A new method for updating and backdating land-cover maps using Landsat and ASTER imagery: Massachusetts, USA

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Introduction:

Land-cover monitoring programs today use medium spatial resolution remote sensing data operationally. Many monitoring programs have been using Landsat data to meet a wide range of goals. However, the collection of new Landsat data is now in jeopardy due to technical problems with Landsat-5 and Landsat-7; the next Landsat launch not expected until 2013.

Several studies have conducted a cross-sensor analysis with Landsat data for a wide range of tasks. Landsat-like sensors have proven to be comparable to Landsat in regional mapping applications.

Many regional change mapping studies rely on visual interpretation of aerial photography or a method of post classification analysis. These methods, however, have high time and cost demands and can be riddled with compounded errors (e.g. 0.85 X 0.85 = 0.70).

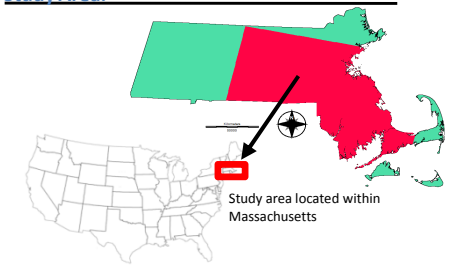
The first task of this research is to evaluate the use of both Landsat and ASTER data for regional land-cover monitoring in central Massachusetts. The second is to develop a new methodology for backdating and updating of an existing land-cover map. The third objective of this study is to conduct a cross-sensor analysis to determine the utility of ASTER data as a suitable Landsat replacement.

Two example of land-cover conversion in Massachusetts; logging and residential development.

References:

•.Collins, J.B., and C.E. Woodcock, 1996. An assessment of several linear change detection techniques for mapping forest mortality using Multitemporal Landsat TM data, *Remote Sensing of Environment,* 56(1): 66-67.
•Eastman, J. Ronald, 2006. Idrisi Andes: Guide to GIS and Image Processing. *Clark University, Worcester, MA*
•Yajuan, W. and Danfeng, S. 2005. The ASTER Tasseled Cap interactive transformation using Gramm-Schmidt method. *Proceedings of SPIE* 6043(2): 184-195

Study Area:



Study area located within Massachusetts

Data and Methods:

Landsat-5 TM acquired on September 16, 1987, Landsat-7 ETM+ acquired on September, 27 2000 and ASTER images acquired August 2007

1987 (TM)	2000 (ETM+)	Change Image	Thresholding Value
Forest	Agriculture	↑ B	(11 →25); (29→31)
		↑ G	(6 →13); (21→28)
Forest	Barren	↓ G	(-49 → -64); (-86 → -100)
		↑ B	(0 → 6); (11→ 35)
Forest	Grass	↑ B	(12 → 32)
		↑ G	(1→ 15); (18 → 25)
Forest	Residential/Comm	↓ G	(-18→-27); (-31→-52); (-59→-79); -100
		↑ B	(9→25)
Agriculture	Residential/Comm	↓ G	(-62→-69); (-76→-82) (-95→-96); -100
		↓ B	(-8 → -59); (-82 → -87); → -100
Agriculture	Barren	↓ G	(-68→-77); (-89→-93); -100
		↑ B	(11 → 26)
Barren	Residential/Comm	↓ G	(-33→-38); (-46→-57); -100
		↑ W	(26→33); (39→ 61)
Grassland	Residential/Comm	↓ G	(-8→-26); (-32→-74); -100
		↑ B	(0→20)
		↑ W	(24→34)

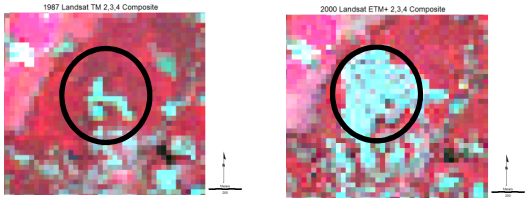
Threshold values determined for land-cover change classes and for each CI Feature

- Image Pre-processing
- Kauth Thomas Transformation on Landsat TM (Collins and Woodcock, 1996), ETM+ (Eastman, 2006) and ASTER (Yajuan and Danfeng, 2005)
- Image Normalization (Eq. 1)
- Change Index (CI) (Eq. 2)
- Create mask of desired land-cover category
- Overlay land-cover type and CI image to create a mask
- Determine appropriate change threshold
- Use threshold to constrain CI image
- Validation of thresholds
- Backdating/Update of land-cover map

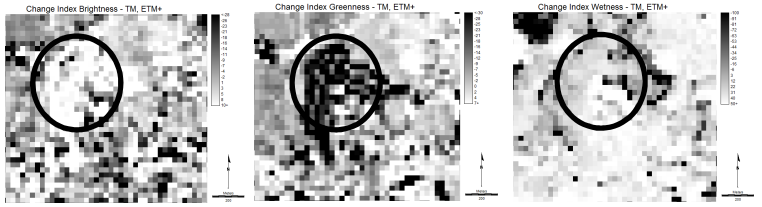
$$X_N = \frac{X - X\mu}{X\sigma} \quad (1)$$

$$CI_X = \frac{X_{T_2} - X_{T_1}}{\left| X_{T_2} + X_{T_1} \right|} \quad (2)$$

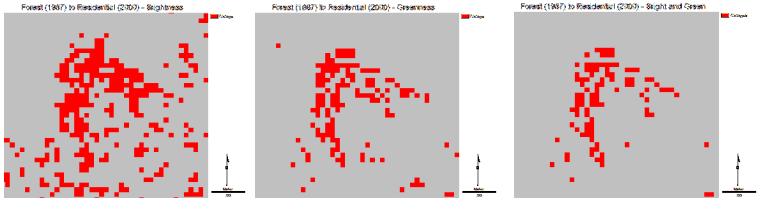
Results:



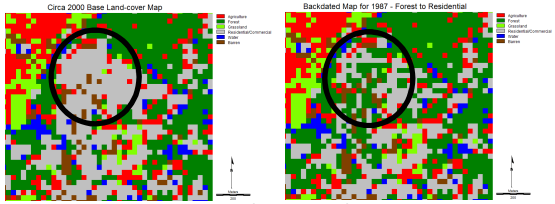
1987 TM and 2000 ETM+ composite images showing a forest to residential conversion



Change Indices for Brightness, Greenness and Wetness computed using the Change Index (TCI)



Change Index for forest to residential conversion in Brightness, Greenness and a combination of Brightness and Greenness



Circa 2000 land-cover map and a backdated product for 1987 with a forest to residential land-cover conversion

Summary:

Preliminary work shows this methodology to be very promising in the detection of change in a heterogeneous landscape as well as for backdating an already existing land-cover map. This methodology allows for fast and accurate land-cover change detection and mapping without the creation of a new land-cover map. Further work will continue in applying this methodology to ASTER data from August, 2007 to update the circa 2000 base map. Those results from that analysis will be referenced to the results from Landsat.

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