

# Air quality forecasting system for “Haze” episode in the upper north of Thailand



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# Outline

- Haze situation in Thailand
- Consequence of Haze
- The forecasting modeling of haze
- Conclusion



Why do haze episode regular occur in the upper north of Thailand?  
 Why not other areas?

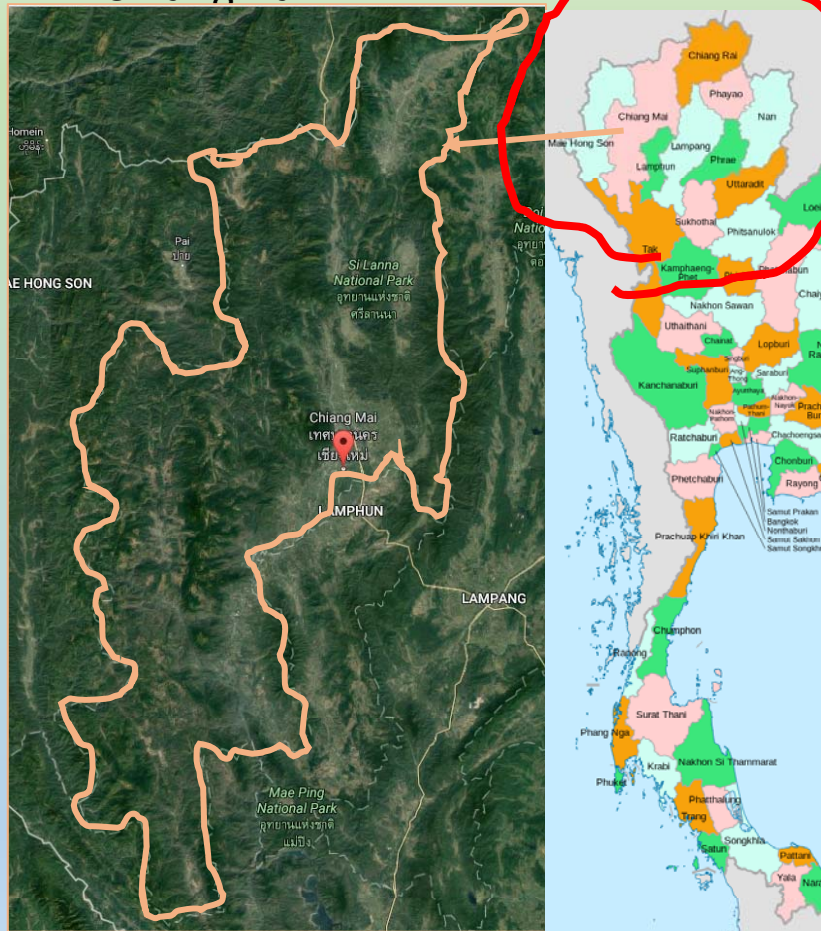
Haze in the southern part of Thailand



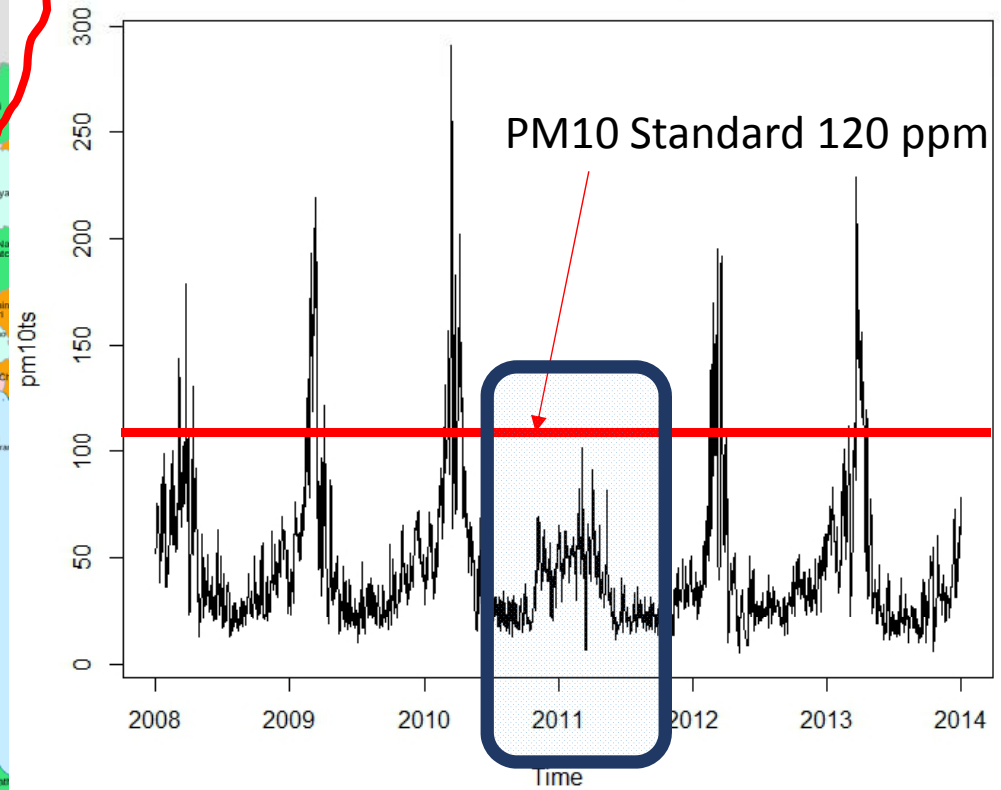


