

DETERMINING LAND USE CHANGE WITHIN THE DOG RIVER WATERSHED USING LANDSAT IMAGERY

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Land use within the Dog River Watershed has undergone major changes in the past two decades. The population has increased and with it, an increase in deforestation and impermeable surfaces. Changes in land use affect every aspect of a watershed within its boundaries. When the surface of an area is changed, the flow of water is disrupted. A faster surface run-off will often yield higher turbidity levels in the receiving body of water. By studying the land use of an area, one can fully understand what impacts humans have had on any given watershed using remote sensing. Even though laws are in place to protect wetland areas, laws are not in place to protect the forested areas that help slow down surface runoff. Landsat 4-5 Thematic Mapper can be utilized in ERDAS Imagine Software to derive numerical values for a given land use type. If this same trend continues there will be a significant difference between impermeable surfaces and forested areas. About 48% of the watershed as of 2008 is an impermeable surface. This project shows the changes in impermeable surfaces and land use since the early 1980's within the watershed. Deforestation is a serious problem within the Dog River Watershed.

Keyword: Land Use Change, Impermeable Surface Change.

Introduction

Dog River Watershed consists of many streams and channelized drainage ditches that drain a large portion of the greater Mobile area into Dog River. This area has gone through a very rapid period of growth since the early 1980's. Changing land use patterns, including increases in impermeable surfaces and construction near riparian zones, affect deposition of sediment and flow patterns (Oberlin et al., 1999). Even soils compacted by urban development are also likely to be impervious (Chesapeake Bay 2007). This urban runoff may cause decreased stream stability, increased turbidity, and sedimentation (Gage M., 2004). Dog River has lost clarity and has become more turbid over the past few decades. The people of Mobile need to know the impact they have on the river.

Other studies have been conducted in the manner. In his study, Seto, uses a method similar to this study only using slightly different software (Seto et al. 2002).

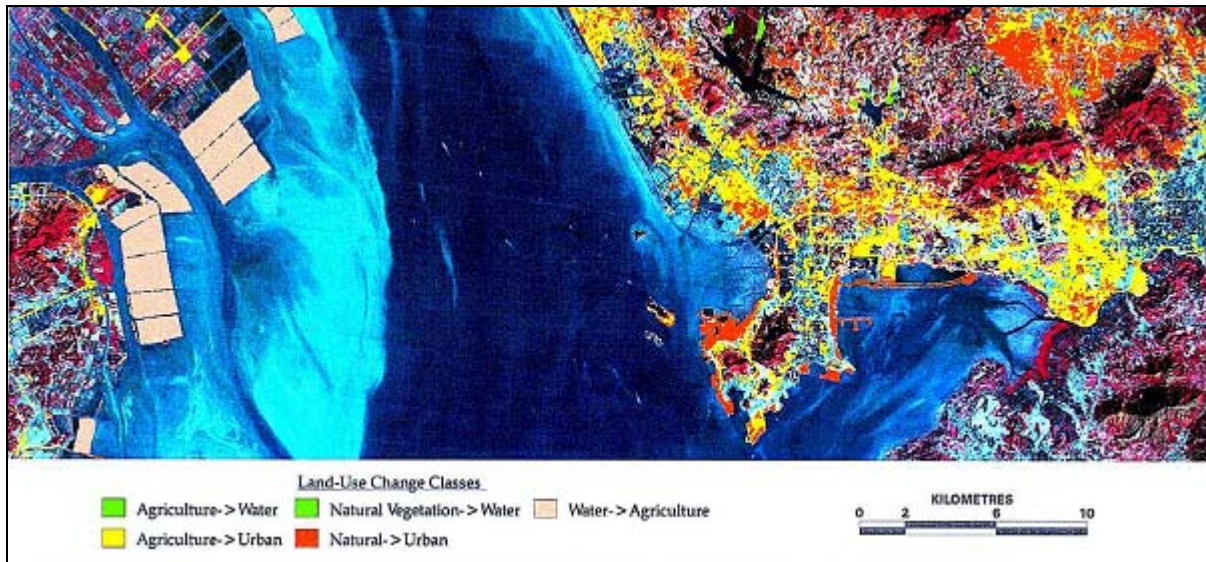


Figure 1. Land classification map produced by Seto et al.

The people and developers of Mobile are not the only ones to blame. Local government has lethargically enforced the laws of site preparation. This is one of the main contributing factors of why we are seeing a decrease in the clarity of our water in Dog River. If properly enforced and regulated, these laws are made to preserve and to protect.

