P - 14

RE-EVALUATION OF HILAAL VISIBILITY CRITERIA IN INDONESIA BY USING INDONESIA AND INTERNATIONAL OBSERVATIONAL DATA

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Abstract

This study using data of hilaal observation compiled by the Ministry of Religious Affairs (MORA) Republic of Indonesia during 1962-2011 period, the observational data of Rukyatul Hilal Indonesia (RHI) during 2007-2009 period and Odeh's international observational data during 1859-2005 period. Those data were selected by applying selection procedure of Djamaluddin (2001) and by eliminating hilal data whose angular distance < 3° between hilaal and particular planet. Next, selected data were plotted to graphic of Sun-Moon altitude difference (ARCV - Arc of Vision) and Sun-Moon angular distance (ARCL - Arc of Light), moon age and Sun-Moon angular distance (ARCL - Arc of Light) and Sun-Moon altitude difference (ARCV - Arc of Vision) and Sun-Moon angular distance (DAz - Delta Azimuth) to propose the new hilaal visibility criteria in Indonesia. The new criteria proposed are ARCL greater than 5.4°, Moon is as old as 9.4 hours after conjuction and $\text{ARCV}\begin{cases} = & 3° \text{ if DAz } \geq 5° \\ \geq & -0.719(\text{DAz})+6.795 \text{ if DAz} < 5° \end{cases}$.

Key words: Hilaal, *Hisab*, *Rukyat*, Hilaal Visibility Criteria in Indonesia.

INTRODUCTION

Indonesia as the largest Muslim country in the world until now has not had unique visibility criteria for hilaal. Two largest islamic organizations in Indonesia, Nahdlatul Ulama (NU) and Muhammadiyah has their own criteria. Government c.q. The Ministry of Religious Affair (MORA) has tried to give solution related to this problem. These criteria resulted from the meeting of Ministers of Religious Affair of Brunei Darussalam, Indonesia, Malaysia and Singapore (MABIMS). According to MABIMS criteria, when the sunset, the altitude of the Moon is not less than 2°, angular distance of the Moon and the Sun is not less than 3° and Moon age is not less than 8 hours after conjunction.

Unfortunately, MABIMS criteria is lack of scientific consideration. Based on this background, the authors are motivated to perform this work to obtain new hilaal visibility criteria in Indonesia, which has a solid scientific foundation using observational data from Indonesia and international.

RESEARCH METHOD

The data used in this work is coming from hilaal sighting report data compiled by Ministry of Religious Affairs of the Republic of Indonesia (1962-2011), data of Rukyatul Hilal Indonesia (RHI) (2007-2009) and international data of Odeh within 1859-2005 period of observations (2005). Then all data selected by using procedure explained in Djamaluddin (2001). Later on the selected data is plotted in some graphs, namely altitude difference between the Moon and the Sun (ARCV - Arc of Vision) versus elongation (ARCL - Arc of Light), the Moon age versus elongation (ARCL - Arc of Light) and ARCV- versus azimuth different (DAZ - Delta Azimut).

RESULT AND DISCUSSION

Data selection for MORA database resulted in 75 selected data and only 20 data from Rukyatul Hilal Indonesia (RHI). For massive database of Odeh, we classify data into two groups, those are tropical data and subtropical data. There are 34 data for tropical latitude (16 data of naked eyes observation, 9 data in binocular-aided and 9 data by using telescope). After conducting the same procedure as for MORA and RHI database, the data is reduced to 32 data. For 466 data from subtropical latitude (239 data of naked eyes observation, 161 data in binocular-aided and 66 data by using telescope), the selected data is as many as 381 data.

When the value of altitude difference (ARCV) between the Moon and the Sun is relatively high, the observation of the hilaal will not be disturbed by twilight sky brightness. In order to see hilaal more easily, observer can make use of binocular or telescope during the observation session. By using binocular or telescope, twilight sky brightness can be reduce significantly to help observer to see the Moon. If the Moon has low altitude difference (ARCV) with the Sun, the Moon would be difficult to be seen. This is because hilaal brightness will be defeated by twilight sky brightness. In this work, the minimum value of ARCV, ARCL and age of the Moon since conjunction is taken based on the histogram in Figure 1, 2, and 3 after doing elimination process. This is because there are some data in the left side of distribution that can be treat as dubious data. If the data are still used, they will affect the minimum limit for ARCV that makes minimum value of ARCV very close to 0°.

