

## Case Study: Integrate Stability Index and Applied GIS for Thunderstorm Risk Assessment in the Northeast of Thailand

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### Abstract

Natural disasters as tropical cyclone, earth quake, flash flood, flooding, droughts landslide and thunderstorms are dangerous for life, property and economics of Thailand in every year. This experiment is to study the thunderstorms occurred in the Northeast of Thailand during 10-15 April 2008. This research performed experiment with the stability atmosphere of K index from numerical weather prediction products. The experiments were conducted by Weather Research Forecast (WRF) model version 3.0.1 to investigate the thunderstorms. The model runs with grid resolution 15-km and 28 levels in the vertical. The technique used K index consider property thunderstorm and in put data in the data based of geography information system (GIS) to analyze. Results showed display four classify levels of risk area of thunderstorms in a map: weak risk, moderate risk, strong risk and very strong risk. In finally, result showed a map of province and communities in the risk thunderstorm area. It should be management and prevention of thunderstorms.

**Key Words:** Thunderstorm, GIS, WRF, northern Thailand

### 1. Introduction

Thailand situated on the south-western part of the Indo-Chinese Peninsula. The weather and climate in Thailand are strongly influenced by the season. The climate of Thailand can be divided from the meteorological point of view into the following season: Cold season setup from mid October to mid February of the year, Summer season being from mid February to mid May. It is the transition period from the northeast to southwest monsoon. The warmest month is April and its average monthly temperature is above 30°C. Rainy season or southwest monsoon from mid May to mid October. The northeast of Thailand mostly thunderstorms occurred. For example, there were widespread thunderstorms at amphoe Kusuman, Sakon Nakhon province, amphoe Yangtalad, Karasin province and amphoe Ponpisai, Nong Khai province during 10-15 April 2008: 253 homes destroyed, 1 person dead and economics lost about five million baths.

Stability is defined as the equilibrium condition of the atmosphere. The atmosphere is considered stable if a parcel resists displacement in a vertical direction or if, after it has been displaced, it returns to its original level. A parcel is considered unstable when it continues to move farther away after being displaced. They are overall stability or instability of a sounding is sometime

expressed from a single value called a stability index. These stability indexes have been introduced mainly as aids used with particular forecasting techniques. K index is one of stability index to consider thunderstorms probability was selected in this research.

### 2. Methodology

The experiments were conducted by using the Weather Research and Forecasting (WRF) modeling system version 3.0.1 used to conduct 24 hours of simulation. The technical model run one way interactive with grid resolution 2 km. and 35 levels in vertical. The initial data input model used 1 degree grid from National Centers for Environmental Prediction (NCEP) global final analysis data. The experiments used physics scheme is Lin et al., The cumulus scheme is Grell-Devenyi ensemble, The planetary boundary layer is Mellor-Yanada-janjic (ETA) TKE scheme. K index from WRF products convert to ASCII file input to data based of GIS. Another data are the spatial data come from observation stations into data based also. The technical analysis in GIS used union method.

### 3. Results and Commendation

#### 3.1 Time and Thunderstorms

Figures 1 to 6 showed frequency thunderstorms

occurred in time measured. During 10-15 April 2551, Mostly thunderstorms occurred in 09Z (16 thund.), 12Z (21 times), 15Z (19 times) and 18Z (17 times) in 13 April 2008 (Figure 1). Each of observation station report thunderstorms every 3 hours during 10-15 April 2008 averaged about 2-3 times per day. The higher thunderstorm event in 13 April 2008 about 11 times at Nang Rong, Buri Rum, and 9 times at Chok Chai in Nakhon Ratsasima province. (Figure 2)

### 3.2 K index, Observation Stations and Frequency of Thunderstorms

The K index has proved useful in indicating the probability of air mass thunderstorms. As the K-Index increases, so does the probability of having an air mass thunderstorm.

The K index takes into account moist air at 700 mb contributing to air mass thunderstorm development.

