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Feasibility Study of the Rooftop of the Research Center Building at the State Islamic University of Mataram as a Location for Rukyatul hilal (Rukyatul Hilal)

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Abstract: *This study aims to evaluate the feasibility of the UIN Mataram Research Center building as a site for rukyatul hilal (rukyatul hilal) based on geographic and meteorological conditions. The research uses a descriptive qualitative method including direct field observations, data from the Meteorology, Climatology, and Geophysics Agency (BMKG), and analysis of accessibility, light pollution, western horizon visibility, and elevation. Geographically, the Research Center is in the center of Mataram city at coordinates 8° 36' S and 116° 8' E, about 3 km from the coast with a clear view to the northwest. The building is easily accessible and has a stable internet connection. However, the area has high light pollution (Bortle scale class 5), which can interfere with moon visibility. The view to the west is blocked by structures like power poles at 265°, a power plant at about 287°, and Mount Agung at about 293°, making it less ideal for rukyatul hilal. Weather-wise, the study analyzed rainfall and humidity data from 2021 to 2023. Mataram experiences varying rainfall, with some months having very high rainfall that can obstruct moon observation. High humidity levels also create clouds and fog, reducing visibility. Based on these findings, the researchers concluded that the UIN Mataram Research Center building is not suitable for rukyatul hilal due to its geographic and weather conditions.*
Keywords: ***Rukyatul hilal (Rukatul Hilal), Geographical Analysis, Meteorological Conditions, UIN Mataram Research Center***.

Abstrak: *Penelitian ini bertujuan untuk mengevaluasi kelayakan Gedung Research Center UIN Mataram sebagai lokasi rukyatul hilal berdasarkan kondisi geografis dan meteorologis. Jenis penelitian ini menggunakan metode kualitatif deskriptif dengan cara observasi langsung ke lapangan, pengumpulan data sekunder dari BMKG, dan analisis kondisi aksesibilitas, polusi cahaya, medan pandang ufuk barat, serta ketinggian lokasi. Secara geografis, gedung Research Center UIN Mataram terletak di pusat kota Mataram dengan koordinat -8^0 36' LS dan 116^0 8' BT, sekitar 3 km dari pesisir pantai dengan pandangan langsung ke arah barat laut. Dari segi aksesibiltas, gedung ini mudah dijangkau dengan jaringan internet dan fasilitas internet yang stabil. Namun, lokasi ini memiliki tingkat polusi cahaya yang tinggi mencapai (skala bortel kelas 5), yang dapat mengganggu visibilitas hilal. Medan pandang ke arah ufuk barat juga terhalang oleh berbagai struktur seperti tiang listrik pada azimuth 265^0 , bangunan PLTU pada azimuth sekitar 287^0 , dan Gunung Agung pada azimuth sekitar 293^0, yang menyebabkan lokasi ini kurang ideal untuk observasi hilal. Namun, di Mataram, hilal beberapa kali terlihat di Pantai Loang Baloq yang terletak pada azimuth 254°, 273°, dan 281°. Secara meteorologis, data curah hujan dan kelembapan udara dari tahun 2021 hingga 2023 dianalisis untuk mendapatkan hasil penelitian. Curah hujan kota Mataram bervariasi rendah hingga tinggi, dengan bulan-bulan tertentu menunjukkan curah hujan yang sangat tinggi, yang dapat menghalangi pengamatan hilal. Kelembapan udara juga berpengaruh terhadap visibiltas hilal, dengan tingkat kelembapan yang tinggi menyebabkan pembentukan awan dan kabut yang mengurangi jarak pandang. Berdasarkan analisis tersebut peneliti menyimpulkan bahwa Gedung Research Center UIN Mataram kurang layak digunakan sebagai tempat rukyatul hilal karena faktor-faktor geografis dan meteorologis yang tidak mendukung.*

Kata kunci: ***Gedung Research Center UIN Mataram, Kelayakan tempat, Rukyatul hilal***..

A. Introduction

The rooftop of the Research Center at the State Islamic University of Mataram has great potential to be used as a location for rukyatul hilal (rukyatul hilal). This location offers various strategic and technical advantages for rukyatul hilal activities. Generally, this rooftop has an ideal height and position, allowing for unobstructed sky observation. Additionally, easy

accessibility for researchers and rukyatul hilal practitioners adds value to using this location. Evaluating the feasibility of the rooftop as a site for rukyatul hilal is crucial as it determines the accuracy and reliability of the observations. Therefore, this study will not only assess the physical and technical aspects of the rooftop but also the availability of supporting facilities such as optical instruments and other essential technologies for rukyatul hilal activities. The primary focus of this research is to ensure that the rooftop of the Research Center at the State Islamic University of Mataram meets all the criteria needed to be an effective and efficient location for moon observation.

