SURVEY OF LIGHT POLLUTION OF ARAK CITY BY USING OF DMSP AND SUONI-NPP SATELLITE IMAGERY

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KEY WORDS: Light pollution, DMSP Satellite, Suomi-NPP Satellite, Imagery.

ABSTRACT:

Today, the use of remote sensing techniques and satellite images of night lights has immensely assisted in investigating this kind of pollution. The objectives of this research is to survey the light pollution of the city of Arak in Iran for the years 1997 and 2009, by utilizing satellite images of DMSP night lights and for the years 2013 through 2018, by taking advantage of Soumi-NPP satellite images of night lights and exploring its connection to the city's electricity power consumption for street lighting. The night light images of the DMSP and NPP satellites, depending on the degree of light intensity, were each, in segregation, categorized into five classes of light pollution levels, ranging from very high to very low levels. Next, light pollution maps were extracted from classified images and then the connection of the 'high and very high' classes of light pollution with electric power consumption for street or road lighting was surveyed in these years. Results of the study indicates that the amount of light pollution in these years was in relevance with road or street lighting, as in the years when the amount of electricity consumption for road lighting was high and its role in connection with light pollution was also in great percentages; and in years with a decrease in electricity consumption for road lighting, lower percentages were displayed.

1. INSTRUCTIONS

The presence of excessive artificial lighting brings about a kind of environmental pollution in the night sky, which is critical, though recognized to a lesser extent; and has destructive environmental, biological and economic impacts, including energy losses, known as light pollution. Light pollution was first identified by astronomers in the 1930s .Because light scattered from the shining sky of the city, it prevented the visual observation of low-light celestial bodies near the cities (Riegel, 1973). The problem of light pollution has been important since the 1960s due to urban development and the use of artificial lights and bulbs at night (Hosseini and Nasiri, 2007). This kind of pollution is a problem that affects almost every urban area and is produced by a large number of light sources that throw light into the sky, and because of the presence of dust and aerosols in the atmosphere, the light scattered by the sky Clarifies (Barducci et al., 2006).

2. LITERATURE REVIEW

The present study was conducted in Arak, one of the metropolitan areas of Iran and the center of Markazi province. The city of Arak is located at an equator of 34°, 4 ' 48 "in the northern hemisphere. It is also on the meridian of 49 °, 42 ' from the Greenwich meridian. Arak is known as the industrial capital of Iran. The objectives of this research is to survey the light pollution of the city of Arak in Iran for the years 1997 and 2005, by utilizing satellite images of DMSP night lights and for the years 2013 through 2018, by taking advantage of Soumi-NPP satellite images of night lights and exploring its connection to the city's electricity power consumption for street lighting. The paper must be compiled in one column for the Title and Abstract and in two columns for all subsequent text. All text should be single-spaced, unless otherwise stated. Left and right justified typing is preferred.

3. PROPOSED METHOD

In order to execute this, upon preparing the satellite images for night lighting for the relevant years; and extracting the area of study under consideration with the Arc GIS 10.2 Software, the range of the degree of light of each image was determined and the night light images of the DMSP and NPP satellites, depending on the degree of light intensity, were each, in segregation, categorized into five classes of light pollution levels, ranging from very high to very low levels. Subsequently, in accordance with the total number of pixels which each image encompasses and comprises of, from the levels of light pollution; a level percentage of light pollution was determined for each year and a set of percentage levels, namely, 'high and very high' on the basis of light pollution surveys was defined. Next, light pollution maps were extracted from classified images and then the connection of the 'high and very high' classes of light pollution with electric power consumption for street or road lighting was surveyed in these years.

4. RESULTS

On investigating the results of the classes of light pollution in respect to the DMSP satellite relative to the years 1997 and 2005 respectively, demonstrated a high level of 93.5% and 96.7% of night lighting. Similarly, in studying the amount of electricity consumption for road lighting in these years, it has been observed that, power consumption has increased by 18905013 million KW/hour in 2009 compared to 1997 for road lighting. In studying the results of the classes of light pollution of the NPP satellite in relative to the years 2013 through 2018, with due attention to the implementation of a plan regarding the optimal alleviation or improvement of road lighting in 2012, it has been noted that the high level of night lighting have illustrated a significant decrease of 1.1 % in 2013 and 1.4 % in 2014. Likewise, an investigation of its relative with road lighting shows a decrease of 7978316 million KW/hour of road lighting power consumption in 2013 compared to the year 2005. But it has been observed that in 2015, the consumption of electric power for street lighting in comparison to 2014 had increased by 1104724 million KW/hour; whereas, this increase in the years 2015 was 654954 thousand KW/hour, there was an increase of 2233607 million KW/hour in 2017 in respect to 2016 and lighting pollution maps also depict an increment of 3.3 %, 3.8 % and 9.6 % in the years 2015 through 2017 respectively. In 2018, road lighting demonstrated a decrease of 1116804 million KW/hour and a high level of night lights, which showed a decrement of 1.4 % and 9.6 % in 2017, registered at 8.2 % in 2018.

