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## The impact of artificial light on the ecosystem of Nocturnal insects in Malaysia: A Review

Ahmad Solihin Sira Juddin<sup>1</sup>, Norhayati Ngah<sup>2</sup>, and Roslan Umar<sup>1\*</sup>

<sup>1</sup>East Coast Environmental Research Institute (ESERI), Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300 Kuala Nerus Terengganu, **Malaysia**

<sup>2</sup>Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut Campus, 22200 Besut Terengganu, **Malaysia**

\*Correspondence: [roslan@unisza.edu.my](mailto:roslan@unisza.edu.my) Received 05-07-2021, Revised: 12-08-2021, Accepted: 15-08-2021 e-Published: 18-08-2021

The use of artificial light has been increasing in the past few years due to human's development. In accordance with that, many researches were done worldwide to investigate the effect of artificial light to the ecosystem. The studies covers many aspects especially on the effect of artificial light to the sky brightness and the effect of artificial light to the natural ecosystem. However, lack of study was done to investigate the effect of artificial light on the natural ecosystem in Malaysia; thus, the public awareness about this topic is very scarce. Therefore, this paper compares the trend of research regarding the effect of light pollution to insects in general and in Malaysia specifically. The analysis was done by using meta-data methodology where the keywords were "light pollution", "insect" and "Malaysia" in the Web of Science. Our findings shows that the number of researches regarding the light pollution is expected to be increasing throughout the last 10 years. However, research regarding the same topic is expected to be very scarce in Malaysia. Therefore, more future research regarding light pollution and insect need to be done in Malaysia as some insects play important role in agriculture and eco-tourism activity.

**Keywords:** Light pollution, insect, natural ecosystem

### INTRODUCTION

Light pollution is a term for environmental change where once a dark area is illuminated by artificial light (Cinzano et al. 2000). Light pollution refers most of the time to astronomical light pollution in which the artificial light of the sky is visible in the sky and therefore other astronomical things are distorted as a result of artificial light scattered throughout the atmosphere (Falchi et al. 2016). In the meantime, the focus of this review is on the ecological light pollution where artificial light disrupts ecosystem function including insects (Rich and Longcore, 2013). Lights are one of the

changes in the environment that positively and negatively influence insect behavior. When part of natural occurrences such as sunlight and moonlight, light will have a positive effect. Artificial light, on the other hand, negatively affects the behavior of insects (Owens et al. 2020).

Nocturnal insects, other than being an indicator for the ecosystem, they also play an important role in agriculture and eco-tourism despite their lack of attention. Many varieties of tropical fruit are produced in Malaysia such as pineapple, durian, starfruits, bananas, papaya, mangos, cempedak and jackfruit (Zakaria and

Rahim, 2014). Some of them are reported to be pollinated by the nocturnal insects. Cempedak (*Artocarpus integer*) is recorded to be pollinated by the various species of nocturnal insects (Momose et al. 1997). Nocturnal moth also recorded to be a pollinator for papaya fruit with more than 95% visits on the flower are from hawkmoth (Martins and Johnson, 2009). Some species of nocturnal moth is also recorded to be complimentary pollinator in the palm oil industry (Rizali et al. 2019). In the tourism field, in particular, in the mangrove forest at Kg, Kuantan, Sungai Kinabatangan, Sungai Garama and Sungai Paitan, fireflies have become the main attraction in eco-tourism in Malaysia (Foo and Mahadimenakbar, 2015).

Therefore, this study is done to investigate the trend of studies regarding the correlation between light pollution to insect for the past 10 years. Then, this paper will also review selected studies regarding light pollution and insect in Malaysia. Lastly, based on the review, few suggestions of future studies were made.

