THE LAND SURFACE TEMPERATURE DISTRIBUTION DURING 7TH-AUGUST-2012 USING MODIS IMAGERY IN IASI METROPOLITAN AREA

I. IORDACHE[1], L. APOSTOL[1], P. ICHIM[1]

ABSTRACT. – The land surface temperature distribution during 7th august 2012 using Modis Imagery in Iasi metropolitan area2012 was the hottest year recorded at Iasi weather station in the 1961-2015 interval. In this paper we investigate the possibility to use MOD11A1 and MYD11A1 as an visualizing and analysis tool of land surface temperatures distribution in urban and nearest rural areas during heat waves according to the land use.. We observed that MODIS nighttime view instances could detect strongly urbanized surfaces like concrete and asphalt to have higher values than the green areas as parks and forests.

Keywords: land surface temperature, MODIS Terra, remote sensing, Iasi, heat waves

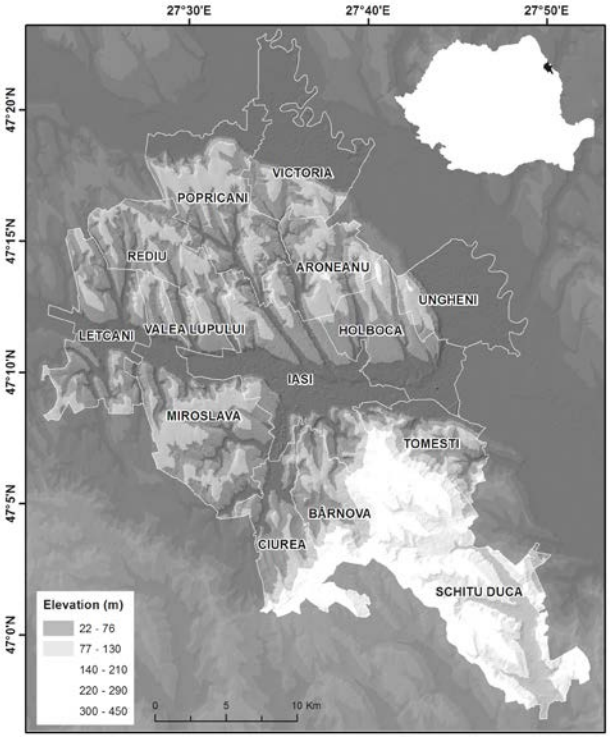

Fig. 1 ***Geographical location of the study area within Romania***

1. INTRODUCTION

2012 was the year who marked the highest recorded temperatures in eastern Romania. During the first decade of August of 2012, the maximum recorded temperature at Iasi weather station (15040) was 41.3° C, marking the maximum absolute value for Iasi in 1961-2015 interval. This event occurred during 7-VIII-2012 at 14:00 UTC. (GSOD, 2017).

The metropolitan area of Iasi is located in the northeastern part of Romania, having a permanent population of 461,862 inhabitants distributed in 14 administrative units (NIS,

[1]Alexandru Ioan Cuza University of Iasi, Faculty of Geography and Geology, Department of Geography, 700505 Iasi, Romania, e-mail: julian.jordache@gmail.com

2016) covering 800 square km. (47° 20′ N and 27° 50′ E).

The Urban Heat Island of Iasi (IUHI The Urban Heat Island of Iasi (IUHI) was highlighted by Alexe et. al (2012) where they found that the maximum differences between the city and the nearest rural areas are produced in the evening and the minimum differences are occurring at noon.

Several papers have shown that land cover is one of the major factors that are influencing the land surface temperature (LST) distribution within urban areas (Vargo et. al, 2013) and it is well documented for the major cities across the Europe, i.e. Bucharest (Cheval et. al., 2009), Athens (Stathopoulou et al., 2007), London and Baghdad (Ali et. al., 2017).

MODIS imagery is widely used in climatological studies especially in urban climatology. Cheval et al., 2015 used MODIS imagery to highlight the UHI of Bucharest during summer.

