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Land-Cover Change in the Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative, 1973 to 2000

By Mark A. Drummond, Michael P. Stier, and Alisa W. Coffin

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Cover photo: Upland forest cover in the South Central Plains ecoregion.
(Photo by U.S. Geological Survey)

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)

SI to Inch/Pound

Multiply	By	To obtain
	Length	
kilometer (km)	0.6214	mile (mi)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
	Area	
square kilometer (km^2)	247.1	Acre
square kilometer (km^2)	0.3861	square mile (mi^2)

Land-Cover Change in the Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative, 1973 to 2000

By Mark A. Drummond,[1] Michael P. Stier,[1] and Alisa W. Coffin[2]

Introduction

Land-use change and other human-caused effects on land cover and biophysical conditions have a pervasive yet variable influence across the national landscape. The contemporary human influence on conditions is occurring at a relatively rapid pace, even while conservation efforts strive to maintain ecological integrity and essential ecosystem services. The underlying causes of these changes are numerous, ranging from demographic and socioeconomic changes to technological advances and government policies. Because of the breadth of human influence on the national landscape, it is vital to improve the understanding of historical, current, and future land-use and land-cover change, its causes, and its ecological and climate interactions (U.S. Global Change Research Program, 2010).

Here, baseline land-cover change information for the Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative (LCC; fig. 1) from target years between 1973 and 2000 is summarized in brief. Landscape Conservation Cooperatives, facilitated by the U.S. Department of the Interior, are regionally focused networks consisting of “applied conservation science partnerships” whose function is to “provide scientific and technical expertise to produce landscape-scale conservation designs” (U.S. Fish and Wildlife Service, 2010, p. 1–2). The following report provides a broad overview of many of the land-use and land-cover trends relevant to landscape management and further research.

[1]U.S. Geological Survey
[2]U.S. Department of Agriculture, Agricultural Research Service

