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ASSESSING THE ROLE OF AIR HUMIDITY IN HILAL VISIBILITY

(Empirical Evidence from Jokotole Observatory, Madura)

Fitryatul Laili
Universitas Islam Negeri Walisongo Semarang
fitryffz@gmail.com

Syifaul Anam
Universitas Islam Negeri Walisongo Semarang
syifaulanam@walisongo.ac.id

Ahmad Fuad Al-Anshory
Universitas Islam Negeri Walisongo Semarang
ahmad_fuad@walinsong.ac.id

Arni Sukarni
Universitas Islam Negeri Walisongo Semarang
sukarni13@madrasah.kemenag.go.id

Abstract

The development of determining the beginning of the Hijri month shows the integration of astronomical and meteorological aspects. Failure to observe the hilal observation often occurs due to meteorological factors, particularly high air humidity, which hinders visibility in the sky. This phenomenon is a significant issue because it has a direct impact on the national determination of the Hijri calendar's beginning. This paper aims to analyze the extent to which air humidity affects the success of hilal observation at the Jokotole Observatory and to identify the most ideal atmospheric conditions for observation. Rukyat and air humidity data were collected, compared, and analyzed descriptively. The results of the study show that air humidity significantly affects the success of rukyat, even when the height and elongation of the hilal observation meet the Neo Mabims criteria. Although the humidity is not completely low, the clarity of the sky and astronomical factors, such as the height of the hilal observation between 7° and 8° and an elongation of more than 9°, still allow the hilal observation to be observed well. Thus, the success of this rukyat reinforces that, in addition to humidity, the height and elongation of the hilal observation also play an important role in its visibility. This study suggests that rukyat activities should integrate real-time meteorological data and choose observation times during seasons with low humidity to improve the accuracy and effectiveness of hilal observations.

Keywords:
Hilal Observation, Air Humidity, Observatory, Emperical, Jokotole

Abstrak

Perkembangan penentuan awal bulan Hijriah menunjukkan adanya integrasi antara aspek astronomis dan meteorologis. Kegagalan pengamatan hilal sering terjadi akibat faktor meteorologis, terutama tingginya kelembaban udara yang menghambat visibilitas langit. Fenomena ini menjadi persoalan penting karena berdampak langsung pada penetapan awal bulan Hijriah secara nasional. Tulisan ini bertujuan untuk menganalisis sejauh mana pengaruh kelembaban udara terhadap keberhasilan rukyatul hilal di Observatorium Jokotole serta mengidentifikasi kondisi atmosfer yang paling ideal untuk pengamatan. Data rukyat dan kelembaban udara di kumpulkan, dikomparasikan dan di analisis secara deskriptif. Hasil penelitian menunjukkan bahwa kelembaban udara sangat mempengaruhi keberhasilan rukyat walaupun tinggi hilal dan elongasi sudah memenuhi kriteria Neo Mabims, begitupula meskipun kelembaban tidak sepenuhnya rendah, kejernihan langit dan faktor astronomis seperti tinggi hilal antara 7° hingga 8° serta elongasi lebih dari 9° tetap memungkinkan hilal untuk teramati dengan baik. Dengan demikian keberhasilan rukyat ini memperkuat bahwa selain kelembaban, tinggi dan elongasi hilal juga berperan penting dalam visibilitas hilal. Penelitian ini menyarankan agar kegiatan rukyat mengintegrasikan data meteorologi real-time dan memilih waktu pengamatan pada musim dengan kelembaban rendah guna meningkatkan akurasi dan efektivitas pengamatan hilal.

Kata Kunci:
Rukyatul hilal, Kelembaban Udara, Observatorium, Empiris, Jokotole

A. Introduction

The determination of the beginning of the *Qamariyah* months in Islamic tradition is normatively based on the *rukyatul hilal* (hilal observation/crescent sighting) method. This is considered obligatory in accordance with the ushul fiqh rule “al-aṣlu fil amri lil-wujūb,” which states that every command originally indicates an obligation. In practice, this is done on the 29th night by observing the possibility of the hilal appearing. However, numerous reports have indicated that the hilal observation is often obscured by clouds, fog, or a thin layer of haze. This includes the UIN Madura Observatory, also known as OJT, where, during the rukyatul hilal process, the hilal observation was only seen once at a height of 7 degrees. Observatories located in high altitudes, far from light pollution and the sea or coast, tend to yield better observational results. Locations near the coast or sea surface are often affected by high humidity, sea fog, and evaporation, which cause the air to be humid and dewy. Several modern astronomy and celestial experts have confirmed that atmospheric factors, particularly air humidity, have a

significant influence on the success of rukyatul hilal. (Schaefer 1988) emphasizes that the brightness of the evening sky and the physiological limits of human vision significantly determine the contrast of the hilal observation against the sky. It also explains that atmospheric conditions, especially water vapor content, affect light scattering and reduce the contrast of the hilal observation against the sky.[1]