The main objective of this paper is to assess the characteristics of spatial distribution of the land surface temperature from a remote sensing point of view using MODIS LST data, during the 7th August 2012. In addition, this paper wants to be a methodological starting point for other works in the near future.

2. DATA ACQUISITION AND METHODS

From a data point of view, the emphasis is putted on the MODIS imagery due to the widely global availability of data and daily availability.

MODIS represents an essential instrument in the NASA Earth Observing System (EOS). The main purpose of this system is to provide long time data series about changes that are occurring in the Earth's geosystems. MODIS mission integrates two satellites Terra and Aqua positioned on a heliosynchronous orbit.

The MODIS data was retrieved from LP DAAC (Land Processes Distributed Active Archive Center – https://lpdaac.usgs.gov/) with some bash scripting.

To obtain the daily LST distribution for 07 th August of 2012 we acquired and processed four images from MOD11A and MYD11A1 products. Each of tbese products provides two instances of night respectively day views of the LST values at 1 km spatial resolution. The main characteristics of MODIS scenes used in our study are presented in **Table 1**.

Table 1. ***Main characteristics of*** **MODIS** ***scenes used in the study, including observation time (Time), spatial resolution (SR), cloud contamination (CC) and maximum (MAX) and minimum (MIN) LST values***

Filename	Time (UTC)	SR (km)	CC (%)	MAX (°C)	MIN (°C)
MOD11A1_LST_Day_2012_220	09:31:40	1	0	51.2	34.4
MYD11A1_LST_Day_2012_220	11:15:36	1	1.2	54.6	33.7
MOD11A1_LST_Night_2012_220	20:40:27	1	0	28.3	21.5
MYD11A1_LST_Night_2012_220	23:11:38	1	0	26.8	18

Also, to assess the differences between different types of land cover during the manifestation of heat wave we used data retrieved from Urban Atlas version 2012, at 2.5 m spatial resolution or 1:10 000 scale or 0.25 ha. According to Land Copernicus platform, Urban Atlas main purpose is to provide land use and land cover data for Functional Urban Areas (FUA).

Data used for validation was obtained from ROCADA (Dumitrescu et al., 2015) a gridded dataset who contains nine climatic variables. We used soil variable to extract the soil gridded values for 7th August 2012 to compare with MODIS values.

All statistical processing and data analysis was carried out in R statistical software environment (R Core Team 2017) mainly due to the open source availability and reproducibility of routines and procedures.

3. STATISTICAL DATA VALIDATION

Williamson et. al., 2014 showed that MODIS imagery and standard air temperature present a strong correlation coefficient with r^2 between 0.7 and 0.9.

We sampled 39 locations according to ROCADA grid structure to obtain values for soil temperature and MODIS LST. The r^2 = 0.4 is small but due to the fact that LST obtained from remote sensing is more a canopy layer temperature than a soil temperature in classical acceptance we consider that MODIS images could be used to assess the land surface temperatures.

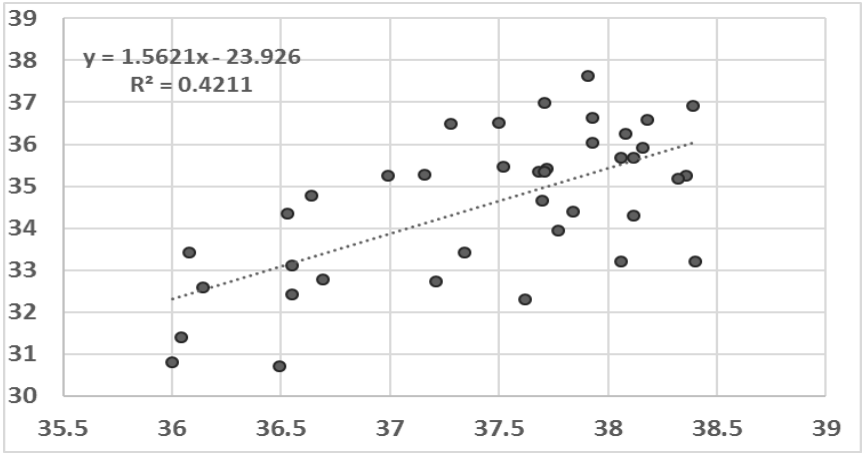

Fig. 2. ***Correlation coefficient between ROCADA Soil Temperature and MODIS LST 7 August 2012***

Regarding the Quality Assurance (QA), every MODIS scene comes with additional metadata information regarding the quality at pixel level. Every scene has passed the QA test.

