much greater moment. The ratio of seaward to soundward sediment transport progressively decreased northward along the Breton-Chandeleur arc, with seaward transport dominating at the southern end and soundward transport dominating at the northern end. Considering the path of the hurricane up Breton and Chandeleur sounds, these variations in transport direction may well be explicable, at least partially, in terms of the relative durations of onshore and offshore flow. At the southern end of the sound, onshore components should have been of short duration, whereas seaward flow would have continued as long as the hurricane remained in the sound and water from farther north continued to be pushed into the sound—i.e., for at least 4 hours.

Variations in the intensity and totality of erosion and dissection



Figure 11. Chandeleur Islands, north end; sound side to the left.

were far more correlative with variations in prehurricane topography than with proximity to the eye of the storm. The greater mobility of beach sands and greater tenacity of marsh deposits exerted considerable influence in patterning the posthurricane residuum, while preexisting passes and tidal channels served as foci for erosive forces.

#### MISSISSIPPI RIVER DELTA

##### Inundation

The storm surge driven onshore by winds from Hurricane Camille inundated a large portion of the coastal marshes and deltaic plain of southeastern Louisiana. The most widespread destruction and modification on the natural landscape appeared to occur eastward of a line drawn from Empire to Venice, Louisiana, and to the mouth of South Pass (Fig. 1). The major changes affecting the vegetation and landforms of this area appear to be predominantly the result of the combination of strong storm surge currents and the seaward return flow; however, wave action and hurricane-force winds also were locally important factors. Although flooding occurred in the marshland to the west of the Mississippi Delta, the surge was not accompanied by high winds, destructive waves, or strong currents (Adams, this Bulletin).

Because of the characteristic circulation pattern of tropical

hurricanes, and the path and size of Hurricane Camille in particular, the eastern half of the Mississippi River Delta was subsequently inundated by a surge generated by onshore (east and northeast) winds as the hurricane passed less than 20 miles east of the Mississippi River. Water levels ranged from near 5 feet at the mouth of South and Southwest passes to over 15 feet in the marshes east of Venice, Louisiana (Fig. 1). All evidence and observations indicate that water levels were generally lower in the southern portion of the delta south of Head of Passes than in the more northern portions, in the vicinity of Buras and Venice. This areal variation in depth of inundation may be explained by the proximity of the area north of Venice to the open waters of Breton Sound and by the existence of high-standing artificial levees and tree-covered natural levees—all factors which would cause water to "pile up" to abnormal depths (Russell, 1936). However, the area south of Venice is relatively open marshland and has only low, narrow natural levees. This area would provide less obstruction to the surge, and consequently it experienced lower water levels. Most water marks and debris lines south of Head of Passes indicate a standing water level of 5 to 6 feet; however, wind- and wave-tossed debris accumulations 15 to 20 feet above marsh level were observed.

Aerial and ground reconnaissance indicate that wind velocities over 100 miles per hour moved a massive, swiftly flowing surge generally southeastward across the marshes east of the Mississippi River in the lower delta. Buildings, trees, debris lines, flotsam, and patterns of flattened marsh vegetation indicate this general trend (Fig. 1).

For the most part, hurricane flood water receded from the marshes within 24 hours after the storm's passage. However, drainage of the remaining turbid water continued for several days. Aerial reconnaissance 4 days after the storm had moved inland indicated that water levels were still above normal in many interdistributary basins within the delta.

#### Sediment Deposition

The storm surge introduced a mass of sediment-laden saline water to the freshwater marshes of the lower delta. Thin inorganic deposits (generally less than 2 inches thick) of mixed clays, silts, and fine sands were noted on natural levees and marshes in Garden Island Bay subdelta. Thicker layers (6 inches to 2 feet) of mixed organic debris and inorganic detritus were common along natural levees and behind obstructions in the marsh. Similar deposits were noted on the coastal marsh of western Louisiana after Hurricane Audrey (Morgan et al., 1958; Chamberlain, 1959).

#### Vegetation

Extensive physical changes to the vegetation of the lower delta resulted from the hurricane-force winds and waves and later from currents

generated by the seaward return flow of the floodwaters. Areas of intensive destruction were scattered and were often separated by areas with only minor damage.

