Progress Towards Using Global Land Survey Data to Measure and Monitor Worldwide Urbanization

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LCLUC Spring Science Team Meeting, Rockville MD, April 3, 2012

Background

- Since about 2008, the U.N. estimates more people live in cities than rural areas. Higher growth rates expected in developing world in next 30 years.

- Cities still represent relatively small ‘footprint’ globally (~3% of land area).

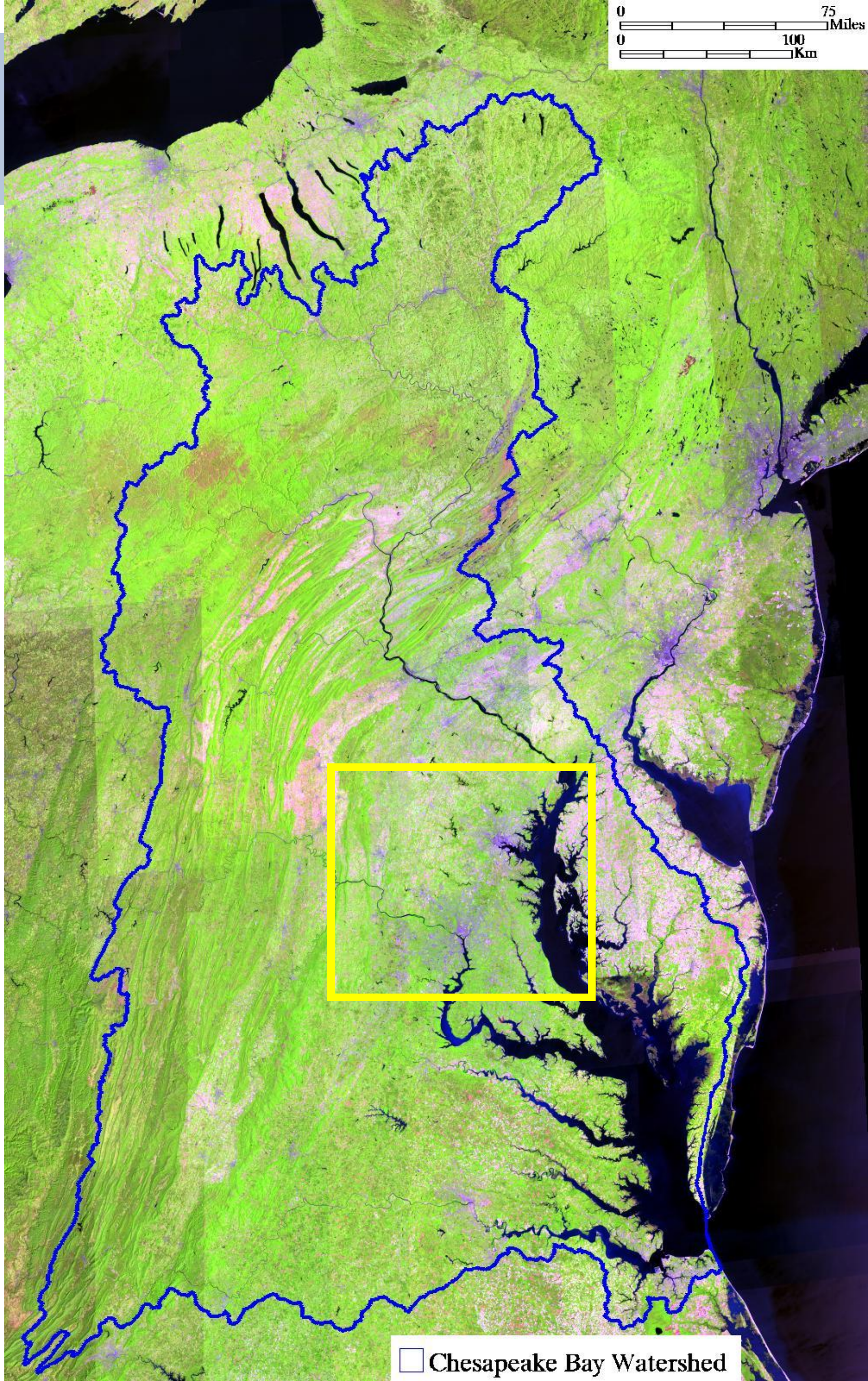
- Process of urbanization is most often irreversible, modifying carbon, water, energy cycles at various spatial scales.

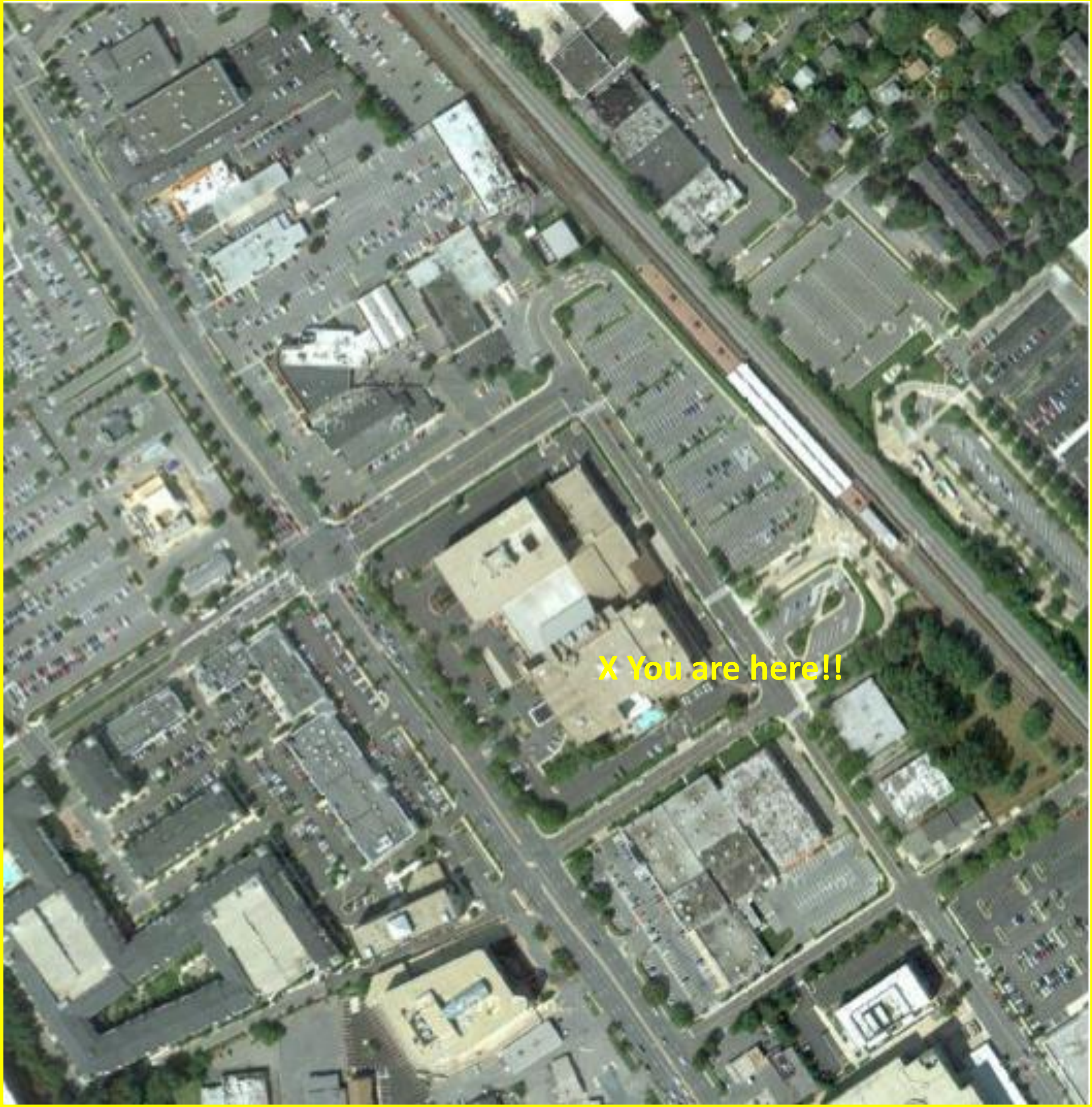
- Cities as entities can be agents of land cover/use changes at local to regional scales.

- New data sets from Landsat and NGA provide great opportunity to map and monitor urbanization at the appropriate spatial scale, and with a look to future sensors (i.e. LDCM).

