HURRICANE ANDREW IMPACT ON THE TIMBALIER BARRIER ISLAND ARC

Terrebonne and Lafourche Parishes, Louisiana

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INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with the Coastal Research Laboratory in the Department of Geology and Geophysics at the University of New Orleans (UNO) and the Center for Coastal Energy and Environmental Resources at Louisiana State University (LSU), is investigating the processes of coastal erosion and wetland loss in Louisiana (Salinger and others, 1987; Salinger and Williams 1989; Penland and others, 1990). Building on the USGS Louisiana Barrier Island Study (Williams and others, 1992), the USGS Open File Report contains the Hurricane Andrew damages to the Timbalier Islands in Terrebonne Parish and Lafourche Parish, Louisiana. The objective is to compare and contrast the impact of Hurricane Andrew with previously published data on the long-term (1887-1988) and short-term (1978-1988) erosion of the Timbalier Islands (McBride and others, 1992).

The Timbalier Islands are located about 120 km southwest of New Orleans (Figure 1). This barrier island shoreline is 70 km long and extends east from Cat Island Pass to Raccoon Pass. The Timbalier Islands represent a flanking barrier island system developed from the reworking and erosion of an abandoned distributary of the Lafourche delta complex within the Mississippi River delta plain (Penland and others, 1988). The Timbalier Islands consist of Timbalier Island to the west and East Timbalier Island to the east. Timbalier Island, located between the two islands within Little Pass Timbalier, is a transient area of moving sand, sometimes subaerial, and is not included in the discussion or area statistics.

In this Hurricane Andrew impact assessment, the authors used the methods and transects from McBride and others (1992) to insure data comparability of the new measurements and analysis (Table 1).

HURRICANE ANDREW

Hurricane Andrew developed from an easterly wave which moved off the west coast of Africa into the Atlantic Ocean on August 14, 1992 (Rappaport, 1994). It developed into a tropical storm on August 17, 1992 approximately 1100 miles east of the Lesser Antilles and moved west southwest for four days with little change in intensity. It gradually strengthened to be classed a Saffir/Simpson Category One hurricane (minimum strength) on August 22, becoming a Category Five hurricane by the afternoon of August 23 with sustained winds of 67 m s-1, gusts to 82 m s-1. Hurricane Andrew came in first U.S. landfall in southern Dade County, Florida at approximately 5:00 a.m. EDT on August 24 with sustained winds of 63 m s-1, gusts to 72 m s-1. The eye of the hurricane crossed southern Florida in only 4 hours. Hurricane Andrew then entered the Gulf of Mexico on August 26, and regained its intensity to a Category Four hurricane. The eye of Hurricane Andrew passed just west of the Isles Dernieres and Timbalier Islands and came at 4:00 CDT on August 26, 1992, passed Point au Fer Island was midnight, and made official landfall in Louisiana as a Category Three hurricane at 0130 CDT on the morning of August 26, 20 miles west-southwest of Morgan City (Figure 2). It then turned more northward around Morgan City to pass through Baton Rouge as a Category One hurricane around mid-day and to continue on through Mississippi and north Alabama as a tropical storm.

Hurricane Andrew was the strongest storm to impact Louisiana since the Chenière Caminada hurricane of 1893. Wind speeds exceeded 60 m s-1 with gusts over 70 m s-1, and offshore wave heights were reported exceeding 14 m. The storm surge was measured at 3.4 m and inundated St. Mary, Terrebonne, Lafourche, Jefferson, and Plaquemines parishes for more than 40 kilometers inland. The northeastern quadrant of Hurricane Andrew passed directly over the Isles Dernieres and Timbalier Islands and cut a 42 kilometer swath of destruction from Pointe-Aux-Chênes, through Cocodrie and Morgan City to Baton Rouge. The vegetated barrier islands suffered severe damage. The Timbalier Islands had much of its sand moved to removed, taking with it the beach and dune habitats so important to nesting marine birds including the endangered brown pelican. The marshes were stripped of exposed vegetation and the substrate was removed, and in some areas the marsh was peeled up in strips and formed into "balls" that were deposited some distance away. Surveys of the eroge in-fashion area revealed a distinct seaward decrease of storm effects: maximum surge line, mud deposition line, debris wrack line, and marsh-ball line. Within the area inundated, a blanket of mud up to 0.5 meters thick was deposited over tens of thousands of acres of marsh and shallow bays. One quarter of the trees within the swamps and forests along the path of Hurricane Andrew were broken and relieved of their foliage. A 2-3 m storm surge forced saltwater into the freshwater marshes, and turbulent, oxygen-depleted water caused a die-off of millions of fish and marine fish.