Previous studies have shown that meteorological factors play a significant role in determining the success rate of crescent moon sightings across various regions. Several studies confirm that air humidity is a key variable affecting crescent visibility, as it is directly related to atmospheric transparency and cloud formation. In his study, Hasan emphasizes that high air humidity can reduce the quality of observations due to increased light scattering in the atmosphere.[2] Similar findings were also presented by Mahczumy[3] and Yayang,[4] who showed that humid atmospheric conditions tend to cause the sky to be overcast, thereby hindering the rukyat process. Additionally, Hayati and Tanjung highlighted that the interaction between humidity and other meteorological factors, such as temperature and air pressure, further worsens the visibility conditions of the crescent moon.[5] Zafanka's research further supports this argument by showing that regions with high humidity levels have a lower probability of successful rukyat

[1] Leroy E. Doggett and Bradley E. Schaefer, "Lunar Crescent Visibility," *Icarus* 107, no. 2 (1994), https://doi.org/10.1006/icar.1994.1031.

[2] Abdulloh Hasan and Ilham Paninggit, "Variasi Lokal Pelaksanaan Rukyatul Hilal Dalam Penentuan Awal Bulan Hijriyah (Tinjauan Parameter Meteorologi)," *Jurnal Penelitian Agama* 25, no. 1 (2024): 105–24, https://doi.org/10.24090/jpa.v25i1.2024.pp105-124.

[3] Machzumy, "Effect of Geographical Environment on Success Rate of Rukyat Hilal at Observatorium CASA Assalam," *Al-Marshad: Jurnal Astronomi Islam Dan Ilmu-Ilmu Berkaitan* 5, no. 2 (2019): 177–91, https://doi.org/10.30596/jam.v5i2.3317.

[4] Yayang Arga Agustriani, "Dampak Polusi Udara Terhadap Keberhasilan Ruyatul Hilal Studi Kasus Di Pelabuhan Tanjung Kendal," 2024, 113.

[5] Zahra Hayati and Dhiauddin Tanjung, "Pengaruh Kelembapan Udara Terhadap Efektivitas Pelaksanaan Rukyatul Hilal Awal Bulan Qamariyah," *Jurnal EDUCATIO: Jurnal Pendidikan Indonesia* 9, no. 2 (2023): 754, https://doi.org/10.29210/1202323206.

compared to areas with a dry atmosphere.[6] On the other hand, Albana,[7] Fitriyah,[8] and Arbisora add that the low success rate of crescent moon sighting is not only caused by the geometric position of the Moon but also by weather conditions such as rain, fog, and thick clouds triggered by high water vapor content in the atmosphere.[9] Thus, it can be concluded that air humidity is one of the dominant factors that must be considered in the scientific and empirical analysis of crescent visibility.

The purpose of this paper is to comprehensively analyze the effect of air humidity on the success of rukyatul hilal at observatories by integrating astronomical and meteorological data. Theoretically, this research is expected to enrich contemporary astronomical studies, which have so far emphasized the geometric aspects of the hilal observation. Practically, the results of this research will benefit hilal observation observers and related institutions in designing more accurate observation strategies that are adaptive to atmospheric conditions. This research is also intended as a critique of previous studies that tended to only mention weather factors in general, without specifically examining the role of relative humidity in crescent visibility. By presenting empirical analysis based on field data, this research aims to fill this gap and provide a more scientific basis by presenting more specific field data, which can be directly applied in the practice of hilal observation sighting at observatories in Indonesia.

In general, atmospheric conditions, particularly air humidity, are factors that cannot be ignored in the success of rukyatul hilal, because humid sky

[6] Muhammad Zafanka Gazalba et al., "Pengaruh Kelembaban Atmosfer Terhadap Visibilitas Hilal Di Pantai Loang Baloq," *Al-Afaq: Jurnal Ilmu Falak Dan Astronomi* 5, no. 2 (2023): 12, https://sumber.belajar.kemdikbud.diakses.

