THE FALAK SCIENCE OBSERVATORY OF UNIVERSITY OF MUHAMMADIYAH NORTH SUMATRA (OIF UMSU) AND THE CONTRIBUTION IN FAJR TIME RESEARCH

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Introduction

The Falak Science Observatory of the University of Muhammadiyah North Sumatra (abbreviated OIF UMSU) is an observatory that is engaged in the study and research of Islamic Astronomy. Structurally, this institution is under the auspices of the University of Muhammadiyah North Sumatra (UMSU). One focus of The Falak Science Observatory of the University of Muhammadiyah North Sumatra is the fajr time (true dawn) research by using Sky Quality Meter (SQM) instruments. OIF UMSU's Fajr time research data has compiled up to hundred data (days), collected from 2017 to 2020. Besides, some of OIF UMSU's data also been utilized by various parties in the research and development of the dawn study and Falak science in general. This article will present at a glance about OIF UMSU and the contribution to Fajr Time research using Sky Quality Meter.

Falak Science and Observatory

- **Science of Falak**

Falak Science or Islamic Astronomy is a branch of science that studying the state of the celestial body in terms of its shape, content, quality, position, and movement. In classical Islamic intellectual treasures, astronomy is a discipline that studies the celestial objects related to the arrangement and order of the orbits of the celestial body, the number of planets, and the configuration of constellations in distance, content, motion, and others. In the history of Islamic civilization, Falak science is also known as *hai'ah which* is the original terminology that appeared in Islamic civilization since the middle of the 3/9 century (Basya, 2008). Observation of celestial objects is an integral part of science, observation itself is usually done in an observatory *(al-marshad)* (Butar-Butar, 2016).

Next development, Falak science continues to develop with various elaboration and scientific acceleration until finally this science with *the* distinctive name 'Falak science' entrenched in Islamic civilization. As seen, in universities, government agencies, Islamic organizations, and others bring out the Falak science studies in theory and practice. More specifically, Falak science plays a detailed role in the interests of Muslims in four things, which are: [1]. Determining the beginnings of the Qamariyah month, [2]. Determining the prayer times, [3]. Determining the qibla direction and qibla's shadow, [4]. Determine when and where the eclipse will take place.

- **Observatory**

The Observatory is a building where the celestial objects are observed. These observations are organized, recorded, and recorded. The Observatory is synonymous with the instruments of various celestial objects, in addition to its strategic location. In Arabic, the observatory is called"al-marshad", while in English it is called "observatory".

The Observatory is both a heritage and a very valuable contribution to Islamic civilization. The observatory is an original contribution of Islamic civilization, in this institution, the astronomy development and related sciences took place rapidly. The Observatory itself is the pinnacle of knowledge, ideas, and concept in astronomy (Butar-Butar, 2014).

In classical Islamic intellectual treasures, the observatory is also called *ar-rashd, dār ar-rashd* and bait *ar-rashd*. By terminology, the observatory is a building where observations of celestial objects are recorded. The Observatory is identic with diverse instruments in a strategic location. In a modern context, the observatory can be declared as a legacy as well as a very valuable contribution from Islamic civilization. According to Seyyed Hosein Nasr, the observatory as a scientific institution is an original contribution of Islamic civilization. This institution that the development of astronomy and related sciences took place vigorously in the middle ages (Mu'min, 2006).

- **History of UMSU Falak Science Observatory**

University of Muhammadiyah North Sumatra (UMSU) is one of the leading private universities in Indonesia. This university does not have many qualified experts in the field of Falak science who can take part both at the local and national level, what else internationally. Undeniably, the absence and scarcity of this effect are felt in the community, where people until now have not understood the essence of determining the praying time, especially the determination of fasting and holidays. Besides, it must be recognized that the role and contribution of Falak science in Muslim worship is very significant such as the determination of prayer times, qibla direction, eclipse, beginning of the month, calendar, and others.

