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Land Loss Rates: Louisiana Coastal Plain

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ABSTRACT

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Land loss mapping and rate curve development for 62 quadrangles in the Mississippi River deltaic and chenier plains shows that land loss rates and trends vary significantly throughout coastal Louisiana. Land loss rates were defined for each quadrangle for 4 time periods (1930's to 1956–1958, 1956–1958 to 1974, 1974 to 1983, and 1983 to 1990). Differences in land loss rates among the individual quadrangles are a function of the geologic and hydrologic setting and the factors which contribute to land loss such as subsidence, storm induced erosion, channelization of streams and rivers, and canal dredging. Of the 62 quadrangles mapped, 8 quadrangles are losing more than 1 percent of their land area each year, while 21 quadrangles are losing more than 0.5 percent per year during the 1983 to 1990 period.

On a regional scale, the land loss rate for the entire Louisiana Coastal Plain has decreased from an average yearly rate of 41.83 square miles in the 1956–1958 to 1974 period to 25.34 square miles during the 1983 to 1990 period. The percentage of land being lost is also decreasing from 0.51 percent per year in the 1956–1958 to 1974 period to 0.35 percent per year during the 1983 to 1990 period. The regional land loss rate will probably continue to decrease slowly until a background rate is reached.

ADDITIONAL INDEX WORDS: *Louisiana Coastal Plain, Mississippi River deltaic plain, Mississippi River chenier plain, land loss, land loss rates, coastal erosion.*

INTRODUCTION

Geomorphic Setting and Nature of Land Loss Problem

Over the past 7,000 years five major delta complexes have prograded into coastal Louisiana (Figure 1). Progradation of these deltas is responsible for the formation of two distinct geomorphic regions; the deltaic plain in the central and southeastern portions of coastal Louisiana and the chenier plain in the southwestern part of the state (Figure 2). In the deltaic plain, shifting courses of the Mississippi River led to the deposition of sediments over an area of approximately 15,000 square miles (Fisk, 1944; Kolb and Van Lopik, 1958; Frazier, 1967). The end result of this long period of deltaic sedimentation has been the formation of a vast expanse of marshlands separated by active and abandoned distributaries. In contrast, the chenier plain formed by longshore transport of fine grained Mississippi River sediments that were deposited to the west of the deltaic plain. These sediments, transported by westward flowing nearshore currents, were eventually deposited along the existing shoreline as mudflats. When deposition ceased or declined due to shifting Mississippi River courses, these deposits were reworked by coastal processes, concentrating the coarse grained sediments, and forming shore-parallel ridges called "cheniers" (Gould and McFarlan, 1959; Byrne *et al.,* 1959). Introduction of new sediment by westward shifts of the Mississippi River delta resulted in the isolation of these ridges by accretion of new material on the existing shoreline. Numerous cycles of deposition and erosion have been responsible for creating the alternating ridges separated by marshlands which are characteristic of the chenier plain.

Until the early 1900's, land building processes dominated in the Mississippi River deltaic and chenier plains. Since then, this trend of land building has reversed and the Louisiana coastal zone is losing land at a high rate, particularly in the deltaic plain (Turner and Cahoon, 1987). Land loss during the past 60 years is responsible for the destruction of hundreds of square miles of wetlands. Causes for this loss range from man's activities (*i.e.* canal dredging, channelization of

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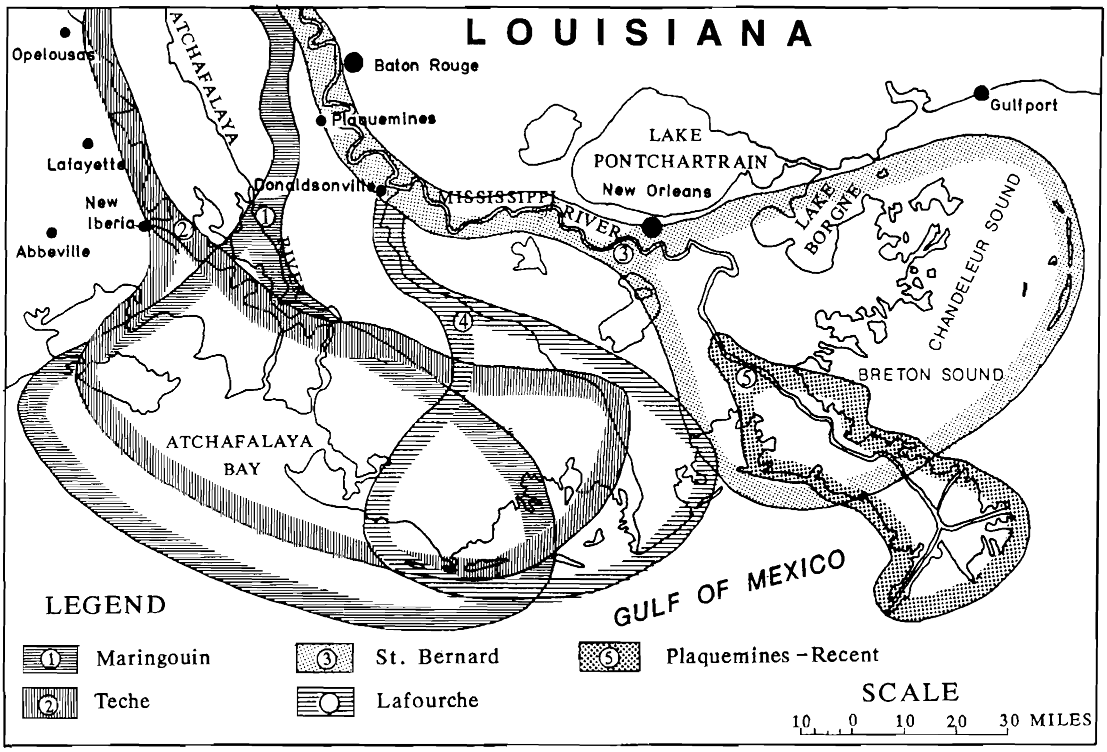


Figure 1. Delta complexes comprising the Mississippi River deltaic plain (from Kolb and Van Lopik, 1966).

streams, levee construction, and hydrocarbon extraction) to various natural phenomena such as subsidence, storm-induced wave erosion, and subsurface geologic control (PENLAND *et al.*, 1990).

Purpose and Scope

This paper presents the results of a four year comprehensive land loss mapping program of the Louisiana coast by the U.S. Army Corps of Engineers, New Orleans District (NOD), and the USAE Waterways Experiment Station (WES), Vicksburg, Mississippi. This paper summarizes the results of the mapping and describes the data sources and methods of interpretation used during this investigation. A detailed discussion concerning the factors responsible for land loss in the Louisiana Coastal Plain is beyond the scope of this paper. The purpose of this study was to determine the magnitude of coastal land loss in Louisiana by documenting on maps the land loss that has occurred in coastal Louisiana during each of four successive time intervals beginning in the 1930's. From the map data, historic land loss areas were measured and used to construct land loss rate curves for the individual 15-min (1:62,500 scale) quadrangles within the study area as well as rate curves for the deltaic and chenier plains and a regional curve representing the entire coastal zone. This study is the most recent and comprehensive inventory of land loss conducted to date in coastal Louisiana. These data are being used by the U.S. Army Corps of Engineers for planning and evaluating projects designed to mitigate land loss in coastal Louisiana.