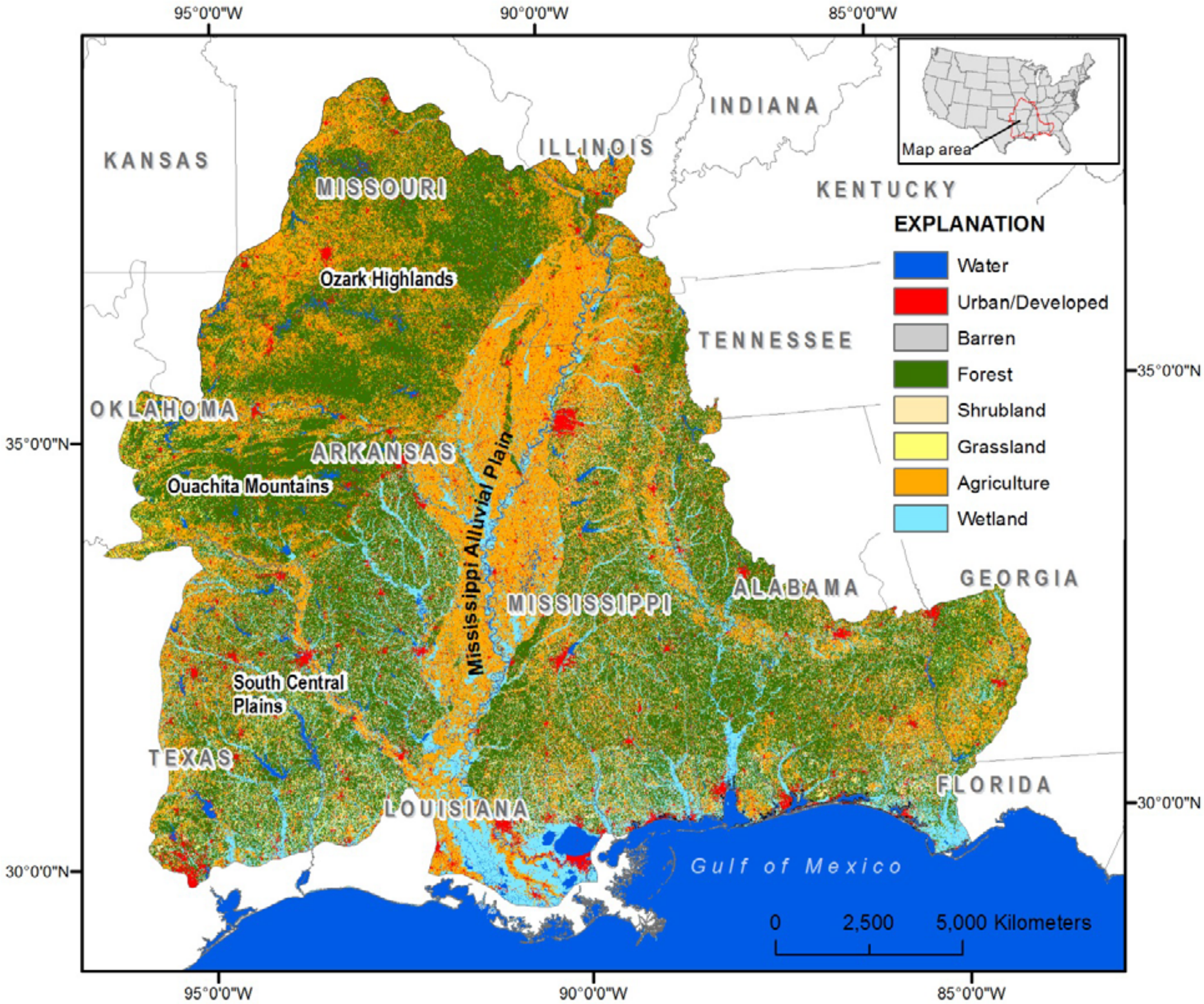

Figure 1. Land-cover patterns in the Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative (LCC).

Approach

The historical baseline of land-cover change between 1973 and 2000 was established using a random sample approach, stratified by U.S. Environmental Protection Agency (EPA) ecoregions (Loveland and others, 2002). The sampling approach was a cost-efficient method for characterizing historical land-cover change across the conterminous United States (Stehman and others, 2003, 2005; Sohl and others, 2004). Estimates of land-use and land-cover change were derived from nearly 2,700 area sample sites (10×10 kilometers [km] and 20×20 km). Statistical estimates of error are provided at the 85-percent confidence level. The changes were originally summarized using the EPA Level III ecoregions described by Omernik (1987; U.S. Environmental Protection Agency, 1999) and are reassessed here using the LCC area (Millard and others, 2012).

The research relied on three decades of Landsat satellite data, along with other information on land use and biophysical factors. Satellite data from the Landsat Multispectral Scanner System (MSS), Thematic Mapper (TM), and Enhanced Thematic Mapper Plus (ETM+) instruments were acquired from the Landsat data archive. Ancillary data, including aerial photography, aided interpreters in manually delineating land use and land cover from the Landsat data at a minimum mapping unit of 60×60 meters (m). Landscape changes were classified using 10 different land-use/land-cover categories for the target years 1973, 1980, 1986, 1992, and 2000. The classification system is a modified Anderson Level 1 (Anderson and others, 1976) and consists of the following general land-cover classes: water, urban/developed, mechanical disturbance, mining, barren, forest, grassland/shrubland, agriculture, wetland, and nonmechanical (primarily natural) disturbance.

Summary of Findings

The Gulf Coastal Plains and Ozarks region (fig. 2) has seen overall declines in forest cover and agriculture as areas of urbanization and mechanical disturbance (forest harvesting) have increased (fig. 3, table 1). Much of the high rate of change is related to intensive pine plantation forestry in the southern coniferous forest belt of the South Central Plains and Southeastern Plains ecoregions, where large expanses of mixed forest have been replaced with loblolly pine (*Pinus taeda*) and shortleaf pine (*P. echinata*). Whereas the total area of forest land use increased, the intensive cutting regime resulted in a transitional grassland state that contributes to an overall decrease in forest cover.

The trends among various types of land conversion that contribute to the overall net change, however, are complex. For example, while forests in the South Central Plains were still being cleared for agriculture (primarily pasture) between 1973 and 1980, the trend reversed (agriculture to forest) after 1986 as plantation forestry intensified. In the Ozarks, forest cover loss to agriculture was the prevailing trend, causing a subregional increase in agricultural land cover that differs from the overall LCC trend. The dynamics of change in the Mississippi Alluvial Plain indicate that conversions from forest to agriculture contributed to a net loss of forest, although larger extents of forest and agriculture were lost to development. Though coastal and other wetland dynamics are highly variable, results indicate an overall loss of wetlands to water (wetland inundation), agriculture, and development.

