Land-Use and Land-Cover Change around Mobile Bay, Alabama from 1974-2008

Executive Summary

This document summarizes the major findings of a Gulf of Mexico Application Pilot project led by NASA Stennis Space Center (SSC) in conjunction with a regional collaboration network of the Gulf of Mexico Alliance (GOMA). NASA researchers processed and analyzed multi-temporal Landsat data to assess land-use and land-cover (LULC) changes in the coastal counties of Mobile and Baldwin, AL between 1974 and 2008. Our goal was to create satellite-based LULC data products using methods that could be transferable to other coastal areas of concern within the Gulf of Mexico. The Mobile Bay National Estuary Program (MBNEP) is the primary end-user, however, several other state and local groups may benefit from the project's data products that will be available through NOAA-NCDDC's Regional Ecosystem Data Management program.

Mobile Bay is a critical ecologic and economic region in the Gulf of Mexico and to the entire country. Mobile Bay was designated as an estuary of "national significance" in 1996. This estuary receives the fourth largest freshwater inflow in the United States. It provides vital nursery habitat for commercially and recreationally important fish species. It has exceptional aquatic and terrestrial bio-diversity, however, its estuary health is influenced by changing LULC patterns, such as urbanization. Mobile and Baldwin counties have experienced a population growth of 1.1% and 20.5% from 2000-2006. Urban expansion and population growth are likely to accelerate with the construction and operation of the ThyssenKrupp steel mill in the northeast portion of Mobile County.

Land-use and land-cover change can negatively impact Gulf coast water quality and ecological resources. The conversion of forest to urban cover types impacts the carbon cycle and increases the freshwater and sediment in coastal waters. Increased freshwater runoff decreases salinity and increases the turbidity of coastal waters, thus impacting the growth potential of submerged aquatic vegetation (SAV), which is critical nursing ground for many Gulf fish species. A survey of Mobile Bay SAV showed widespread decreases since the 1940s. Prior to our project, coastal environmental managers in Baldwin and Mobile counties needed more understanding of the historical LULC for properly assessing the impacts of urbanization. In particular, more information on the location and extent of changing urbanization LULC patterns was needed to aid LULC planning and to assess predictions of future LULC patterns. Our products will assist the coastal environmental managers and land-use planners in making better community growth planning decisions. Our project also will help to establish a historical baseline of LULC distributions, which is a fundamental need in any stewardship plan.

The primary research objective of our project was to produce historic and current geospatial LULC change products across a 34-year time frame. A multi-decadal coastal LULC change product was the major project deliverable. The geographic extent and nature of change was quantified and assessed for the upland herbaceous, barren, open water, urban, upland forest, woody wetland, and non-woody wetland-dominated land cover types. We focused on regional analyses of decadal-scale urban expansion and watershed-scaled analyses of LULC change for multiple areas of concern to the Mobile Bay NEP (Figure A). We used the following dates to derive LULC classification products from Landsat data: 1974, 1979, 1984, 1988, 1991, 1996, 2001, 2005, and 2008. We assessed the accuracy of our products using randomly sampled locations and digital geospatial reference data including field survey data, high resolution ortho-rectified aerial photography, high resolution multispectral and panchromatic satellite data displays (from QuickBird and Corona sensors), digital elevation model data, and National Wetlands Inventory wetland cover type data. NOAA's Coastal Change Assessment Program's (C-CAP) and National Land Cover Database (NLCD) products were used for qualitative comparison in assessing map accuracy. We calculated an average overall classification accuracy of 87% with similar overall accuracies for the older (MSS) and newer (TM and ETM) Landsat LULC products.

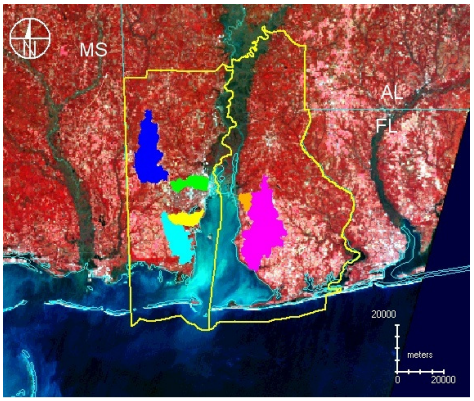


Figure A. Location map of study area. Yellow identifies the Mobile (left) and Baldwin (right) counties – the regional-scale area of study. The watershed-scale regions are shown in orange (D'Olive Bay), magenta (Fish River), green (Three Mile Creek), cyan (Fowl River), yellow (Dog River), and blue (Big Creek). State boundaries (cyan) are draped upon an AWiFS satellite image.