Study Area

The study area is contained on sixty-two 15-min USGS quadrangle maps as shown in Figure 2. Each quadrangle map identified in this study was assigned the name of the corresponding USGS topographic quadrangle map. If there was no 15-min map available, the name of one of the 7½-min quadrangles contained within the 15-min area was used to represent the larger map. Twelve quadrangles comprise the chenier plain of southwestern Louisiana and the remaining 50 quad-

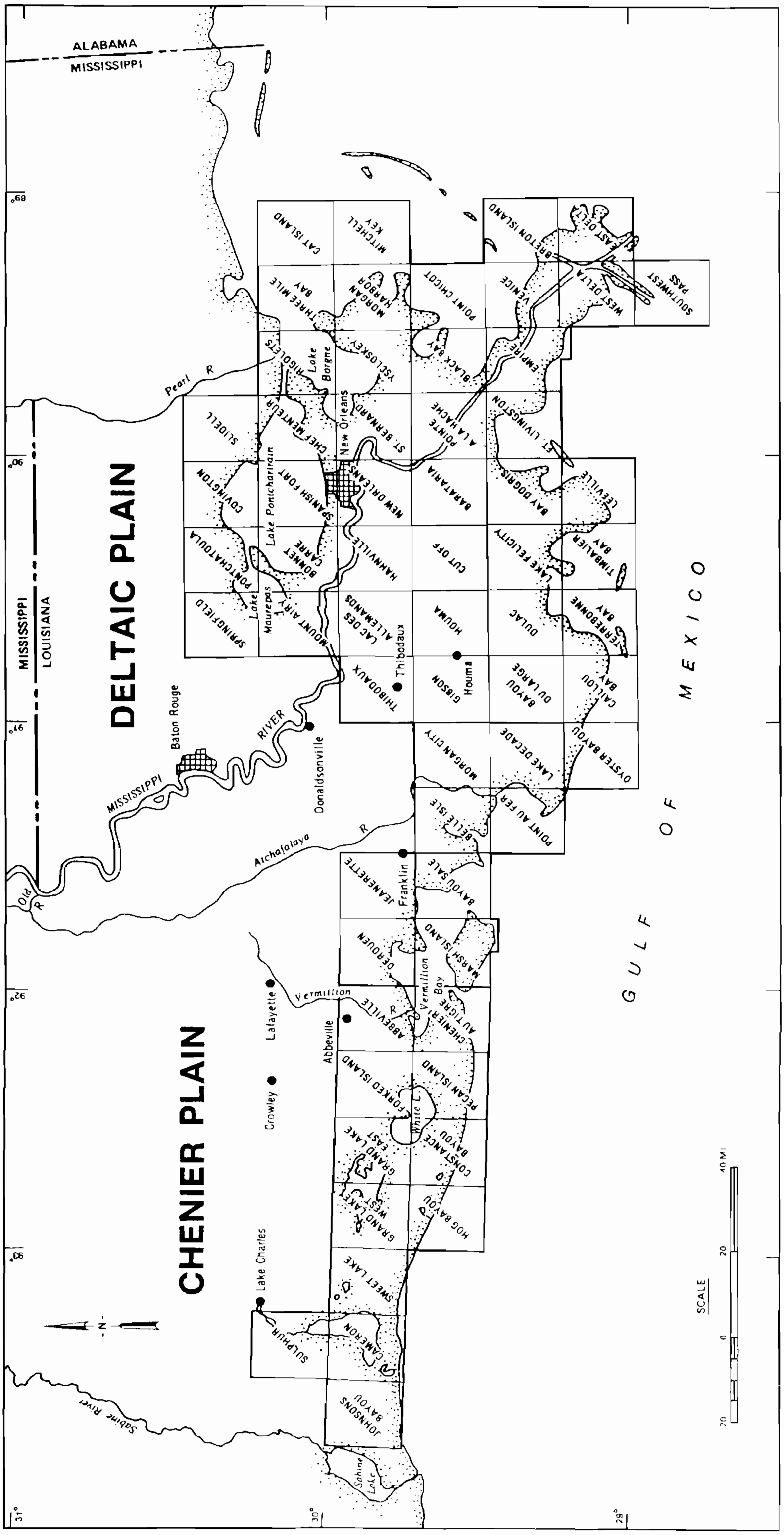


Figure 2. Index map of the Louisiana Coastal Plain.

rangles comprise the deltaic plain of central and southeastern Louisiana. The chenier plain is characterized by extensive marshes separated by stranded beach ridges or "cheniers." The deltaic plain is generally characterized by interdistributary marshes separated by abandoned Mississippi River distributary channels. Both the chenier and deltaic plains contain fresh, brackish, and salt marshes.

Previous Studies

Numerous studies have examined various aspects of land loss along the Louisiana coastline (CRAIG *et al.*, 1980; MORGAN and MORGAN, 1983; SASSER *et al.*, 1986; SCAIFE *et al.*, 1983; and WALKER *et al.*, 1987). Comprehensive inventories of land loss in the Mississippi River deltaic plain have been conducted by GAGLIANO *et al.* (1981), MAY and BRITSCH (1987), and the U.S. Fish and Wildlife Service (WICKER, 1980). The study by Gagliano *et al.* involved comparison of various dates of USGS topographic maps (1890–1967) and aerial photography (1955–1956 and 1978). MAY and BRITSCH (1987) produced a folio of maps depicting total land loss and land accretion throughout the deltaic plain for the 1930's to 1983 time period. This folio illustrates that land loss is not evenly distributed throughout the coast; rather, it is concentrated in specific areas.

The U.S. Fish and Wildlife Service conducted a detailed examination of habitat change in the Mississippi River deltaic plain, by comparing 1955–1956 black and white aerial photo mosaics with 1978 NASA color infrared (IR) photography (WICKER, 1980). Habitat types were interpreted and digitized to extract land loss data. This study was used as part of the land loss investigation conducted by GAGLIANO *et al.* (1981).

Studies evaluating the causes of land loss include a recent study by TURNER and CAHOON (1987). This study is a comprehensive analysis into the causes of land loss in relationship to offshore oil and gas activity along the Louisiana, Texas, and Mississippi coastlines. In addition, many smaller, site-specific studies have examined land loss and/or its causes along the Louisiana coastline (DELAUNE *et al.*, 1986; JOHNSON and GOSSILINK, 1982; CRAIG *et al.*, 1979; BAUMANN *et al.*, 1984; TURNER, 1985). These studies provide valuable insight into the magnitude of the land loss problem and the factors contributing to land loss at specific sites along the Louisiana coast. Currently the U.S. Army Corps of Engineers is participating in a cooperative study with the Louisiana Geological Survey, U.S. Geological Survey, Argonne National Laboratories, Louisiana State University, and the Gas Research Institute to develop a detailed classification of the causes of land loss in coastal Louisiana.

Table 1. *Sources of map and photographic data.*

Date	Source	Original Scale
1932–1933	U.S. Coast and Geodetic Survey Air Photo Compilation Sheets (T-sheets)	1:20,000
1933–1955	USGS 15-Minute Topographic Quadrangle Maps	1:62,500
1933–1935	Tobin Surveys, Black-And-White Aerial Photo Mosaics	1:62,500
1956–1958	Tobin Surveys, Black-And-White, Aerial Photo Mosaics	1:24,000
1974	NASA Color IR	1:120,000
1983	National High Altitude Program, Color IR	1:58,000
1990	NASA Color IR	1:62,500

METHODS

Data Sources

Land loss mapping was accomplished by comparing four dates of aerial photography to a base map and delineating the change in the land/water area. U.S. Coast and Geodetic Survey Air Photo Compilation Sheets or "T-sheets" were used as base maps on which the land loss areas were delineated. These maps were found to be the oldest coverage available for the majority of the study area, and contained the level of detail necessary for the mapping. T-sheets contained shoreline and lake boundaries, bench marks, latitude and longitude grid lines, and cultural features. Also, T-sheets were produced at a time before land loss had become a major problem, and therefore represent an excellent temporal baseline for the study. However, the T-sheets were not available for the entire study area. Approximately 63 percent of the study area is covered by T-sheets. For those areas not covered, USGS 15-min quadrangle maps published closest to 1932 were used.

