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The Effect Of Seawater Evaporation On The Visibility Of The Cross-Crescent
(Case Study of Loang Baloq Beach, Mataram)

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Abstract

The visibility of the crescent moon is a crucial factor in the crescent moon sighting (rukyatul hilal) to determine the beginning of the lunar month. Ideally, crescent moon observations should be conducted in a location with a clean and transparent atmosphere, but these conditions are often lacking in coastal areas affected by seawater evaporation. This study aims to analyze the effect of seawater evaporation on crescent moon visibility at Loang Baloq Beach, Mataram City, one of the official crescent moon sighting locations in West Nusa Tenggara Province. This study uses a field research method (field research) with a qualitative approach. Data were obtained through observation, interviews, documentation, and meteorological data from the Meteorology, Climatology, and Geophysics Agency (BMKG) covering evaporation, air humidity, air pressure, and reports of the results of the crescent moon sighting. The results showed that the rate of seawater evaporation at Loang Baloq Beach is relatively high, ranging from 123–169 mm per month, with an average atmospheric humidity of 84.5%. This condition increases the content of water vapor and atmospheric aerosols, which causes a decrease in sky transparency and a decrease in the contrast of the crescent moon against the background of the twilight sky. This relationship forms a series of processes, including seawater evaporation, increased atmospheric water vapor, increased air humidity, decreased sky transparency, reduced crescent moon contrast, and decreased chances of successful sighting. This study concludes that seawater evaporation is one of the atmospheric factors that contribute to the visibility of the crescent moon in coastal areas, although it is not the only determining factor in the success of the observation

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1. INTRODUCTION

Determining the beginning of the lunar month in Islam is a matter that has not only a religious dimension but also an astronomical dimension that demands a high level of observation accuracy (Rofiuddin & Ardliansyah, 2024). Normatively, rukyat hilal is carried out to obtain certainty of the beginning of the Hijri month, as instructed in the hadiths of the Prophet (Nurkhanif et al., 2022). In an ideal perspective, rukyat should be carried out in a location with clear atmospheric conditions, an open horizon, and free from various visual obstructions that can reduce the visibility of the hilal. However, in practice, this idealism often clashes with the reality on the ground (Awaludin et al., 2020).

Many rukyat areas considered geographically strategic actually have complex atmospheric characteristics, particularly in coastal areas prone to high humidity, marine aerosols, fog, and seawater evaporation. Consequently, a crescent moon that is potentially visible astronomically may not be empirically observed. This situation demonstrates a clash between the idealistic concept of rukyat, which requires clear skies, and the dynamic reality of the atmosphere, which often serves as a limiting factor for successful crescent observation (Arkanuddin & Sudibyo, 2015).

Sociologically, rukyat hilal (crescent moon sighting) is still the official method used by the Indonesian government in determining the beginning of Ramadan, Shawwal, and Zulhijah through isbat areas involving various observation points throughout Indonesia (Ahmad Syifaul Anam, 2022). Loang Baloq Beach in Mataram City has been one of the official rukyat areas used by the Regional Office of the Ministry of Religious Affairs of West Nusa Tenggara Province since 2013, after the area was moved from Malimbu Beach due to the horizon being blocked by Mount Agung in Bali. As a coastal area facing directly onto the Bali Sea, Loang Baloq Beach has an environmental character that is greatly influenced by the process of seawater evaporation (Gazalba et al., 2023).

BMKG data shows that the seawater evaporation rate in this area is relatively high, reaching 168.76 mm in January and averaging above 140 mm in most months of the year (BMKG Class 1 Lobar). On the other hand, observational data show that the crescent moon is only successfully observed in certain months, while in other months it is not successfully observed (Gazalba et al., 2023). This phenomenon indicates a possible relationship between coastal atmospheric conditions and the success rate of crescent moon observations, which has not received much attention in contemporary astronomical studies.

