SHORELINE CHANGES IN THE PLAQUEMINES BARRIER ISLAND SYSTEM - 1884 - 1996 PLAQUEMINES PARISH, LOUISIANA

Shea Penland1[1], Chris Zganjar1[2], Karen A. Westpahl[2], Andrew Beall[1], Paul Connor[1],
Jeff List3[3] and S.J. Williams[3]

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 in Louisiana (Sallenger and others, 1987; Sallenger and Williams 1989; Penland and others, 1992)..Building on the USGS Louisiana Barrier Island Study (Williams and others, 1992), this USGS Open-File Report depicts shoreline changes between 1884 and 1996, which provides an 8.9-year update of McBride and others (1992). In order to quantify shoreline changes since January 21, 1988, new vertical aerial mapping photography was acquired on December 9, 1996. The methods and transects used by McBride and others (1992) were used to insure data compatibility of the new measurements and analysis. Tables 1 and 2 presents the transect measurements of shoreline change for the Plaquemines Islands. For gulfside change measurements, a negative (-) sign signifies landward movement or erosion and a positive (+) sign signifies a seaward movement or progradation. For bayside change measurements, a negative (-) sign signifies a seaward movement or erosion and a positive (+) sign signifies a landward movement or accretion.

The Plaquemines barrier shoreline is located about 45 km northwest of the mouth of the Mississippi River and about 80 km south-southeast of New Orleans (Figure 1). The arcuate barrier system is approximately 48 km long and forms the eastern flank of Barataria Bight. It extends from Grand Terre Islands to Sandy Point. The Plaquemines shoreline has undergone a dramatic transformation between the years 1884 and 1996. Factors that account for the severe coastal erosion are primarily a lack of sediment supply, rapid subsidence, and storms and human impacts. In 1884 the shoreline was dominated by a series of deltaic headlands separated by barrier islands and tidal inlets. In 1884 Grand Terre Island was a continuous barrier island that extended from Barataria Pass in the west to Quatre Bayoux Pass in the east. By 1956 newly formed breaches were beginning to alter the appearance and evolution of the Plaquemines barrier system. Grand Terre deteriorated into three smaller islands. Lanaux Island (Shell Island) was breached as its eastern end welded to the mainland. Sandy Point was cut off from the mainland forming Sandy Point Island. By 1956, man-made influences to this region included the Mississippi River levees to the north, extensive canal dredging in the back-barrier marsh, and the creation of Fontanelle Pass (known as Empire Jetties). These three influences severely disrupted the natural sediment dispersal system. Submergence and canal

[1] Department of Geology and Geophysics, University of New Orleans
[2] Center for Coastal, Energy and Environmental Resources, Louisiana State University
[3] U.S. Geological Survey, Coastal and Marine Geology Program

dredging caused large areas of back-barrier marsh to be converted to open water while the Empire Jetties blocked long shore sediment transport to the west-northwest creating a downdrift offset due to a reduction in sediment supply causing shoreline recession.

SHORELINE MOVEMENT

Magnitude and rate of change for the Plaquemines coast were derived from 149 shore-normal transects along the gulf and bay shorelines (Transects Map, Table 1 and 2). Comparisons of shoreline positions are made for the periods 1884 and 1988, 1988 and 1996, and 1884 and 1996. The overlay map illustrates land loss and quantitative change for the Plaquemines barrier system. For the purposes of this study, the Plaquemine barrier system was sub-divided into four distinct regions beginning in the west with Grand Terre Islands between Barataria Pass and Quatre Bayoux Pass, Cheniere Ronquille between Quatre Bayoux Pass and Grand Bayou Pass, Shell Island between Grand Bayou Pass and Fontanelle Pass, and Scofield Bayou headland between Fontanelle Pass and Sandy Point Island.

GULFSIDE SHORELINE CHANGES

In terms of long-term gulfside shoreline change history for the 112-year period between 1884 and 1996, Grand Terre's shoreline transects measured between -24 m and -1548 m (Table 1, 1884-1996, transects 1-23). This was an average change of-555m or =5.0m/y (Table 3). The Cheniere Ronquille experienced shoreline changes between +91m and -2071m (Table 1, 1884-1996, transects 24-64) yielding an average change of -787m or -7.0m/yr (Table 3). Shell Island's gulf shoreline transect measurements range from -128m to -1967m (Table 1, 1884-1996, transects 65-81), which equals an average change of-1087m or -9.7m/ye (Table 3). The eastern most section of the Plaquemines barrier shoreline, Scofield Bayou headland, measured shoreline changes between + 88m and -1077m (Table 1, 1884-1996, transects 82-112) with an average change of-342.2m or -3.1m/yr (Table 3).