Realizing the facts above and to encourage the acceleration of UMSU's progress in the field of Falak Science, the best way to do this is to build engineering, training, and research in this field professionally and simultaneously, which is part of the effort to produce quality human resources, which have technical advantages, and ready to answer various public questions related to Falak Science. Therefore, it is considered consciously necessary to establish the "Observatory of Falak Science University of Muhammadiyah North Sumatra" (OIF UMSU).

Falak Science Observatory of University of Muhammadiyah North Sumatra (abbreviated OIF UMSU) is an institution in UMSU engaged in the Falak science (Islamic astronomy) field. OIF was established in 2014 based on the Rector's Decree of UMSU (Dr. Agussani, MAP) number 1060/KEP/II.3-AU/UMSU/D/2014, and subsequently, on 09 Jumadil Tsani 1436 H (30 March 2015 M) inaugurated by the Chairman of the Assembly of Tarjih and Tajdid Muhammadiyah Central Leadership (Prof. Dr. H. Syamsul Anwar, MA). Furthermore, at the Advanced Indonesian National Convention (KNIB) in Yogyakarta, May 23, 2016, OIF was again inaugurated by the President of the Republic of Indonesia (Joko Widodo) marked by the signing of inscriptions.

OIF activities are research, dedication, training, and education to the community in the field of Science Falak (Islamic Astronomy). OIF has the vision to be the center of engineering, research, thought and concept of Falak Science that combines the treasures of Islam and modern science, and the mission of conducting training programs, assessment, and counseling of Falak Science in the campus environment and the community. Meanwhile, OIF's motto is

"photographing the universe for faith and civilization". It is for this spirit, vision, mission, and motto that OIF moves and moves forward (OIF UMSU team, 2020).

OIF UMSU Fajr Time Research Data

- **Instruments and Locations of Data Retrieval**

Over the past three years (20017-2020), OIF has retrieved SQM data in three different places, all within the territory of North Sumatra Province. The three locations are: (1) medan city (OIF UMSU headquarters), (2) Romantic Beach (Deli Serdang Regency), and (3) Barus beach (Central Tapanuli Regency).

In this dawn research, OIF team generally uses two types of instruments, which are the main instruments and supporting instruments. The main instrument is the Sky Quality Meter (SQM), currently, OIF has 5 units with different type LE, LU, and LU-DL. While the supporting instruments are Laptop, Canon EOS 600D DSLR Camera, and All Sky Camera.

The SQM instruments are as follows:

- Sky brightness measuring device;
- Purpose: measure the brightness level somewhere.
- How it works: convert light into digital signals.

- **OIF UMSU's SQM Data**

From 2017 to 2020, OIF has collected several data:

Location	Eastern Horizons (0^o)	30^o	45^o	60^o	90^o	Western Horizons (0^o)
OIF (Medan) 3° 34' LU – 98° 43' BT	635	26	-	-	685	549
Romantic Beach 3° 35' LU – 99° 01' BT	43	45	39	2	40	-
Recently 02 00' LU - 98 24' BT	-	-	-	-	17	-
Total	678	71	39	2	742	549

- **Data Processing Method**

Processing the obtained SQM data, the OIF UMSU team used the *Moving Average method.* The Moving Average is as follows:

- Moving Average serves to smooth the *noise so that* changes in the brightness of the sky can be identified.
- Moving Average represents the average value over a set period.
- The advantage of Moving Average is that it can filter the movement of data and then describe it into a smoother and clearer trend.
- While the weakness of Moving Average is still not necessarily how many periods it takes to get an accurate change value.