Landsat 5 imagery can be obtained for the past thirty years. Once analyzed, this will give the public a good idea about what changes have occurred within the Dog River Watershed and where our problem areas are. This technique will easily show in acres what areas need the most attention. If more effort was put into public outreach, more people would be on the lookout for developers who disregard the laws. It will be beneficial to show the public these results so they can contribute to the efforts to discontinue the ongoing trend of degradation in the river. If managed responsibly, a city can remain environmentally responsible (Winter et al., 1998).

Research Question

Can Landsat satellite imagery be obtained and analyzed to derive numerical values of land use change within the Dog River Watershed?

Methods

Landsat 5 TM imagery was downloaded using the USGS Global Visualization Viewer (GloVis) at the Earth Resources Observation and Science Center (EROS) (<http://glovis.usgs.gov/>). The imagery will be obtained for the watershed every 5 years and classified into seven classes: Water, Wetlands, Forest, Cultivated, Residential and Urban. Graphs will be prepared as well as a poster in order to show changes visually. These graphs will be published to demonstrate to the public, and show in acres, exactly which of the seven classes have changed and how much.

Landsat TM is an optical mechanical whiskbroom sensor located on the Landsat 5 satellite, which was launched by NASA on March 1, 1984. Data from the Landsat satellites is now managed by the U.S. Geological Survey (USGS). Landsat TM has 7 spectral bands. The VNIR wavelengths, bands 1-5, and 7, range from .45 to 2.35 μ m and have a spatial resolution of 30 x 30 m. Band 6 is a thermal band that ranges from 10.4-12.5 μ m and has a spatial resolution of 120 x 120 m. Landsat TM's swath width is 185 km (Jenson 199, 203-205).

In ERDAS Imagine, an unsupervised ISODATA (Iterative Self-Organizing Data Analysis Technique Algorithm) classification was performed for each subset image using 150 classes, 150 iterations, and a convergence threshold of .995. Zeros were ignored in Stats. The pixels classes for each image were manually determined to be one of seven classes: water, wetlands, barren,

cultivated, forest, residential, and urban. The process of subsetting an image is demonstrated in Figure 2.

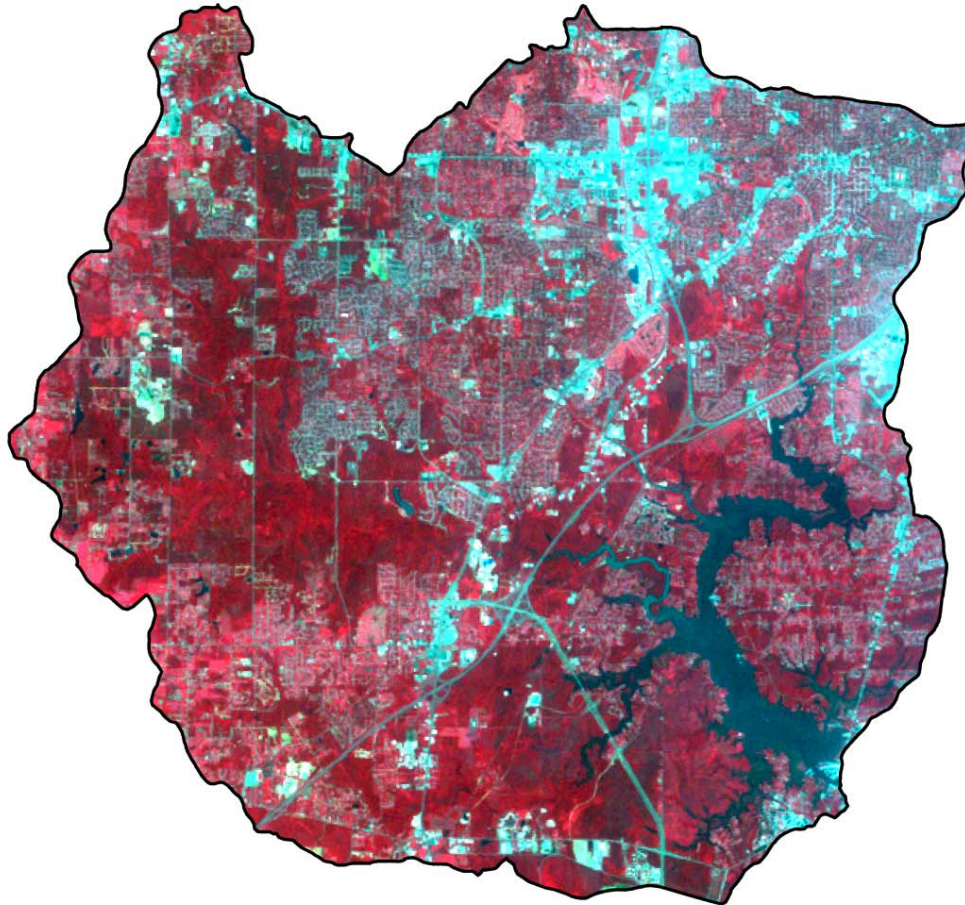


Figure 2. Subsetting Landsat image. This is displaying the NIR bands (4,3,2). The red represents healthy vegetation and light blue represents urbanized areas.