Leaves were stripped from most trees and shrubs, limbs were broken, and entire trees were uprooted by a combination of winds, wave action, and currents. This condition was especially prevalent along the natural levees where thin bands of trees and shrubs were exposed to the full fury of the hurricane. Trees protected in dense stands, low shrubs, and grasses apparently incurred less damage from the wind, wave, and current forces in general.

Severe damage occurred from floodwater currents and winds to the extensive stand of Phragmites communis (Roseau cane) along Pass a Loutre, South Pass, and within the Cubits Gap and Garden Island Bay subdeltas. Phragmites typically grows to heights of 8 to 12 feet in dense stands whose form would offer high resistance to winds and flowing water (Chamberlain, 1959). Entire stands were flattened and leaves were stripped, so that brown stalks (culms) were exposed (Fig. 12). Dead stalks of the previous years' growth were broken and removed by the high winds and water. Great masses of this debris were observed floating in the Gulf of Mexico around the margins of the delta (Fig. 13).



Figure 12. South Pass; flattened Roseau toward channel; erect fringe of Roseau in foreground.

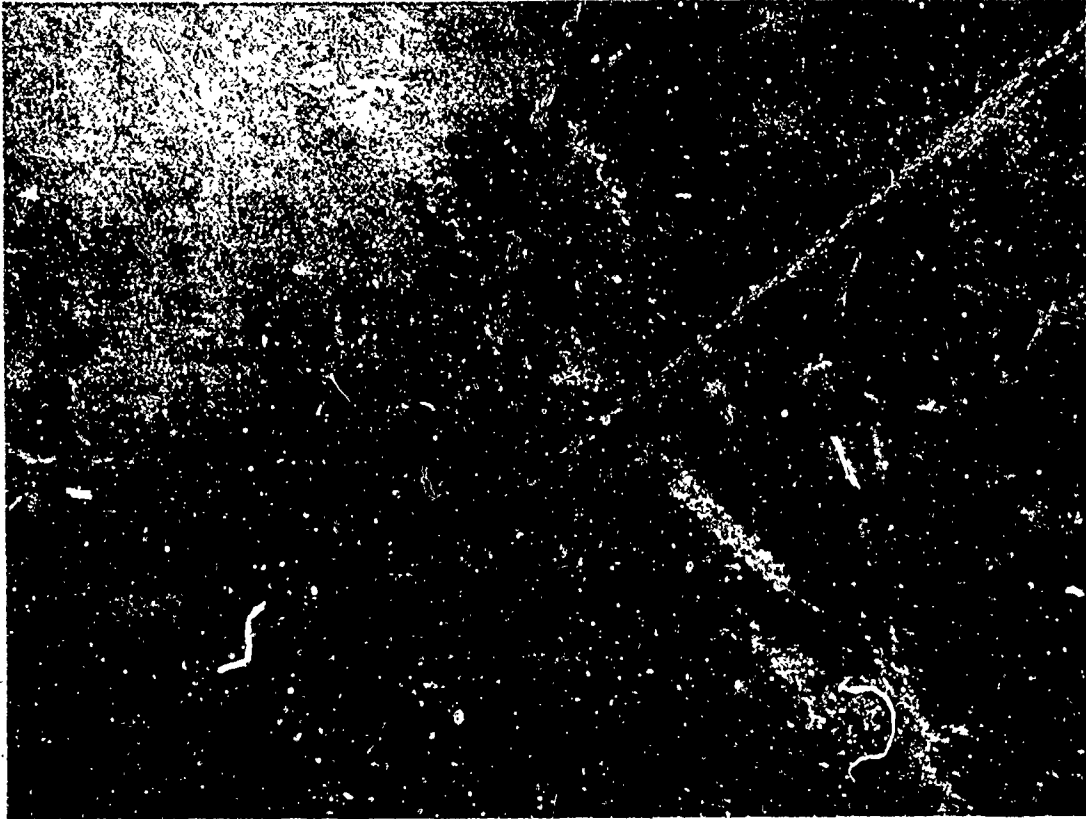


Figure 13. Freshwater (to left) and saltwater interface seaward of South Pass, with masses of Roseau debris in the fresh water.

