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Land-Cover Change in the Lower Mississippi Valley, 1973–2000

Open-File Report 2009–1280

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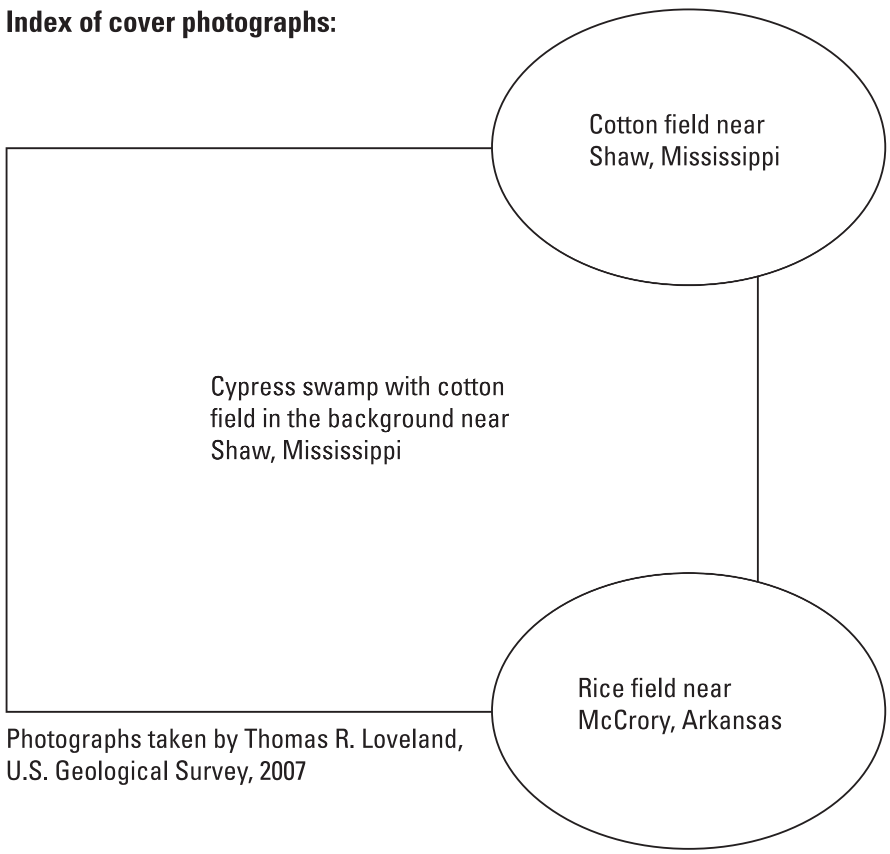

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Land-Cover Change in the Lower Mississippi Valley, 1973–2000

By Krista A. Karstensen and Kristi L. Sayler

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Conversion Factors

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Land-Cover Change in the Lower Mississippi Valley, 1973–2000

By Krista A. Karstensen[1], and Kristi L. Sayler[2]

Project Background

The Land Cover Trends is a research project focused on understanding the rates, trends, causes, and consequences of contemporary United States land-use and land-cover change. The project is coordinated by the Geographic Analysis and Monitoring Program of the U.S. Geological Survey (USGS) in conjunction with the U.S. Environmental Protection Agency (EPA) and the National Aeronautics and Space Administration (NASA). Using the EPA Level III ecoregions as the geographic framework, scientists process geospatial data collected between 1973 and 2000 were processed to characterize ecosystem responses to land-use changes. The 27-year study period was divided into four temporal periods: 1973 to1980, 1980 to 1986, 1986 to 1992, 1992 to 2000 and overall from 1973 to 2000. General land-cover classes for these periods were interpreted from Landsat Multispectral Scanner, Thematic Mapper, and Enhanced Thematic Mapper Plus imagery to categorize and evaluate land-cover change using a modified Anderson Land Use Land Cover Classification System (Anderson and others, 1976) for image interpretation.