Table 1- Percentage of light pollution in 1997-2009

Class Name	1997 %	2005 %	2007 %	2009 %
Very Low	0	0	0	0
Low	6.5	3.2	1	1
Moderate	21.5	29	36.6	18.3
High	72	67.8	62.4	80.7
Very High	0	0	0	0
Total	100	100	100	100

Figure 1. Light pollution map 1997

Figure 2. Light pollution map 2009

Table 2- Light pollution in 2013-2018

Class Name	2013 %	2014 %	2015 %	2016 %	2017 %	2018 %
Very Low	15.15	14.6	11.3	14	8	9.3
Low	53.45	53.7	45.45	42.2	40	43
Moderate	30.3	30.3	39.95	40	42.4	39.5
High	1.1	1.4	2.2	3	8	7.1
Very High	0	0	1.1	0.8	1.6	1.1
Total	100	100	100	100	100	100

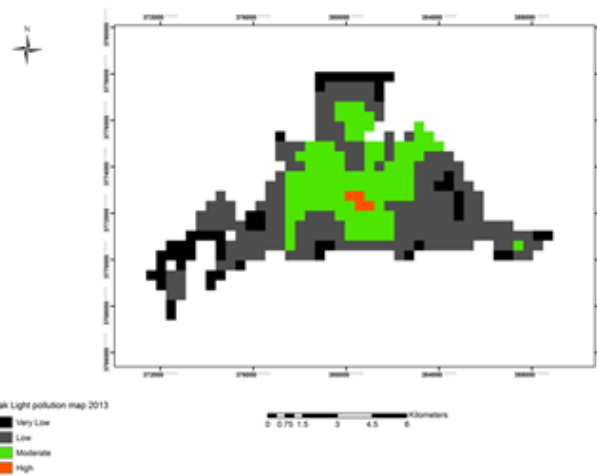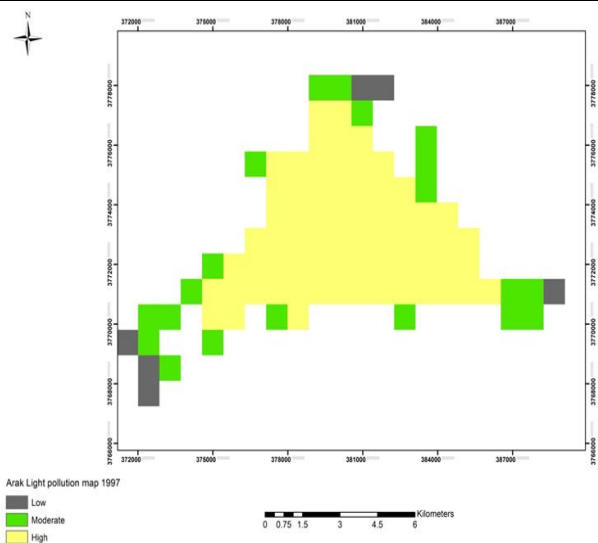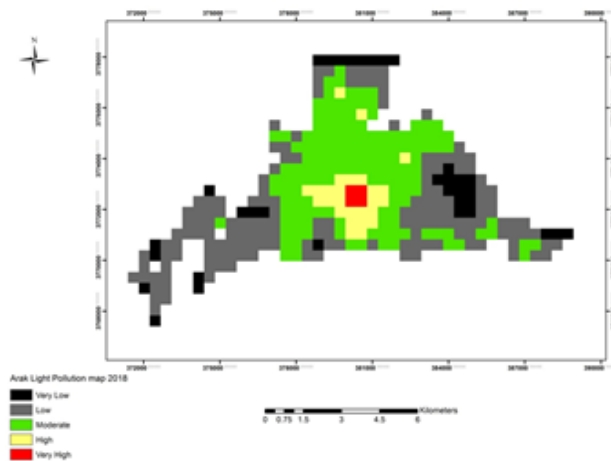Figure 3. Light pollution map 2013
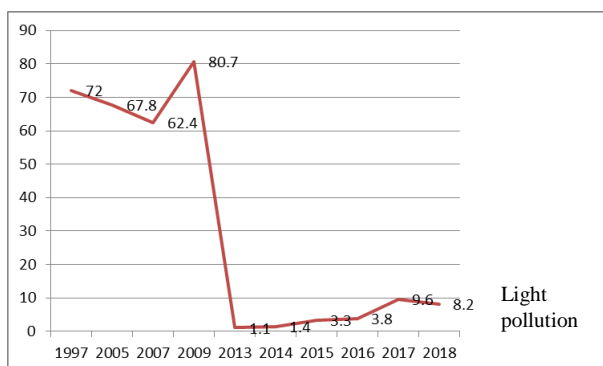
Figure 4. Light pollution map 2018

Figure 5. Chart of light pollution from 1997 to 2018

5. CONCLUSIONS

Results of the study indicates that the amount of light pollution in these years was in relevance with road or street lighting, as in the years when the amount of electricity consumption for road lighting was high and its role in connection with light pollution was also in great percentages; and in years with a decrease in electricity consumption for road lighting, lower percentages were displayed.

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