Subpixel Land Cover Change from Landsat: A Case Study for Durban, South Africa (1985-2009)

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Introduction

Satellite-based land cover change characterization of urban areas and their surrounding regions offers a valuable tool for investigating the effects of socio-economic changes on the physical environment, and thus understand the challenges for sustainable development.

However, land cover change characterization over urbanized areas is complicated by the presence of spectrally heterogeneous land cover types within the field of view of satellite sensors with spatial resolution greater than a few meters. Multitemporal spectral mixture analysis (MSMA) derives physical representations of the temporal changes within spectrally mixed pixels as areal fractions of spectral endmembers.

Here we show an example of land cover change prepared in occasion of the 2011 COP 17 meeting in Durban, South Africa. Durban is an example of an African city where changes in climate have the potential to pose significant challenges on the local population that is already vulnerable in terms of poverty, health, and secure access to food and water. Characterization and maping of changes in vegetation, shadow and impervious fractions from the Landsat archive offers an opportunity to examine the effects of significant socio-economic changes during the pre- and post Apartheid period (before and after 1994) on the urbanization of South Africa from 1985 to 2009.

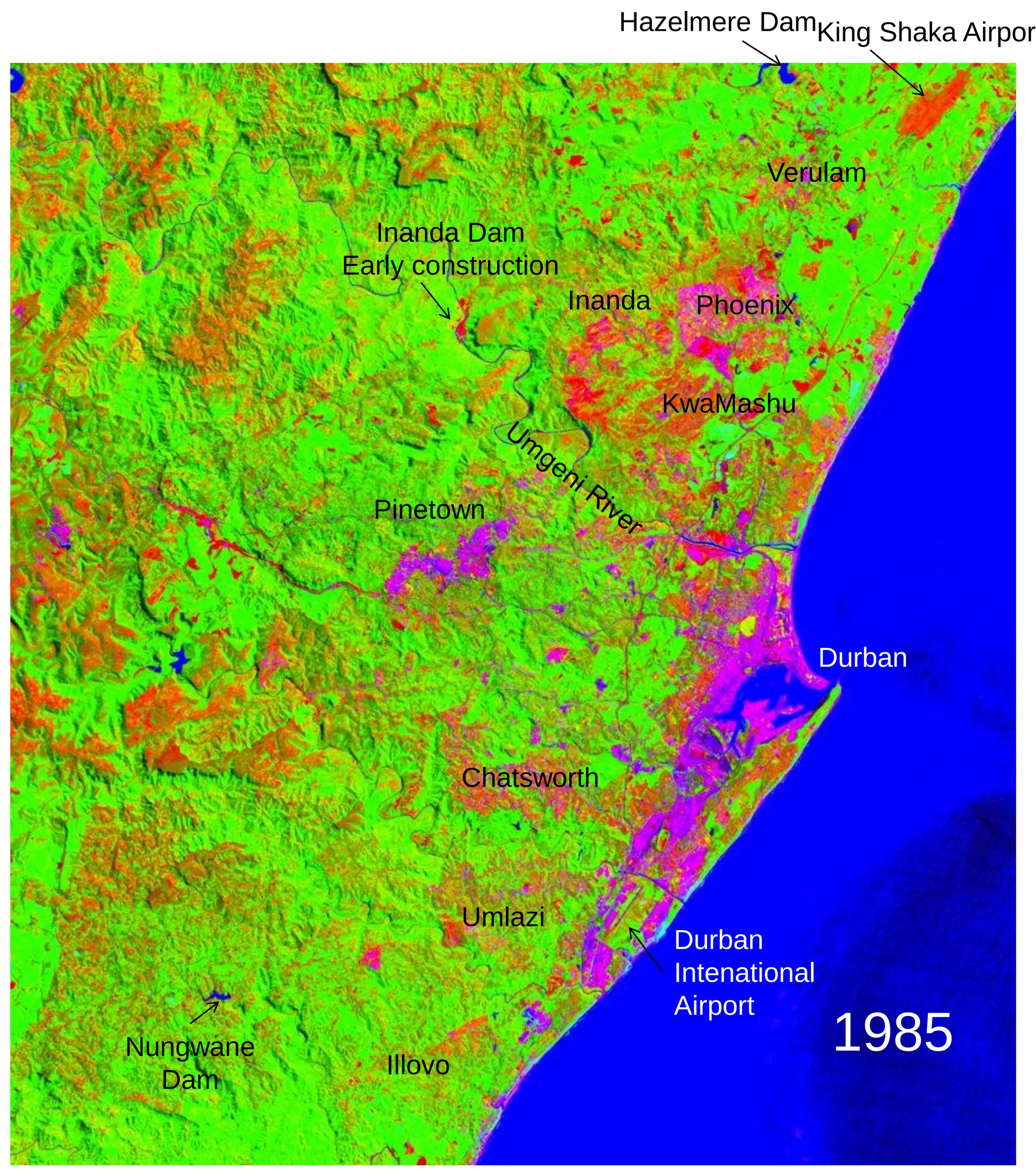
Methods

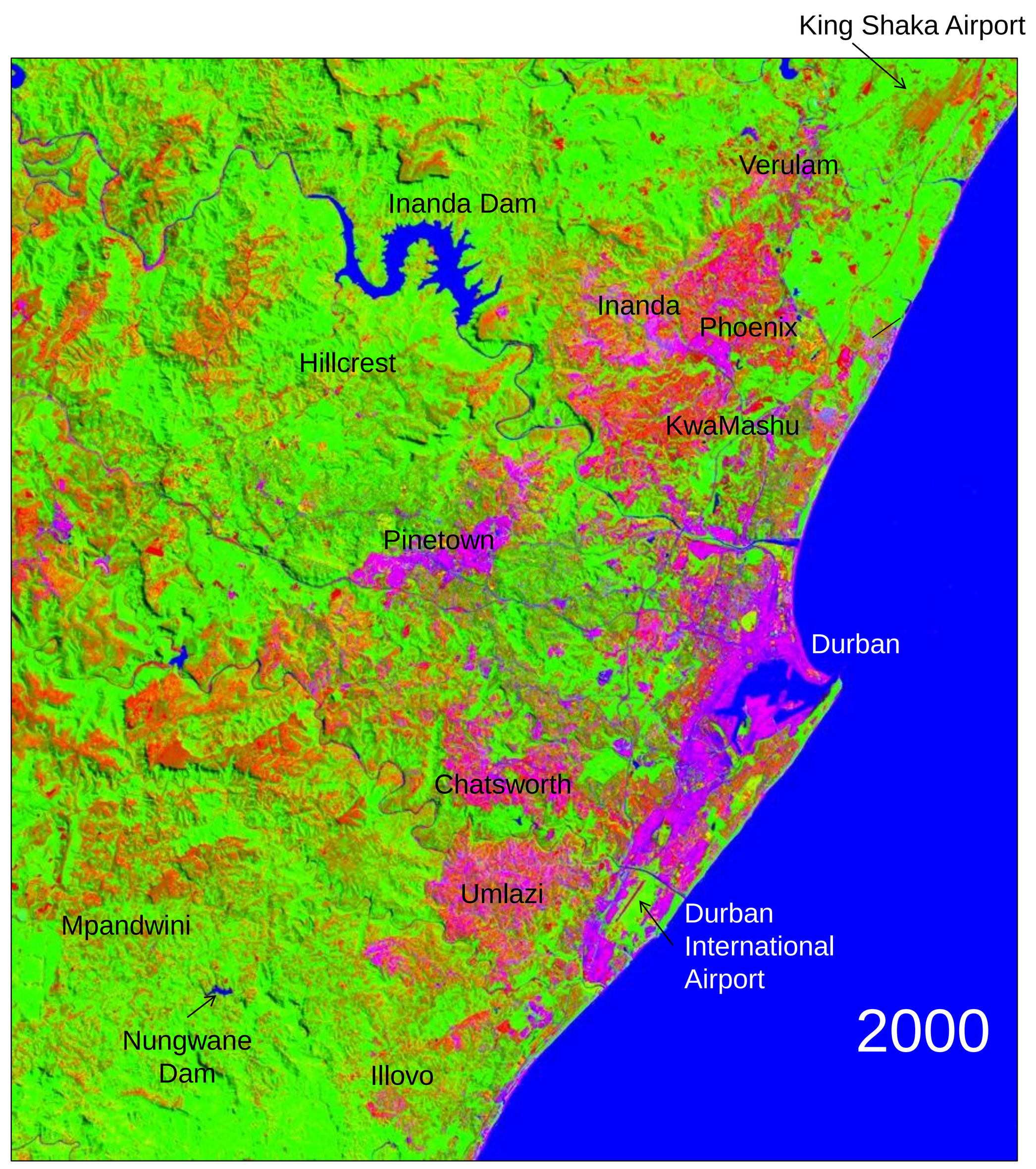
We use the linear spectral mixture model (Adams et al. (1986, 1993) to represent land cover as fractions of Substrate, Vegetation and Dark surfaces. The Substrate endmember represents SWIR-bright rock, soil and impervious surfaces. The Vegetation endmember represents illuminated foliage. The Dark endmember represents water, shadow and absorptive materials. We use a unity-constrained inversion of the 6x3 linear mixture model based on the Singular Value Decomposition given by Boardman (1989, 1990). Calibration to exoatmospheric reflectance, radiometric rectification, and use of generic global endmembers (Small, 2004) reduce, but do not completely eliminate spurious change., Modal difference fractions of Substrate and Vegetation are 0.01 and 0.005 respectively, indicating that the calibration and rectification are effective. The modal difference fraction for the Dark endmember is -0.35; a result of actual changes in both atmospheric opacity and turbidity in the coastal ocean.