LEDAPS Mosaic of the Chesapeake Bay Watershed

2000 Epoch

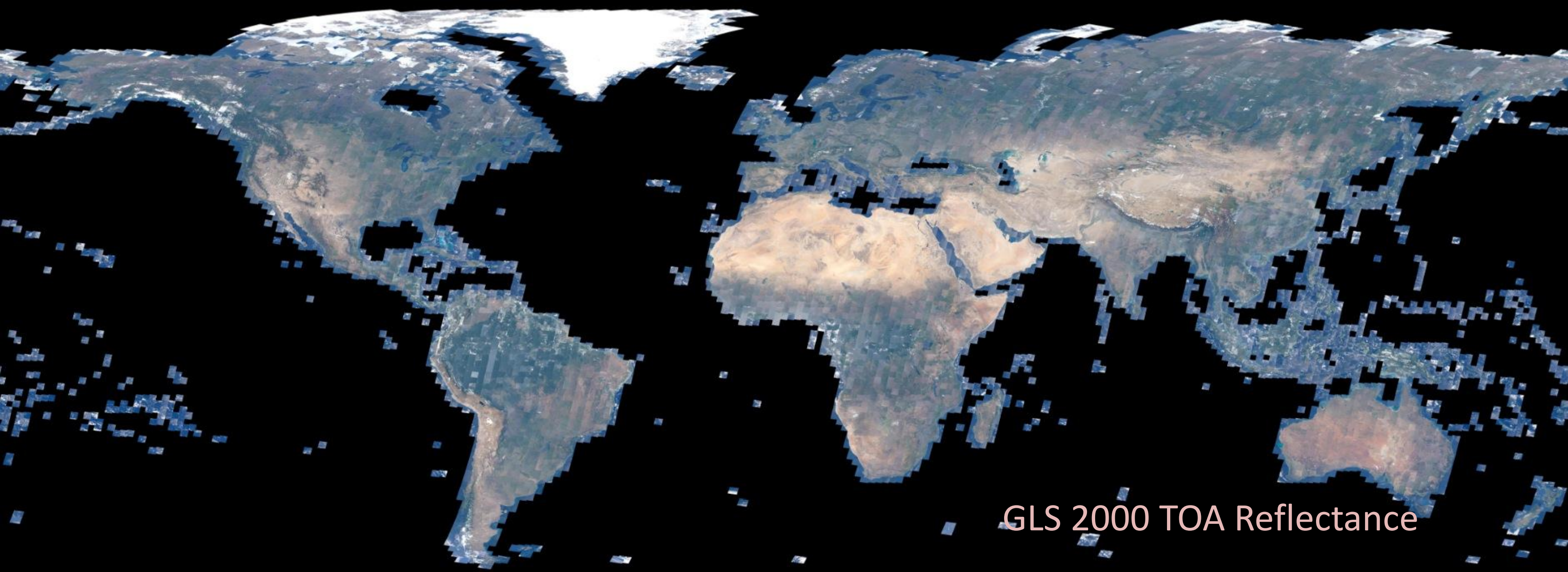


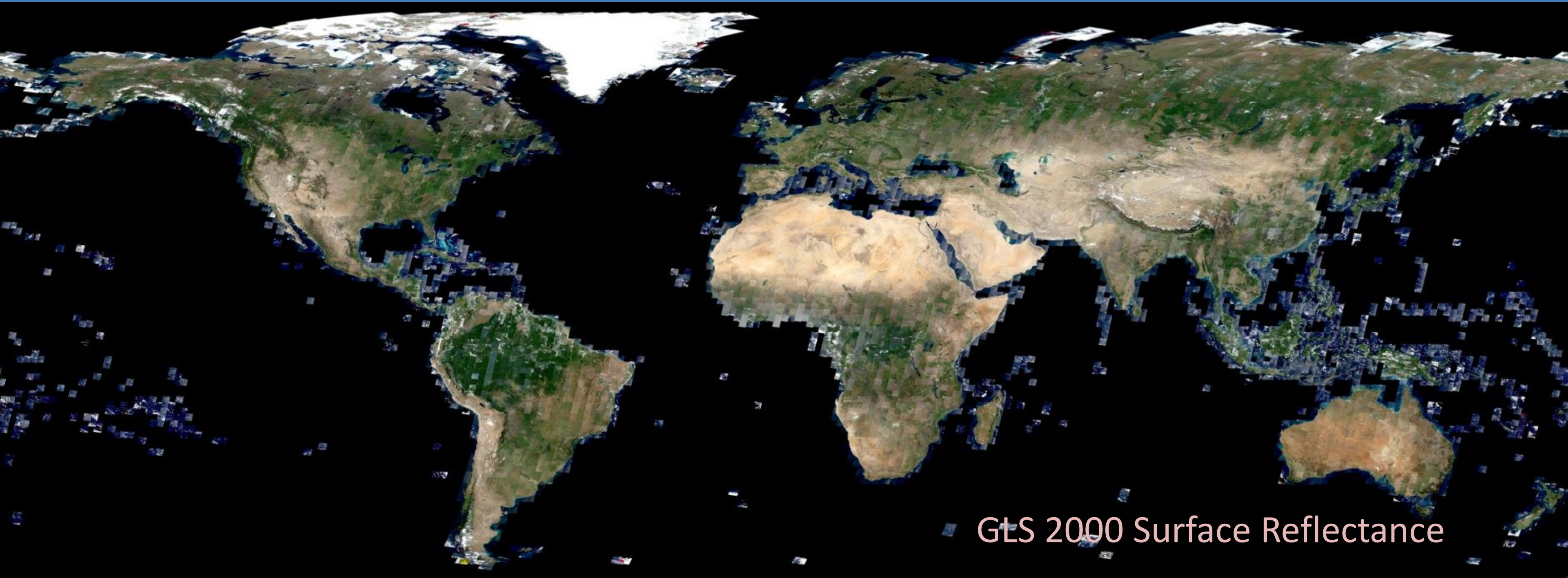

X You are here!!

Objectives

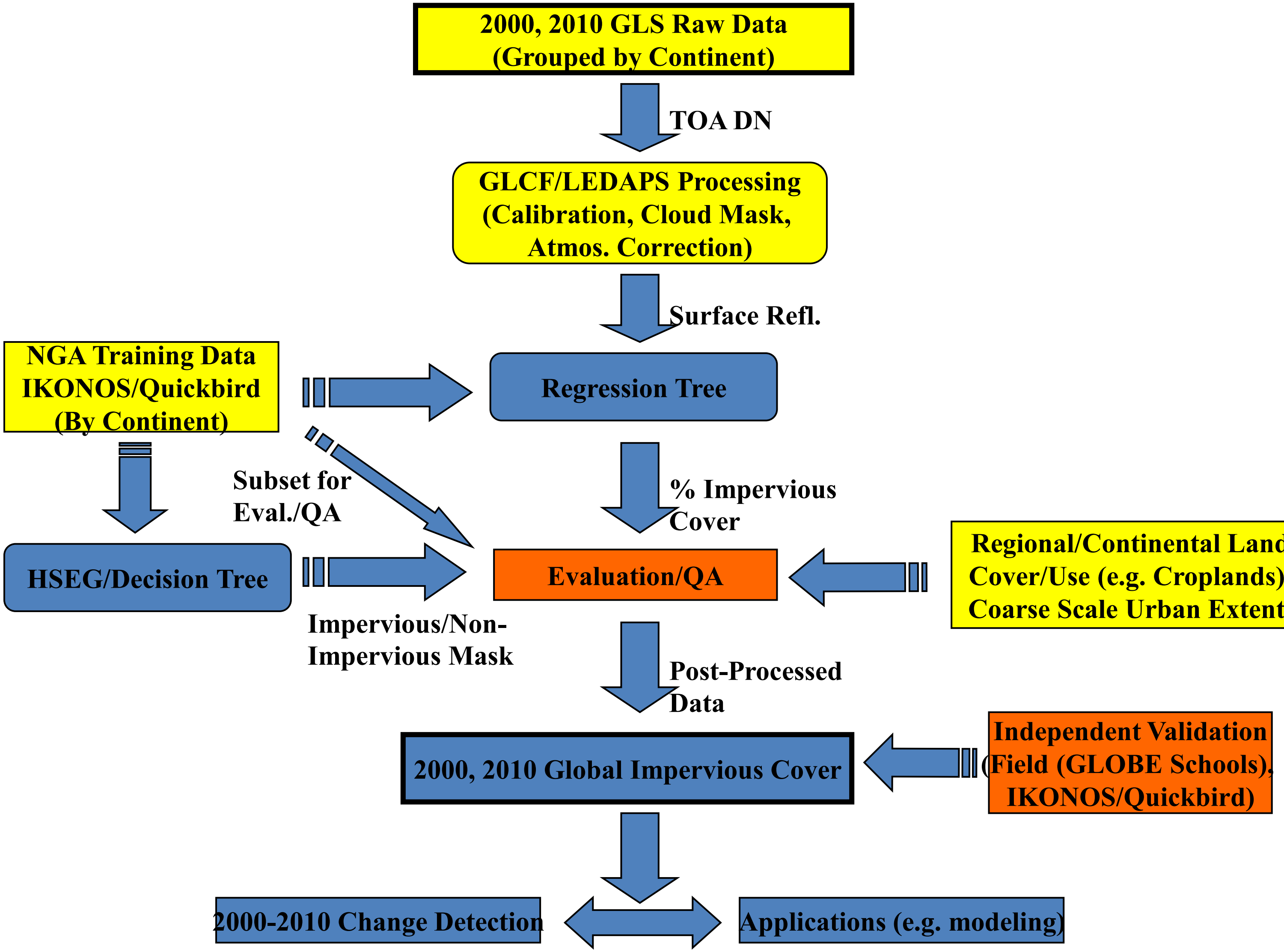
- Use the Landsat GLS data set, processed to surface reflectance, to develop high spatial resolution, baseline measurements of global % impervious cover for the 2000 and 2010 time periods.

- Compare % impervious cover for 2000 and 2010 to detect and map urbanization ‘hot-spots’ at the global scale.