4. THE ANALYSIS OF THE LAND SURFACE TEMPERATURE

As we said, the purpose of this paper is not to find explanations for Iasi UHI but rather to find a feasible methodology for working with satellite imagery.

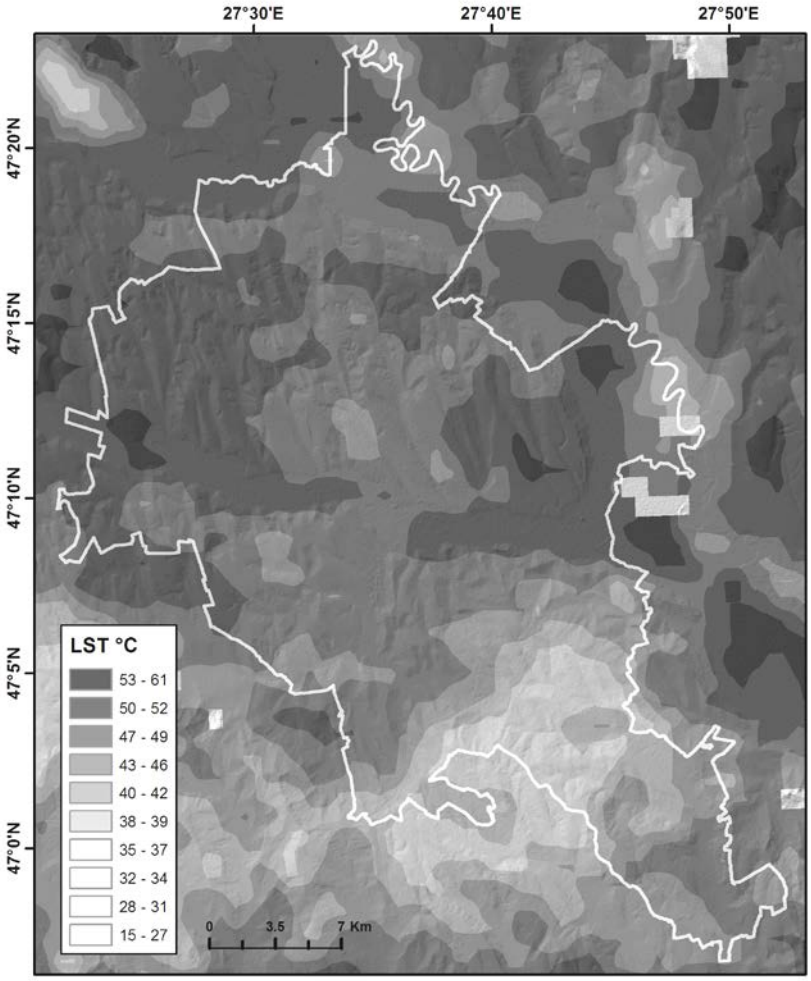

Fig. 3. ***LST distribution over Iasi Metropolitan Area taken from MODIS Aqua overpass at 11:36 AM UTC on 07-VIII-2012***

In the picture above (Fig. 3), we find the LST distribution in August 7, 2012 at 11:36 pm UTC. We note that the highest temperature values are recorded in the eastern part of the metropolitan area of Iasi. This area corresponds to the highly industrialized objectives of the city. Moving to east, the highest temperature values are recorded on arable lands due to the fact that recolts are harvested, the temperatures tend to have higher values than still cultivated areas.