A

B

Figure 2. Photos of the Gulf Coastal Plains and Ozarks region. *A*, Managed pine forest in the South Central Plains. *B*, Rice fields on the Mississippi Alluvial Plain. *C*, Ozark Highlands. *D*, Mosaic of forest and agriculture (tobacco). (All photos by U.S. Geological Survey)—Continued on next page

C

D

Figure 2. Photos of the Gulf Coastal Plains and Ozarks region. *A*, Managed pine forest in the South Central Plains. *B*, Rice fields on the Mississippi Alluvial Plain. *C*, Ozark Highlands. *D*, Mosaic of forest and agriculture (tobacco). (All photos by U.S. Geological Survey)

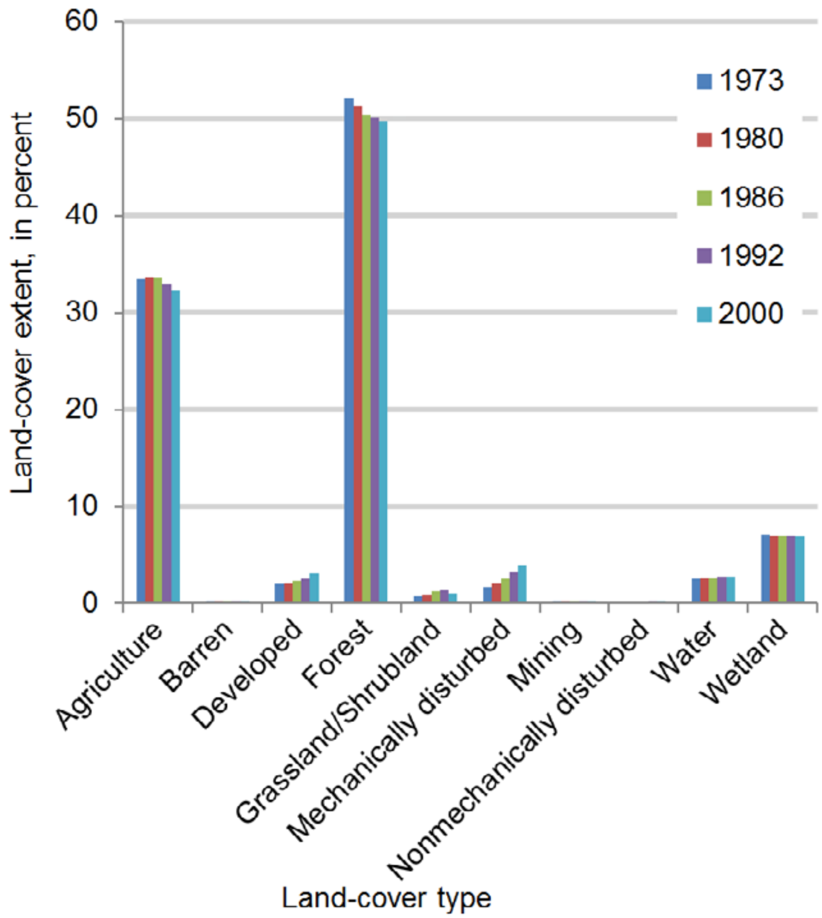

Figure 3. Trends in land use and land cover (in percent) for five target years between 1973 and 2000. Margin of error can be found in table 1.

Table 1. Estimated land-cover extent (in percent) and margin of error, calculated at an 85-percent confidence level, for five target years between 1973 and 2000.