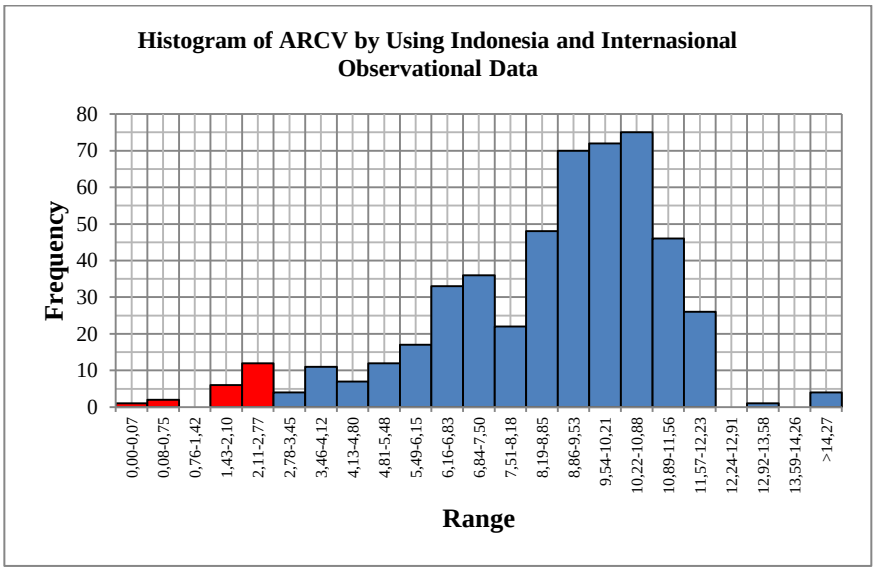

Figure 1. Histogram of ARCV for tropical zone (using observational data of MORA (1962-2011), RHI (2007-2009) and international tropical and subtropical data of Odeh.

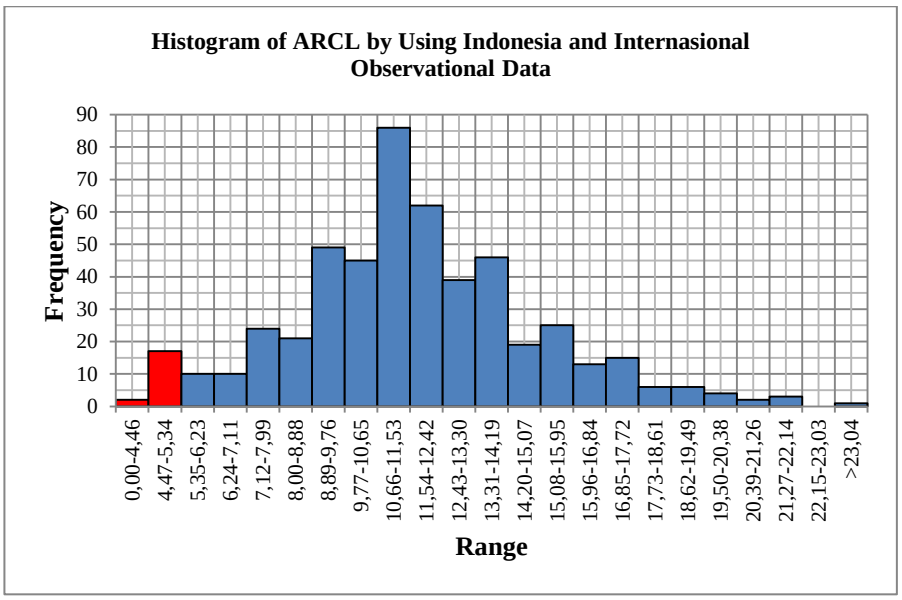

Figure 2. Histogram of ARCL for tropical zone (using observational data of MORA (1962-2011), RHI (2007-2009) and international tropical and subtropical data of Odeh.

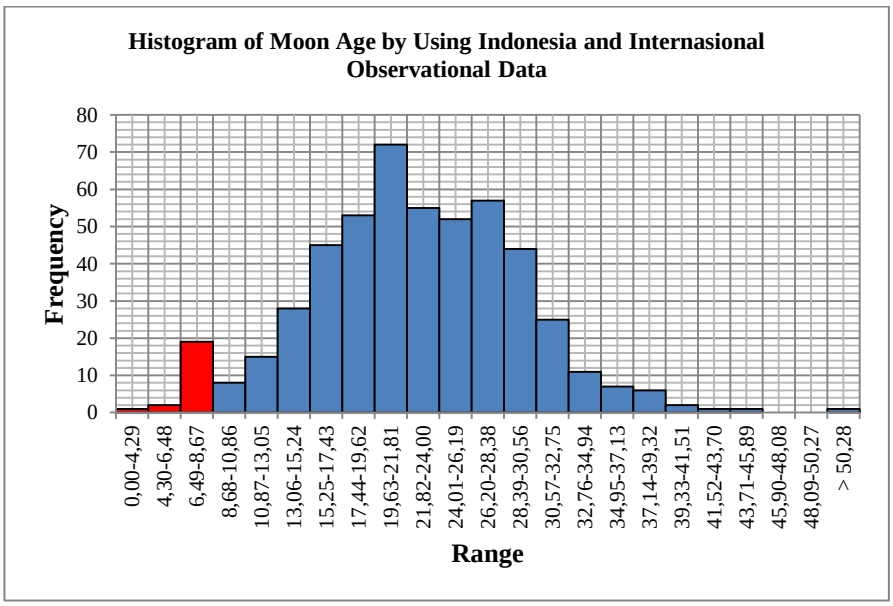

Figure 3. Histogram of Moon age for tropical zone (using observational data of MORA (1962-2011), RHI (2007-2009) and international tropical and subtropical data of Odeh.

