

## Analysis of Nite Sky Brightness on Star Observation in the City of Makassar

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### ARTICLE INFO

### ABSTRACT

#### Article history:

Submitted Jan 08, 2026

Accepted May 22, 2026

Published Jun 30, 2026

#### Keywords:

Night sky brightness,

Light pollution,

Bortle scale,

Limiting magnitude,

Islamic astronomy.

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*This The main research problem of this study is how the brightness of the night sky affects the visibility of stars in Makassar City, and what solutions can be applied to overcome the limitations caused by light pollution. This problem is formulated into two sub-problems: (1) How does night sky brightness impact stellar observation in Makassar? and (2) What strategies can be used to address the challenges of observing under urban sky conditions? This study employs a descriptive mixed-method approach with a falak-astronomical perspective. Quantitative data were obtained from secondary measurements of night sky brightness using Light Pollution Map values expressed in mag/arcsec<sup>2</sup> and classified through the Bortle Scale. Qualitative analysis was conducted by interpreting the observational implications of skyglow on falak practices and stellar visibility. Data were collected from four observation locations: Pantai Losari, Pantai Tanjung Layar Putih, UIN Samata, and Malino. The results show significant variation in sky brightness across the locations. Pantai Losari recorded the lowest darkness level (18.85 mag/arcsec<sup>2</sup>), categorized as urban sky, where only bright stars can be observed. Meanwhile, Malino showed the darkest condition (21.01 mag/arcsec<sup>2</sup>), classified as rural sky, allowing clearer visibility of faint stars. These findings confirm that increasing urban light pollution reduces the limiting magnitude and restricts astronomical observation in falak studies. The implications of this research are: (1) night sky brightness is a crucial factor in supporting observational astronomy; (2) the study highlights the need for darker observation zones around Makassar; and (3) it strengthens the*

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*relevance of integrating falak tradition with modern sky-quality analysis to preserve accurate celestial observation.*

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**ABSTRACT**

*Pokok masalah penelitian ini adalah bagaimana dampak kecerlangan langit malam terhadap observasi bintang di Kota Makassar serta solusi yang dapat digunakan dalam mengatasi keterbatasan langit malam akibat polusi cahaya. Pokok masalah tersebut dijabarkan dalam dua submasalah, yaitu: (1) Bagaimana pengaruh kecerlangan langit malam terhadap visibilitas bintang di Makassar? dan (2) Bagaimana solusi yang dapat diterapkan untuk mengatasi keterbatasan observasi di wilayah urban? Penelitian ini menggunakan metode deskriptif dengan pendekatan mixed-method dalam perspektif falak-astronomis. Data kuantitatif diperoleh dari nilai kecerlangan langit malam berbasis Light Pollution Map dalam satuan mag/arcsec<sup>2</sup> yang kemudian diklasifikasikan menggunakan Skala Bortle. Analisis kualitatif dilakukan dengan menafsirkan implikasi skyglow terhadap praktik falak dan pengamatan bintang. Data dikumpulkan dari empat lokasi observasi, yaitu Pantai Losari, Pantai Tanjung Layar Putih, UIN Samata, dan Malino. Hasil penelitian menunjukkan adanya perbedaan signifikan kualitas langit malam antar lokasi. Pantai Losari memiliki tingkat kegelapan terendah (18,85 mag/arcsec<sup>2</sup>) dengan kategori urban sky, sehingga hanya bintang-bintang terang yang dapat diamati. Sebaliknya, Malino menunjukkan kondisi langit paling gelap (21,01 mag/arcsec<sup>2</sup>) dengan kategori rural sky, yang memungkinkan pengamatan bintang redup lebih optimal. Temuan ini menegaskan bahwa polusi cahaya perkotaan berpengaruh langsung terhadap limiting magnitude dan membatasi observasi astronomis dalam konteks ilmu falak. Implikasi penelitian ini adalah: (1) kajian kecerlangan langit penting bagi penguatan astronomi observasional; (2) perlunya kawasan langit gelap sebagai lokasi pengamatan di sekitar*

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*Makassar; serta (3) pentingnya integrasi tradisi falak klasik dengan analisis modern kualitas langit malam.*

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## INTRODUCTION

The nite sky is one of the important objects in the study of astronomy and celestial navigation, particularly in the context of observing celestial bodies such as stars. In the tradition of astronomy, the visibility of stars is not only understood as an astronomical phenomenon but also relates to their function as navigational aids, time markers, and part of the cosmic order that has captured the attention of scientists since classical times. Fikri and Syarif explain that the thoughts of astronomical figures like Abu Ma'shar al-Falaky place stars as an important element in understanding the relationship between humans and the sky, as well as natural events.<sup>1</sup>

