SATELLITE DETECTION OF THE THERMAL GRADIENTS OVER THE ROMANIAN REGION

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Abstract
Remote sensing techniques were used to detect the heat islands over the Romanian region, based on multi-temporal Meteosat Second Generation, Land Surface Analysis Satellite Applications Facility/ Land Surface Temperature products (MSG LSASAF/LST). A method was proposed for the rapid and accurate mapping of heat island areas based on the combinational use of normalized land surface temperatures. In order to do it, the IDL routines developed locally have been used. It was studied. 2976 LSA-SAF/LST images acquired during the period of August 2008 and it were used to calculate LST parameters. The LST values from 15 August 2008 were used to detect expansion and heat islands changes over the Romanian region. The LST product has a temporal resolution of 15 minutes. The LST values can be determined, theoretically, 96 times per day. Although heat islands and its change were affected by urban expansion, it is a complicated phenomenon affected by many factors. Other factors affecting heat islands will be discussed in further studies. This research work has been done under contract DESATEMP, number 31 - 007/18.09.2007, from ,,Partnership into Research Domains" Program, category ,,Complex Projects, financed by the Ministry of Education, Research.

Keywords: heat islands, satellite, LST, SEVIRI

1. INTRODUCTION

Urban development usually gives rise to a dramatic change of the earth's surface, as natural vegetation is removed and replaced by non-evaporating and non-transpiring surfaces such as metal, asphalt, and concrete. This alteration will inevitably result in the redistribution of incoming solar radiation, and induce the urban-rural contrast in surface radiance and air temperature.
The surface temperature is a main indicator of the surface energy balance of the Earth and it is used as input data in climate change models, agro-meteorological or hydrological models to forecast the soil freezing, to analyze *heat islands in urban areas*, to decide the optimal timing of agricultural activities, to study volcanoes and geothermal activities, to detect fires, and the exploration of natural resources
The new generation of EUMETSAT satellite sensors on board of both geostationary (SEVIRI-MSG) satellites provide a better characterization of land surface processes, which can have a large impact in a wide range of fields. The new series of Meteosat satellites – MSG provides multispectral data with high temporal resolution of 15 min. Based on this data, the Satellite Application Facility (SAF) generates and distributes many satellite products. One of the main products of the Land Surface Analysis (LSA-SAF) is the land surface temperature (LST), generated from the MSG split-window-channels

2. MATERIALS AND METHOD

The satellite remotely sensed data sets used in this work were 2976 MSG LSA-SAF/LST images, acquired during the period of August 2008. At our institute (NMA - National Meteorological Administration, Romania) they are accessible through our MSG reception stations, installed at Satellite Meteorology Department of NMA. The projection and spatial resolution of LSA-SAF/LST data correspond to the characteristics of Level 1.5 MSG/SEVIRI instrument data. Data users have access to the following data: LST data, quality control information field, LST error estimated

[1], [2]. In order to obtain the LST data for the Romanian region a set of adjustments has been done. These adjustments included:

- Extraction of the LST data from HDF5 format for a Europe geographical area; Documentation to implement this step is provided by the following web site http://hdf.ncsa.uiuc.edu/HDF5/doc/H5.format.html
- Geometric coding; The latitude and longitude data (in degrees) in the satellite projection are available on the HDF5 format on the following ftp site: ftp://gerb.oma.be/seviri/Geolocation
- Mapping LST data using Polar Stereographic North projection;
- LST images product for an established geographical area of Europe and Romania region;

The software was developed using IDL (Interactive Data Language) language for running into operational mode and the efficient extraction of LST data for different geographical location of Romania area.

A new and simple method was proposed for the rapid and accurate mapping of heat island areas based on the combinational use of normalized land surface temperature. [3], [4].

Normalization was done according to the following formula

$$Tnorm = (T - Tmin)/(Tmax - Tmin) \quad (1)$$

where T indicates the temperature before normalization, Tmax and Tmin are the maximum and minimum temperatures before normalization, Tnorm represents the normalization result. Tnorm belongs to 0-1 after normalization. 0 and 1 represent the minimum and maximum normalized temperature respectively. Then we can compare the relative value. The Tnorm values belonging to 0.6-1 were considered to be the heat island area. In this way, the distribution map of urban heat island was obtained.

