



EVALUATION OF LIGHT POLLUTION IN THE STREETS AND THE ROADS OF AL-NAJAF CITY, IRAQ

Hayder K. Admawi¹

¹ Lecturer, Department of Environmental Planning, University of Kufa, Iraq. Email:
hayderk.abdulkareem@uokufa.edu.iq

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ABSTRACT

The use of night-time lighting is an irreplaceable technique in modern urban societies. On the other hand, its excessive use is accompanied by undesirable effects on humans and nature, as well as on all living beings. This has been declared in the last two decades. Nowadays, light pollution is getting increasing attention all over the world, particularly in developed countries, as most of the global researches have proven that there is a direct link between serious health problems and the increase in the levels of light intensity that people are exposed to. However, to minimize the use of exceeding lighting, some countries such as South Korea and many international organizations concerned with light pollution such as CIE (Commission Internationale de l'Eclairage) have developed specifications and determinants to minimize light pollution. Furthermore, these countries have enacted laws and legislations that regulate and limit artificial lighting use. Whereas in other countries, such as Iraq, the issue of light pollution has not given enough attention from researchers or officials and there have been no specifications that limit this widespread phenomenon. In this study, a field survey was performed that included many famous commercial and main streets as well as some external roads that link Al-Najaf city with other cities in Iraq. Moreover, this investigation included measuring the intensity of lighting in many significant squares in Al-Najaf city. This study concluded out there is clear and tangible light pollution and exceeds determinants many times in most streets and roads. In Al-Sadiq Street, for example (the main street in the old city), light pollution was 16.78 times greater than the allowable limit. This is the highest value that exceeds the standard limits for a survey of the selected streets in Al-Najaf city. As for the city squares, they were all higher than the permitted limit, whether during pre-curfew or postcurfew times. In this respect, the light pollution in "Thworat al-Ishreen Square" exceeded by 48.96 times and 233.8 times the official standard of (CIE) recommendations during the period of pre-curfew and post-curfew respectively. This indicates a lack of environmental awareness in reducing unnecessary lighting as well as the absence of legislation and laws that limit the use of lighting, mainly after midnight, and that is entirely different from the way the developed countries have handled the adverse effects of light pollution.

KEYWORDS

Light Pollution, ALAN, Light Intensity, Standard Limits, Environmental Zones, Measured Spots.

1. INTRODUCTION

A modern artificial lighting system can be regarded as a fundamental contribution to the technological revolution in the twentieth century. Although artificial lighting is enormously useful to modern societies, it still has considerable deficiencies, in the form of pollution, to the health of the human being and the environment as well (Hollan, 2007). The light pollution concept may be defined as “the presence of excess, poorly directed, and unnecessary artificial lighting at night, which in the natural environment crosses the boundary of fulfilling basic lighting needs and may become obtrusive or harmful”. In its most visible form, light pollution can be seen as skyglow “the artificial diffuse luminance of the night sky” (Kocifaj and Kómar, 2016). Light pollution “also appears in the form of glare, light trespass, and overillumination” (Brons, Bullough, and Rea, 2008).

Artificial lighting, especially ALAN (Artificial Lighting at Night), could provide security and safety, but this may not be improved by extensive brightness. The design of light can emphasize the beauties of landmarks during the night, but it could also steal us of the wonderful beauty of the sky at night and our scenery of the Milky Way. Artificial light after the beginning of the night may prevent melatonin secretion of higher vertebrates, thus obstructing “circadian rhythms and dysregulating organisms” (Kyba and Hölker 2013). Specific to light pollution's role in disrupted melatonin production, researches have also proved a connection with lowered quality of sleep (Shea, 2003) and some types of cancers (Anisimov, 2006; Kloog, Haim, Stevens, Barchana & Portnov, 2008; Kloog et al., 2009). For example, Rybnikova et al., (2017) mentioned in their study, which is based on World Bank databases, that there is a statistically considerable connection between ALAN and prostate cancer disease. A possible relationship between outdoor ALAN and women breast cancer incidence had also been declared by (Peter et al., 2017). Besides, ALAN has been associated with diabetes (Hu and Jia, 2016), fatigue, and depression (Weinert, and Waterhouse, 2017). Also, extreme and unnecessary ALAN is an essential contributing factor to energy loss (Gaston et al., 2012).

Besides the direct influence by point sources of light such as streetlights, skyglow is a landscape-scale phenomenon influencing vast areas. Indeed, skyglow now constitutes one of the most essential changes in the biosphere (Kyba and Hölker 2013). According to recent researches during 2012–2016, artificial light emissions grew globally at an average rate of about 2% per year, both in total radiance and artificially lit area (Kyba et al., 2017).

Environmental scientists recently created an atlas of the world's sky detailing the amount of light pollution that exists across regions. This atlas shows that over 80% of the world as a

whole is affected by artificial light pollution and that 99% of locations within the United States suffer from some degree of light pollution (Falchi et al., 2016; Jechow and Hölker, 2019). In many regions of the world, the light pollution dangers have authorized the government to take action. The Czech Republic, for instance, is the first country to issue legal limits to use outdoor artificial lighting. Other nations have announced legal ways to minimize light pollution like Slovenia. Light pollution laws, regulations, and prescriptive measures have become widespread in many European countries (Morgan-Taylor, 2015), Asia (Cha et al., 2014, Ho and Lin, 2015), and America (Taylor, 2006). The United Kingdom has extended the aforementioned “existing law on air pollution to include light pollution” (Zitelli, Di Sora, and Ferrini, 2001). In the continent of Asia, South Korea and China are among the few countries that have enacted ordinances to reduce light pollution (Guanglei, Ngarambe and Gon Kim, 2019).

