Microclimate of a Peri-Urban Community in Albuquerque, NM

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Abstract

The present study is using thermal imaging to assess the microclimatic impacts of small-scale agriculture, specifically the cooling effect of agriculture in a desert environment and its impact on residents' quality of life in Albuquerque, NM. Remotely sensed imagery is used to measure Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST), and Albedo (2009 - 2010) from Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper (ETM+). Results of the research will characterize the relationship between temperature and land cover types and explore questions related to temperature rates in urban versus agricultural lands and affects of climate change.

Introduction

Microclimate studies improve the understanding of urban climatology, environmental change, and human-environment interactions that affect the quality of human life. Research has shown that the encroachment of urbanization from agriculture leads to higher temperatures at night, presenting as a contribution to some of the climate change issues. This situation is particularly acute in the South Valley of Albuquerque, NM (figure 1.). This unincorporated community, located on the southern fringe of the Albuquerque metro areas, has been home to irrigated agriculture for many centuries, and is in the process of dramatic transformation due to urbanization (figure 2.).

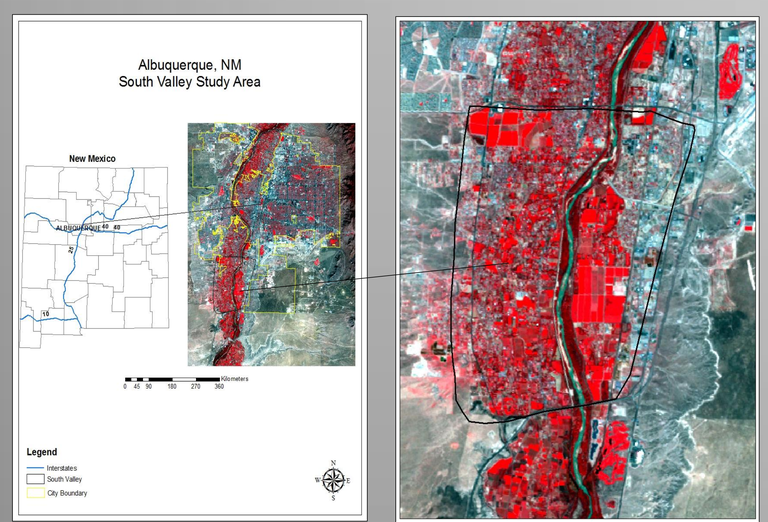


Figure 1. Study Area

Objectives

The objectives are to explore the relationships between air temperature and land use/land cover (LULC) of the South Valley and Albuquerque, NM. LST, albedo, and NDVI derived from Landsat 5 Thematic Mapper (TM) and Landsat 7 (ETM+) to calculate evapotranspiration (ET), sensible heat, and sensible air temperature using the Regional ET Estimation Model (REEM, Samani et al. 2009).

