Re-evaluation of Hilaal Visibility in Indonesia

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Abstract

So far, there is no single criterion of hilaal (the first Crescent) visibility adopted in Indonesia. In making calendar, it is used "wujudul hilaal" criteria, i. e. moonset later than sunset, even for one minute. The present hilaal visibility criteria is based on simple observational analysis, i. e. Moon altitude more than 2^o, Sun-Moon distance more than 3^o, and Moon age more than 8 hours. By documentation of hilaal sighting during 1962-1997 in Indonesia, systematical analysis was done. All reports have passed religious procedure, i. e. taking the oath in front of local religious court official. After removing reports of low altitude sighting from less then three independent location and that with probable Venus or Mercury confusion, it is obtained the revised criteria of hilaal visibility in Indonesia: (1). Moon age should be > 8 hours. (2). Sun-Moon angular distance should be > $5,6^o$. (3). Sun-Moon altitude difference should be > 3^o (crescent's altitude > 2^o) for Sun-Moon azimuth separation of ~ 6^o, while for Sun-Moon azimuth separation < 6^o, it is needed more altitude difference. For Sun-Moon azimuth separation of about 0^o, the altitude difference should be > 9^o.

1. INTRODUCTION

In general there are two opinions adopted by Islamic organizations in Indonesia in determining the first of Ramadhan or eid, i. e. *ru'yatul hilaal* (crescent observation) with or without astronomical calculation support (adopted by Nahdatul Ulama, NU) and *hisab* (astronomical calculation) without waiting hilaal sighting (adopted by Muhammadiyah and Persatuan Islam – Islamic Unity, Persis –). The government represented by Ministry for Religious Affairs only accommodates all opinions. Usually there is a single decision, but once, for Eidul Fitr 1418/1998, the government could not compromise the different opinions. The decision was "Eidul Fitr on 30 January 1998, but people who want to celebrate Eid on 29 January 1998, it is OK".

Before making decisions in meeting on 28 January 1998 there were four main opinions: (1) Central executive committee of NU rejected crescent observation reports due to very low altitude Moon, (2) East Java regional executive committee of NU accepted the observation reports, (3) Muhammadiyah decided to celebrate eid on 29 January based *hisab* with *wujudul hilaal* criterion (i. e. moonset later than sunset), (4) Persis decided to celebrate eid on 30 January based on *hisab* with Indonesian *imkanur ru'yat criteria* (hilaal visibility criteria, see below). The main problem of the case is that there is no single hilaal (first crescent) visibility criterion. Actually, the visibility criterion is the interface between observation and astronomical calculation.

So far the criteria suggested by government, adopted from Islamic organization meetings (in Indonesia and MABIMS – including Brunei, Indonesia, Malaysia, and Singapore) are: (a). Moon altitude more than 2^o, (b) Sun-Moon angular distance more than 3^o, and (c) Moon age more than 8 hours (Dirbinapera, 2000). But the criteria have not accepted yet by Muhammadiyah due to reasoning of no scientific basis, while they adopted *wujudul hilaal*, which is also no scientific basis. The criteria are less than the known international criteria (e. g. Danjon limit which theoretically supported by Schaefer, 1991; Ilyas, 1988; Ilyas and Khalid-Taib, 1989).

This paper reports an effort to re-evaluate Indonesian Hilaal visibility criteria based on documentation of the reported observation in Indonesia. The observations are not repeatable, so that it needs selection criteria to take into account only the reliable reports. It is important to note that all reports have passed religious procedure, i. e. taking the oath in front of local religious court official. It means the observers are very sure what they observed. The main problem is that there might be foreground or background object similar to part of crescent.

2. DATA REDUCTION

Hilaal observations are collected from reports to Ministry for Religious Affairs during period of 1962 – 1997 (Depag RI, 2000). There are 38 observational reports (for Sha'ban, Ramadhan, and Shawal). The data was analyzed based on observational date, number of independent reporting groups, and time of observation. Then the informations were compared with astronomical data of Sun, Moon, Venus, and Mercury by using Astro Info (Zephyr Services, 1989). The astronomical data are sunset time at the observational location (t_s), time of new moon (t_n), and altitude and azimuth of Sun and Moon at sunset time. Then it could be derived Moon age (t_s-t_n), Sun-Moon altitude difference (Δh), Sun-Moon azimuth separation (ΔA), and Sun-Moon angular distance ($=[\Delta h^2 + \Delta A^2]^{0.5}$).