Unfortunately, there have been no Iraqi laws or legislations that regulate lighting or reduces light pollution. Moreover, there is no enough interest among Iraqi researchers in the area of light pollution where research articles in this regard are relatively limited. Therefore, the scope of this study is to assess the status of light pollution and its unfavorable effects on human health and the ecological system as a whole in Al-Najaf city. It also to provides more information and suggestions to the officials and decision-makers in Iraq about the dangers of artificial light pollution, to take real steps against the improper use of lighting, especially at night to reduce this widespread pollution.

2. SPECIFICATIONS AND LIMITATIONS OF LIGHT POLLUTION

As mention above, there have not been any Iraqi specifications or clear restrictions that limit light pollution in Iraq. Also, there is no Iraqi law that regulate light pollution, therefore the implemented work had to rely on some international specifications and limitations. Therefore, South Korea’s specifications were adopted as determinants to measure the amount of excess of light intensity at the roads and streets.

On the other hand, (CIE) specifications were adopted to identify the amount of excess of the intensity of lighting for the main town squares in Al-Najaf city, as it includes the additional item, such as the applicable curfew condition. As a result, light intensity was measured pre and post curfew at those squares.

Until now, no law specifies curfew times in Al-Najaf city, thus to assess ALAN, pre-curfew times had assumed to begin from the first hour after the sunset until midnight while postcurfew times start from 12.00 a.m. until one hour before sunrise.

The purpose of using determinants and specifications of light pollution is for reasonable usage of ALAN and to minimize the harmful effects as much as possible. However, most of the international standards for limiting light pollution divide the areas into four environmental zones. These zones were classified according to the nature of using any area and depending on the required amount of light for each zone. CIE has adopted the concept of environmental zones (Narisada and Schreuder, 2004; Hong et al., 2018) described in Table 1.

Table 1. Description of the environmental zones lighting, as adapted by (CIE)

Zones by CIE			
Zone	Surroundings	Lighting Environment	Examples
En1	natural	Intrinsically dark	national parks or protected sites
En2	rural	low district brightness	agricultural or residential rural areas
En3	suburban	Medium district brightness	industrial or residential suburbs
En4	urban	high district brightness	town centers and commercial areas

For vertical illuminance, CIE has suggested limits for the different environmental zones (Narisada and Schreuder, 2004; Hong et al., 2018), as shown in Table 2.

Table 2. Illustration of light pollution standards (Vertical illuminance) by CIE.

Light Technical Parameter	Application Conditions	Lighting Environmental Zones			
		En1	En2	En3	En4
Vertical illuminance (lux)	Before curfew	2.0	5.0	10.0	25.0
	After curfew	0.0	1.0	2.0	5.0

Table 3 illustrates Environmental Management Zones as adopted by the LPPA (Light Pollution Prevention Act) of South Korea (Narisada and Schreuder, 2004; Hong et al., 2018). The Korean government has enacted lighting legislation similar to those of the CIE. “The Environmental Management Zones” adopted by the South Korean LPPA is also divided into four zones, and lighting recommendations are also assigned for each zone (Kim et al., 2011; Hong et al., 2018).

Table 3. The zones by Korean LPPA, 2013.

Zone	Description
En1	Green zones used for ecological purposes and wildlife protection
En2	Green zones used for agricultural purposes
En3	Residential and semi-residential zones

En4

Commercial and industrial areas

The lighting standards by the South Korean LPPA are almost the same as those of the CIE. The two groups of standards are different only on small details, such as the degree to which light is limited in different environmental zones (Hong et al., 2018). Table 4 illustrates the recommendation of light by the South Korean LPPA.

Table 4. Standards of light pollution in Korea

Category	Parameter (lux)	Time of Application	Zones			
			En1	En2	En3	En4
Roads and street	Max. vertical plane Illuminance	60 min after sunset to 60 min before sunrise	10.0	10.0	10.0	25.0

3. MATERIALS AND METHOD

3.1. Study area and measurement of light pollution

The evaluation and analysis of ALAN were conducted in the city of Al-Najaf for three months from 1st December 2019 to 1st March 2020. Table 5 illustrates the information of Al-Najaf city in context to demographic, geographic locations, and meteorological aspects (Hayder, 2018).

Table 5. Demographic, geographic locations, and meteorological aspects of Al-Najaf city.

No.	Parameters	Documented values
1	Population (according to the statistics of 2017)	1500522
2	Geographical area	28824 km ²
3	Population density	52 No. of persons/km ²
4	Latitude	31°59' N
5	Longitude	44°19' E
6	Mean sea level	70m

The field study was conducted on a total of 17 important streets and roads, which includes some main and commercial streets as well as external roads that share borders with Al-Najaf city. Also of 5 main town squares in the mentioned city.

