Importance of lightning detection network development in Peninsular Malaysia

M.A Islam1, A. Chan1, S. K. K. Khaw1, S. A. Salleh 23, N. H. Zakaria2, N.A. Isa3, M.O.C. Gee4 and M. Azari1

1Department of Civil Engineering, Faculty of Engineering, University of Nottingham, Malaysia Campus, Semenyih 43500, Selangor, Malaysia.
2Centre of Studies of Surveying Science and Geomatics, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam 40450, Selangor, Malaysia.
3Applied Remote Sensing and Geospatial Research Group, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia.
4Department of Atmospheric Sciences, National Central University, Chung Li 32001, Taiwan.

Email: islamccs@gmail.com (M. A. Islam)

Abstract. Lightning is a major climatic phenomenon in Southeast Asia over Indian Ocean and Malaysia is the most affected area in the region. Damages in the different industries, real estate, defense and human fatalities are caused by lightning strikes and it is very common in Malaysia. Existing non-effective lightning detection network in Malaysia now has become an urge to modify the system and improve it according to the need of the Malaysian Meteorological Department. Research facilities in the Malaysian universities and related research organizations need to give substantial effort in developing lightning science and technology to solve this problem. In this article, current status of lightning detection network in Malaysia and its weaknesses have been discussed briefly. Also, suggestion have been proposed to improve it.

1. Background
Maritime Continent in Southeast-Asia is one of the most important areas of attention for the atmospheric scientists [1]. What plays important role in this area is the Inter-tropical Convergence Zone (ITCZ) as it affects the global circulation system of the atmosphere [2]. ITCZ is also familiar as Equatorial Convergence Zone or Inter-tropical Front. This low-pressure belt encircles the earth near the equator where the trade winds meet and converge [3]. According to Köppen’s classification of the climate, Malaysia and Indonesia are in the tropical rain-forest climate [4]. Thunderstorm, and lightning to be specific, is a major natural hazard in this area not only to the humans but also to many industries, real estates, power producers, wildlife managing governmental organizations, defense sector etc. [5]. According to Gomes et al. (2011) every year globally over 20,000 human lives are affected and thousands of them get direct injured by lightning which left them with life time injuries, temporary or permanent disabilities or trauma, and even death [6].

Malaysian Meteorological Department characterizes Malaysia as a high lightning activity zone and claimed that it has over 200 days in a year lightning of different intensities occur in this area [7]. The biggest electric utility company in Peninsular Malaysia - Tenaga Nasional Berhad (TNB) claimed that, 70% power supply failure and transient tripping in their transmission and distribution network occur
due to lightning problem and the effects account for damages of the electrical equipments, downtime, data loss and the controlling automated system they use. These losses costs millions of dollars and human fatalities [8]. The defense sector of Malaysia also suffers due to lightning related accidents (e.g. radar and other equipments malfunctioning) which is a big threat to the national security [9].

![Figure 1: Average numbers of lightning strikes in Peninsular Malaysia [10]](image)

### 1.2 Lightning in Malaysian Climate

There are intracloud – IC, cloud to cloud – CC and cloud to ground – CG lightning types and occurrence follows the local weather pattern [11]. Malaysian wind pattern is characterized by 2 monsoon wind patterns – Southeast Monsoon (April-September) which makes the area drier and Northeast Monsoon (October-March) that brings rainfall to this area [12]. Most lightning in Malaysia is observed during the inter-monsoon period. In Malaysia lightning type CG makes up around 23% of total lightning and during the daytime lightning strikes are the most. During the night and day times lightning changes its frequency. It is more frequent over the land during the daytime and less over sea and opposite during the night time [9].

### 1.3 Lightning caused fatalities in Malaysia

In terms of lightning density, Malaysia is ranked among top 3 in the world which is more than any other country in the Asian region [13]. The citizen of this area also lacks proper education about lightning protection which increases the fatality rate. It is estimated that 1 in 10 people is a possible victim of lightning strike [13]. Table 1 below is an indicator of fatalities and injuries due to lightning strikes recorded in Malaysia during 2008-2015 [13].