# Air quality data in some provinces

## Chiangmai

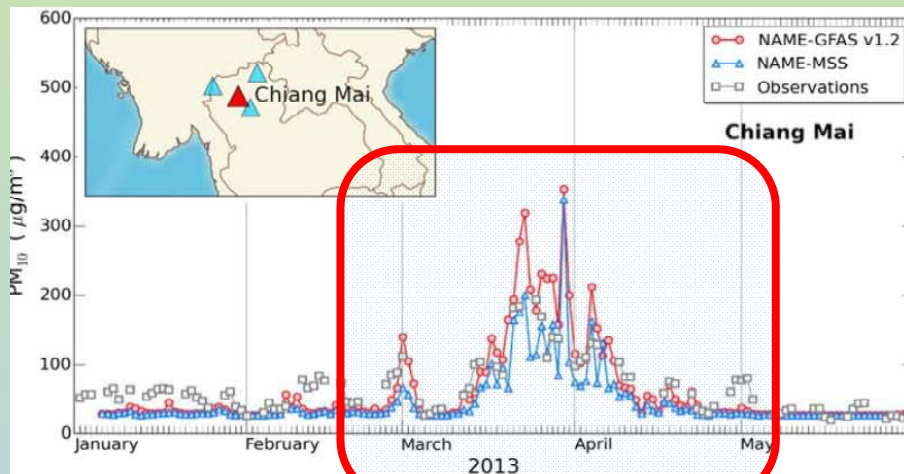


PM10 concentration : Chiangmai station

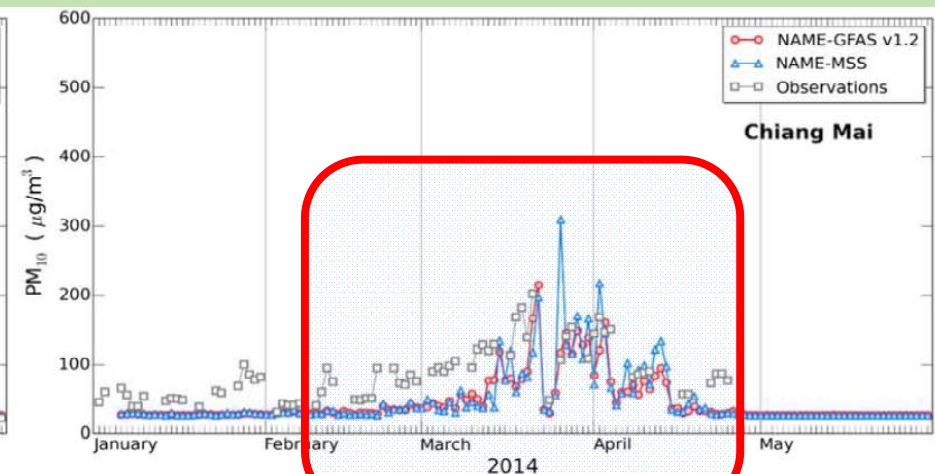


# Chiangmai

Mar-Apr



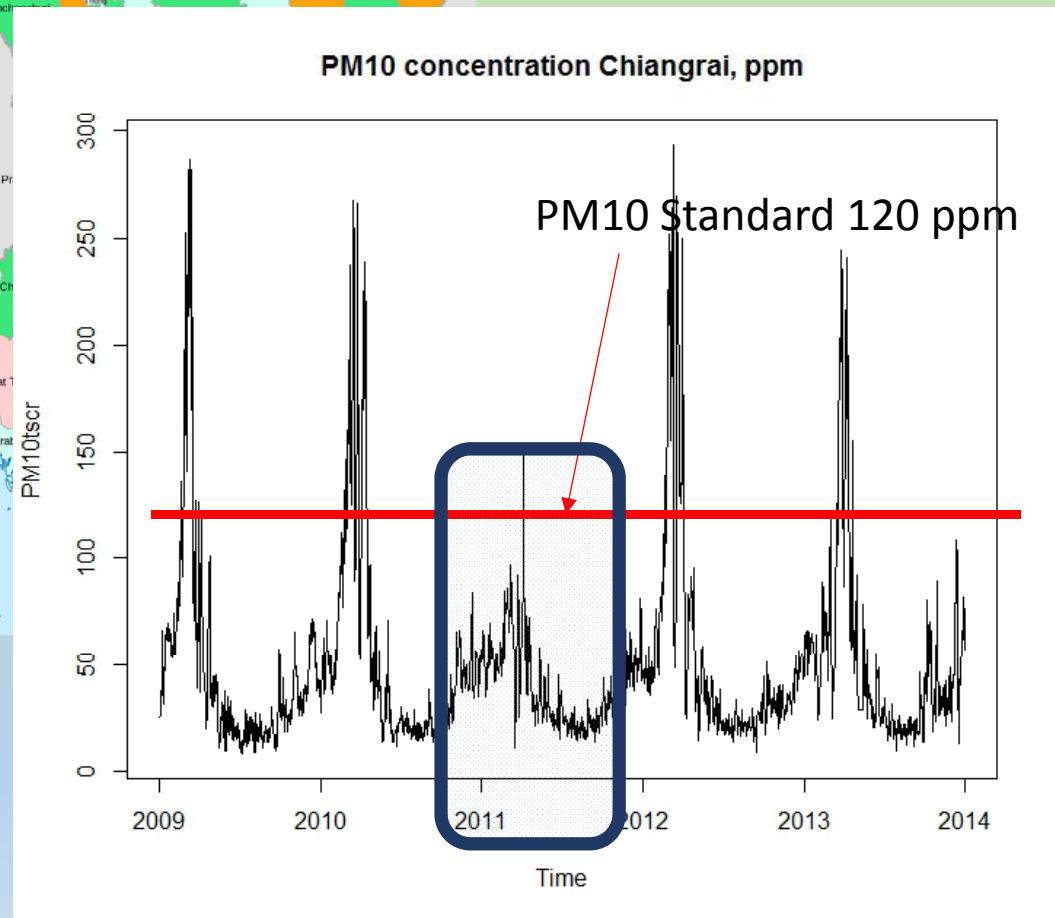
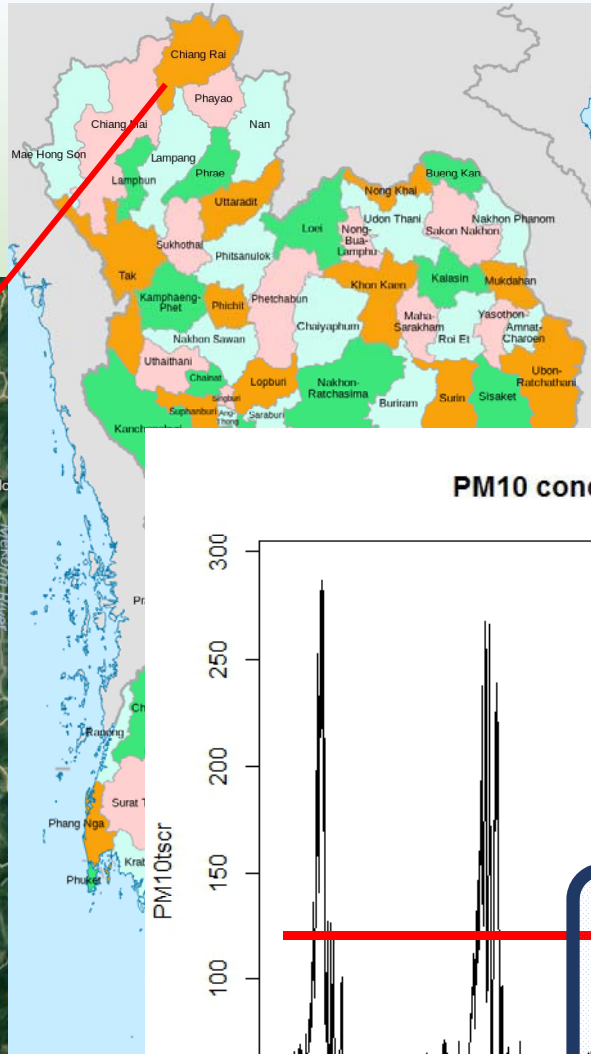
2013