It can be seen from histogram in Figure 1, 2 and 3, there are dubious data in the left side (colored red). Based only on data with high confident level (colored blue), the range of minimum ARCV value is 2.78° to 3.45°, with the actual minimum ARCV value within the range is 2.96° or around 3°. The minimum ARCV value of 3.0° is the same as proposed by Utama (2013) by using observational data Rukyatul Hilal Indonesia (2007-2009) and applying Kastner model of twilight sky brightness in the selection process. Meanwhile minimum ARCL value is

in the range of 5.35° to 6.23°, with the actual minimum ARCL value is 5.4°. The minimum Moon age since conjunction is found to be between 8.68 to 10.86 hours, with the actual minimum age of the Moon is 9.4 hours.

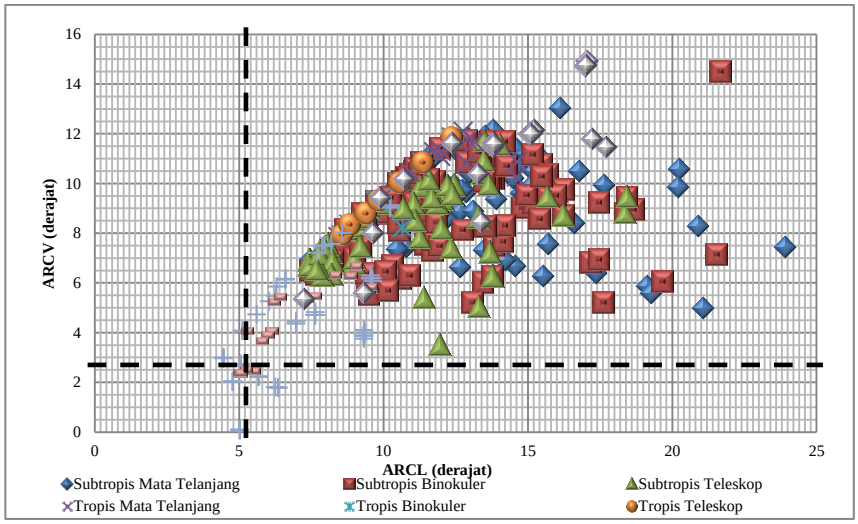

Figure 4. Plot of all data in Moon Age versus ARCL after selection process by using the primary and additional criteria of Djamaluddin (2001). Data for which hilaal has angular distance < 3° from particular planets are eliminated. The dashed line indicates the minimum value of ARCV and ARCL is 3.0° and 5.4° respectively.

The dashed lines in Figure 4 are constructed in this work as limit for ARCV and ARCL. Data under this limit should be eliminated because data have dubious value.

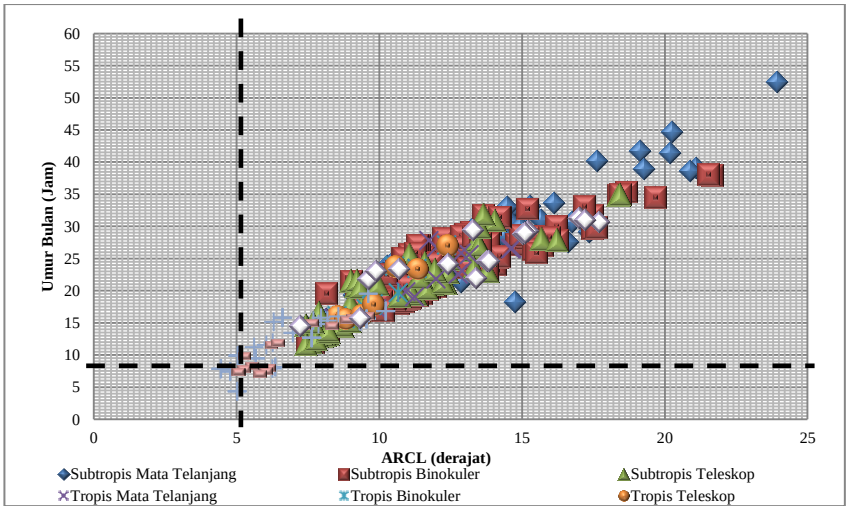

Figure 5. Plot of all data in Moon Age versus ARCL after selection process by using the primary and additional criteria of Djamaluddin (2001). Data for which hilaal has angular distance < 3° from particular planets are eliminated. The dashed line indicates the minimum value of ARCL and Moon age is 5.4° and 9.4 hours respectively.