The rates of land-cover change were estimated using a stratified, random sampling of 10-kilometer (km) by 10-km blocks allocated within each ecoregion. For each sample block, satellite images were used to interpret land-cover change. The sample block data then were incorporated into statistical analyses to generate an overall change matrix for the ecoregion. These change statistics are applicable for different levels of scale, including total change for the individual sample blocks and change estimates for the entire ecoregion.

Ecoregion Description

The Mississippi Alluvial Plain (MAP) ecoregion (fig.1), as defined by Omernik (1987), follows the Mississippi River south from Illinois and Missouri through Arkansas, Tennessee, Mississippi and Louisiana, ending at the Gulf of Mexico. The ecoregion is a mostly flat, agriculturally dominated alluvial floodplain covering approximately 141,895 square kilometers (km^2). The alluvial valley extends 954 river miles from the confluence of the Ohio and Mississippi Rivers at Cairo, Illinois, to the Gulf of Mexico (Miller and Nasser, 2000). In 2000, the land cover was approximately 49 percent agriculture, 19 percent wetland, 16 percent water and 10 percent forest and 6 percent other land-cover classes. The climate of the ecoregion is mild in the winter and hot in the summer with average temperatures increasing from north to south with a mean temperature of 28 degrees Fahrenheit (ºF) in the winter to 94 degrees oF in the summer. The precipitation of the ecoregion also increases from north to south with a mean annual precipitation range of 110 to155 centimeters (cm).

Historically, the entire ecoregion was covered by bottomland deciduous forests, but large-scale tree clearing started in the 1940s and continued into the early 1970s (McWilliams and Rosson, 1990, p. 491). The systematic removal of bottomland deciduous forests allowed a conversion to agriculture in most of the ecoregion. The northern and central parts of the ecoregion are now highly cropped; soybeans, rice, and cotton are the leading commodities. Cotton production has recovered from the low prices and weevil infestations of the 1970s (Firestone, 2001). Aquaculture also is important, and catfish production is the leading commodity. The southern part of the ecoregion is a forested wetland alluvial plain and contains New Orleans and Baton Rouge, Louisiana. The bottomland forests of the ecoregion are mostly deciduous and consist of the following main species groups: sugarberry/American-elm/green-ash, sweetgum/Nuttall-oak/willow-oak, cypress/tupelo, and overcup-oak/water-hickory (McWilliams and Rosson, 1990, p. 493).

The Lower Mississippi Valley (LMV) is a sub-region that lies within the boundaries of the MAP (fig. 1). The northern extent of this sub-region aligns closely with that of the MAP, but does not include the narrow reach that extends into western Louisiana and southern Arkansas along the Red River. The southern boundary of the LMV is marked by the Louisiana towns of Laplace on the east, Bayou Cane to the south, and Lafayette on the west thus excluding the Louisiana Delta. The MAP ecoregion has 36 randomly selected 100-km^2 sample blocks 24 of which are in the LMV sub-region.