In addition to weather conditions, geographic location is also important in rukyatul hilal activities. An ideal location must meet geographic and astronomical criteria such as being at a high place with an unobstructed view from obstacles like buildings, mountains, trees, and light pollution. In Indonesia, especially in the NTB region, the Ministry of Religious Affairs has designated several locations for rukyatul hilal, including Loang Baloq Beach[1], Pacific Hotel Senggigi, and the Asmaul Husna Tower at the Islamic Center. However, there needs to be alternative locations around West Nusa Tenggara. The Research Center building at the State Islamic University of Mataram has never been assessed for its feasibility as a rukyatul hilal location. This building is located in the center of Mataram City at Jalan Gajah Mada No. 100, Jempong Baru, with coordinates 8° 36' S and 116° 8' E, facing northwest where the sun sets. The building has four floors with a rooftop that will be assessed for its feasibility as a rukyatul hilal location.

One location that is routinely used for rukyatul hilal is Loang Baloq Beach; however, the moon is often not visible because it is blocked by Mount Agung, which causes the western horizon to be cloudy even when local weather is clear. The average atmospheric humidity at Loang Baloq Beach was 84.5% throughout 2022, which also affects the visibility of the moon by increasing cloud formation. Therefore, alternatives such as the rooftop of the Research Center at the State Islamic University of Mataram are needed. This research aims to assess the feasibility of the Research Center's rooftop as a rukyatul hilal location, which is expected to enhance the Astronomy Study Program and make this building an observation site for the academic community.

B. Method

The research method used in this study is field research, which aims to assess the feasibility of the Research Center building at the State Islamic University of Mataram as a rukyatul hilal location. This research involves direct observation of the research object to obtain primary data. Primary data is collected through field observations, which include conditions of the horizon, sky brightness, and accessibility at the Research Center building. Additionally, this study uses documentation methods to collect secondary data from various sources such as books, articles, scientific works, journals, and research reports related to rukyatul hilal. The collected data is analyzed using qualitative descriptive analysis techniques, which include data reduction, data

[1] Nurnadiyah Syuhada, Herlina, Arino Bemi Sado, " Pemetaan Posisi Hilal Terhadap Gunung Agung di Lokasi Rukyat Pantai Loang Baloq ", *Al-afaq*, Vol.5, Nomor 1, Juni 2023, hlm.88

presentation, and conclusion drawing. To ensure data validity, this study uses data triangulation from BMKG Mataram to gain a deeper and more focused understanding of the research theme.

C. Result and Discussion

1. Geographic Conditions of the UIN Mataram Research Center Building as a Rukyatul hilal Location

The UIN Mataram Research Center building is located in the city center at Jalan Gajah Mada No. 100, Jempong Baru, Mataram City, geographically located at coordinates 8° 36' S and 116° 8' E. The Research Center building is about 3 km from the coastline with a direct view to the northwest.

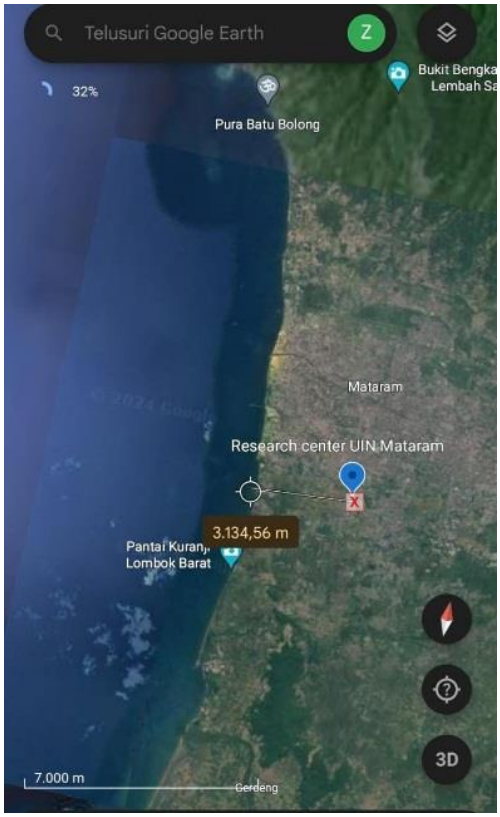

Image 1. Building Distance to the Beach[2]

Factors affecting rukyatul hilal activities geographically are as follows:

a. Accessibility

Accessibility refers to the ability to reach a specific goal, which can be easier or more difficult. It is a concept that integrates the geographical land use management system with

[2] Data diambil menggunakan aplikasi Google Earth pada tanggal 27 Februari 2024 pukul 12.01.

the transportation network system connecting it. Accessibility measures the convenience or ease of accessing a location[3]

To reach the State Islamic University of Mataram is very easy because the road access to UIN Mataram and the Research Center building is excellent and paved since it is in the city center. Observers can use private vehicles such as motorcycles and public vehicles such as cars. Since it is in the city center, the UIN Mataram Research Center building is connected to electricity and internet networks. The electricity in the UIN Mataram Research Center building comes from PLN. The available electricity capacity at the Research Center building is sufficient to meet the electricity needs of rukyatul hilal observers. The internet in the UIN Mataram Research Center building is very stable, so it can be used for communication and data transfer[4].