- **About Light Pollution**

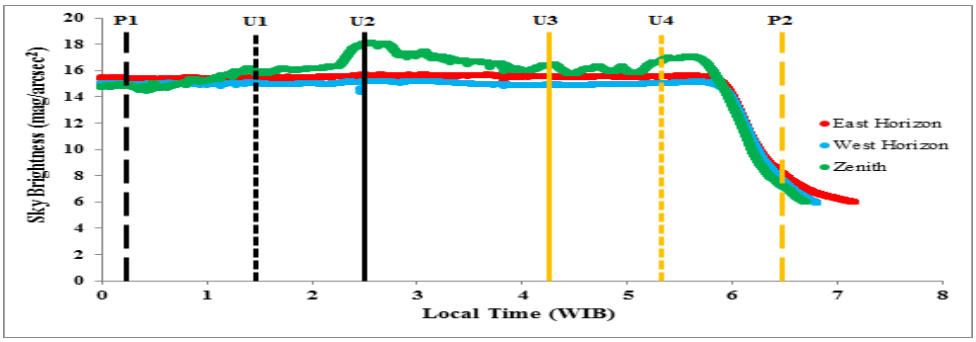

Figure (1): Total Lunar Eclipse July 28, 2018 at OIF UMSU

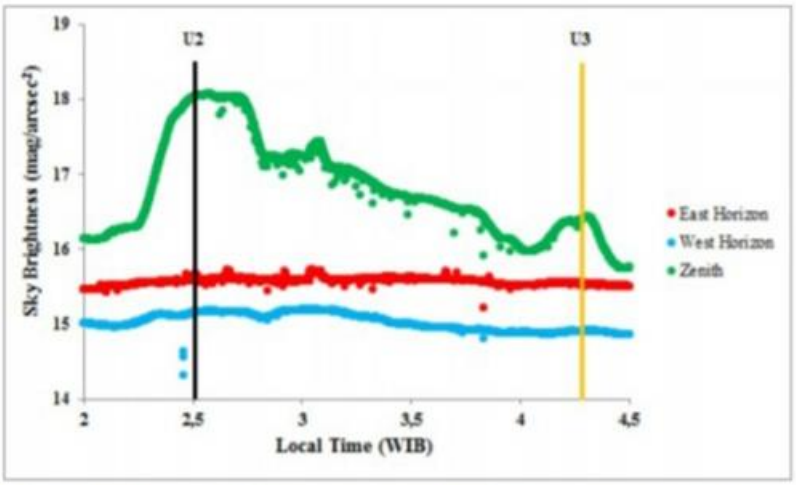

Figure 5. The sky brightness value from three SQMs during the total lunar eclipse phase.

Figure (2)

The image above is a map and pattern during the Total Lunar Eclipse, in which the direction of Zenit brightness value changes. The direction of the eastern horizon and the western horizon did not change at all. P1, U1, U2, U3, U4, and P4 are the phases during a total Lunar eclipse. This research has been published in the Journal of Physics: Conference Series (Q3) *with the title "The effect of total lunar eclipse of July 28, 2018 on the night sky brightness at the OIF UMSU"* (Butar-Butar et al, 2020).

Another OIF's research on light pollution article titled: " *Pengaruh Tingkat Polusi Cahaya dan Awal Waktu Subuh di OIF UMSU dengan Menggunakan Sky Quality Meter* " (Rakhmadi et al, 2020).

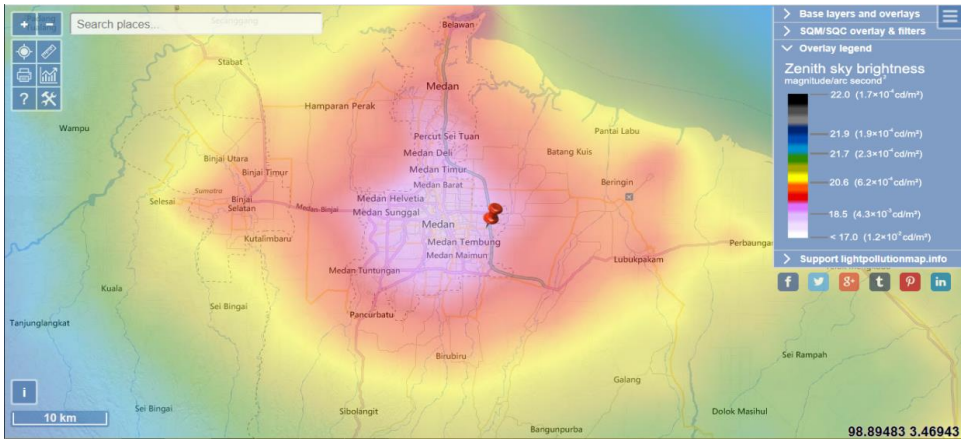

Image (3): Map of light pollution in Medan (OIF UMSU) Source: *lightpollutionmap.info*

