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STUDING LST AND NDVI VALUES FOR SUHI non-SUHI OCCUPIED BY CONSTRUCTIONS AND BUILDINGS: A CASE STUDY OF IASI

Paul Marian GHERASIM [1], Mihai DIMA[1], Ioana AGAPIE (MEREUȚĂ)[1]

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ABSTRACT. In this paper we tried to study the values of radiant temperatures (Land Surface Temperature) and NDVI (Normalized Difference Vegetation Index) for areas occupied by buildings and green spaces. The area affected by the Urban Heat Island (UHI) was also determined. Study Area, Iasi, the largest city in eastern Romania, is geographically situated on latitude 47°12'N to 47°06'N and longitude 27°32'E to 27°40'E. LST is an estimate of ground temperature and is important to identify change in environment. An important parameter in global climate change is rapid urbanization which leads to an increase in Land Surface Temperature (LST). The urban heat island (UHI) represents the phenomenon of higher atmospheric and surface temperatures occurring in urban area or metropolitan area than in the surrounding rural zones due to urbanization. It also been found that night UHI is more powerful than day. At night the LST values for SUHI varies between 24.5°C-25.9°C, and during the day between 35°C-38.7°C. With the development of remote sensing technology, it has become an important approach to urban heat island research. MODIS and Landsat data were used to estimate the LST and NDVI. From the analysis of the images it can be seen that the temperatures in SUHI are lower where there are green spaces around the buildings, and temperatures are higher in the non-UHI area, where inside or around the green spaces there are surfaces built or covered with concrete. Statistical data show very average temperatures for areas affected by UHI, 37.8°C for daytime and 24.6°C for night.

Keywords: Iasi, LST, NDVI, Remote Sensing, UHI.

1. INTRODUCTION

Thermal properties of surface, Earth's surface energy balance and atmospheric conditions effect the land surface dramatically. Local and global change continues in the Earth's climate since the industrial era continues.

Some of the changes occurs due to natural phenomena and anthropogenic activities such as: greenhouse gas, land cover and land use change, uncontrolled

[1] „Gheorghe Asachi" Technical University of Iasi, Faculty of Hydrotechnical Engineering, Geodesy and Environmental Engineering, 700050, Iasi, Romania, e-mail gheraspaul@gmail.com , ioanaagapie@yahoo.com

use of groundwater, deforestation, rising water demands, urbanization, and irrigation activities (Penny and Kealhofer, 2005).

The Urban Heat Island (UHI), according to Voogt and Oke (2003), represents the phenomenon of higher atmospheric and surface temperatures occurring in urban area or metropolitan area than in the surrounding rural zones due to urbanization. Also this phenomenon is most noticeable during the summer and winter.

Land surface temperature is an estimate of ground temperature and the important to identify changes in environment. Land surface temperature can provide important information about the surface physical properties and climate which plays a role in many environmental processes (Dousset and Gourmelon, 2003). Many studies have estimated the relative warmth of cities by measuring the air temperature, but this method can be both expensive and time consuming. Remote sensing is a better alternative to the aforesaid methods. The advantages of using remotely sensed data are the availability of high resolution, consistent and repetitive coverage and capability of measurements of earth surface conditions (Owen et al.,1998).

The degree of Surface UHI varies with different impervious surfaces, wind and rainfall, variation of vegetation cover and climatic conditions like season. Formation of UHI is one attribute of urban land transformation of the nature lands into impervious built-up lands may have significant impacts on the ecosystem, hydrologic system, biodiversity and local climate. LST can be used as parameter for representing UHI phenomenon. While surface temperatures can be used as both higher and more variable than concurrent air temperatures due to the complexity of the different land surface types in urban environments and variations in urban topography (Nichol, 1996).

Remotely sensed data of LST, vegetation and urban indices and other surface characteristics have been widely used to study UHI phenomenon (Carlson et al., 1994). The advantages of using remotely sensed data are the availability of high resolution, consistent and repetitive coverage and capability of measurements of earth surface conditions.