GLS 2000 TOA Reflectance

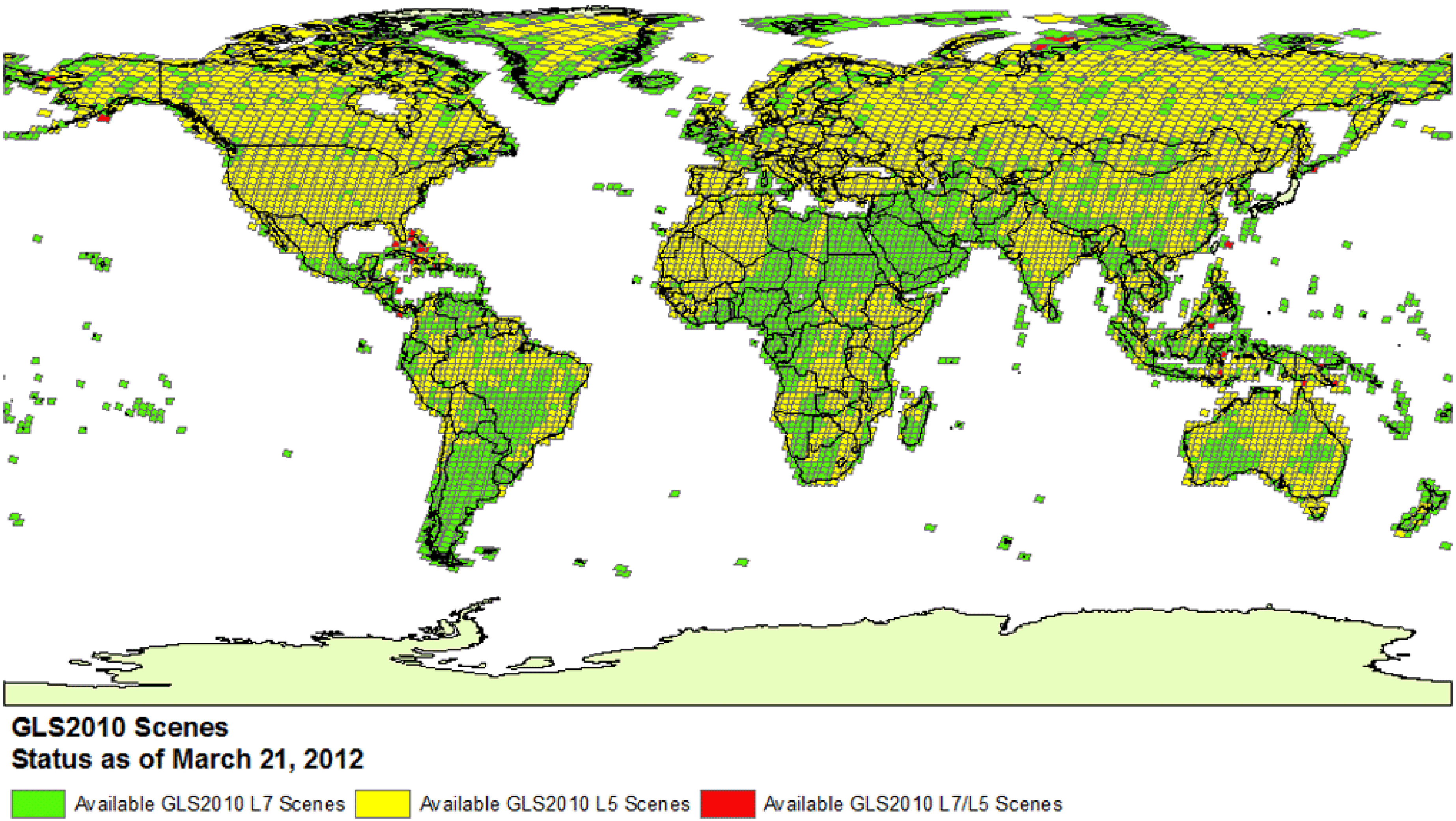

GLS 2000 Surface Reflectance

Approach



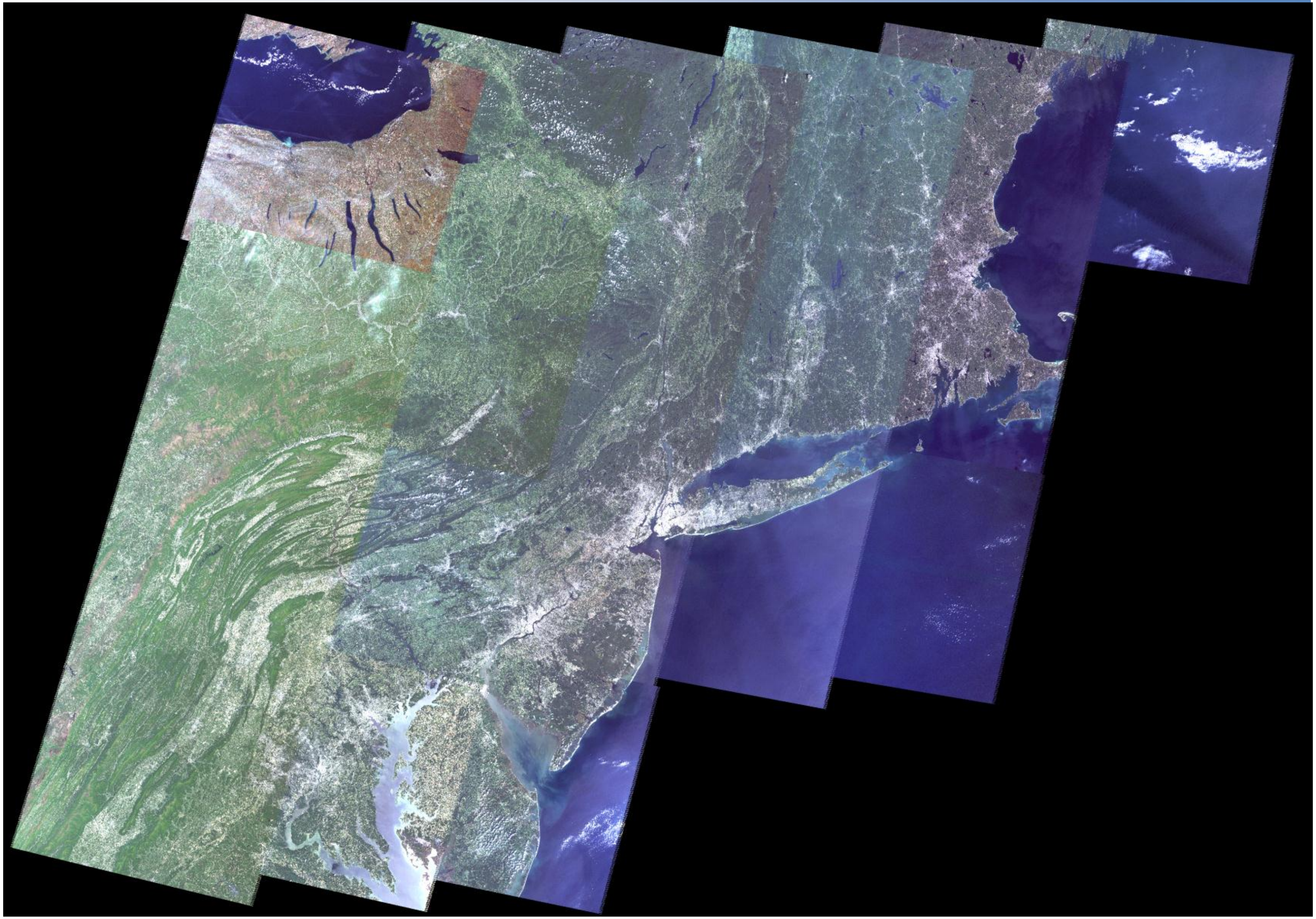
2000, 2010 GLS Raw Data (Grouped by Continent)
TOA DN
GLCF/LEDAPS Processing (Calibration, Cloud Mask, Atmos. Correction)
Surface Refl.
NGA Training Data IKONOS/Quickbird (By Continent)
Regression Tree
Subset for Eval./QA
% Impervious Cover
HSEG/Decision Tree
Evaluation/QA
Regional/Continental Land Cover/Use (e.g. Croplands), Coarse Scale Urban Extent
Impervious/Non-Impervious Mask
Post-Processed Data
2000, 2010 Global Impervious Cover
Independent Validation Field (GLOBE Schools), IKONOS/Quickbird)
2000-2010 Change Detection
Applications (e.g. modeling)

GLS 2010 Almost Ready



Just need to fill Japan and some islands.

GLS 2010 Results



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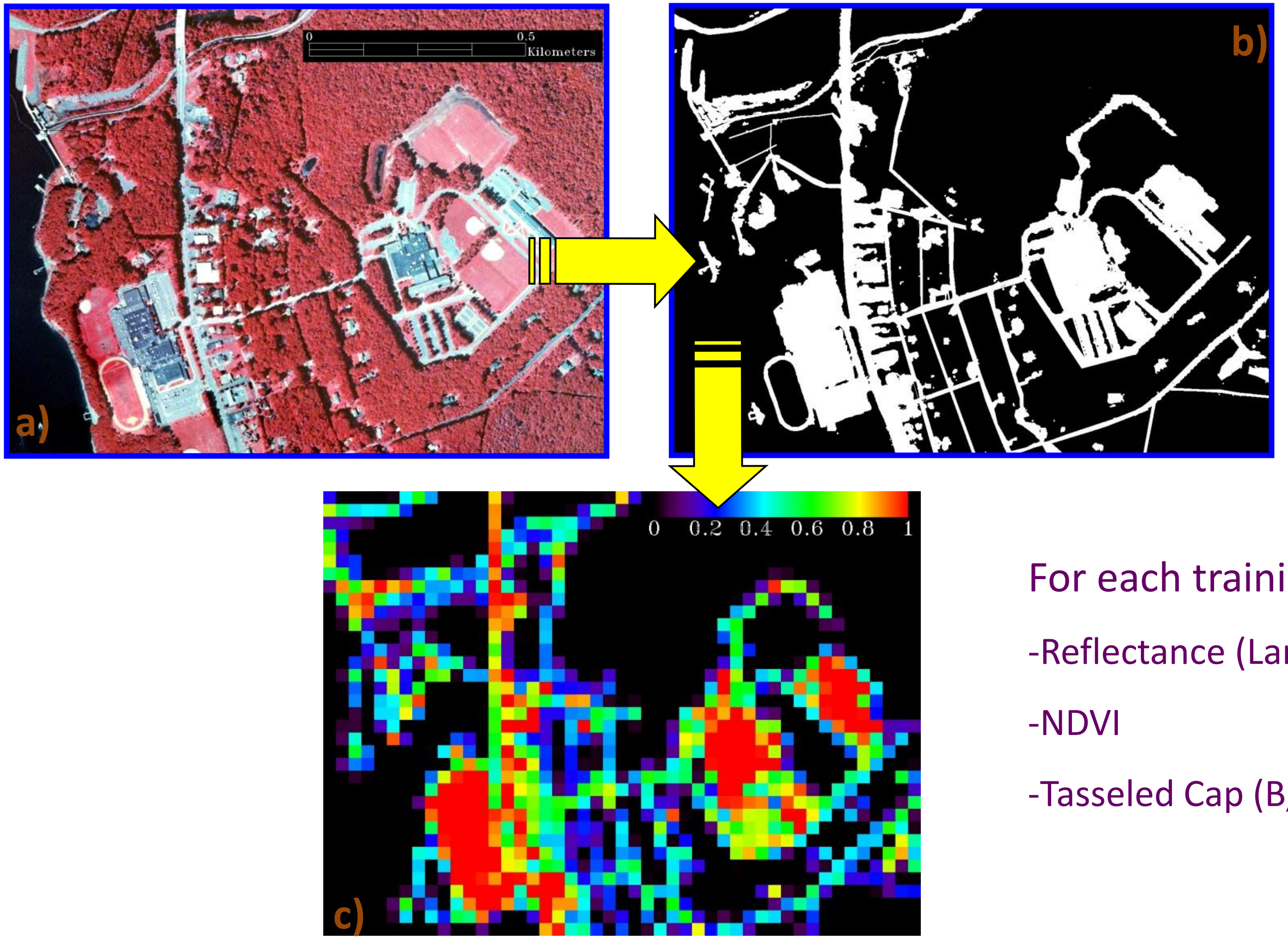
Training Data Generation