3. RESULTS AND DISCUSSION

In this study, 2976 LSA-SAF/LST images acquired during the period of August 2008 were used to calculate LST parameters. The LST values from 15 August 2008 were used to detect expansion and heat islands changes over the Romanian region. The LST product has a temporal resolution of 15 minutes. . The LST values can be determined 96 times per day from MSG but in practice less observation are available due to cloud cover. The identification of cloudy pixels is based on the cloud mask generated by the Nowcasting and Very Short Range Forecasting Satellite Application Facility (NWC SAF) software. A daily synthesis for the Romanian region is produced that offers a less cloud covered image (figure 1 and figure 2). The 2008 summer is characterized by high land surface temperature values in special on August month (Table 1). From this table, it is clear that there has been a considerable high LST values during the August period.

Table 1. Maximum LST values over the Romanian region obtained using LSA-SAF/LST products during on August 2008

MAXIMUM LAND SURFACE TEMPERATURE DERIVED FROM METEOSAT SECOND GENERATION LSA SAF DATA

YEAR	MONTH	DAY	BUCURESTI-BANEASA	BUCURESTI-AFUMATI	BUZAU	CRAIOVA	CLUJ	TIMISOARA
2008	08	1	32.55	37.59	39.40	39.77	32.81	37.95
2008	08	2	35.61	38.14	40.91	40.09	32.32	39.72
2008	08	3	35.90	40.10	44.55	40.62	29.37	40.91
2008	08	4	40.13	43.96	50.33	40.72	33.63	39.86
2008	08	5	43.32	46.38	48.97	43.57	33.25	35.42
2008	08	6	34.80	39.19	40.67	41.09	30.57	37.61
2008	08	7	34.65	37.20	45.68	41.83	29.13	38.68
2008	08	8	35.17	38.46	44.72	40.86	31.62	41.03
2008	08	9	32.48	39.58	46.69	38.25	-8000.00	26.53
2008	08	10	-8000.00	-8000.00	-8000.00	39.81	20.87	30.43
2008	08	11	34.51	38.48	32.72	36.71	28.44	38.65
2008	08	12	37.39	40.10	44.13	42.84	33.47	40.41
2008	08	13	40.12	43.77	49.67	45.22	38.50	45.53
2008	08	14	41.93	43.25	51.90	45.28	37.75	44.78
2008	08	15	40.97	43.37	48.21	43.26	36.67	40.02
2008	08	16	40.87	43.95	49.28	40.94	33.71	34.41
2008	08	17	41.75	44.71	49.94	42.98	29.26	30.24
2008	08	18	34.43	38.87	40.51	38.19	28.51	34.78
2008	08	19	36.69	39.79	38.73	41.58	32.78	39.36
2008	08	20	39.01	42.24	43.74	42.57	34.80	41.64
2008	08	21	41.15	43.33	44.09	44.21	33.96	41.26
2008	08	22	38.87	41.48	44.47	42.48	36.41	41.47
2008	08	23	41.61	43.71	46.53	43.73	34.99	42.49
2008	08	24	44.06	45.65	47.70	42.66	-8000.00	-8000.00
2008	08	25	34.67	39.28	42.18	41.65	23.32	-8000.00
2008	08	26	36.07	39.96	42.68	42.08	26.24	36.57
2008	08	27	33.02	36.46	42.02	40.36	30.85	38.91
2008	08	28	36.13	40.50	41.52	42.98	-8000.00	32.40
2008	08	29	37.39	39.61	42.96	38.36	23.44	27.44
2008	08	30	33.27	34.72	29.86	39.43	23.65	31.94
2008	08	31	33.25	37.06	36.07	37.93	27.37	33.62

Note
*: 8000.0 : clouds, etc

The maximum and minimum land surface temperature images obtained using the IDL developed application are shown in figure 1 and figure 2.

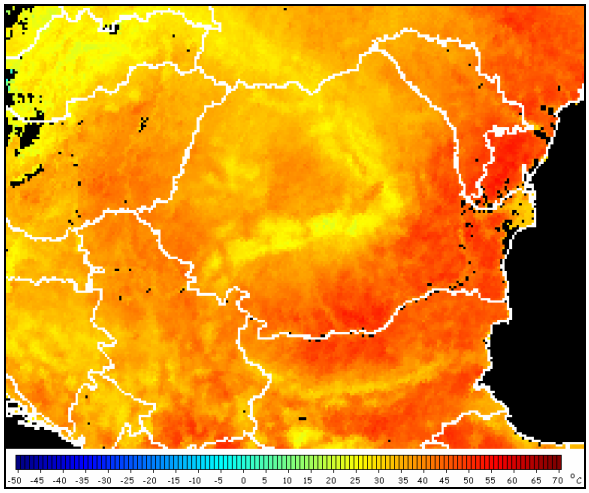

Figure 1. Maximum LST values over the Romanian region obtained using LSA-SAF/LST products on 15 August 2008.