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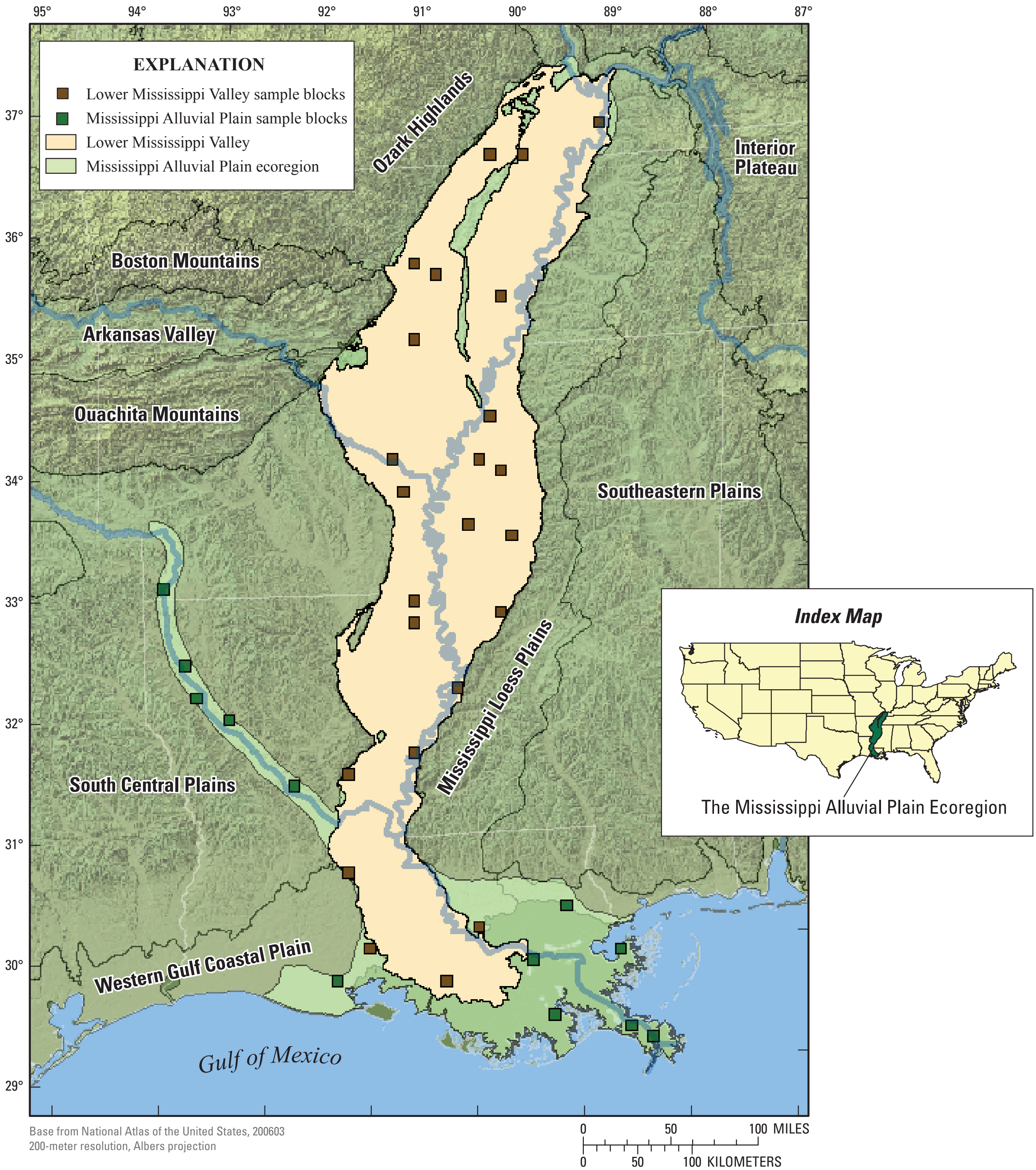

Figure 1. Map showing the Lower Mississippi Valley within the Mississippi Alluvial Plain.

Contemporary Land-Cover Change

Mississippi Alluvial Plain

The overall spatial change from 1973 to 2000 for the MAP was 9.4 percent (+/-2.7 percent) (table 1), which was a moderate amount of change as compared to the surrounding ecoregions. An estimated 7.4 percent (+/-2.2 percent) of the ecoregion changed from one land cover to another only once during the study period (table 1). The amount of change varied slightly from 1973 to 2000 and ranged from a low of 2.7 percent to a high of 3.6 percent (table 2). The average annual rates of change indicated that the 1973 to 1980 period had the greatest amount of change with a rate of 0.5 percent per year (table 2) (rounding makes the 1986 to 1992 rate also 0.5 but it is actually slightly lower). When compared to the Mississippi Valley Loess Plains which boarders ecoregion to the east, the raw estimates of percent change in the ecoregion computed for the four time periods and the associated margin of error at an 85 percent confidence interval, the total change is greater in the MAP in the 1973 to 1980 and 1980 to 1986 time periods and smaller in the latter half of the study period.