Figure B shows an example of the LULC products computed during the project. It shows LULC in 1974 (baseline, left) and in 2008 (right). We found a substantial LULC change over the 34-year study period. The most striking qualitative (visual) change is the urban expansion around the City of Mobile and along the Eastern Shore. In the northeast portion of the study area, some upland forest has changed to the upland herbaceous land cover type. The latter change is probably transitional, due to forest harvesting cycles.

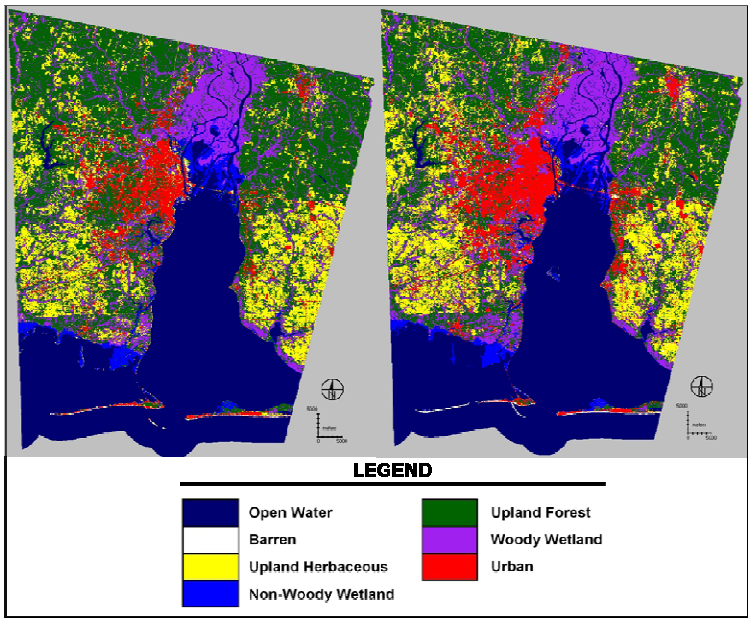
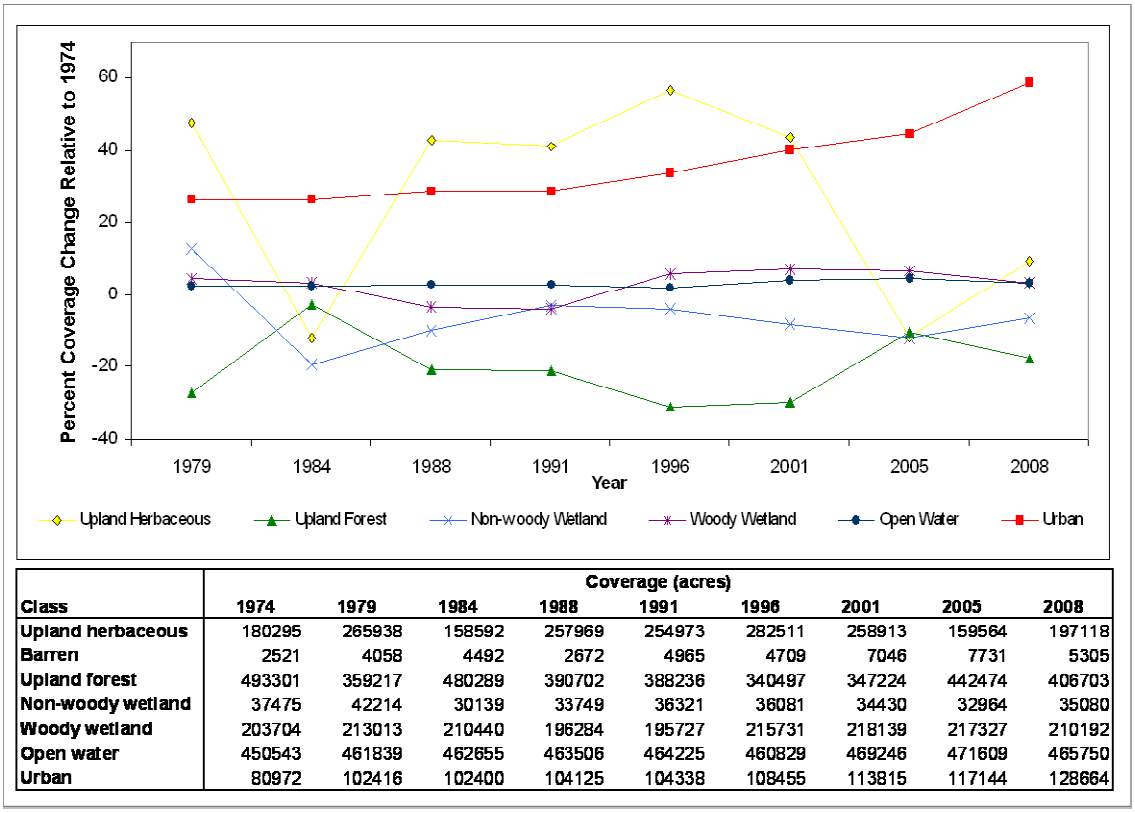


Figure B. Landsat-derived land-use and land-cover data product for 1974 (left) and 2008 (right) showing surveyed area within Mobile and Baldwin counties.

