

Determining trends in impervious cover for the Mobile Bay, AL region for 1974-2008, based on a Landsat time series

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This presentation will discuss the development and use of Landsat-based impervious cover products in conjunction with land use land cover change products to assess multi-decadal urbanization across the Mobile Bay region at regional and watershed scales. This nationally important coastal region has undergone a variety of ephemeral and permanent land use land cover change since the mid-1970s, including gradual but consequential increases in urban surface cover. This urban sprawl corresponds with increased regional percent impervious cover. The region's coastal zone managers are concerned about the increasing percent impervious cover, since it can negatively influence water quality and is an important consideration for coastal conservation and restoration work. In response, we processed multi-temporal Landsat data to compute maps of percent impervious cover for multiple dates from 1974 through 2008, roughly at 5-year intervals. Each year of product was classified using one single date of leaf-on and leaf-off Landsat data in conjunction with Cubist software. We are assessing Landsat impervious cover product accuracy through comparisons to available reference data, including available NLCD impervious cover products from the USGS, raw Landsat data, plus higher spatial resolution aerial and satellite data. In particular, we are quantitatively comparing the 2008 Landsat impervious cover products to those from QuickBird 2.4-meter multispectral data. Initial visual comparisons with the QuickBird impervious cover product suggest that the 2008 Landsat product tends to underestimate impervious cover for high density urban areas and to overestimate impervious cover in established residential subdivisions mixed with forested cover. Landsat TM and ETM data appears to produce more accurate impervious cover products compared to those using lower resolution Landsat MSS data. Although imperfect, these Landsat impervious cover products have helped the Mobile Bay National Estuary Program visualize basic urbanization trends for multiple HUC-12 watersheds of concern to them and their constituents.

Keywords: impervious cover trend analysis Landsat



# Efforts to map impervious cover for the Mobile Bay, Alabama region for 1974-2008, based on Landsat data

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# Introduction



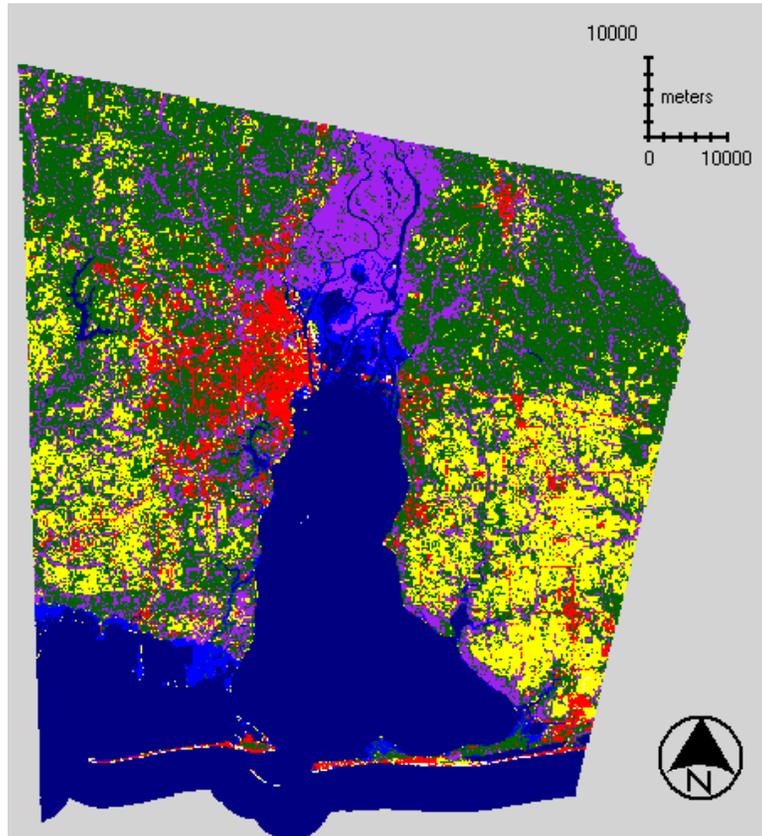
- The Mobile Bay region is invaluable to the nation in terms of economic benefits and ecological services
- Coastal communities surrounding this estuary have grown during the past 50 years. This urbanization has led to impaired water quality for many waterways draining into the bay.
- The amount of impervious cover in a given watershed can negatively influence water quality and aquatic biota
- Impervious cover is an important factor in managing and/or promoting coastal regional water quality and fisheries
- In response, our project team began in 2010 to develop and assess a time series of impervious cover maps from 1974-2008
- This presentation discusses the results of this study as part of a bigger project to assess land-use land-cover (LULC) change in the region

# Previous Work: LULC Maps Derived from Landsat Data

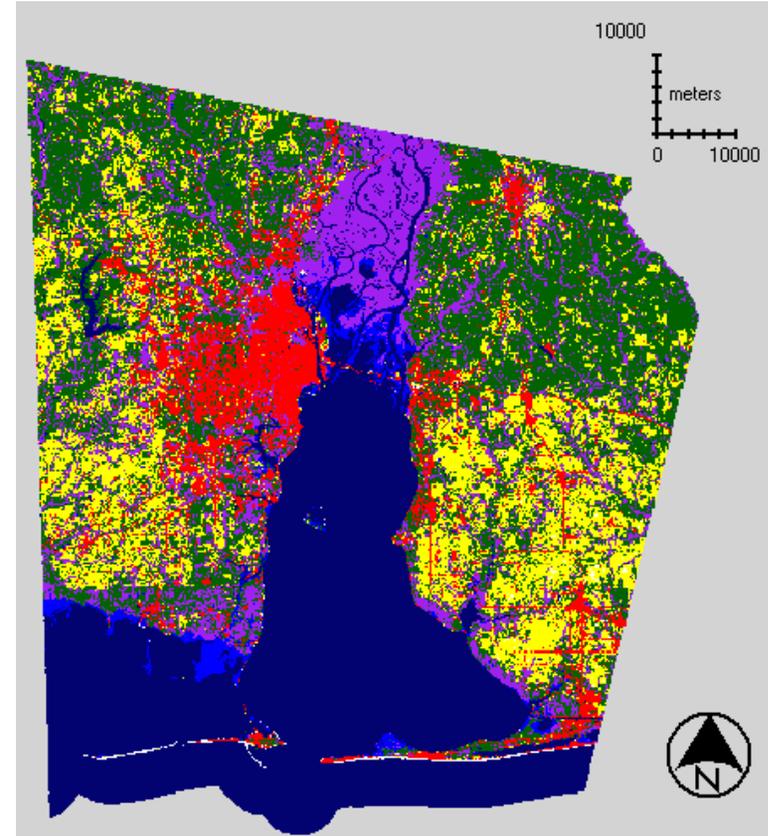
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1974 LULC from Landsat MSS Data