2014

# Chiangrai

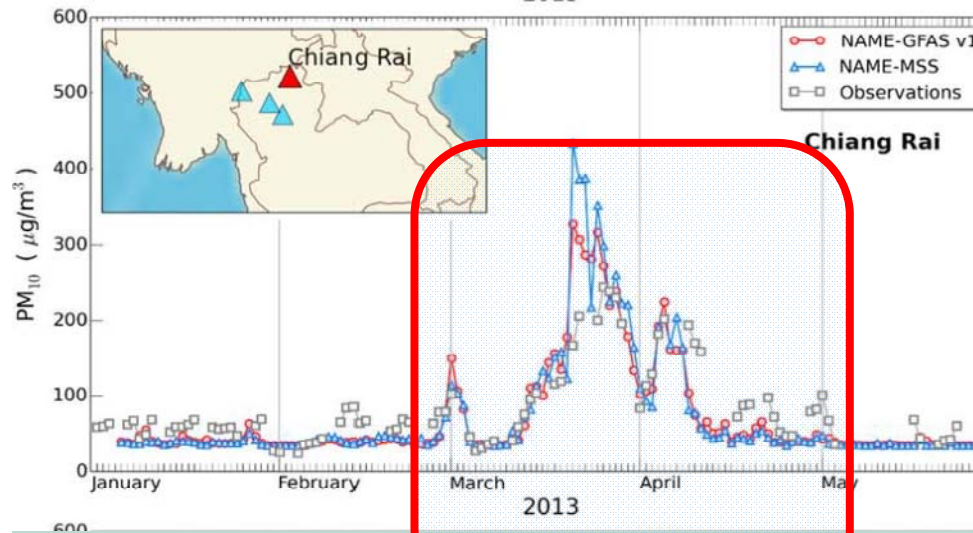
Mar-Apr



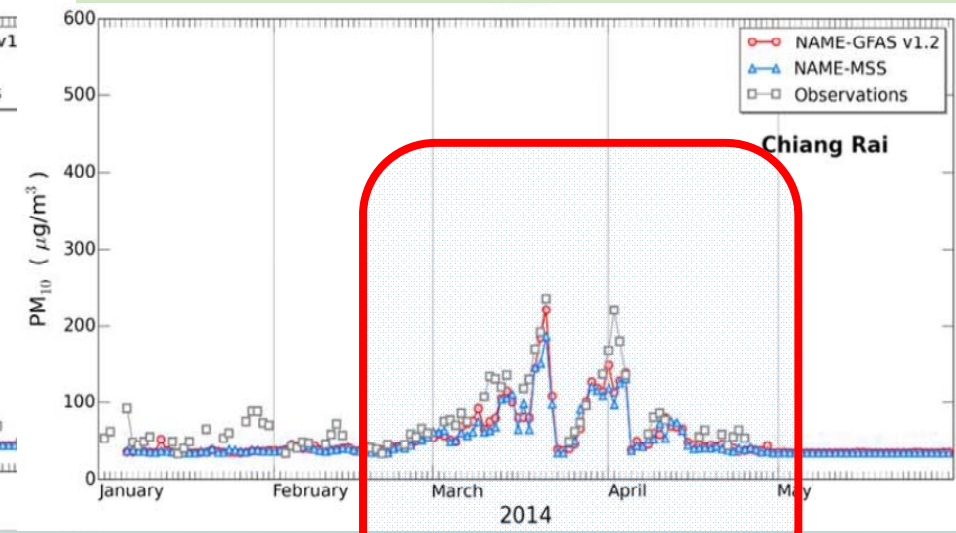


