

Visual Quality Assessment of Night Sky in Binjai City

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| Article Info | ABSTRACT |
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| Article History Received 15-06-2024 Revision Accepted | Finding a Good Night Sky in North Sumatra is a challenge since some developing city contribute more light to the night. A short distance city from Medan is Binjai City. This study was conducted to measure the night sky's quality visual in Binjai City, North Sumatra, Indonesia. This activity is carried out by conducting a process of direct observation and taking pictures in several stages with a camera followed by calculating between naked eye visibility and image results. With this comparison, we will find the visibility and quality value ratio of the night sky in the city of Binjai. The results obtained from this study show that Binjai City is in the level 5 category on the light pollution scale. |
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I. Introduction

Artificial light at night affects the quality of the sky location far from the location of the light source through scattered light in the sky. The light in the sky can even be seen from underdeveloped areas hundreds of kilometers away from major cities. This degrades the quality of night sky visibility and can alter the night environment and visual performance in all organisms. The pristine sky, free from artificial skylight, provides the greatest opportunity to experience the phenomenon of the natural night sky [1].

Large cities produce light pollution and form bright light domes along the horizon to some zenith parts of their locations, even affecting relatively remote areas that experience significant degradation of sky quality. When night streetlights are dispersed from a city light source, it greatly impacts the visual level of observers at that location as seen in Figure 1. The existence of light pollution also reduces the visibility of dim celestial bodies even high light pollution in a place can eliminate opportunities for people to observe stars, meteor showers to comets.

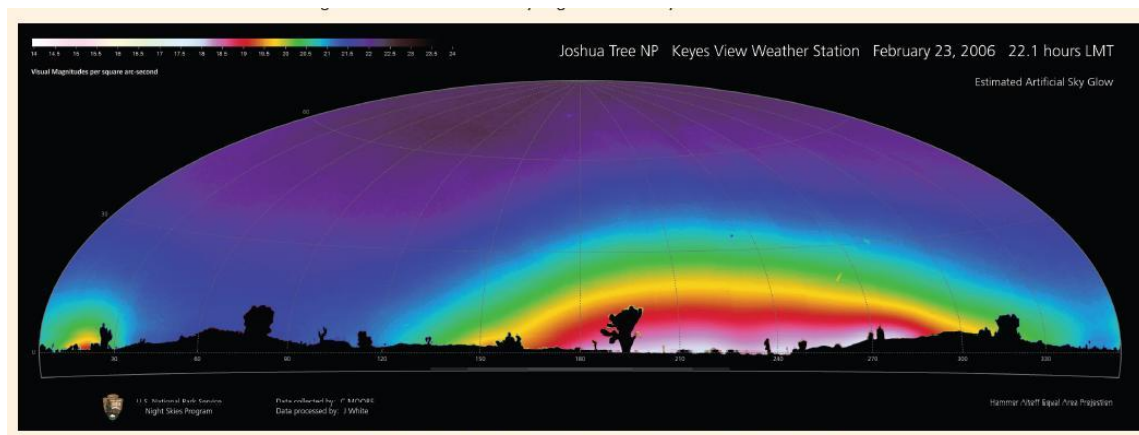


Figure 1. Example: Light pollution from a big city seen from the suburbs

Light pollution alters the natural light levels of the night sky. The effect of urban lighting, also known as light pollution, can reach surprisingly far [2]. Natural light comes from celestial bodies, especially the Moon, natural emissions of the atmosphere (airglow), stars and galaxies of the Milky Way, and the light of the Zodiac. On a moonless night, illumination from a clear night sky will be able to display galaxies and zodiac light worth about 22 magnitudes per second of quartic arc ($\text{mag}/\text{arcsec}^2$) [3]. Artificial light scattered across the sky in the atmosphere increases the illumination of the night sky, producing visible negative effects from light pollution. What's more, it hinders optical astronomical observations from inside the Earth.

A map of the earth showing light pollution in the sky published in July 2015 has provided estimates of the geographical position and severity of light pollution in the place [4]. In recent times, everyone has been able to access the light pollution map online on the site that provides the information. However, it is not as accurate as direct observations, but mostly based on the help of night satellite imagery.

A detailed comparison between map predictions of naked-eye limiting magnitudes and visual estimates requires observations made (i) at a large number of sites, (ii) by a large number of observers in each site to have a statistical treatment of eye capabilities, (iii) on nights with the same vertical extinction and horizontal visibility assumed in the map computation, (iv) on many similar nights to smooth atmospheric fluctuations by averaging, (v) in the same period in which the satellite image was taken, and (vi) with accurate geographical positions (better than 15 arcsecs) [5].