2008 LULC from Landsat TM Data



Color	LULC Class Description
Dark Blue	Open Water
White	Barren
Yellow	Upland Herbaceous
Blue	Non-Woody Wetland
Green	Upland Forest
Purple	Woody Wetland
Red	Urban

*For more information, see Ellis et al. (2011) in Journal of Coastal Conservation*

# Research Goal and Objectives

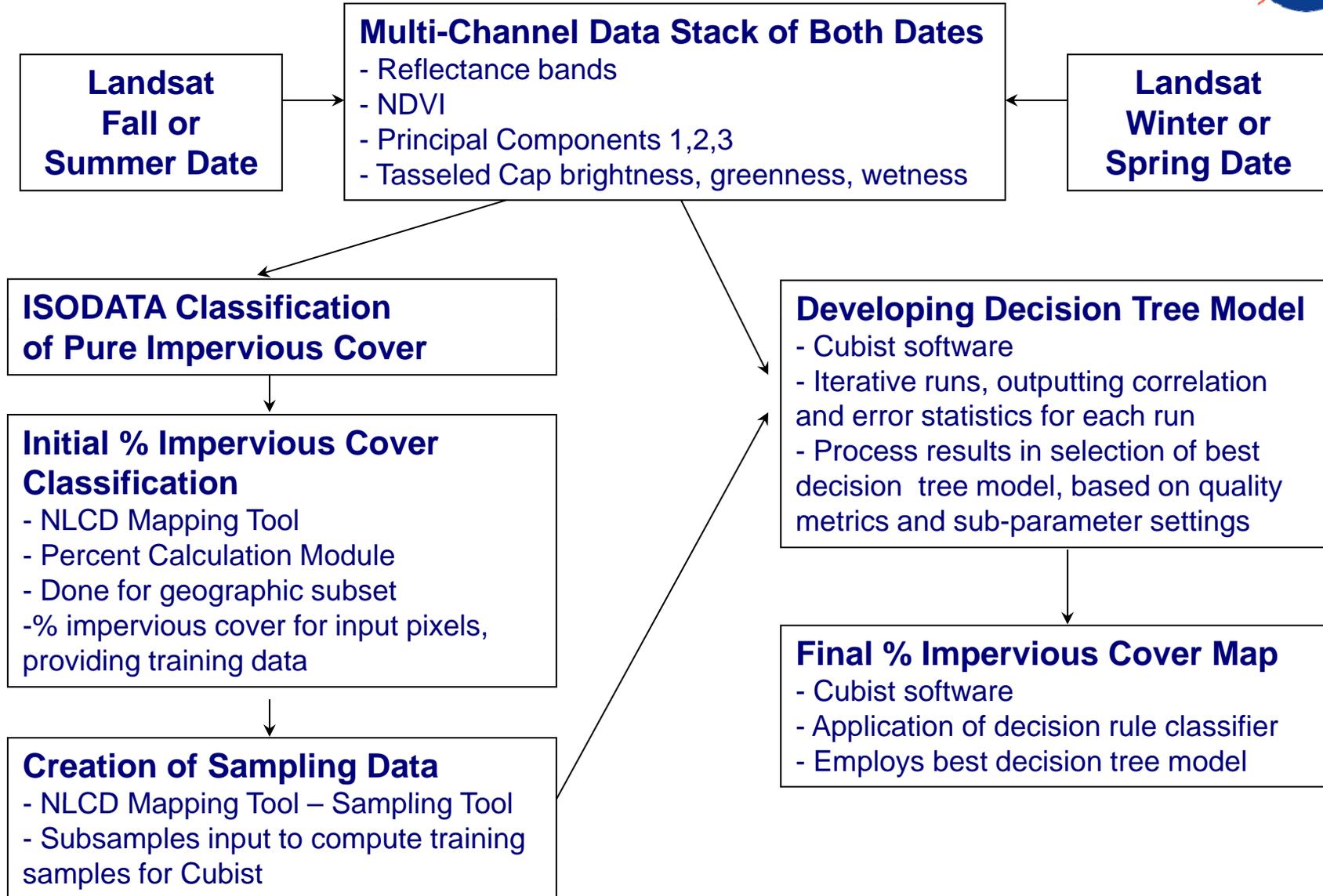


- Goal - Assess trends in impervious cover between the years of 1974-2008, based on impervious cover products derived from Landsat Multispectral Scanner System (MSS), Thematic Mapper (TM), and Enhanced Thematic Mapper (ETM+) data
  - Objective 1 - Assess potential of computing impervious cover products from Landsat TM/ETM+ data to supplement existing National Land Cover Database (NLCD) products
  - Objective 2 - Assess potential of computing impervious cover products using Landsat MSS data

# Impervious Cover Mapping Method

## --- For Each Targeted Year ---

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# Landsat Data Used to Compute % Impervious Cover (IC) Time Series