[7] Moh. Nasrudin Albana, *Pengaruh Kelembapan Udara Terhadap Kegiatan Rukyatul Hilal Studi Kasus Rukyatul Hiolal Di POB IAIN Pekalongan*, *Sustainability (Switzerland)*, vol. 11, 2019.

[8] Khana Fitriyah, "Efek Kelembaban Udara Terhadap Pelaksanaan Rukyatul Hilal (Studi Kasus Di Menara Al-Husna MAJT)," 2021.

[9] M Arbisora Angkat et al., "Feasibility Test of Setumu Beach in Tanjungpinang City Riau Islands Province as a Rukyatul Hilal Location" 11, no. 1 (2025): 79–105.

conditions will affect light transparency and reduce the contrast of the hilal observation against the sky background. Specifically, this study argues that the relative humidity level at the observatory plays a significant role in determining the success or failure of observations, even when the geometric parameters of the moon meet the visibility criteria. Therefore, empirical studies on the relationship between air humidity and rukyah results are important not only to strengthen modern astronomy literature but also to provide practical recommendations for planning hilal observations in Indonesia. Several key issues to be discussed are as follows: What are the air humidity conditions in the Jokotole Observatory area of UIN Pamekasan, Madura? How does air humidity affect the success of crescent sighting at the Jokotole Observatory of UIN Pamekasan, Madura?

B. Methods

The collected data are presented descriptively and analytically using a deductive approach. Primary and secondary data were combined and then organized in the form of narratives, tables, and graphs to show the relationship between air humidity and the success rate of rukyatul hilal. The analysis process focused on interpreting atmospheric phenomena that affect the visibility of the hilal observation, allowing for systematic and contextual understanding of the results.

This study employed a qualitative approach, incorporating field research. Primary data was obtained from observations of rukyatul hilal at the Jokotole Observatory, UIN Pamekasan, interviews with observatory managers, and records of air humidity parameters sourced from BMKG Trunojoyo Sumenep. Secondary data was obtained from literature in the form of books, articles, and journals relevant to the topic of rukyatul hilal and atmospheric meteorology studies.

C. Result and Discussion

1. Hilal Observation and Air Humidity

Successful hilal observation is a condition in which the hilal observation can be clearly observed, either with the naked eye (bil-‘ain) or through modern optical

instruments. In astronomical terminology, successful observation is defined as the visibility of the hilal observation after sunset at the beginning of the lunar month. This success is determined not only by the geometric position of the Moon relative to the Sun, but also by the quality of the atmosphere and the clarity of the view on the western horizon. The success of this observation is an important indicator in determining the beginning of the Hijri month, which is both religious and scientific in nature. Therefore, effective crescent observation requires coordination between the expertise of observers, the availability of instruments, and stable weather conditions. A clearly observable hilal observation indicates that the visibility criteria have been met, which serves as the basis for both religious and astronomical decisions in determining the change of the lunar month.[10]

Air humidity refers to the amount of water vapor present in the air at a specific temperature, expressed as a percentage (%). In meteorological studies, humidity is a crucial factor that influences cloud formation and precipitation patterns, playing a significant role as it directly affects the transparency of the sky and the visibility of celestial objects. When the air reaches a saturation point above 80%, water vapor will condense to form clouds that block the light of the Sun and other celestial objects, including the hilal observation. High humidity levels can reduce visibility and sky clarity, often causing rukyat observations to fail. Therefore, ideal astronomical observations should be conducted under humidity conditions below 75%, where the sky tends to be clear and cloudless. In coastal areas such as Pamekasan, humidity levels tend to be high throughout the year due to the influence of the sea and low air pressure.[11]

[10] Ahmad. dkk Izzudin, *Mekanisme Penentuan Hari Raya Di Indonesia Dan Malaysia* (Semarang, 2021).

[11] Zafanka Gazalba et al., "Pengaruh Kelembaban Atmosfer Terhadap Visibilitas Hilal Di Pantai Loang Baloq."

