



## Evaluation of light pollution awareness and residential lights in Pasig City

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### Abstract

Light pollution is unwanted or excessive artificial light. This research study aimed to know the residential artificial light source of Pasig City and their awareness of light pollution by using a simple survey questionnaire. This study reveals that the residents are unaware of light pollution and its effect on animals, plants, humans, and the environment. Most people are sleeping with lights on and turning it off from 12:00 am to 2:00 am. Also, most of the respondents answered that streetlights, light bulbs, residential lights, business establishments, and car headlights are their primary light sources. It is notable that based on the study result, the light condition on a usual night outside the residences is in fair brightness, which is also their ideal light condition. Light trespass is the typical type of light pollution that may be observed in the City. It is essential to deliver and provide facts and information about light pollutions and its effect on the community and the industry. The creation of policies is advisable to minimize and control light pollution in municipalities.

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## Introduction

Light pollution is known as photo pollution, or luminous pollution is excessive, misdirected, or invasive use of artificial outdoor lighting. It is also defined as the result of the development of manufactured artificial lights that significantly affects the change in the natural quantity or measure of light at nighttime (Cinzano and Falchi, 2014). Also, Light Pollution can affect Human Health, such as the Suppression of Pineal Gland Melatonin (Kogevinas *et al.*, 2018). Sleep disorders, Diabetes, Obesity, and other diseases (Bray and Young, 2012). Well-established adverse health effects of ALAN include decreasing sleep quality and insomnia, increased alertness, depression, higher or elevated risk of hormone-dependent cancers (Rybnikova, Haim and Portnov, 2016).

Light pollution is defined as the result of the development of manufactured artificial lights that significantly affect the change in the natural quantity of light at night (Cinzano & Falchi, 2014). The luminosity of the night sky is described by the obtained light and dispersed properties of the atmosphere (Horvath, 2014). It is a broad range expression describing the uncontrolled use of artificial lights. In account with this are sky glow, light trespass, and glare (Gallway *et al.*, 2010). Skyglow is the light that comes from the ground that fills the sky with various light colors. Glare is denoted as the light that, instead of illuminating its subject, conceals its subject because of imperfectly directed light. The dispersed light where it is not intended or needed is described as obtrusive light or light trespass. Spill light refers to radiated light extending beyond the property boundary where the lighting system is installed. Luminaires that have been misapplied, poorly directed, or poorly constructed are the most common causes. The source of the problem might be nearby street lamps, sports field illumination, and residential, parking lot, or commercial area lighting.

Associated with this is 'light trespass' or 'light nuisance,' in which the light is poorly controlled. As a result, the light dimmed the subject rather than illuminate it (Dunnett, 2015).

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The primary origin of light pollution is said to have emerged from the lighting of streets and highways, and its rapid increase is due to urbanization (Fletcher & Crampton, 1973). The necessity in building infrastructures to support population growth signals the continued production of artificial light (Luarte *et al.*, 2016). The production of outdoor lighting symbolizes a more civilized society that is inclined to a safer environment at night, but this also symbolizes the disruptions of the natural night glow (Pun *et al.*, 2014). Discharge lights from road lamps that keep road flood with light, vehicles that move along a non-illuminated area, traffic signs, and safety warning lights are great contributors as well (Lyytimaki & Tapio, 2011).

As a way of living in modern society, most people nowadays are more likely to stay inside infrastructures, producing a disturbing level of illumination compared to the natural light that the environment produces (Bara & Escofet, 2017). The improper and overwhelming use of lighting is simply producing light pollution (Elsahragtya & Kimb, 2015)

As the light pollution increases, the willingness and interest in protecting the night sky have increased (Kocifaj, 2007).

Urbanization invades areas near observatories that threaten the dim skies (Fletcher & Crampton, 1973). Light pollution hinders night time view of astronomical objects (Brons *et al.*, 2008)

The Discovery of this artificial light plays a vital role in turning man's day into a productive one, either for work or recreational activities. Thus, artificial light's benefits are indeed very evident (Operti *et al.*, 2017). Nevertheless, intensive studies showed that the intolerable use of artificial lights has unfavorable effects on humans, animals, and as well as for astronomical observations and discoveries (Bara *et al.*, 2018).

Light pollution is an environmental problem that increases drastically in the past decades. However, because of the intensification of other environmental problems, light pollution gained minimal attention.

Every City in National Capital Region is experiencing population growth. One of these is the City of Pasig that consists of 30 barangays with over 755,300 total populations and 180,612 estimated households based on the 2015 census. Thus, Pasig City is classified as one of the most urbanized cities in the Philippines. It is also known for its business district that also consists of commercial and residential buildings. Nevertheless, the continued increase of figures is also associated with the increase in environmental problems. Light pollution is said to be the aftereffect of urbanization.