Fig. 1 describes selected streets and roads, numbers of measured spots according to the length of the roads, and the distance between each two chosen spots. When the street length was 1 Km or less, the distance between two measured spots was 100m while the distance between

two spots was taken 250 m for a street of 1 to 2 km. For a road that was more than 2 km long, the distance between two spots was taken per 500 m.

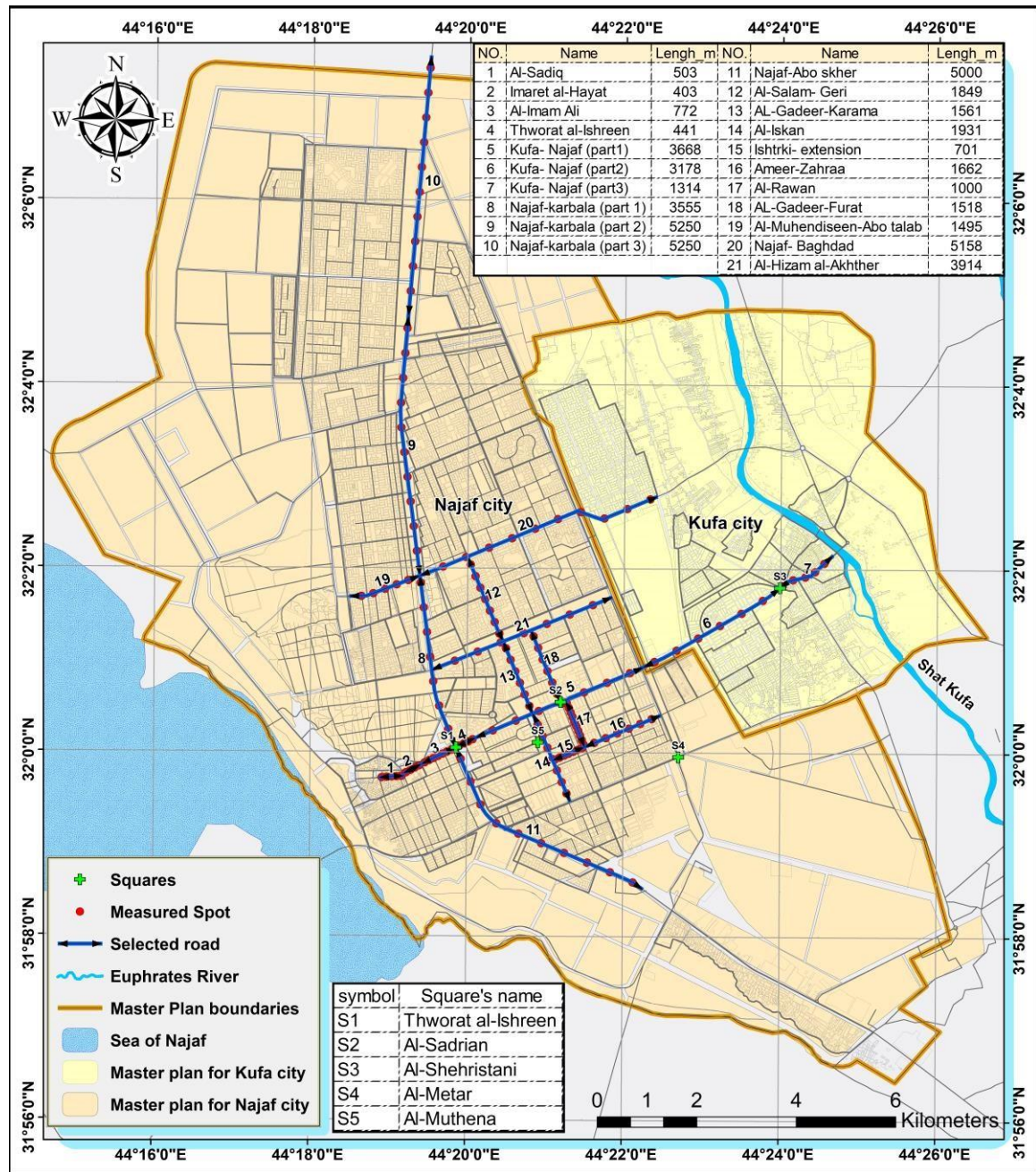


Fig. 1. Selected streets and roads, length of the road, measured spots, and selected town squares.

3.2. Materials

ALAN levels were measured using Light Meter CEM DT-8820, which was made up of Germany. This device included a sensitive lens in determining applied light density by Lux unit as well as an included thermometer to compute the heat degree of the light source. In addition to using GPS & iPhone maps to take location coordinates for field area surveys so

that they used the GIS ArcView 9.3 program to draw the maps which are needed in the present study.

3.3. Method

The method of measuring the light intensity is to place a light-sensing lens of a light measuring intensity device in a horizontal position to be similar to the way that the light source falls on the ground. Therefore, for the best evaluation, the measurements were taken in which the lens was placed at a distance of not less than 1.5 m from the ground, and that represents the average of the sightline. Whereas, the horizontal distance was 1 m from the edge of the curb towards the paved road.

