Assessing the relationship between urban parameters and the LST derived by satellite and aerial imageries in a GIS environment: the case of Bari (Italy)

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Introduction & Motivations

A large number of researches were recently focused on the relationship between land surface temperature and several urban physical factors. The remote sensing data are recognized as the most appropriate to study the thermal behavior at the urban or meso-scale. Within such studies various indicators representative of the urban environment have been used to describe their influence on the different urban thermal patterns. For this purpose several correlation techniques were applied. Amongst global multivariate regression relationships are relatively well established, the statistical analysis used are very often spatial, not representing the spatial nature of the relationship among the involved factors. In order to highlight the spatial nature and scale dependence of the thermal processes occurring within urban areas used as case study, we established the existing relationships between selected Land Surface Temperature (LST) and the physical geometrical parameters of the urban environment. A better knowledge on the effect of increasing spatial resolution of thermal data from space on the overall analysis was achieved by using thermal data from Terra ASTER and Landat platforms.

Methodology

- In order to explore the relationship between LST and the urban physical parameters we have:
  - performed the estimation of this through the methodology suggested by Sobrino et al. (2004), as an alternative to the widely used method such as the TES and EBC;
  - oversampled the LST ground resolution to 15 m for the thermal data from ASTER image, and 50 m for the thermal data from Landat image;
  - applied an exploratory multiple regression analysis (i.e. no geographical location is considered in the estimation of the model parameters);
  - applied a spatial multiple regression analysis.

Study Area & Dataset

STUDY AREA

Bari Metropolitan Region, Italy
K (S17°W, E16°E)
Geographical location
114.33ha 228.915 habitants
Population density
Dense urban mosaic with medium height buildings.

ASTER Level 10

DATE OF ACQUISITION: 26 July 2001 (approx. 10:00 a.m.)
GROUND RESOLUTION: 15 m (9 x 9 m) and 80 m (4 x 4 m)
SPECTRAL RESOLUTION: 16 bands 

LANDAT

DATE OF ACQUISITION: 19 May 2013 (9:34 a.m.)
GROUND RESOLUTION: 30 m (6 x 6 m) and 60 m (3 x 3 m)
SPECTRAL RESOLUTION: 15 bands (5.88 m)

Thermal analysis

Multiple Regression Analysis

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<th>LST</th>
<th>LST (quality)</th>
<th>LST (temperature)</th>
<th>LST (present)</th>
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Results

Regression analysis applied to the thermal imaging highlighted the relationship between LST and physical factors included in the analysis. From the obtained bi-linear prediction, the evaluation of the morphometric protection index (MPI) was excluded due to the very high value of statistical significance. Subsequently, both models, aerial and spatial, used with thermal data with dual spatial resolution, showed a better overall result. This can be probably explained by the former more complex algorithm that has parameters more suitable to the Sun View Factor (SVF) variable. This value is about 0.6. However, the SVF seems to show a greater predictive power with respect to the MPI. By substituting such a factor in place of the MPI in the model, the predicted value is lower.

Multiple Regression Analysis

Conclusions

The methodological behavior of the regression analysis, both spatial and spatial, demonstrates the strong effect of spatial resolution on the thermal processes occurring at urban scale.

This was demonstrated by inspecting the values of the determination coefficient and residuals provided as outcomes for the two thermal images. In particular, the analysis of residuals shows the need to integrate the explanatory variables with other descriptive of the urban environment, such as the analysis of impervious surfaces. The overall results of the analysis are not satisfactory and could allow to predict the variations of surface temperature with respect to variations of the urban parameters, such as the extension of vegetated surfaces, which would produce an increase of factors NDVI and Fv.