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Year	Landsat Data Type	Path	Row	Acquisition Dates
<b>1974</b>	Landsat MSS	22	39	11/12/74 and 04/10/74
<b>1979</b>	Landsat MSS	22	39	10/26/79 and 05/26/79
<b>1984</b>	Landsat MSS	22	39	09/06/84 and 06/02/85
<b>1987</b>	Landsat TM	21	39	01/02/87 and 07/29/87
<b>1991</b>	Landsat TM	21	39	02/14/91 and 09/26/91
<b>1996</b>	Landsat TM	21	39	01/27/96 and 05/02/96
<b>2001</b>	Landsat ETM+/TM	21	39	03/05/01 and 06/17/01
<b>2005</b>	Landsat TM	21	39	04/09/05 and 09/16/05
<b>2008</b>	Landsat TM	21	39	03/01/08 and 08/07/08

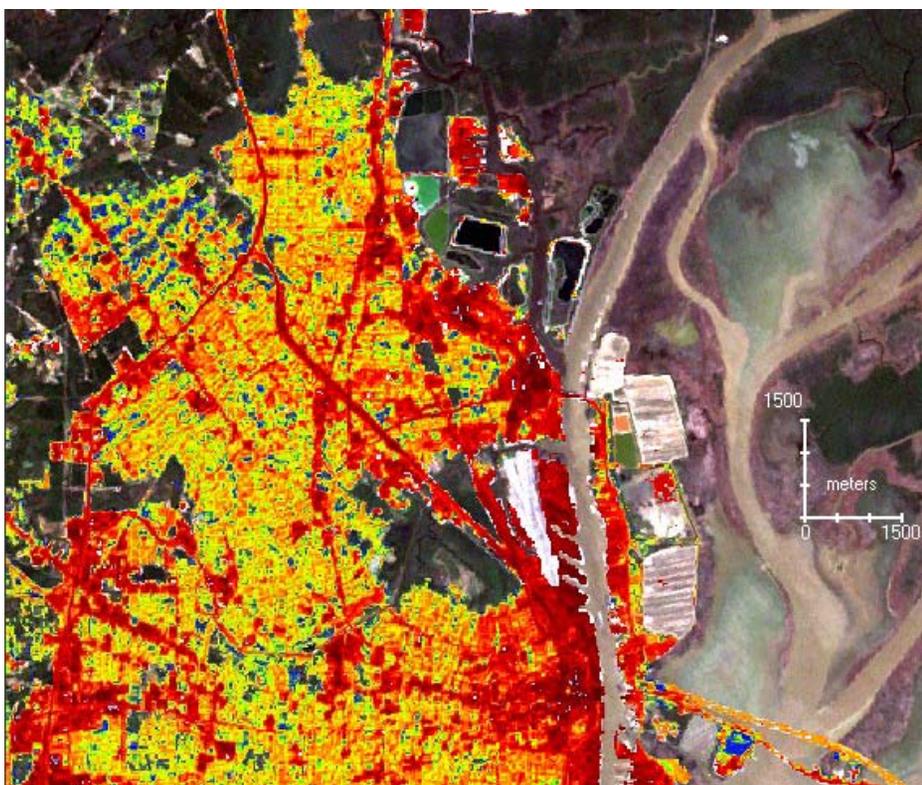
# 2001 Project IC Map versus Landsat True Color RGB

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Project % IC for 2001

Landsat ETM+ Acquired 3-5-2001



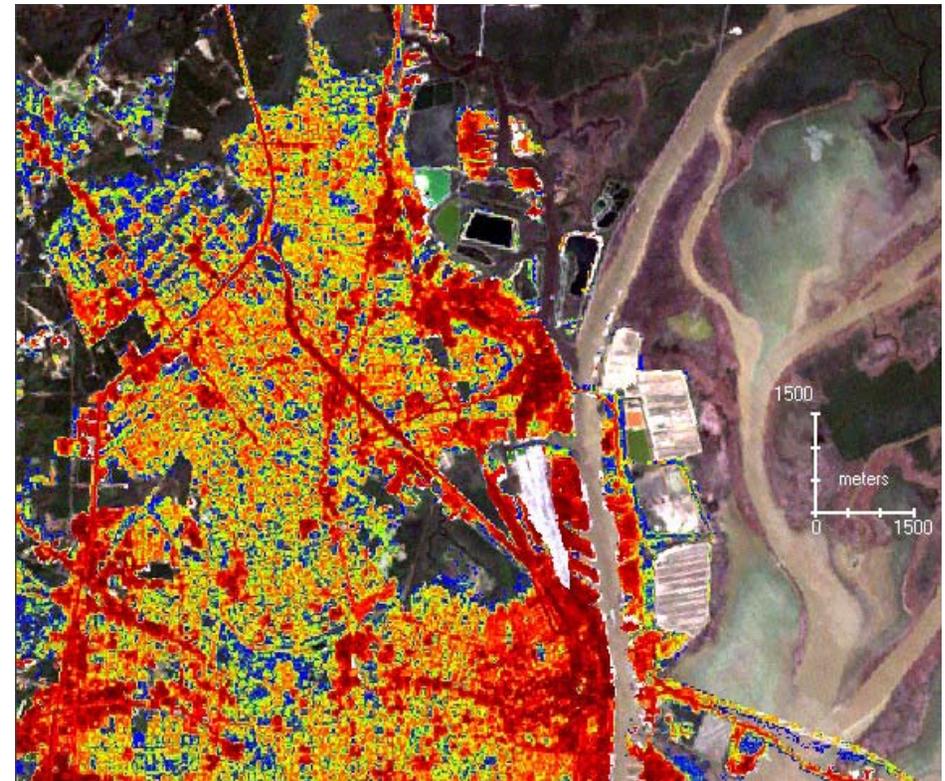
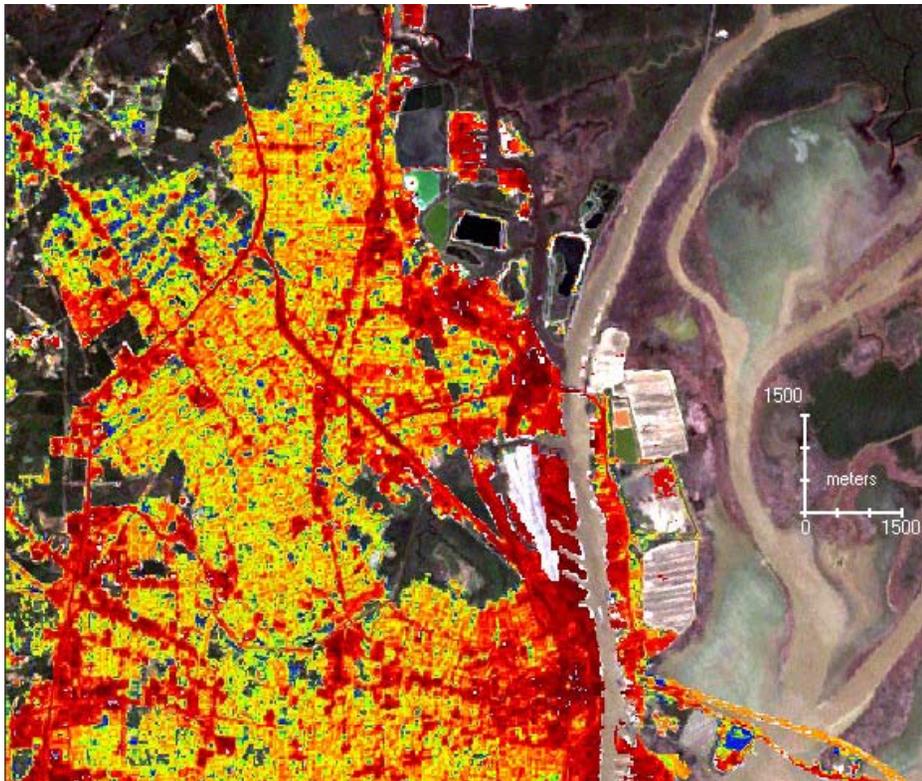
# Project IC Map for 2001 versus NLCD IC Map for 2001