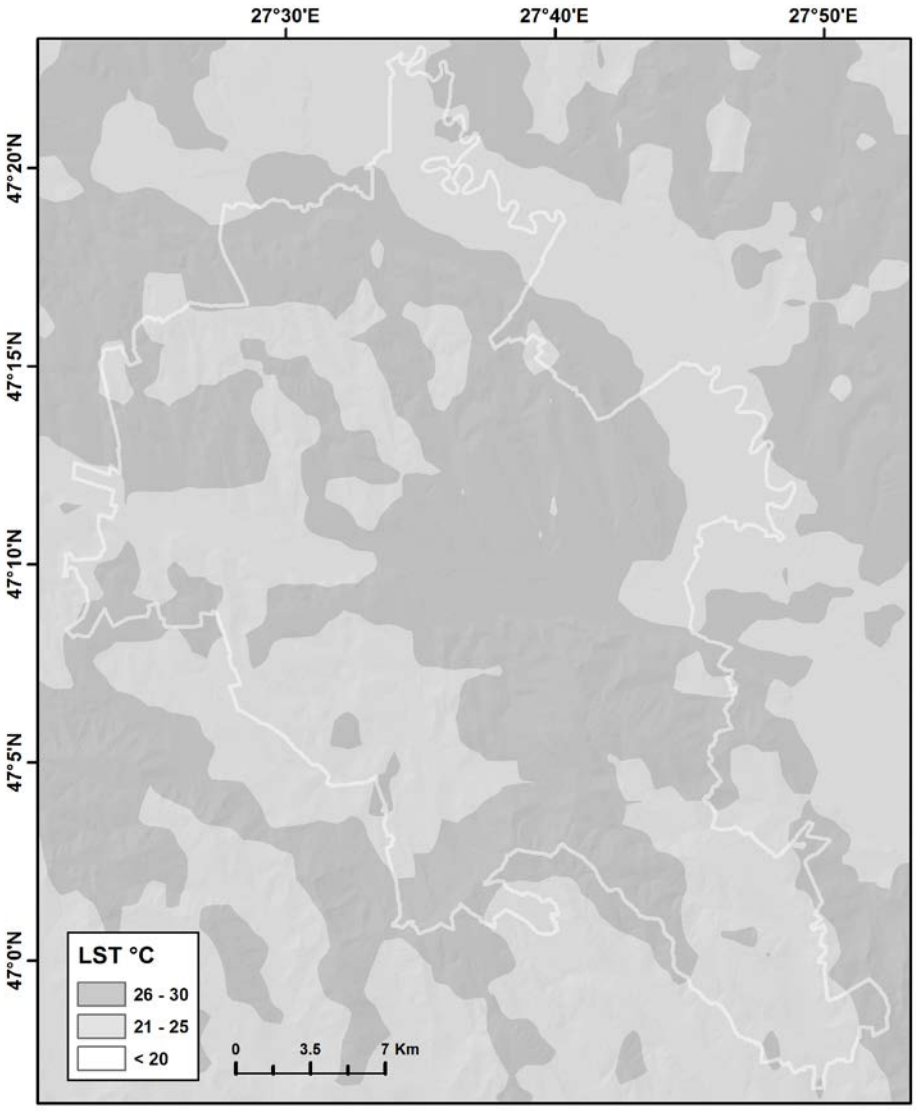

Fig. 4. ***LST distribution over Iasi Metropolitan Area taken from MODIS Terra overpass at 20:40 PM UTC on 07-VIII-2012***

In the LST distribution map (Fig. 4) corresponding to the nightly Terra's overpass we can observe that agricultural land usages have similar recorded values like highly urban fabric. A single day is not enough to highlight the presence of UHI but is worth mentioning that harvested arable terrains present and interesting behavior during hot days.