In terms of short-term shoreline change for the 8.9-year period between 1988 and 1996, Grand Terre's shoreline transects measured between +40m and -197m (Table 1, 1988-1996, transects 1-23) for an average change of-63.1m or -7.1m/yr (Table 3). The Cheniere Ronquille shoreline changes ranged from +94m to -376m (Table 1, 1988-1996, transects 24 - 64) yielding an average change of -44m or -3.9m/yr (Table 3). Shell Island reported shoreline change measurements between -108m and -457m (Table 1, 1988-1996, transects 65-81) for an average change of -296m or -33.2m/yr (Table 3). During this 8.9 year period, the Scofield Bayou headland experienced shoreline changes between 108m and -144m (Table 1, 1988-1996, transect 18-112) resulting in an average change of -29m or -3.2m/yr (Table 3).

Previous work by McBride and other (1992) documented long-term change between years 1884 and 1988 (104 years) and short-term change between years 1973 and 1988 (15 years). Grand Terre's long-term shoreline change rate was calculated to be -4.0m/yr., and the short-term change rate was calculated to be -7.9m/yr. The Cheniere Rouquille shoreline experienced a long-term change rate of -6.7m/yr. and a short-term change rate of-7.9m/yr. The shoreline change rates for Shell Island were observed to be -10.1m/yr. in the long-term and -24.2m/yr. in the short-term. The Scofield Bayou headland reported a long-term shoreline change rate of -3.1m/yr and a short-term shoreline change rate of-6.1m/yr.

Comparing the new long-term shoreline change rates with the long-term change rates documented by McBride and others (1992), a slight change can be observed (Table 3). Grand Terre's long-term shoreline change rate changed from -4.0m/yr (1884-1988) to -5.0m/yr (1884-1996) indicating an increased erosion rate of 1m/yr. The three remaining sub-regions' shoreline change rates remained nearly the same with Cheniere Ronquille showing an increased erosion rate of 0.3m/yr., Shell Island's erosion rate decreasing by 0.4m/yr., and the Scofield Bayou headland shoreline change rate remaining unchanged.

A comparison between the new short-term change rate and the previous short-term change rate reveals much variability (Table 3). The Grand Terre shoreline change rate showed a slight increase in erosion by 0.9m/yr. However, the three remaining sub-regions displayed a more dramatic change in the calculated short-term erosion rates. Cheniere Ronquille's gulf shoreline loss increased by 4.0m/yr.; Shell Island's change rate decreased by 9.0m/yr.; and the Scofield Bayou headland shoreline erosion rate increased by 2.9m/yr.

BAYSIDE SHORELINE CHANGES

In contrast to other Louisiana barrier island shorelines, the Plaquemines Barrier System consists predominately of two deltaic headlands and a large, sandy beach ridge plain with no back barrier lagoon or bay. For the purposes of this study, only the bayside shore-normal transects of Grand Terre Island and Shell Island were used to quantify the bayside shoreline changes of the Plaquemines Barrier System.

In terms of long-term bay shoreline change history for the 112-year period between 1884 and 1.996, Grand Terre's shoreline transects measured between 244m and -512m (Table 2, 1884-1996, transects 1-16). The average change was calculated to be -217m or -1.2m/yr (Table 4). Shell Island experienced shoreline change measurements between 1679m and -104m (Table 2, 1884-1996, transects 67-80) yielding art average change rate o£ 1035.9 or 7.6m/yr (Table 4).

In terms of the short-term bay shoreline change rate for the 8.9 year period between 1988 and 1996, Grand Terre Island revealed transect measurements between 343m and -61m (Table 2, 1989-1996, transects 1-16). The average shoreline change was determined to be 2.9m or 0.3m/yr (Table 4). Shell Island underwent shoreline change between 410m and 181m (Table 1, 1988-1996, transects 65'-81) resulting in an average change rate of 305m or 34.3m/yr (Table 4).

McBride and others (1992) studied long-term change rates between years 1884 and 1988 (104 years) and short-term change, rates between years 1973 and 1988 (15 years). In this earlier study, long-term bayside change rates were determined to be 7.9m/yr. for the long-term and 20.6m/yr. for the short-term (Table 4).

A comparison between the long-term and short-term bay shoreline change rates from McBride and others (1992) and this more recent study reveal expected results (Table 4). The long-term bayside change rate for Grand Terre lsland decreased from -2.1m/yr. (1884-1988) to -l.2m/yr. (1886-1996) showing a reduced gulfward migration by 0.9m/yr (Table 4). The short-term change rate for Grand Terre Island increased from -l.2m/yr. (1973-1988) to 0.3m/yr. (1988-1996) indicating a decline in gulf-ward migrations of 1.5m/yr (Table 4).

McBride and others (1992) documented the long-term bay shoreline change for Shell Island to be 7.9m/yr. (Table 4). This study calculated a new long-term change rate of 7.6m/yr. (Table 4). Comparing the two studies, a statistically negligible change in gulf-ward movement of 0.3m/yr. was observed. The short-term bay shoreline change rates for Shell Island in the two studies were much more dissimilar. McBride and others (1992) reported a shoreline change of 20.6m/yr (Table 4). This new analysis showed a bayside change rate of 34.3m/yr (Table 4), or an increased migration toward the mainland of 13.7m/yr. This dramatic change in short-term bay shoreline change rotes indicates the importance of storm impacts between the years 1988 and 1996, Elevated water levels associated with storms carry sediment across islands and deposit it as washover fans along the bay shoreline to result in shoreline progradation.

