Analysis of Urban sprawl and its effect on Urban Environmental characteristics using spectral reflectance and Landsat Data

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Abstract

Urban landscapes are a complex combination of buildings, roads, pavements, roofs, vegetation, soil, and water, each of which exhibits unique spectral reflectance and thermal properties. To understand the interactions and impact of these heterogeneous urban landscapes on their environmental surroundings, more precise urban mapping techniques are of essential importance. Several studies have demonstrated that spectral reflectance characteristics (in the range of 350-2500 nm) of the different urban landscapes are varied and distinctly different. However the application of this spectral information to map and accurately classify the urban features at local, regional and global scales has rarely been explored. The **goal** of this research project is to investigate the effects of urban landscape features on the local and regional environmental quality in Houston, Texas. The **specific objectives** of the study are, 1) to develop a spectral library of the urban landscape features, 2) Identify and analyze the spectral characteristics of the urban features, 3) Use of multi spectral and multi temporal Landsat imagery to accurately classify and map the urban features and 4) Identify and map the effects of urban sprawl on environmental quality.

Materials and Methods

- The Landsat TM images of Path 25, Row 39; Path 25, Row 40 and Path 26, Row39 were used in this study.
- The georeferenced and terrain corrected Landsat TM images obtained from 1984 to 2011 were downloaded from the USGS EROS Data Center. The Landsat TM images was processed using the ERMapper image processing software, a commercial product of Earth Resources Mapping, Inc. (now part of ERDAS).
- The spectral range of these LANDSAT TM bands are as follows: Band 1: 450-520 nm; Band 2: 520-600 nm; Band 3: 630-690 nm; Band 4: 760-900 nm; Band 5: 1550-1750 nm; and Band 7: 2080-2350 nm.
- Different spectral combination and spectral ratio images were derived from the time series Landsat images.
- The spectral index NDVI (Normalized Difference Vegetative Index) was calculated from the formula NDVI = ((Band4-Band3)/(Band4+Band3)).

