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Night sky brightness measurement during the March 2018 Earth Hour in Yogyakarta

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Abstract. Switching off the light for one hour is annual global event to celebrate the Earth Hour. At that time, there is also campaign to observe the night sky with minimal light pollution. Hence, during this event, it is important to measure the level of light pollution using the Sky Quality Meter (SQM) device that was directed to the zenith. The research is intended to obtain comparison of the night sky brightness (NSB) between regular days (23th and 25th of March) and Earth Hour day (24th of March). The measurement was performed in Yogyakarta that is located in -7.798893° south and 110.364992° East using the SQM-LU device. The location is the city center where the artificial light comes from the building, advertising boards, city lights and vehicles. The data distribution analysis was performed to obtain the mode value of NSB for each day. The mode value of NSB on 23th, 24th, 25th of March 2018 are $15.5 \text{ mag/arcsec}^2$, $14.61 \text{ mag/arcsec}^2$, $15.02 \text{ mag/arcsec}^2$ and the mode value on the Earth Hour event is $17.4 \text{ mag/arcsec}^2$. Hence, it can be concluded that the night sky in Yogyakarta has a high level of light pollution. By turning off the light, the light pollution can be reduced.

Keywords: *Night sky brightness and East Yogyakarta*

1. Introduction

The sources of light pollution are the natural lighting and excessive artificial lighting. The light pollution will make the sky glow thus the number of visible stars will be decreasing. The street lighting, garden lighting, billboard lighting and the stadium lighting are some example of the artificial light that potentially contributes to the light pollution. Research in the city of Hong Kong about the protection of light in several places including cities and rural areas including differences in the sky in these places. The measurement results in the city have a value of $15.0 \text{ mag/arcsec}^2$ while the city has a value of $20.1 \text{ mag/arcsec}^2$ [1]. the impact of this light pollution is not only to the astronomy but also in the other aspect. Light pollution also affects animal behavior. The glatik (great tits, *Parus Major*) who sleeps in a bed exposed to LED light all night long wakes up from its nest than birds that sleep when it's dark. The birds exposed to these lights earlier start the day out of the clover. The impact of the environment, especially for animals that are active at night (nocturnal), such as owls, one time the owls will migrate to a distant place and will return to place of origin. These birds use light from the moon as well as constellations to be used as a guide in migration. The astronomers are the most disadvantaged people on light pollution. They have difficulties to obtain the celestial object data since the sky is too bright the number of visible light is decreasing. As the



pollution is getting worse, the bird migration got disrupted. The light pollution is bad for human health, especially for the hormonal system because the brightness of the lights will change the cycle of human hormones. Hence, changes in health and psychology in humans [2].

On March 24th, 2018, there was an event of Earth Hour. On that event, the light was switching off for one hour. Therefore, all this time, it is very important to measure the level of light using the Sky Quality Meter (SQM) device which is directed to the zenith. This research was conducted to obtain accurate information of night sky brightness (NSB) between regular days (23th and March, 25th) and Earth Hour (March, 24th). Hence, the effect of earth hour to the light pollution can be investigated. The figure 1 shows. The Light pollution is very high because the city center is full of artificial lighting

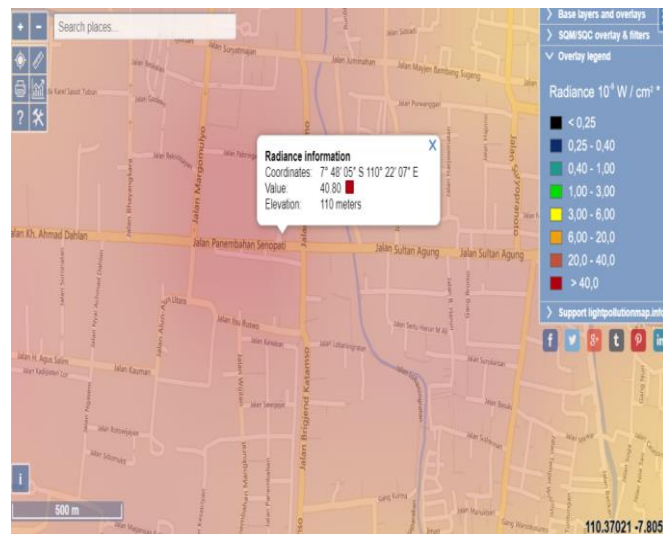


Figure 1. Location of data collection is in the cityater. The light pollution is high. (<https://www.lightpollutionmap.info>).