However, the development of modern urban areas brings serious consequences for the quality of the nite sky.<sup>2</sup> The increase in artificial lighting in urban areas has led to the phenomenon of light pollution, which makes the sky brighter and reduces the visual contrast of celestial objects. Firdaus et al. assert that excessive artificial light will produce skyglow, thereby disrupting astronomical observations and reducing the visibility of faint stars.<sup>3</sup> This condition poses a real challenge for

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<sup>1</sup>Mursyid Fikri and Muh Rasywan Syarif, "Eksplorasi Pemikiran Abu Ma'shar Al Falaky Tentang Manusia Dan Bintang," *ELFALAKY* 3, no. 2 (December 15, 2019), <https://doi.org/10.24252/ifk.v3i2.14152>.

<sup>2</sup>Alhan Devina Kharida Ismail, Ruslandi, "Analisis Tingkat Kecerahan Langit Malam Terhadap Visibilitas Hilal Menggunakan Sky Quality Meter Di Observatorium Malikussaleh Lhokseumawe," *Astroislamica: Journal of Islamic Astronomy* 4, no. 1 (2025): 25–39, <https://doi.org/10.47766/astroislamica.v4i1.3374>.

<sup>3</sup>Muhammad Dimas Firdaus et al., "ANALISIS DAMPAK POLUSI CAHAYA LAMPU ARTIFISIAL TERHADAP KECERLANGAN LANGIT MALAM MENGGUNAKAN SKY QUALITY METER :," *ELFALAKY: Jurnal*

observational astronomy practices in major cities like Makassar, which are experiencing rapid growth in urban lighting.

In a broader context, the visibility of stars also has applicative value in the history of human civilization, especially in navigation. Hikmatul Adhiyah Syam and Nur Aisyah show that stars have long been used as reference points for orientation, direction determination, and the formation of celestial maps thru constellations.<sup>4</sup> Thus, the discussion on the brilliance of the nite sky is not only relevant to modern astronomy but also has a direct contribution to strengthening contemporary celestial navigation, particularly in maintaining the sustainability of star observation amidst the limitations of urban skies.<sup>5</sup>

Based on this background, this research focuses on analyzing the level of nite sky brightness in Makassar City and its surroundings, as well as its impact on star observation. This research is important to conduct considering the increasing urban light pollution that has the potential to reduce the quality of celestial object observations and hinder observational astronomy practices in urban areas.

Observational astronomy, the quality of the nite sky can be measured thru the level of sky brightness (night sky brightness) expressed in units of magnitudes per square arcsecond ( $\text{mag}/\text{arcsec}^2$ ). The higher the sky brightness value (SQM), the darker the sky conditions and the more faint stars can be observed. Conversely, a low SQM value indicates high light pollution, which limits the limiting magnitude and the number

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*Ilmu Falak* 6, no. 2 (December 7, 2022): 197–206, <https://doi.org/10.24252/IFK.V6I2.33787>.

<sup>4</sup>Hikmatul Adhiyah Syam and Nur Aisyah, "INTEGRASI NAVIGASI DAN RASI BINTANG (Tradisi Astronomi Masyarakat Etnis Sulawesi)," *ELFALAKY* 8, no. 2 (December 18, 2024): 231–55, <https://doi.org/10.24252/ifk.v8i2.51279>.

<sup>5</sup>Laksmiyanti Annake Harijadi Noor and Fahmi Fatwa Rosyadi Satria Hamdani, "The Dawn Sky Brightness Observations in the Preliminary Shubuh Prayer Time Determination," *QIJIS (Qudus International Journal of Islamic Studies)* 6, no. 1 (July 2, 2018): 25–38, <https://doi.org/10.21043/QIJIS.V1I1.2870>.

of stars that can be seen with the naked eye.<sup>6</sup> The Bortle scale is then used as a practical classification to describe sky conditions from urban sky categories to rural sky categories.

Astronomy, as a discipline related to the observation and calculation of celestial bodies, is directly linked to the conditions of the nite sky.<sup>7</sup> The tradition of falak is not only based on calculations but also on observational practices that require a dark and clear sky for celestial objects to be optimally observed. In the context of Indonesia, contemporary studies in astronomy emphasize that the development of observation technology and the presence of modern astronomical facilities such as observatories and planetariums are important factors in supporting the accuracy of celestial observations.<sup>8</sup> This indicates that the quality of the nite sky is an integral part of the development of observational astronomy.