The availability of electricity and internet at the Research Center building of the State Islamic University of Mataram will be very useful for observers to provide information to other observers conducting observations to compare the success rate of observations. The internet and electricity network at the UIN Mataram Research Center is very good, so researchers state that the Research Center building is suitable as a rukyatul hilal location.

b. Light Pollution

One important factor in rukyatul hilal activities is the level of light pollution. Light pollution is pollution caused by excessive light intensity. Light pollution comes from external and internal buildings, offices, factories, and street lights[5]. According to Law No.42 of 1982 concerning basic provisions for environmental management, environmental pollution is the entry of living organisms, substances, energy, and other components into the environment through human activities or natural processes, thus lowering the environmental quality to a certain level that makes the environment less or no longer functioning as it should.[6]

[3] Endang Susumaningsih dkk, "Studi Aksesibilitas Objek Wisata Di Kabupaten Pesaman", Rang Teknik Journal,Vol.3,Nomor 1,Januari 2020,hlm.41.

[4] *Observasi*, Gedung *Research Center* UIN Mataram 10 Februari 2024.

[5] Wikipedia,Polusi Cahaya, https://id.wikipedia.org/wiki/*Polusicahaya*,diakses pada 23 maret 2024.

[6] UU No.42 Tahun 1982 tentang ketentuan-ketentuan Pokok pengelolaan Lingkungan Hidup.

According to an Astronomy expert from Program Studi Ilmu Falak UIN Mataram, high light pollution can become an obstacle during rukyatul hilal activities, so a location free from light pollution is needed for rukyatul hilal activities.

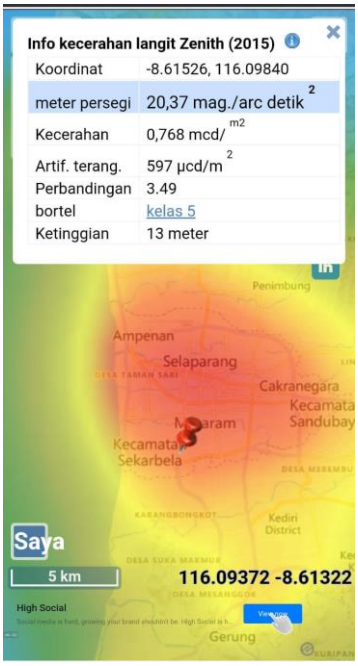

Image 2. Light Pollution in Mataram City[7]

The above image shows that light pollution in Mataram City reaches a Bortle scale of class 5, indicating that light sources are clearly visible in almost all directions, and clouds are brighter than the sky itself. The Bortle scale is a way to measure the brightness of the night sky at a certain location. There are nine Bortle scales with 9 classes representing extreme light pollution. Class 1 (Excellent dark sky site), Class 2 (Truly dark site), Class 3 (Rural sky), Class 4 (Rural/suburban transition), Class 5 (Suburban sky), Class 6 (Bright suburban sky), Class 7 (Suburban/urban transition), Class 8 (City sky), Class 9 (Inner-city sky).[8]

Based on the light pollution image and scale in Mataram City, light pollution is classified as class 5 with a scale value of 5. Class 5 or a scale value of 5 indicates a suburban area where many light sources are visible and clouds appear brighter than the sky, making it less suitable for rukyatul hilal.

c. Western Horizon Conditions

The western horizon is very important in rukyatul hilal activities because the observation area is directed towards the west where the sun sets. The conditions around the Research Center building's horizon, which is crucial for rukyatul hilal, show many power poles around the Research Center building and high-rise buildings.[9]

[7] https://www.lightpollutionmaps.info
[8] https://astrobackyard.com/the-bortle-scale/, diakses pada tanggal 24 maret 2024 pada pukul 20:17.
[9] Ruslandi dkk, "Analisis Tingkat Keberhasilan Rukyat Hilal di Observatorium Teungku Chiek Kuta Karang Lhoknga Aceh Besar" Astroislamica, Vol.1,Nomor 1, Juni 2022,hlm.99.

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An unobstructed view of the western horizon is the main requirement for observing the hilal. If the view from west to north and from west to south covers about 240° to 300°, the location is suitable for hilal sighting. However, researchers found the western horizon of the Research Center Building obstructed at various azimuths: around 264° by electric poles, around 287° by a PLTU emitting smoke pollution, around 293° by Mount Agung, around 295° by electric poles, and around 300° by another PLTU emitting smoke pollution. As shown below.

Image 3. Horizon View from the Research Center Building [10]

The image above shows the western horizon of the Research Center Building on May 9, 2024, at 18:21 WITA. After calculating the positions of the sun and the moon at that time, researchers used the Star Walk and Satellite Pointer apps to determine the sunset and moonrise locations. The observation revealed that the sun's azimuth was around 287° and the moon's azimuth was around 298°. This means Mount Agung was positioned to the right of the sun's azimuth and to the left of the moon's azimuth. Due to poor weather conditions, such as cloudy or overcast skies, Mount Agung, the moon, and the sun's positions were not clearly visible as they were obscured by clouds or fog. Additionally, smoke pollution from the PLTU contributed to the formation of dark clouds, further obstructing the view towards the horizon.

The image illustrates that the view from the Research Center building is blocked by Mount Agung in Bali. This mountain, located northwest of the Research Center building, obstructs the visibility of the moon when it is near Mount Agung, as well as the western horizon, making it less effective for rukyatul hilal activities. Based on this information, the Research Center building is not suitable for rukyatul hilal activities because the view to the western horizon is blocked by Mount Agung. Although the moon has been observed several times in Mataram, especially at Loang Baloq Beach at azimuths of 254°, 273°, and 281°, researchers concluded that the Research Center Building is not suitable for rukyatul hilal activities due to various obstructions that could interfere with the observation.