Sources and types of photography used in the land loss mapping are identified in Table 1. Criteria used to select the photo coverages used in this study were: (a) the photography provided coverage of the entire study area; (b) the photography had little or no cloud cover, and good color contrast between land and water; (c) appropriate

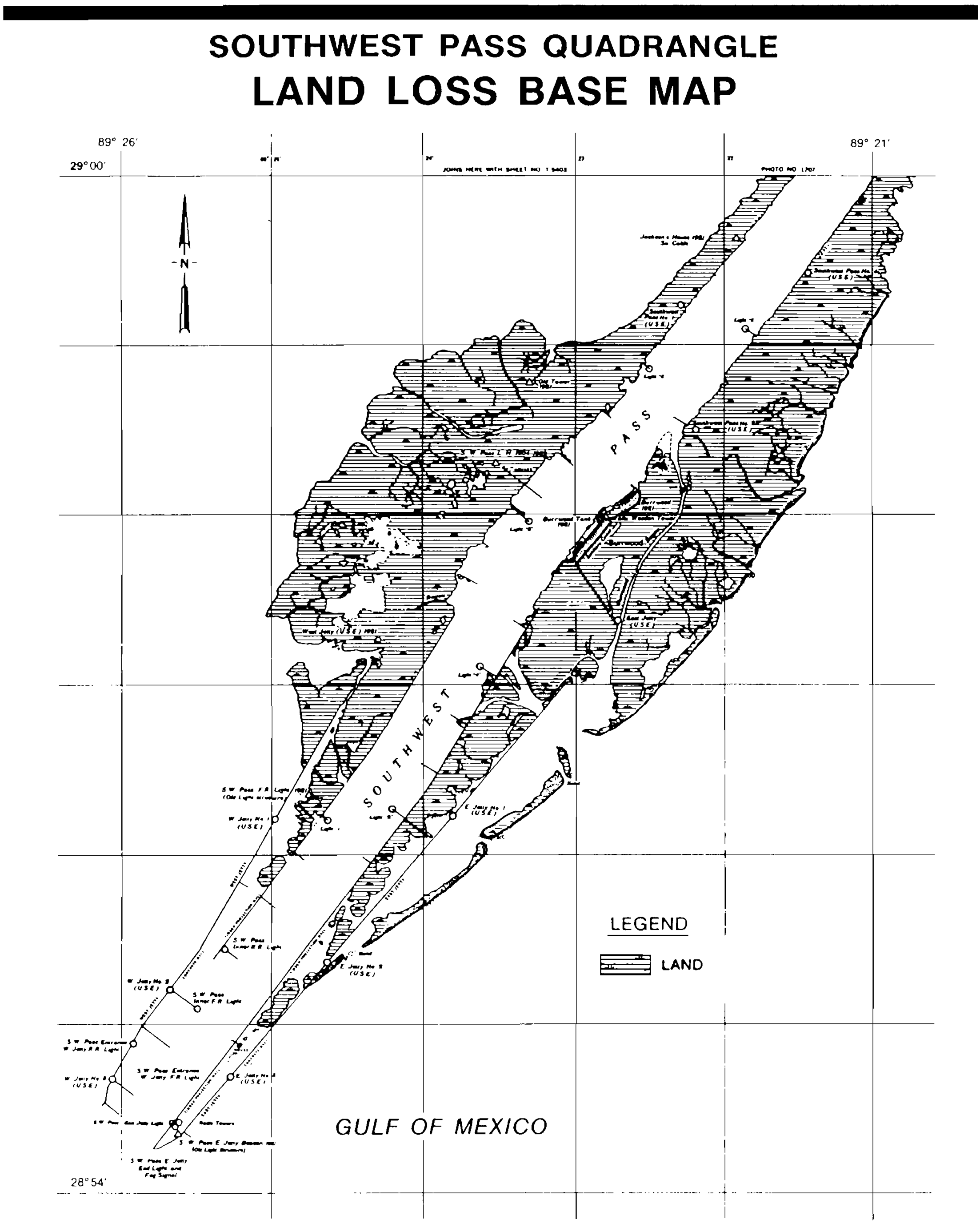


Figure 3. 1932 U.S. Coast and Geodetic Survey Air Photo Compilation Sheet (T-Sheet) of Southwest Pass used as the base map for the land loss mapping.

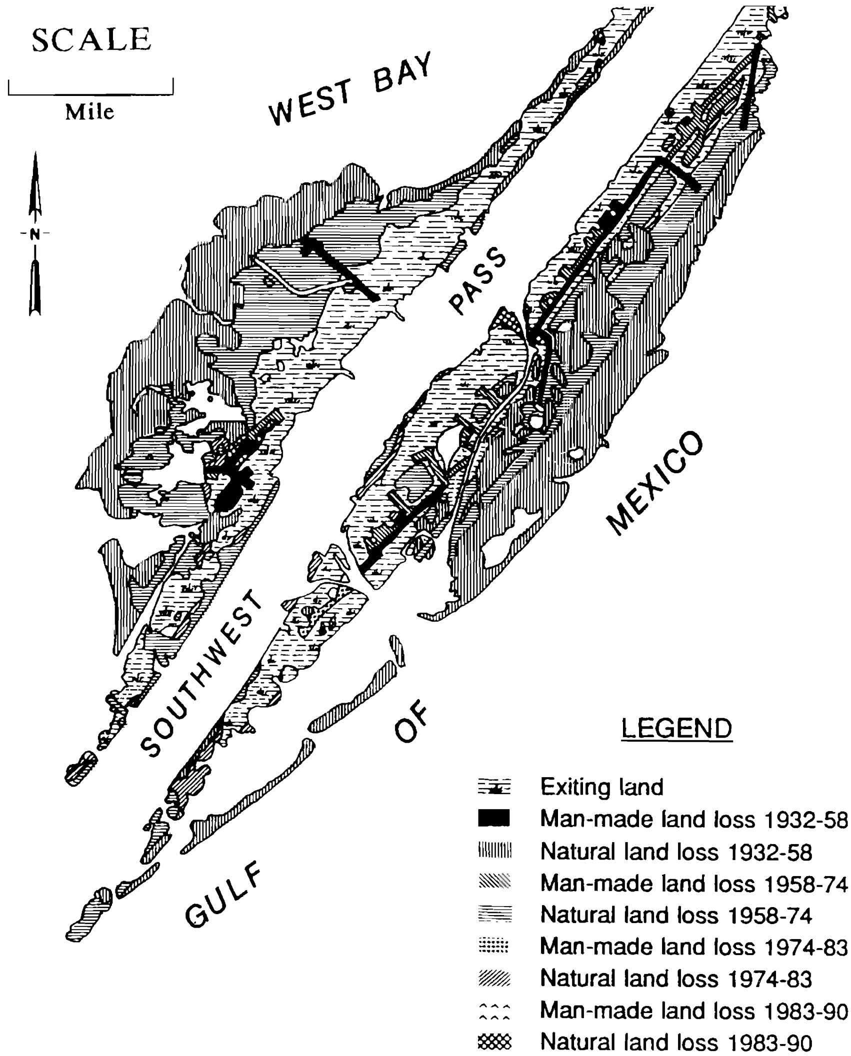


Figure 4. Example of completed land loss map of Southwest Pass.

interval between dates when the photography was flown; and (d) the photography was flown during the winter when most floating vegetation is dormant, aiding in identification of land/water interfaces.