Land-cover type	1973		1980		1986		1992		2000	
	Land-cover total	Margin of error, ±	Land-cover total	Margin of error, ±	Land-cover total	Margin of error, ±	Land-cover total	Margin of error, ±	Land-cover total	Margin of error, ±
Water	2.6	0.8	2.6	0.8	2.6	0.8	2.6	0.8	2.6	0.8
Developed	2.0	0.4	2.1	0.4	2.4	0.5	2.6	0.5	3.1	0.6
Mechanically disturbed	1.7	0.5	2.1	0.3	2.6	0.5	3.2	0.4	3.9	0.8
Mining	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.1
Barren	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Forest	52.2	3.9	51.3	4.0	50.4	3.7	50.1	3.9	49.7	3.3
Grassland/Shrubland	0.9	0.2	1.0	0.2	1.3	0.2	1.4	0.2	1.0	0.2
Agriculture	33.4	4.4	33.7	4.6	33.5	4.6	32.8	4.5	32.2	4.2
Wetland	7.1	1.4	7.1	1.5	7.0	1.5	7.0	1.4	6.9	1.4
Nonmechanically disturbed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Land-Use and Land-Cover Change, 1973 to 2000

Cycles of tree cutting and regrowth contribute to a fast, generally increasing rate of landscape change. The total annual extent of land-cover change (all gross gains and losses) increased from 0.72 percent (1973–1980) to 1.2 percent (1992–2000) of the LCC total area (table 2). The extent of change includes both the expansion and decline of all land cover types that determine the net changes shown in figure 3. Moreover, the region has a large total footprint of change, with 17.7 percent (±1.2) of the total area changing at least once between 1973 and 2000 (table 3).

- The cyclic harvest-regrowth dynamics that contribute to the large spatial footprint of land change are highest in the Ouachita Mountains and the South Central Plains. Approximately half (8.8 percent) of the total spatial extent of change underwent a land-cover change during two or more time intervals, which is indicative of the cyclic pattern of forest harvest and regrowth (table 3).
- Forest harvest (forest to mechanically disturbed) was the most extensive type of land conversion during all time intervals (fig. 4). Despite extensive tree planting, harvest cycles contributed to an overall net loss of forest cover. Forest cover declined by 4.7 percent from 1973 to 2000.
- Forest cover, similar to other land-cover types, had a greater extent of change that is somewhat obscured by the broad spatial scale of the study (fig. 5). Total change in forest cover (gross gains and losses) was greater than 65,000 square kilometers (km^2), while net change at the scale of the LCC was approximately 18,000 km^2.
- Between 1973 and 1980, conversions from forest to agriculture were a leading type of change, although the trend reversed after this interval. By the 1992–2000 interval, conversions from agriculture to forest were more than twice as extensive as forest clearance for agriculture, resulting in a gain in forest cover of nearly 2,500 km^2.
- Agricultural land had a net decline of 3.5 percent between 1973 and 2000 (fig. 6), primarily as cropland and pasture were reforested (approx. 1,950 km^2), converted to grassland cover (approx. 3,200 km^2), and lost to development (approx. 3,400 km^2).
- Urban growth and other development expanded by an estimated 56 percent (approx. 3,515 km^2), from 2.0 percent in 1973 to 3.1 percent in 2000. The expansion occurred on forest (53 percent of total development) and agriculture (38 percent of total development).

Table 2. Average annual extent of land-cover change for the four time intervals of the study and margin of error, calculated at an 85-percent confidence level.

[LCC, Landscape Conservation Cooperative; km^2, square kilometers]

Time interval	Average annual change in the LCC, in percent	Margin of error, ±	Annual extent of change, in km^2
1973–1980	0.72	0.07	5,240
1980–1986	1.00	0.10	7,270
1986–1992	1.28	0.16	9,340
1992–2000	1.19	0.09	8,620

Table 3. Spatial extent, or footprint, of land-cover change (in percent) sorted by the number of time intervals during which an area underwent change (margin of error is calculated at an 85-percent confidence level).