[10] Observasi, Gedung *Research Center* 20 April 2024

2. Meteorological Conditions of the UIN Mataram Research Center Building as a Rukyatul hilal Location

Meteorological conditions such as rainfall, temperature and humidity levels at the Research Center building at UIN Mataram will be analyzed to determine its feasibility as a rukyatul hilal location.

1. Rainfall

Rainfall or precipitation refers to water and ice that falls to the Earth's surface. This process begins with the evaporation of water from various sources on the Earth's surface, which then rises into the atmosphere. As the air ascends into the atmosphere, its temperature decreases, causing the water vapor in the air to become saturated, leading to condensation and the formation of rainfall deposits. [11]

Rainfall is one of the factors that affects the practice of 'rukyatul hilal'. Heavy rainfall can cause fog or clouds that can obscure the western horizon, making the crescent moon invisible. Additionally, heavy rainfall can cause water vapor to condense in the atmosphere, forming clouds. These clouds can obstruct the view of observers, thereby making the crescent moon invisible.[12]

Moreover, high rainfall can also lead to air pollution. Air pollution can cause smoke haze, which can also obstruct the view of observers and make the crescent moon invisible. Therefore, clear weather conditions are crucial for 'rukyatul hilal' activities. Places with high rainfall will affect the success rate of 'rukyatul hilal.[13]

Table 1. Rainfall Data (mm/month) Average 2021, 2022, 2023 City of Mataram [14]

Month	Year		
	2021	2022	2023
January		259 mm	212 mm
February		309 mm	281 mm
March		173 mm	213 mm
April		109 mm	220 mm
May		144 mm	199 mm
June		323 mm	134 mm
July		0 mm	10 mm
August		41 mm	130 mm
September		65 mm	64 mm
October		126 mm	395 mm
November		291 mm	433 mm
December		344 mm	385 mm

[11] Machzumy, "Kriteria Ideal Lokasi Rukyat" *At-Tafkir*, Vol.XI, Nomor 2. Desember 2018,hlm.83.
[12] Usroatul Mardiah, *Studi k10elayakan*…,hlm.32.
[13] Rafi'I Suryatna, *Meteorolo130gy dan klimatologi*, (Bandung:Angkasa,1995),hlm.142.
[14] Data BMKG Klimatologi Kelas 1 Lombok Barat..

Explanation: Rainfall index is divided into 3 categories:

- 0-100 mm/month: low
- 100-300 mm/month: moderate
- 300-500 mm/month: high
- >500 mm/month: very high [15]

Based on the above rainfall table, Mataram City experiences low to high rainfall. In 2021, the average annual rainfall was 182 mm (with no rainfall in July and highest rainfall of 344 mm in December), in 2022 it was 223 mm (with lowest rainfall of 10 mm in July and highest rainfall of 433 mm in November), and in 2023 it was 136 mm (with no rainfall in June and highest rainfall of 454 mm in February).

Observing the crescent moon is significantly affected by weather conditions, including rainfall. Below is the impact of rainfall on crescent moon visibility based on data from 2021, 2022, and 2023.

Table 2. Impact of Rainfall on Crescent Moon Visibility

Bulan	Tahun	Keterangan
January	2021:259mm/month	• High rainfall, limited visibility of the crescent moon.
	2022:212mm/month	• Quite high rainfall leading to frequent cloudy skies.
	2023:254mm/month	• High rainfall, lower visibility of the crescent moon, similar to 2021 compared to 2022.
February	2021:309mm/month	• Very high rainfall, very low visibility of the crescent moon.
	2022:281mm/month	• Very wet month, reducing chances of seeing the crescent moon.
	2023:454mm/month	• Extremely high rainfall, making crescent moon observation nearly impossible.
March	2021:173mm/month	• Moderate rainfall, possible cloud interference for observation.
	2022:213mm/month	• Fairly high rainfall, limited visibility of the crescent moon.
	2023:264mm/month	• Wetter than 2022, lower visibility of the crescent moon.
	2021:109mm/month	• Lower rainfall, fairly good chances for crescent moon observation.

[15] https://www.bmkg.go.id diakses pada tanggal 19 April 2024 pukul 22:15 WITA.