Interpretation and Classification

This study documents changes from land to water in coastal Louisiana over a period of approximately 60 years. *Land loss* is defined by this study as any land area present on the 1930's base maps that was interpreted as water on later photographic coverages. This loss includes man-made loss as well as loss due to natural processes. The majority of land loss classified as *man-made loss* is the result of dredging activity associated with drill rig location canals, pipe lines, and waterways designed to aid navigation. *Natural loss* was considered to be all land loss not the direct result of man's activities.

Because the distinction between land and water is so critical to the accuracy of this study, it is important to identify the criteria used for their identification. *Water* was classified as any area of

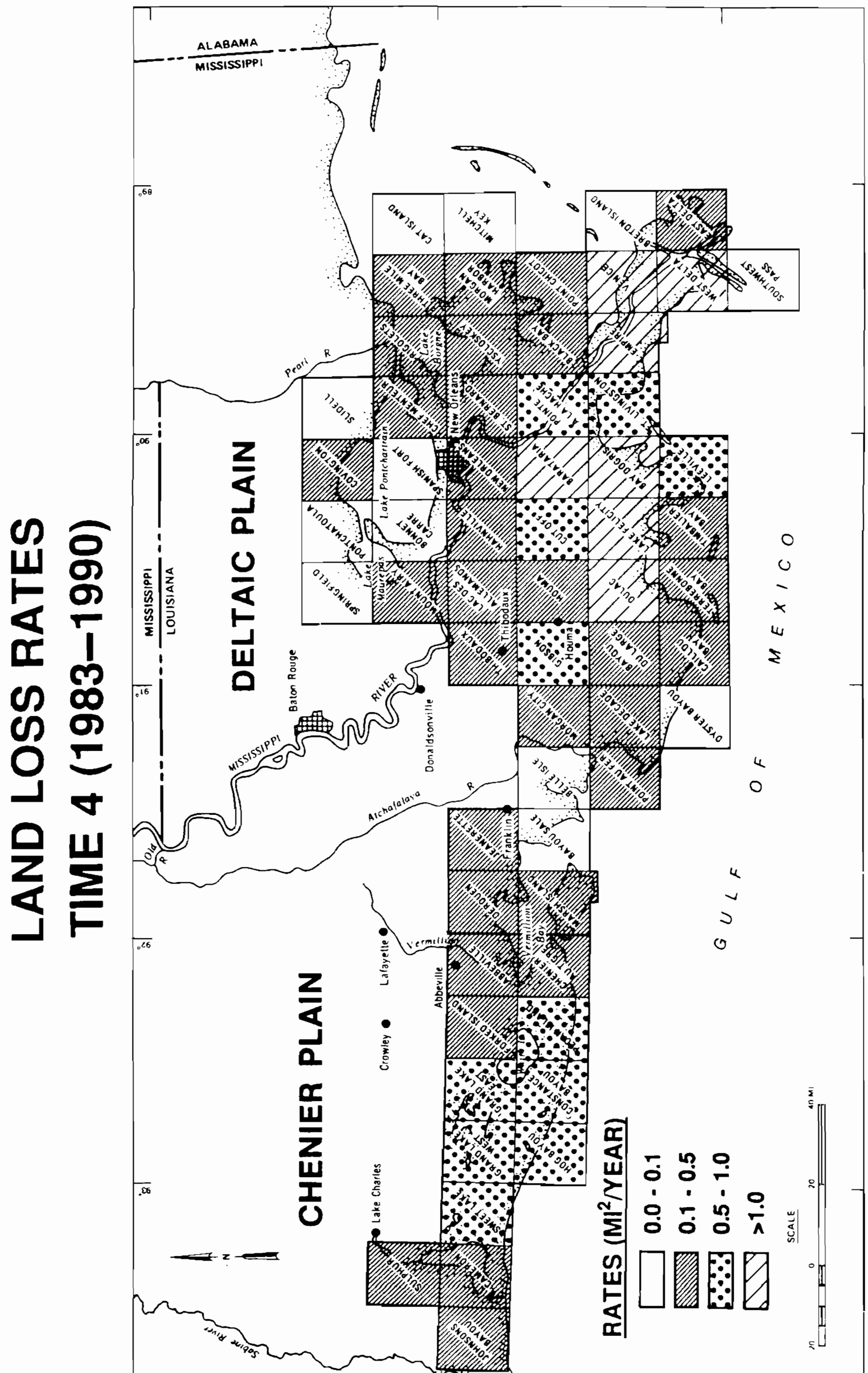


Figure 5. Summary of land loss rates in square miles per year for time period 4 (1983 to 1990).

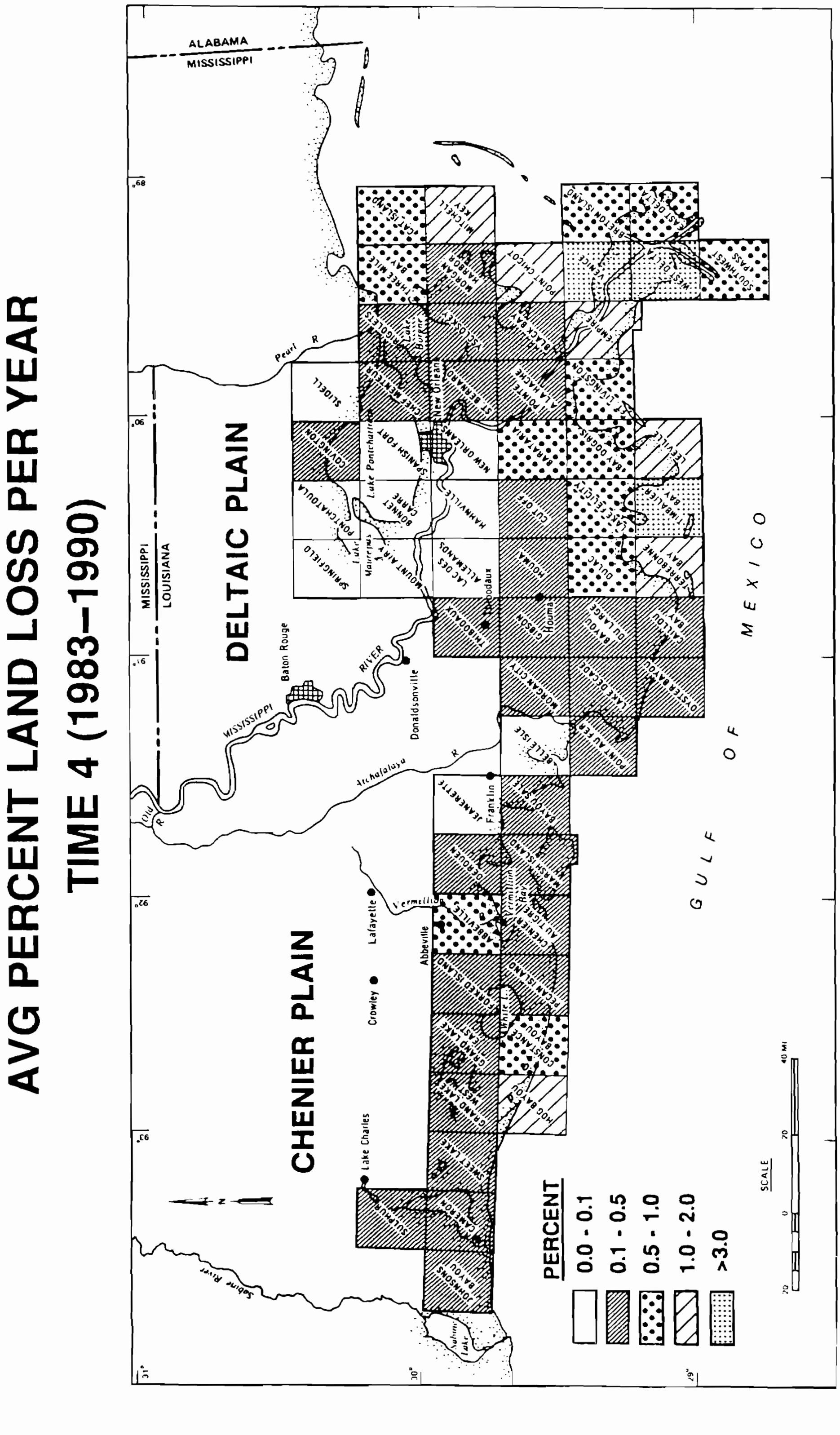


Figure 6. Summary of land loss rates in percent per year for time period 4 (1983 to 1990).