Previous research has examined various atmospheric factors that influence the visibility of the crescent moon. Siti Rohmah Sakohwati's research discusses the influence of atmospheric conditions on the crescent moon sighting at the Banyu Urip Tower in Tuban (Sakohwati, 2019). Machzumy examined the influence of rainfall on the success of the crescent moon sighting at the Lhoknga Observatory in Aceh (Machzumy, 2019). Zuni Faridatul Magfiroh examined the relationship between rainfall and crescent moon visibility using the Kastner brightness model in Pasuruan (Faridatul Magfiroh, 2022). Meanwhile, Muhammad Zofanka Gazalba examined the influence of atmospheric humidity on the visibility of the crescent moon at Loang Baloq Beach. However, these studies focused more on rainfall factors, general atmospheric conditions, and light pollution. No research has been found that specifically examines the influence of seawater evaporation as the main variable that can influence atmospheric quality and crescent moon visibility at coastal rukyat locations. Thus, there is a research gap in the form of a lack of empirical studies regarding the relationship between the level of seawater evaporation and the success of crescent moon observations.

Based on these conditions, this study argues that seawater evaporation is one of the atmospheric variables that has the potential to affect the visibility of the crescent moon through increasing water vapor content, atmospheric humidity, marine aerosol formation, and decreasing sky transparency around the western horizon. Therefore, the study of seawater evaporation is important not only to understand the factors that influence the success of the crescent moon sighting, but also to evaluate the level of ideality of a crescent moon sighting location from an observational astronomy perspective. This study attempts to fill this gap by analyzing the effect of seawater evaporation on the visibility of the crescent moon at Loang Baloq Beach as one of the official crescent moon sighting locations in West Nusa Tenggara Province.

2. RESEARCH METHODS

This research is field research with a qualitative approach. The author used this qualitative approach because he wanted to reveal a natural phenomenon, namely, seawater evaporation due to air humidity, which can affect the visibility of the crescent moon. The research location is at Loang Baloq Beach, Mataram City, which is one of the official crescent moon sighting points in West Nusa Tenggara Province. Primary data was obtained through field observations and semi-structured interviews with BMKG officers and parties involved in crescent moon observation. Secondary data was obtained from BMKG documents, crescent moon sighting reports, and literature related to crescent moon visibility and atmospheric conditions.

3. RESULTS AND DISCUSSION

3.1 RESULTS

Characteristics of Seawater Evaporation at Loang Baloq Beach

The research results show that Loang Baloq Beach experienced a relatively high seawater evaporation rate throughout 2022. According to BMKG data, the highest evaporation rate occurred in January at 168.76 mm, while the lowest value occurred in June at 123.16 mm. Overall, the evaporation rate ranged from 123 to 169 mm per month, indicating continuous evaporation in this coastal area.

The high evaporation rate is influenced by the intensity of solar radiation received by the sea surface. Data shows that the highest light intensity occurs in March at 318.2 cal/cm² and the lowest in December at 183 cal/cm². The average light intensity reaches 271.7 cal/cm² with an average temperature of around 25°C. In March, when light intensity reaches its highest value, the evaporation rate also increases, indicated by the evaporation percentage reaching around 85% (Yu et al., 2024).

The data shows that Loang Baloq Beach's geographical location, as a coastal area open to the west, receives significant sunlight exposure, contributing to intensive seawater evaporation throughout the year. Atmospheric conditions at Loang Baloq Beach are dominated by high humidity levels. According to 2022 BMKG data, atmospheric humidity ranges from 82% to 87%, with an annual average of 84.5%. The highest humidity occurs in October at 87%, while the lowest humidity occurs in July at 82% (Gazalba et al., 2023).

Atmospheric Conditions of Loang Baloq Beach

In addition to humidity, atmospheric conditions are also characterized by relatively stable air pressure throughout the year. The highest air pressure was recorded in September at 1006.7 mb, while the lowest was in December at 1003.3 mb. Overall, the average air pressure at Loang Baloq Beach reaches 1004.7 mb.

The high humidity indicates that the atmosphere at Loang Baloq Beach contains a large amount of water vapor (Feistel & Hellmuth, 2023). This condition aligns with the characteristics of coastal areas, which are influenced by continuous seawater evaporation. Therefore, the atmosphere at Loang Baloq Beach can be categorized as humid, with a relatively high-water vapor content throughout the year.