Binjai City itself is a city that is quite far from the big city – Medan City – which is the largest source of light pollution in North Sumatra. The management of the distribution of lighting on infrastructure has followed a good procedure for handling the distribution of streetlights to the sky with the use of battery-powered white LED model spotlights and solar panels pointing only downward reducing light pollution in the city. Although there are still advertising media lighting lights such as billboards that scatter light into the night sky. Visual observations in Binjai City can show many constellations with complete and good star parts. The sky is quite black and not reddish like the sky in a big city. Night photography

environment monitoring and modeling are necessary for informed management actions. The light pollution around Binjai City can be seen in Figure 2 below.

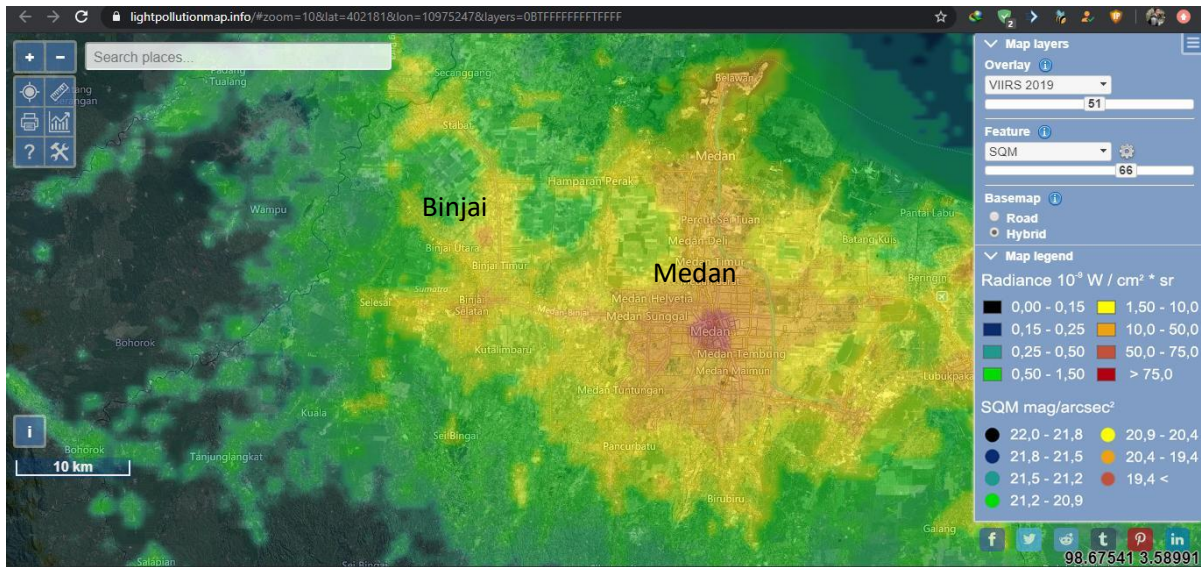


Figure 2. Medan and Binjai light pollution maps (source: lightpollutionmap.info)

Communicating information about the state of resources and their relationship to the distribution of light in Binjai City through geospatial models helps raise public awareness. And it helps for society to enjoy the night sky full of stars.

Novice astronomers usually assess their skies by finding the magnitude of the faintest star on naked-eye observations depending on the observational ability and sharpness of the observer's eye. And there are capabilities relative to different observers. To help observers assess the level of darkness of the night sky in a place, a scale with 9 levels was made based on 50 years of experience known as the Bortle scale [6].

As a comparison for the night sky simulation software such as Stellarium to see the full night object. In Stellarium, there is also a feature that can show simulations of celestial conditions that are in light pollution levels in certain classes so that they can match the state of the sky and the visibility of the number of stars in a condition at the place where the observation is located [7].

II. Method

The Artificial Sky Brightness Map utilizes upward light measures from the Suomi NPP Day/Night Band. With the separation of assumptions into emission functions, including Lambertian reflection from the ground (a), scattering light at low angles to the horizon from partially shielded fixtures (b), and pointing upwards at one higher angle (c), three separate geospatial models of artificial sky prediction of peak brightness were lowered. In this way, the model can be more accurately set to a specific region using ground-based sky brightness measurements for calibration.

The steps include the approximation of artificial components, with a natural background modeled and subtracted from observations in data reduction. The brightness of the artificial zenith sky is significantly measured, the brightness can be considered significant to the the entire sky degradation. The artificial skylight from a collection of sources is the result of the linear addition of each source. Light pollution levels of artificial skies are easily revealed as thematic maps in a false color representing geometric scales of increased brightness of different skies. Next, the data obtained was matched to Bortle scale readings to obtain a night sky class score in Binjai city. The comparison of the number of stars in the observed sky area will be juxtaposed with the sky in the Stellarium software which can display stars well according to their position and magnitude value.

III. Results and Discussion

On the light pollution map of Binjai city, it can also be shown the estimated amount of Radiance (radiation) and the estimated value of Sky Quality Meter readings which are very helpful in planning observations and research in the city.