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Project % IC for 2001

NLCD % IC for 2001



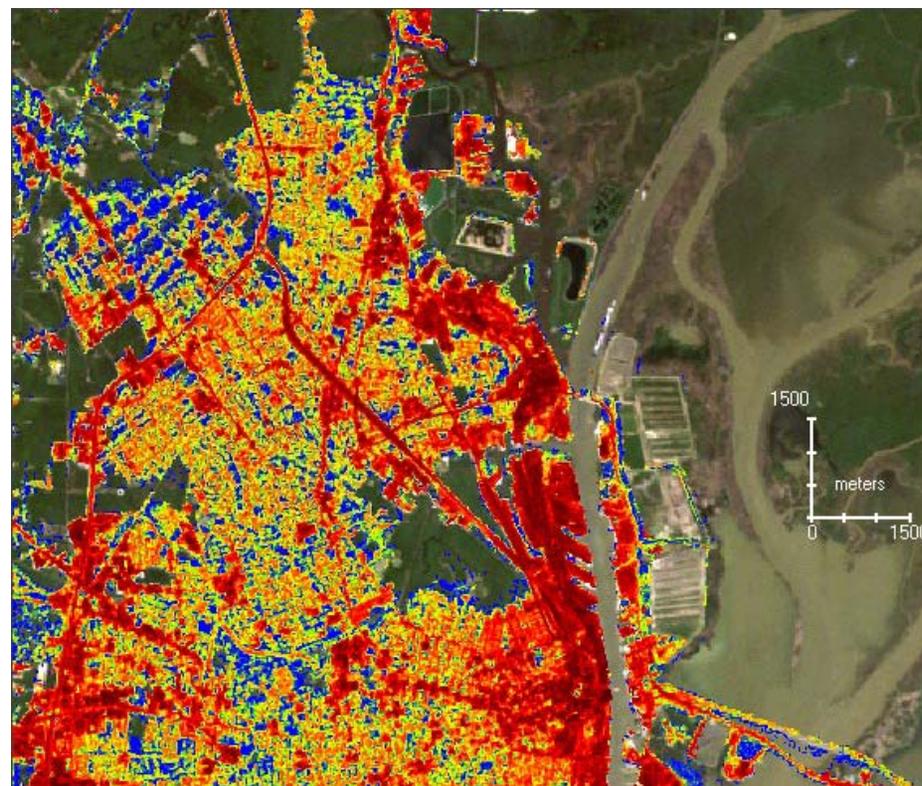
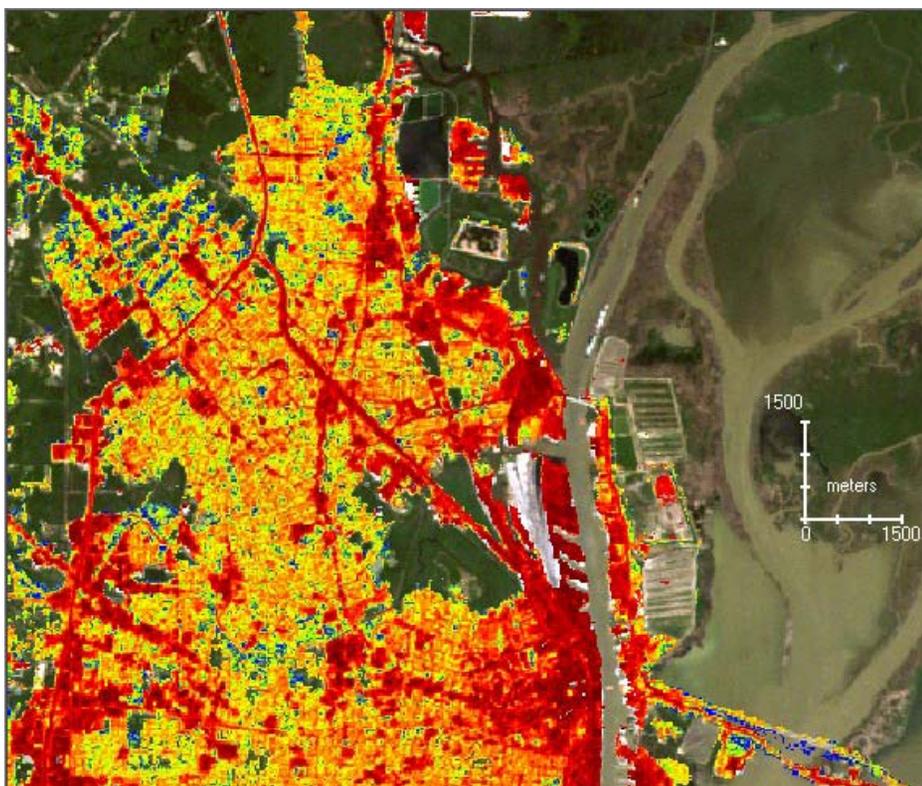
# Project IC Map for 2005 versus NLCD IC Map for 2006