The K index is defined as follows:

$$(1.1) \quad K = T_{850} - T_{500} + T_{d850} - (T_{700} - T_{d700})$$

Where

$T_{850}$  = Temperature at 850 hPa,

$T_{500}$  = Temperature at 500 hPa,

$T_{700}$  = Temperature at 700 hPa,

$T_{d850}$  = The dew point temperature at 850 hPa,

$T_{d700}$  = The dew point temperature at 700 hPa,

The risk of air mass thunderstorms is defined as follows:

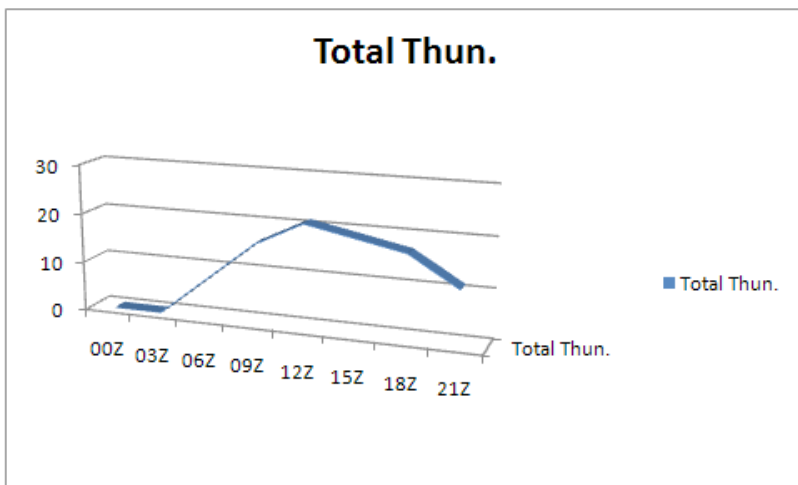


Figure 1 Frequency Thunderstorm occurred in each time, 13 April 2008

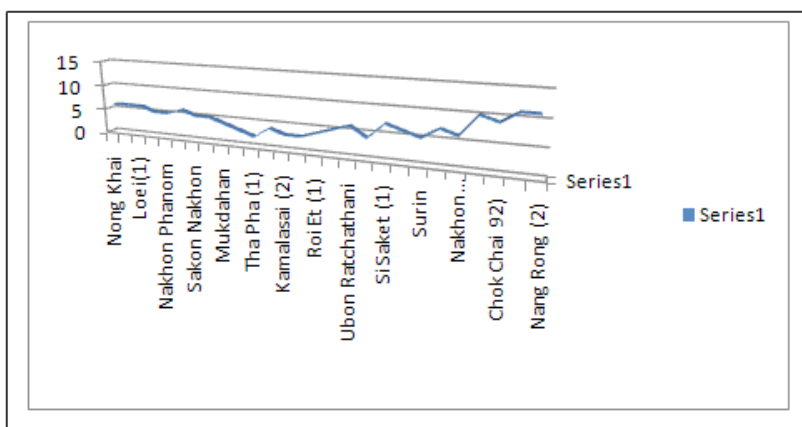


Figure 2 Frequency Thunderstorm in every 3 hrs. and each Observation station during 10-15 April 2008

Table 1. K index and Thunderstorm probability

K index	Thunderstorm probability (%)
<15	near 0
15 - 20	20
21 - 25	20 to 40
26 - 30	40 to 60
31 - 35	60 to 80
36 - 40	80 to 90
> 40	near 100

Summary thunderstorms occurred in the Northeast of Thailand during 10-15 April 2008 related to each observation station showed in figure 1.3. Average K index

about , and mostly thunderstorm occurred in the north part: Nong Khai, Sakon Nakhon, Mukdahan, Nakhon Phanom, Udonthani, Karasin etc.