The overall leading land-cover change in the Mississippi Valley Loess Plains also differs from that of the MAP. The two largest overall conversions in the Loess Plains were from forest to mechanically disturbed, and from agriculture to forest. Where water and wetland conversions play a large role in the story of the Lower Mississippi Alluvial Plain, these conversions are not even ranked among the top five conversions in the Mississippi Valley Loess Plains to the east.

The water, wetland, developed, and forest classes had the most change during the study period (table 3). The wetland class showed a net loss of 2.4 percent and the water class showed a near inverse net increase of 2.6 percent (table 3). These changes in the wetland and water land cover classes may be related to the loss of coastal wetland areas in this ecoregion, most specifically in coastal Louisiana.

Wetland to Water Conversions

The leading land-cover conversion in all time periods was wetland to water (table 4). The ecoregion lost 4,368 km^2 of wetlands to water between 1973 and 2000. The coastal wetland areas of the MAP ecoregion have been affected by human factors such as levees on the Mississippi River, hydrologic modification, sediment erosion, and land subsidence (Caffey and Schexnayder, 2003; Morton and others, 2003), as well as natural factors such as delta switching, subsidence, sea-level rise, and storms (Williams and Cichon, 1994). The effects of the wetland to water conversion are most drastically seen in coastal Louisiana where the wetlands currently represent only about 40 percent of all the wetlands of the continental United

Table 1. Percentage of the Mississippi Alluvial Plain that experienced spatial change and associated error.

[+, plus; -, minus; %, percent]

Number of changes	Percent of ecoregion	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	7.4	2.2	5.1	9.6	1.5	20.7
2	1.6	.7	.9	2.3	.5	30.6
3	.4	.3	.1	.8	.2	50.7
4	.1	.1	0	.1	0	61.3
Overall spatial change	9.4	2.7	6.7	12.1	1.8	19.5

Table 2. Raw estimates of percent change in the Mississippi Alluvial Plain computed for each of the four time periods and associated error at an 85 percent confidence level.

[+, plus; -, minus; %, percent]

Period	Total change (% of ecoregion)	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)	Average rate (% per year)
1973–1980	3.6	1.5	2.1	5	1	27.9	0.5
1980–1986	2.7	.8	1.8	3.5	.6	21	.4
1986–1992	2.7	1	1.7	3.7	.7	26.1	.5
1992–2000	3.1	1.2	1.9	4.3	.8	26.4	.4

Table 3. Estimated area for each land-cover class in the Mississippi Alluvial Plain between 1973 and 2000.

[%, percent; km^2, square kilometers]

	Water		Developed		Mechanically disturbed		Mining		Barren		Forest		Grass/Shrub		Agriculture		Wetland		Nonmechanically disturbed	
	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²
1973	13.7	19,498	3.7	5,222	0.1	187	0	0	0.2	254	10.6	15,042	0.3	439	49.6	70,342	21.8	30,882	0	0
1980	14.8	21,033	3.9	5,577	.2	342	0	0	.1	212	10.1	14,327	.4	576	50	70,877	20.4	28,906	0	0
1986	15.5	21,998	4.3	6,148	.3	489	0	0	.1	197	9.7	13,716	.5	768	49.8	70,644	19.7	27,899	0	0
1992	16.1	22,850	4.6	6,498	.4	559	0	0	.1	97	9.6	13,553	.6	801	49.2	69,771	19.5	27,712	0	0
2000	16.3	23,197	5.1	7,190	.3	414	0	0	.1	142	9.6	13,577	.5	738	48.7	69,060	19.4	27,537	0	0
Net change	2.6	3,698	1.4	1,968	.2	227	0	0	-.1	-112	-1	-1,465	.2	299	-.9	-1,282	-2.4	-3,345	0	0

States, but account for 80 percent of the losses (Williams, 1995).