# Chiangrai

## (March-April)



2013

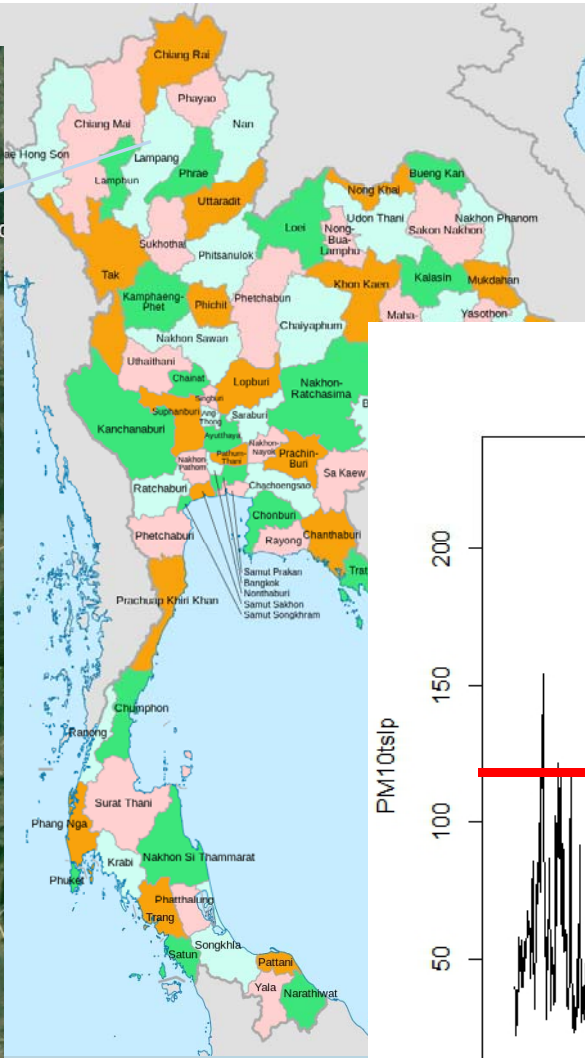
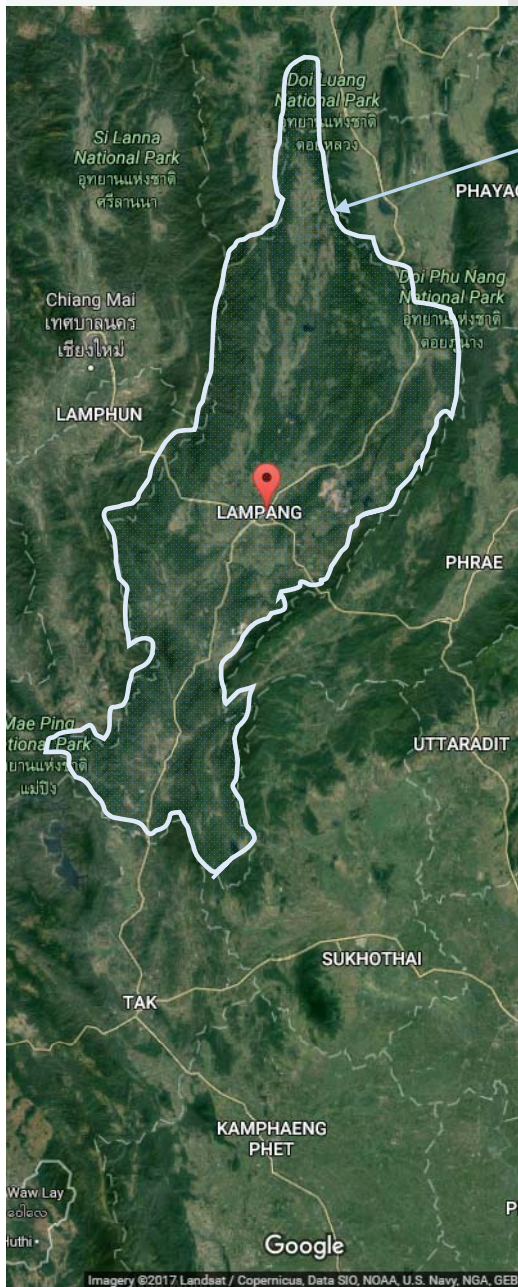