4. RESULTS AND DISCUSSION

The studies on light pollution and its potentially harmful impacts in Al-Najaf city, as well as the other cities in Iraq, are limited and rare. However, this study was conducted to evaluate the actual artificial light pollution in Al-Najaf city and to be considered as a starting point for handling all the effects.

4.1. Light intensity measurements in roads and streets

The field survey results of the road lighting located within (En4) showed that most of the lighting intensity rates in the chosen roads had exceeded the vertical lighting values that have recommended by the Korean specifications. As shown in [Table 6](#), which also indicates the number of the measured spots for each street and the highest light intensity in which it is marked in red.

The obtained lighting intensity rates were compared with the standard limits, as shown in [Fig. 2](#). Accordingly, the highest average of recorded light intensity was (444.6 Lux) on Al-Sadiq Street as it is a commercial street that located in the center of the old city and close to Imam Ali holy shrine. The second highest value was (354.9.lux) on Al-Rawan Street, which is famous for its modern shops, hotels, and restaurants.

Table 6. The light intensity for chosen spots of selected roads with summation and average light intensity*.

No,	Roads Name	Spot 1	Spot 2	Spot 3	Spot 4	Spot 5	Spot 6	Spot 7	Spot 8	Spot 9	Spot 10	Sum ation	Average
1	Al-Sadiq	191	214	470	543	805						2223	444.6
2	Imaret al-Hayat	101	465	355	174							1095	273.75
3	Al-Imam Ali	62	84	77	55	59	67	104				441	73.50
4	Thworat alIshreen	233	347	70	92							650	216.67
5	Kufa- Al-Najaf (part1)	221	66	87	286	114	119	72				965	137.86
6	Kufa- Al-Najaf (part2)	268	69	84	77	91	110					699	116.5
7	Kufa- Al-Najaf (part3)	199	228	159	145	108						839	167.8
8	Al-Najaf – Karbala (part 1)	201	136	97	82	77	69	110				772	110.29
9	Al-Najaf – Karbala (part 2)	44	40	37	32	39	41	28	22	21	33	337	33.70
10	Al-Najaf - Karbala (part 3)	29	27	20	14	19	21	18	12	11	17	188	18.80
11	Al-Najaf –Abo skher	198	204	216	150	50	32	28	22	16	9	925	92.50
12	Al-Salam- Geri	66	70	58	61	80	96	113				544	54.40
13	AL-Gadeer-Karama	142	88	94	225	349	370					1268	211.33
14	Al-Iskan	130	121	106	118	79	68	49				671	95.86
15	Ishtarki- extension	30	37	27	73	58	44	79				348	49.71
16	Ameer-Zahraa	94	124	135	111	101	70					635	105.83
17	Al-Rawan	552	498	390	366	190	89	202	345	416	501	3549	354.90
18	AL-Gadeer-Furat	235	119	349	57	77	99					936	156.00
19	Al-Muhendiseen-Abo talab	199	160	147	80	72						658	131.60
20	Al-Najaf - Baghdad	50	67	54	80	98	45	19	8	31	39	491	49.10
21	Al-Hizam al-Akhther	45	22	19	66	87	20	57				316	45.14

*The first 4 data sets were taken on 1/12/2019 and serial numbers 5-7 were taken on 16/12/2019, 8-10 readings were taken on 2/1/2020, and readings from 11 to 13 were taken on date 15/1/2020. From serial numbers 14-17 were taken on 27/1/2020 and serial numbers 18-21 were taken on 9/2/2020.

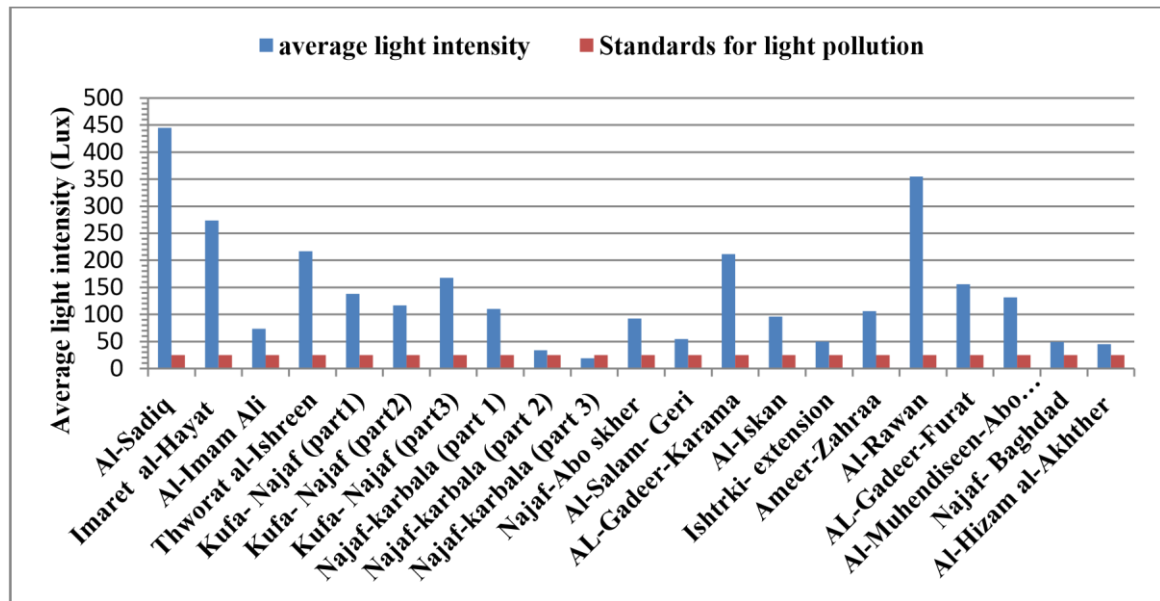


Fig. 2. Illustrated average light intensity for selected roads compared with standards.