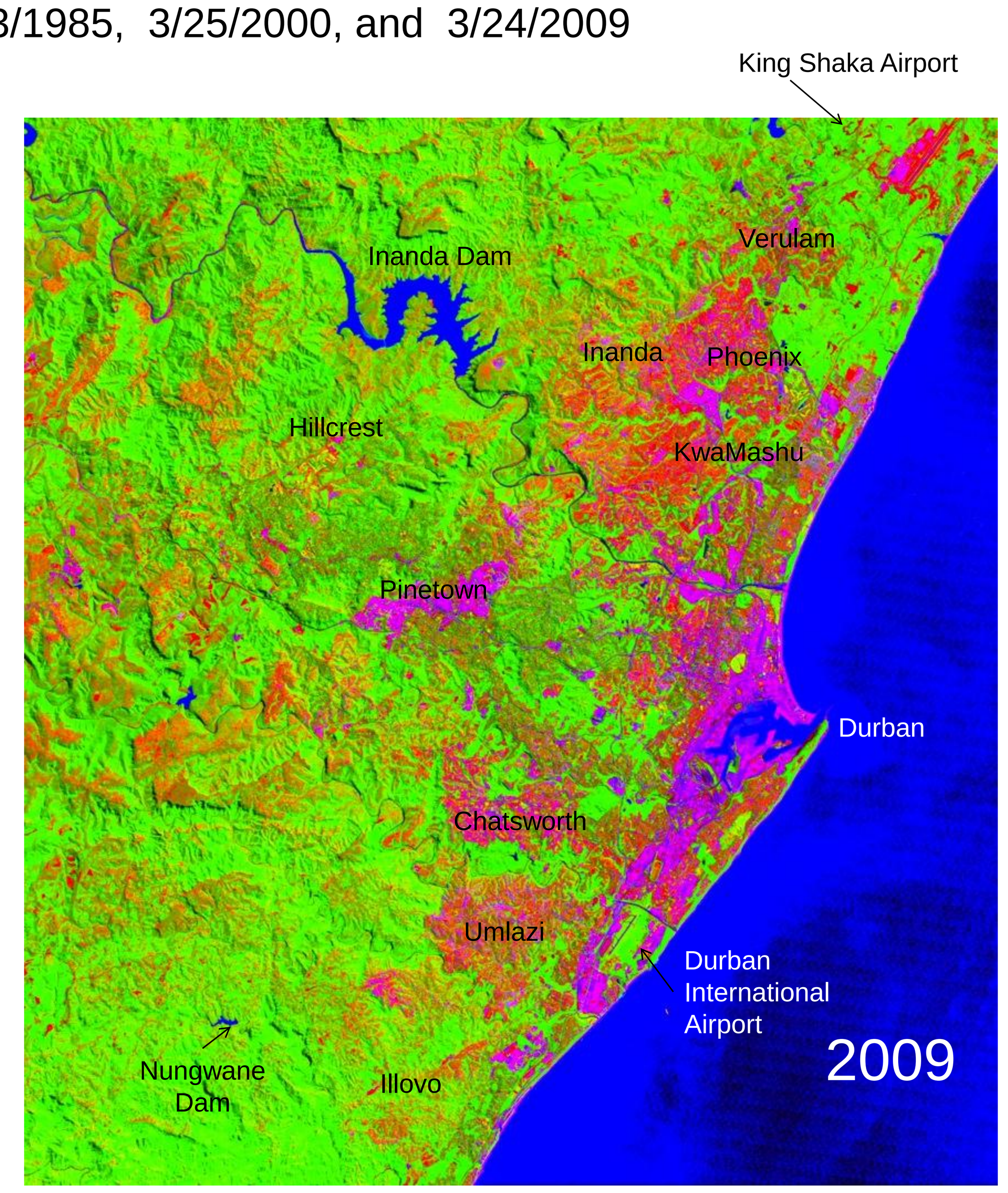
RGB composites of the SVD fractions show the dominant endmember combinations as additive colors. RGB composites of the fraction differences show relative increases in SVD fractions. Relative increases in one or two fractions may result from decreases in the complementary fraction(s).