April	2022:220mm/month	• High rainfall, difficult crescent moon observation.
	2023:114mm/month	• Low rainfall, better chances for observation.
May	2021:144mm/month	• Moderate rainfall, possible cloud interference for observation.
	2022:199mm/month	• Significant rainfall, reducing crescent moon visibility.
	2023:8mm/month	• Almost no rain, ideal conditions for crescent moon observation.
Juni	2021:323mm/month	• Very high rainfall, very low visibility of the crescent moon.
	2022:134mm/month	• Moderate rainfall, possible cloud interference for observation.
	2023:4mm/month	• Very dry, excellent visibility of the crescent moon.
July	2021:0mm/month	• No rain, optimal conditions for crescent moon observation.
	2022:10mm/month	• Very dry, ideal conditions for observation.
	2023:69mm/month	• Low rainfall, good conditions for observation.
August	2021:41mm/month	• Fairly low rainfall, good conditions for observation.
	2022:130mm/month	• Quite high rainfall, may reduce crescent moon visibility.
	2023:0mm/month	• No rain, optimal conditions for observation.
September	2021:65mm/month	• Low rainfall, quite good for observation.
	2022:64mm/month	• Low rainfall, good conditions for observation.
	2023:1mm/month	• Very dry, almost no rain, ideal conditions for observation.
October	2021:126mm/month	• Moderate rainfall, possible cloud interference for observation.
	2022:395mm/month	• Very high rainfall, low visibility of the crescent moon.
	2023:31mm/month	• Much drier, much better visibility.
November	2021:291mm/month	• High rainfall, low visibility of the crescent moon.
	2022:433mm/month	• Very high rainfall, very unlikely for observation.

	2023:137mm/month	• Drier, increasing chances for crescent moon observation.
December	2021:344mm/month	• High rainfall, disturbed visibility of the crescent moon.
	2022:385mm/month	• Very high rainfall, low visibility of the crescent moon.
	2023:303mm/month	• High rainfall, low visibility of the crescent moon.

It can be concluded that in 2021, rainfall was quite high throughout the year, thereby reducing opportunities for conducting the crescent moon sighting (rukya). In 2022, rainfall was generally high throughout the year, decreasing the chances of observing the crescent moon in many months. Meanwhile, in 2023, there were months with lower rainfall compared to previous years, especially in May, June, and August, which would greatly support the crescent moon sighting process with clearer skies and fewer clouds. On the other hand, months with high rainfall like February and December in these three years above will hinder the crescent moon sighting process due to the likelihood of cloudy skies. Changes in rainfall patterns clearly affect crescent moon visibility, and drier weather conditions generally support greater success in crescent moon observation

2. Air Humidity

Air humidity refers to the concentration of water vapor in the air. Warm air holds more water vapor compared to cold air. High humidity levels cause clouds that affect visibility. The higher the humidity, the lower the temperature. It becomes more susceptible to cloud and fog formation.

The average air humidity data (percentage) in Mataram City from 2021, 2022, to 2023 are as follows:

Table 3. Average Air Humidity Data (%) 2021, 2022, 2023
Mataram City

Bulan	Year		
	2021	**2022**	**2023**
January	83%	84%	85%
February	81%	86%	88%
March	79%	84%	85%
April	75%	83%	85%
May	77%	84%	84%
June	81%	86%	83%
July	75%	82%	84%
Agustus	76%	83%	81%
September	76%	84%	79%

October	73%	87%	79%
November	82%	86%	81%
December	80%	85%	82%

Explanation: Air Humidity Indicator

- Relative humidity <70% : clear
- Relative humidity 70 – 80% : cloudy
- Relative humidity >85% : rainy

From the table above, it can be observed that the air humidity in Mataram City ranges from 79% to 87%. In 2021, the annual average air humidity was 78%, which provided better opportunities for crescent moon sighting activities. In 2022, the annual average air humidity was 84.5%, peaking in October at 87% and lowest in July at 82%. In 2023, the annual average air humidity was 83%, with February recording the highest at 88% and September the lowest at 79%.

Observing the crescent moon is greatly influenced by atmospheric conditions, including air humidity. High air humidity can lead to cloud and fog formation, reducing crescent moon visibility. This is illustrated in the table below:

Table 4. Effect of Air Humidity on Crescent Moon Visibility

Month	Year	Description
January	2021:83%	• High humidity, reduced crescent moon visibility
	2022:84%	• Slightly higher, crescent moon visibility remains low.
	2023:85%	• Slightly higher again, crescent moon visibility lower.
February	2021:81%	• Lower humidity, better crescent moon visibility.
	2022:86%	• Very high humidity, difficult to see crescent moon.
	2023:88%	• Even higher, harder to see crescent moon.
March	2021:79%	• Lower humidity, better for crescent moon observation.
	2022:84%	• High humidity, crescent moon visibility affected.
	2023:85%	• Slightly higher, crescent moon visibility remains low.
April	2021:75%	• Fairly low humidity, possible for observation.
	2022:83%	• High humidity, possibility of fog.
	2023:85%	• Higher, harder to see crescent moon.

May	2021:77%	• Fairly low humidity, crescent moon visibility fairly clear.
	2022:84%	• High humidity, low crescent moon visibility.
	2023:84%	• High humidity, low crescent moon visibility.
June	2021:81%	• Fairly low humidity, easier to see crescent moon.
	2022:86%	• Very high humidity, low crescent moon visibility.
	2023:83%	• Lower, easier to see crescent moon.
July	2021:75%	• Low humidity, crescent moon visibility not affected.
	2022:82%	• Higher humidity, lower crescent moon visibility.
	2023:84%	• Higher, reduced crescent moon visibility.
Agustus	2021:76%	• Fairly low humidity, crescent moon visibility not affected.
	2022:83%	• High humidity, crescent moon visibility affected.
	2023:81%	• Lower humidity, easier to see crescent moon.
September	2021:76%	• Fairly low humidity, crescent moon visibility not affected.
	2022:84%	• High humidity, crescent moon visibility affected.
	2023:79%	• Lower humidity, better for observation.
October	2021:73%	• Very low humidity, better for crescent moon observation
	2022:87%	• Very high humidity, very difficult to see crescent moon.
	2023:79%	• Lower, easier to see crescent moon.
November	2021:82%	• Low humidity, better for observation.
	2022:86%	• Very high humidity, low crescent moon visibility.
	2023:81%	• Lower, better crescent moon visibility.
December	2021:80%	• Low humidity, fairly good for observation.
	2022:85%	• High humidity, crescent moon visibility affected.