Fig. 3 shows the number of exceeding times comparing with the recommended limits for each street. As an example, Al-Sadiq Street, the average lighting intensity is exceeded 16.78 fold more than the standard limits. This is a clear indication that the permissible limit has been exceeded and hence the light intensity poses a high intensity for pedestrians of this street.

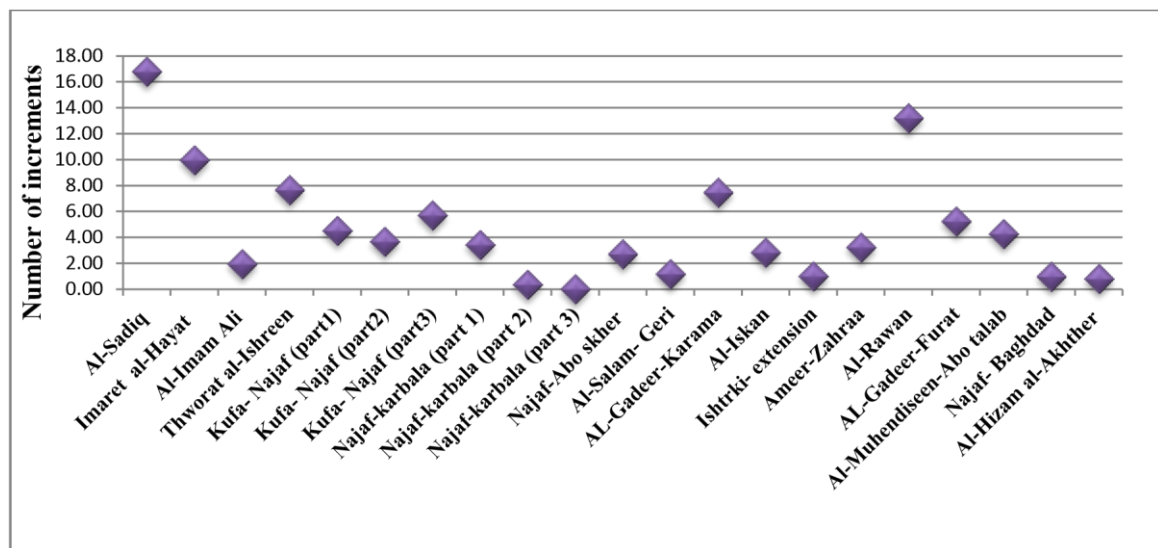


Fig. 3. Number of increments over standards for selected streets and roads.

4.2. Light intensity in town squares

The field survey in this study also includes measuring the intensity of lighting in five famous main town squares in Al-Najaf city pre-curfew and post-curfew. These squares were chosen

because they are expected to be the brightest and thus can be selected as an example of the existence of light pollution in the city of Al-Najaf.

Table 7 shows that all the recorded data pre-curfew and post-curfew were higher than the standard limits.

Table 7. Light intensity at pre-curfew and post-curfew for selected squares*.

No.	Square's name	pre-curfew (Lux)	post-curfew (Lux)
1	Thworat al-Ishreen	1249	1174
2	Al-Sadrian	509	428
3	Al-Shehristani	307	213
4	Al-Metar	241	199
5	Al-Muthena	1211	1099

* The first 2 data sets were taken on 19/2/2020 and serial numbers 3-4 were taken on 1/3/2020.

The highest recorded reading of the light intensity was 1249 Lux in the Thworat al-Ishreen square (below the bridges), during the pre-curfew time, as shown in Fig. 4.