Results

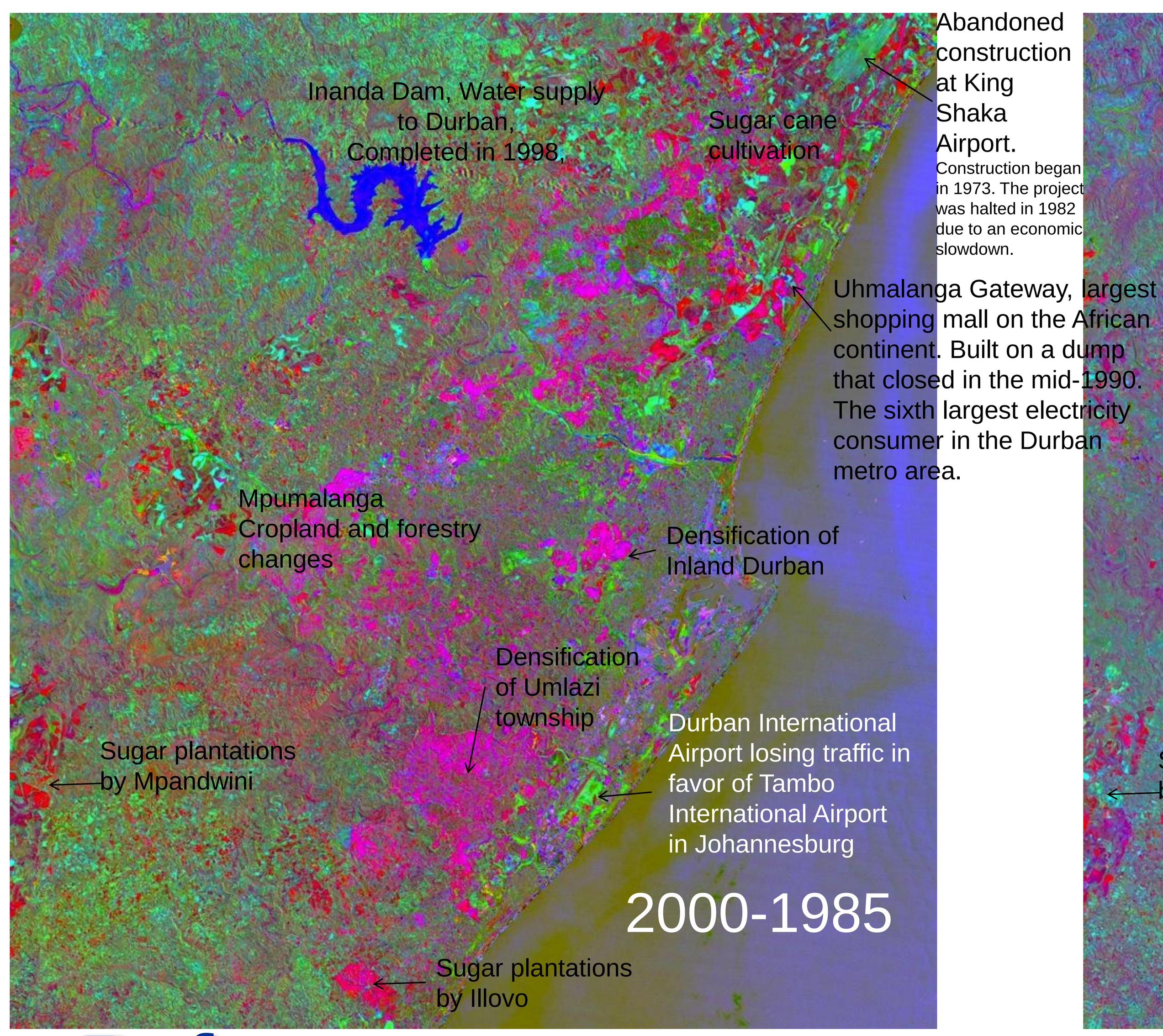
RGB composites of Substrate, Vegetation & Dark fractions derived from Spectral Mixture Analysis for 3/23/1985, 3/25/2000, and 3/24/2009