Results

With an increase in impermeable surfaces, we see a decrease in water quality due to the water not being able to be absorbed by the land, which yields faster run-off. Local governments tend to improvise with channelized streams to drain the water rapidly from this urbanizing watershed (Figure 3).

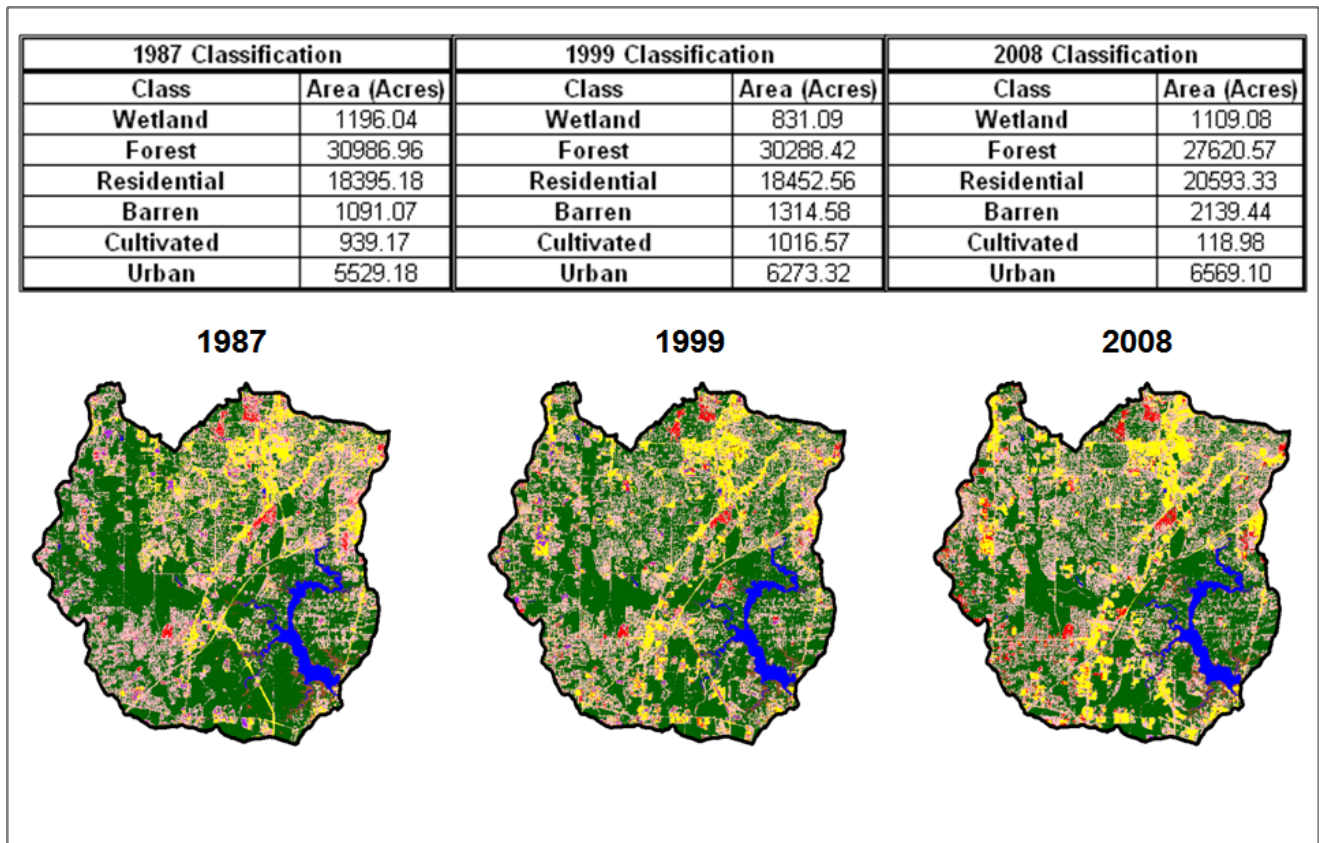


Figure 3. Maps showing changes in Land Use from 1987-2008

The results of this project show that the land use is changing drastically. The land use of the Dog River Watershed has gone from about 52% Forest down to about 48% (Figure 4). This tells us that deforestation is increasing and urbanization is occurring. As we analyze the seven classes, a pattern begins to emerge and we begin to see that deforestation is not our only problem. The channelization of streams will not allow the water to properly settle out the silt and clay as it does naturally. These impermeable surfaces are one of the main causes of water quality degradation.