[LCC, Landscape Conservation Cooperative; km^2, square kilometers]

Number of time intervals with land-cover change	Percent of LCC	Margin of error, ±	Area of change, in km^2
1	8.9	0.5	64,710
2	7.3	0.8	52,770
3	1.4	0.3	10,230
4	0.1	0.0	1,080
Total footprint	17.7	1.2	128,800

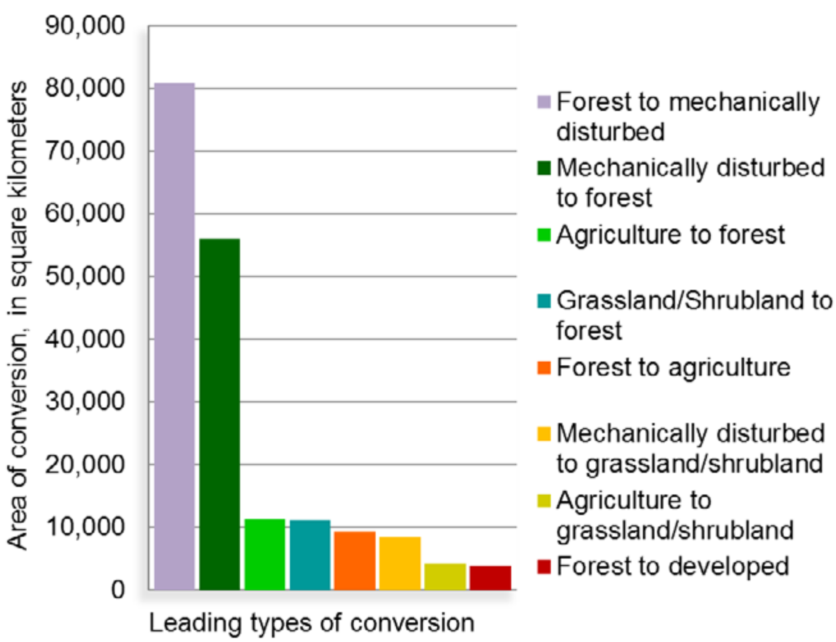

Figure 4. Summary of the most extensive types of land coversions between 1973 and 2000. This figure shows the cumulative land-cover conversions for all four time intervals combined.

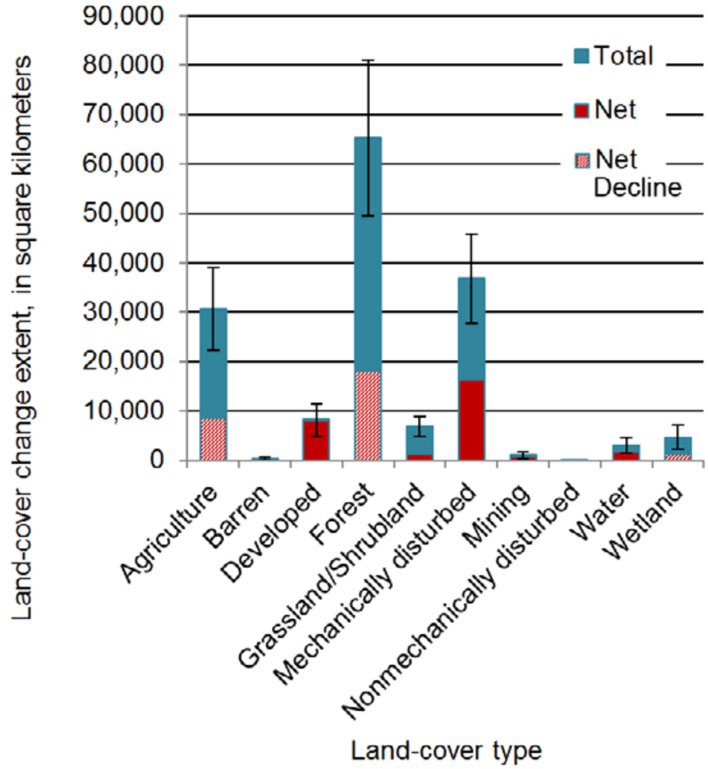

Figure 5. Total change and absolute net change between 1973 and 2000, in km^2. Diagonal shading indicates a net decline (margin of error is calculated at an 85-percent confidence level).