## MATERIALS AND METHODS

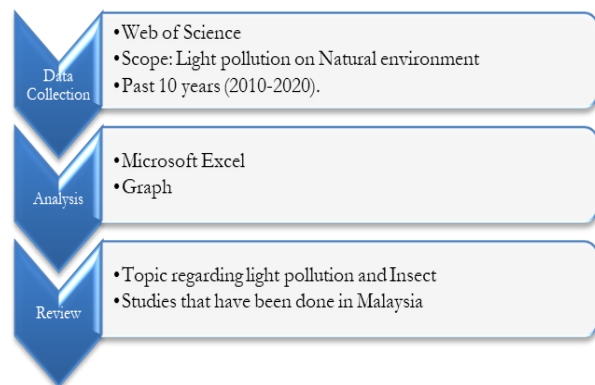
In order to review researches regarding light pollution on insect, few searches were done in order to collect data regarding the mentioned topic. The data were collected on the studies that published since 2010 until 2020 in the Web of Science. General topic such as "Light Pollution" or "Artificial Light at Night" were refined into few fields of study to limit the scope into light pollution from artificial light at night that has an effect to natural environment and not vice versa. Analysis was done with Microsoft Excel by building graph regarding the trend of studies regarding light pollution and insects in that period (Figure 1).

For data collection, published articles regarding the effect of light pollution were searched from Web of Science database (ISI) using the keywords "artificial light" or "light pollution" together with "insect". Firstly, the articles were searched using (TS= Light Pollution OR Artificial Light at Night). The search was refined into the following research area: "Ecology", "Marine Freshwater Biology", "Biodiversity Conservation", "Biology", "Astronomy Astrophysics", "Zoology" and "Entomology". After that, another search was done using (TS= Light Pollution AND CU= Malaysia) without refining to see the trend of studies regarding light pollution throughout the past 10 years. Then, the articles were also searched using (TS=Light Pollution AND Insect) and (TS =Light Pollution AND Insect

AND CU= Malaysia) to investigate the trend regarding studies correlated with light pollution and insect in the world and in Malaysia specifically throughout the mentioned period. All searches are since 2010 to 2020.

The number of studies that has been collected were put into the Microsoft Excel to produce a graph to observe the trend of the published research papers throughout the mentioned period.

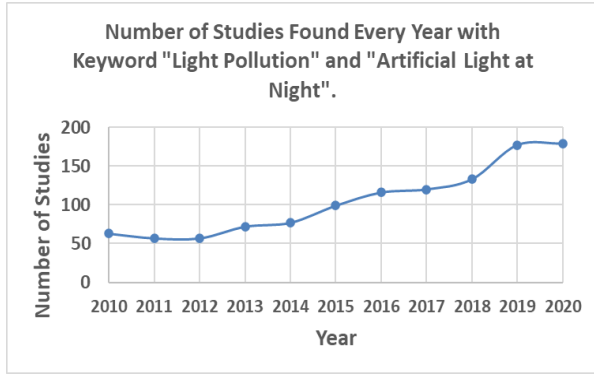
For the review, studies that has been found using (TS= Light Pollution AND Insect AND CU= Malaysia) were reviewed. After that, few articles were searched manually from (TS=Light Pollution AND CU= Malaysia) to find articles that met the criteria where the light pollution is about light that is caused by artificial light and have an effect to the natural environment and not vice versa.



**Figure 1: Flow chart of the methodology of this study.**

## RESULTS AND DISCUSSION

Trend of studies regarding light pollution was searched using keywords (TS=Light Pollution OR Artificial Light) with refinement to few fields of studies which are "Ecology", "Marine Freshwater Biology", "Biodiversity Conservation", "Biology", "Astronomy Astrophysics", "Zoology" and "Entomology". The search is limited to the mentioned field of studies in order to limit the scope into studies regarding light pollution caused by the artificial light and its effect to the natural environment such as sky brightness, ecosystem, and insects' behavior (Figure 2).