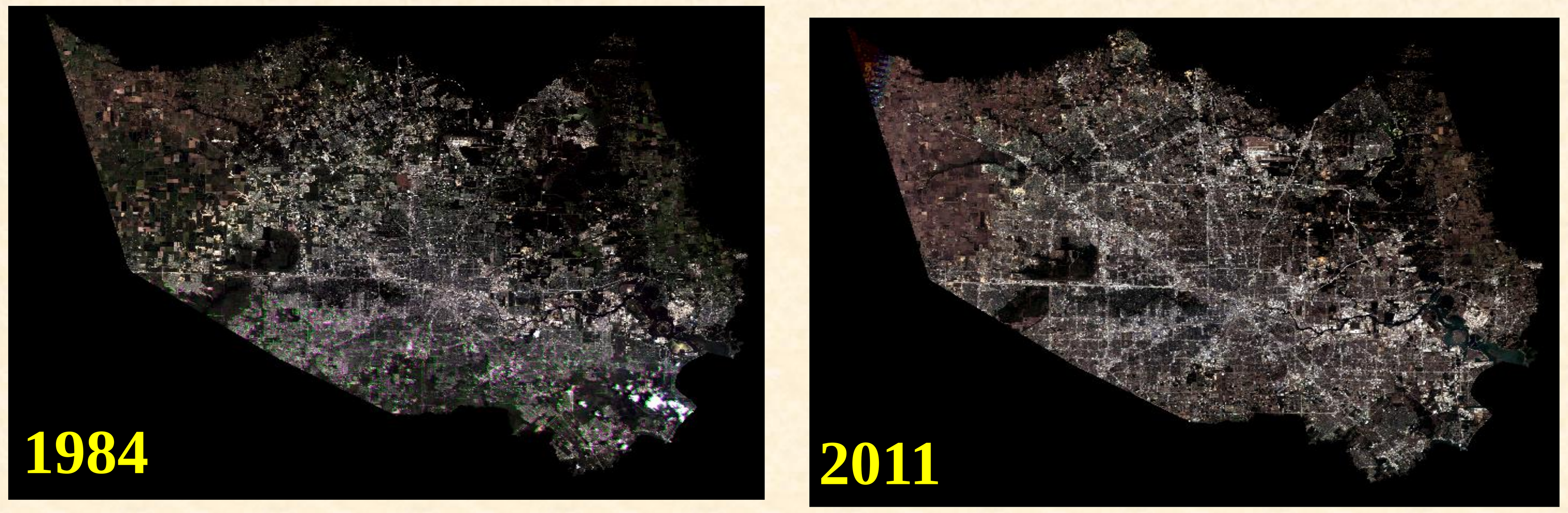

Fig 1. The Landsat TM natural color image (TM bands 1, 2, and 3 displayed as BGR, respectively) showing the Harris County in Texas. The urban areas were seen in grey to white color, vegetation in green color and the surface water bodies in dark color.

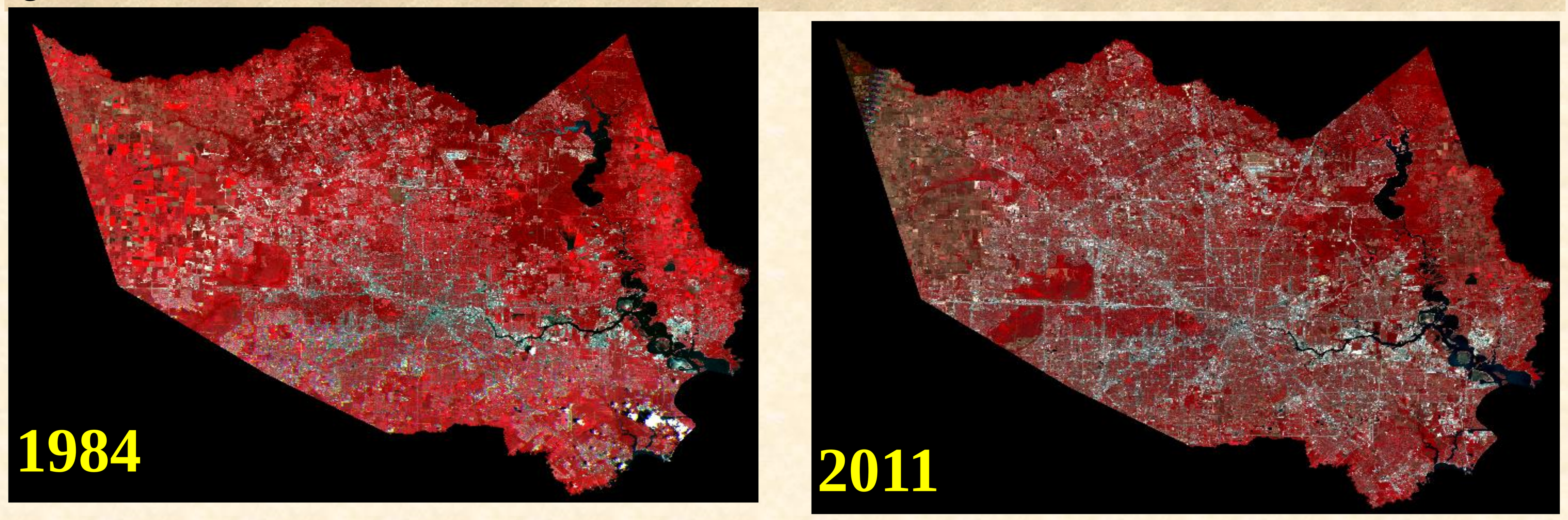

Fig 2. The Landsat TM pseudo color image (TM bands 2, 3, and 4 displayed as BGR, respectively) showing the Harris County in Texas. The urban areas were seen in grey to white color, vegetation in different shades of red color and the surface water bodies in dark color.