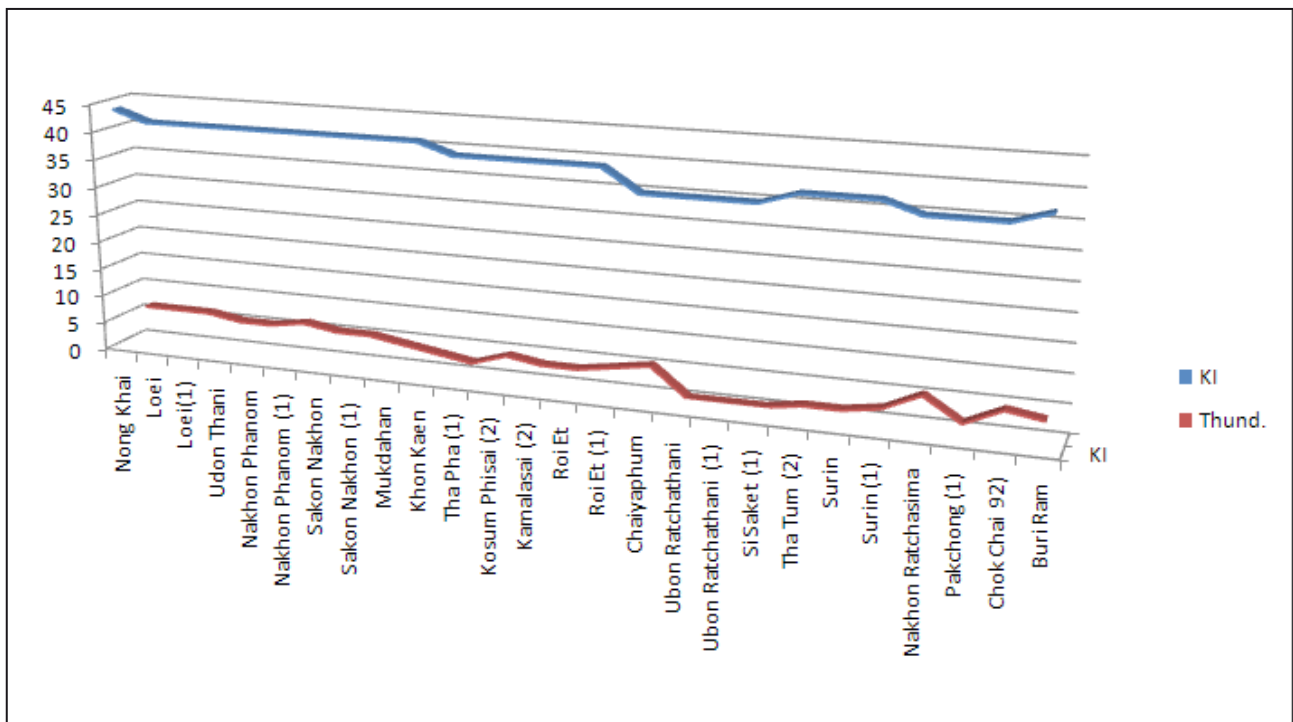


Fig. 1.3 Frequency Thunderstorm occurred in every 3 hours, Observation stations and K index in 13 April 2008

### 3.3 Thunderstorm Risk Assessment

K index from numerical weather prediction products related the frequency of report thunderstorm were union and intersect methods then it get result is a shape files. Finally results in a thunderstorm risk map. It can separate

about 4 classifies levels as 1 = weak thunderstorm risk (blue), 2 = moderate thunderstorm risk (yellow), 3 = strong thunderstorm risk (orange) and 4 = very strong thunderstorm risk (red).