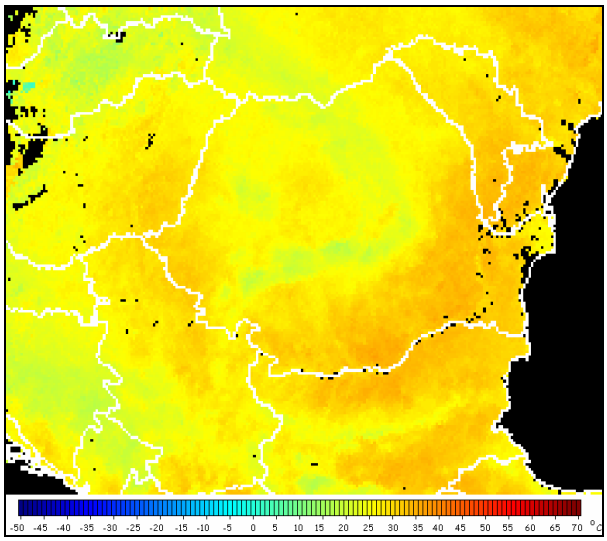

Figure 2. Minimum LST values over the Romanian region obtained using LSA-SAF/LST products on 15 August 2008.

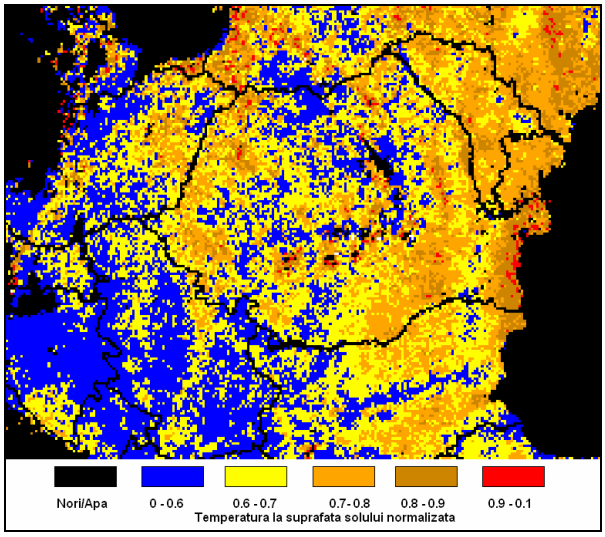

Figure 3. The distribution map of the heat islands on 15.08.2008, 9:00 GMT over the Romanian region

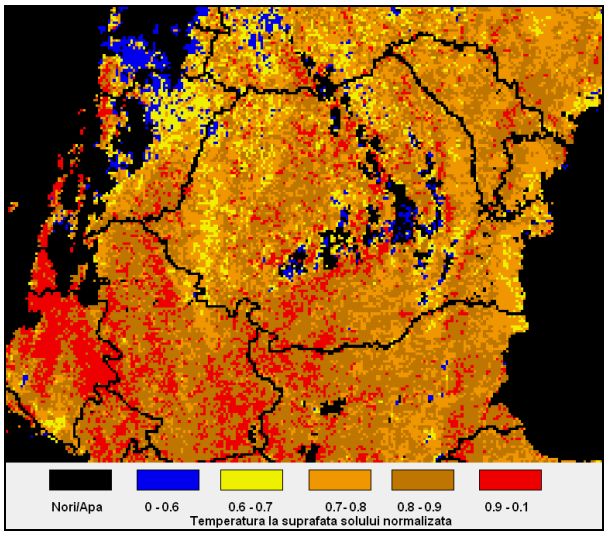

Figure 4. The distribution map of the heat islands on 15.08.2008, 13:00 GMT over the Romanian region.

Land surface temperature retrieved was normalized in order to do the heat island mapping. It was considered that the normalized temperature values less than 0.6 value (blue color) belong to the category of non heat-islands area (Zhang, 2005[4]).

The heat islands increased sharply during the day period. The predominant color in the figure 4 is darkish orange (0.8-0.9) than in the figure 3.

Although heat islands and its change were affected by urban expansion, it is a complicated phenomenon affected by many factors. Other factors affecting heat islands will be discussed in further studies.

4. CONCLUSION

For this research work, 2976 LSASAF/LST images during the period of August 2008, were used to extract the LST values and to detect expansion over the Romanian region. The maximum and minimum temperatures for every

pixel have been calculated. The normalized land surface temperatures have been proposed for the mapping of heat island areas. The heat islands increased sharply during the day period. More improvement could be made to the mapping heat islands using LST from MSG data by taking into account on the others satellite parameters derived from MSG data and also by refining the cloud mask algorithm.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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