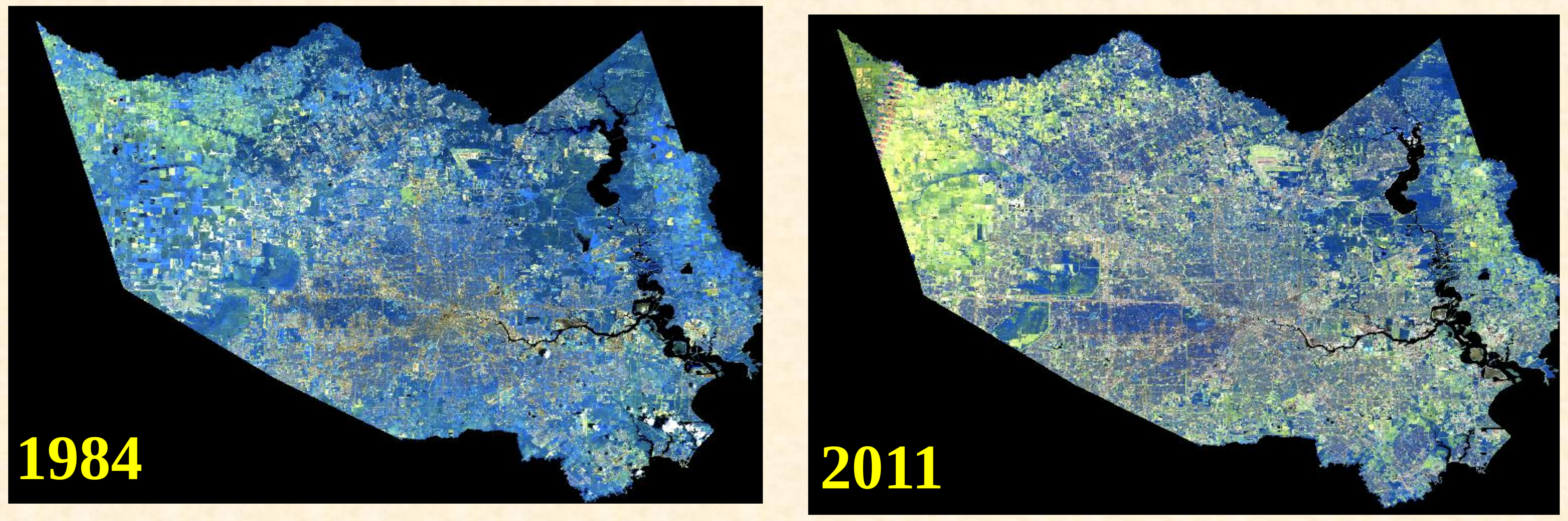

Fig 3. The Landsat TM pseudo color image (TM bands 4, 5, and 7 displayed as BGR, respectively) showing the Harris County in Texas. The urban areas were seen in grey to pink color, vegetation in different shades of blue and green color and the surface water bodies in dark color.