SHORELINE CHANGE ASSOCIATED WITH HURRICANE ANDREW

The storm surge of Hurricane Andrew inundated the Timbalier Islands with severe overwash conditions that produced dramatic shoreline erosion, barrier island breaching, and sand dune destruction. The areas of greatest erosion produced by Hurricane Andrew occurred along the margins of Little Pass Timbalier and Raccoon Pass between 1992 and 1993. The high wave energy and storm conditions widened these tidal inlets and completely eroded many sections of shoreline (Figures 3-6).

To quantify the storm line changes associated with the Hurricane Andrew impact, vertical aerial photography was used. The pre-storm baseline aerial photography was taken December, 1990. A post-storm aerial photography mission was flown on October 12, 1992 to document the impact of Hurricane Andrew. An additional aerial photography mission was flown on January 16, 1993 to record the storm impact and post-storm recovery of the Timbalier Islands since the 1990 baseline conditions. Table 1 presents the measured measurements of shoreline change for the Timbalier Islands. For gulfside change measurements, a negative (-) sign signifies landward movement or erosion and a positive (+) sign signifies a seaward movement or accretion. For bayside change measurements, a negative sign signifies a seaward movement or erosion and a positive sign signifies a landward movement or accretion. A gulfside measurement followed by a "w" indicates that the width of the island was enlarged by erosion but the measurement is of the width loss. A gulfside measurement followed by an "s" indicates that the shoreline is still in existence but has changed position and the measurement is of this change.

TIMBALIER ISLAND

Between 1990 and 1992, the shoreline change measurements along Timbalier Island are attributed to the Hurricane Andrew impact. The gulfside shoreline change measurements for Timbalier Island ranged between -12 m and +804 m (Table 1) with an average of -76.2 m. The area of greatest erosion was at the eastern end of Timbalier Island, and the area of accretion was found along the west central part of the gulf shoreline. The average rate of shoreline erosion was -41.8 m y-1. Between 1992 and 1993, Timbalier Island entered its post-storm recovery phase. The measurements of gulfside shoreline change ranged between +120 m to -92 m with an average change amount of +12.5 m as normal wave energy moved sand toward the island to form a beach. The average rate of gulfside shoreline change for Timbalier Island for the four months between 1992 and 1993 was +70 m y-1. The areas of continued erosion persisted on the east end of Timbalier Island, while the west end of Timbalier Island showed significant recovery and shoreline progradation. This was because the dominant pattern of longshore sediment transport was to the west. Between 1990 and 1993, including both the impact of Hurricane Andrew and the post-storm recovery period, the Timbalier Island gulfside shoreline changes ranged between +56 m and -421 m with an average of -46.7 m. The average rate of East shoreline change for the 1990-1993 period was measured at -22.4 m y-1.

The area of Timbalier Island measured 479 ha in 1990 and decreased to 400 ha in 1992 after the impact of Hurricane Andrew (Table 2). The loss of 79 ha of land represents a 16 percent decrease in area as a result of Hurricane Andrew. During the post-storm recovery phase, the area of Timbalier Island increased from 400 ha in 1992 to 409 ha in 1993, which represents an increase of 9 ha or an area increase of +2 percent. The total area lost between 1990 and 1993 was 70 ha which represents a 15 percent decrease of the island area.