2. Methodology

Observation has been conducted at coordinates of -7.798893° South and 110.364992° East in Yogyakarta. The location is the city center. Hence, the light pollution is high due to lighting from building. The moon phase at the time of data collection was the first quarter. The SQM was pointed to the zenith as shown in figure 2. The data collection for 3 days on 23rd, 24th and 25th of March 2018 with data collection time from 6:00 pm to 10:00 pm local time. The time interval for data collection is every 10 seconds



Figure 2. The design of data collection. The Sky Quality Meter (SQM) was directed to the zenith <http://unihedron.com>.

3. Data and Analysis

NSB on Earth Hour day and the day before and after Earth Hour day are shown in figure 3. On March 23rd, the data collection was stop at 8:00 p.m due to rain. Figure 3 show that there is jump on NSB value on 24th of March. The NSB increase about 2 magnitude/ arcsec². This is due to the light being swithed off.

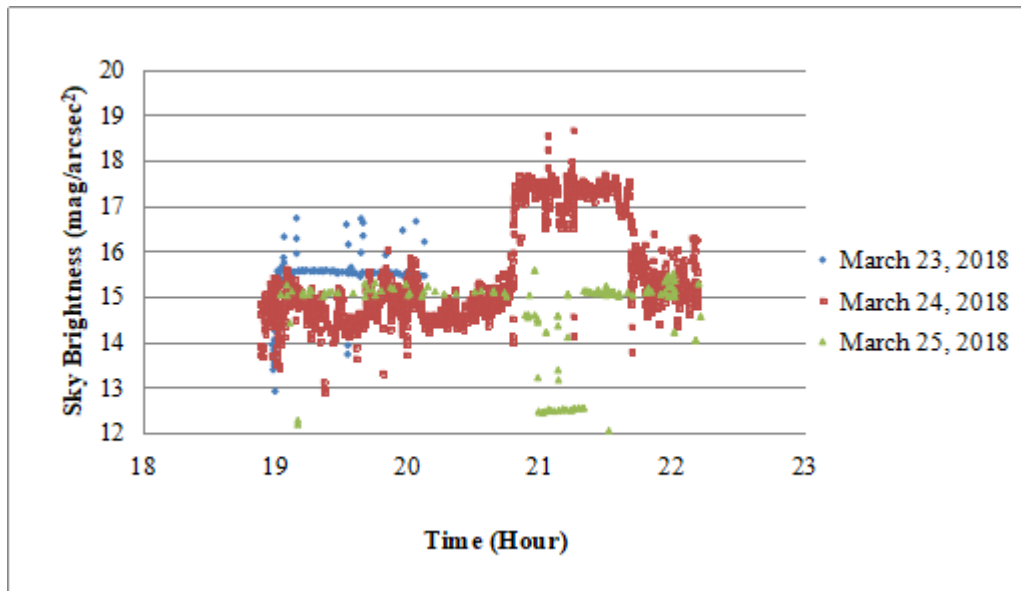


Figure 3. NSB as function of time on 3 days.

The figure 4 shows using statistical approach, the number of data at particular interval of NSB can be calculated. The mode of NSB data on March 23th is in the interval of 15.51 - 15.60 mag/arcsec². The mode of data collected on the 23rd of March is 2665 data at a value of sky brightness of 15.51 - 15.60 mag / arcsec². This shows the normal brightness value of the sky, the brightness value of the sky due to the amount of light pollution in the location.