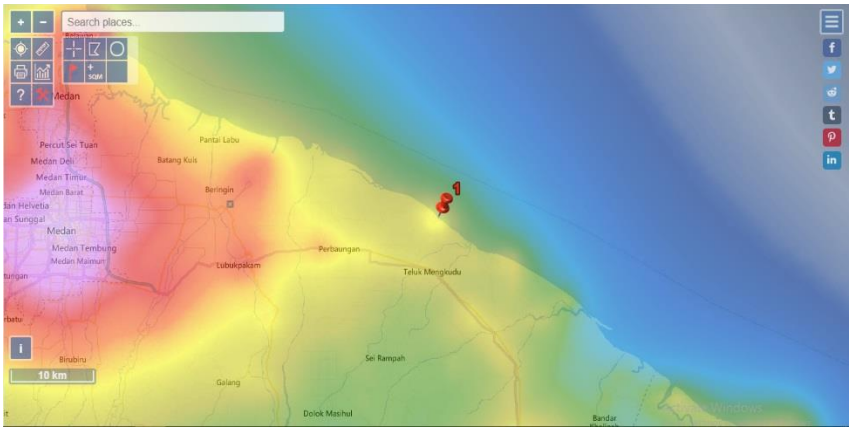

Image (4): Map of light pollution in Pantai Romantis (Kab. Deli Serdang)
Source: lightpollutionmap.info

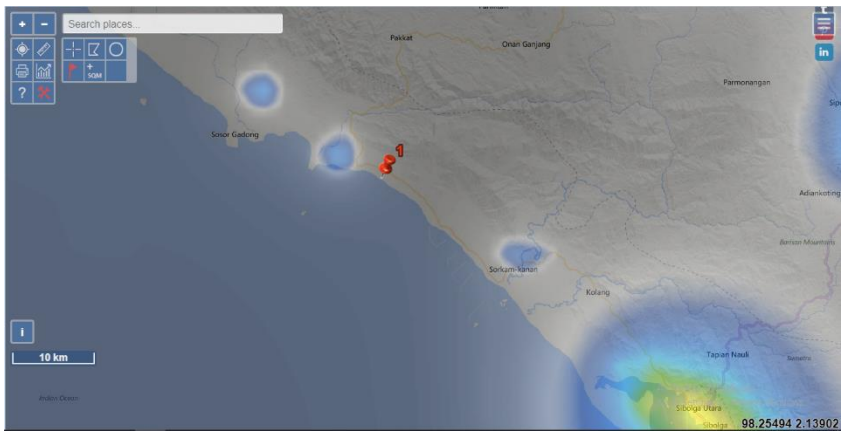

Figure (5): Map of light pollution in Barus (Central Tapanuli District)
Source: lightpollutionmap.info

The OIF sky map (figure 3) shows the highest pollution. The Romantic Beach sky map (figure 4) shows the effects of pollution better than OIF. Meanwhile, the Barus sky map (figure 5) shows better pollution from OIF and Romantic Beach locations. Therefore, light pollution affects the dip of Dawn. Based on *lightpollutionmap.info*, the brighter the color is shown, the higher the light pollution in the location.

Analysis and Provisional Conclusions

1. The sky in the OIF area has considerable light pollution because it is located near and or in the center of the city.
2. SQM in the direction of the eastern horizon and the western horizon in OIF is ineffective because it is directly affected by city lights and pollution.
3. SQM data on Zenit's direction at OIF and on the Romantic Beach, slightly confirmed that the -20 dip was indeed too fast.
4. Average Dip Dawn of 2017 with direction SQM 0° = 13.34 degrees.
5. Average dip Dawn of 2018 with direction SQM 0º = 9.75 degrees, and direction SQM 90º = 11.31 degrees.
6. Average dip Dawn of 2019 with direction SQM 0º = 9.51 degrees, direction SQM 45º = 11.60 degrees, and direction SQM 90º = 11.56 degrees.
7. Average Dip Dawn of 2020 with a direction of SQM 45º = 11.43 degrees, direction SQM 90º = 11.19 degrees.
8. Average Dip Subuh in OIF (Date 1-7 Hijri) :