The bayside shoreline of Timbalier Island also experienced erosion from Hurricane Andrew. The bayside shoreline change measurements ranged between +212 m and -37 m with an average change of -16.9 m. The average rate of shoreline change primarily attributed to Hurricane Andrew was -8.7 m y-1. The areas of progradation were associated with overwash deposition, and areas of erosion were associated with tidal retreat. During the post-storm recovery phase the bayside shoreline changes ranged between +73 m and -81 m with an average of -3.0 m. The average rate of change was measured at -1.9 m y-1 as stream deposits were eroded and became subaerial. Between 1990 and 1993 including the impact of Hurricane Andrew and the following post-storm recovery phase, the amount of shoreline change ranged between +18 m and -431 m with an average of -26.1. The average rate of bayside shoreline change was calculated at -17.2 m y-1.

EAST TIMBALIER ISLAND

At East Timbalier Island between 1990 and 1992, the gulfside shoreline change measurements due to Hurricane Andrew ranged between +12 m and -314 m with an average of -93.2 m. Areas of greatest erosion were associated with breaks of the island at Little Pass Timbalier and Raccoon Pass. Large erosion measurements were also found at the middle of East Timbalier Island where the island narrows. The average rate of gulfside erosion was -44.2 m y-1. Between 1992 and 1993, East Timbalier Island entered into the post-storm recovery phase. The amount of gulfside shoreline change decreased during this period, ranging between +36 m and -124 m with an average of -11.6 m. Erosion and accretion of the shoreline were unevenly distributed along the island with the average rate of change measured at -46.4 m y-1. Between 1990 and 1993, including both the impact of Hurricane Andrew and the post-storm recovery period, the gulfside shoreline change measurements for East Timbalier Island ranged between +6 m and -1.8 m with an average of -100.8 m. The average rate of gulfside shoreline change was measured at -19.4 m y-1.

The area of East Timbalier Island decreased between 1990 and 1992 by -74 ha primarily as the result of the Hurricane Andrew impact. This represents a loss of -34 percent of the area of East Timbalier Island. The island decreased further by -14 ha during the post-storm recovery phase which represents a -10 percent decrease. The total area of East Timbalier Island decreased from 216 ha in 1990 to 128 ha in 1993 by -88 ha which represents a -41 percent decrease in island area.

The bayside shoreline of East Timbalier Island also experienced erosion from Hurricane Andrew. The 1990-1992 bayside shoreline change measurements ranged between +13 m and -125 m with an average of -37.2 m. The average East Timbalier Island shoreline change rate attributed to Hurricane Andrew was -20.3 m y-1. High wave energy conditions after the passage of Hurricane Andrew were responsible for bayside erosion. Shoreline change measurements during the 1992-1993 post-storm recovery phase ranged between +22 m and -41 m with an average of +3.4 m. The average post-storm bayside shoreline change rate decreased to -1.8 m y-1. For the entire period 1990 to 1993 including the impact of Hurricane Andrew and the post-storm recovery period, the bayside shoreline change measurements ranged between +9 m and -121 m with an average of -34.5 m. The average 1990-1993 bayside shoreline change rate was -17.8 m y-1.

THE TIMBALIER ISLANDS

Considering Timbalier Island and East Timbalier Island as a whole, the Timbalier gulfside shoreline measurements ranged between -12 m and +804 m with an average of -42.2 m during the period of 1990 and 1992 when Hurricane Andrew made impact. The average rate of gulfside shoreline change for this storm-impact period was -45.6 m y-1. During the storm recovery period of 1992 to 1993, the amount of gulfside shoreline change ranged between +120 m and -124 m with an average of +6.5 m. The average rate of gulfside shoreline change for the period 1992-1993 was +26.0 m y-1. For the entire period of 1990-1993, the range of gulfside shoreline change was between +56 m and -318 m with an average of -46.8 m. The average rate of shoreline change for the Timbalier Islands for this period was -31.0 m y-1.

The total area of the Timbalier Islands in 1990 was measured at 695 ha. After the impact of Hurricane Andrew the area of the Timbalier Islands was measured at 542 ha representing a decrease of -153 ha or a 22 percent decrease in area. During the post-storm recovery phase, the area of the Timbalier Islands diminished further to 537 ha representing a loss of 5 ha or a decrease of 1 percent. The total area lost by the Timbalier Islands between 1990 and 1993 was 158 ha or a 23 percent decrease in area.