Several studies in *ELFALAKY: Journal of Astronomy Science* also highlight the importance of the observation aspect in modern astronomy. For example, the discussion on the significance of observatories and planetariums emphasizes that observation facilities require adequate sky conditions to function optimally.<sup>9</sup> Additionally, studies in astronomy related to the determination of prayer times also show that astronomical

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<sup>6</sup>P. Cinzano, F. Falchi, and C.D. Elvidge, "The First World Atlas of the Artificial Night Sky Brightness," *Monthly Notices of the Royal Astronomical Society* 328, no. 3 (December 2001): 689–707, <https://doi.org/10.1046/j.1365-8711.2001.04882.x>.

<sup>7</sup>Ravik Walhidayah and Ismail Ismail, "The Effect of Full Moon Light on the Brightness of the Sky in Lhokseumawe City," *AL - AFAQ: Jurnal Ilmu Falak Dan Astronomi* 7, no. 2 (December 2, 2025): 176–90, <https://doi.org/10.20414/AFAQ.V7I2.13995>.

<sup>8</sup>Susiknan Azhari, "Ilmu Falak: Perjumpaan Khazanah Islam Dan Sains Modern," *Suara Muhammadiyah*, 2007, <https://www.suaramuhammadiyah.or.id/products/detail/ilmu-falak-perjumpaan-khazanah-islam-dan-sains-modern-569>.

<sup>9</sup>Abdul Kohar, "SIGNIFIKANSI OBSERVATORIUM DAN PLANETARIUM DI ERA MODERN," *ELFALAKY* 8, no. 2 (December 18, 2024): 293–314, <https://doi.org/10.24252/ifk.v8i2.51599>.

phenomena are greatly influenced by atmospheric conditions and the environment of the nite sky. Thus, research on the brightness of the nite sky has direct relevance in the context of academic astronomy studies at UIN Alauddin Makassar.

The city of Makassar, as one of the urban centers in eastern Indonesia, is experiencing rapid development that has led to increased artificial lighting at nite. This condition has the potential to reduce the quality of the nite sky and limit the visibility of stars, especially in areas dominated by urban skyglow. In fact, stars in the perspective of astronomy are not only understood as astronomical objects but also as guides for humans.

This research aims to analyze the brightness levels of the nite sky in several locations around Makassar, namely Losari Beach, UIN Samata, Tanjung Layar Putih Beach, and Malino. Sky brightness data were obtained thru the Light Pollution Map in units of magnitudes per square arcsecond ( $\text{mag}/\text{arcsec}^2$ ) and classified using the Bortle scale as an indicator of nite sky quality. This research is expected to contribute to the development of observational astronomy, particularly in determining ideal locations for stargazing in urban areas.

The problem formulation in this research is: (1) what is the impact of nite sky brightness on star observation in the city of Makassar? and (2) what solutions can be used to address the limitations of the nite sky due to light pollution?

## **METHOD**

This research uses a mixed methods approach, which combines quantitative and qualitative methods in analyzing the brightness of the nite sky for star observation in the city of Makassar. This approach was chosen because the study of sky quality not only requires numerical data on sky brightness but also needs descriptive interpretation of the observation environment conditions and their implications in contemporary observational astronomy.

This research is a field study that is descriptive in nature. Quantitative data is used to measure the brightness level of the nite sky based on the magnitude value per square arcsecond

(mag/arcsec<sup>2</sup>), while qualitative data is used to describe environmental factors that affect sky quality, such as city light intensity, community activities, and the geographical characteristics of the location.

The main research data in the form of nite sky brightness values were obtained thru the Light Pollution Map site, which provides estimates of sky brightness levels based on satellite imagery and atmospheric modeling. This data is expressed in units of mag/arcsec<sup>2</sup> and is used to determine the quality of the nite sky at each research location. The values are then classified using the Bortle Scale, which is a categorization system for nite sky quality ranging from class 1 (very dark natural sky) to class 9 (very bright city sky).<sup>10</sup>

## RESULTS AND DISCUSSIONS

The research results show a significant variation in the brightness levels of the nite sky at several observation locations in the Makassar City area and its surroundings. This variation shows that urban sky conditions tend to experience high light pollution, while areas farther from the city center have darker sky quality and support better visibility of faint stars.<sup>11</sup>

The measurement of nite sky brightness in this study is expressed in magnitudes per square arcsecond (mag/arcsec<sup>2</sup>).

The higher the mag/arcsec<sup>2</sup> value, the darker the sky conditions, and the greater the potential visibility of faint stars.