Generally, observations with low Sun-Moon altitude difference (less than 3^o) were reported by 1 or 2 group(s). This indicates that reports with low Sun-Moon altitude difference was cause by misjudgement of bright object considered as hilaal. The object might be foreground one (such as lamp, airplane, or bright tiny cloud) or background one (such as planet Venus or Mercury). To minimize such confusion, the data was selected as follows:

a. *Main criteria:* If Sun-Moon altitude difference less than 4^o (minimum altitude difference of Ilyas, 1988), the observations must be done by three ore more independent groups. Besides, at least one report should be a complete one, which can be compared with astronomical calculation. If the reported time of observation after the calculated time of moonset, the data was rejected. By using this strict criteria, the data reduced from 38 to be 15. This main criterion was intended to eliminate confusion from foreground objects.
b. *Additional criteria:* Background object such as bright Venus or Mercury might confuse the observers. So that the reported observation with Venus or Mercury very close to the Moon were also rejected. There were four such cases, making the final data to be analyzed further 11 reports (5 for the beginning of Ramadhan and 6 for Eidul Fitr).

3. RESULTS

By comparing distribution of low altitude difference in the reports of Sha'ban, Ramadhan, and Shawal which are very similar (found in all three months), it indicates that there were no observational bias in determining Ramadhan and Shawal. The summary of the accepted 11 reports can be seen in Table 3.1. and the plotting of (a) Sun-Moon azimuth separation vs. Sun-Moon altitude difference and (b) Moon age vs. Sun-Moon angular distance can be seen in Figure 3.1. a and b.

Tabel 3.1 The accepted reports of Hilaal Sighting and the astrononomical calculations

Month, year	Sunset		Moonset		Observer Groups (time, group member)
	dAz	dAlt	dist	Age	
1 Ramadhan 1389	17.48		18.11		10 Nov 1969: Jakarta A (17:54, 3), Jakarta B (17:53, 11), Bekasi (17:52, 4), Jakarta C (18:02, 2), Pelabuhan Ratu (18:02, 3)
	5.72	6.07	8.34	12.63	
1 Ramadhan 1394	17.50		17.58		16 Sep 1974: Jakarta A (18:04*, 4), Jakarta B (17:55, 3), Yogyakarta (17:37, 3) [* not accurate] (Sunset in Yogyakarta ~ 14 minutes earlier)
	6.03	3.02	6.75	8.08	
1 Ramadhan 1395	17.52		18.19		6 Sep 1975: Jakarta A (18:04, 3), Bekasi (17:55, 3), Jakarta B (18:01, 3), Pelabuhan Ratu (17:59, 3)
	6.93	7.62	10.30	15.55	
1 Ramadhan 1397	17.54		18.14		15 Aug 1977: Jakarta (17:57, 4), Pelabuhan Ratu (17:58, 3)
	5.15	5.65	7.64	13.40	
1 Ramadhan 1398	17.54		18.07		4 Aug 1978: Jakarta A (18:04, 3), Jakarta B (3), Tegal (2), Pelabuhan Ratu (3)
	4.12	3.85	5.64	9.88	
1 Shawal 1392	17.47		17.58		6 Nov 1972: Jakarta A (17:55, 4), Bekasi (18:00, 4), Jakarta B (17:55, 3)
	5.12	3.38	6.13	9.42	
1 Shawal 1400	17.54		18.22		11 Aug 1980: Jakarta A (18:02, 3), Ampenan Lombok (18:20 WITA, 2), Pelabuhan Ratu (17:59, 2), Jakarta (18:00, 2) [WITA: Central Indonesia Standard Time]
	0.98	7.45	7.51	15.72	
1 Shawal 1402	17.53		18.31		21 Jul 1982: Pelabuhan Ratu (17:55, 3), Ampenan (18:26 WITA, 3), Ternate (18:42 WIT, 2) [WIT: East Indonesia Standard Time]
	1.47	9.45	9.56	15.92	
1 Shawal 1407	17.43		18.14		28 May 1987: Pelabuhan Ratu (17:46, 3), Jakarta (17:48, 2), Manado (≥1)
	7.13	7.37	10.25	19.47	
1 Shawal 1408	17.44		18.01		16 May 1988: Jakarta A (17:48, 3), Jakarta B (17:55, 2)
	6.75	4.53	8.13	12.52	
1 Shawal 1411	17.52		18.10		15 Apr 1991: Jakarta A (17:56, 3), Jakarta B (18:00, 3), Pelabuhan Ratu (17:58, 2), Jakarta C (18:10, 2)
	8.32	5.20	9.81	15.20	

Notes: Time is based on West Indonesia Standard Time (UT + 7). Astronomical calculation for the first group location. dAz: Sun-Moon azimuth separation. dAlt: Sun-Moon altitude difference. dist: Sun-Moon angular distance. Age: Moon age at sunset.