2. BMKG and Observation

The Trunojoyo Sumenep Meteorological Station is a technical implementation unit under the Meteorology, Climatology, and Geophysics Agency (BMKG) located at Jl. Raya Kalianget Barat No. 8, Sumenep Regency, Madura, East Java. This station was previously known as the Kalianget Class III Meteorological Station; since the enactment of BMKG Regulation No. 1 of 2022, it has been officially renamed the Trunojoyo Meteorological Station. [12] Functionally, this station is tasked with conducting routine observations of meteorological elements, including temperature, humidity, air pressure, wind direction and speed, rainfall, and solar radiation, 24 hours a day. The data obtained is used for weather forecasting, climatological analysis, and atmospheric research in the eastern part of Madura. In addition, BMKG Trunojoyo regularly publishes a Monthly Meteorological Bulletin and provides real-time weather information through its official website.

The Jokotole Observatory (OJT) at UIN Pamekasan is one of the Islamic astronomy observation centers established as a facility for education, research, and community service in the field of astronomy, particularly in the Madura region. Established on campus in 2018 at coordinates 7°11'58.2“S and 113°28'2.29” E, with an elevation of approximately 46 meters above sea level, OJT is strategically located for observing celestial objects on the western horizon. Its first Rukyat activity was conducted in early Shawwal in 2019. The observatory is equipped with various instruments including refracting telescopes, theodolites, and digital cameras used in hilal observation activities. In addition to its academic functions, OJT also plays a role in determining the start of the Hijri month in collaboration with the Ministry of Religion and the Regional Astronomical Observation Board (BHRD). In its development, the observatory has become a

[12] BMKG, *Peraturan BMKG No. 1 Tahun 2022 Tentang Organisasi Dan Tata Kerja Stasiun Meteorologi,* (Jakarta, 2022).

practical laboratory for astronomy students at UIN Pamekasan, where theoretical calculations are verified through field observations[13]

According to Ilyas 1994 in his article "Lunar Crescent Visibility Criterion and Islamic Calendar", published in the Quarterly Journal of the Royal Astronomical Society, the criteria for the location of rukyat play an important role in determining the success of crescent observation. Ilyas emphasizes that the observation location must meet adequate astronomical and meteorological requirements, including an unobstructed western horizon, sufficient elevation to reduce the effects of refraction and light pollution, and stable atmospheric conditions. He explained that the success of rukyat is not only determined by the geometric positions of the Sun and Moon (such as elongation and crescent height), but also by the optical quality of the local atmosphere. Factors such as air transparency, humidity levels, and the presence of dust and pollutants can significantly reduce the contrast between the crescent and the evening sky. Therefore, Ilyas recommends choosing a rukyat location in an area with dry weather, high visibility, and far from urban light pollution so that the observation results are more accurate and consistent.[14]

The rukyat data collected by the Jokotole Observatory at UIN Pamekasan during the 2022–2024 period shows mixed results. From several observation activities carried out, the hilal observation was only observed once, specifically at the beginning of the month of Zulhijjah 1441 Hijri (July 21, 2021 AD), at an altitude of approximately seven degrees. On other occasions, the hilal observation could not be observed due to unfavorable atmospheric conditions, such as fog and thick clouds on the western horizon. The observation data show that, although the geographical position and azimuth orientation were in accordance with standards, external factors such as weather remained a significant obstacle. Field notes from

[13] Nurmila, "Analisis Tehadap Pelaksanaan Kegiatan Rukyatulhilal Di Observatorium Jokotole Institut Agama Islam Negeri Madura Pamekasa," 2022, 80.

[14] Muhammed Ilyas, "Lunar Crescent Visibility Criterion and Islamic Calendar" 35 (1994).

the OJT also indicate that the success rate of observations is directly proportional to clear skies and low humidity levels. This underscores the need for rukyat activities to be consistently linked to meteorological variables to achieve accurate and scientifically accountable results.

Based on air humidity data obtained from the Trunojoyo Sumenep BMKG Meteorological Station, the Pamekasan region has an average annual humidity level of between 75% and 88% throughout the year. During months with high rainfall, such as December to April, humidity tends to increase to 90%, while during the dry season, humidity decreases to between 68% and 75%, creating more stable atmospheric conditions that are ideal for observation. During rukyat activities at the Jokotole Observatory, high humidity is a major obstacle that causes cloudy skies and stratiform clouds. Observation data show that the hilal observation is difficult to see when humidity exceeds 85%, because condensed water vapor particles thicken the cloud layer. Conversely, when humidity is below 70%, the chances of successful rukyat increase significantly.[15] This pattern reveals a direct correlation between meteorological conditions and the outcomes of astronomical observations in the field. This shows a direct relationship between atmospheric humidity and the success of hilal observations. Thus, meteorological parameters must be a primary consideration in determining the rukyat schedule.