AREA CHANGES

Coalescing deltaic headlands with numerous spits dominate the Plaquemines shoreline. Therefore, Grand Terre and shell Islands are the only locations along the Plaquemines coast were true area calculations could be obtained.

Area changes of Grand Terre have been dramatic since 1884. Between 1884 and 1996, Grand Terre's arc decreased from 4199 acres to 1103 acres (Table 5). This represents a 74% loss of island area at a rate of -27.6 acres/yr (Table 6). This long-term, rate of loss, acting on Grand Terre's area in 1996, forecasts a disappearance date of 2036(Table 6). Previously in McBride and others (1992), Grand Terre Island decreased in area at a rate of 28.2 acres/yr between 1884 and 1988 suggesting the long-term date of disappearance to be 2033 (Table 6). The small decrease in the long-term land loss rate was calculated to lengthen the life of Grand Terre Island by 3 years. For the short-term area loss analysis, between the years 1988 and 1996, Grand Terre Island's area decreased from 1268 acres to 1103 acres (Table 5). This indicates a 13% loss at a rate of 18.5 acres/yr (Table 6). This new short-term loss rate predicts the disappearance date of Grand Terre Island to be 2056 (Table 6). Utilizing a short-term loss rate of -26.7 acres/yr., McBride and others (1992) predicted a disappearance date of 2036 (Table 6), Comparing the previous analysis with this current study, the life of Grand Terre Island has increased by 20 years (Table 6). The high short-term loss rate of the McBride study was most likely attributed to the direct impact of hurricanes Bob and Juan in 1985.

Shell Island also underwent dramatic area loss rates between 1884 and 1996. The new long-term analysis shows the island's area, between 1884 and 1996, decreases from 314 acres to 85 acres (Table 5), resulting in a 73% loss at a rate of-2.0 acres/yr (Table 6). Based on this new loss rate, the projected date of disappearance is 2039 (Table 6). McBride and others (1992) predicted a disappearance date of 2103 using loss rate of-1.5 acres/yr, between the years 1884 and 1988 (Table 6). This new long-term analysis decreases the life of Shell Island by 64 years. In the short-term area loss analysis for Shell Island, the total area decreased from 171 acres in 1988 to 85 acres in 1996 (Table 5). This demonstrates a 50% reduction in island area at a rate of-9.6 acres/yr (Table 6). The disappearance date, using a -9.6 acre/yr rate, for Shell Island will be 2005 (Table 6). This new short-term analysis extends the life of Shell Island by 3 years. McBride and others (1992) calculated a disappearance date of 2002 utilizing a 12.3 acre/yr. loss rate (Table 6).

SUMMARY

This Plaquemines barrier system shoreline update indicates a long-term increase in gulfside erosion from -6.0m/yr to -6.2m/yr. The short-term gulfside rate also increased from -9.9m/yr to -11.9m/yr. In terms of bayside change there has been a change from landward building to island narrowing. The long-term bayside change rate switched from +0.4m/yr to -4.4m/yr. The short-term bayside change rate switched form +3.Sm/yr to -4.4m/yr. The disappearance dates for the Grand Terre Islands and Shell Island slightly increased. Overall, erosion and shoreline retreat continue to dominate the Plaquemine barrier shoreline landscape.

ACKNOWLEDGEMENT

The analysis of shoreline changes along the Louisiana barrier shoreline was funded by the U.S. Geological Survey Coastal and Marine Geology Program.

DISCLAIMER

This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards (and stratigraphic nomenclature). Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

BIBLIOGRAPHY

McBride, R.A., Penland, S., Hiland, M., Williams, S.J., Westphal, K.A., Jaffe, B., and Sallenger, A.H., Jr., 1992. Louisiana barrier shoreline change analysis- 1853 to 1989: methodology, database, and results. *in:* Williams, S.J., Penland, S., and Sallenger, A.H., (editors), Atlas of Shoreline Changes in Louisiana from 1853 to 1989. US Geological Survey, Reston, Virginia.

Penland, S., Williams, S.J., Davis, D.W., Sallenger, A.H., Jr., and Groat, C.G., 1992. Barrier island erosion and wetland loss in Louisiana, *in* Williams, S.J., Penland, S., and Sallenger, A.H., Jr., eds., Louisiana Barrier island erosion study--atlas of barrier shoreline changes in Louisiana from 1853 to 1989: U.S. Geological

Survey Miscellaneous Investigations Series 1-2150.A, p.2-7.

Sallenger, A.H., Jr, Penland, S., Williams, S.J., and Suter, J.R., 1987. Louisiana barrier island erosion study: Coastal Sediments '87, American Society of Civil Engineers, p. 1503-1516.

Sallenger, A.H., Jr., and Williams, S.J., 1989. U.S. Geological Survey studies of Louisiana barrier island erosion and wetlands loss: An interim report on status and results: U.S. Geological Survey Open-File Report 89-372, 17 p.