For each training pixel:

-Reflectance (Landsat 1-7)

-NDVI

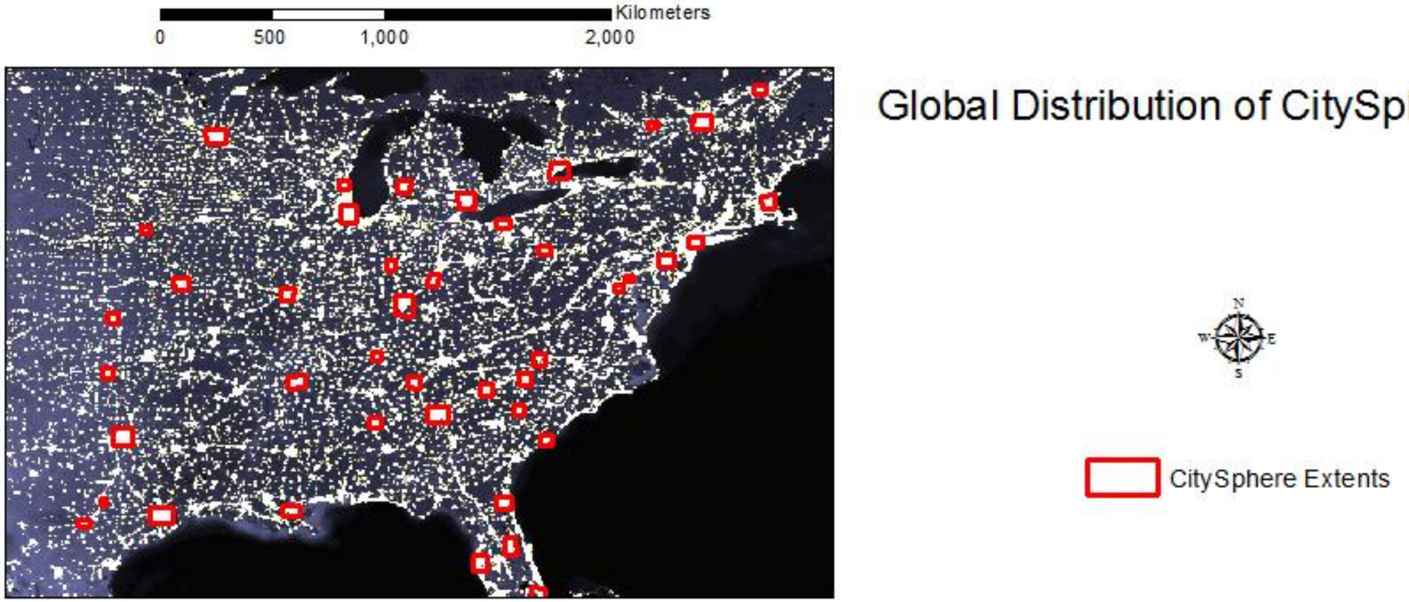
-Tasseled Cap (B, G, W)

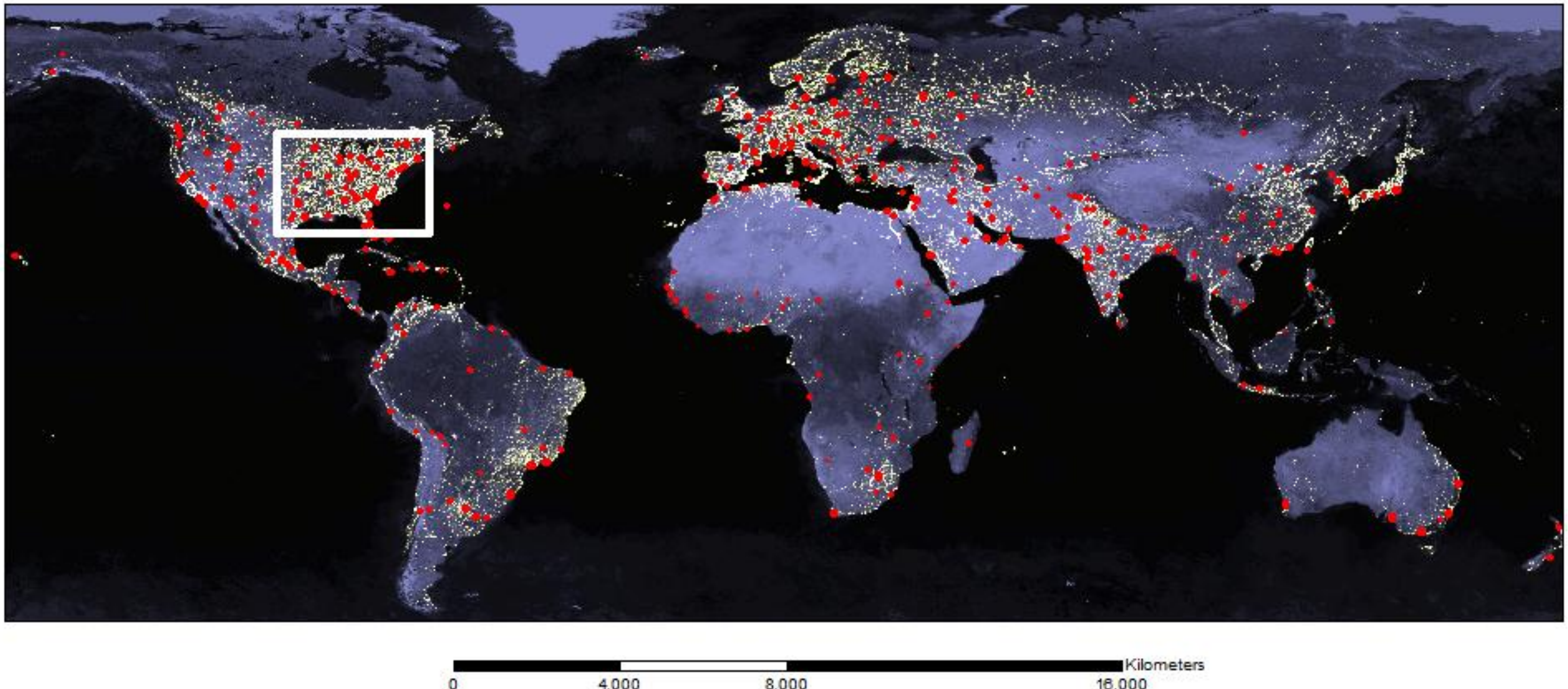
City Sphere Data

- Acquired from NGA who bought the original data from DigitalGlobe.