Commonly, the Phragmites stands were twisted and flattened in tortuous patterns (Fig. 14). As the hurricane floodwaters receded, these distorted stands trapped large quantities of floating organic debris and trash.

Wave action, inundation, and subsequent receding waters removed most of the floating aquatic vegetation from the ponds and bays. Large patches of alligator weed (Alternanthera ramosissima) and water hyacinth (Eichhornia crassipes) were observed floating seaward in distributary channels and canals (Fig. 15).

In two observed cases, floating masses of this vegetation dammed the mouths of small distributary channels. The flow of Raphael Pass, in the Cubits Gap subdelta, was restricted for at least 2 weeks after the hurricane because organic debris clogged the river mouth and distal portion of the channel. A small crevasse channel branching off Raphael Pass was similarly blocked (Fig. 16). At present, both channels have been reopened because river inflow and tides have flushed the hurricane-deposited debris from the channels.

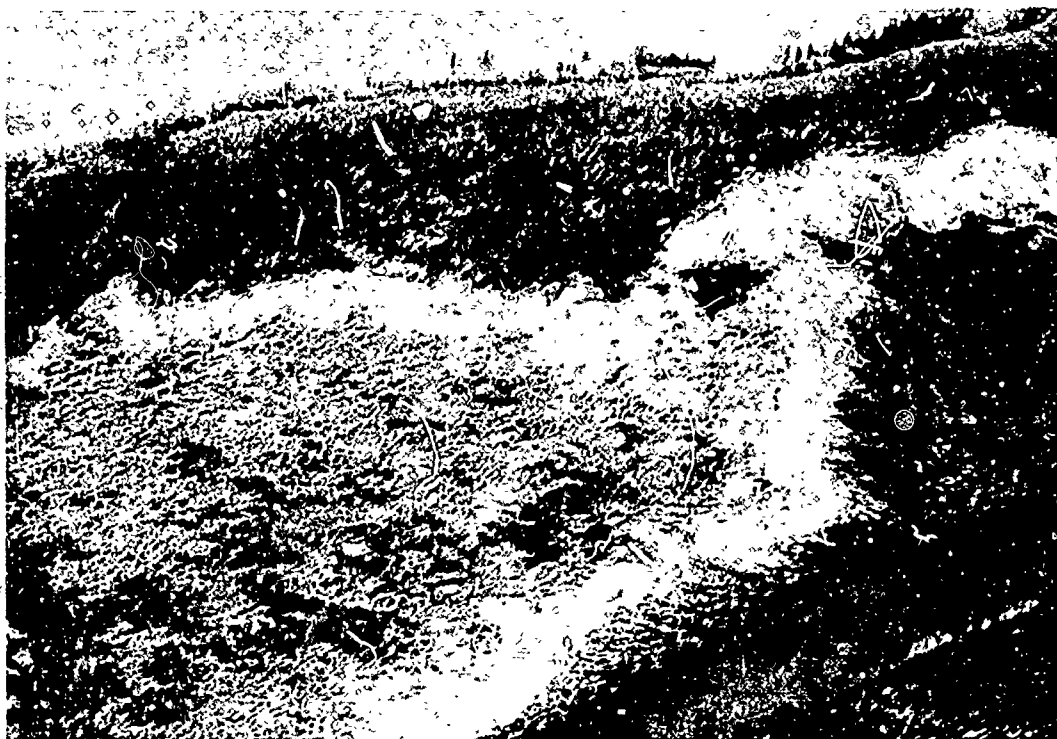


Figure 14. South Pass; patterns in Roseau debris.



Figure 15. Garden Island Bay; floating aquatic vegetation moving seaward.



Figure 16. Raphael Pass, Cubits Gap area, channel clogged by organic debris.

Although the destruction to the marsh vegetation of the lower Mississippi River Delta was extensive, the hurricane damage apparently is rather temporary and will be healed by regrowth during the coming spring. Surprisingly little destruction to the root mat seems to have occurred; however, many trees were totally destroyed. Only very local areas of the tenaciously rooted marsh were torn from the substrate. Observations in November 1969, 3 months after Camille, indicated that recovery of the marsh was already underway. However, the long-term effects of the hurricane on the ecology cannot be determined at this time.