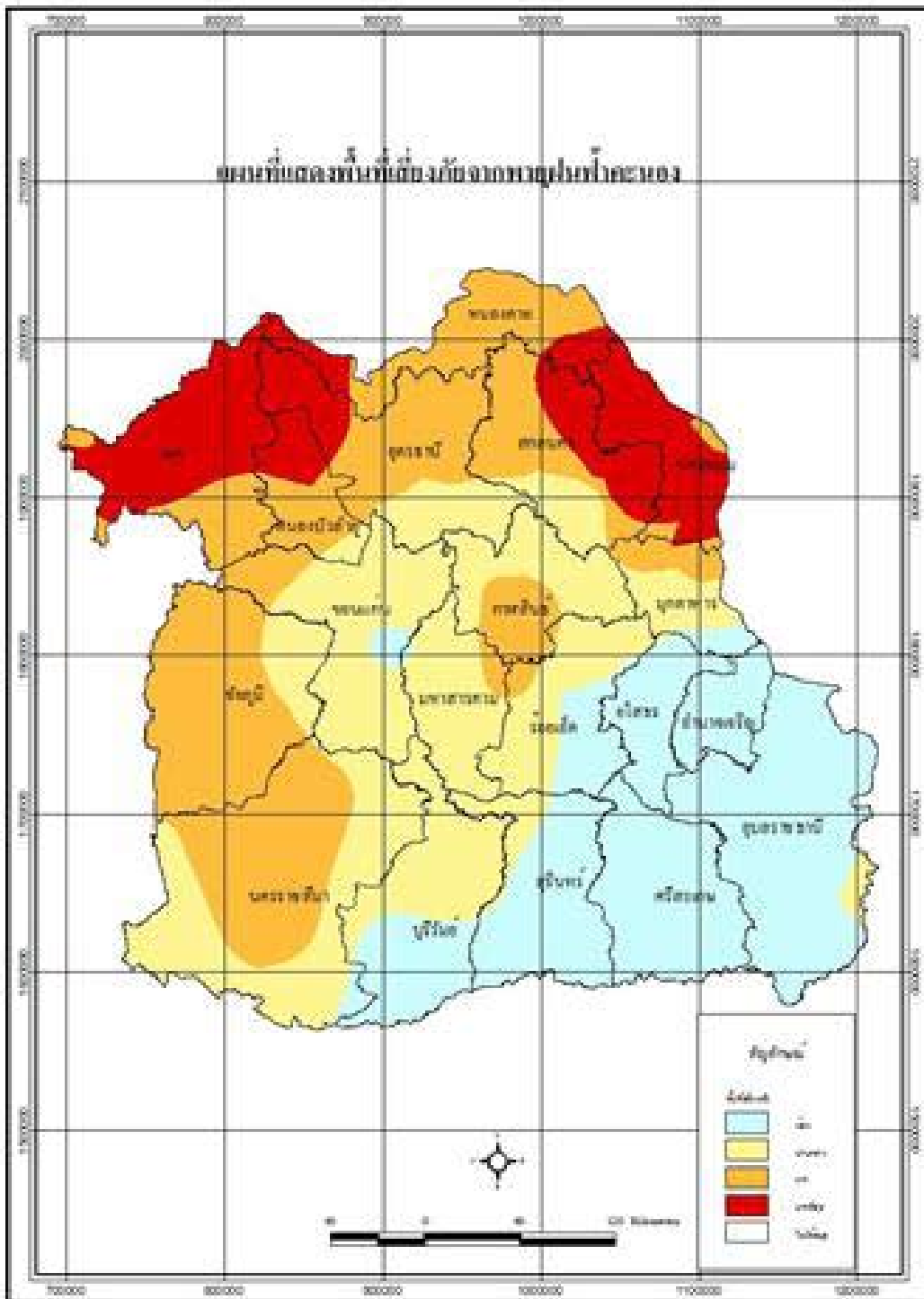


Figure 4 Thunderstorm risk area in the Northeast

Table 2. Observation stations and thunderstorm risk assessment

Item	Station	Thunderstorm risk assessment
1	Nong Khai	3
2	Loei	4
3	Udon Thani	4
4	Nakhon Phanom	4
5	Sakon Nakhon	4
6	Mukdahan	3
7	Khon Kaen	2
8	Karasin	3
9	Roi Et	2
10	Chaiyaphum	3
11	Ubon Ratchathani	1
12	Si Saket	1
13	Surin	1
14	Nakhon Ratchasima	3
15	Buri Ram	2
16	Nongbualumphu	3
17	Makhasarakram	2
18	Amnatcharean	1
19	Yasothon	1

#### 4. Conclusion

There experiment thunderstorm used K index is one of parameter in WRF model using for measure instability of atmosphere. It can relate with frequency thunderstorm and get result a hazard map. The risk

area showed communities thunderstorm risk is 4 levels: weak risk, moderate risk, strong risk and very strong risk. Then it can get to preparing and management of the thunderstorm risk area.