The dashed lines in Figure 5 are constructed in this work as limit for ARCV and Moon age. Data under this limit should be eliminated.

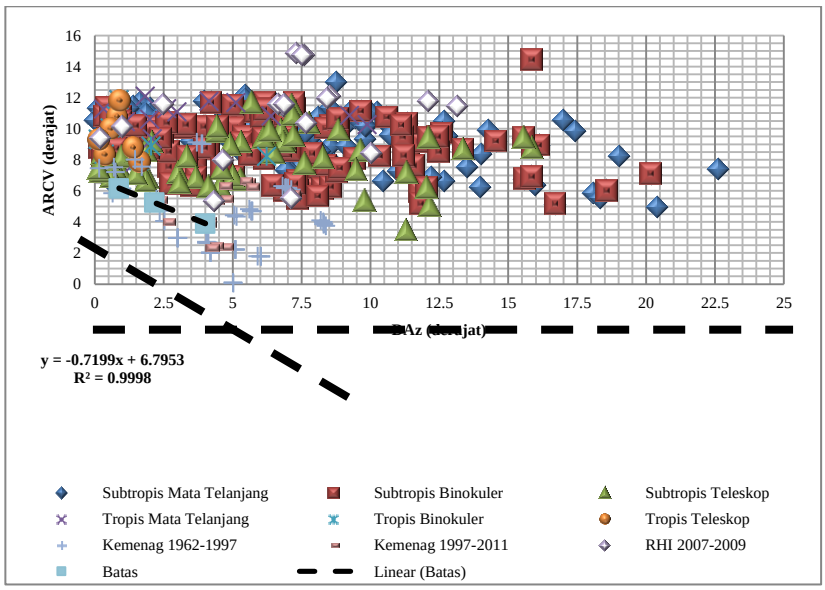

Figure 6. Plot of all data in ARCV versus DAZ after selection process by using the primary and additional criteria of Djamaluddin (2001). Data for which hilaal has angular distance < 3° from particular planets are eliminated. The dashed line indicates the minimum value of ARCV and ARCL is 3° and 5.4° respectively.

The dashed lines in Figure 6 are constructed in this work as limit for ARCV and ARCL value. Data under this limit should be eliminated. Minimum value of ARCV depends on DAZ. If DAZ ≥ 5°, then ARCV still remain 3°, otherwise follow inequality of ≥ -0.719 (DAZ) + 6.795. If the Moon have ARCV, ARCL and age since conjunction relatively small value, hilaal brightness will be defeated by twilight sky brightness. Comparison of ARCV, ARCL and moon age based according to various criteria.

Table 1. Comparison of ARCV, ARCL and moon age

Criteria	ARCV (°)	ARCL (°)	Moon Age (hour)
UPI*	3	5.4	9.4
MABIMS	2.8	3	8
LAPAN (Djamaluddin, 2001)	9.1	5.6	8
LAPAN yang disempurnakan (Djamaluddin, 2010)	4	6.4	8
Utama & Siregar (2013)	10.69	8	15
Utama (2013)	3		
Utama & Hilmansyah (2013):			
a. Naked Eyes:	11.45	12.57	24.07
b. Binocular & Telescope:	9.99	10.20	20.84
Ramadhan (2013)	13	4.86	7.05
Fathoohi *et al.* (1998)		7.5	-
Ilyas (1988)	4	10	-
Odeh (2005):			
a. Naked Eyes:	≥8.5	6.4	15
b. Binocular & Telescope:	≥5.6	7.7	13

* UPI: result of this study by taking into account the Sun's depression angle of 0.8°

Based on this discussion, the proposed criteria based on Indonesia and International observational data are ARCL greater than 5.4°, Moon is as old as 9.4 hours after conjuction and $\text{ARCV}\begin{cases} = & 3° \text{ if DAz } \geq 5° \\ \geq & \text{-0.719(DAz)+6.795 if DAz} < 5° \end{cases}$.

CONCLUSION AND SUGGESTION

The proposed of hilaal visibility criteria in Indonesia are as follows:

1 $\text{ARCV}\begin{cases} = & 3° \text{ if DAz } \geq 5° \\ \geq & \text{-0.719(DAz)+6.795 if DAz} < 5° \end{cases}$

2 ARCL greater than 5.4°

3 Moon is as old as 9.4 hours after conjuction

The proposed criteria in this study is dynamic, meaning that they subject to change as there are many supporting valid observational data.

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