#### Natural Levees and River Banks

All natural levees in the area investigated were inundated during the hurricane. Significantly, no new major breaks in the natural levees resulted from the destructive forces of the hurricane. Some erosion from the swift currents of the receding floodwaters caused local areas of scour, primarily where natural vegetation was stripped away or not well developed, on areas of spoil deposits, and where natural or artificial cuts or crevasses had previously occurred.

On the natural levees of the Mississippi River above the Head of Passes, the prehurricane crenulated configuration of the banks was accentuated by scour from water flowing westward over the levees from

the marshes into the river during the hurricane surge (Fig. 17).

The natural levees below Venice, Louisiana, were not seriously modified. Aerial reconnaissance indicated only local areas of bank retreat. Scour was noticed in at least one small crevasse channel along the south bank of Pass a loutre. Degradation of mudflats by the entrainment of sediment by waves and currents also occurred on a minor scale within inter-distributary ponds and bays in the Garden Island Bay subdelta. Superficial changes in the configuration of many natural levees appeared because masses of debris were trapped on these topographically high areas.

#### Remarks and Conclusions

The significance of changes in the natural landscape of the lower Mississippi River Delta caused by Hurricane Camille can be properly determined only after recognition of the nature and permanency of such changes. The obvious modifications to the landscape observed immediately after the hurricane and discussed above may prove to be less important in the long run than the more subtle but lasting effects of the saline water inundation on the edaphic and vegetational complexes. From the present evidence it may be concluded that currents and wave action within the storm surge and seaward return flow of the floodwaters caused greater destruction and modification to the natural landscape of the delta than the direct effects of winds.

It is hoped that through continued observation and analysis both the temporary and the permanent effects of hurricanes on deltaic environments can be understood.

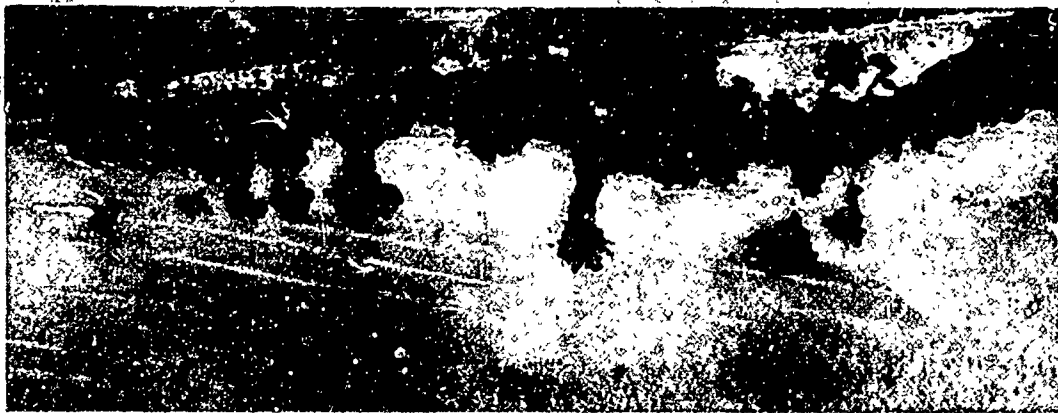


Figure 17. Mississippi River bank across from Boothville School; debris curried westward by hurricane surge waters.

#### ACKNOWLEDGMENTS

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| 13. ABSTRACT<br><br>Air and ground reconnaissance immediately following the passage of Hurricane Camille disclosed significant modifications to the natural landscape of the Breton-Chandeleur Island arc and to the eastern portion of the lower Mississippi Delta. Considerable dissection and redeposition was evident along beach and barrier formations, and total obliteration dominated numerous sections. Trends of redistributed beach material strongly reflected the final direction of hurricane-induced mass transport of water. In the lower delta damage was mainly to marsh vegetation and was attributable to high water and surge currents directed almost entirely from north to south. (U) |                                                                                                        |                                                    |

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