Based on crescent moon observation data obtained from the Meteorology, Climatology, and Geophysics Agency (BMKG), the visibility of the crescent moon at Loang Baloq Beach showed varying results throughout 2022. The crescent moon was only successfully observed in five months: April, May, June, August, and October. Meanwhile, the crescent moon was not observed in the other seven months (Gazalba et al., 2023).

The data shows that the success rate of crescent moon sighting at Loang Baloq Beach is only around 41.7%, while the failure rate is around 58.3%. These findings indicate that although Loang Baloq Beach has an open sea horizon and is frequently used as an official crescent moon sighting location, successful observations are not always achieved in every crescent moon sighting. These variations in crescent moon visibility indicate the presence of non-astronomical factors that influence the success of observations, particularly the atmospheric conditions surrounding the observation location.

Sea Water Evaporation Conditions and Crescent Visibility

Research results indicate a link between high seawater evaporation and atmospheric conditions, which affect the visibility of the crescent moon. High evaporation rates lead to increased water vapor content in the atmosphere, indicated by an average humidity of 84.5%. This condition has the potential to affect sky clarity, especially in the western horizon, the primary area for crescent moon observation.

Research data shows that in months with relatively more favorable atmospheric conditions, the crescent moon was successfully observed, while in most other months it was not visible. This finding indicates that seawater evaporation does not directly determine whether the crescent moon is visible, but rather contributes to the formation of atmospheric conditions that can affect the quality of observations (Sakohwati, 2019).

Thus, the research results indicate that seawater evaporation, atmospheric humidity, and crescent moon visibility are interrelated phenomena in the context of crescent moon observation in coastal areas. This relationship demonstrates that the success of crescent moon sighting is influenced not only by the crescent's astronomical position but also by local atmospheric conditions that develop due to the characteristics of the coastal environment.

3.2 DISCUSSION

Seawater Evaporation as an Obstacle Factor in Crescent Visibility

Astronomically, crescent moon observation is highly dependent on atmospheric clarity. Even if a location has a clear horizon and the crescent moon's position meets visibility criteria, the success of the sighting can still be compromised if the atmosphere contains particles that scatter light. In the context of Loang Baloq Beach, the high level of seawater evaporation indicates a continuous supply of water vapor to the lower atmosphere (Syuhada et al., 2023).

The evaporation process results in an increase in water vapor content, which can subsequently affect atmospheric transparency. The higher the water vapor content, the greater the likelihood of the formation of aerosols and microscopic particles that scatter sunlight after sunset. This condition causes the background sky around the western horizon to become brighter, reducing the contrast between the crescent moon and the twilight sky. As a result, the crescent moon, which is astronomically possible to observe, becomes more difficult for observers to see.

The evaporation theory states that the intensity of solar radiation is the main factor influencing the rate of water evaporation. The greater the heat energy received by the sea surface, the greater the number of water molecules that turn into vapor and enter the atmosphere (Mazra & Arino Bemi Sado, 2025). This condition is seen at Loang Baloq Beach, which has an average light intensity of 271.7 cal/cm² and an average air humidity of 84.5%.

Compared to Siti Rohmah Sakohwati's research, which examined the influence of atmospheric conditions on the crescent moon sighting at the Banyu Urip Tower in Tuban (Sakohwati, 2019), this research shares a similar focus on atmospheric studies as a factor influencing crescent moon observation. However, Siti Rohmah's research focused more on general atmospheric conditions, while this study specifically identifies seawater evaporation as the primary source of humid atmospheric conditions at coastal crescent moon sighting locations. Thus, this research provides a more specific perspective on the origins of atmospheric disturbances that affect crescent moon visibility.

The research results show that Loang Baloq Beach has a high humidity level, averaging 84.5%. This high humidity indicates a high-water vapor content in the atmosphere around the observation location. In observational astronomy, high water vapor content can reduce atmospheric transparency through scattering (*scattering*) and absorption *of* light. This phenomenon can be explained through the theory of atmospheric extinction, which states

that the light of celestial objects will be weakened when passing through atmospheric layers containing water particles, dust, and aerosols (Mulyadi, 2024). Because the crescent moon is an astronomical object with a low brightness level and is very close to the horizon, its presence is very sensitive to changes in atmospheric conditions.