The bayside shoreline changes between 1990 and 1992 for the Timbalier Islands after the impact of Hurricane Andrew ranged between +212 m and -127 m with an average of -24.0 m. The average rate of bayside shoreline change for this period was -13.7 m y-1. For the post-storm recovery phase between 1992 and 1993, the bayside shoreline changes ranged between +22 m and -41 m with an average of -8 m. The average rate of post-storm bayside shoreline change was -7.6 m y-1. For the period of 1990 to 1993, the Timbalier Islands bayside shoreline change measurements ranged between +18 m and -221 m with an average of -31.7 m. The average rate of shoreline change for this 1990 to 1993 period was -17.6 m y-1.

SUMMARY

The high wave energy and storm surge condition generated by Hurricane Andrew produced dramatic changes to Timbalier Island and East Timbalier Island. McBride and others (1992) documented the long-term (1887-1988) and short-term (1978-1988) gulfside average erosion rates for Timbalier Islands as -2.4 m y-1 and -7.0 m y-1, respectively. The impact of Hurricane Andrew temporarily accelerated the gulfside shoreline change rate between December 1990 and October 1992 to -41.8 m y-1 (Table 2).

For East Timbalier Island, McBride and others (1992) documented the long-term (1887-1988) and short-term (1978-1988) gulfside shoreline change rates of -23.1 m y-1 and -21.2 m y-1, respectively. Hurricane Andrew temporarily accelerated the rate of gulfside shoreline change to -44.2 m y-1.

For the entire Timbalier Islands, McBride and others (1992) documented the long-term (1887-1988) and short-term (1978-1988) gulfside shoreline change rates of -2.2 m y-1 and -14.0 m y-1, respectively. For the entire gulfside shoreline of the Timbalier Islands, Hurricane Andrew temporarily accelerated the rate of shoreline change to -45.6 m y-1.

For the bayside shoreline of Timbalier Island, McBride and others (1992) documented the long-term (1887-1988) and short-term (1978-1988) bayside shoreline change rates of -5.8 m y-1 and -14.1 m y-1, respectively. The Timbalier Island bayside shoreline change rate as a result of Hurricane Andrew was measured at -8.7 m y-1.

At East Timbalier Island, McBride and others (1992) documented the long-term (1887-1988) and short-term (1978-1988) bayside shoreline change rates at -24.0 m y-1 and -1.5 m y-1, respectively. Hurricane Andrew temporarily accelerated the rate of bayside shoreline change to -20.3 m y-1.

For the Timbalier Islands as a whole, McBride and others (1992) documented the long-term (1887-1988) and short-term (1978-1988) bayside shoreline change rates at -11.7 m y-1 and -7.8 m y-1, respectively. The Timbalier Islands bayside shoreline change rate as a result of Hurricane Andrew was calculated at -13.1 m y-1.

In terms of area changes, McBride and others (1992) calculated the long-term (1887-1988) and short-term (1978-1988) area loss rates for Timbalier Island at -5.3 ha y-1 and -45.7 ha y-1 respectively. The area loss rate measured for Hurricane Andrew (1990-1992) was -43.1 ha y-1. Hurricane Andrew changed the long-term (1887-1993) loss and short-term (1990-1993) loss rates to -10.2 ha y-1 and -26.6 ha y-1, respectively.

McBride and others (1992) calculated the long-term (1887-1988) and short-term (1978-1988) area loss rates for East Timbalier Island at -10.6 ha y-1 and -32.2 ha y-1 respectively. The area loss rate measured for Hurricane Andrew (1990-1992) was -44.2 ha y-1. Hurricane Andrew accelerated the long-term (1887-1993) and short-term (1978-1993) area change rates to -0.6 ha y-1 and -22.8 ha y-1, respectively.

For the Timbalier Islands as a whole, McBride and others (1992) calculated the long-term (1887-1993) and short-term (1978-1992) area loss rates at -15.9 ha y-1 and -77.3 ha y-1, respectively. The area loss rate measured for Hurricane Andrew (1990-1992) was -85.3 ha y-1.

Figure 1. The Timbalier Islands barrier island arc located 120 km southwest of New Orleans.