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Project % IC for 2005

NLCD % IC for 2006



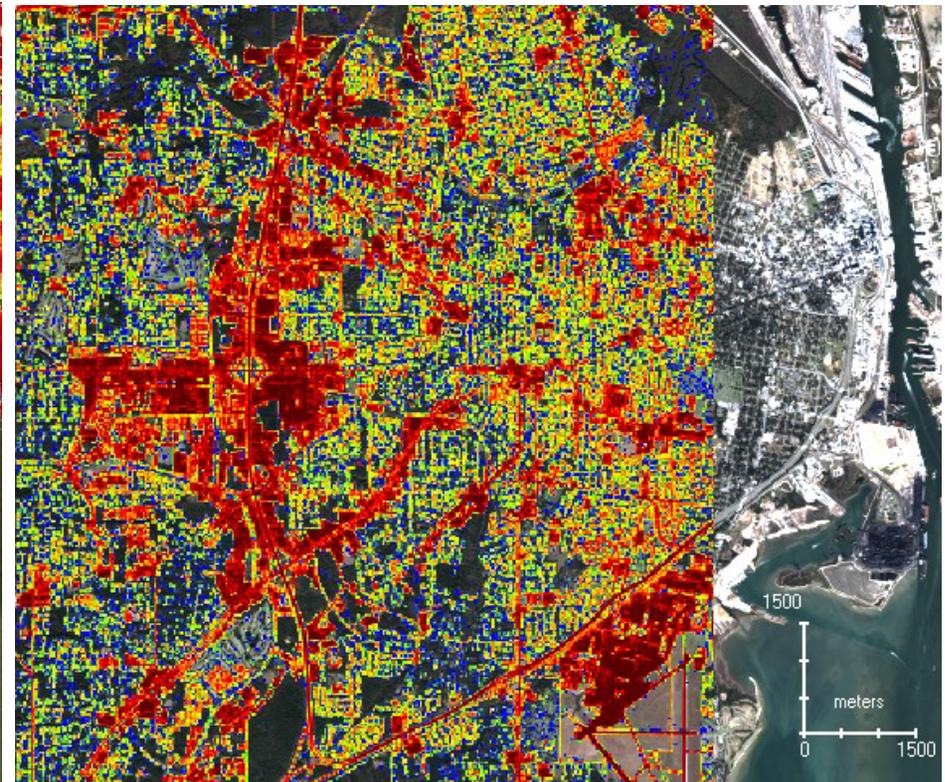
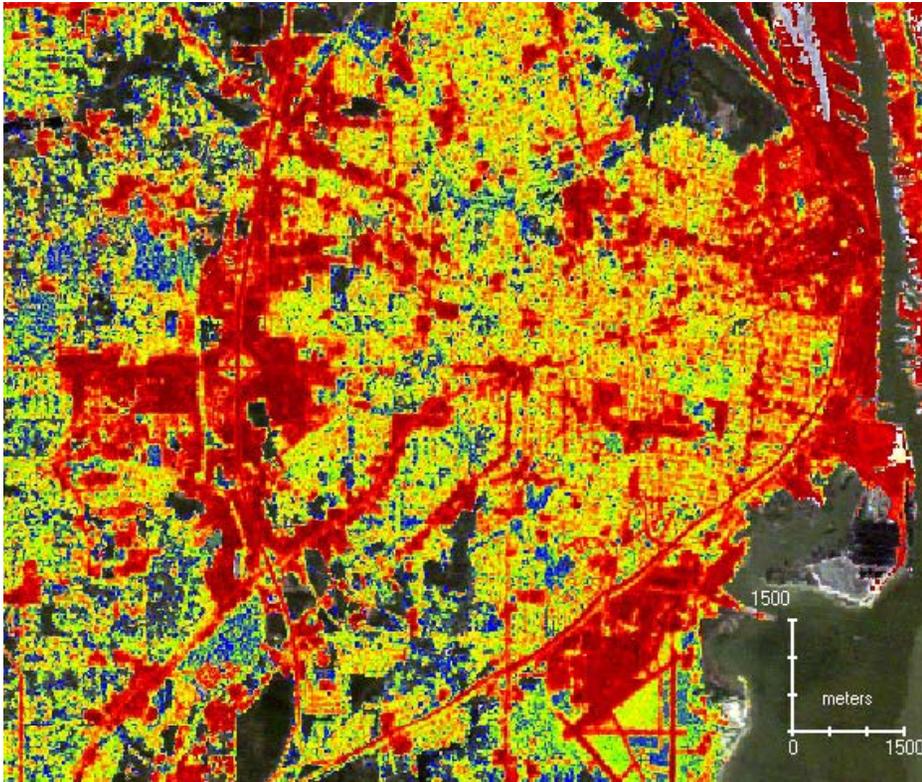
# Project IC Map for 2008 versus QuickBird IC Map for 2008