Conversely, smaller values indicate a brighter sky due to the dominance of urban skyglow.<sup>12</sup> The following table presents the

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<sup>10</sup>Clara Yono Yatini et al., "An Overview of Sky Brightness Surrounding Timau National Observatory (TNO), Indonesia," *Indonesian Journal of Geography* 56, no. 2 (August 14, 2024), <https://doi.org/10.22146/ijg.90436>.

<sup>11</sup>Muhammad Awaludin, "Etnoastronomi Perbintangan Masyarakat Lombok," *Astroislamica: Journal of Islamic Astronomy* 3, no. 2 (December 1, 2024): 211–32, <https://doi.org/10.47766/astroislamica.v3i2.3862>.

<sup>12</sup>M Kocifaj and F Falchi, "Generalizing the World Atlas of Artificial Night Sky Brightness to Encompass a Wide Range of Sky States," *Monthly*

results of nighttime sky brightness at four research locations:

Table 1. The Brilliance of the Sky in Makassar City

| No | Research Location         | SQM Value (mag/arcsec <sup>2</sup> ) | Bortle Category Losari Beach          |
|----|---------------------------|--------------------------------------|---------------------------------------|
| 1  | Losari Beach              | 18,85                                | Class 8-9 (Urban Sky)                 |
| 2  | UIN Samata                | 20,12                                | Class 6-7 (Suburban Sky)              |
| 3  | Tanjung Layar Putih Beach | 20,42                                | Class 5-6 (Suburban-Rural Transition) |
| 4  | Malino                    | 21,01                                | Class 3 (Rural Sky)                   |

Based on the table, Losari Beach has the lowest brightness value (18.85 mag/arcsec<sup>2</sup>), indicating a very bright sky and falling into the urban sky category. This condition reflects high light pollution due to city activities, streetlights, and commercial lighting in the urban coastal area. In such conditions, only bright stars can be comfortably observed, while faint stars are almost invisible.

The phenomenon of light pollution in urban areas such as Losari Beach shows that the urban sky experiences a significant decline in visual quality due to the dominance of artificial light. This condition is in line with the research by Firdaus et al. which asserts that the increase in artificial lighting directly reduces the brightness value of the nite sky and limits the visibility of dim objects, especially stars with low magnitudes.<sup>13</sup>

In modern astronomical terminology, this condition is identical to the dominance of skyglow, which is the background

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*Notices of the Royal Astronomical Society: Letters* 542, no. 1 (June 14, 2025): L154-57, <https://doi.org/10.1093/mnrasl/slaf083>.

<sup>13</sup>Hariyadi Putraga et al., "Analisis Peningkatan Polusi Cahaya Berdasarkan Pembacaan SQM Dan Citra Satelit VIIRS Tahun 2017 - 2022 Di Kota Medan," *AL - AFAQ : Jurnal Ilmu Falak Dan Astronomi* 5, no. 1 (2023): 28-41, <https://doi.org/10.20414/afaq.v5i1.7250>.

light that envelops the sky due to the scattering of artificial light in the atmosphere.<sup>14</sup> In the context of contemporary astronomy, this phenomenon poses a significant challenge because observing celestial objects requires sufficient visual contrast for accurate recognition. Saputra and Wakia emphasize that the modernization of astronomy must be accompanied by the enhancement of observational quality, as the limitations of urban skies can reduce the accuracy of observational astronomy practices.<sup>15</sup>

Meanwhile, the UIN Samatra area shows a brightness value of 20.12 mag/arcsec<sup>2</sup>, which falls into the suburban sky category. This condition is still influenced by urban light, but it has better sky quality compared to the city center. In this location, stars with moderate magnitudes can still be observed, although the visibility of faint objects remains limited.

Tanjung Layar Putih Beach has a value of 20.42 mag/arcsec<sup>2</sup>, indicating a transition condition between suburban and rural. The sky at this location is relatively darker and allows for more optimal star observation compared to the urban areas of Makassar. This condition shows that the distance from the city center and the minimal direct light sources significantly contribute to improving the quality of the nite sky.

The location with the best quality in this study is Malino, with a brightness value of 21.01 mag/arcsec<sup>2</sup>, which falls into the Bortle class 3 category (rural sky). In this category, the nite sky still retains its natural darkness, allowing dim stars and celestial structures like the Milky Way to be seen more clearly. The Bortle scale explains that class 3 is an ideal condition for amateur

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<sup>14</sup>Roslan Umar et al., "Assessment of Light Pollution at New Crescent Moon Observation Sites in Terengganu, Malaysia: A Multi Brightness Metric Approach," *Proceedings of International Exchange and Innovation Conference on Engineering & Sciences (IEICES)* 11 (October 30, 2025): 1044–51, <https://doi.org/10.5109/7395641>.