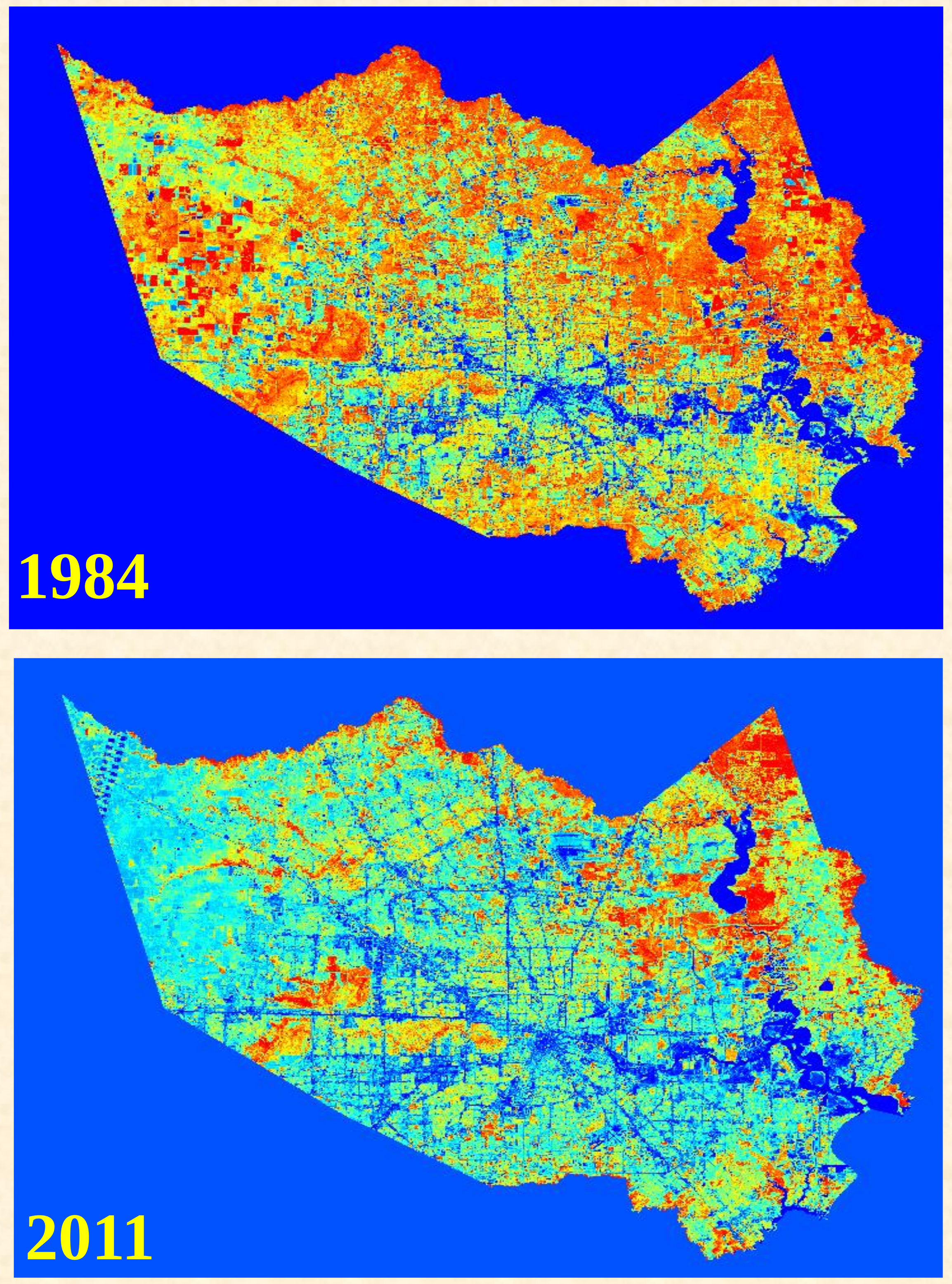

Fig 4. The Landsat TM NDVI image showing the Harris County in Texas. The vegetation appears in different shades of red color.

Results

- From figure 1, the bright and white areas represent road, concrete pavement or building where much heat is generated and seems enormously greater in 2011 than 1984. Urban sprawl has taken much green spaces.
- From figure 2, the bright red color represents greenish vegetation. There seems not to be any bright red nowhere in the 2011 image compare to 1984. The area occupied by the water bodies has reduced consistently from 1984 to 2011.
- Figure 3 and 4 show the deforestation greatly modified the environment. From about 90% of blue (figure 3) or red (figure4) areas in 1984, we have only about 25% of blue (figure3) or red (figure4). Vegetation loss has increased greatly from 1984 to 2011.
- **The direct consequences** are Decrease in water Quality, decrease in air quality, less groundwater, loss of farmland, loss of wetland, loss of green space, pollution increase, increase of CO_2 and decrease of O_2, loss of wildlife, more heat island effect, and temperature variations.

Conclusions

- **Land clearing impacts on biodiversity** Millions of animals and plants are killed directly when native vegetation is cleared (Cogger et al., 2003)
- **Biodiversity Loss** that follows a reduction in the amount of forested land. Trees, shrubs and other plants provide shelter, food and shade for an enormous range of bacteria, fungi, insects, animals and birds. When deforestation occurs, it generally is much harder for the environment to sustain this variety, simply because not all organisms can survive in the same habitat or conditions.
- The **potential benefits** of this study includes long term monitoring of urban sprawl and land use efficiency, quantifying the impervious surface, accurate measurement of heat island effects, linking urban growth to energy efficiency, Ozone concentration and regional flooding.