- Data Specifics
  - Natural Color, pansharpened 8 bit (3 band, RGB)
    - Looking to get NIR band original from NGA
  - Tile Size 14K x 14K
  - Spatial Resolution 60 cm
  - Projection UTM, Datum WGS84, Units – Meters
  - AOI, Tile, & Extent Shapefiles (ancillary data)
    - AOI is the image outline.
  - Pansharpened Kernel

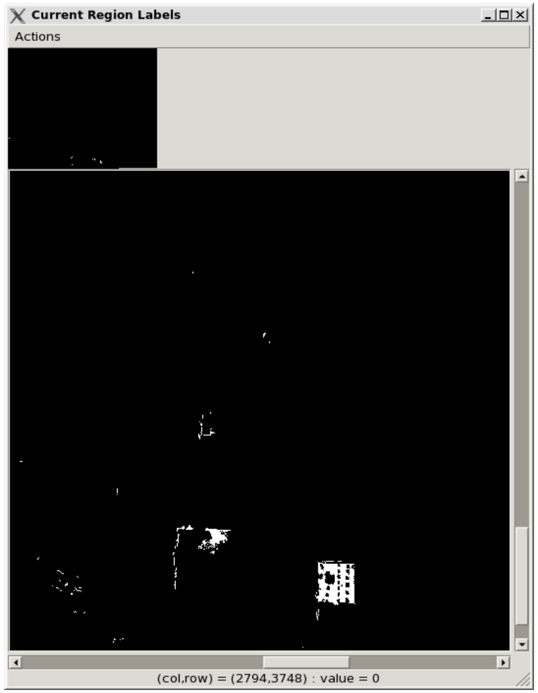
Global Distribution of CitySphere Data



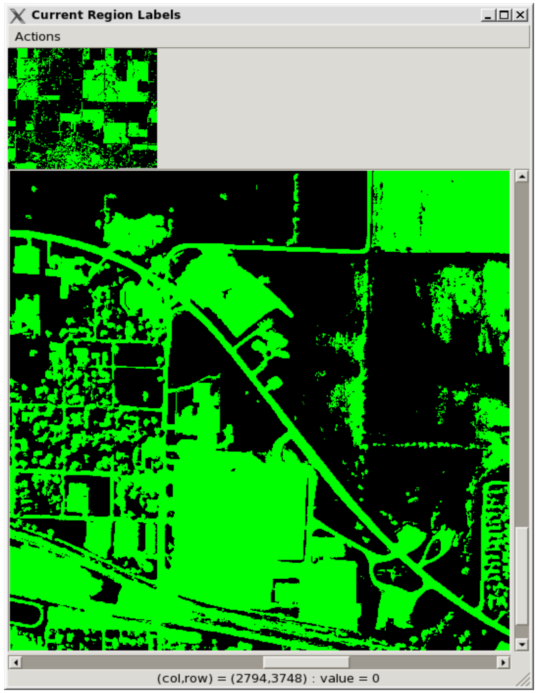


Using HSegLearn for training

Input image data. A portion of a Quickbird image over Centralia, MO, USA.

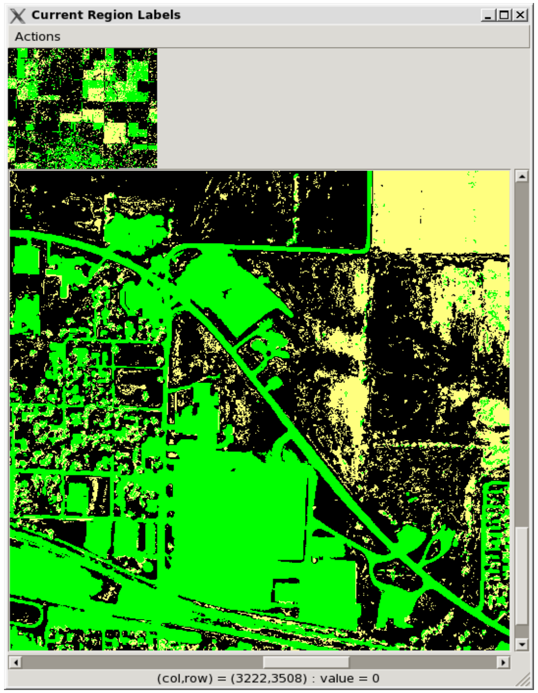


Highlight brown roofs.

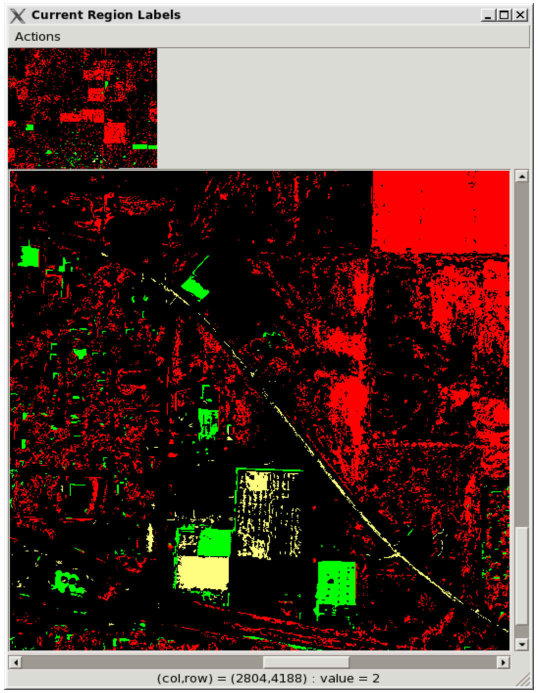


Submit brown roofs as a positive example.

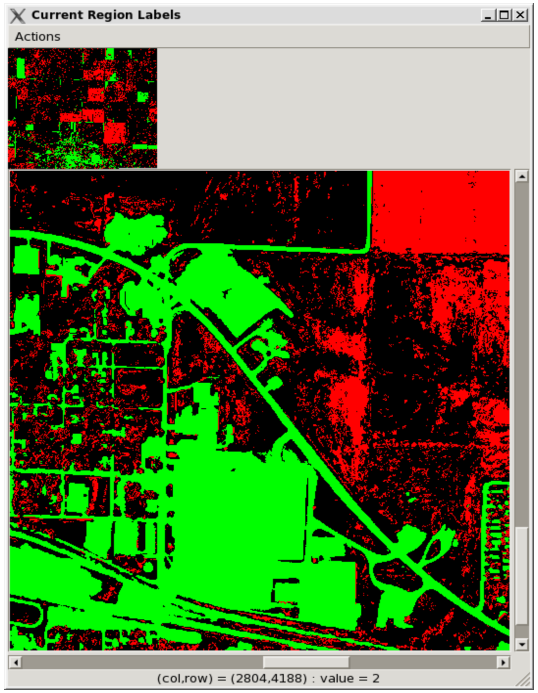
Using HSegLearn for training (cont.)



Highlight negative examples (yellow).



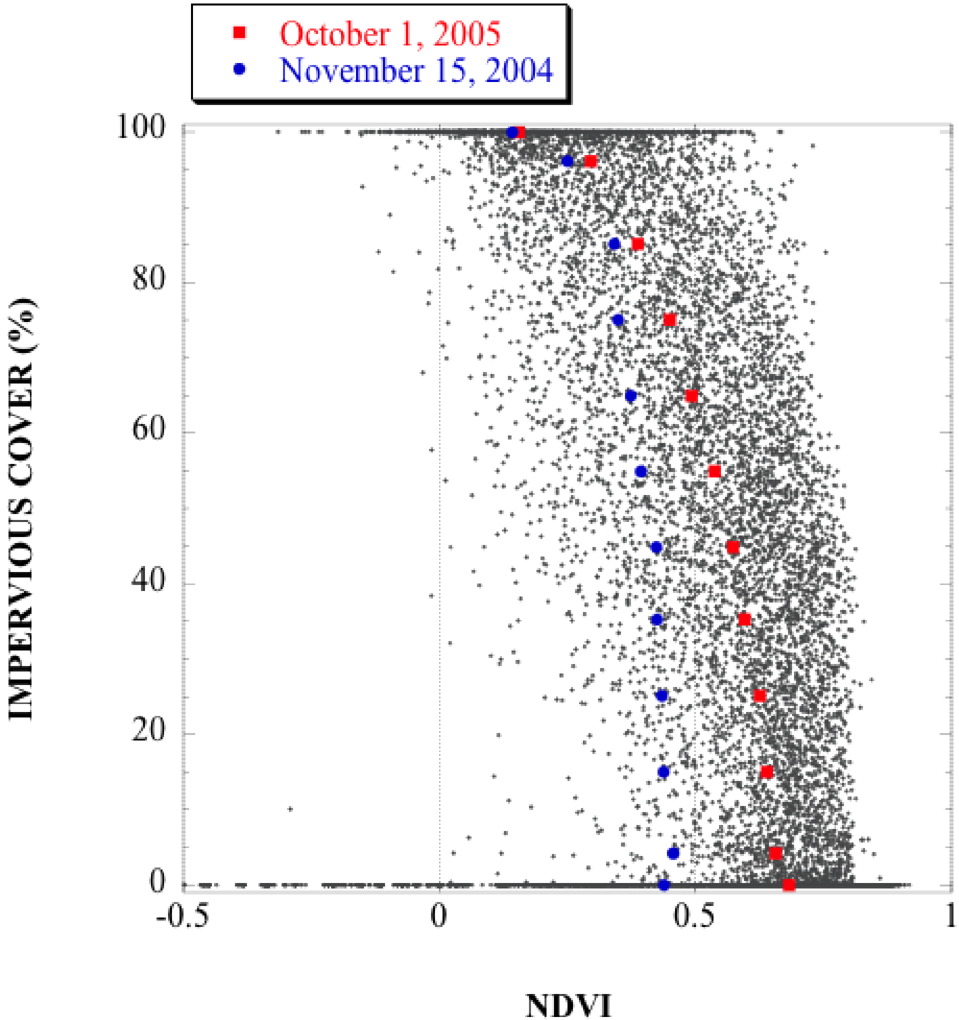
Submit negative examples (red) + Highlight positive examples (yellow).



Submit positive examples.