Table 2. *Land loss rates in square miles per year for Louisiana Coastal Plain.*

Quadrangle Name	Time Period 1	Average Loss (mi^2/yr)	Time Period 2	Average Loss (mi^2/yr)	Time Period 3	Average Loss (mi^2/yr)	Time Period 4	Average Loss (mi^2/yr)
Abbeville	1935–1954	0.07	1954–1974	0.23	1974–1983	0.24	1983–1990	0.43
Barataria	1939–1956	1.08	1956–1974	1.20	1974–1983	0.70	1983–1990	1.06
Bay Dogris	1932–1958	0.42	1958–1974	1.44	1974–1983	1.26	1983–1990	1.15
Bayou Du Large	1932–1958	0.18	1958–1974	1.61	1974–1983	0.65	1983–1990	0.47
Bayou Sale	1937–1956	0.31	1956–1974	0.36	1974–1983	0.19	1983–1990	0.07
Belle Isle	1940–1956	0.38	1956–1974	0.32	1974–1983	0.15	1983–1990	0.07
Black Bay	1932–1958	0.21	1958–1974	0.37	1974–1983	0.52	1983–1990	0.22
Bonnet Carre	1936–1958	0.10	1958–1974	0.44	1974–1983	0.19	1983–1990	0.07
Breton Island	1932–1958	0.26	1958–1974	0.18	1974–1983	0.11	1983–1990	0.05
Caillou Bay	1932–1958	0.22	1958–1974	0.40	1974–1983	0.43	1983–1990	0.21
Cameron	1933–1955	0.08	1955–1974	2.47	1974–1983	0.60	1983–1990	0.25
Cat Island	1932–1958	0.07	1958–1974	0.09	1974–1983	0.11	1983–1990	0.07
Chef Menteur	1932–1958	0.49	1958–1974	0.41	1974–1983	0.28	1983–1990	0.28
Chen. Au Tigre	1935–1951	0.08	1951–1974	0.36	1974–1983	0.13	1983–1990	0.32
Constance Bayou	1932–1955	0.64	1955–1974	0.82	1974–1983	0.50	1983–1990	0.59
Covington	1932–1958	0.02	1958–1974	0.18	1974–1983	0.02	1983–1990	0.18
Cut Off	1939–1958	0.22	1958–1974	0.53	1974–1983	0.39	1983–1990	0.51
Derouen	1932–1956	0.24	1956–1974	0.22	1974–1983	0.24	1983–1990	0.25
Dulac	1932–1958	0.37	1958–1974	0.98	1974–1983	1.99	1983–1990	1.49
East Delta	1932–1958	1.17	1958–1974	1.90	1974–1983	0.27	1983–1990	0.34
Empire	1932–1958	0.35	1958–1974	1.12	1974–1983	2.66	1983–1990	2.08
Forked Island	1935–1955	0.01	1955–1974	0.15	1974–1983	0.14	1983–1990	0.27
Fort Livingston	1932–1958	0.34	1958–1974	0.53	1974–1983	0.89	1983–1990	0.54
Gibson	1939–1958	0.11	1958–1974	1.50	1974–1983	0.45	1983–1990	0.54
Grand Lake East	1932–1955	0.29	1955–1974	0.41	1974–1983	1.54	1983–1990	0.62
Grand Lake West	1933–1955	0.05	1955–1974	1.12	1974–1983	1.30	1983–1990	0.44
Hahnville	1935–1958	0.11	1958–1974	0.57	1974–1983	0.43	1983–1990	0.17
Hog Bayou	1932–1955	0.54	1955–1974	0.72	1974–1983	0.15	1983–1990	0.56
Houma	1939–1958	0.13	1958–1974	0.24	1974–1983	0.17	1983–1990	0.29
Jeanerette	1937–1956	0.08	1956–1974	0.08	1974–1983	0.06	1983–1990	0.10
Johnsons Bayou	1933–1955	0.09	1955–1974	3.12	1974–1983	1.02	1983–1990	0.30
Lac des Allemands	1945–1958	0.13	1958–1974	0.11	1974–1983	0.66	1983–1990	0.19
Lake Decade	1931–1956	0.25	1956–1974	1.31	1974–1983	0.38	1983–1990	0.26
Lake Felicity	1932–1958	0.29	1958–1974	1.32	1974–1983	1.61	1983–1990	1.35
Leeville	1932–1958	0.28	1958–1974	0.40	1974–1983	0.90	1983–1990	0.73
Marsh Island	1932–1956	0.23	1956–1974	0.39	1974–1983	0.24	1983–1990	0.25
Mitchell Key	1932–1956	0.05	1956–1974	0.03	1974–1983	0.07	1983–1990	0.02
Morgan City	1931–1956	0.20	1956–1974	1.37	1974–1983	0.93	1983–1990	0.31
Morgan Harbor	1932–1958	0.19	1958–1974	0.32	1974–1983	0.38	1983–1990	0.32
Mount Airy	1939–1958	0.05	1958–1974	0.08	1974–1983	0.08	1983–1990	0.12
New Orleans	1935–1958	0.17	1958–1974	0.26	1974–1983	0.14	1983–1990	0.15
Oyster Bayou	1931–1956	0.07	1956–1974	0.18	1974–1983	0.15	1983–1990	0.07
Pecan Island	1935–1951	0.06	1951–1974	0.79	1974–1983	0.75	1983–1990	0.62
Point Chicot	1932–1958	0.08	1958–1974	0.08	1974–1983	0.07	1983–1990	0.15
Point au Fer	1931–1956	0.11	1956–1974	0.16	1974–1983	0.17	1983–1990	0.11
Pointe ala Hache	1932–1958	0.28	1958–1974	0.75	1974–1983	0.71	1983–1990	0.75
Pontchatoula	1939–1958	0.07	1958–1974	0.09	1974–1983	0.08	1983–1990	0.05
Rigolets	1932–1958	0.11	1958–1974	0.24	1974–1983	0.26	1983–1990	0.12
Slidell	1939–1958	0.06	1958–1974	0.15	1974–1983	0.05	1983–1990	0.04
Southwest Pass	1932–1958	0.10	1958–1974	0.12	1974–1983	0.02	1983–1990	0.02
Spanish Fort	1936–1958	0.03	1958–1974	0.01	1974–1983	0.003	1983–1990	0.01
Springfield	1939–1958	0.01	1958–1974	0.01	1974–1983	0.03	1983–1990	0.003
St. Bernard	1932–1958	0.29	1958–1974	1.23	1974–1983	0.70	1983–1990	0.26
Sulphur	1933–1955	0.05	1955–1974	1.82	1974–1983	0.40	1983–1990	0.28
Sweet Lake	1933–1955	0.13	1955–1974	1.80	1974–1983	0.84	1983–1990	0.68
Terrebonne Bay	1932–1958	0.18	1958–1974	0.29	1974–1983	0.49	1983–1990	0.35
Thibodaux	1949–1958	0.003	1958–1974	0.02	1974–1983	0.07	1983–1990	0.26

Table 2. *Continued.*

Quadrangle Name	Time Period 1	Average Loss (mi²/yr)	Time Period 2	Average Loss (mi²/yr)	Time Period 3	Average Loss (mi²/yr)	Time Period 4	Average Loss (mi²/yr)
Three Mile Bay	1932–1958	0.08	1958–1974	0.11	1974–1983	0.10	1983–1990	0.19
Timbalier Bay	1932–1958	0.21	1958–1974	0.22	1974–1983	0.41	1983–1990	0.31
Venice	1932–1958	0.61	1958–1974	1.50	1974–1983	0.54	1983–1990	1.60
West Delta	1932–1958	1.41	1958–1974	2.00	1974–1983	1.04	1983–1990	1.64
Yscloskey	1932–1958	0.12	1958–1974	0.60	1974–1983	0.53	1983–1990	0.14

water having no permanent vegetation visible at the surface. Permanent vegetation, as defined in this study, is that which is attached to the substrate, not floating vegetation such as hydrilla and hyacinths. *Land* was simply defined as everything on the photography not classified as water. The only land features without some visible vegetation were beaches and dredged material.