	2023:81%	• Lower, slightly better crescent moon visibility.

Therefore, it can be concluded that in 2021, humidity was relatively low, allowing for crescent moon observation activities. In 2022, humidity was generally high throughout the year, often resulting in fog and reduced moon visibility. In 2023, several months had lower humidity levels, such as June, August, September, October, November, and December, which were more favorable for crescent moon observation.

Overall, 2021 and 2023 had better humidity conditions for crescent moon observation compared to 2022, especially in months with lower humidity like June, August, September, and October. Lower humidity in these months reduces the likelihood of fog and clouds, thus increasing the chances of successful crescent moon observation.

3. Temperature

Temperature measures the average kinetic energy of all atoms and molecules in the air. Heated air has higher kinetic energy, causing it to expand and become less dense. Due to its equatorial location, Indonesia receives a nearly constant amount of solar energy throughout the year. Therefore, temperature in Indonesia is more dependent on altitude than on latitude. The maximum temperature occurs around 2:00 PM, while the minimum temperature is around 6:00 AM local time.

The average monthly temperatures (in degrees Celsius) in Mataram City from 2021 to 2023 are as follows:

Table 5: Average Monthly Temperatures (°C) in Mataram City (2021-2023)

Month	Year		
	2021	2022	2023
January	27.94 ^{0}C	27.2 ^{0}C	26.9 ^{0}C
February	28.35^{0}C	26.6 ^{0}C	26.5 ^{0}C
March	28.78^{0}C	27.6 ^{0}C	26.6 ^{0}C
April	29.41^{0}C	27.4 ^{0}C	27.1 ^{0}C
May	29.16^{0}C	27.3 ^{0}C	26.3 ^{0}C
June	28.38^{0}C	26.2^{0}C	26.1 ^{0}C
July	28.19^{0}C	25.4 ^{0}C	25.3 ^{0}C
Agustus	28.56^{0}C	25.7 ^{0}C	25.3 ^{0}C
September	28.58^{0}C	26.6 ^{0}C	26.0 ^{0}C
October	29.28^{0}C	26.8 ^{0}C	27.7 ^{0}C
November	28.25^{0}C	26.8 ^{0}C	28.3 ^{0}C
December	28.96^{0}C	26.7 ^{0}C	28.1 ^{0}C

Temperature Indicators:
Air temperature > 29°C: clear
Air temperature 26°C – 29°C: cloudy

Air temperature < 26°C: rainy

From the table, it can be observed that the average monthly temperatures in Mataram City from 2021 to 2023 ranged from approximately 25.4°C to 28.3°C.

- In 2021, the average annual temperature was 28.65°C, with the highest temperature in December (28.96°C) and the lowest in January (27.94°C).
- In 2022, the average annual temperature was 27.1°C, with the highest temperature in March (27.6°C) and the lowest in July (25.4°C).
- In 2023, the average annual temperature was 26.6°C, with the highest temperature in November (28.1°C) and the lowest in July (25.3°C).

The observation of the crescent moon (hilal) is influenced by atmospheric conditions, including air temperature. Higher temperatures can cause air turbulence and optical distortion, reducing the visibility of the hilal. This is detailed in the table below:

Table 6: Effect of Monthly Temperature on Hilal Visibility

Month	Year	Description
January	2021:27.94^{0}C	• Higher temperature, can cause air turbulence.
	2022:27.2^{0}C	• Slightly higher, can cause cloud turbulence.
	2023:26.9^{0}C	• Lower temperature, more stable conditions for observation.
February	2021:28.35^{0}C	• Higher temperature, can reduce hilal visibility.
	2022:26.6^{0}C	• Lower temperature, minimal impact on visibility.
	2023:26.5^{0}C	• Similar to 2022.
March	2021:28.78^{0}C	• Higher temperature, increases chance of air turbulence.
	2022:27.6^{0}C	• Higher temperature, increases chance of air turbulence.
	2023:26.6^{0}C	• Lower temperature, better conditions for observation.
April	2021:29.41^{0}C	• Higher temperature, increases chance of air turbulence.
	2022:27.4^{0}C	• High temperature, can reduce hilal visibility.
	2023:27.1^{0}C	• Slightly lower, better for observation.
	2021:29.16^{0}C	• Higher temperature, increases chance of air turbulence.