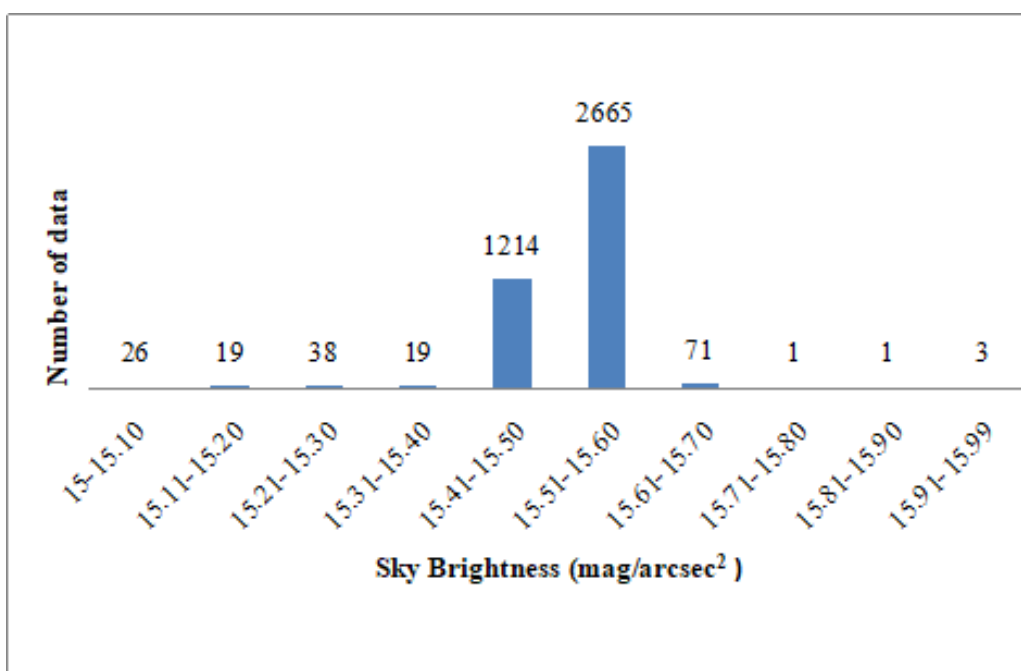


Figure 4. The number of data at particular interval NSB on March 23th.

The figure 5 shows the mode of NSB at March 25th is in the interval of 12.41 - 12.50 mag/arcsec . The cloudy condition at March 23th caused the difference of mode between day before and after the Earth Hour. In addition, both days can be categorized as the regular day. The cloud make the sky darker

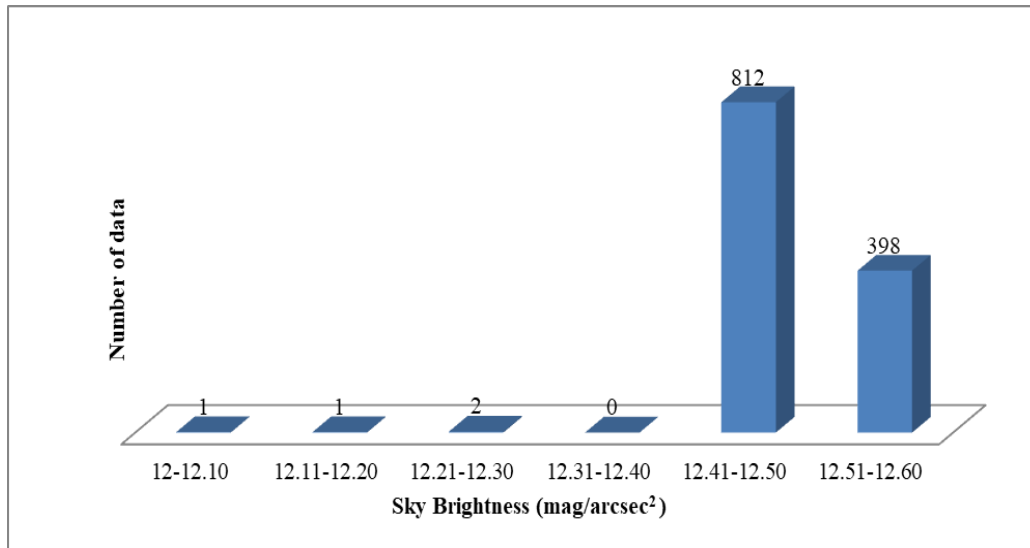


Figure 5. The number of data at particular NSB on March 25th .

The Earth Hour day, the figure 6 indicated that the mode occurred in the interval of 14.81 - 14.90 mag/arcsec² as show in figure 6. To emphasize the effect of Earth Hour celebration by turning light off, the figure 6 show the shifting of the mode by turning light off. The NSB increasing to the value of 17 mag/arcsec². This value is also higher compared to the regular days NSB.