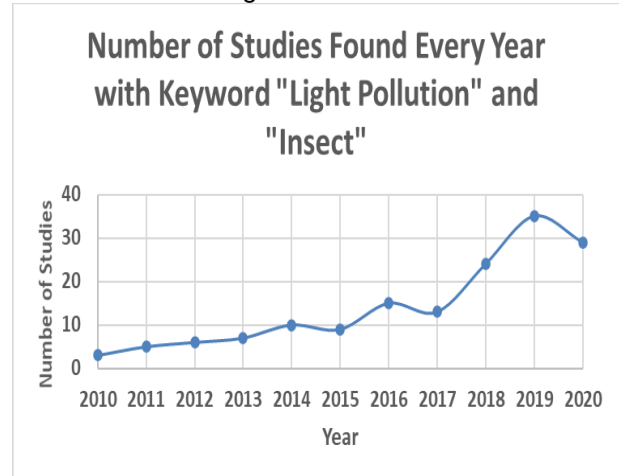


**Figure 2: Trend of studies regarding light pollution since 2010 until 2020.**

Studies regarding light pollution and artificial light at night are found to be steadily increase since 2010 until 2020 (10 years period) showing that the concern regarding light pollution has been increasing among researchers worldwide. Previously, Davies and Smyth (2018) has made a study on research trend regarding light pollution in comparison to research trend on climate change. Their result also shows that studies regarding light pollution has been increasing from the year 2000 until 2016. However, their study is more general and cover a broader field of studies; while our research is focusing on insect ecosystems and includes recent studies.

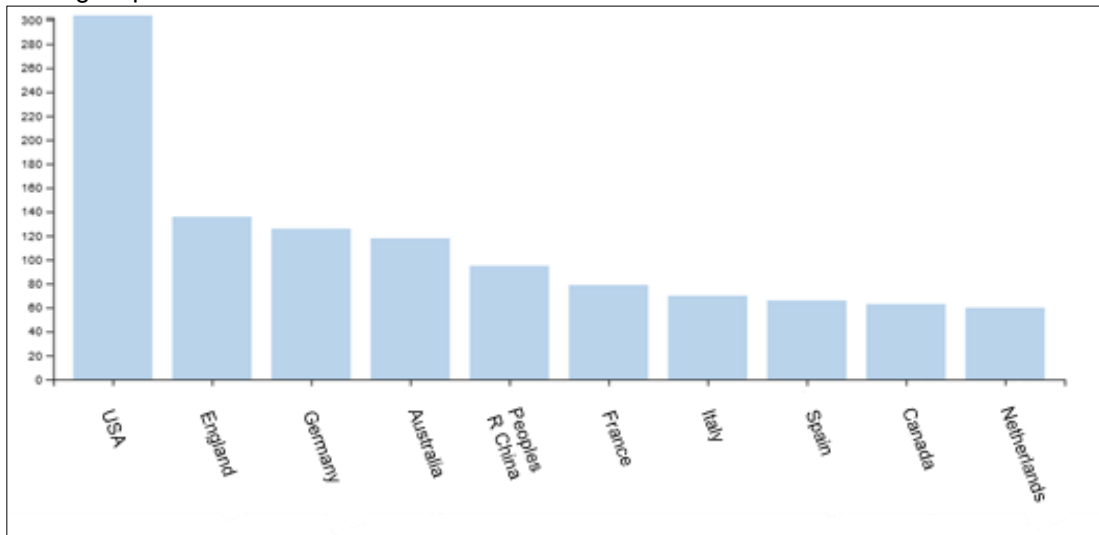
Figure 3 shows the number of studies found when extracted in the Web of Science system using keywords (TS=Light Pollution AND Insects). The result obtained shows that the studies on the effect of light pollution on insects has been

increasing for the period of 10 years (2010 until 2020). Both of these graphs shows that researchers have realize that the effect of light pollution can be a threat to the natural ecosystem especially on the insects' ecosystem; thus gain more interest among researcher.



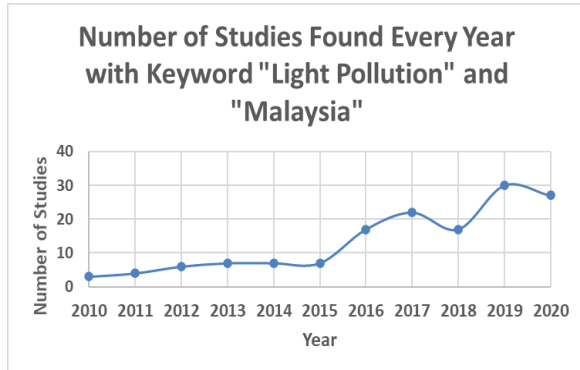
**Figure 3: Trend of studies regarding light pollution since 2010 until 2020.**

We then try to detail our research by searching the keywords (TS= Light Pollution OR Artificial Light at Night); where we found the top 10 countries in the world that has done research regarding light pollution is mostly from developed country (Figure 4). None of those countries is from developing country nor any country from Southeast Asia or even Malaysia.