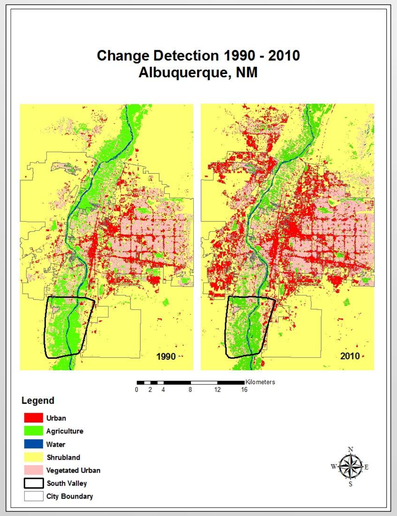


Figure 2. Land Cover

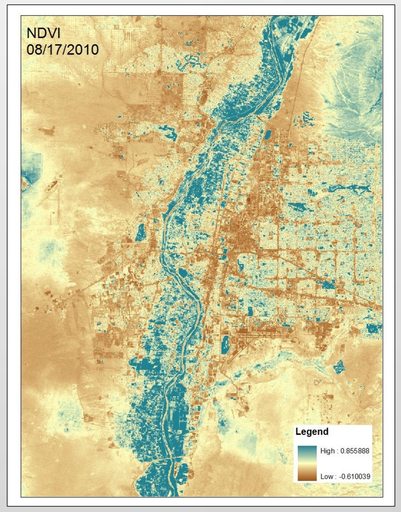


Figure 3. NDVI

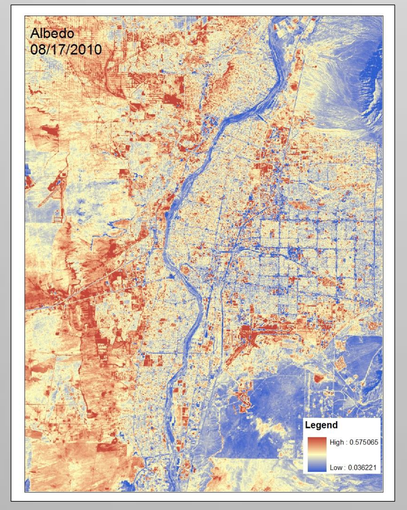


Figure 4. Albedo

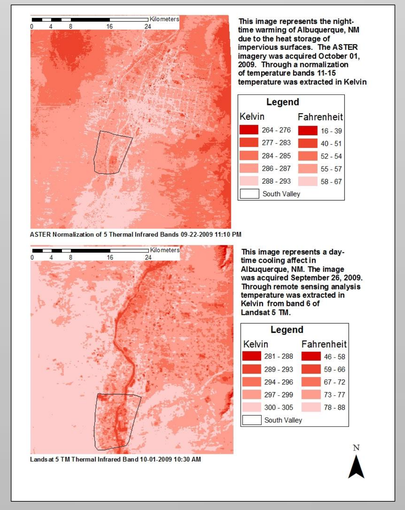


Figure 5. LST

Methodology and Materials

Landsat 5 TM and Landsat 7 ETM+ are used to calculate Albedo, NDVI, and LST. Landsat products are free and have a polar sun-synchronous orbit capturing the same location on earth's surface every 16 days. This allows for a minimum of 2 images per month to use in this study. All image processing was performed using ENVI remote sensing software, by Research Systems Inc., Boulder, CO. NDVI (figure 3) was calculated by the following equation:

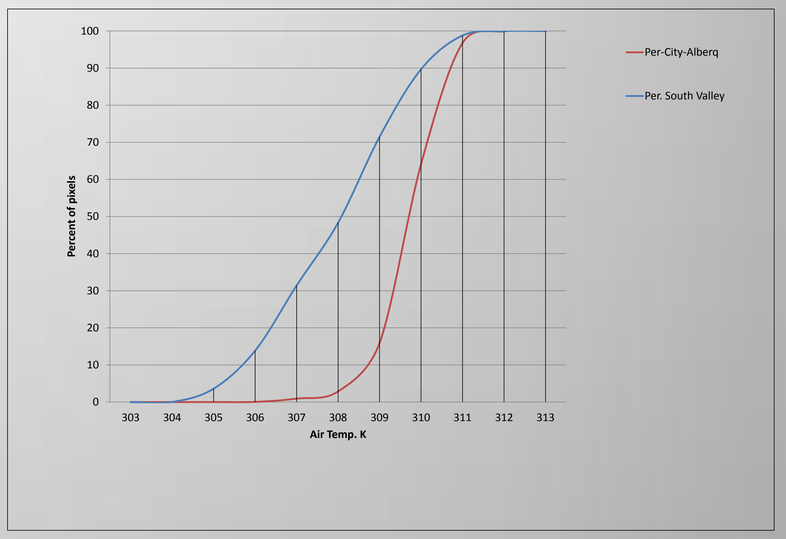
NDVI: (band 4- band 3)/(band 4 + band 3).

Albedo (Figure 4) was calculated using methodology described by Liange et al. (2002), Samani et al. (2009): $\alpha = 0.356\rho_1 + 0.13\rho_3 + 0.373\rho_4 + 0.085\rho_5 + 0.072\rho_7 - 0.0018$

LST(Figure 5) parameters needed are as follows: Top of atmosphere radiance by satellite instrument, upwelling and downwelling radiance, transmissivity and emissivity, and plank equation (converts radiometric temp at surface).

The parameters calculated will be processed using REEM. REEM will calculate the ET then use a back calculation to calculate the air temperature using these parameters as follows: latent Heat flux, sensible heat flux, ground heat transfer, instantaneous radiation ,atmospheric emissivity, surface thermal emissivity, and leaf area index (LAI).

Preliminary Results



REEM output of Air Temperature

Future Research

After deriving the parameters for REEM as described earlier, surface temperature (T_s)will be converted to air temperature (T_a) for one time period of each month for the year of 2010. For comparison of past T_a readings a historical look will be taken and will go back 20 years to 1990 and for every year two images will be acquired for computation of the parameters needed to run REEM. Through the historical look a relationship will be established between not only urban and biophysical descriptors but also how urbanization over time in the Albuquerque/South Valley area has changed the micro-climate in this area. The two images acquired for each year will be leaf on (summer) and leaf off (winter). This is to study the relationship between the seasonal variations of LST, NDVI, albedo, and land cover types. As research has shown, winter can display distinct landscape and LST patterns (Liu and Weng 2008). Therefore, the study will include the two seasons most affected by urbanization.

Acknowledgements

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