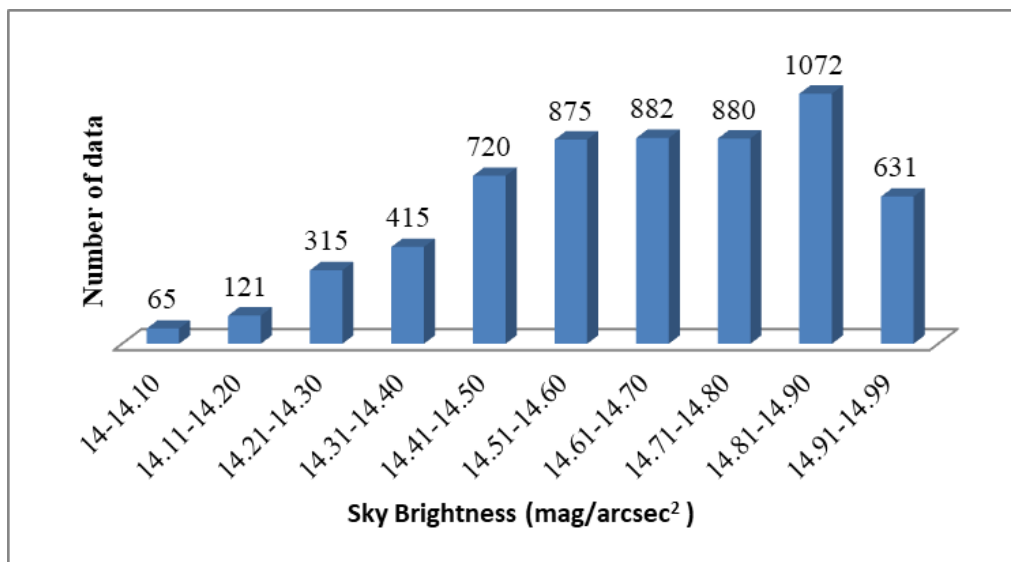


Figure 6. The number of data at particular NSB data on March 24th excluding the Earth Hour

The figure 7 shows. The data collection on sky brightness on the 24th Earth Hour is different from regular and event sky brightness during earth hour. At normal sky brightness of 14 mag / arcsec² with 5973 data while when earth hour sky brightness is 17 mag / arcsec² with 2725 data amount this is because when the Earth Hour event at that location simultaneously turns off the lights resulting in dark lagging and the SQM measurement values are increasing.

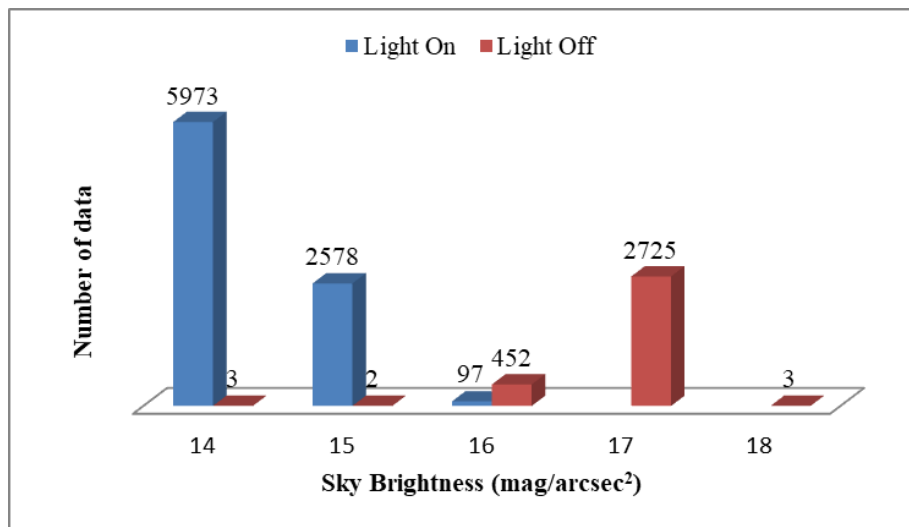


Figure 7. The comparison between the number of data at particular interval on Earth Hour day at the time of light was tuning on and period of turning light off only.

4. Discussion

The data distribution analysis was performed to obtain the mode value of NSB for each day. The mode value of NSB on 23th, 24th, and 25th of March 2018 are 15.5 mag/arcsec², 14.61 mag/arcsec², 15.02 mag/arcsec². The sky condition on the 23rd is cloudy resulting in scattering of light that makes the sky bright. The results of earth hour measurements are in line with the research conducted [3] that is, clouds will cause light reflection, the brightness of the sky on the 23rd is better than the 25th and at the Earth Hour on the 24th the sky brightness value of the mode is 17.4 mag/arcsec² at the event all the lights are turned off but there are still interference from artificial light such as traffic signs and lights from vehicle lights around the Earth hour event. Hence, it can be concluded that the night sky in Yogyakarta has a high level of light pollution. By turning off the light, the light pollution can be reduced.

Acknowledgment

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