**Figure 4: Top ten countries in the world that report about light pollution in Web of Science**

Therefore, our next objective is to investigate the number of research regarding light pollution that has been done in Malaysia. We once again extract the information from the Web of Science using keywords (TS= Light Pollution AND CU= Malaysia); where we found 160 studies have been reported. These studies has been increasing since 2010 until 2020 (Figure 5).



**Figure 5: Trend of studies regarding light pollution in Malaysia since 2010 until 2020.**

However, when search using keywords (TS= Light Pollution AND Insect AND CU=Malaysia), there are only 3 studies were reported in the Web of Science in that particular year (Table 1).

**Table 1: Studies that have been found using keywords "Light Pollution", "Insect" and "Malaysia" in the Web of Science.**

Author	Year	Title
Latiff, A.	2010	Conservation strategies for endangered mangrove swamp forests in Malaysia.
Yule, et al.	2015	Urbanization affects food webs and leaf-litter decomposition in a tropical stream in Malaysia
Lewis, et al.	2020	A global perspective on firefly extinction threats.

All of these three studies are related to insect; however, only two are actually specifically mentioning about light pollution. Latiff (2010) has made a review regarding the status of mangrove swamp forest in Malaysia. The paper discusses about the threats and conservation activities that have been done to preserve the mangrove forests. The only insect mentioned in that review

is fireflies where Latif (2010) conclude that the reduction of mangrove forest will reduce the number of fireflies due to its habitat loss.

Yule et al. (2015) focused on the effect of urbanization generally to the food webs and leaf-litter decomposition in a tropical stream in Malaysia. In that study, 10 sites were chosen along Ampang River, Kuala Lumpur. Sites 1-4 are located inside a forest reserve while site 5 located in the exit of the forest. The rest of sites (6-10) are located in urban area. Unfortunately, the study not focused on the effect of light pollution on the insect. However, the intensity of light at all sampling area are measured in the unit of lux. Even though the study did not focus directly on the light pollution and insects, the data provided can still be useful to evaluate any correlation on the artificial light and how it affect the ecosystem generally.

Lewis et al. (2020) has made a research on the threats to the firefly ecosystem. This study is done by distributing a survey by email to approximately 350 respondents who are listed in Fireflies International Network, a scientific organization consists of many experts regarding the studies of firefly. The respondents are divided into 8 group of regions where Southeast Asia is one of them which includes Malaysia and Thailand. The objective of that research is to investigate the threats on firefly ecosystem. Findings shows that in Southeast Asia region, light pollution is listed as second biggest threat to firefly ecosystem after habitat loss. This is expected since firefly is nocturnal insect and will heavily affected by artificial light. A study from Mbugua et al. (2020) has shown that the larvae of firefly will stop its activity when exposed to artificial light.

We actually found 160 studies in the Web of Science when search using keywords (TS= Light Pollution AND CU= Malaysia); however, not all of those studies are about the effect of artificial light on the ecosystem or to the environment. When search using more specific keywords like (TS= Light Pollution AND Insect AND CU=Malaysia) only three studies are left. Therefore, we had to look into all 160 studies manually one-by-one to find more studies regarding light pollution. As a result, we have found another 5 studies regarding light pollution (Table 2).

**Table 2: Studies that have been found with manual search from keywords “Light Pollution” and “Malaysia”**

Author	Year	Title
Shariff, et al.	2015	Creating Awareness on Light Pollution'(CALP) Project as a Platform in Advancing Secondary Science Education.
Faid, et al.	2016	Monitoring the Level of Light Pollution and Its Impact on Astronomical Bodies Naked-Eye Visibility Range in Selected Areas in Malaysia Using the Sky Quality Meter.
Faid, et al.	2018	Semi-Empirical Modelling of Light Polluted Twilight Sky Brightness
Tahar, et al.	2020	Identifying Light Pollution Sources at Two Major Observatories in Malaysia
Mbugua, et al.	2020	Effects of Artificial Light on the Larvae of the Firefly <i>Lamprigera</i> Sp. in an Urban City Park, Peninsular Malaysia

Out of these five studies, only one study is about the effect of light pollution onto insects. Shariff et al. (2015) has done a research to identify the requirements for school and university to have a collaboration in a project called 'Creating Awareness for Light Pollution' (CALP). As the name of the project suggest, this project aim to create awareness among the society regarding the effect of light pollution. Even though it is not about the ecological light pollution, creating awareness about light pollution at all is better than nothing. Early education like school is a good place to start in creating awareness.