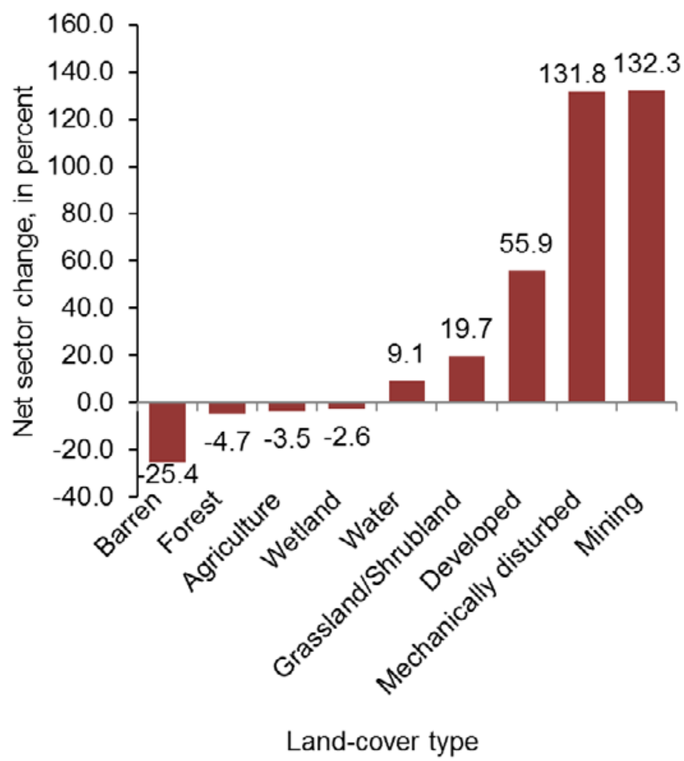

Figure 6. Comparison of the sector-based changes between 1973 and 2000, as a percent of the initial land-cover total in 1973.

Causes and Drivers

- Silviculture is economically important across the South, where pine plantations increased 2.5-fold between 1970 and 1997, from approximately 49,000 km^2 to 120,000 km^2. Another 35,000 km^2 were added by 2007 (Zhang and Polyakov, 2010). Demand for timber is expected to increase.
- The warm and wet climate (40–70 inches of annual precipitation) is favorable for productive, fast-growth pine forests and is augmented by the genetic modification of tree species, nutrient additions, thinning, and other vegetation management.
- Higher quality land is generally used for agriculture, while lower quality land is used for silviculture, but shifts between these uses can also depend on other factors, such as changes in prices of the respective commodities and external demand as well as encroaching urbanization.
- The Conservation Reserve Program (enacted 1985) and other conservation efforts have resulted in some conversion from lower quality cropland and pasture uses to forest use.
- Pine plantations might become increasingly important economically as a source of woody biomass.
- Population growth and urbanization vary across the LCC, with large areas of rural population as well as more densely populated urban areas. As pine plantations are converted to residential land-use in some areas, including ecoregions outside the LCC, there might be increasing pressure to expand pine plantations onto the agricultural and natural forest land of the Gulf Coastal Plains and Ozarks (Prestemon and Abt, 2002) (fig. 7).

Consequences and Challenges of Land-Cover Change

- The extensive but spatially variable changes in forest composition, structure, and pattern affect wildlife habitat, biodiversity, and ecosystem services (fig. 8).
- Despite a significant amount of activity affecting regional forest cover, there are local areas experiencing a net gain in forest cover, primarily along the loess plains and terraces east of the Mississippi River.
- Stream alterations and wetland drainage caused by historical ditching, agriculture, and ongoing urban development—when combined with the flat terrain, high rainfall, and high water table of the coastal plain—contribute to problems with water quality, flooding, and the degradation of aquatic habitats.
- Wetland losses from agriculture, urbanization, and inundation that leads to surface-water expansion in the Mississippi Alluvial Plain degrade wildlife habitat and ecosystem services.
- Drought, hurricanes, tornadoes, fires, and other natural disturbance might have a cumulative effect on forest cover and economically productive silvicultural activities.
- Insect outbreaks and diseases have ecological and economic effects on forests that might be exacerbated by climate change (Mistretta, 2002).
- As new lands for plantations are sought, conversion of hardwood forests to pine plantations could adversely affect ecosystem services such as wildlife habitat and carbon storage (Sohngen and Brown, 2006).

A

B

Figure 7. Cumulative development contributes to forest cover decrease. *A*, New housing development. *B*, Construction of a new dam and reservoir. (All photos by U.S. Geological Survey)

A

Figure 8. Forest management activities in the region. *A*, Recent forest clearance. *B*, Sustainable management of forests and woodlots are a concern. (All photos by U.S. Geological Survey)

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