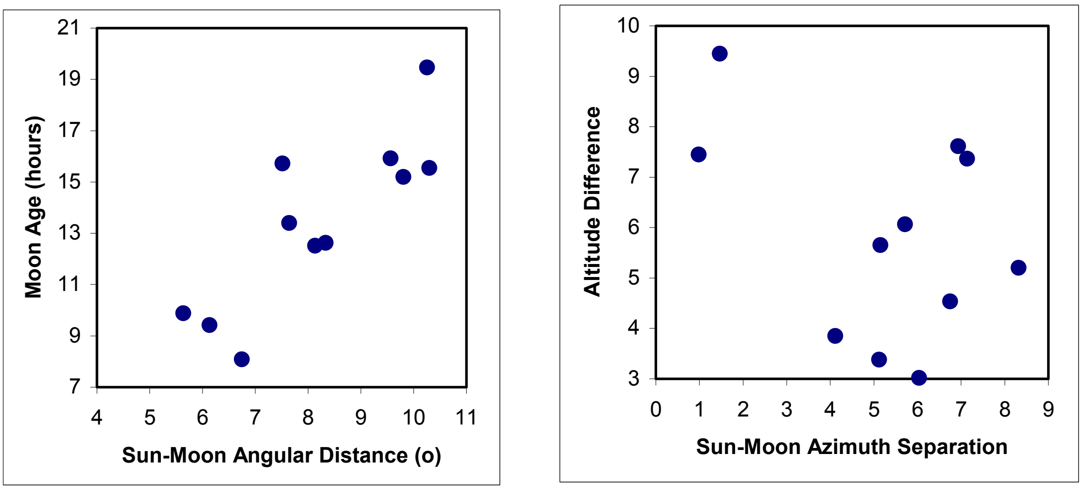

Figure 3.1. Astronomical data of the accepted reports of hilaal sighting in Indonesia

Figure 3.1. summarize the revised hilaal visibility criteria in Indonesia as follows:

a. Moon age must be > 8 hours.
b. Sun-Moon angular distance must be > 5.6^o.
c. Sun-Moon altitude difference (h) depends on azimuth separation (a). For azimuth separation ~ 6^o Sun-Moon altitude difference must be >3^o. For azimuth separation < 6^o it can be used a formula $h > 0.14\ a^2 - 1.83\ a + 9.11$.

4. DISCUSSION

Three of fours rejected reports due to Venus/Mercury probable confusions have low Sun-Moon altitude difference. This indicates that point like objects with atmospheric scattering effect have confused the observers. There are some reports that passed the selection criteria, but considered to be too low compared to the international criteria such as Ilyas (1988). But, there is no scientific reason to reject the remaining reports, since all probable confusions have been removed in addition to the honesty of the observers who took the oath by the name of Allah.

The criteria are less than that of Ilyas (1988) and other international criteria (e.g. Caldwell & Laney, 2001). The minimum Sun-Moon altitude difference come from observation on 16 September 1974 in determining the beginning of Ramadhan 1394 (see Table 3.1). It was observed in Yogyakarta (7.8^{o}S, 110.37^{o}E) at 17:37 WIB (West Indonesia Standard Time, UT+7) by a group of 3 people and in Jakarta (6.18^{o}S, 106.83^{o}E) at 17:55 WIB by two groups of 4 and 3 people, respectively. Sun-Moon altitude difference was 3^o, azimuth separation 6^o, and Moon age 8.1 hours. The Sun-Moon angular distance of 6.75 ^{o} is close to Danjon limit (see Shaefer, 1991). According Shaefer (1991), the main reason of Danjon limit is human eye sensitivity. So that, in principle it is possible to observe hilaal with angular distance from the Sun less than 7^o if the observer's eyes have a good sensitivity.

The same reasons may be adopted for minimum Sun-Moon angular distance of 5.6 ^{o} from observation on 4 August 1978 (in determining 1 Ramadhan 1398). The hilaal reported by 4 independents groups: 2 in Jakarta (3 people per group), 1 in Tegal (2 people), and 1 in Pelabuhan Ratu (7 ^{o} S, 106.63 ^{o} E, 3 people). Did they all make erroneous observations, although they have taken the oath by the name of Allah? It might be, but there is not enough reason to reject it. All known criteria are based on empirical observation of identified crescent like hilaal. While according to Shaefer

(1991) model, it is possible a very young hilaal seen as a point like appearance, without any cusp.

Although the revised criteria are less than the international criteria, it can be considered as temporary local criteria to improve "wujudul hilaal" criteria used in Indonesia. It is difficult to ask local Islamic organizations the to adopt international criteria drastically, changing from "wujudul hilaal" criterion (Moon altitude $\cong 0$) or even without criteria. The Government cannot force them to accept any criteria, but only collect their agreement.

5. CONCLUDING REMARKS

Analyzing 38 reports of hilaal sighting in Indonesia during 1962-1997, it can be summarized as follows:

a. Most of low Sun-Moon latitude difference were reported only by 1 or 2 group(s). It seems that they saw foreground local bright objects, not actual hilaal. While some reports from three or more groups with low Sun-Moon altitude difference seem to be confused by Venus or Mercury close to the Moon position.
b. After removing all probable confusion factors, it is recommended new criteria, which improves the previous one. The improvements include increasing minimum Sun-Moon angular distance from 3^o to 5.6^o and minimum Sun-Moon altitude difference from about 3^o (Moon altitude 2^o) to be dependent to azimuth separation, similar to the international criteria.

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