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THE RELATIONSHIP BETWEEN THE LAND SURFACE TEMPERATURE AND NORMALIZED DIFFERENCE VEGETATION INDEX

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Abstract: In recent years, land cover/use has undergone major changes, and this aspect and other factors in climate change both in our country and globally. Vegetation indices based on satellite images are increasingly used to characterize the response of vegetation to climate variability and change over large spatial scales. One of the parameters estimated based on remote sensing and used in calculating temperature interception is the LST index. This study proposes to evaluate the trend of the spatial-temporal relationship between land surface temperature (LST) and normalized difference vegetation index (NDVI) in different ranges of LST and NDVI values for Timis County. Vegetation is very sensitive to climate changes and various anthropogenic influences, and these variations of the NDVI index can cause changes in the temperature of the land surface. In the final part, the correlation between the spectral indices of land cover (NDVI and NDWI) and soil surface temperature (LST) was made. The remote sensing images were processed using the Geographic Information System (GIS).

• Introduction

This study used the Landsat 8 imagery, obtained from the United State Geological Survey (USGS) (<https://earthexplorer.usgs.gov/>). These images were selected for the same month over a 3-year period with a spatial resolution of 30 meters. Remote sensing satellites at various spatial, spectral, and temporal resolutions provide a solution, regarding database as a primary source, being used on a large scale in many fields. The studies show that the land use change accentuated in recent years can have an effect on the hydrological response from the catchment area regarding precipitation and not only (Huang et al. 2008). Monitoring of the land surface temperature (LST) through remote sensing imagery is one of the most important contributions to climatology. LST (land surface temperature) results indicate the areas affected by the heat island effect and local thermal differences on different types of surfaces.

• Material and method

This study was realized for Timis County, an area located in the western part of Romania, being the most extensive county in the country, with an area of 8,696.7 km². The hydrographic network of this county includes two large catchment areas: Bega-Timiș-Caraș and Mureș. In the northwest, it borders Hungary, and in the southwest Serbia. The territory of the county is traversed from east to southwest by the Bega River and Timiș River, and in the north follows its course from east to west, the Aranca River, an old branch of the Mureș River. Landsat 8 is one of the Landsat series of NASA (National Aeronautics and Space Administration) and it is available on the USGS (United States Geological Survey) Earth Explorer website for research purposes. In the present study, the TIR bands 4 and 5 were used to generate NDVI of the study area from the Landsat 8 image. Satellite data over the study region of April of 2018 2019 and May 2023 have been used in this study.



Figure 1. The study area

The NDVI is the most used index for vegetation monitoring and is based on the combination of red band and near-infra-red (NIR) band wavelengths and can be computed by the well-known formula (Eq. 1) of Rouse et al. (1974).

$$NDVI = (NIR - RED) / (NIR + RED) \quad (1)$$

Where: NDVI is the Normalized Difference Vegetation Index;
NIR is the near infra-red band (841–876 nm);
RED is the red band (620–670 nm).

Another index used is NDWI, a parameter used to monitor water body changes based on the wavelength of the green band and the NIR band. It can be calculated by the formula (Equation 2) of McFeeters (1996):

$$NDWI = (GREEN - NIR) / (GREEN + NIR) \quad (2)$$

Where: NDWI is the Normalized Difference Water Index;
GREEN is the green band (525–600 nm).

• Results and discussions

Figure 3 shows the spatial-temporal distribution of the NDVI index of the study area for the months of April 2018, 2019, and May 2023 processed in ArcGIS based on Landsat collection 2 -Level 2 satellite images. The vegetation cover had a spatial variability especially for the years 2019, respectively 2023.