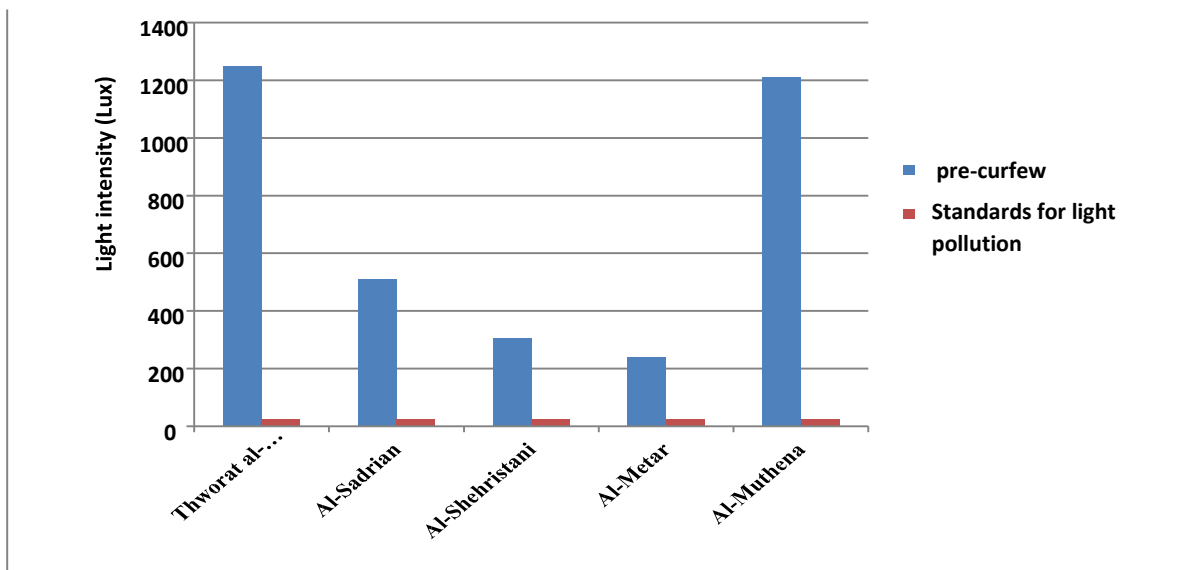


Fig. 4. Illustrates light intensity at pre-curfew for selected squares compared with standards.

The reading of the light intensity was slightly less during the post-curfew period of the Thworat al-Ishreen town square; also, this case was on the other squares. Nevertheless, it remained exceeding the allowed limit, as shown in Fig. 5. The reason was that the nearby shops turned off their lights during that time, and also the number of cars decreased after midnight.

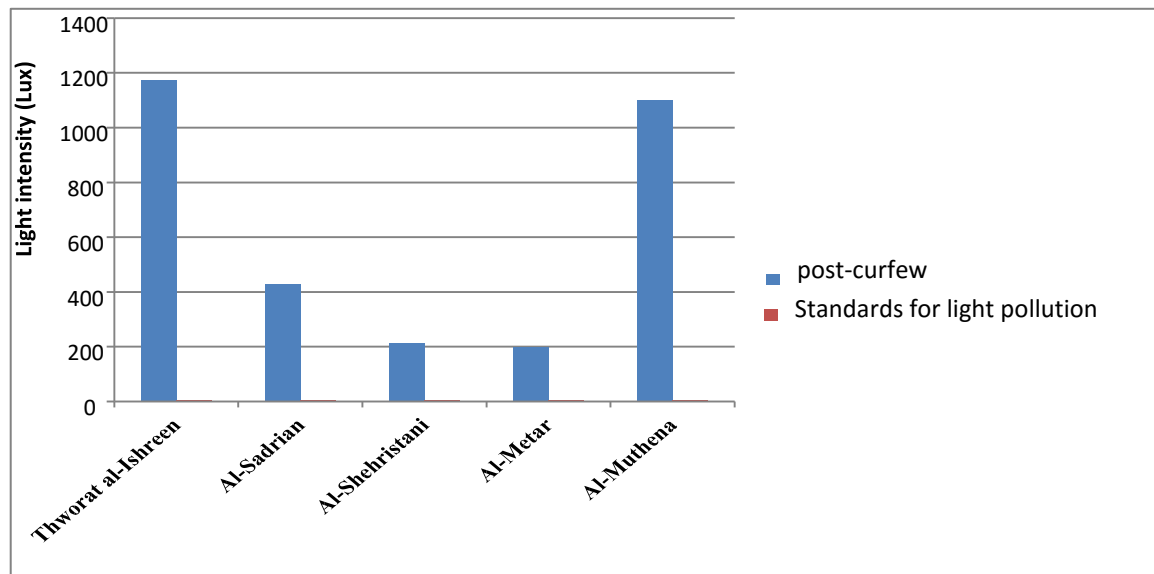


Fig. 5. Illustrates light intensity at post-curfew for selected squares compared with standards.

Figs. 6 and 7 illustrate the number of times the measured illumination intensity exceeded the permissible limit for each square before and after curfew, respectively.

The maximum number of times going beyond the allowed light intensity was recorded in the Thworat al-Ishreen Square and its value 48.96 fold during the pre-curfew period and 233.8 fold during the post-curfew period. The number of overtaking times in the post-curfew period is much higher than the pre-curfew period because the allowable limit after curfew is less. Regarding the airport area, the light intensity had recorded the lowest reading comparing to the city squares. Still considers higher than the recommended values by 8.64 fold during the pre-curfew period and 38.8 during the post-curfew period.

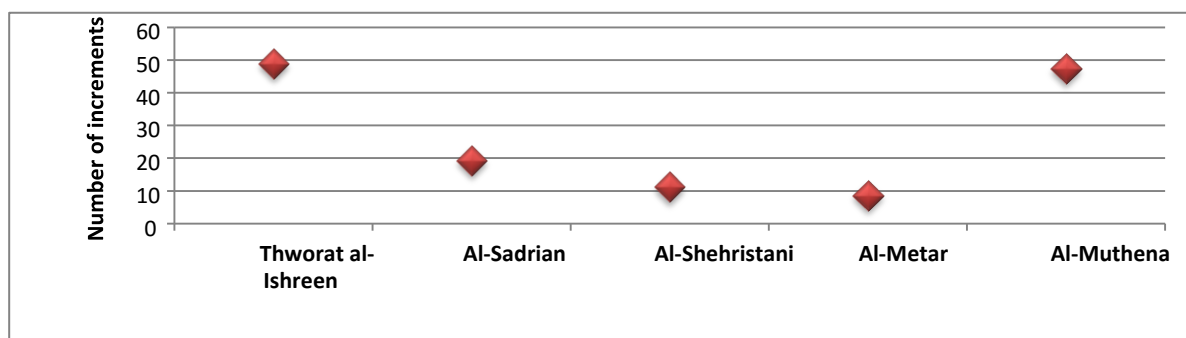


Fig. 6. Number of increments over standards at pre-curfew.