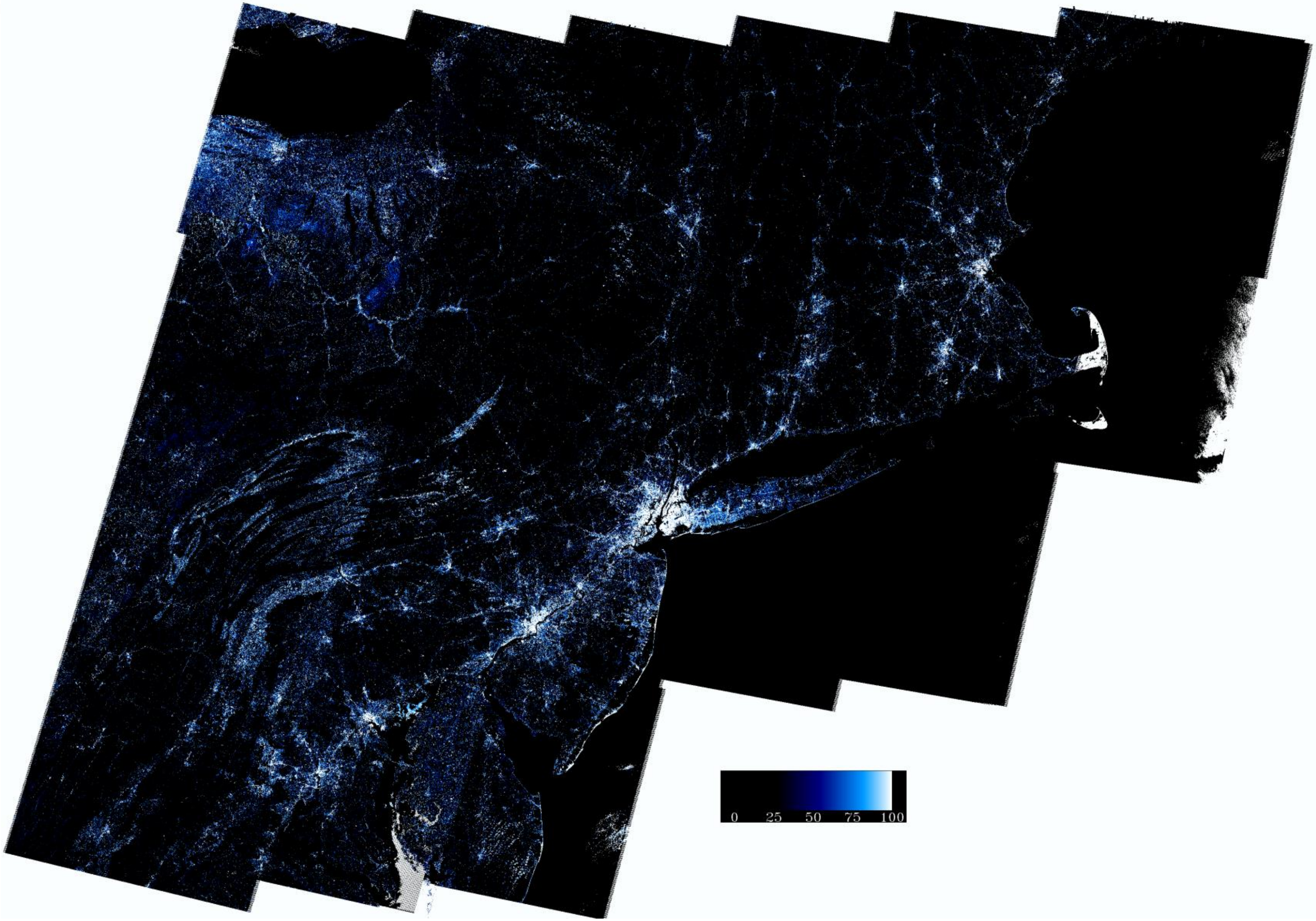
The positive cases are green (impervious) and negative cases are red.

The Devil is in the details!



-Leaf-on and Leaf-Off Training Data for a previous study in Delaware River Basin.

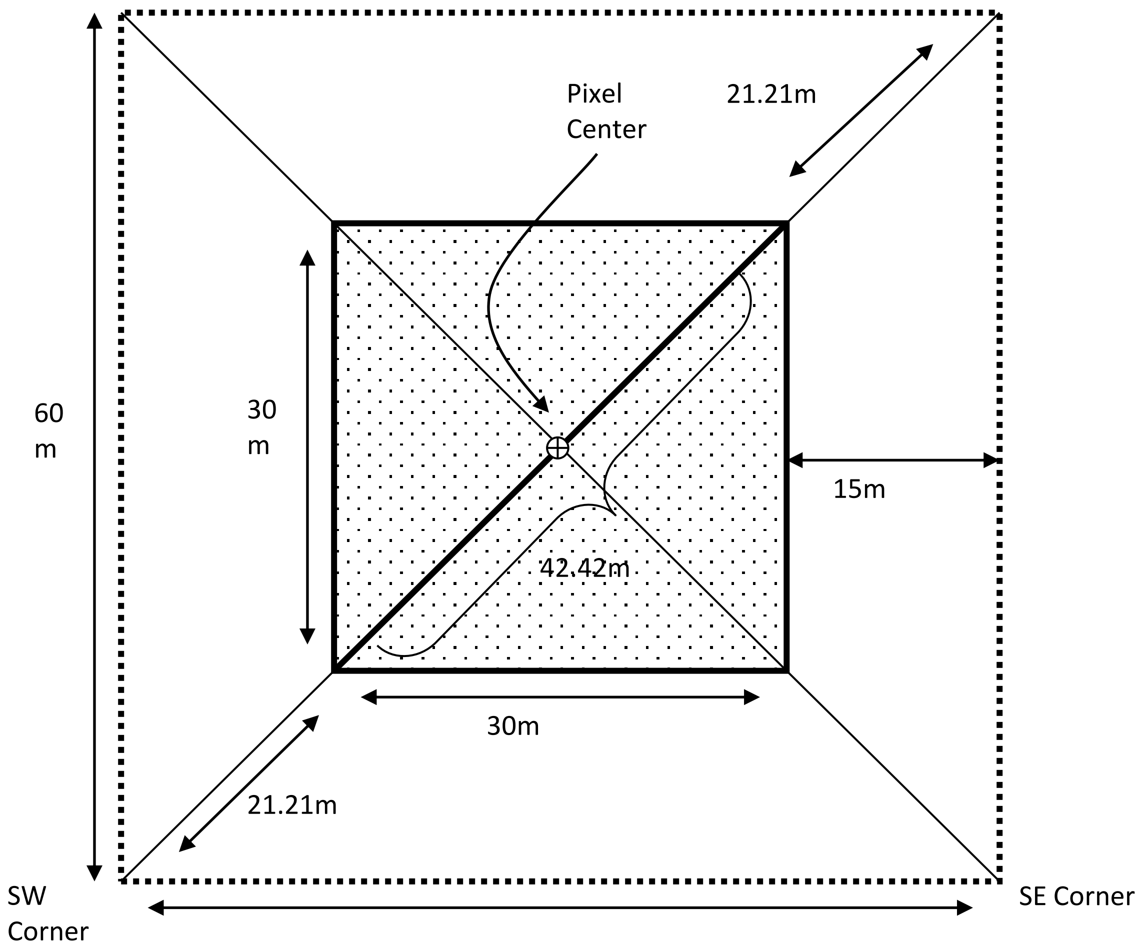
Preliminary 2010 Results



Next Steps

- Continue work on NE US. Comparisons with Milesi group, NLCD.
- Continue development of HSEGLearn tool to facilitate training data selection.
- Integrate training data selection into end-to-end processing framework.
- Development of training data for Europe:
  - Update/enhance CitySphere data (e.g. NIR)?
  - Order new data?
- Develop coarse-scale urban mask from best available sources.
- Organize field validation campaign with GLOBE schools (fall 2012).

Landsat Pixel for Validation



Backup

The Devil is in the details!

CitySphere data for Brussels ,Belgium

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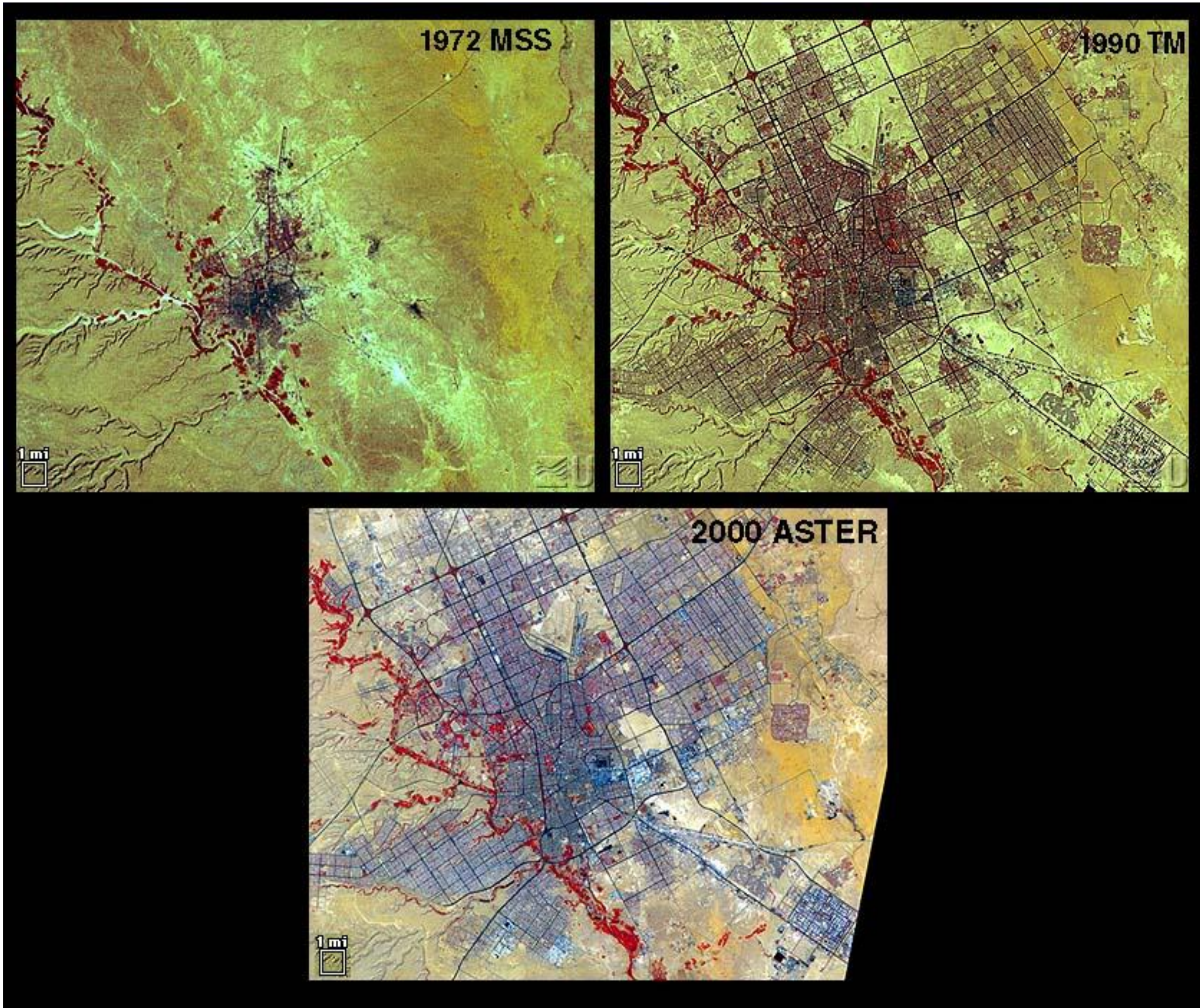
Global Urban Growth