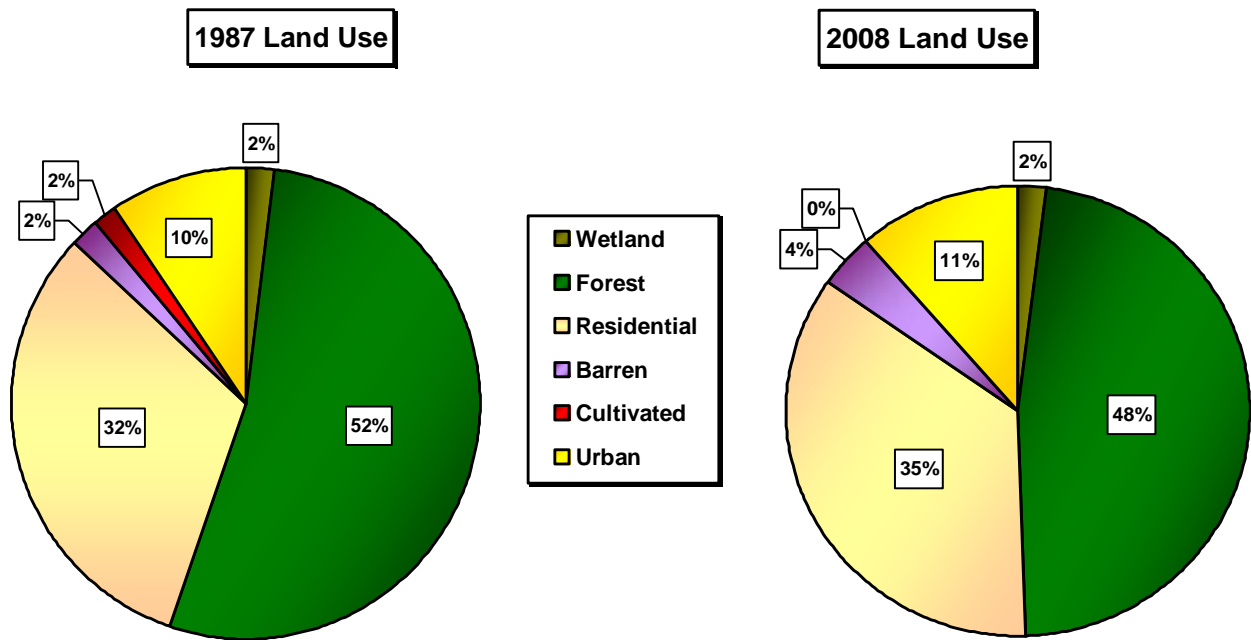


Figure 4. Pie Chart showing changes in Land Use by comparing 1987 with 2008.

The land use maps that were created in ERDAS show, visually and numerically in acres, that in fact forested areas are decreasing and impermeable surfaces are increasing (Figure 5). Figure 6 shows this trend in another way. More generalized classes were made such as impermeable surfaces and non-forested areas by combining classes that contain these characteristics. Somewhere between the years of 1999 and 2008 is when a substantial increase in deforestation led to a greater overall area of non-forested areas than forested areas.