2. MATERIAL AND METHODS

2.1. Study area

Iaşi county is considered as study area in this research. Study area is geographically situated on latitude 46°48'N to 47°35'N and longitude 26°29'E to 28°07'E. Neighbours of Iaşi county are Botosani to the north, Neamt to the west, Vaslui to the south and Republic of Moldova to the east. Iaşi county is situated in easten of Romania and it has an area of 5.476 km². Iasi, the largest city in eastern Romania, is the seat of Iaşi County. Capital of the historical region of Moldavia, Iaşi, has traditionally been one of the leading centres of Romanian artistic life, cultural, academic and social. The city is positioned on the Bahlui River. This is an affluent of Jijia that flows into the Prut River. This is one of the "legendary city of

the seven hills", namely Bucium, Cetățuia, Galata, Copou, Șorogari, Breazu and Repedea, just like so many cities around world, one such example being Rome. The local climate is continental with low rainfall and with large temperature differences between the seasons. Summer is hot and it lasts from the end of the month of May up to the half of September.

Autumn is a short season, of transition. In the second half of November there is usually frost and snow. Winter is a freezing season with temperatures dropping to –20ºC (https://en.wikivoyage.org/wiki/Iași).

2.2. Data resources

Landsat 8 was used in this study to determinate NDVI value, while MODIS data was used to calculate LST value. The study was performed by selecting the swelter days for the period 2016-2020. Data (for swelter days) from the National Meteorological Agency were used to determine the days used in this study. In cases where satellite images were affected by clouds, they were not used.

2.3. Data processing

2.3.1. Image preprocessing

Preprocessing of Landsat-8 OLI images stage represent that operations that prepare images for subsequent analysis that attempts to compensate/correct for systematic errors (miningeology.blogspot). Both Landsat and Modis images have been processed in Arcmap. Only MODIS data showed a clear sky was used in this research.

2.3.2. Normalized Difference Vegetation Index

NDVI, according to Rouse, is a numerical indicator that uses the visible (Vis) and near-infrared (NIR) bands of the electromagnetic spectrum and is adopted to analyze remote sensing measurements and assess whether the aim being observed contains live green vegetation or not (Rouse J. et al., 1974). The NDVI algorithm subtracts the red reflectance values from the near-infrared (NIR) and divides it by the sum of them.

$$\text{NDVI}=\frac{(NIR-RED)}{(NIR+RED)} \qquad (1)$$

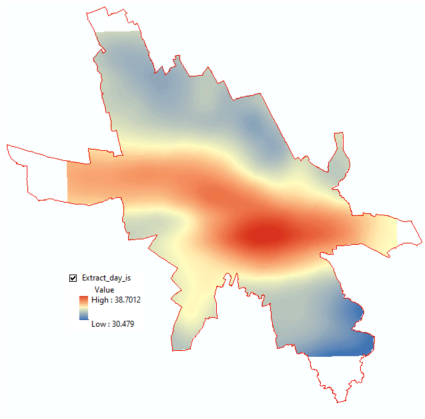
2.3.3. Land Surface Temperature (LST)

To estimate the LST from MODIS data was use ArcMap and was follow steps indicated by official site (https://modis.gsfc.nasa.gov/data/).

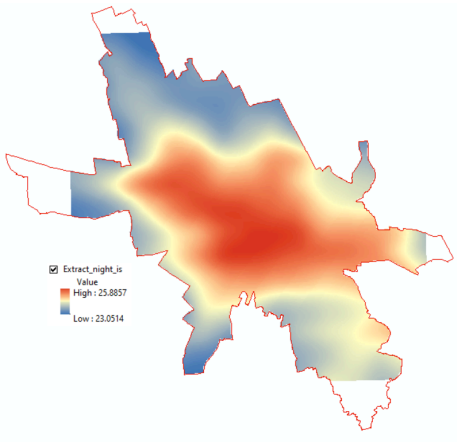
3. RESLUTS AND DISCUSSION

Figure 1 shows SUHI for day and for night, green space, built-up area, non-UHI area for day and for night, LST value for built-up area for SUHI for day and night