Riyadh, the national capital of Saudi Arabia, is shown in 1972, 1990 and 2000. Its population grew in these years from about a half million to more than two million.



NASA/GSFC/MITI /ERSDAC/JAROS, and U.S./Japan ASTER Science Team

Studying Urbanization from Space

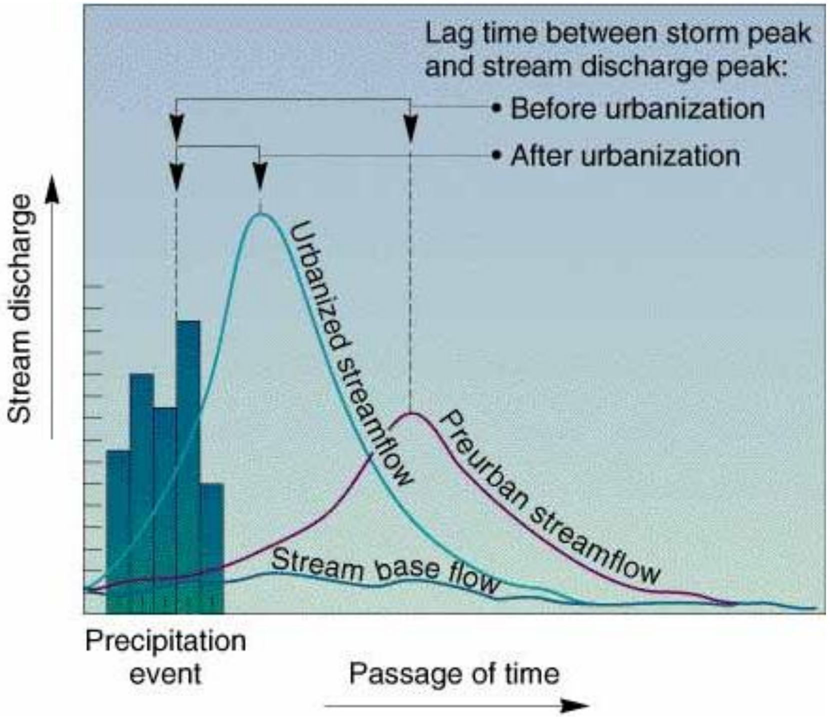
NASA Applications

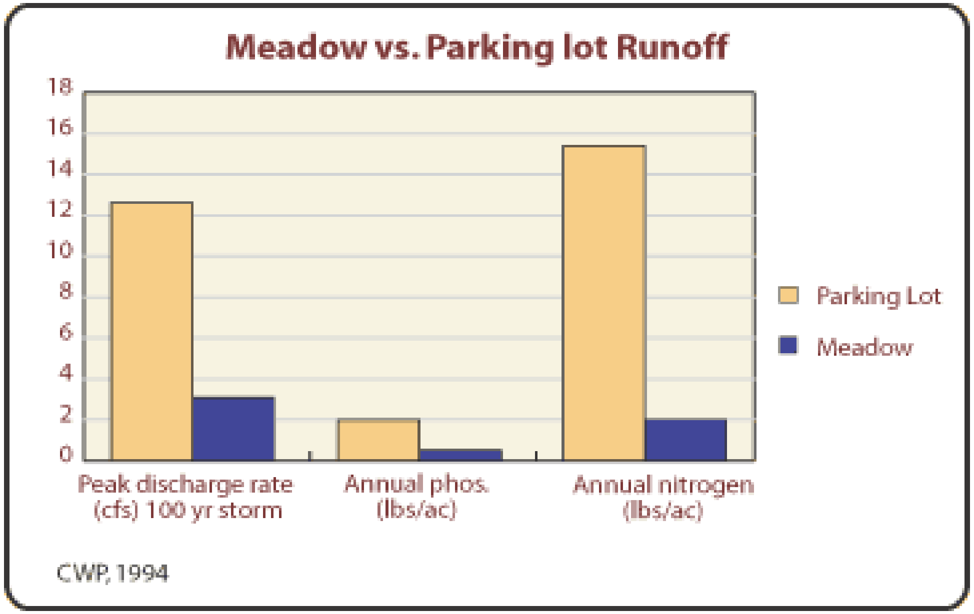
Community Growth

Urban growth and sprawl can have significant impacts on:

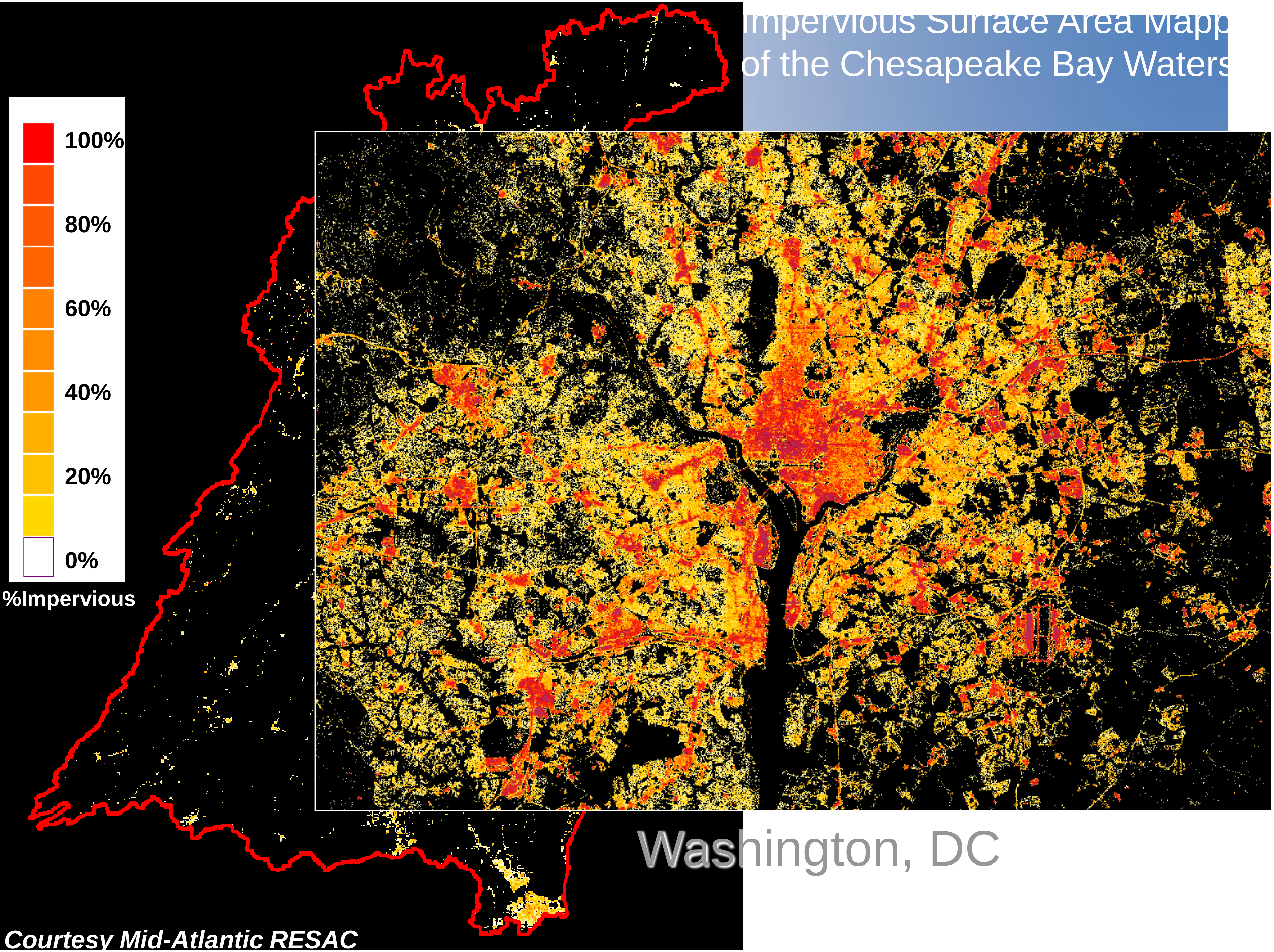
- -Local meteorology (e.g. Urban "Heat Islands").
- -Hydrology through increased runoff and/or modified streamflow dynamics.
- -Air pollution and water quality.

Scientists use Landsat data to generate accurate maps of urban extent and track the changes in impervious surfaces over time.