### **Materials and methodology**

Methods typically refer to the strategy or plan that a researcher has devised in order to gather data. The researcher used a simple survey questionnaire to identify resident's awareness of light pollution and its effect. In addition, the researcher identified the light source that can be seen from the residences.

#### *Research Location*

Pasig City is a 1<sup>st</sup> class highly urbanized city in Metro Manila, Philippines. According to the 2015 census, its population reached 755,300 people and 180,612 estimated households. The City is a Lone District and was founded in 1573 and has 30 barangays including

Bagong Illog, Bagong Katipunan, Bambang, Buting, Caniogan, Dela Paz, Kalawaan, Kapasigan, Kapitolyo, Malinao, Manggahan, Maybunga, Orlando, Palatiw, Pinagbuhatan, Pineda, Rosario, Sagad, San Antonio, San Joaquin, San Jose, San Miguel, San Nicolas, Santa Cruz, Santa Lucia, Santa Rosa, Santo Tomas, Santolan, Sumilang, and Ugong.

#### *Sampling Method and Materials*

The study used Slovin's formula to determine the sample size of the population to consolidate the total number of respondents of Pasig City. The researcher calculated three hundred and seventy (370) respondents to represent the whole population. However, the researchers used 770 respondents to increase the reliability of the results. The survey questionnaire was made for this study to emphasize the study's objective and provide appropriate answers to the problems. The research survey questionnaire was guided by the two different studies conducted by Bashiri (2014) and Lyytimäki & Rinne (2013).

#### *Data gathering procedure*

The research survey questionnaire was made based on two different studies that are relevant to this study. Astronomers and educators verify the research survey questionnaire. Second, the respondents are randomly selected, and the dissemination of the survey questionnaire is done within a month.

### **Results and discussion**

The table below shows the results gathered on the survey questionnaire. The survey was composed of questions on awareness on light pollution, a light condition outside their residence and their ideal light conditions, sources of artificial light seen in their residence, the time they usually turn off their lights, and the number of lights used in their home. These are the questions used to assess the residents' awareness, probable light conditions, and source of light pollution in the said City.

Table 1 shows that 65.97% of the respondents are not aware of Light Pollution. On top of that, 48.05% are not aware that light pollution harms human health.

At the same time, 58.96% and 58.70% do not have any idea that light pollution affects animals and plants, respectively. Therefore, understanding the relationship between the awareness of the effects of light pollution and artificial light will be a good platform for addressing this severe environmental problem adequately. However, with the intensification of other environmental problems, the problem with light pollution gained minimal attention (Stone, 2017). Thus, according to International Dark-Sky Association, safeguarding the night sky from artificial lights is crucial to restoring the naturally dark sky.

**Table 1.** Evaluation of knowledge the Public regarding Light pollution.

Questions	Yes	No
Do you know about light pollution?	262 34.03%	508 65.97%
Do you know excessive lighting can adversely affect a person's health?	400 51.94	370 48.05%
Do you know that artificial lighting can harm animals?	316 41.01%	454 58.96%
Do you know that excessive light can negatively affect plants?	318 41.30%	452 58.70%
Do you sleep with lights on?	344 44.48	426 55.32%
Do you use LED light bulbs at home?	650 84.42%	120 15.58%

It also observed that 55.32% sleeps while the lights are on. There are 84.42% already using LED light bulbs in their home. Although 84.42% uses LED light bulbs, they still opt to sleep with lights off.

The community is switching in LED lights for cost-efficient. However, right from the introduction of the LED lights, the problem of light pollution increases (Brady, 2017). Increased knowledge of light pollution in urban and suburban regions might have consequences for planners and conservation ecology in urban and non-urban settings. (Ziou & Kerouch, 2018).

Table 2 shows that 3.77% has pitch-black night condition outside their residence. While 3.64% with as bright as day condition. In addition, the result shows that 32.86% are still in a little black condition, and 59.73% were in fair brightness light condition outside their residence.