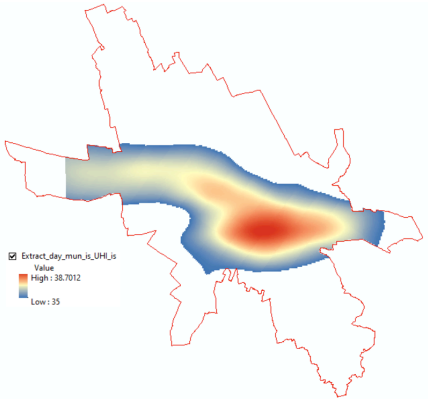
and LST value for green space for non-UHI zone for day and night. Also figure 1 shows NDVI maps for UHI and non-UHI zone. Statistical data for all maps is presented by table 1.



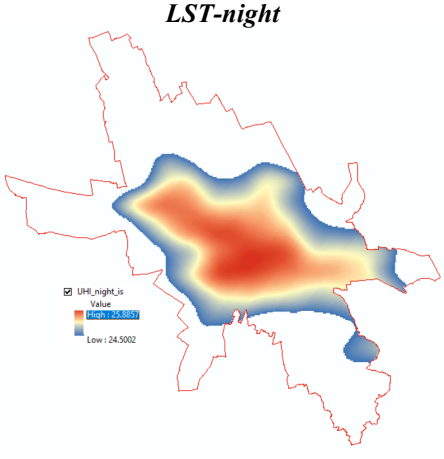
LST-day



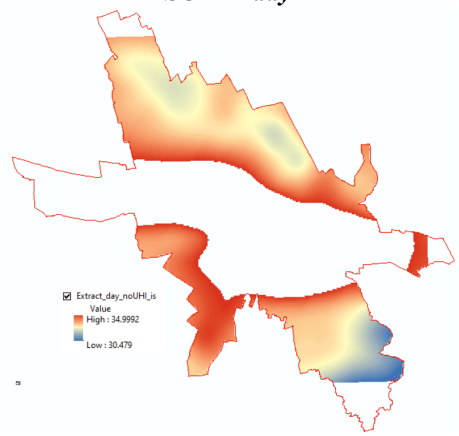
LST-night



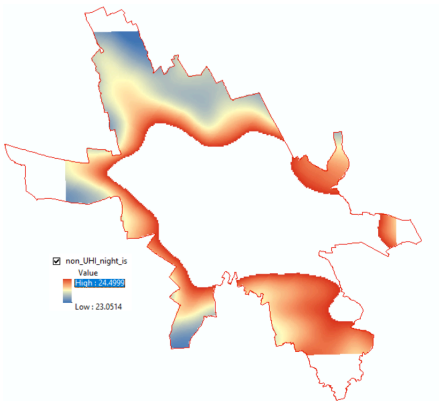
SUHI - day



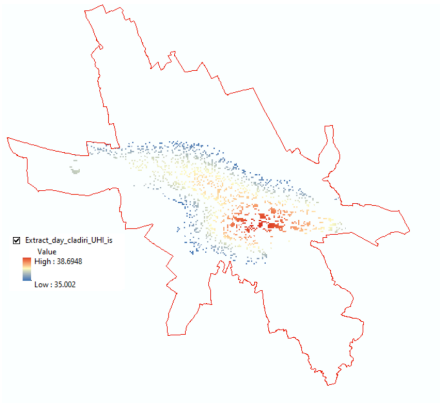
SUHI - night



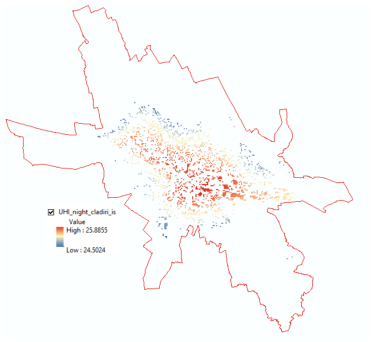
Non-UHI day



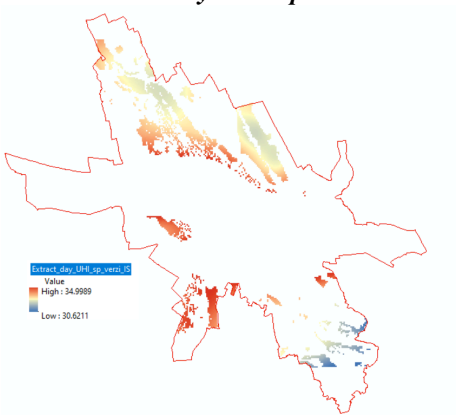
Non-UHI night



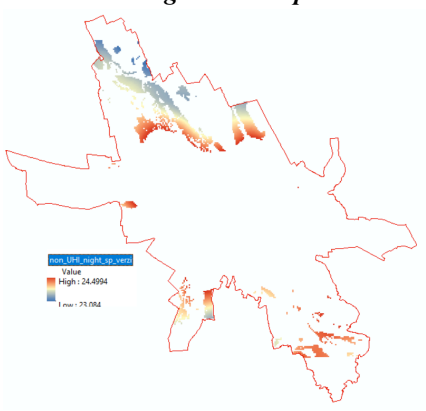
UHI – day built-up area



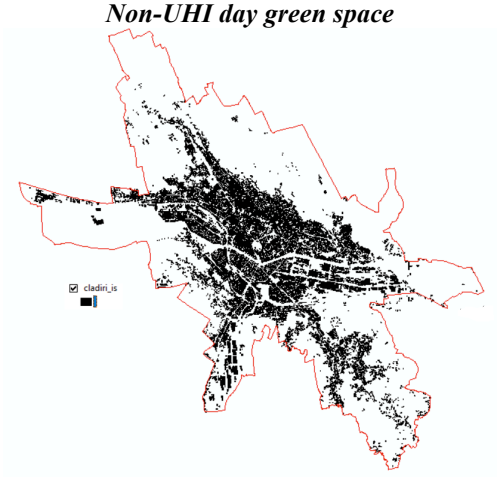
UHI – night built-aup area



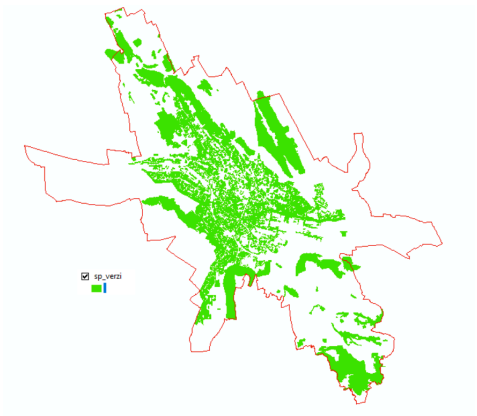
Non-UHI day green space



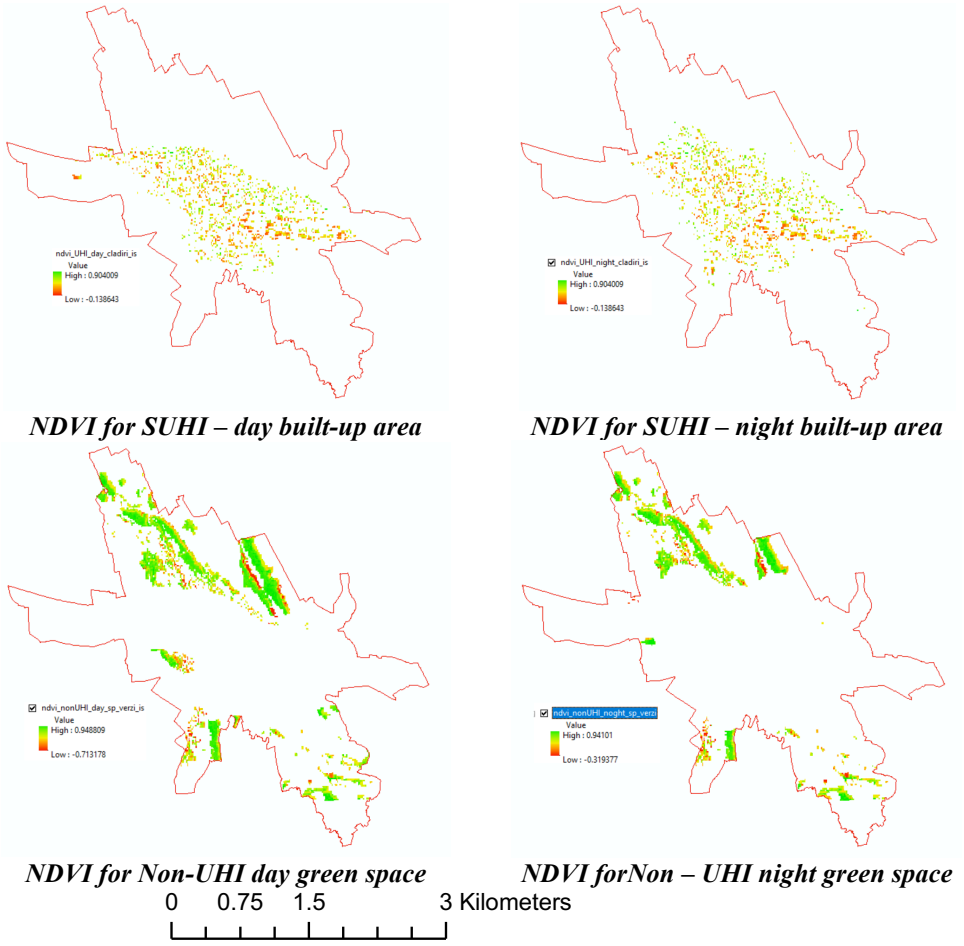
Non – UHI night green space



Built -up area Iasi



Green space Iasi



NDVI for SUHI – day built-up area ***NDVI for SUHI – night built-up area***

NDVI for Non-UHI day green space ***NDVI forNon – UHI night green space***

Fig. 1. UHI analisys maps