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Project % IC for 2008

QuickBird 30m % IC for 2008  
(Excludes Urban Open Space)



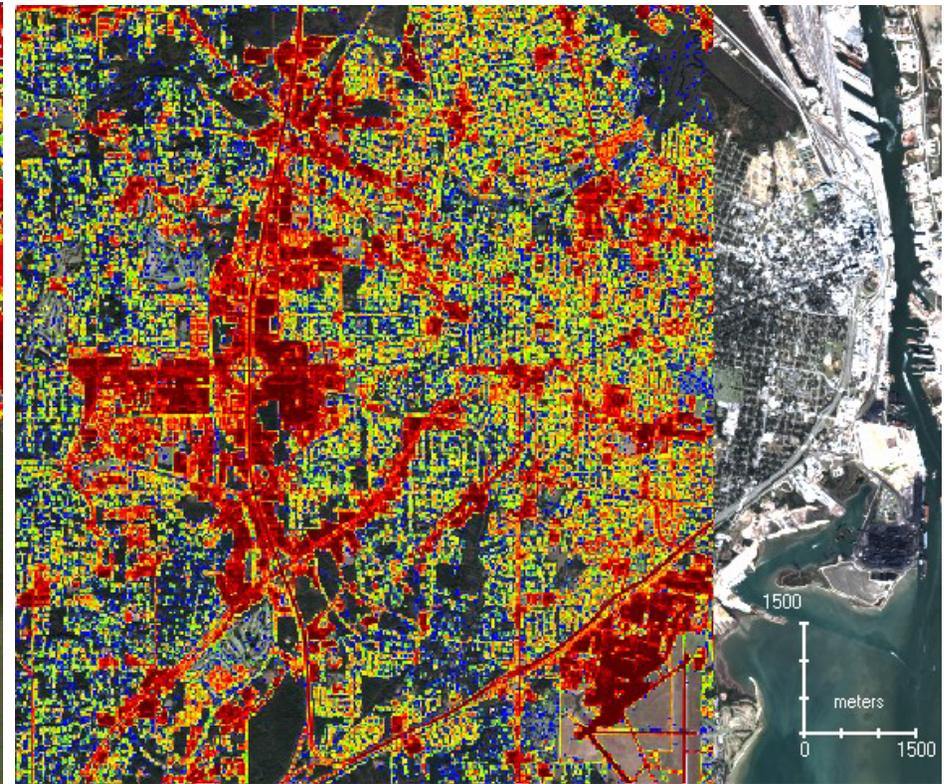
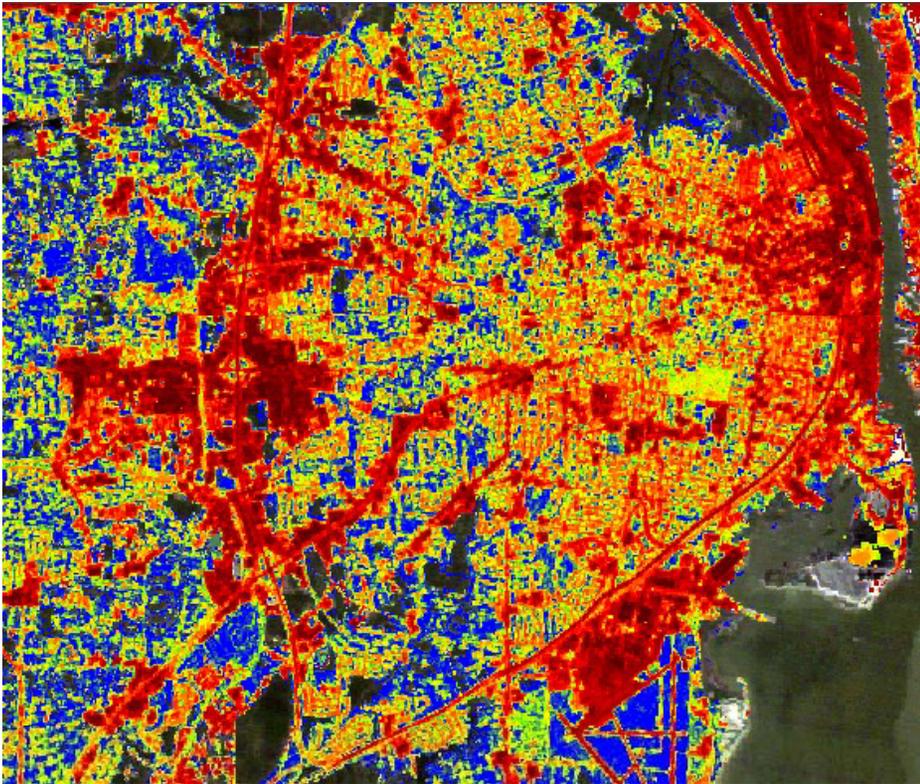
# NLCD IC Map for 2006 versus QuickBird IC Map for 2008

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NLCD % IC for 2006

QuickBird 30m % IC for 2008  
(Excludes Urban Open Space)



