Analysis of urbanization induced land cover change and impact on land surface temperature with Landsat, MODIS, and ERA5 imagery

Tancara, A1 ; Soria, F. A.2

1,2Centro de Investigación en Agua, Energía y Sostenibilidad (CINAES), Universidad Católica Boliviana "San Pablo", La Paz - Bolivia.

*Correspondence YP: [1]moraleta1698@gmail.com, [2] fsoria@ucb.edu.bo

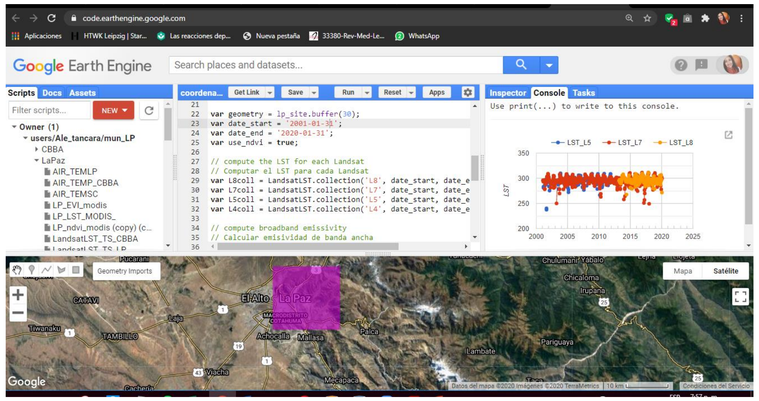
Abstract : Bolivia's cities continue developing among size and population. Growing urbanization has a significant impact on Urban heat islands affecting environmental conditions and human comfort. Vegetation indicators are widely used to estimate the vegetation coverage based on remote sensing. Therefore, this research uses Google Earth engine to demonstrated a multitemporal correlation between land cover change and Land Surface Temperature (LST) in the three most important cities of Bolivia using NDVI and EVI indexes. This study used MODIS, Landsat and Era satellites. The results show an inverse correlation between LST and in NDVI depending on the geographical location.

Keywords: Urban Heat Island, sustainable development goals, Google Earth Engine, remote sensing, time series, Land Surface Temperature.

Methods

- Study Region: La Paz, Cochabamba and Santa Cruz cities.
- Time series: 2001-2019
- Google Earth Engine sign up to pre and process the data.
- For LST:
  - The Statistical Mono- Window Algorithm using Landsat satellites 5,7,8, ASTER GED, NCEP/NCAR data from 2001-2019.
- For Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI)
  - MODIS Terra data was acquiered, selecting the bands and filtering the dates.
- For Air Temperature
  - ERA 5 data was used selecting an specific band.
- Data Analysis
  - Linear regression for each city.

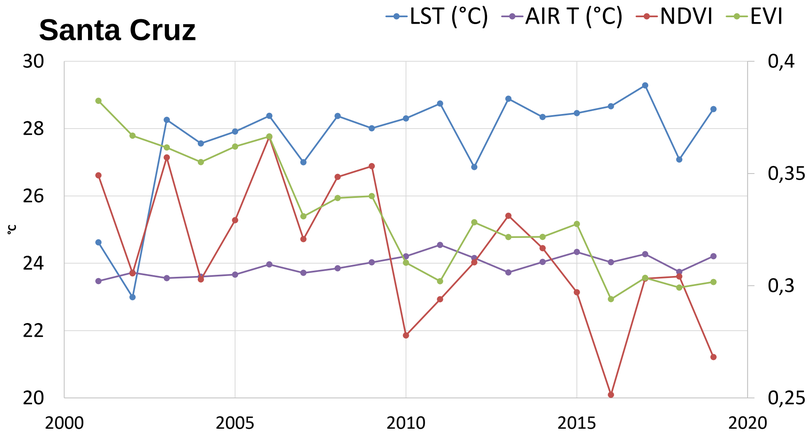
Figure 1: Google Earth Engine Platform



Results

- The increase of LST per year in La Paz, Cochabamba and Santa Cruz are: 0,15, 0,11.0,17°C respectively. For Air temperature: La Paz and Cochabamba 0,04 and for Santa Cruz 0,03°C. The NDVI average in La Paz, Cochabamba and Santa Cruz are: 0,12 bare vegetation, 0,21 and 0,32 : grassland and shrubs.
- Among the figures we can observe that when there are an increase of LST, there are a decrease of NDVI and EVI in the three cities. We can infer an inverse correlation. The correlation may be different in each city due the diverse geographical locations and climate.

FIGURE 1: Time series of LST, air temperature, NDVI and EVI from 2001 to 2019



Conclusions

- NDVI and EVI has an inverse correlation with LST in the three cities.
- LST is a significant indicator to monitoring the increase or presence of UHI's
- NDVI and EVI are an important indicator for vegetation coverage. In addition, these indexes are useful to analyze time series due to the facility to calculate and precision in the results.
- Santa Cruz is considered the city with most of land cover changes due to the decrease of NDVI indicator of 0.1 over the years and an increase of LST and air temperature.
- We suggest to compare these spatial measurements with in situ ones.

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