The conversion of wetland to water can also be caused by other natural factors. The 300 km-wide Mississippi River delta plain and its associated wetlands and barrier shorelines are the product of the continuous accumulation of sediments deposited by the river and its distributaries during the past 7,000 years (Williams, 1995). Regular shifts in the course of the river have resulted in four ancestral and two active delta lobes that accumulated as overlapping, stacked sequences of unconsolidated sands and muds (Williams, 1995). As each delta lobe was abandoned by the river, its main source of sediment, the deltas eroded and degraded due to compaction of loose sediment, rise in relative sea level, and catastrophic storms (Williams, 1995). Currently, most of the sediment carried by the Mississippi River is channeled over the Continental Shelf rather than being allowed to flow into and rebuild the Louisiana coast (Miller and Nassar, 2000). This natural and human-induced subsidence exceeds accretion causing the wetlands to sink below sea level and subsequent conversion of wetlands to water (Templet and Meyer-Arendt, 1988.)

Since the turn of the century and through the late 1970s, coastal loss in the deltaic plain accelerated to a rate of 75 square kilometers (km^2)/year (Williams and Cichon, 1994). A study conducted by the U.S. Army Corps of Engineers, however, indicates that this rate decreased in the early 1990s to 50 km^2/year (Williams and Cichon, 1994). These rates also may be reflected in the land-cover statistics. Though the conversion from wetland to water remained the leading conversion during each time period, the overall percent of change in this conversion compared to the other leading conversions declined over the study period (table 4).

Forest Conversions

The developed class increased by 1.4 percent from 1973 to 2000 (table 3) with land conversion coming from agriculture and forest. The 1 percent forest loss was caused by the small amount of upland forests being harvested, primarily in the Red River Valley of Louisiana and southwest Arkansas. Conversions associated with timber harvesting and re-growth (forest to mechanically disturbed and mechanically disturbed to forest) were the next most common land-cover conversions. Approximately 96 percent of the bottomland hardwood forest losses can be attributed to increases in agriculture whereas additional losses have been caused by the construction of structures for flood control and navigation, surface mining, and urban development (Schoenholz and others, 2001).

Forested land in the MAP has also been affected by the construction of levees along the Mississippi River. The flood control construction not only minimized the overall size of the floodplain, but it also allowed the clearing of the floodplain forest and the conversion of the valley to agriculture (Miller and Nassar, 2000). This change in land use may be reflected in

Table 4. Land-cover conversions in the Mississippi Alluvial Plain during each of four time periods and overall.

[%, percent; km^2, square kilometers]

Period	From Class	To Class	Area changed (km^2)	Percent of all changes (%)
1973–1980	Wetland	Water	1,844	36.5
	Wetland	Agriculture	725	14.4
	Water	Wetland	419	8.3
	Forest	Agriculture	372	7.4
	Forest	Mechanically disturbed	298	5.9
	Other	Other	1,388	27.5
	Total		5,046	100
1980–1986	Wetland	Water	1,037	27.6
	Forest	Mechanically disturbed	385	10.2
	Forest	Developed	266	7.1
	Agriculture	Developed	210	5.6
	Water	Wetland	178	4.7
	Other	Other	1,687	44.8
	Total		3,763	100
1986–1992	Wetland	Water	702	18.3
	Forest	Mechanically disturbed	399	10.4
	Grass/Shrub	Forest	286	7.5
	Mechanically disturbed	Grass/Shrub	254	6.6
	Agriculture	Water	239	6.2
	Other	Other	1,960	51
	Total		3,840	100
1992–2000	Wetland	Water	784	17.8
	Water	Wetland	497	11.3
	Mechanically disturbed	Forest	408	9.2
	Gass/Shrub	Forest	405	9.2
	Agriculture	Developed	355	8
	Other	Other	1,970	44.6
	Total		4,419	100
1973–2000	Wetland	Water	4,368	25.6
	Forest	Mechanically disturbed	1,411	8.3
	Water	Wetland	1,271	7.4
	Wetland	Agriculture	1,048	6.1
	Agriculture	Developed	922	5.4
	Other	Other	8,048	47.2
	Total		17,068	100

the land-cover change statistics in the early part of the study period because forest to agriculture was among the leading conversions between 1973 and 1980. During this time, the land use emulated these statistics as steady increases in economic returns from soybeans and other crops caused farmers to convert many bottomland hardwoods to croplands (Schoenholz and others, 2001).