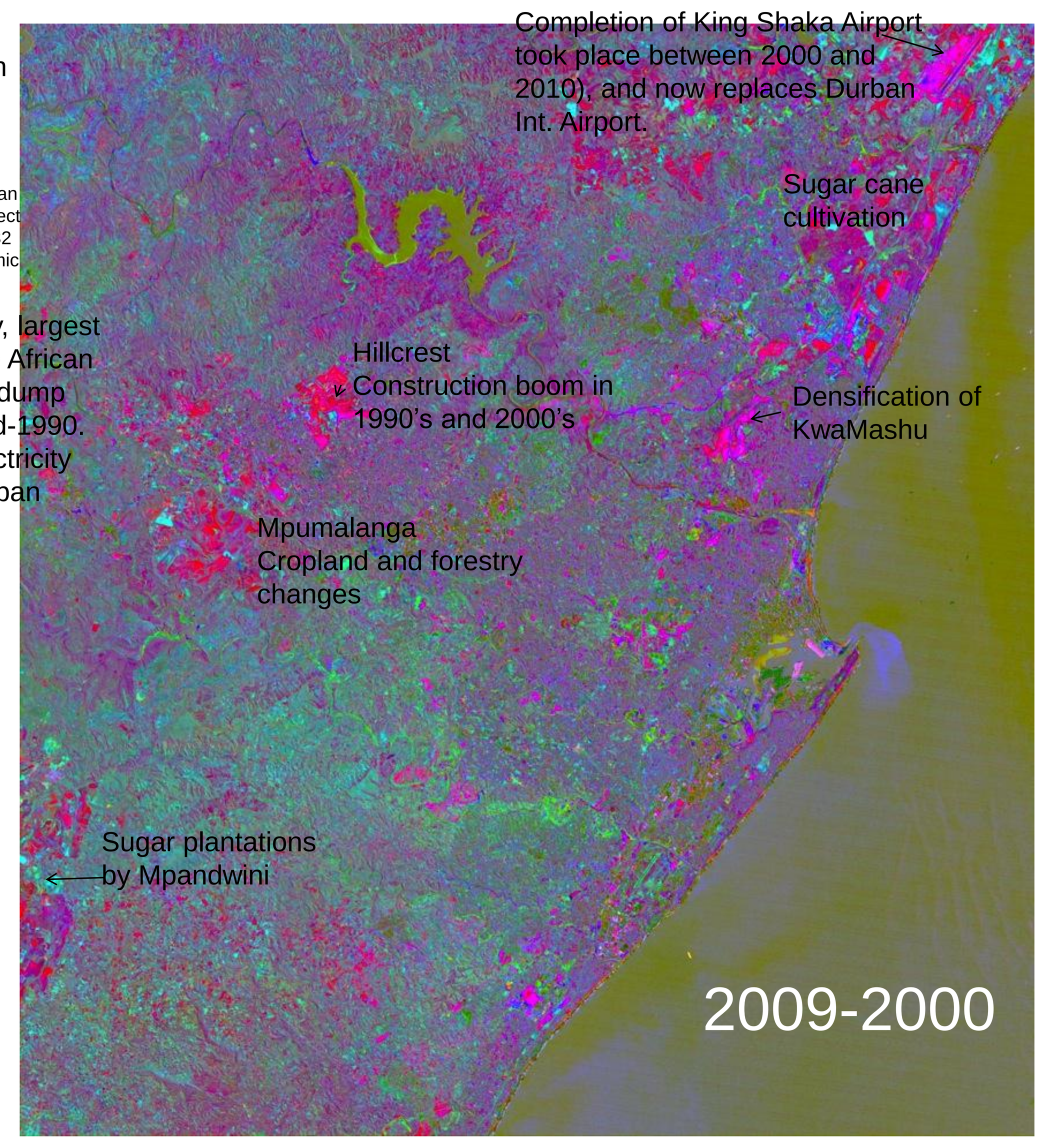


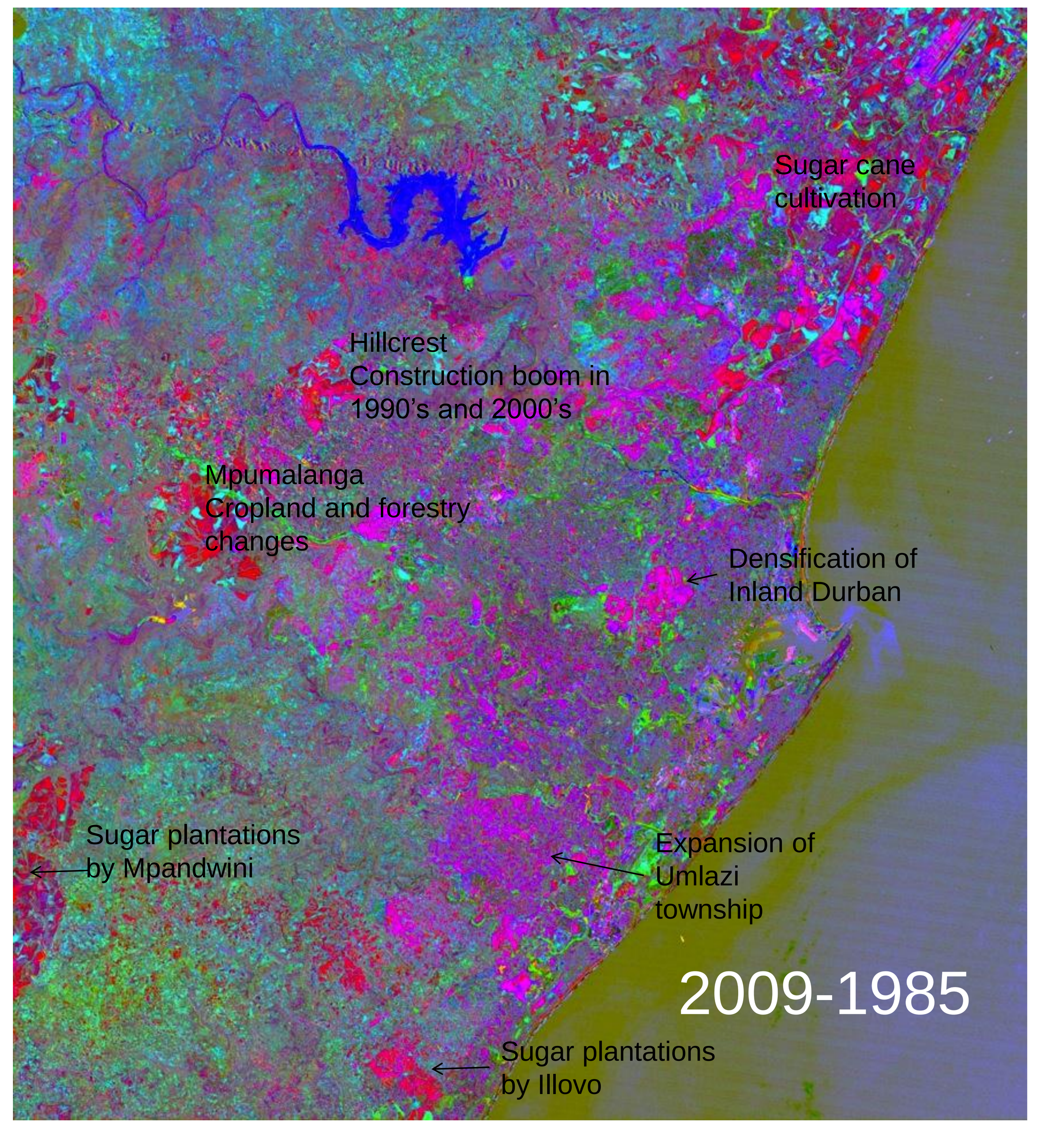




RGB composites of change in fractions derived from Spectral Mixture Analysis for 2000-1985, 2009-2000, and 2009-1985. Color indicates increase in substrate, increase in vegetation, and increase in dark fraction (water or shadow). Prominent changes include Increase in impervious+shadow, impounded water and Increase in fallow croplands.







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