Figure 2. The track of Hurricane Andrew in the Gulf of Mexico.

Figure 3. Photographs taken 2 weeks apart of the west end of Timbalier Island illustrating the post-Andrew storm erosion caused by Hurricane Andrew: A) Before - taken July 9, 1992, and B) After - taken August 30, 1992.

Figure 4. Photographs taken 2 weeks apart of a breach created through Timbalier Island as a result of Hurricane Andrew: A) Before - taken July 9, 1992, and B) After - taken August 30, 1992.

Figure 5. Photographs taken 2 weeks apart of the east end of Timbalier Island illustrating the storm erosion that occurred along the margins of Little Pass Timbalier during Hurricane Andrew: A) Before - taken July 9, 1992, and B) After - taken August 30, 1992.

Figure 6. Photographs taken 2 weeks apart of East Timbalier Island illustrating the effects of Hurricane Andrew along the narrowest, least resistant shoreline. Land was overwashed and the width of the island was narrowed: A) Before - taken July 9, 1992, and B) After - taken August 30, 1992.

Table 1

Timbalier Islands gulfside magnitude of change (meters)								Timbalier Islands bayside magnitude of change (meters)							
Jan 90-Oct 92			Oct 1992-1993		Jan 90-Jan 93			Jan 90-Oct 92			Oct 1992-1993		Jan 90-Jan 93		
1	-48	w	1	28	w	1	21	s	1	-44	w	1	42	w	1	-41	s
2	-12	w	2	-20	w	2	-32	w	2	-37	w	2	-8	w	2	-45	w
3	5	s	3	3	s	3	8	s	3	-19	s	3	-12	s	3	-105	s
4	-34	s	4	26	s	4	7	s	4	-7	s	4	-7	s	4	-13	s
5	-26	s	5	20	s	5	10	s	5	-7	s	5	-7	s	5	-17	s
6	-42	s	6	25	s	6	13	s	6	-112	s	6	-3	s	6	184	s
7	-7	s	7	39	s	7	32	s	7	-46	s	7	-5	s	7	-39	s
8	12	s	8	42	s	8	56	s	8	6	s	8	6	s	8	13	s
9	-34	s	9	16	s	9	18	s	9	-7	s	9	-6	s	9	-13	s
10	-12	s	10	24	s	10	12	s	10	-14	s	10	5	s	10	-30	s
11	-23	s	11	19	s	11	4	s	11	-36	s	11	13	s	11	-38	s
12	-12	s	12	6	s	12	18	s	12	na		12	na		12	na	
13	-34	s	13	-3	s	13	-37	s	13	-137	s	13	na		13	-137	w
14	-30	s	14	6	s	14	32	s	14	1	s	14	-1	s	14	1	s
15	-2	s	15	32	s	15	19	s	15	-7	s	15	-9	s	15	-14	s
16	-1	s	16	3	s	16	3	s	16	-46	s	16	2	s	16	-5	s
17	-7	s	17	-4	s	17	-7	s	17	-60	s	17	54	s	17	-5	s
18	-26	s	18	11	s	18	-16	s	18	-16	s	18	-2	s	18	-18	s
19	-6	s	19	5	s	19	-4	s	19	-24	s	19	-10	w	19	-35	w
20	-64	s	20	13	s	20	-11	s	20	-22	s	20	1	s	20	-33	s
21	-25	s	21	-11	s	21	-32	s	21	na		21	na		21	s	
22	-167	w	22	na		22	-32	w	22	-64	s	22	33	s	22	8	s
23	-24	s	23	1	s	23	-23	s	23	-18	s	23	4	s	23	-16	s
24	-24	s	24	2	s	24	-26	s	24	-23	s	24	1	s	24	-19	s
25	-12	s	25	2	s	25	-16	s	25	-21	s	25	14	s	25	-20	s
26	-41	s	26	-19	s	26	-35	s	26	-33	s	26	-7	s	26	-38	s
27	-686	w	27	83	s	27	-421	w	27	-19	s	27	-33	w	27	-51	s