Air humidity has a significant effect on the success of rukyat because it determines the extent to which the light of the hilal observation can penetrate the atmosphere. In saturated air conditions, water vapor particles act as a scattering medium reducing the intensity of the moonlight, and making the hilal observation difficult to see. Empirical observations at the Jokotole Observatory indicate that a 5% increase in humidity can reduce the chances of a successful observation by up to 20%. This condition is reinforced by field data, which show thick clouds at the time of unsuccessful observations. The implication is that observatories need to

[15] Zafanka Gazalba et al., "Pengaruh Kelembaban Atmosfer Terhadap Visibilitas Hilal Di Pantai Loang Baloq."

adopt an integrative approach between calculation analysis, atmospheric measurements, and humidity forecasts. Thus, modern astronomy is not only a theoretical science but also an applied science based on scientific data and empirical observations. Therefore, air humidity is one of the meteorological parameters that needs to be seriously considered in determining the success of Hilal observation in Indonesia. In a scientific context, the relationship between air humidity and the success of observation can be explained physically through the optical properties of the atmosphere, which cause light scattering when the amount of water vapor increases.

Table 1. Air Humidity in Madura (2020-2024)[16]

MONTH	(%)2020	(%)2022	(%)2023	(%)2024
January	83.6	85.0	83.0	84.0
February	86.6	88.0	86.0	87.0
March	85.9	87.0	87.0	86.0
April	84.6	85.0	86.0	86.0
May	83.2	84.0	80.0	79.0
June	77.2	82.0	80.0	78.0
July	73.0	79.0	76.0	74.0
August	73.3	76.0	74.0	73.0
September	70.0	74.0	70.0	72.0
October	74.0	80.0	73.0	69.0
November	78.5	86.0	74.0	80.0
December	86.3	81.0	80.0	86.0
Average	79.7	82.3	79.1	79.5

From Table 1.1, it can be inferred that humidity levels in Madura exhibit only minor fluctuations, with a monthly variation of approximately 6%. The highest humidity during the 2020–2024 period occurred in February 2022, reaching 88.0%, while the lowest was in October 2023, at 69.0%. Overall, air humidity in Madura is relatively high, with an annual average ranging between 79.1% and 82.3%. Humidity typically peaks in November and begins to decline around May,

[16] BMKG Trunojoyo, "BMKG Trunojoyo," n.d., Data Online - Direktorat Data dan Komputasi BMKG.

corresponding to the onset of the rainy and dry seasons, respectively. Nevertheless, due to Madura's geographic position, surrounded by the sea, rainfall may still occur occasionally even during the dry season.

Table 1. Results of hilal and Sky condotions[17]

Month & Year	Humidity (%)	Apparent Hilal Altitude & Elongation	Observation Result
Żulhijjah 1441 21 July 2020	76.0	7º 25' 02"	Successfully observed
Muharram 1444 29 July 2022	78.0	6º 19'16,91" 9º 5' 59,28"	Not visible due to clouds cover
Ramaḍan 1444 21 March 2023	86.0	7º 21' 38,7" 9º 50' 51,92"	Not visible due to clouds cover
Syawal 1444 20 April 2023	80.0	1º 18'19,16" 3º 16' 15,35"	Not visible due to being below Neo MABIMS criteria
Muharram 1445 18 July 2023	70.0	5º 43'39,29" 8º 50' 2,25"	Not visible due to clouds cover
Ṣafar 1445 16 August 2023	69.0	0º 6' 55,83" 4º 31' 11,84"	Not visible due to being below Neo MABIMS criteria
Rabiul Awal 1445 15 September 2023	70.0	2º 48'58,21" 4º 42' 42,6"	Not visible due to being below Neo MABIMS criteria
Rabiul Ṡani 1445 15 October 2023	70.0	5º 35'31,08" 7º 49' 07,33"	Not visible due to clouds cover
Ramaḍan 1445 10 March 2024	84.0	0º 28'44,16" 2º 23' 8,14"	Not visible due to being below Neo MABIMS criteria
Syawal 1445 9 April 2024	93.0	5º 34'10,13" 9º 26' 26"	Not visible due to clouds cover
Muharram 1446 6 July 2024	77.0	3º 49'35,07" 7º 33' 53,26"	Not visible due to clouds cover