May	2022:27.3^{0}C	• Higher temperature, can cause optical distortion.
	2023:26.3^{0}C	• Lower temperature, better for hilal observation.
June	2021:28.38^{0}C	• High temperature, can cause optical distortion
	2022:26.2^{0}C	• Lower temperature, minimal impact on visibility.
	2023:26.1^{0}C	• Similar to 2022.
July	2021:28.19^{0}C	• High temperature, can cause optical distortion.
	2022:25.4^{0}C	• Stable conditions for hilal observation.
	2023:25.3^{0}C	• Similar to 2022.
August	2021:28.56^{0}C	• High temperature, can cause optical distortion.
	2022:25.7^{0}C	• Slightly higher, possible air turbulence.
	2023:25.3^{0}C	• Similar to 2022.
September	2021:28.58^{0}C	• High temperature, can cause optical distortion.
	2022: 26.6°C	• Higher temperature, can affect hilal visibility.
	2023: 26.0°C	• Lower temperature, better for observation.
October	2021: 29.28°C	• Very high temperature, can affect hilal visibility.
	2022: 26.8°C	• Lower temperature, better for hilal observation.
	2023: 27.7°C	• Higher temperature, can cause optical distortion.
November	2021: 28.25°C	• Higher temperature, can cause air turbulence and distortion.
	2022: 26.8°C	• Lower temperature, better for hilal observation.
	2023: 28.3°C	• Higher temperature, possible air and optical turbulence.
	2021: 28.96°C	• Higher temperature, can reduce hilal visibility.

December	2022: 26.7°C	• Lower temperature, better for observation.
	2023: 28.1°C	• Higher temperature, can reduce hilal visibility.

In summary, 2021 had relatively high temperatures, causing reduced hilal visibility, air turbulence, and optical distortion. In 2022, temperatures were generally lower, providing better conditions for hilal observation. In 2023, temperatures were similar to 2021 but higher than 2022, especially in October, November, and December, causing air turbulence and optical distortion, which can reduce hilal visibility. Overall, 2022 offered more stable and supportive temperature conditions compared to 2021 and 2023.

4. Air Turbulence and Optical Distortion in Hilal Observation

Air turbulence and optical distortion are atmospheric phenomena that can affect the quality of visual observations.

Air turbulence refers to irregular or chaotic movement in the atmosphere caused by differences in temperature and pressure at various air levels. When air temperature rises, the air becomes more unstable and moves faster, leading to turbulence. The effects of air turbulence on hilal observation include:

- Image Shaking: The crescent moon might appear to vibrate or shake, making observation difficult.
- Light Refraction: Light from the crescent moon can be bent or reflected by moving air, altering the apparent position of the hilal.
- Reduced Sharpness: Images of the crescent moon might appear blurry due to inconsistent air movement.

5. Optical Distortion

Optical distortion refers to changes in the shape and quality of an image as it passes through the atmosphere, caused by variations in air density and temperature affecting the light's path. In hilal observation, optical distortion includes:

- Aberration: The hilal might appear imperfect or unclear due to light reflecting differently through various atmospheric layers.
- Atmospheric Refraction: Light from the hilal can be affected by different atmospheric layers, making it appear higher or lower in the sky than its actual position.
- Blurring: Higher temperatures can cause mirage effects, making the hilal appear to shift or distort as the air becomes denser.

6. The relevance to lunar observation

Higher air temperatures, observed in some months of 2021 and 2023 compared to 2022, increase the likelihood of air turbulence and optical distortion, leading to:

- Blurred Hilal Vision: The hilal might appear less clear or not perfectly shaped

- Difficulty Determining Position: The hilal might seem to be in a different place in the sky, complicating the observation process.
- Visual Discomfort: Observers may experience eye strain and reduced observation accuracy.

Thus, calm and stable atmospheric conditions with lower temperatures are more favorable for clear and accurate hilal visibility.

D. Conclusion

Based on the analysis of the feasibility of the Research Center rooftop at Universitas Islam Negeri Mataram as a site for hilal observation, it is concluded that the location is geographically unsuitable. Despite easy access and modern facilities like electricity and internet, the urban location leads to high light pollution (Bortle scale class 5), reducing hilal visibility. Additionally, the view towards the horizon is obstructed by various buildings and structures, such as power poles, the PLTU plant emitting smoke, and Mount Agung, all of which significantly hinder hilal observation.

Meteorologically, the conditions around the Research Center are also not conducive to hilal observation. Mataram City experiences high rainfall throughout the year, often accompanied by high humidity, leading to cloud and fog formation. These unstable weather conditions can obstruct a clear view of the hilal. Therefore, considering both geographical and meteorological aspects, the Research Center at UIN Mataram is deemed less ideal for hilal observation activities requiring clear and unobstructed skies. Although the hilal has occasionally been observed in Mataram, particularly at Loang Baloq Beach at azimuths of 254°, 273°, and 281°, it is concluded that the Research Center is unsuitable for hilal observation due to these various obstructions, which can interfere with the observation process.

References

Ahmad Rijali, “ Analisis Data Kualitatif”, Alhadharah, Vol.17, Nomor 33, Januari-juni 2018.

Ahlan Syaeful Millah dkk, “Analisis Data Dalam Penelitian Tindakan Kelas”,Jurnal Kreativitas Mahasiswa,Vol.1,Nomor2,2023.

Ardiansyah, Risnita, M Syahran Jailani, “Teknik Pengumpulan Data Dan Instrumen Penelitian Ilmiah Pendidikan Pada Pendekatan Kualitatif dan Kuantitaif”, Jambi: Yayasan Pendidikan Dzurriyatul Quran,2023.