# Example 2001 Mean % IC Map According to HUC-12 Sub-Watersheds

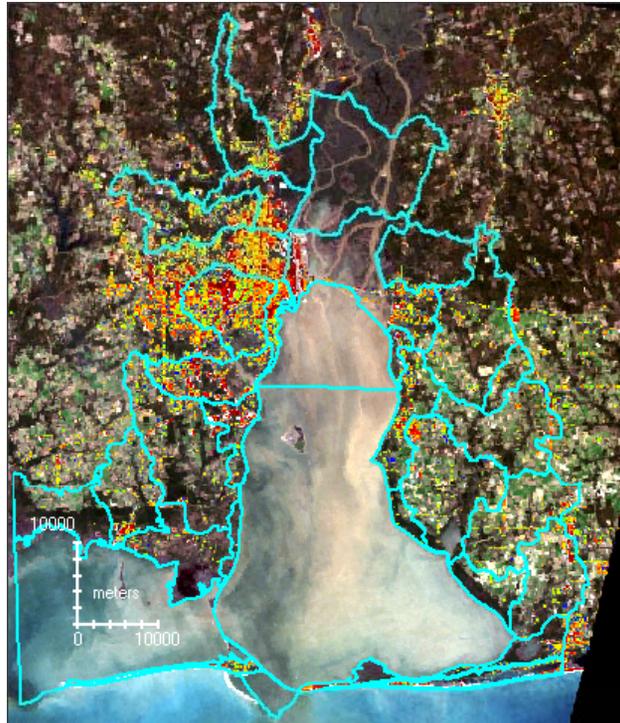
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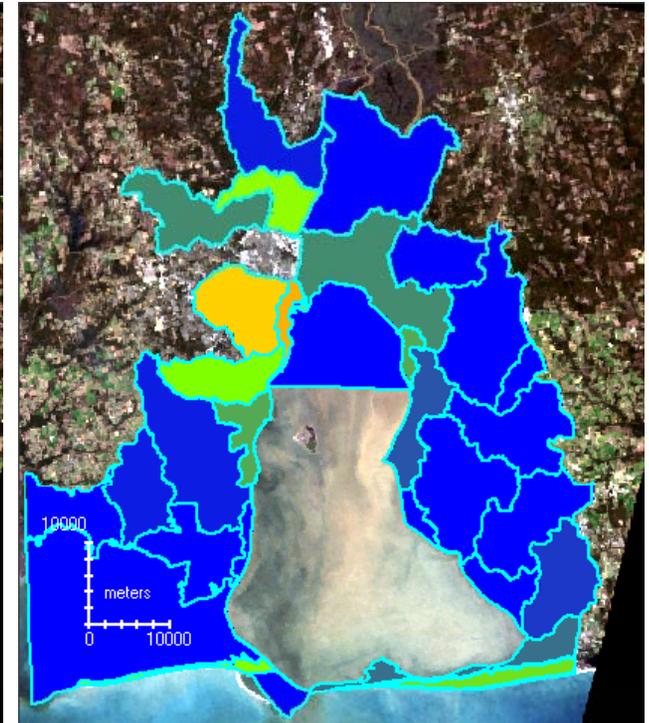
Landsat ETM+ Data with HUC-12s  
Acquired March 5, 2001



Project % IC for 2001  
Overlay onto 2001 Landsat RGB



Project 2001 Mean % IC for  
HUC-12 Sub-Watersheds



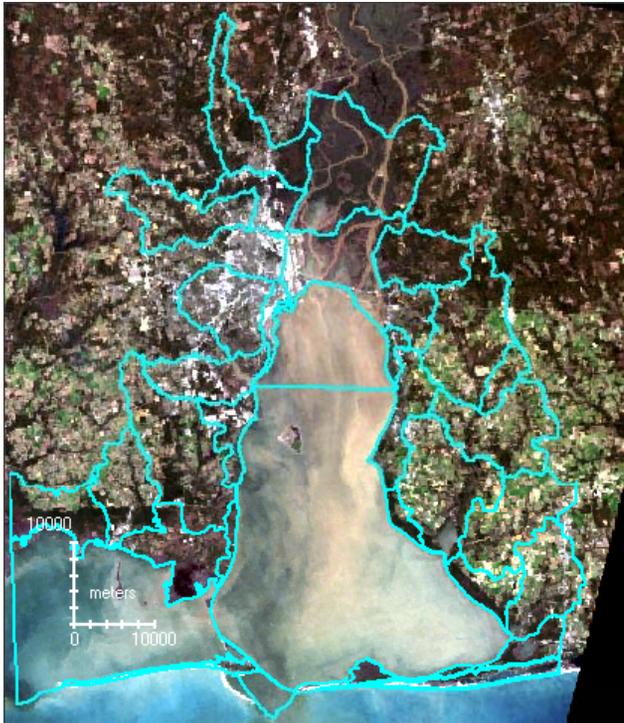
Range in % IC		Range in Color on % IC Maps			Watershed Health Class Description, Based on Schuler (1994)
Low	High	Low	Mid	High	
>= 1%	10%				Class 1 - stressed aquatic biota
> 10%	25%				Class 2 - impacted aquatic bio-diversity
> 25%	100%				Class 3 - most degraded, lowest bio-diversity