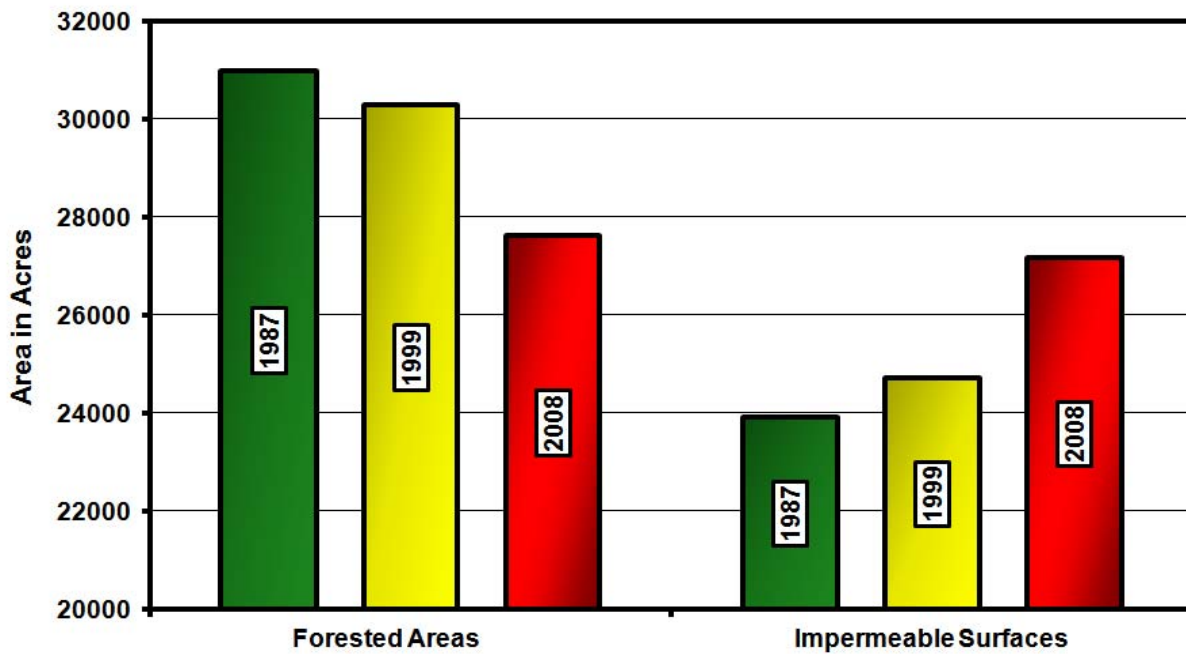


Figure 5. Graph of Land Use Change within the Dog River Watershed from 1987-2008

Table 1. Charts created to determine land use change. Negative percentages show loss of that class from the previous image. Red data indicates classes that were combined in order to create these classes.

Year	Percent Change $[(\text{New}-\text{Old})/\text{New} \times 100]$				
	1987 (Acres)	1999 (Acres)	1999 (% Change)	2008 (Acres)	2008 (% Change)
Wetland	1196.04	831.09	-43.91	1109.08	25.07
Forest	30986.96	30288.42	-2.31	27620.57	-9.66
Residential	18395.18	18452.56	0.31	20593.33	10.40
Barren	1091.07	1314.58	17.00	2139.44	38.56
Cultivated	939.17	1016.57	7.61	118.98	-754.39
Urban	5529.18	6273.32	11.86	6569.10	4.50
Fields	2030.24	2331.14	12.91	2258.42	-3.22
Impermeable Surfaces	23924.36	24725.88	3.24	27162.44	8.97
Non-Forested Surfaces	25954.61	27057.02	4.07	29420.86	8.03

Discussion

Landsat 4-5 Thematic Mapper can be utilized in ERDAS Imagine Software to derive numerical values for a given land use type (Al-Bakri et al., 2001). Seven classes can be formed including: water, wetlands, forest, residential, barren, cultivated and urban. When combining the urban and residential classes, an impermeable surface class is then created to be interpreted (Heiko et al., 2009). Also, to take into the account of crops not being planted certain years, cultivated and barren were combined to make a fields class. Finally, we must understand that non-forested areas do not slow down water as fast as forested one, therefore a non-forested class was created by combining: barren, cultivated, urban, and residential.

Conclusion

Changes in land use affect every aspect of a watershed within its boundaries (Wretenberg et al., 2010). When the surface of an area is changed, the flow of water is disrupted. A faster surface run-off will often yield higher turbidity levels in the area of deposition. By studying the land use of an area, one can fully understand what impacts humans have had on any given watershed using remote sensing (Seto et al., 2002). Even though laws are in place to protect wetland areas, laws are not in place to protect the forested areas that help slow down surface runoff.

The similar study by Seto et al. ended up with an overall accuracy of 93% using slightly older technology and methods (Seto et al., 2002). This project seems to line up with historical aerial photos from the southeast portion of the watershed quite nicely, however, an exact date was not able to be compared.

This project shows the changes in impermeable surfaces and land use since the early 1980's. Deforestation is a serious problem within the Dog River Watershed. With this said, impermeable surfaces are on the rise. If this same trend continues there will be a significant difference between impermeable surfaces and forested areas. About 48% of the watershed as of 2008 is an impermeable surface (Figure 4).

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