According to the data listed in Table 2 above, the results of the hilal observation at OJT UIN Pamekasan were almost entirely unsuccessful because

[17] Hosen(*Kepala Laboratorium Jokotole UIN Madura), wawancara oleh penulis, Pamekasan, 02 Januari* 2025.

every time the hilal observation was carried out, the horizon was always cloudy from the west, where clouds are a collection of water vapor that originates from humidity in the air. It was successfully observed only once, at the beginning of the month of Zulhijjah in the year 1441 H, with a hilal observation height of 7º 25’ 02" and an air humidity value of 79.0%. At that time, there had been no update using the Neo MABIMS criteria, and no oath had been taken by a judge. However, all those present at the event could serve as witnesses to the success of the rukyat. The lowest humidity value occurred during the observation of the beginning of the month of Rabiul Awal 1445, which corresponds to September 2023, with a humidity value of 70. However, the hilal observation's altitude and elongation did not meet the imkanurrukyah criteria, making it impossible to successfully observe the hilal observation.

Some of the calculation data results during the implementation of rukyatul hilal met the criteria of imkanurrukyah Neo MABIMS, namely a minimum height of 3º above the horizon at sunset and a minimum elongation angle of 6º4'. However, due to cloudy skies during the implementation of rukyatul hilal, it was difficult to successfully carry out rukyatul hilal in OJT Pamekasan. Previously, the hilal observation was carried out at Ambhet Talanakan beach, and the results were the same as those from the hilal observation at the Jokotole Observatory, UIN Pamekasan, namely that it was difficult to see due to the cloudy sky from the western horizon where the sun sets.[18]

Tabel 3. Manual Calculation Data (Ephemeris System) for 1 Żulhijjah 1441

Data	**Calculation**
Location	Jokotole Observatory UIN Pamekaan
Date	July 21 2020
Latitude	-07° 11' 58,20''
Longitude	113° 28' 22,90''
Elevation	46MDPL
Conjunction/Ijtima'	23° 07' 49,67''

[18] Hosen, *Kepala Laboratorium Jokotole UIN Madura, Wawancara Online, (04 Juni 2025).*, 2025.

Sunset	17°26' 17,45''	
Sun azimuth	290° 21' 56,35''	
Crescent azimuth	292° 57' 20,87''	
True crescent height	08° 12' 49,50''	
Upper apparent crescent height	07° 49' 42,86''	Above the apparent horizon
Center apparent crescent height	07° 33' 45,85''	Above the apparent horizon
Mar'i lower crescent altitude	07° 17' 48,84''	Above the Mar'i Horizon
Crescent position	02° 35' 24,52''	Crescent to the North of the Sun
Topocentric elongation	08°47' 15,38''	
Geocentric elongation	09°36' 12,55''	
Arc distance	08°14' 36,23''	
Hilal observation	00° 35' 30,93''	
Hilal observation setting	18° 01' 48,38''	
Crescent illumination	0,72%	
Crescent brightness	0,549728837512983 fingers	
Crescent inclination	Crescent tilted northward	

Tabel 4. Manual Calculation Data (Ad-Durrul Aniq System) for 1 ḍulhijjah 1441

Latitude		-7,1995	***-7***	***-11***	***-58,2***
Longitude		113,4730278	***113***	***28***	***22,9***
Conjunction	Time (WD)	00 : 32 : 53 WD			
	Day	Monday Pahing + Conjunction= Selasa Pon			
	Date-Month-Year	20+Conjunction = 21-7-2020			
Sunset		17 26' 17,81			
Geocentric Crescent Height		08 13' 41,23			
Topocentric Crescent Height		07 18' 14,42			
Sun Azimuth		290 21' 46,83			
Hilal observation Azimuth		292 52' 30,31			
Hilal observation Position		02 30' 43,48			
Elongation		09 34' 36,50			
Hilal observation Age		16 53' 24,92			

Crescent Duration	00 32' 54,75
Crescent Illumination	0,704328046690921%
Crescent Sunset	17 59' 12,56