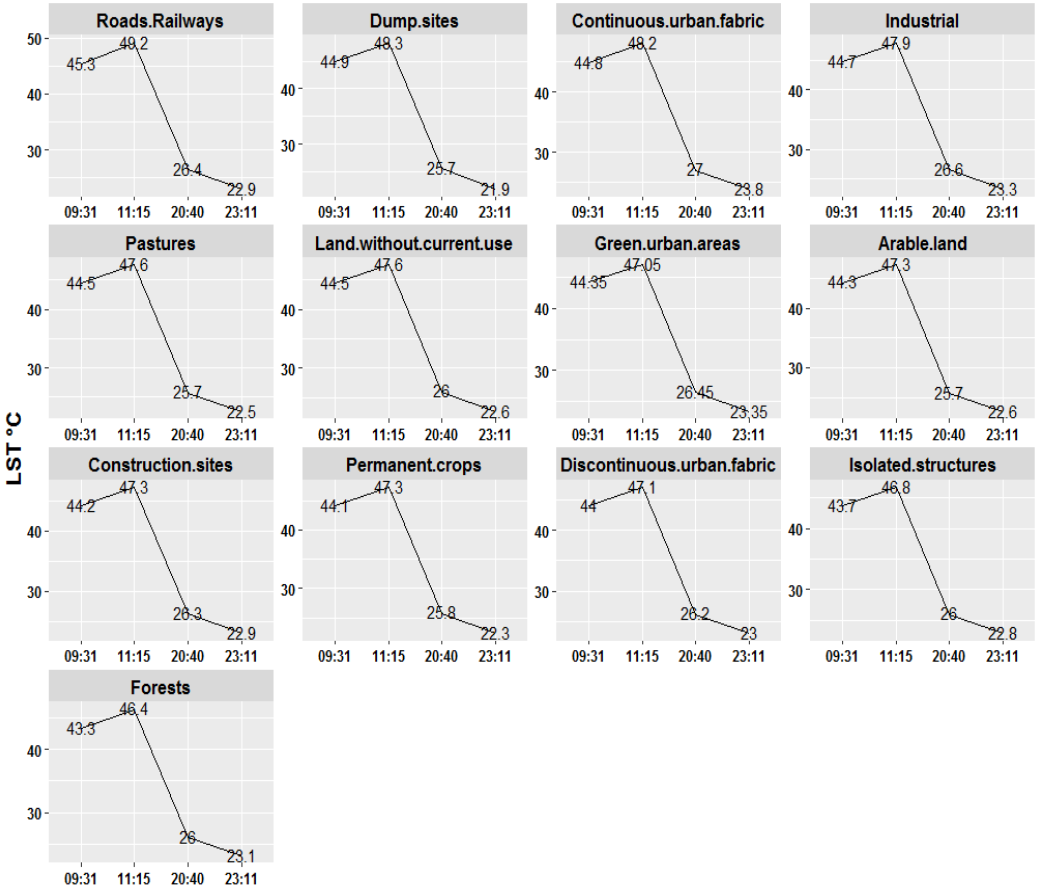

Fig. 5. ***The behavior of different land uses during the 7th august 2012 for every daily MODIS overpasses 09:31, 11:15, 20:40, 23:11***

In terms of the different behavior of land cover use during this day we notice that strong anthropisized surfaces such as roads, railways, construction have among arable lands presents the highest recorded temperatures. At the opposite pole are areas with a lower degree of human intervention such as green spaces, parks, cultivated areas. However, the daily differences are not so big between the types of use. A longer time series is required to obtain more reliable results.

5. CONCLUSIONS

This paper presented the use of MOD11A1 and MYD11A1 products to assess the land surface temperature characteristics during the 7th August 2012 in the Iasi Metropolitan Area.

During that day, the maximum recorded value of air temperature was 41,3 C while the maximum LST of canopy layer values was 61.

A single day is not enough to highlight the presence or absence of UHI phenomena but still we can observe the LST distribution characteristics during the hottest day on record. The harvested agricultural terrains present the same values as highly urbanized areas especially in the night when absorbed infrared radiation is released into the environment.

The results presented in this paper must be taken into consideration more like a methodological workflow because more data analysis and a longer time series derived from MODIS is required to get more precise measurements.

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