28	-349	s	28	-62	w	28	-421	w	28	16	s	28	-60	w	28	-383	w
29	-41	s	29	na		29	10	w	29	10	na	29	10	na	29	10	w
30	-423	w	30	na		30	-423	w	30	-10	w	30	na		30	-10	w
31	5	s	31	na		31	5	s	31	-31	s	31	na		31	-31	s
32	na		32	na		32	na		32	na		32	na		32	na	
33	na		33	na		33	na		33	na		33	na		33	na	
34	na		34	na		34	na		34	na		34	na		34	na	
35	na		35	na		35	na		35	na		35	na		35	na	
36	na		36	na		36	na		36	na		36	na		36	na	
37	na		37	na		37	na		37	na		37	na		37	na	
38	na		38	na		38	na		38	na		38	na		38	na	
39	-12	w	39	36	s	39	-24	w	39	-29	s	39	4	s	39	-25	s
40	-12	w	40	na		40	-12	w	40	-29	s	40	na		40	-29	w
41	-34	w	41	na		41	-34	w	41	-36	s	41	na		41	-36	w
42	-29	w	42	na		42	-29	w	42	-39	w	42	na		42	-39	w
43	-72	w	43	na		43	-72	w	43	-71	w	43	na		43	-71	w
44	-224	w	44	na		44	-193	w	44	-118	w	44	na		44	-118	w
45	-12	w	45	na		45	-12	w	45	-43	w	45	na		45	-43	w
46	na		46	na		46	na		46	-27	w	46	na		46	-27	w
47	na		47	na		47	na		47	-33	s	47	na		47	-33	s
48	na		48	na		48	na		48	-33	s	48	na		48	-33	s
49	na		49	na		49	na		49	na		49	na		49	na	
50	na		50	na		50	na		50	na		50	na		50	na	
51	-18	s	51	38	s	51	-18	s	51	-18	s	51	12	s	51	-18	s
52	-25	s	52	-124	s	52	-204	s	52	na		52	na		52	na	
53	-12	s	53	-2	s	53	-46	s	53	-21	s	53	1	s	53	-22	s
54	-82	s	54	-7	s	54	-71	s	54	-3	s	54	-3	s	54	-6	s
55	-24	s	55	-4	s	55	-27	s	55	-12	s	55	2	s	55	-9	s
56	-24	s	56	-13	s	56	-36	s	56	-9	s	56	3	s	56	-5	s
57	-14	s	57	-17	s	57	-71	s	57	-1	s	57	-3	s	57	-4	s
58	-21	s	58	21	s	58	-37	s	58	-1	s	58	1	s	58	-3	s
59	-29	s	59	4	s	59	-26	s	59	-9	s	59	-22	s	59	-24	s
60	-12	s	60	1	s	60	-11	s	60	-36	s	60	5	s	60	-31	s
61	-97	w	61	na		61	-97	w	61	-118	w	61	na		61	-118	w
62	-24	s	62	3	s	62	-21	s	62	-118	w	62	na		62	-118	w
63	-78	s	63	-13	w	63	-78	w	63	-60	w	63	na		63	-60	w
64	-14	w	64	na		64	-14	w	64	-5	s	64	12	s	64	7	s
65	-22	s	65	-7	s	65	-29	s	65	-5	s	65	-12	s	65	3	s
66	-67	s	66	-6	s	66	-71	s	66	-36	s	66	10	s	66	-16	s
67	-48	s	67	-12	s	67	-59	s	67	-29	s	67	1	s	67	-29	s
68	5	s	68	1	s	68	6	s	68	-13	s	68	5	s	68	-8	s
69	-254	s	69	-64	s	69	-318	s	69	-4	s	69	0	s	69	-4	s
70	-152	w	70	na		70	-152	w	70	na		70	na		70	na	

Table 2
The Timbalier Islands Area Measurements By Island (hectares)

The Timbalier Islands	Dec 1990	Oct 1992	Jan 1993
Timbalier Island	479	400	409
East Timbalier Island	216	142	128
Total	695	542	537

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ACKNOWLEDGEMENT

The analysis of the impact of Hurricane Andrew on Louisiana's barrier island arc was funded by the U.S. Geological Survey Coastal and Marine Geology Program.

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