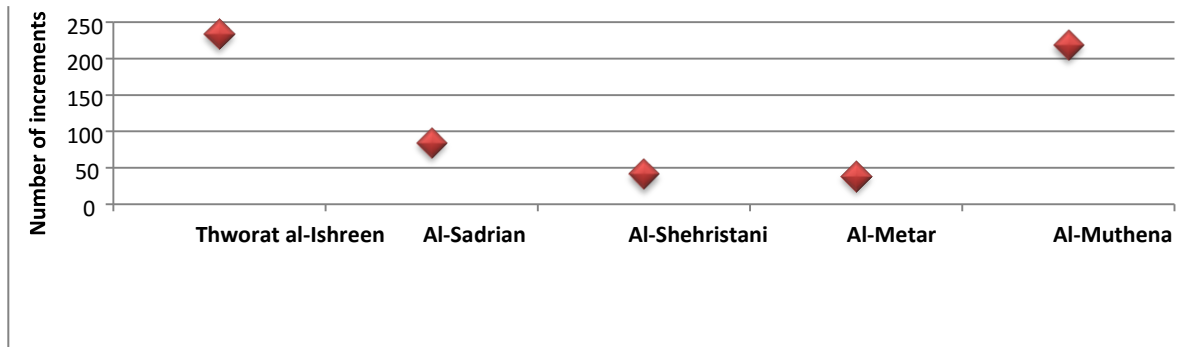


Fig. 7. Number of increments over standards at post-curfew.

5. CONCLUSIONS

During the work of this study, the following conclusions as a result of the research:

- 1) There is an apparent and significant excess in the rates of light pollution of the measured spots for roads and squares comparing to this study's identified International specifications. This is an alarming situation that most measured spots are facing large scale light intensity beyond the permissible limits, and Iraqi officials and environmental protectors are not aware of this fact.
- 2) There are no specifications, limitations, and legislations in Iraq that would limit light pollution and regulate the amount of permitted lighting in the streets, roads, and squares. In that aspect, Iraq is not following what the developed countries are performing, such as some Asian countries, South Korea, and China.
- 3) The technology used for the lighting poles in the streets and squares of Al-Najaf city is an old technology that has been considered more than two decades ago. It has a high level of lighting that is responsible for increasing the percentage of light pollution comparing to modern technology, which is supposed to take into account the rationalization of consumption to reduce light pollution.
- 4) Excessive Lighting along all sides of roads for most shops and markets, also the advertisement and decorations boards in the squares, as well as the light bulletin those used by the municipality to beautify the streets. That played a significant role in which directed to increase the light intensity and reflect in various directions that have led to rising the light pollution. Most likely that has badly affected drivers and pedestrians as well.
- 5) Lack of environmental awareness for some segments of society, which was represented by using very high lighting in the facades of buildings and shops to attract customers.

Furthermore, the trend of leaving lighting on until early morning hours is another factor of that pollution.

6) There is a close correlation between air pollution and light pollution because excessive use of lighting leads to high consumption of electrical energy, which in turn increases fuel consumption in power stations and domestic diesel generators. That is one of the main sources of air pollution.

6. RECOMMENDATION

This study recommends the following:

- 1) Draw the decision-makers and officials' attention of the local government and central government to cooperate with the scientific and academic institutions; those are concerns with limiting light pollution to work on issuing determinants and laws that limit light pollution.
- 2) Develop a strategy and educational awareness programs to improve environmental awareness and clarify its harmful effects on humans, animals, and plants. Accordingly, people will be more eager to turn off unnecessary lights, especially during the post-curfew times.
- 3) Reconsideration, economically and environmentally, of the numbers and randomness of setting light bulletins used in the median strips and on both sides of the road, as they lead to the consumption of electric energy and the increase in the percentage of light pollution affecting in all directions.

7. REFERENCES

- Hollan, J. (2007) 'What is light pollution, and how do we quantify it', 7th European Symposium for the Protection of the Night Sky-Light Pollution and Global Warming. In Proceedings of the Workshop Paper at Darksky 2007 Conference, Brno, Czech Republic, 5–6 October 2007.
- Kocifaj, M.; Kómar, L. (2016) 'A role of aerosol particles in forming urban skyglow and skyglow from distant cities', *Mon. Not. R. Astron. Soc.*, 458, 438–448.
- Brons, J.A.; Bullough, J.D.; Rea, M.S. (2008) 'Outdoor site-lighting performance: A comprehensive and quantitative framework for assessing light pollution'. *Light. Res. Technol.*, 40, 201–224.
- Kyba CCM, Höcker F. (2013) 'Do artificially illuminated skies affect biodiversity in nocturnal landscapes', *Landsc Ecol* 28:1637–1640.