Lower Mississippi Valley

The percentage of area that changed at least one time from 1973 to 2000, was 6.1 percent (+/- 1.6 percent) in the Lower Mississippi Valley; moderately lower than that of the MAP and about one-half as low as that of the Mississippi Valley Loess Plains (table 5). An estimated 4.9 percent (+/- 1.2

Table 5. Percentage of the Lower Mississippi Valley that experienced spatial change and associated error.

[+, plus; -, minus; %, percent]

Number of changes	Percent of ecoregion	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	4.9	1.2	3.7	6.0	0.8	16.0
2	.9	.5	.4	1.4	.3	35.1
3	.3	.2	0	.5	.2	59.1
4	.1	.1	0	.2	.1	80.9
Overall spatial change	6.1	1.6	4.6	7.7	1.1	17.1

Table 6. Raw estimates of percent change in the Lower Mississippi Valley computed for each of the four time periods and associated error at an 85-percent confidence level.

[+, plus; -, minus; %, percent]

Period	Total change (% of ecoregion)	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)	Average rate (% per year)
1973–1980	2.3	0.8	1.5	3.1	0.5	22.7	0.3
1980–1986	1.7	.7	.9	2.4	.5	28.8	.3
1986–1992	1.9	.7	1.2	2.6	.5	24.8	.3
1992–2000	1.9	.6	1.3	2.5	.4	22.3	.2

percent) of this sub-region changed once while 0.9 percent (+/- 0.5 percent), 0.3 percent (+/- 0.2 percent), and 0.1 percent (+/- 0.1 percent) changed two, three, and four times during the 27-year study period (table 5). The amount of change varied slightly and ranged from a low of 1.9 percent to a high of 2.3 percent (table 6). Again, these values are lower than those of the MAP and the Mississippi Valley Loess Plains.

The agriculture, wetland, developed, and water classes changed the most during the study period (table 7). The agriculture class showed a net loss of 0.8 percent and the wetland class showed a net loss of 0.6 percent over the study period. The classes with the largest gains were developed and water at 0.8 percent and 0.6 percent.

Between 1973 and 2000, the five most common land-cover conversions were; (1) wetland to agriculture, (2) wetland to water, (3) water to wetland, (4) agriculture to developed, and (5) agriculture to water (table 8). Since the sub-region excludes the Louisiana Delta, the water to wetland conversion is not as significant as it is in the MAP, and more area has been converted from agriculture from wetlands in this region.

Wetland to Agriculture Conversions

Historic wetland loss has been attributed to the draining of wetlands for agriculture (Caffey and Schexnayder, 2003). From 1973 to 2000, a similar pattern was noted. This conversion was more prominent from 1973 to 1980 and 1980 to 1986. The agriculture-related wetland loss began to be dramatically curtailed in the 1980s with the advent of agro-environmental policy (Caffey and others, 2003). This is reflected in the land-cover statistics as the leading change in the third time period changes from wetland to agriculture to wetland to water (tables 4 and 8). Of particular interest has been the evolution of conservation compliance and incentive programs first instituted in the 1985 Farm Bill, which may help to explain why more land was not converted into agriculture throughout the remainder of the study period.

Wetland to Water Conversions

Although the wetland coverage in the LMV is not as expansive as in the MAP, it is the predominant land cover in the southern most part of the region. The driving forces behind the wetland to water conversions in the LMV may be similar to those in the MAP. The water to wetland conversions may be attributed to the Wetland Reserve Program (WRP) which, working congruently with the Conservation Reserve Program (CRP), was created to protect and restore wetlands located on marginal farmland (U.S. Department of Agriculture Natural Resources Conservation Service, 2009a; U.S. Department of Agriculture Natural Resources Conservation Service, 2009b). These programs may be reflected in the statistics because with the inception of the WRP and CRP in 1985, the leading conversions from 1986 to 2000 include agricultural land converting to both wetland and water. This conversion from agriculture to water and wetlands is less apparent in the MAP.