### Table 1: Fatalities and injuries during 2008-2015 due to lightning in Malaysia [13]

| Year | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| 2008 | 3   | 0   | 0   | 3   | 3   | 2   | 0   | 0   | 0   | 0   | 9   | 0   | 20    |
| 2009 | 0   | 0   | 0   | 0   | 13  | 6   | 0   | 0   | 0   | 8   | 0   | 5   | 32    |
| 2010 | 0   | 0   | 2   | 0   | 0   | 0   | 0   | 9   | 2   | 0   | 0   | 0   | 13    |
| 2011 | 1   | 2   | 1   | 0   | 3   | 3   | 12  | 2   | 1   | 4   | 1   | 4   | 30    |
2. Lightning distribution and density in Peninsular Malaysia

According to Ibrahim and Ghazali (2012) [14] in Peninsular Malaysia the range of lightning intensity is mostly in between 5kA to 25kA, and sometimes with exception even up to 32kA is recorded. More lightning strikes are observed during the Southeast Monsoon period rather than Northeast Monsoon. Despite less lightning during Northeast Monsoon, the intensity is stronger than during the Southeast Monsoon and lies between 15kA-25kA. The Klang Valley area is found to have most lightning. Because of the influence of sea breeze, land area along the mountain used to have more lightning. Strait of Malacca during the Southeast Monsoon receives more lightning than average. During Northeast Monsoon lightning becomes weaker in the east coast and during Southeast Monsoon east coast sees more lightning.

3. Effective factors for improved lightning detection

Before working on the lightning protection system (LPS), lightning detection system (LDS) and therefore lightning prediction, it is very important to understand the background lightning physics, its related engineering and technical matters [15]. Lightning protection system works by providing the electric charge produced by the clouds a path of least resistance to the ground. It is a passive means of preventing damages of property and lives from the effects of lightning strikes. Lightning detecting system is a group of equipments that detects lightning produced by thunderstorms and they are ground based, mobile systems (usually by aircraft) based and space based (satellites). Lightning prediction is determined by the equipments which work on the detection system and according to the measured and validated data, observing the weather pattern they can predict the possible outcome of lightning [16].

Lightning itself is a very complex atmospheric phenomenon and its proper detection depends on some basic important factors. Factors which should be systematically maintained to establish effective lightning detection network are:

- configuration of the network
- strength of the waveform
- unique character of lightning
- distance of the lightning from the network
- sensor status
- local sensor interference
- geography of the network [17]

4. Current lightning detection network in Malaysia, its weaknesses and necessary work for improvement

Jabatan Meteorologi Malaysia (Malaysian Meteorological Department - MMD) operates 2 subsystems:

- wide area lightning localization sub-system (SAFIR) and
- precision lightning warning sub-system (PLWS).

SAFIR station consists of 8 interferometry sensors, 2 central processors and 2 main user terminals. They provide per second lightning data and status of the detection station per second. This system is also capable of auto data testing every 5 minutes. The other subsystem (PLWS) involves 7 remote alarm displays, 3 electrostatic field mills and 2 consoles for precision lightning warning. But MMD claims that these detection systems are weak and are unable to provide correct and enough data to understand, detect and
predict lightning effectively. MMD also claims that, the number of available sensors is not enough to cover
the area of Peninsular Malaysia, the installation sites are not suitable for smooth functioning as they are
located in noisy areas and get frequent obstructions and the spacing of the sensors are also uneven and fails
to provide information with maximum efficiency [18]. Lightning detection sensors need to be upscaled and
sensor replacement with modern equipments has become crucial at this stage. For the relocation of the new
sensors better sites need to be chosen using proper scientific methods and calculations.

5. Conclusion
Malaysia is a very important area in the Asian region for its special geographical location and its climate.
It requires to develop a generation of scientific researchers to work on developing an advanced lightning
detection, protection and prediction system for Malaysia. With available funding it is of course possible to
collaborate with organizations who are specialized in this field and can help with lightning science and
technology, but it still requires own skilled people to learn from the skilled collective, maintain it up-to the
mark and working on further improvement.

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