Land Loss Mapping

Land loss maps were compiled from comparisons of four vintages of aerial photography. Land loss mapping was conducted at a scale of 1:62,500. T-sheets (dated 1932–1933) and 1930's vintage USGS 15-min topographic maps were used as a base on which areas of land loss were delineated. The T-sheets (original scale 1:20,000) were photographically reduced to a scale of 1:62,500 and printed on stable transparent film. For those areas not covered by T-sheets, early 1930's 15-min base maps were transferred photographically to stable transparent films.

Mapping was begun once all the photographic products were referenced to the desired scale (see Table 1). To scale the 1956–1958 Tobin photography (1:24,000 original scale), interpretative overlays delineating land-water interfaces were made from the photography for the entire study area. These overlays were photographically reduced to 1:62,500 and printed on stable transparent film. The 1974 photography was purchased as custom enlargements at a 1:62,500 scale for this project. The 1983 photography was reduced to 1:62,500 from 1:58,000 using a Kail Autofocus projector. The 1990 photography was flown by NASA specially for this project at a scale of 1:62,500.

The first step in the mapping process involved placing the base map over the 1956–1958 Tobin photography overlay, orienting it with the aid of control points, and mapping the land loss which had occurred from the date of the T-sheet to 1956–1958. Areas of land loss (both natural and man-made) were manually linked onto the base maps as polygons. These polygons were color coded to reflect the time period which they represent and to differentiate between natural and man-made land loss. The result of this first step was a base map with the land loss that occurred during the 1932 to 1956–1958 time period represented as colored polygons. This step was repeated using the 1974 color IR photography. The base map showing the 1932 to 1956–1958 land loss was placed over the 1974 photography, oriented using control points, and the land loss that occurred from 1956–1958 to 1974 was delineated on the base map. Inked polygons representing the land loss between 1956–1958 and 1974 were then color coded. The next step in the mapping process involved placing the base map, containing land loss identified for 1932 to 1956–1958 and 1956–1958 to 1974 time preiods, over the 1983 color IR photography. The 1983 photography was registered to the base map with the aid of the Kail mapping projector and land loss from 1974 to 1983 was added to the base map and color coded. This process was again repeated for the 1990 photography. The base map was registered to the 1990 color IR photography, land loss areas formed between 1983 and 1990 were added to the base map, and color coded. The total number of inked polygons varies widely for each map. A typical land loss map may be represented by well over a thousand polygons, each spatially oriented with respect to the base map, and color coded to reflect the time interval in which the land loss occurred and whether the land loss was natural or man-made. This procedure was followed for all 62 quadrangles in the study area. An example of a T-sheet (base map) and its associated land loss map are presented in Figures 3 and 4 for Southwest Pass, Louisiana. For illustration purposes, the T-sheet and land loss map of Southwest Pass are shown as two

Table 3. *Land loss rates in percentage per year for Louisiana Coastal Plain.*

Quadrangle Name	Time Period 1	Average Percent Loss/ Year	Time Period 2	Average Percent Loss/ Year	Time Period 3	Average Percent Loss/ Year	Time Period 4	Average Percent Loss/ Year
Abbeville	1935–1954	0.08	1954–1974	0.25	1974–1983	0.27	1983–1990	0.50
Barataria	1939–1956	0.56	1956–1974	0.69	1974–1983	0.46	1983–1990	0.73
Bay Dogris	1932–1958	0.24	1958–1974	0.89	1974–1983	0.91	1983–1990	0.90
Bayou Du Large	1932–1958	0.08	1958–1974	0.77	1974–1983	0.36	1983–1990	0.27
Bayou Sale	1937–1956	0.35	1956–1974	0.44	1974–1983	0.26	1983–1990	0.10
Belle Isle	1940–1956	0.17	1956–1974	0.15	1974–1983	0.07	1983–1990	0.03
Black Bay	1932–1958	0.21	1958–1974	0.39	1974–1983	0.58	1983–1990	0.26
Bonnet Carre	1936–1958	0.09	1958–1974	0.41	1974–1983	0.19	1983–1990	0.07
Breton Island	1932–1958	1.42	1958–1974	1.55	1974–1983	1.26	1983–1990	0.65
Caillou Bay	1932–1958	0.26	1958–1974	0.50	1974–1983	0.59	1983–1990	0.30
Cameron	1933–1955	0.05	1955–1974	1.55	1974–1983	0.53	1983–1990	0.23
Cat Island	1932–1958	0.61	1958–1974	0.92	1974–1983	1.33	1983–1990	0.96
Chef Menteur	1932–1958	0.48	1958–1974	0.46	1974–1983	0.34	1983–1990	0.35
Chen. Au Tigre	1935–1951	0.08	1951–1974	0.38	1974–1983	0.15	1983–1990	0.37
Constance Bayou	1932–1955	0.43	1955–1974	0.62	1974–1983	0.43	1983–1990	0.52
Covington	1932–1958	0.03	1958–1974	0.27	1974–1983	0.03	1983–1990	0.28
Cut Off	1939–1958	0.10	1958–1974	0.24	1974–1983	0.19	1983–1990	0.25
Derouen	1932–1956	0.12	1956–1974	0.11	1974–1983	0.12	1983–1990	0.13
Dulac	1932–1958	0.18	1958–1974	0.51	1974–1983	1.13	1983–1990	0.94
East Delta	1932–1958	1.16	1958–1974	2.70	1974–1983	0.68	1983–1990	0.91
Empire	1932–1958	0.22	1958–1974	0.75	1974–1983	2.01	1983–1990	1.92
Forked Island	1935–1955	0.01	1955–1974	0.12	1974–1983	0.11	1983–1990	0.22
Fort Livingston	1932–1958	0.40	1958–1974	0.69	1974–1983	1.31	1983–1990	0.90
Gibson	1939–1958	0.04	1958–1974	0.59	1974–1983	0.20	1983–1990	0.24
Grand Lake East	1932–1955	0.16	1955–1974	0.24	1974–1983	0.95	1983–1990	0.41
Grand Lake West	1933–1955	0.02	1955–1974	0.53	1974–1983	0.68	1983–1990	0.25
Hahnville	1935–1958	0.05	1958–1974	0.24	1974–1983	0.19	1983–1990	0.08
Hog Bayou	1932–1955	0.66	1955–1974	1.04	1974–1983	0.27	1983–1990	1.04
Houma	1939–1958	0.05	1958–1974	0.10	1974–1983	0.07	1983–1990	0.12
Jeanerette	1937–1956	0.05	1956–1974	0.05	1974–1983	0.04	1983–1990	0.07
Johnsons Bayou	1933–1955	0.04	1955–1974	1.23	1974–1983	0.53	1983–1990	0.16
Lac des Allemands	1945–1958	0.06	1958–1974	0.05	1974–1983	0.29	1983–1990	0.09
Lake Decade	1931–1956	0.13	1956–1974	0.69	1974–1983	0.23	1983–1990	0.16
Lake Felicity	1932–1958	0.14	1958–1974	0.67	1974–1983	0.91	1983–1990	0.83
Leeville	1932–1958	0.33	1958–1974	0.52	1974–1983	1.28	1983–1990	1.17
Marsh Island	1932–1956	0.21	1956–1974	0.38	1974–1983	0.25	1983–1990	0.27
Mitchell Key	1932–1956	1.24	1956–1974	0.74	1974–1983	3.06	1983–1990	1.20
Morgan City	1931–1956	0.09	1956–1974	0.64	1974–1983	0.49	1983–1990	0.17
Morgan Harbor	1932–1958	0.18	1958–1974	0.31	1974–1983	0.39	1983–1990	0.34
Mount Airy	1939–1958	0.02	1958–1974	0.04	1974–1983	0.04	1983–1990	0.05
New Orleans	1935–1958	0.08	1958–1974	0.12	1974–1983	0.07	1983–1990	0.07
Oyster Bayou	1931–1956	0.20	1956–1974	0.54	1974–1983	0.50	1983–1990	0.24
Pecan Island	1935–1951	0.03	1951–1974	0.44	1974–1983	0.47	1983–1990	0.40
Point Chicot	1932–1958	0.66	1958–1974	0.80	1974–1983	0.81	1983–1990	1.86
Point au Fer	1931–1956	0.33	1956–1974	0.53	1974–1983	0.62	1983–1990	0.42
Pointe ala Hache	1932–1958	0.13	1958–1974	0.37	1974–1983	0.37	1983–1990	0.40
Pontchatoula	1939–1958	0.05	1958–1974	0.07	1974–1983	0.06	1983–1990	0.04
Rigolets	1932–1958	0.10	1958–1974	0.23	1974–1983	0.26	1983–1990	0.12
Slidell	1939–1958	0.09	1958–1974	0.24	1974–1983	0.08	1983–1990	0.07
Southwest Pass	1932–1958	1.45	1958–1974	2.82	1974–1983	0.86	1983–1990	0.93
Spanish Fort	1936–1958	0.10	1958–1974	0.03	1974–1983	0.01	1983–1990	0.03
Springfield	1939–1958	0.01	1958–1974	0.01	1974–1983	0.03	1983–1990	0.003
St. Bernard	1932–1958	0.14	1958–1974	0.61	1974–1983	0.38	1983–1990	0.15
Sulphur	1933–1955	0.02	1955–1974	0.78	1974–1983	0.20	1983–1990	0.14
Sweet Lake	1933–1955	0.05	1955–1974	0.77	1974–1983	0.42	1983–1990	0.35
Terrebonne Bay	1932–1958	0.40	1958–1974	0.73	1974–1983	1.39	1983–1990	1.13