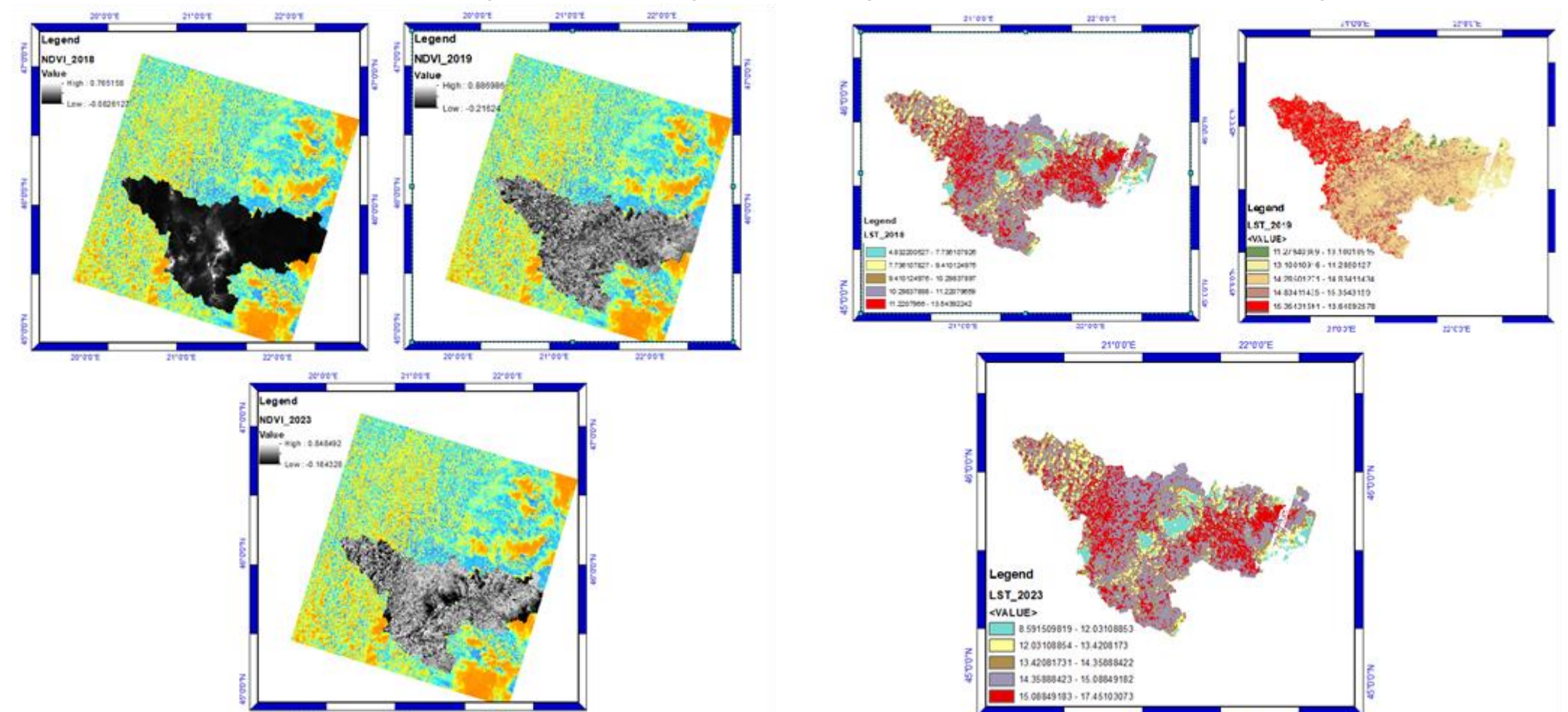


Figure 3. NDVI maps of the study

Figure 4. LST maps of the study area

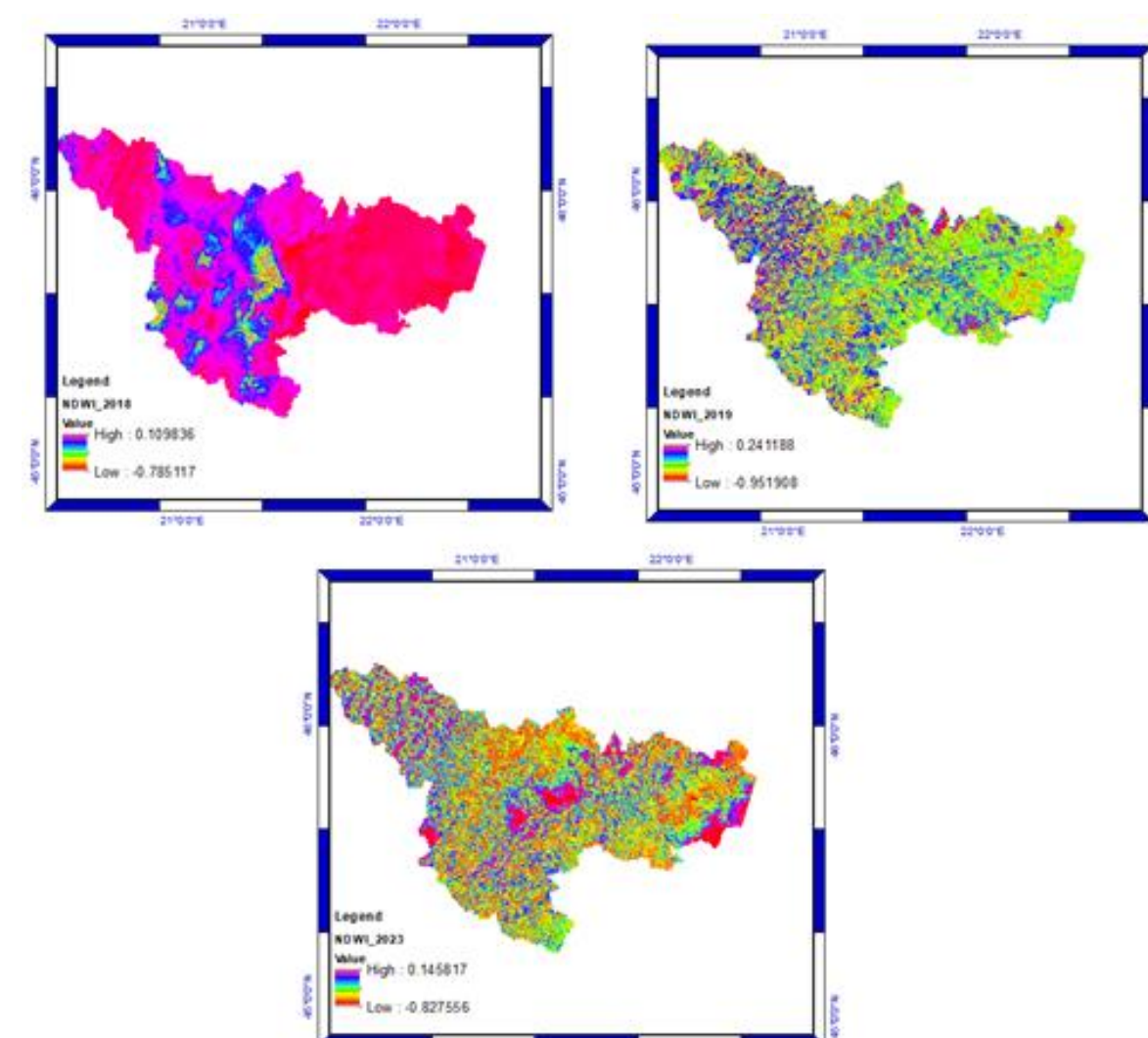


Figure 5. NDWI maps of the study area

Gao, 1996 calculates the NDWI index from NIR - Near Infrared band – which reflects the content of dry matter, and SWIR- Short Wave Near Infrared band – which reflects the water content of the vegetation. NDWI value ranges from -1 to + 1, McFeeter (1996), suggested a threshold of zero for extracting water bodies, where all positive NDWI values are categorized as water and values less than or equal to zero (i.e. ≤ 0) are classified as non-water

• Conclusions

The LST maps were prepared from the satellite data, and the analysis represents the spatial distribution of surface temperature for Timis County. The analysis of the LST index showed a higher surface temperature in the built-up area and lower in areas with healthy vegetation. The maximum value of LST observed in each month was 17.45°C for 2023 year, 13.54 °C for 2018, and 18.64 °C for 2019 year. This study highlights the association of the LST index with land cover indices, and from the obtained data it can be observed that the correlation between NDVI and LST is negative. The relationship between land surface temperatures derived from Landsat satellites and land cover indicators can give an indication of the possibility of monitoring the phenomenon of desertification, urban development, expansion, drought, and wetlands.