Table 7. Estimated area for each land-cover class in the Lower Mississippi Valley between 1973 and 2000.

[%, percent; km², square kilometers]

	Water		Developed		Mechanically disturbed		Mining		Barren		Forest		Grass/Shrub		Agriculture		Wetland		Nonmechanically disturbed	
	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²
1973	5.6	6,138	3.2	3,567	0	11	0	28	0.1	142	5.9	6,513	0.3	338	66.4	73,090	18.4	20,214	0	0
1980	5.5	6,075	3.3	3,652	0.2	168	0	22	.1	100	5.6	6,168	.3	357	67.1	73,879	17.8	19,671	0	0
1986	5.6	6,138	3.6	3,923	.1	72	0	19	.1	136	5.5	6,015	.5	521	67	73,703	71.7	19,512	0	0
1992	6.2	6,785	3.7	4,068	.2	71	0	13	.1	55	5.8	6,366	.4	403	66.4	73,034	17.5	19,297	0	0
2000	6.2	6,775	4.1	4,464	.1	102	0	13	.1	110	5.9	6,433	.4	446	65.6	72,171	17.7	19,526	0	0
Net Change	.6	637	.8	897	.1	91	0	-15	0	-32	-.1	-80	.1	108	-.8	-919	-.6	-688	0	0

Table 8. Land cover conversions in the Lower Mississippi Valley during each of four time periods and overall.

[%, percent; km², square kilometers]

Period	From Class	To Class	Area changed (km²)	Percent of all changes %)
1973–1980	Wetland	Agriculture	879	36.6
	Water	Wetland	328	13.7
	Forest	Agriculture	299	12.5
	Wetland	Water	160	6.7
	Forest	Mechanically disturbed	146	6.1
	Grass/Shrub	Forest	99	4.1
	Agriculture	Grass/Shrub	96	4
	Agriculture	Wetland	91	3.8
	Agriculture	Water	89	3.7
	Agriculture	Developed	73	3.1
	Barren	Water	50	2.1
	Barren	Wetland	46	1.9
	Water	Barren	44	1.8
	Total		2,399	100
1980–1986	Wetland	Agriculture	199	12
	Agriculture	Developed	181	10.9
	Forest	Agriculture	162	9.8
	Agriculture	Grass/Shrub	150	9.1
	Mechanically disturbed	Grass/Shrub	146	8.8
	Water	Wetland	141	8.5
	Agriculture	Water	140	8.5
	Agriculture	Wetland	131	7.9
	Grass/Shrub	Agriculture	107	6.4
	Wetland	Water	106	6.4
	Wetland	Developed	90	5.4
	Water	Barren	60	3.6
	Forest	Mechanically disturbed	44	2.7
	Total		1,657	100
1986–1992	Wetland	Water	406	20.8
	Agriculture	Water	257	13.2
	Grass/Shrub	Forest	210	10.8
	Agriculture	Forest	207	10.6
	Agriculture	Grass/Shrub	163	8.4
	Agriculture	Developed	144	7.4
	Grass/Shrub	Agriculture	131	6.7
	Agriculture	Wetland	122	6.3
	Water	Wetland	97	5
	Barren	Water	86	4.4
	Mechanically disturbed	Grass/Shrub	44	2.3
	Forest	Agriculture	44	2.2
	Wetland	Agriculture	39	2
	Total		1,950	100

Table 8. Land cover conversions in the Lower Mississippi Valley during each of four time periods and overall.—Continued

[%, percent; km^2, square kilometers]