# NLCD versus Project 2001 Mean % IC Map for HUC-12 Sub-Watersheds

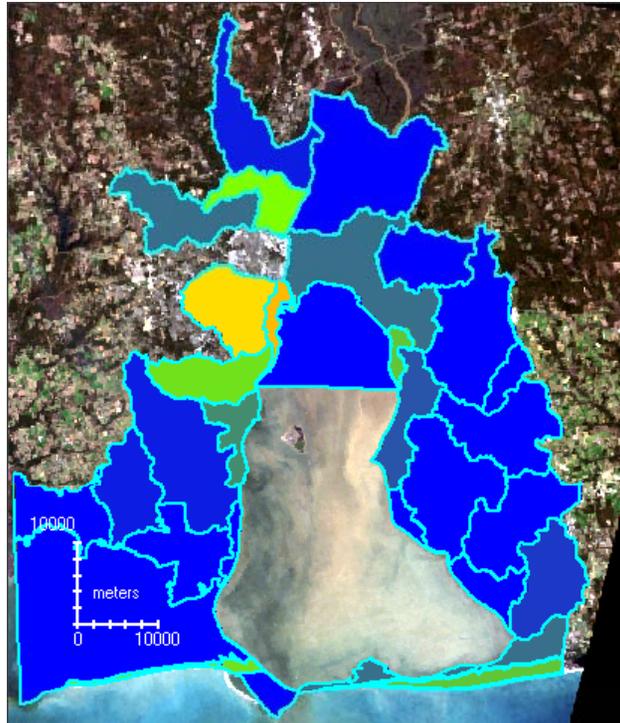
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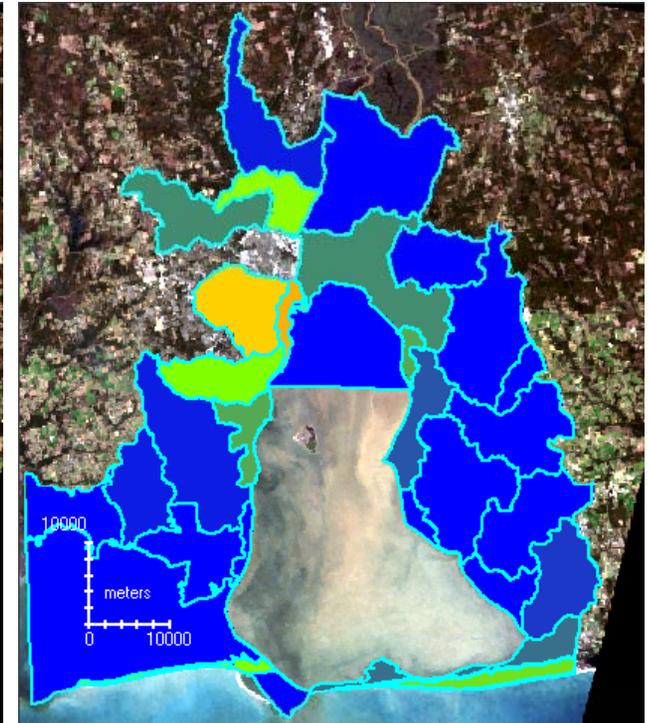
Landsat ETM+ Data with HUC-12s  
Acquired March 5, 2001



NLCD 2001 Mean % IC for  
HUC-12 Sub-Watersheds



Project 2001 Mean % IC for  
HUC-12 Sub-Watersheds



Range in % IC		Range in Color on % IC Maps			Watershed Health Class Description, Based on Schuler (1994)
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> 25%	100%				Class 3 - most degraded, lowest bio-diversity

# MSS-Based % IC Map for 1974 Compared to MSS and Corona Data

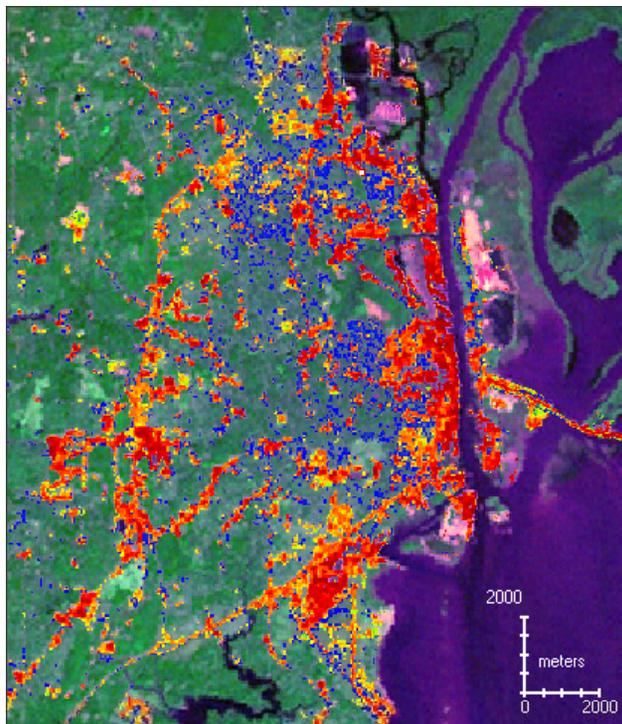
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**Landsat MSS Data**  
Acquired November 12, 1974



**1974 % IC Map**  
from Landsat MSS



**Corona Data**  
Acquired December 12, 1968



# Comments on Results



- Landsat TM IC products produced in this project demonstrated good overall visual agreement when compared with NLCD impervious cover maps
  - Especially for the 2001 HUC-12 mean % IC products
- The 2008 QuickBird IC product from this project showed less IC in residential areas, compared to the 2008 TM IC map or the 2006 NLCD IC
- IC products from MSS data appeared to under classify low % IC areas, compared to available reference data
- IC mapping results may be improved by the use of better training data if/when available
- MSS-based IC products for low IC residential areas may be improved with other image processing methods

# Final Remarks



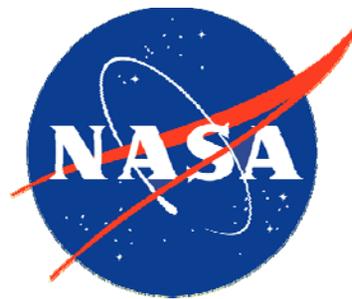
- Impervious cover maps were produced from Landsat data for 9 dates between 1974-2008
- The products provide a means to view change in impervious cover at regional and sub-watershed scales
- The products are now being used for aiding coastal zone conservation work being conducted by the Mobile Bay National Estuary Program (NEP)
- In particular, the products are being used to aid HUC-12 watershed health studies - see on-line video example at: [http://www.mobilebaynep.com/land\\_use/](http://www.mobilebaynep.com/land_use/)
- For more information on this presentation, email [joseph.p.spruce@nasa.gov](mailto:joseph.p.spruce@nasa.gov)

# References



Ellis, J.T., Spruce, J.P., Swann, R.A., Smoot, J.C., and Hilbert, K.W., 2011. An assessment of coastal land use and land cover change from 1974-2008 in the vicinity of Mobile Bay, Alabama. *Journal of Coastal Conservation*, 15, 139-149.

Schueler, T., 1994. The importance of imperviousness. *Watershed Protection Techniques*, 1 (3), 100-111.



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