Faid et al. (2016) studies the level of light pollution by measuring sky brightness using Sky Quality meter at two different cities in Malaysia; a densely populated city, Kuala Lumpur and less populated city, Teluk Kemang. It is not surprising that Kuala Lumpur is highly polluted with 17.59 mag/arc<sup>2</sup>, however, Teluk Kemang, where an observatory is located also at worrisome level of 19.288 mag/arc<sup>2</sup>. This shows that light pollution can no longer be taken lightly. Another research from Faid et al. (2018) shows that light pollution not only affected the sky brightness at night but it also has significant effect on twilight sky brightness.

Tahar et al. (2017) and Tahar et al. (2020) identifies the major sources of light pollution on two major observatories which are Balai Cerap Teluk Kemang (BCTK) and Langkawi National Observatories (LNO). The measurement for BCTK in 2018 reported by Tahar et al. (2020) is about the same as Faid et al. (2016) which is 19.33 mag/arc<sup>2</sup> showing that the light pollution in Teluk Kemang stays almost the same as reported in the particular years. However, LNO suffers an increase of light pollution from 21.08 mag/arc<sup>2</sup> in 2013 to 19.64 mag/arc<sup>2</sup> in 2018. High Pressure Sodium (HPS) light is found to be the highest contributor to the light pollution in both areas even though light-emitting diode (LED) spotlight is used

near both observatories. Regardless of which is the major contributors, both types of light; HPS and LED will have significant effect, not only to the sky brightness but also on nocturnal insects (Wakefield, et al. 2018). Another observatory, Balai Cerap KUSZA which is located in Terengganu, Malaysia may also suffer from light pollution from Merang Jetty with a reading of 20.294 mag/arc<sup>2</sup> (Umar et al. 2018). Even though the observatory is not heavily polluted yet, the lack of exposure among public regarding the effect of light pollution on astronomical observation may cause the light pollution to keep increasing over time.

Mbugua et al. (2020) is the only study in Malaysia which focused on the effect of artificial light on insect. The study is about the behavior of larvae of firefly (*Lamprigera* sp.) in the exposure of artificial light at Kuala Lumpur, Malaysia. The larvae are found to be actively moving at night and found to be immobile in the exposure of high intensity artificial light. This research is a great start and more future studies regarding the effect of light pollution on insect need to be done.

## CONCLUSION

In conclusion, we found that the trend of studies regarding light pollution and artificial light at night specifically on their effect on natural environment has been increasing since 2010 until 2020. The number of studies regarding the correlation between light pollution and insects is also increasing in that period. However, in Malaysia, the number of studies regarding the effect of light pollution or artificial light on natural environment is worrisome with only seven studies were found in that 10 years' time; whereas four of them is about astronomical light pollution. In the other three, only one of those study is totally focused on the effect of artificial light on insects.

More research regarding the effect of light pollution or artificial light on insect's natural ecosystem need to be done in Malaysia. The

measurement of sky brightness can also be used to find the correlation of insects' behavior in response to different sky brightness. Spatial analysis using Geographic Information System (GIS) can also be used to investigate how many area in Malaysia is affected by light pollution and what is the effects of light pollution to the natural ecosystem in that particular area.

#### CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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#### AUTHOR CONTRIBUTIONS

ASSJ collected the data, analyzed and reviewed it. NN and RU supervised and edited the manuscript. All authors read and approved the final version.