Period	From Class	To Class	Area changed (km^2)	Percent of all changes %)
1992–2000	Agriculture	Developed	369	18.5
	Agriculture	Wetland	280	14.1
	Water	Wetland	216	10.8
	Agriculture	Grass/Shrub	194	9.7
	Wetland	Water	168	8.4
	Agriculture	Water	151	7.6
	Grass/Shrub	Forest	150	7.5
	Wetland	Agriculture	100	5
	Forest	Mechanically disturbed	100	5
	Agriculture	Forest	78	3.9
	Water	Barren	77	3.9
	Water	Agriculture	64	3.2
	Forest	Agriculture	45	2.2
	Total		1,993	100
1973–2000	Wetland	Agriculture	1,217	16
	Wetland	Water	839	11
	Water	Wetland	783	10.3
	Agriculture	Developed	766	10.1
	Agriculture	Water	638	8.4
	Agriculture	Wetland	624	8.2
	Agriculture	Grass/Shrub	603	7.9
	Forest	Agriculture	549	7.2
	Grass/Shrub	Forest	488	6.4
	Agriculture	Forest	354	4.6
	Forest	Mechanically disturbed	302	4
	Grass/Shrub	Agriculture	238	3.1
	Water	Barren	206	2.7

Summary

The dynamic nature of the Louisiana coast is mirrored by the land cover change in the Mississippi Alluvial Plain water to wetland and wetland to water statistics. Within the boundary of the Mississippi Alluvial Plain lies the Lower Mississippi Valley. The water to wetland and wetland to water conversions within this boundary are not as significant since it excludes the Louisiana Delta. Here, the more common land conversions were from wetlands to agriculture. In addition to the different physical characteristics between the entire ecoregion and its sub-region, the overall rates of land cover change indicate that the Lower Mississippi Valley underwent lower rates of change than those of the entire Mississippi Alluvial Plain.

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Appendix 1

The following definitions describe each land-cover class:

Water Areas persistently covered with water, such as streams, canals, lakes, reservoirs, bays, or oceans.

Developed Areas of intensive use with much of the land covered with structures or anthropogenic impervious surfaces (e.g., high-density residential, commercial, industrial, roads, etc.) or less intensive uses where the land cover matrix includes both vegetation and structures (e.g., low-density residential, recreational facilities, cemeteries, parking lots, utility corridors, etc.), including any land functionally related to urban or built-up environments (e.g., parks, golf courses, etc.).

Mechanically disturbed Land in an altered and often unvegetated state that, due to disturbances by mechanical means, is in transition from one cover type to another. Mechanical disturbances include forest clear-cutting, earthmoving, scraping, chaining, reservoir drawdown, and other similar human-induced changes.

Mining Areas with extractive mining activities that have a significant surface expression. This includes (to the extent that these features can be detected) mining buildings, quarry pits, overburden, leach, evaporative, tailings, or other related components.

Barren Land comprised of soils, sand, or rocks where less than 10 percent of the area is vegetated. Barren lands are usually naturally occurring.

Forest Tree-covered land where the tree cover density is greater than 10 percent. Note that cleared forest land (i.e., clear-cuts) is mapped according to current cover (e.g., mechanically disturbed or grassland/shrubland).

Grassland/Shrubland Land predominately covered with grasses, forbs, or shrubs. The vegetated cover must comprise at least 10 percent of the area.

Agriculture Land in either a vegetated or an unvegetated state used for the production of food and fiber. This includes cultivated and uncultivated croplands, hay lands, pasture, orchards, vineyards, and confined livestock operations. Note that forest plantations are considered forests regardless of the use of the wood products.

Wetland Land where water saturation is the determining factor in soil characteristics, vegetation types, and animal communities. Wetlands usually contain both water and vegetated cover.

Non-mechanically disturbed Land in an altered and often unvegetated state that, due to disturbances by non-mechanical means, is in transition from one cover type to another. Non-mechanical disturbances are caused by fire, wind, floods, animals, and other similar phenomena.

Ice and Snow Land where the accumulation of snow and ice does not completely melt during the summer period (e.g., alpine glaciers and snowfields).

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