Diana Hikmah, S.Tr, “Mengenal Fenomena Turbulensi Dalam Dunia Penerbangan”.

Endang Susumaningsih dkk, “Studi Aksesibilitas Objek Wisata Di Kabupaten Pesaman”, Rang Teknik Journal,Vol.3,Nomor 1,Januari 2020.

M. Djamal,” Paradigma Penelitian Kualitatif”, (Yogyakarta ; Pustaka Pelajar , 2017).

Machzumy, “Kriteria Ideal Lokasi Rukyat” *At-Tafkir*, Vol.XI, Nomor 2. Desember 2018,

Misbah Khusurur, “Perpaduan Hisab dan Rukyat Sebagai Metode Penentuan Awal Bulan Hijriah”, Vol.5,Nomor 2, Tahun 2020.

Muhammad Syarief Hidayatullah, Desy Kristiane,”Fikih Falakiyah Persfektif Teori Atronomi (Analisis Tinggi Hilal dari Segi Koreksi Semidiameter Bulan),*Elfalaky*,Vol.6,Nomor 2, 2022.

Muhammad Zafanka Gazalba, Arino Bemi Sado, Muhammad Saleh Sofyan, " Pengaruh Kelembapan Atmosfer Terhadap Visibilitas Hilal Dipantai Loang Baloq", *Al-afaq,* Vol.5, Nomor 2, Desember 2023.

Nuril Farida Maratus, "Implementasi Neo Visibilitas Hilal MABIMS Di Indonesia",*Ahkam,*Vol.10,Nomor 2, November 2022.

Nurnadiyah Syuhada, Herlina, Arino Bemi Sado, " Pemetaan Posisi Hilal Terhadap Gunung Agung di Lokasi Rukyat Pantai Loang Baloq Mataram", *Al-afaq,* Vol.5, Nomor 1, Juni 2023.

Ruslandi dkk, "Analisis Tingkat Keberhasilan Rukyat Hilal di Observatorium Teungku Chiek Kuta Karang Lhoknga Aceh Besar" Astroislamica, Vol.1,Nomor 1, Juni 2022.

Salsabila Nanda, "Metode Penelitian Kualitatif", 1 Agustus 2023.

Tim Penyusun KBBI, "Kamus Besar Bahasa Indonesia Edisi Kedua", (Jakarta: Balai Pustaka 1991).

UU No.42 Tahun 1982 tentang ketentuan-ketentuan Pokok pengelolaan Lingkungan Hidup.

Yulia Siska, "Geografi Sejarah Indonesia".

Zahra Hayati dkk, "Pengaruh Kelembapan Udara Terhadap Efektivitas Pelaksanaan Rukyatul Hilal Awal Bulan Qamariyah", Journal IICET, Vol.9, Nomor 2,2023.

Undergraduate Thesis / Master's Thesis / Doctoral Dissertation

Agam Marwansyah "Uji Kelayakan Gedung Badan Hisab Rukyat Provinsi Kalimantan Barat Sebagai Tempat Rukyatul Hilal", [Skripsi Strata 1 Jurusan Ilmu Falak Universitas Islam Negeri Walisongo, Semarang, 2021].

Ilma Naila Rasyidah,"Uji Kelayakan Hotel Novita, Hotel Abadi Suite Dan Tower, Hotel Odua Weston Sebagai Tempat Rukyatul Hilal Di Kota Jambi (Analisis Berdasarkan Geografis, Meteorologi Dan Klimatologi)".[Skripsi, Fakultas Syariah dan Hukum UIN Walisongo, Semarang, 2019].

Imroatus Sakinah "Studi Kelayakan Tempat Rukyatul Hilal Di Bukit Banyu Urip kecamatan Senori Kabupaten Tuban Dalam Perspektif Astronomis Geografis", [Skripsi Jurusan Perdata Islam Fakultas Syariah dan Hukum Universitas Islam Negeri Sunan Ampel, Surabaya, 2019].

M. Aufa Anis Ar Rofif,"Optimalisasi Instrumen Optik dan Pengaruhnya pada Kalibrasi Proses "*setting circle"* Teleskop Skywatcher 90/910 EQ2 Untuk Keperluan Rukyat Hilal",[*Skripsi,* Fakultas Syariah dan Hukum UIN Walisongo, Semarang,2022].

Nurfitriani Suciyati,"Uji Kelayakan Pantai Toro Kabamba Kecamatan Kilo Kabupaten Dompu Sebagai Tempat Rukyatul Hilal Ditinjau Dari Perspektif Geografis", [Skripsi, Fakultas Syariah UIN Mataram, Mataram,2022].

Reza Sartika Dewi,"Studi Kelayakan gedung Kebudayaan Sumatera Barat Di Kota Padang Sebagai Tempat Rukyatul Hilal", [Skripsi Strata 1 Fakultas Syariah dan Hukum UIN Walisongo, Semarang, 2023].

Usrotul Mardiah," Studi Kelayakan Pantai Beraringan KLU sebagai Tempat Rukyatul Hilal", [Skripsi, Fakultas Syariah UIN Mataram, Mataram,2024].