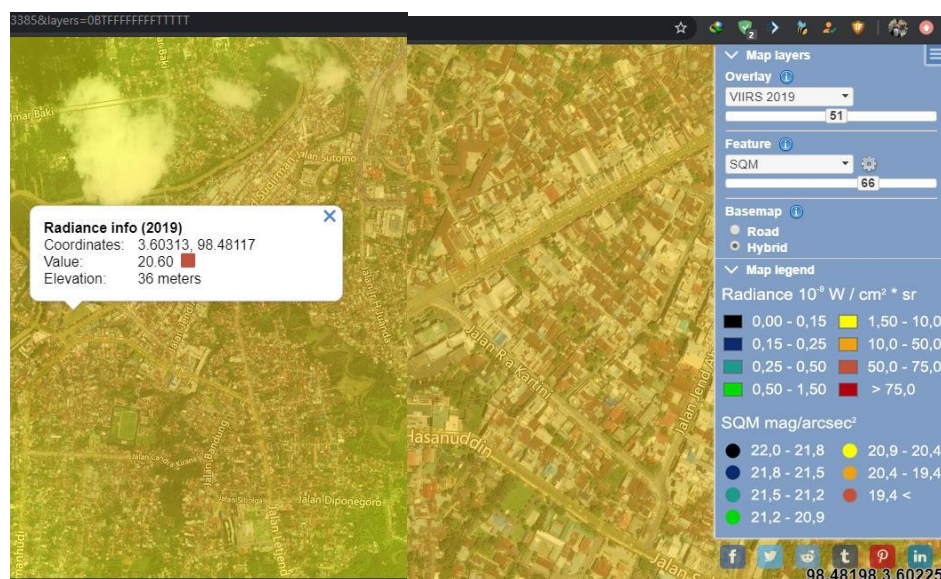


Figure 3. Overview of Light Pollution Readings

The reading of the light pollution map in Figure 3, shows a sky brightness reading with a value of SQM in the range of 19.4 – 21.2 (marked in orange, yellow, and green) which shows a fairly low level of light pollution because it does not show red or brighter. Binjai City is in class 5 or the suburban sky on the Bortle scale.

In observations made on the night sky in the city of Binjai, the results of the visibility of stars are quite good and numerous. Observers can mark the main stars of large constellations, but small constellations still have difficulty finding companion stars in that constellation. The experiment conducted by comparing the number of stars seen over the area between the constellations Taurus and Aries to avoid mixing large stars and dark skies. On naked eye observation in the western sky of Binjai City, near the constellation Aries are 4 stars visible (Hamal, Sheratan, Mesarthim, and Baharani), and in the constellation Taurus, there are 4

stars and 1 star cluster (Atlas, Hyadum, λ Tau and \omicron Tau). Other stars that can be seen are Menkar, Khaffaljidhma, Zaurak, Rana, Ran, and Azha. The constellation seen from Binjai and compared with Stellarium in the light pollution level can be seen in Figure 4.

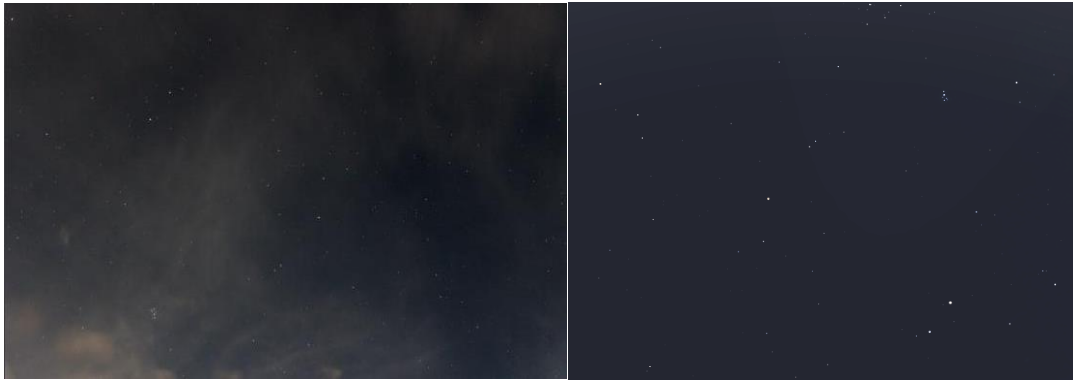


Figure 4. Comparison of the night sky in Binjai City (left) and Stellarium at the level 5 Light pollution (right)

With the number of visible stars less than 14, the estimated western threshold of visibility (Naked Eye Limit Magnitude) is in the range of 5.6 – 6.0. The NELM value range shows that the city of Binjai is in class 5 on the Bortle scale. These stars matched the position of stars in the Stellarium, and it verified the star. Small and faint stars are difficult to see because the sky from the observation site still gets artificial light sources from residential locations.

IV. Conclusion

Binjai city's night sky is in good condition with low light pollution levels. The night sky shows a bluish-dark night and gives some visible stars. However, it cannot display galaxies and other faint celestial bodies. NELM value is in the range of 5.6 – 6.0 and puts Binjai City in the class 5 category on the Bortle scale.

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