- Average in 2017 (direction SQM 0º) :
  - ✓ June = 14.42 degrees
  - ✓ July = 13.43 degrees
  - ✓ August = 13 degrees
  - ✓ September = 11.42 degrees
  - ✓ October = 14.11 degrees
  - ✓ November = 11.75 degrees
  - ✓ December = 15 degrees

- Average in 2018 :
  - ✓ January (direction SQM 0º) = 11.29 degrees
  - ✓ February (direction SQM 90º) = 10.34 degrees
  - ✓ March (direction SQM 90º) = 10.99 degrees
  - ✓ April (sqm direction 90º) = 11.67 degrees
  - ✓ May (direction SQM 90º) = 10.72 degrees
  - ✓ June (sqm direction 90º) = 8.38 degrees
  - ✓ July (direction SQM 90º) = 13.58 degrees
  - ✓ August (direction SQM 90º) = 14.17 degrees
  - ✓ September (direction SQM 90º) = 11.99 degrees
  - ✓ October (sqm direction 90º) = 11.50 degrees
  - ✓ November (sqm direction 90º) = 12.00 degrees
  - ✓ December (sqm direction 90º) = 13.18 degrees

- Average in 2019 :
  - ✓ January (sqm direction 0º = 9.73 degrees and SQM direction 90º = 11.51 degrees)
  - ✓ February (sqm direction 0º = 11.09 degrees and SQM direction 90º = 13.38 degrees)
  - ✓ March (SQM direction 0º = 9.94 degrees and SQM direction 90º = 11.95 degrees)
  - ✓ April (SQM direction 0º = 10.79 degrees and SQM direction 90º = 12.13 degrees)
  - ✓ May (sqm direction 0º = 9.39 degrees and SQM direction 90º = 11.34 degrees)
  - ✓ June (SQM direction 0º = 9.22 degrees and SQM direction 90º = 11.29 degrees)
  - ✓ July (SQM direction 0º = 9.73 degrees and SQM direction 90º = 12.14 degrees)

- ✓ August (sqm direction 45º = 12.89 degrees and SQM direction 90º = 12.74 degrees)
- ✓ September (SQM direction 45º = 12.83 degrees and SQM direction 90º = 12.28 degrees)
- ✓ October (sqm direction 45º = 12.69 degrees and SQM direction 90º = 13.23 degrees)
- ✓ November (sqm direction 45º = 11.07 degrees and SQM direction 90º = 11.15 degrees)
- ✓ December (sqm direction 45º = 10.18 degrees and SQM direction 90º = 10.54 degrees)

- Average in 2020 :
  - ✓ January (sqm direction 45º = 11.52 degrees and SQM direction 90º = 10.90 degrees)
  - ✓ February (direction SQM 90º = 11.88 degrees)
  - ✓ March (direction SQM 45º = 11.92 degrees and SQM direction 90º = 12.64 degrees)
  - ✓ April (sqm direction 45º = 11.39 degrees and SQM direction 90º = 11.52 degrees)
  - ✓ May (direction SQM 45º = 10.08 degrees)
  - ✓ June (SQM direction 45º = 10.65 degrees and SQM direction 90º = 10.45 degrees)
  - ✓ July (sqm direction 90º = 11.39 degrees)

9. Average Dip Subuh on Romantic Beach (Deli Serdang)
   - ✓ DIRECTION SQM 0º = 14.85 degrees
   - ✓ DIRECTION SQM 30º = 15.30 degrees
   - ✓ SQM direction 45º = 16.54 degrees
   - ✓ DIRECTION SQM 60º = 14.18 degrees
   - ✓ SQM direction 90º = 15.35 degrees
10. The average dip of Dawn in Barus (Central Tapanuli) with a direction of SQM 90º is -16.48 degrees.
11. The data of Dip Subuh in Barus are as follows:

Coordinates: 2º 01' LU & 98º 24' BT

Ce	Hijri	SQM Direction				
		0	30	45	60	90
24/02/2020	30/06/1441	-	-	-	-	16.61
25/02/2020	01/07/1441	-	-	-	-	16.86
26/02/2020	02/07/1441	-	-	-	-	16.69
27/02/2020	03/07/1441	-	-	-	-	16.80
28/02/2020	04/07/1441	-	-	-	-	16.13
29/02/2020	05/07/1441	-	-	-	-	16.39
21/08/2020	02/01/1442	-	-	-	-	16.75
23/08/2020	03/01/1442	-	-	-	-	16.17
24/08/2020	04/01/1442	-	-	-	-	15.95
Average		-	-	-	-	16.48

Conclusion

In the research of Dawn time, light pollution is very influential on the dip at Dawn. This research conducted by OIF UMSU confirms that the -20 degree Dawn dip used in Indonesia and Southeast Asia is too fast. OIF's 'best' SQM data is with a value of 16.48 degrees, i.e. the average data from Barus Beach (Central Tapanuli Regency) with an SQM direction of 90 degrees. In this case, SQM data collection will continue by the OIF UMSU team, especially for Barus and other places. Therefore we would like to thank all those who have helped and are willing to cooperate in this research.

UMSU Falak Science Observatory has played a role in the community of North Sumatra and continues to be determined to develop and introduce Falak science in the community, especially for students and students. In the context University of Muhammadiyah North Sumatra, the establishment of the observatory is the spirit of "Advanced Islam", and in a universal context is part of the effort to link the ideal dimensions of revelation and human civilization. []

Source:

- Abdul Amīr Mu'min, *Qāmūs Dār 'Ilm al-Falakī* (Beirut: Dār al-'Ilm li al-Malāyīn, cet. I, 2006)
- Ahmad Fuad Basya, *al-'Athā' al-'Ilmy li al-Hadhārah al-Islāmiyyah wa Atsāruhu fī al-Hayāh al-Insāniyyah* (Cairo: Maktabah al-Imāmal-Bukhārī,cet. I, 1429/2008)
- Arwin Juli Rakhmadi Butar-Butar, *Treasure of Medieval Islamic Astronomy* (Purwokerto: UMP Press, cet. I, I, 2016)
- ----------, *Observatory for History and Its Functions in Islamic Civilization* (Medan: UMSU Press, cet. I, 2014)
- Abu Abdillah Muhammad bin Ahmad bin Yusuf al Khawarizmy, *Mafatîh al 'Ulûm* , Editor: G. Van Vloten, Introduction: Prof. Dr. Muhammad 'Abd al-'Aziz (Serial Az Dzakha'ir (118) al-Hay'ah al-'Ammah li Qushur al-Tsaqafah-Cairo, 2004)
- Ibn An-Nadim, *Al Fihrist*, Editor: Muhammad Ahmad Ahmad (Maktabah Tawfiqiyyah-Cairo, t.t.)
- Carlo Nillino, *'Science[l] Falak; Hesaid, "O* my people, worship God;
- OIF UMSU Team, Brief *Profile of Falak Science Observatory, Muhammadiyah University of North* Sumatra (Yogyakarta: Bildung, cet. I, 2020), h. 2-5. OIF UMSU Team, *OIF UMSU Encyclopedia (Profile, Work, Activities & Description of Astronomical Instruments)* [Medan, t.t.]
- A. J. R. Butar-Butar, A. Y. Raisal, and Y. Pramudya, 2020, Effect of the total lunar eclipse of 28 July 2018 on the night sky brightness at the Observatorium Ilmu Falak Universitas Muhammadiyah Sumatera Utara, Journal of Physics: Conference Series, 1523, pp 1-6. https://doi.org/10.1088/1742-6596/1523/1/012005
- Rakhmadi, A., Setiawan, H., & Raisal, A. (2020). Pengukuran Tingkat Polusi Cahaya dan Awal Waktu Subuh di OIF UMSU dengan Menggunakan Sky Quality Meter. Titian Ilmu: Jurnal Ilmiah Multi Sciences, 12(2), 58 -. https://doi.org/10.30599/jti.v12i2.667