<sup>15</sup>Sadri Saputra s and Nurul Wakia, "Diskursus Rukyat: Metode Mengilmiahkan Kebenaran Hisab Awal Bulan Kamariah," *ELFALAKY* 4, no. 1 (June 7, 2020), <https://doi.org/10.24252/ifk.v4i1.14165>.

astronomical observation and observational astronomy studies because light pollution is relatively low.<sup>16</sup>

This result reinforces that the quality of the nite sky is a key factor in supporting star observation. In the perspective of astronomy, stars are not only understood as astronomical objects but also as guiding tools with practical functions, as emphasized in the Qur'an. Thus, research on the brightness of the nite sky becomes an important part of strengthening contemporary astronomy, especially in urban areas increasingly affected by light pollution.

Sakirman also emphasized that the challenges of modern astronomy cannot be separated from environmental changes and the complexities of urban life, making the study of nite sky quality relevant in maintaining the sustainability of celestial observations in Indonesia.<sup>17</sup>

In addition to mapping the brightness levels of the nite sky, this research also highlights the need for practical solutions to address the limitations of star observation in urban areas such as Makassar. One of the main steps is the selection of alternative observation locations further from the city center, such as highland areas or outskirts with lower levels of skyglow. In the context of observational astronomy, the strategy of relocating the sighting and star observation points to darker areas is a realistic form of adaptation, considering that urban skies are increasingly difficult to meet the optimal visibility requirements. Saputra and Wakia emphasize that the strengthening of modern astronomy does not only rely on the theory of calculation but also on the

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<sup>16</sup>Arwin Juli Rakhmadi et al., "Pengaruh Emisi Cahaya Dari Data VIIRS Day/Night Band Pada Kecerlangan Langit Malam Di Observatorium Ilmu Falak Universitas Muhammadiyah Sumatera Utara (OIF UMSU)," *Wahana Fisika* 8, no. 1 (June 28, 2023): 1–23, <https://doi.org/10.17509/wafi.v8i1.42451>.

<sup>17</sup>Sakirman, Judhistira Aria Utama, and Othman bin Zainon, "Intergrasi Hisab Rukyat Awal Ramadan 1442 H Dengan Model Visibilitas Kastner," *Elfalaky: Jurnal Ilmu Falak* 6, no. 2 (2022), <https://doi.org/https://doi.org/10.24252/ifk.v6i2.30766>.

readiness of adequate observation fields so that celestial phenomena can be observed accurately.<sup>18</sup>

In addition, the use of supporting technologies such as light pollution mapping applications, simple photometric instruments, and satellite data integration can assist the astronomical community in determining the best locations for observation.<sup>19</sup> This approach is important because observing stars and faint celestial objects requires high sky contrast, which is difficult to achieve in urban areas without proper location planning. The International Dark-Sky Association also emphasizes that the protection of dark skies is both a scientific and ecological necessity, as excessive artificial lighting directly impacts the visibility of astronomical objects.

## CONCLUSION

This study shows that the brightness levels of the nite sky in the Makassar City area and its surroundings vary significantly, ranging from very bright urban sky categories to relatively dark rural sky categories. Losari Beach, as the city center area, has the highest level of light pollution with a value of 18.85 mag/arcsec<sup>2</sup>, making the visibility of faint stars very limited. In contrast, Malino has the best sky quality with a value of 21.01 mag/arcsec<sup>2</sup> and falls into the rural sky category, which is more conducive to optimal star observation.

These results confirm that urban light pollution is the main factor affecting the effectiveness of star observation, both in the context of modern astronomy and observational astronomy. Therefore, adaptive strategies are needed, such as selecting alternative observation locations that are darker, utilizing sky

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<sup>18</sup>Ravik Walhidayah and Ismail Ismail, "Verification of Hilāl Image Using AI-Based Web Tool in Aceh Jaya," *Al-Hilal: Journal of Islamic Astronomy* 7, no. 2 (October 28, 2025): 225–40, <https://doi.org/10.21580/al-hilal.2025.7.2.28809>.

<sup>19</sup>Hector Linares Arroyo et al., "Monitoring, Trends and Impacts of Light Pollution," *Nature Reviews Earth & Environment* 5, no. 6 (May 23, 2024): 417–30, <https://doi.org/10.1038/s43017-024-00555-9>.

mapping technology, and raising awareness about the importance of protecting the night sky. This study reinforces the relevance of sky brightness research as part of the development of contemporary astronomy, particularly in addressing the challenges of observing celestial objects in urban areas.

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