Table 3. *Continued.*

Quadrangle Name	Time Period 1	Average Percent Loss/ Year	Time Period 2	Average Percent Loss/ Year	Time Period 3	Average Percent Loss/ Year	Time Period 4	Average Percent Loss/ Year
Thibodaux	1949–1958	0.001	1958–1974	0.01	1974–1983	0.03	1983–1990	0.10
Three Mile Bay	1932–1958	0.26	1958–1974	0.38	1974–1983	0.36	1983–1990	0.72
Timbalier Bay	1932–1958	0.91	1958–1974	1.26	1974–1983	2.93	1983–1990	3.01
Venice	1932–1958	0.63	1958–1974	1.87	1974–1983	0.96	1983–1990	3.11
West Delta	1932–1958	1.23	1958–1974	2.55	1974–1983	2.24	1983–1990	4.42
Yscloskey	1932–1958	0.08	1958–1974	0.40	1974–1983	0.38	1983–1990	0.10

illustrations and the different land loss attributes are represented by line patterns rather than color as on the actual base map.

Area Measurement and Rate Curve Development

Data from the completed land loss maps were used to calculate the total number of acres of land loss that occurred during each time interval and what portion of that total was attributed to natural and man-made causes. To derive these values, a separate ink overlay representing all the polygons for each color was drafted (two for each time period, one natural and one man-made, eight total for each map). The ink overlays for each color were converted to digital data by optical scanning and this data was processed on a personal computer to determine the total number of acres of land loss for each color overlay. Acres of land loss for each time interval were converted to square miles of land loss and were divided by the number of years in the specified time interval to derive the average land loss rate. These values were used to construct rate curves for each quadrangle in the study area as well as for the entire coastal plain.

RESULTS

Land Loss Rates for Individual Quadrangles

Land loss rates in square miles per year for the 62 USGS quadrangle maps in the Louisiana Coastal Plain are shown in Table 2. Land loss rates vary significantly throughout coastal Louisiana as shown by Table 2. In general, this variability reflects differences in the geologic setting of individual quadrangles and differences in the factors contributing to land loss. Land loss rates for the latest time period mapped, Time 4 (1983 to 1990), are summarized in Figure 5. For the 1983 to 1990 time period, the highest land loss rates in square miles per year are occurring in the modern delta and the central chenier plain.

As another method of presenting the land loss trend data, the 1930's base maps were digitized in order to determine the percentage of land lost for each quadrangle. Land loss rates as a percentage of the land area present in each time period are identified in Table 3. Land loss rates in Table 3 are expressed as average percent land loss per year and were derived by dividing the land loss rate (in square miles per year) for each quadrangle by the land area present at the beginning of each time period mapped. Land loss data presented as a function of percent allows comparison between quadrangles with small initial land areas

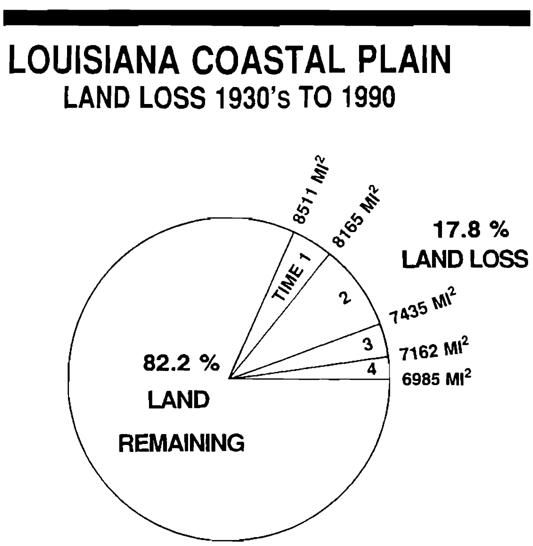
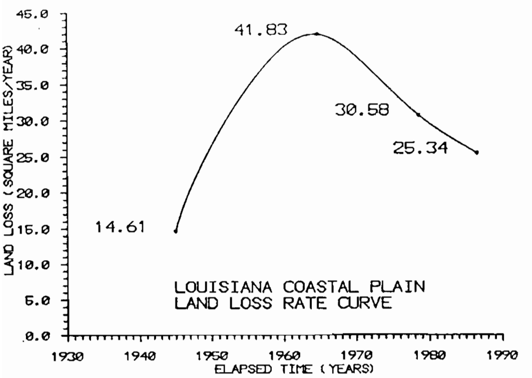
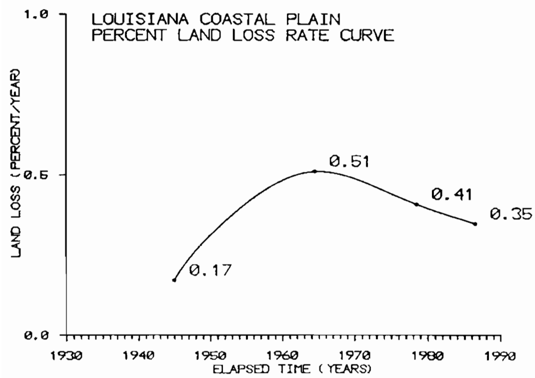


Figure 7. Pie chart showing gross land loss changes between the 1930's and 1990. Time periods mapped are as follows: Time 1 (1930's to 1956–1958), Time 2 (1956–1958 to 1974), Time 3 (1974 to 1983), Time 4 (1983 to 1990).