This finding is related to Machazumy's research, which examined the effect of rainfall on the success of crescent moon sighting at the Lhoknga Observatory in Aceh. (Machzumy, 2019). This research showed that meteorological conditions can influence the success of crescent moon observations. The difference is that Machazumy's research focused on rainfall as a weather indicator, while this study places seawater evaporation as the initial factor contributing to increased atmospheric humidity. In other words, this research seeks to explain the roots of atmospheric processes that can ultimately affect the visibility of the crescent moon.

Observation data show that the crescent moon was only successfully observed in five months of the observation year. This finding indicates that the success of the sighting is not only determined by the fulfillment of astronomical parameters, but is also influenced by the atmospheric conditions that develop during the observation. In the theory of crescent visibility, as proposed by Schaefer and various modern visibility models, the success of crescent observation is influenced by the contrast between the light of the crescent moon and the background of the twilight sky (Doggett & Schaefer, 1994). The higher the level of light scattering in the atmosphere, the lower the contrast formed, thus reducing the chance of seeing the crescent moon.

These findings are similar to those of Zuni Faridatul Magfiroh, who studied the relationship between rainfall and crescent moon visibility using the Kastner brightness model. This study emphasized the importance of atmospheric factors in determining the success of crescent moon observations. However, this study differs in that it focuses not on rainfall as a weather indicator, but rather on seawater evaporation, one of the primary sources of atmospheric water vapor formation in coastal areas.

Relation: Seawater Evaporation Affects Crescent Visibility

The research results show that the relationship between seawater evaporation and crescent moon visibility forms a series of interconnected atmospheric processes. This series of processes begins with seawater evaporation due to the high intensity of solar radiation received by the sea surface at Loang Baloq Beach. This evaporation causes an increase in water vapor content in the lower atmosphere around the observation location. The greater accumulation of water vapor is directly proportional to the higher level of atmospheric humidity.

Increased atmospheric humidity results in an increase in water particles and aerosols in the air. The presence of these particles increases the scattering and absorption of light in the atmosphere, thereby decreasing sky transparency. This reduced atmospheric transparency makes it increasingly difficult for the naturally dim light of the crescent moon to penetrate the atmosphere to reach observers.

The scattering of twilight light around the western horizon simultaneously causes the background sky to appear brighter. This condition reduces the contrast between the crescent moon and the twilight sky. In fact, in the theory of crescent moon visibility, the level of contrast is one of the main factors determining whether or not the crescent moon can be observed. The lower the contrast, the less likely the crescent moon will be visible, either with the naked eye or using optical instruments.

The relationship between seawater evaporation and crescent visibility can thus be understood as a single sequential process, namely: seawater evaporation to -increase in

atmospheric water vapor to -increase in air humidity to -decrease in sky transparency to -reduction in crescent contrast against the twilight sky to -decrease in the chance of successful crescent sighting. This series of processes shows that local atmospheric factors, especially in coastal areas, have an important role in determining the quality of crescent observations in addition to astronomical factors such as crescent height, elongation, and age of the moon.

4. CONCLUSION

This study shows that seawater evaporation at Loang Baloq Beach contributes to atmospheric conditions that affect the visibility of the crescent moon. High solar radiation intensity increases evaporation, leading to increased water vapor and atmospheric humidity. This condition results in decreased sky transparency due to increased light scattering in the atmosphere, thus reducing the contrast between the crescent moon and the background twilight sky. This relationship forms a series of processes that influence the chances of successful crescent moon sighting, although it is not the sole determining factor, as the visibility of the crescent moon is also influenced by astronomical parameters and weather conditions during observation.

The limitations of this study lie in the use of observational data over a limited time period and the lack of direct measurements of atmospheric transparency, aerosol content, and atmospheric extinction levels during the crescent sighting. This study also failed to quantitatively test the influence of each meteorological element on the visibility of the crescent.

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