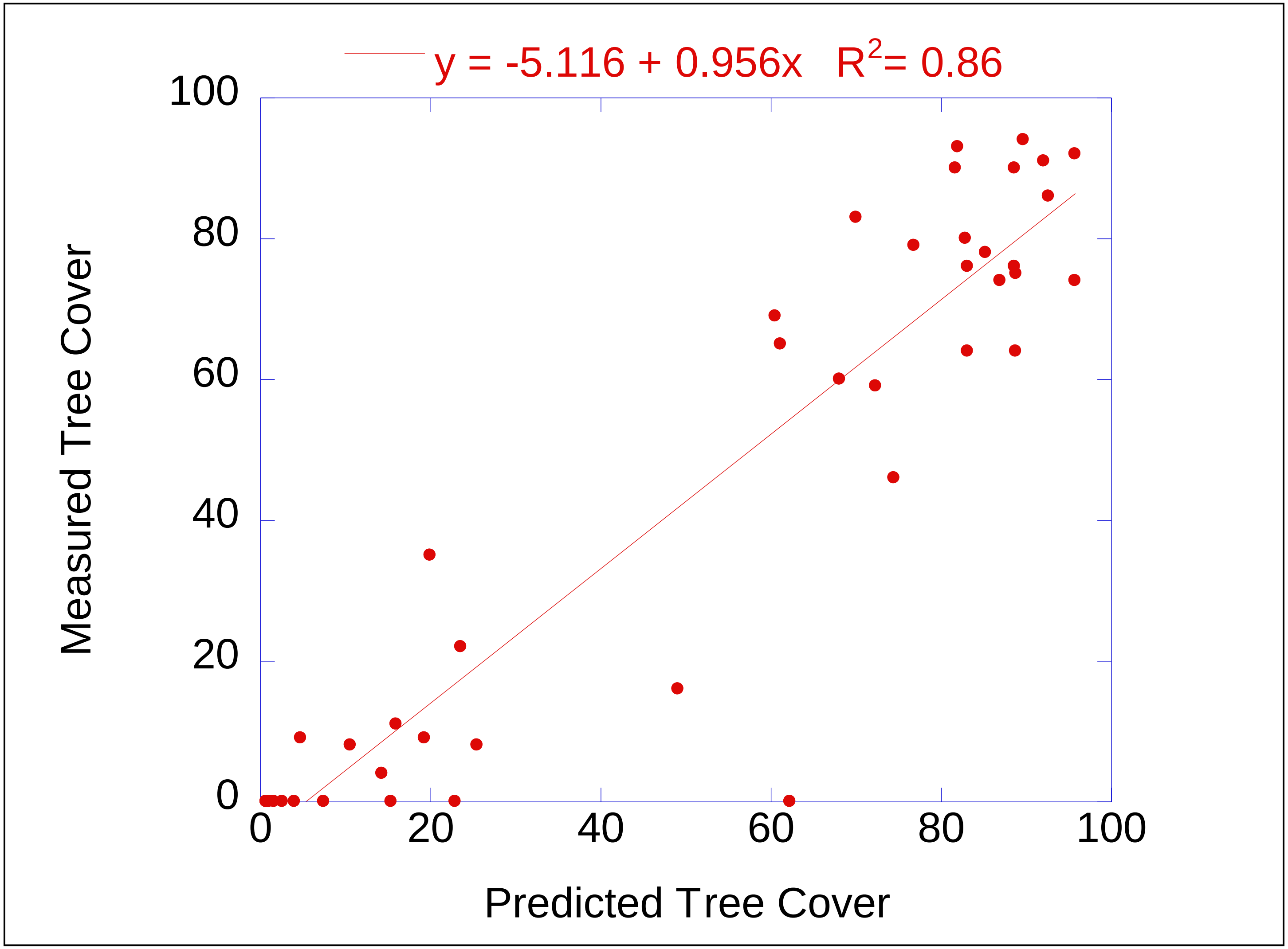


Impervious Surface Area Mapping of the Chesapeake Bay Watershed



Washington, DC

2005 Tree Cover Validation with Student Acquired Data



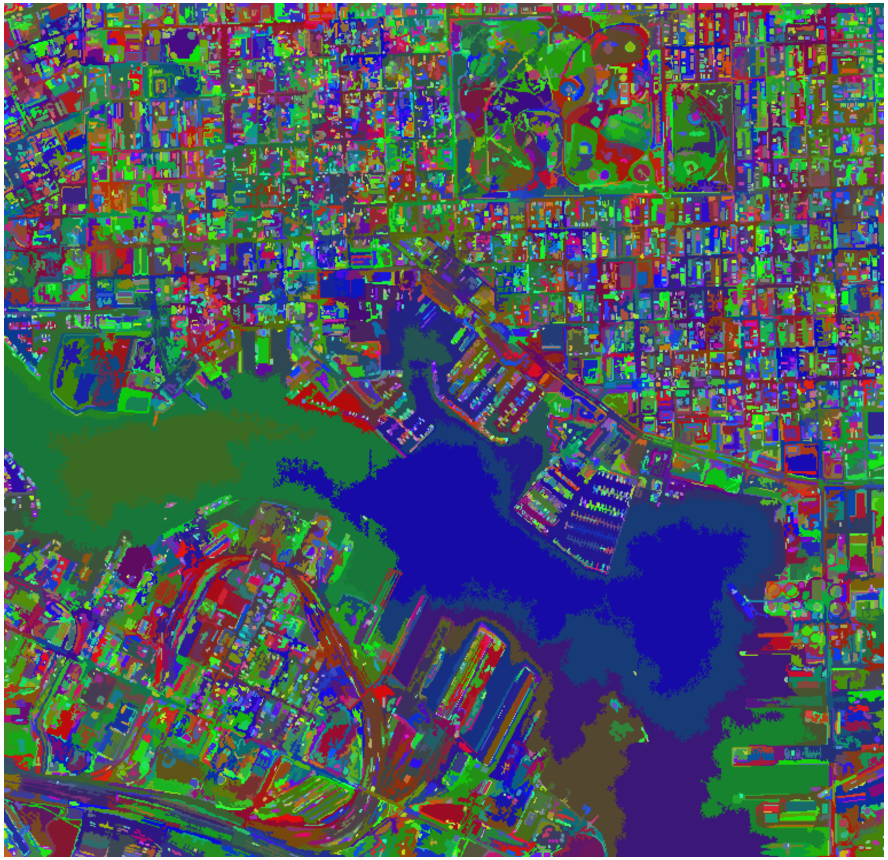
City Sphere Data Break Down Cont.

- 361 Cities total
  - Africa - 43
  - Asia - 110
  - Australia - 8
  - Europe - 73
  - North America - 97
  - South America - 30

- Gaps in Saharan Africa, Amazon, Central Asia

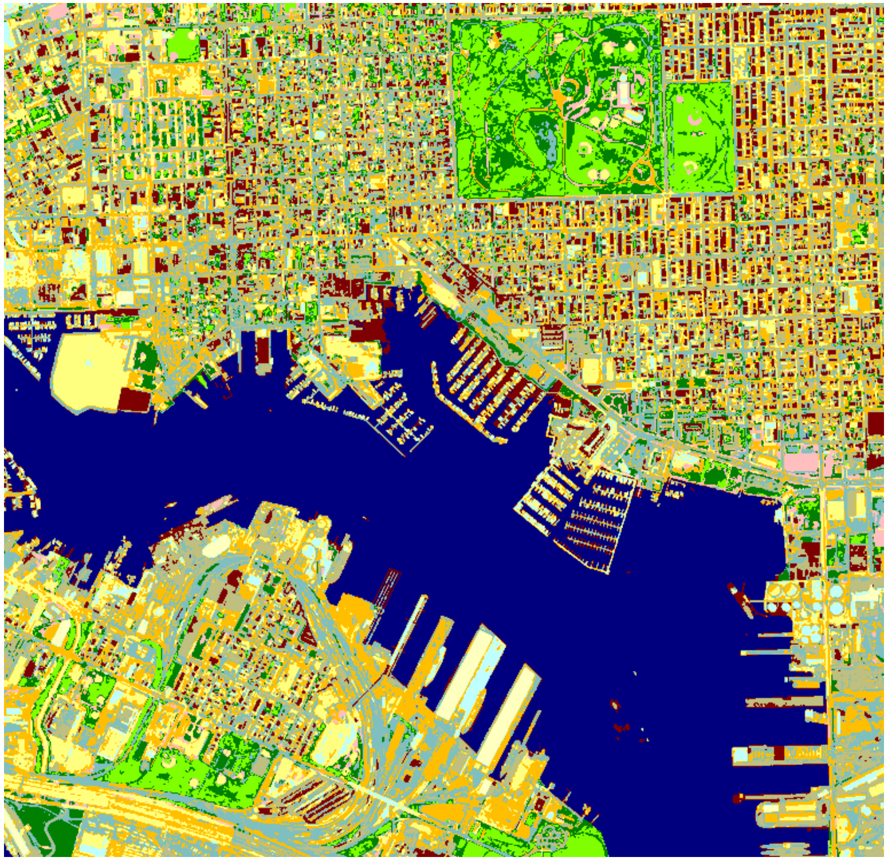
Using Image Segmentation for training

A true color rendition of a 768x768 pixel section of Ikonos data from the Patterson Park/Inner Harbor area of Baltimore, MD.



HSWO Segmentation with 7415 region objects.
(global dissimilarity = 0.346)

Using Image Segmentation for training (cont.)



A true color rendition of a 768x768 pixel section of Ikonos data from the Patterson Park/Inner Harbor area of Baltimore, MD.

HSeg Segmentation with 11 region classes and 38,773 region objects. (global dissimilarity = 0.345)