Kyba CCM, Kuester T, Sánchez de Miguel A, Baugh K, Jechow A, Hölker F, Bennie J, Elvidge CD, Gaston KJ, Guanter L. (2017) 'Artificially lit surface of earth at night increasing in radiance and extent'. *Sci Adv*;3:e1701528. doi: 10.1126/sciadv. 1701528.

Shea, K.M. (2003) 'Global environmental change and children's health: Understanding the challenges and finding solutions', *The Journal of Pediatrics* 143 (2), 149–154.

Anisimov, V.N. (2006) 'Light pollution, reproductive function and cancer risk', *Neuroendocrinology Letters* 27 (1–2), 35–52.

Kloog I, Haim A, Stevens RG, Barchana M, Portnov BA. (2008) 'Light at night co-distributes with incident breast but not lung cancer in the female population of Israel', *Chronobiol. Int.* 25:65–81.

Itai Kloog, Abraham Haim, Richard G. Stevens, and Boris A. Portnov (2009) 'GLOBAL CO-DISTRIBUTION OF LIGHT AT NIGHT (LAN) AND CANCERS OF PROSTATE, COLON, AND LUNG IN MEN'. Articles PDF, available in:

<http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.718.647>

Rybnikova, N.A.; Haim, A.; Portnov, B.A. (2017) 'Is prostate cancer incidence worldwide linked to artificial light at night exposures, Review of earlier findings and analysis of current trends', *Arch. Environ. Occup. Health*, 72, 111–122.

James, P.; Bertrand, K.A.; Hart, J.E.; Schernhammer, E.S.; Tamimi, R.M.; Laden, F. (2017) 'Outdoor light at night and breast cancer incidence in the nurses' health study II'. *Environ. Health Perspect*, 125, 087010.

Hu, C.; Jia, W. (2016) 'Linking MTNR1B Variants to Diabetes: The Role of Circadian Rhythms', *Diabetes*, 65, 1490–1492.

Weinert, D.; Waterhouse, J. (2017) 'Interpreting Circadian Rhythms, in *Biological Timekeeping: Clocks, Rhythms and Behaviour*', Springer: Berlin, Germany, pp. 23–45.

Gaston, K.J.; Davies, T.W.; Bennie, J.; Hopkins, J. (2012) 'REVIEW: Reducing the ecological consequences of night-time light pollution: Options and developments', *J. Appl. Ecol.*, 49, 1256–1266.

Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C. C. M., Elvidge, C. D., Baugh, K., Furgoni, R. (2016) 'The new world atlas of artificial night sky brightness', *Science Advances*, 2, e1600377.

- Jechow, A., Hölker, F. (2019). 'How dark is a river? Artificial light at night in aquatic systems and the need for comprehensive night-time light measurements', wiley. p.p. 1-19, Available: link <https://onlinelibrary.wiley.com/doi/pdf/10.1002/wat2.1388>
- Morgan-Taylor, M. (2015) 'Regulating Light Pollution in Europe: Legal Challenges and Ways Forward', Routledge: Abingdon, UK.
- Cha, J.; Lee, J.; Lee, W.; Jung, J.; Lee, K.; Han, J.; Gu, J. (2014) 'Policy and status of light pollution management in Korea', *Light. Res. Technol.*, 46, 78–88.
- Ho, C.; Lin, H. (2015) 'Analysis of and control policies for light pollution from advertising signs in Taiwan', *Lighting Res. Technol.*, 47, 931–944.
- Taylor, M.M. (2006) 'Light pollution and nuisance: The enforcement guidance for light as a statutory nuisance', *JPL*, 8, 1114–1127.
- Zitelli, V.; Di Sora, M.; Ferrini, F. (2001) 'Local and national regulations on light pollution in Italy', In *Symposium-International Astronomical Union*; Cambridge University Press: Cambridge, UK.
- Wu Guanglei, Jack Ngarambe, Gon Kim. (2019) 'REVIEW: A Comparative Study on Current Outdoor Lighting Policies in China and Korea: A Step toward a Sustainable Nighttime Environment', *Sustainability journal*, 11, 3989.
- Narisada, K.; Schreuder, D. (2004) 'Light pollution and astronomy', In *Light Pollution Handbook*; Springer: Amsterdam, The Netherlands, pp. 115–138.
- Kim, K.T.; Oh, M.S.; Kim, H.S. (2011) 'A Study on the Control Standards and an Environmental Lighting Zone-Setting method for Making Light Pollution Management', *J. Korean Inst. Illum. Electr. Install. Eng.*, 25, 27–33.
- Hayder K. Abdulkareem. (2018) 'Evaluation of Noise Pollution Indicators in Al-Najaf city', *Kufa Journal of Engineering*, 9(4), 258-272.
- Hong Soo Lim, Jack Ngarambe, Jeong Tai Kim and Gon Kim. (2018) 'The Reality of Light Pollution: A Field Survey for the Determination of Lighting Environmental Management Zones in South Korea', *Sustainability*, 10(374), 1-12, Available: www.mdpi.com/journal/sustainability.