The hilal observation sighting was conducted at the Jokotole Observatory, UIN Pamekasan, at the beginning of the month of Zulhijjah 1441 AH or July 21, 2020 AD. Based on the results of manual calculations using two systems, namely Ephemeris and Ad-Durrul Aniq, both showed consistency in estimating the position of the hilal observation on July 21, 2020 AD. The conjunction occurred on Tuesday, July 21, 2020, at 00:32:53 WIB, and the rukyat was carried out at sunset at 17:26 WIB, when the hilal observation was above the horizon at a height of approximately 8°12'49.50'' (Ephemeris) and 8°13'29'' (Ad-Durrul Aniq). The elongation value indicated 9°36'12.55''(Ephemeris) and 9°34'36.50'' (Ad-Durrul Aniq), indicating a sufficient angular distance for possible visibility. The crescent is north of the Sun with an azimuth of approximately 292°–293°, and appears tilted to the north. These results confirm that, based on calculations and observations, the crescent of the beginning of Zulhijjah 1441 AH has met the visibility criteria.

Figure 1. Crescent Image on 1 Żulhijjah 1441 H

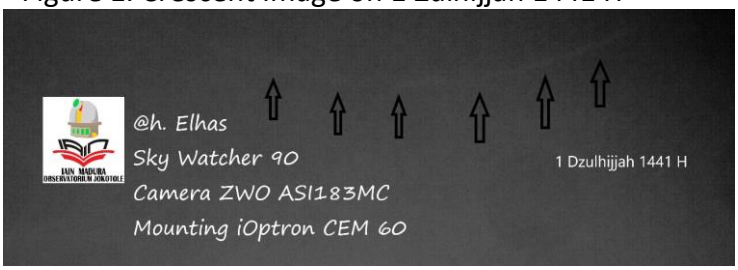


Figure 1 shows an image of the hilal observation successfully recorded on the 1st of Zulhijjah 1441 AH through the hilal observation activity at the Jokotole Observatory, UIN Pamekasan, Madura. This image serves as visual evidence of the successful hilal observation conducted by the UIN Pamekasan astronomy team using a high-resolution refracting telescope integrated with a digital CCD camera. The observation results clearly show the crescent shape of the young moon above the western horizon just before sunset. The position of the crescent, which was very thin with a small elongation and low altitude, indicates that the image is the

first crescent after conjunction. The atmospheric conditions around the observation site at that time were relatively clear with moderate humidity, thus supporting optimal visibility of the crescent light.

This image has scientific and religious significance, as it provides empirical observational data that reinforces the results of the initial calculation of the lunar month previously carried out by the calculation-observation team. The successful documentation of the hilal observation through digital images at the Jokotole Observatory demonstrates the strategic role of UIN Pamekasan in the development of observation-based astronomy and in supporting the scientific determination of the beginning of the Hijri month. Thus, the image above is not merely visual documentation, but also verified astronomical evidence of the success of rukyatul hilal in the academic environment of UIN Pamekasan. These results demonstrate how the integration of calculation, observation, and observatory technology methods can enhance the credibility of determining the beginning of the lunar month in both academic and religious contexts in Indonesia.

D. Conclusion

The Jokotole Observatory at UIN Pamekasan meets the criteria for rukyatul hilal (moon sighting) set by the Indonesian Meteorological, Climatological, and Geophysical Agency (BMKG), but it is the humidity that makes it difficult for observers to see the crescent moon. Humidity in Madura does not vary significantly, with a monthly average difference of only 11%. The highest humidity from 2020 to 2024 occurred in February 2022 at 88.0%, and the lowest humidity occurred in October 2023 at 69.0%. The air humidity value at the time of rukyatul hilal is often above 65%, so it is not uncommon for the horizon to be cloudy, and even when it is not cloudy, sometimes the hilal and elongation are below the imkanurrukyah criteria, making it impossible to see the hilal.

This study focuses specifically on the Madura region, thus providing a new contribution in the form of local empirical analysis that has not been widely studied in Indonesian astronomy studies. However, this study has several

limitations. The data sample used is still limited to the 2022–2024 period, and the observation location only covers the Jokotole Observatory at UIN Pamekasan, so it cannot represent atmospheric conditions throughout the Indonesian coast. In addition, the methods used are still simple descriptive-correlation methods, without the application of multivariate statistical models or more complex spatial analysis.

For further research, it is recommended that cross-observatory comparisons (e.g., between Pamekasan, Yogyakarta, and Gowa) be conducted with a longer observation period and the integration of meteorological satellite data and computer-based crescent visibility models. With this approach, astronomy can develop into a more empirical, modern discipline capable of explaining the scientific relationship between atmospheric phenomena and the success of rukyat more accurately.

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