**Table 2.** Light condition on a usual night outside the residence.

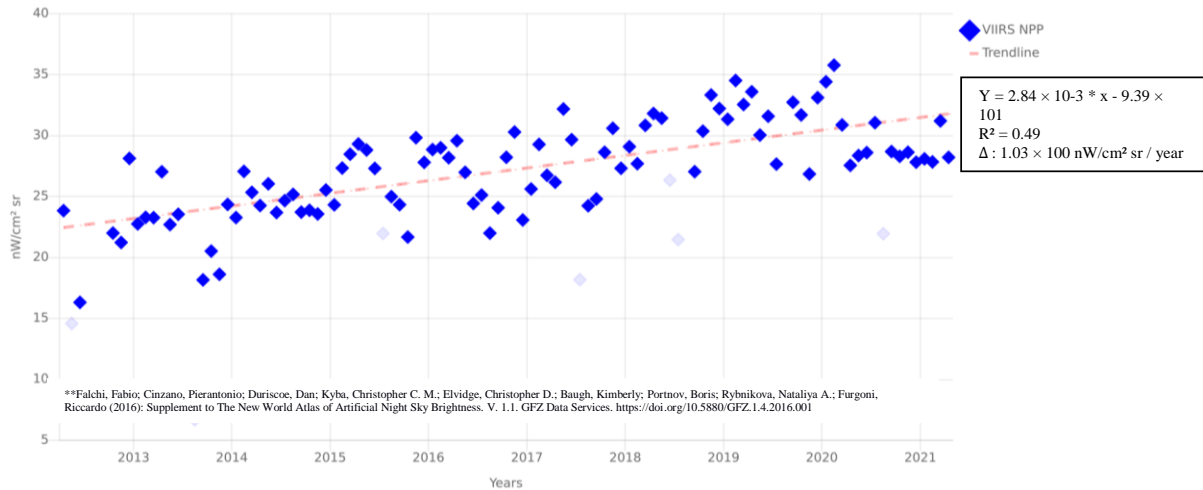
Light condition on a usual night outside a residence	No. of Response	Percentage
Pitch Black	29	3.77%
A Little Black	253	32.86%
Fair Brightness	460	59.73%
Bright as Day	28	3.64%

As a way of living in modern society, most people nowadays are more likely to stay inside infrastructures, producing a disturbing level of illumination compared to the natural light that the environment produces (Bara & Escofet, 2017). The improper and overwhelming use of lighting produces light pollution (Elsahragtya & Kimb, 2015).

Based on the result, there is only 3.77% part that the residents' sky in the Pasig is of good sky quality for observation in an urban setting. It is widely evident that there is astronomical light pollution in the sky of the City. Astronomical light pollution is the loss of our capacity to see the night sky owing to artificial light dispersion in the atmosphere. (Cinzano *et al.*, 2001). As the light pollution increases, the willingness and interest in protecting the night sky have increased (Kocifaj, 2007). Urbanization invades areas near observatories that threaten the dim skies (Fletcher & Crampton, 1973). Light pollution hinders night time view of astronomical objects (Bronson *et al.*, 2008).

The Fig.1 shows the weak trend of Pasig City from 2013-2020. Notably, the increase of light pollution in the City has an average of 21 nW/cm<sup>2</sup> to 31 W/cm<sup>2</sup> per year. The values of radiance fall fit to the linear line with R<sup>2</sup> 0.49, shows a positive linear correlation. The Bortle Scale class is ranging from Class 5 to Class 6. It shows that Pasig City is exposed to light pollution.

As a result, most residents live in a fair brightness light condition; moreover, it is also their ideal light condition with 40.39% responses. On the other hand, only 15.84% are likely to live with a pitch-black light condition and 35.97% with a bit of black. Notably, there is 7.79% who prepared to have a bright daylight condition.



**Fig. 1.** Monthly average of radiance value of Pasig City from 2013-2020.

As described by the respondents, the primary light source in their residence is light bulbs (98.18%) and street lights (91.04%) shown in Table 4. Next on the line is the 45% lights from cars, 41.40% business establishments, and 36.88% from residential buildings. Also, there are light sources from commercial buildings with 18.96% and 16.75% LED Lights. Notably, there is 13.64% light that the resident cannot identify where it comes from.

**Table 3.** Residents Ideal Light Condition outside their resident.

Ideal Light Condition	No. of Response	Percentage
Pitch Black	122	15.84%
A Little Black	277	35.97%
Fair Brightness	311	40.39%
Bright as Day	60	7.79%

**Table 4.** Residence different sources of light.

Sources of Light	No. of Response	Percentage
Light Bulbs	756	98.18%
Street Lights	701	91.04%
Commercial Building	146	18.96%
Residential Building	284	36.88%
Business Establishments	319	41.40%
Car Headlights	353	45.84%
LED Lights	129	16.75%
Unidentified Light Sources	105	13.64%

Pasig City is a first-class, highly urbanized city in the National Capital Region (NCR) in the Philippines. As described in table 2, most residents have a little black to fair brightness night light condition outside their residence. The result shows that the residents are

exposed to different light sources such as residential and street lights. It only shows that residents may also be experiencing light trespass from a different source of light. It is also important to emphasize that there are lights that the residents cannot identify.