LULC change was normalized within each class to the baseline (1974; Figure C). Urban landscapes consistently increase through time and there is an approximate 30% increase in urban land-cover between 1974 and 1979, with that change increasing to almost 60% when considering the entire time series. There is noteworthy fluctuation amongst the upland herbaceous and upland forest landscapes. These data suggest a cyclical land swapping between upland herbaceous and upland forest landscape, however, our research is unable to make this conclusion definitively. The non-woody wetlands decreased over time (-6.4%, or ~2400 acres), while the woody wetlands slightly increased (+3.4%, or ~6500 acres).

Urban expansion in northern Mobile Bay is shown in Figure D. These satellite-based estimates indicate that during the 34-year study period urban areas increased from 80,972 to 128,662 acres, representing a 58.9% increase, or 1.73% per annum for both counties. The period between 1974 and 1984 shows the greatest expansion in the urban landscape (21428 acres, or 1.48%, Mobile and Baldwin counties), and the expansion was most dominant in the northern Mobile Bay region shown in Figure D.

Information from the project was immediately used for aiding Mobile Bay NEP LULC planning efforts. Results from the project were incorporated into the Mobile Bay NEP's State of the Bay report.



Class	Coverage (acres)								
	1974	1979	1984	1988	1991	1996	2001	2005	2008
Upland herbaceous	180295	265938	158592	257969	254973	282511	258913	159564	197118
Barren	2521	4058	4492	2672	4965	4709	7046	7731	5305
Upland forest	493301	359217	480289	390702	388236	340497	347224	442474	406703
Non-woody wetland	37475	42214	30139	33749	36321	36081	34430	32964	35080
Woody wetland	203704	213013	210440	196284	195727	215731	218139	217327	210192
Open water	450543	461839	462655	463506	464225	460829	469246	471609	465750
Urban	80972	102416	102400	104125	104338	108455	113815	117144	128664

Figure C. Percent coverage change relative to 1974 for each land-use and land-cover class (except barren) for Mobile and Baldwin counties. Tabular data show the Landsat-derived geospatial statistics for each land-use and land-cover class in acres. Barren was excluded from the figure because this land cover type comprises a small percent of the total coverage (<0.5%, is often transitional in nature, and its small acreage changes are not readily observed in relation to the other LULC categories.

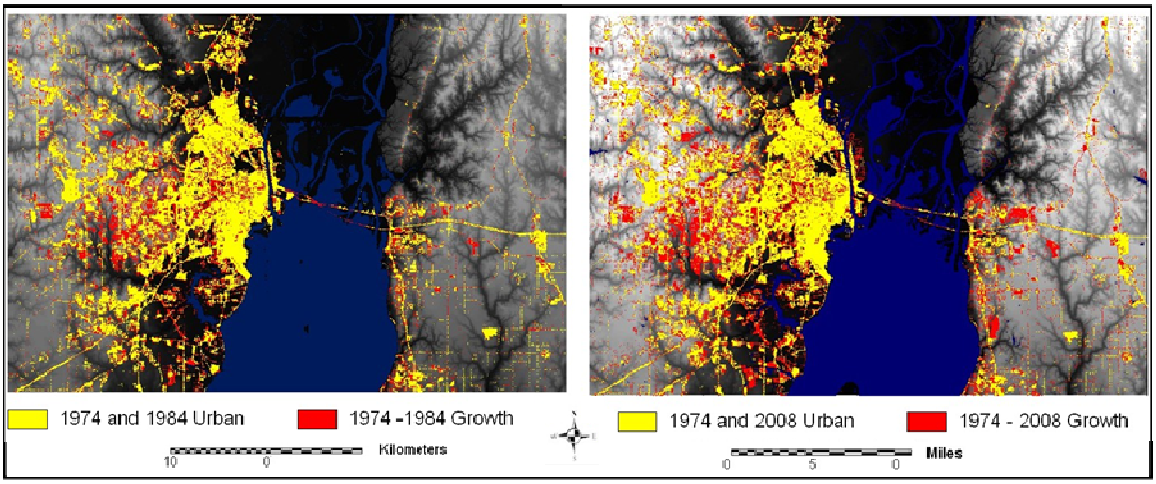


Figure D. Urbanization for the northern portion of Mobile Bay between 1974 and 1984 (left) and 1974 and 2008 (right). Yellow regions in both figures were urbanized in 1974. Red regions show the growth of urban regions from 1974 to 1984 (left) and 1974 to 2008 (right). The backdrop is a USGS DEM where dark grays designate lower elevations and lighter grays and white tones denote higher elevations.

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