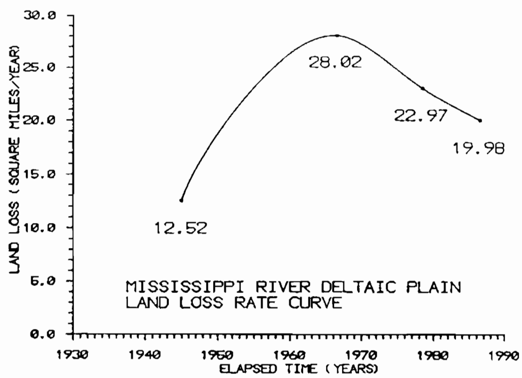


a. Curve expressed in square miles per year

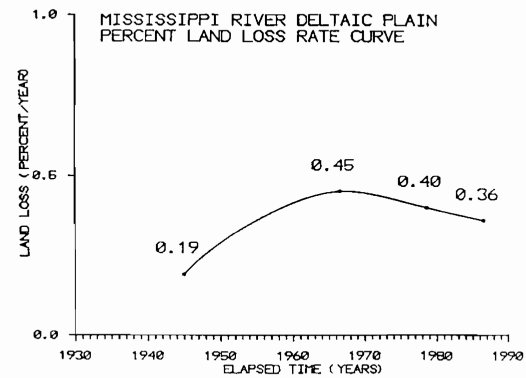


b. Curve expressed in percent per year

Figure 8. Land loss rate curves for the Louisiana Coastal Plain.



a. Curve expressed in square miles per year



b. Curve expressed in percent per year

Figure 9. Land loss rate curves for the Mississippi River deltaic plain.

and quadrangles with large land areas. With land loss rates expressed as percent loss, the comparison is independent of the total amount of land present for each quadrangle. It is then possible to compare quadrangles which contain little land area (*i.e.*, Cat Island, Mitchell Key, Point Chicot, *etc.*) with quadrangles that are nearly all land (Cut Off, Gibson, Houma, *etc.*). Table 3 shows that quadrangles with little land area have some of the highest land loss rates in the study area.

A summary of land loss rates expressed as average percent per year for the 1983 to 1990 time period is presented in Figure 6. The highest land loss rates based on percentage change are occurring along the coast. Percentage loss rates are highest in the modern delta, in the coastal quadrangles of the eastern and southern deltaic plain, and in the south-central chenier plain. Percentage land loss rate trends are generally consistent among the four time periods mapped for these same areas except for the western chenier plain, where the rates are more variable.

1930's Base Land and Water Data

From the 1930's land data, it is possible to determine the gross land changes that have occurred in coastal Louisiana. Beginning in the early 1930's, there was approximately 8,511 square miles of land in the study area. By the end of the 1990 time period, the total land loss that occurred was 1,526 square miles or approximately 17.8 percent of the original land area. Approximately 11.7 percent (*i.e.*, 178 square miles) of this loss was identified in the mapping as direct man-made loss. Of the 17.8 percent total loss, 74.4 percent occurred in the deltaic plain and 25.6 percent occurred in the chenier plain. Figure 7 summarizes the general land changes that have occurred in coastal Louisiana during approximately the past 60 years and shows the percent contribution that occurred in each period. In time period 2 (1956–1958 to 1974), the greatest amount of land was lost with nearly half of the total loss occurring during this period. For time periods 3 and 4, the loss contribution has decreased for each period from the proceeding time period.

Composite Land Loss Rates

Composite land loss rate curves for the entire study area, the Mississippi River deltaic plain, and chenier plain are presented in Figures 8, 9, and 10, respectively. The curves are expressed in square miles per year and average percent per year, respectively. The land loss rate during time period 4 (1983 to 1990) for the Louisiana Coastal Plain is 25.34 square miles per year or 0.35 percent per year; for the deltaic plain (50 quadrangles, see Figure 1), the rate is 19.98 square miles per year or 0.36 percent per year; and for the chenier plain (12 quadrangles), the rate is 5.36 square miles per year or 0.33 percent per year. The rate curves show the trend has been consistently decreasing for the entire coastal plain and the deltaic and chenier plains from their peak in time period 2.

CONCLUSIONS

Land loss mapping from the 1930's to 1990 for 62 USGS quadrangles in the Louisiana Coastal Plain indicates:

(A) The location and magnitude of land loss is highly variable throughout the coastal plain.

(B) The land loss rate for the entire study area has decreased from its high of approximately 42 square miles per year in 1974 to approximately 25 square miles per year in 1990.

(C) The percentage of land being lost in the study area is also decreasing from its high of approximately 0.51 percent per year in 1974 to approximately 0.35 percent per year in 1990.

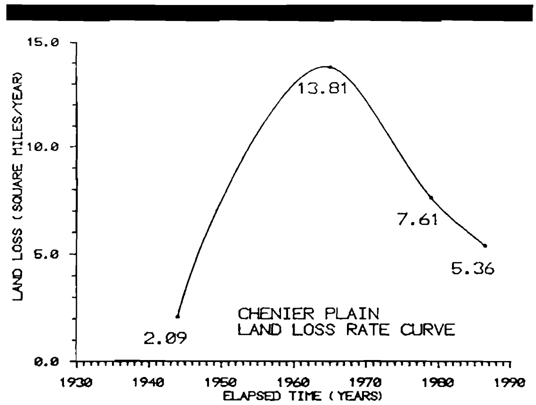
(D) Total land area has decreased from 8,511 square miles in the 1930's to 6,985 square miles in 1990.

(E) Approximately 17.8 percent of the available land in the study area has been lost since the 1930's.

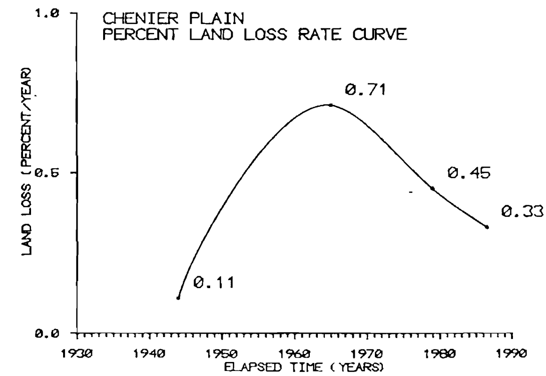
(F) Approximately 11.6 percent of the total land lost (*i.e.* 1,526 square miles) since the 1930's is direct man-made loss.

(G) The highest land loss rates and percentage loss are occurring along the coastline. Rates are highest in the Modern Delta and in the eastern and south-central portions of the deltaic plain.

(H) Natural land loss rates will probably continue to decrease slowly until a background rate is reached. Since most of coastal Louisiana is in the destructional phase of delta development, there is an inherent land loss rate. The land loss rate for time period 1 (14.61 square miles per year or 0.17 percent per year) may be representative of the inherent background rate because it reflects the land loss rate in the coastal area prior to the major impacts from man's activities.



a. Curve expressed in square miles per year



b. Curve expressed in percent per year

Figure 10. Land loss rate curves for the chenier plain.

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