This substantial shift in nighttime illumination, which affects almost two-thirds of the world's population, is closely linked to metropolitan regions, which contain many sources of artificial light, such as street lights and lighting from residential, commercial, and industrial locations (Elvidge, Baugh, Kihn, Kroehl, & Davis, 1997; Doll, 2008; Kuechly *et al.*, 2012; Hale *et al.*, 2013; Levin, Johansen, Hacker, & Phinn, 2014; Li, Ge, & Chen, 2014; Kyba *et al.*, 2015). The primary origin of light pollution is said to emerge from the lighting of streets and highways, and its rapid increase is due to urbanization (Fletcher & Crampton, 1973). The necessity in building infrastructures to support population growth signals the continued production of artificial light (Luarte *et al.*, 2016).

The production of outdoor lighting symbolizes a more civilized society that is inclined to a safer environment at night, but this also symbolizes the disruptions of the natural night glow (Pun *et al.*, 2014). Discharge lights from road lamps that keep road flood with light, vehicles that move along a non-illuminated area, traffic signs, and safety warning lights are great contributors as well (Lyytimaki & Tapio, 2011).

Based on table 5, 56.10% of the residents use 4-6 lights, and 28.44% use an average of 5-7 number lights. At the same time, only 10.39% use only 1-3 lights. Thus, at the least, only 5.06% of residents used more than seven lights in their household.

**Table 5.** Residents Number of Lights used by the household.

Number of Lights used by the household	No. of Response	Percentage
1-3	80	10.39%
4-6	432	56.10%
5-7	219	28.44%
Eight and above	39	5.06%

The Discovery of this artificial light plays a vital role in turning man's day into a productive one, either for work or recreational activities. Thus, artificial light's benefits are indeed very evident (Operti *et al.*, 2017). Nevertheless, intensive studies showed that the intolerable use of artificial lights has unfavorable effects on humans, animals, and as well as for astronomical observations and discoveries (Bara *et al.*, 2018).

While artificial lighting has certain apparent benefits for humanity, its detrimental consequences, often known as "light pollution" and frequently referred to as "over lighting," "glare," or "light trespass," have sparked growing concerns ((Burne, 1972; Riegel, 1973; Kyba *et al.*, 2013a; Kyba *et al.*, 2015).

As shown in table 6, 16.49% turn off their residential lights from 10 pm-12 am, and 61% turn off their lights from 12 am-2 am of midnight. While there is 14.55% turn off their lights between 2, am-4 am and 7.01% between 4 am-6 am. The most significant environmental element influencing sleep is light. While most individuals intuitively understand that sleeping in the dark is more manageable, the relationship between light and sleep is considerably more complex. The circadian rhythm, the body's internal clock that indicates when to be awake and when to relax, is regulated in part by light. Melatonin, an essential sleep-promoting hormone, is similarly affected by light. Studies show that there might be effects of too much exposure to light to human health from sleeping and acquiring diseases such as breast

cancer and other health issues. According to Rea 2002, lighting just for the sake of visual acuity or aesthetic effects is no longer acceptable. The lighting should also be considerate of the circadian cycle (Pauley, 2004). In connection with understanding peoples' behavior regarding light pollution, Bashiri (2014) study provides results on how people behave with light pollution and the common sources of light pollution that people believe significantly contribute to the rapid propagation of light pollution. The study also provides data that shows consequences of light pollution on human health, plants, and animals were determined.

**Table 6.** Residents Time of Turning off of their Lights.

Usual Turning off of Lights	No. of Response	Percentage
10:00PM-12:00AM	127	16.49%
12:00AM-2:00AM	477	61.95%
2:00AM-4:00AM	112	14.55%
4:00AM-6:00AM	54	7.01%

**Conclusions**

The paper found out that most residents are not aware of Light Pollution and its effect on animals, humans, the environment, and plants. As a result, only residents live in pitch-black light conditions and still chose to sleep with lights on and stay in the light overnight. Light trespass is the typical type of light pollution that may be observed in the City. It is essential to deliver and provide facts and information about light pollutions and its effect on the community and the industry. The creation of policies is advisable to minimize and control light pollution in municipalities. It will be helpful to prevent the escalation of the problem in light pollution and its adverse effect.

**Recommendations**

This research suggests identifying the present amount of light pollution in the Philippines and correlating it with the public's awareness. In addition, a review of policies in lighting in the Philippines is highly recommended for future research.

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