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#### REFERENCES

- Cinzano P, Falchi F, Elvidge CD, and Baugh KE, 2000. The artificial night sky brightness mapped from DMSP satellite Operational Linescan System measurements. *Monthly Notices of the Royal Astronomical Society*, 318(3), 641-657.
- Faid MS, Husien N, Shariff NNM, Ali MO, Hamidi ZS, Zainol NH, and Sabri SNU, 2016. Monitoring the level of light pollution and its impact on astronomical bodies naked-eye visibility range in selected areas in Malaysia using the Sky Quality Meter. In 2016 International Conference on Industrial Engineering, Management Science and Application (ICIMSA) (pp. 1-6). IEEE.
- Faid MS, Shariff NNM, Hamidi ZS, Kadir N, Ahmad N, and Wahab RA, 2018. Semi-Empirical Modelling of Light Polluted Twilight Sky Brightness. *Jurnal Fizik Malaysia*, 39(2), 30059-30067.
- Falchi F, Cinzano P, Duriscoe D, Kyba CC, Elvidge CD, Baugh K, and Furgoni R, 2016. The new world atlas of artificial night sky brightness. *Science advances*, 2(6), e1600377.
- Foo K, and Mahadimenakbar MD, 2015. Diversity of fireflies (Coleoptera: Lampyridae) of Sungai Teratak, Sabah, Malaysia. *Journal of Tropical Biology and Conservation*, 12, 1-11.
- Latiff A, 2012. Conservation strategies for endangered mangrove swamp forests in Malaysia. *Pakistan Journal of Botany*, 44, 27-36.
- Lewis SM, Wong CH, Owens A, Fallon C, Jepsen S, Thancharoen A, and Reed JM, 2020. A global perspective on firefly extinction threats. *BioScience*, 70(2), 157-167.
- Martins DJ, and Johnson SD, 2009. Distance and quality of natural habitat influence hawkmoth pollination of cultivated papaya. *International Journal of Tropical Insect Science*, 29(3), 114-123.
- Mbugua SW, Wong CH, and Ratnayeke S, 2020. Effects of artificial light on the larvae of the firefly *Lamprigera* sp. in an urban city park, Peninsular Malaysia. *Journal of Asia-Pacific Entomology*, 23(1), 82-85.
- Momose K, Hatada A, Yamaoka R, Inoue T, 1997. Pollination Biology of the Genus *Artocarpus*. *Moraceae, Tropics*. 7(3+4).
- Owens AC, Cochard P, Durrant J, Farnworth B, Perkin EK, and Seymoure B, 2020. Light pollution is a driver of insect declines. *Biological Conservation*, 241, 108259.
- Rich C, and Longcore T, Eds. 2013. *Ecological consequences of artificial night lighting*. Island Press.
- Rizali A, Rahardjo B, Karindah S, Wahyuningtyas FR, Nurindah, Sahari B, and Clough Y, 2019. Communities of oil palm flower-visiting insects: investigating the covariation of *Elaeidobius kamerunicus* and other dominant species. *PeerJ*, 7.
- Shariff NNM, Hamidi ZS, Musa AH, Osman MR, and Faid MS, 2015. Creating Awareness on Light Pollution'(CALP) Project as a Platform in Advancing Secondary Science Education. In International Conference of Education,

- Research and Innovation, Seville. Spain.
- Tahar MR, Ahmad N, and Ismail N, 2020. Identifying Light Pollution Sources at Two Major Observatories in Malaysia. *Sains Malaysiana*, 49(2), 439-445.
- Tahar MR, Kamarudin F, Umar R, Kamarudin MKA, Sabri NH, Ahmad K, and Baharim MSA, 2017. Spatial model of sky brightness magnitude in Langkawi Island, Malaysia. *Research in Astronomy and Astrophysics*, 17(4), 037.
- Umar R, Awang WJ, Berzanji SN, Abd Majed NF, Kamarudin MKA, and Abdullahi MG, 2018. Spatial Model of Sky Brightness Magnitude in KUSZA Observatory, UniSZA. *International Journal of Engineering & Technology*, 7(2.15), 13.
- Wakefield A, Broyles M, Stone EL, Harris S, and Jones G, 2018. Quantifying the attractiveness of broad-spectrum street lights to aerial nocturnal insects. *Journal of Applied Ecology*, 55(2), 714-722.
- Yule CM, Gan JY, Jinggut T, and Lee KV, 2015. Urbanization affects food webs and leaf-litter decomposition in a tropical stream in Malaysia. *Freshwater Science*, 34(2), 702-715.
- Zakaria NA and Rahim ARA, 2014. An overview of fruit supply chain in Malaysia. *Jurnal Mekanikal*, 37(1).