In order to identify SUHI, the condition suggested by the specialty literature was imposed. Thus, only surfaces with a temperature higher than 34.5º degrees were included in SUHI.The analysis of the maps presented in fig. 1 shows that UHI occupies especially the central area of Iasi municipality, an area that is heavily urbanized. Also, the effects of this phenomenon are stronger during the night. Also from the analysis of the images it can be seen that the temperatures in SUHI are lower where there are green spaces around the buildings, and the temperatures are higher in the non-UHI area, where inside or around the green spaces there are surfaces built or covered with concrete.

Statistical data show very high average temperatures for areas affected by UHI, 37.8°C during the day and 24.6°C for the night, respectively. The statistics also indicate that the phenomenon is stronger during the night than during the day.

Table 1. ***Statistics data***

Parameter	Minimum	Maximum	Mean	Standard deviation
LST day	30.5	38.7	37.8	1.6
LST night	23	25.9	24.6	0.71
SUHI day	35	38.7	36.4	0.87
SUHI night	24.5	25.9	25.2	0.39
non-UHI day	30.5	35	33.6	0.85
non-UHI night	23	24.5	24	0.39
UHI day – built-up area	35	38.7	36.7	0.95
UHI nigh – built-up area	24.5	25.9	25.4	0.34
Non-UHI day – green space	30.6	34.5	33.4	0.85
Non-UHI nigh – green space	23	24.5	23.9	0.31
NDVI for UHI day – built-up area	-0.14	0.9	0.34	0.21
NDVI for UHI nigh – built-up area	-0.14	0.9	0.36	0.22
NDVI forNon-UHI day – green space	-0.71	0.95	0.67	0.25
NDVI for Non-UHI nigh – green space	-032	0.94	0.69	0.21

4. CONCLUSIONS

In this paper drought was used MODIS and Landsat image to create NDVI and LST maps for Iasi. From LST maps was extracted SUHI for Iasi.. The temperature for the built-up areas and the one occupied by green spaces was also studied and maps were created for them.

It has been observed that the phenomenon is stronger during the night than during the day. Also, the effects of this phenomenon are stronger for built-up area.

Also from the analysis of the maps it can be seen that the temperatures in SUHI are lower where there are green spaces around the buildings.

Temperatures are higher in the non-UHI area, where inside or around green spaces there are built-up area.

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