2014

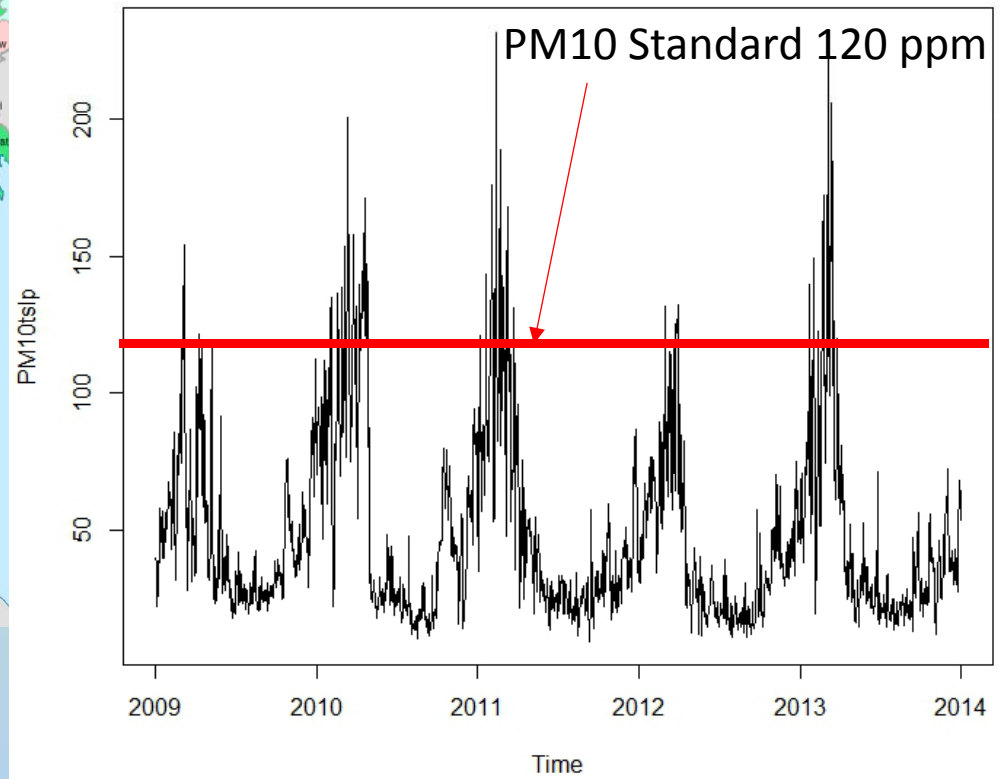
Why do we have haze episode only this period?



# Lampang



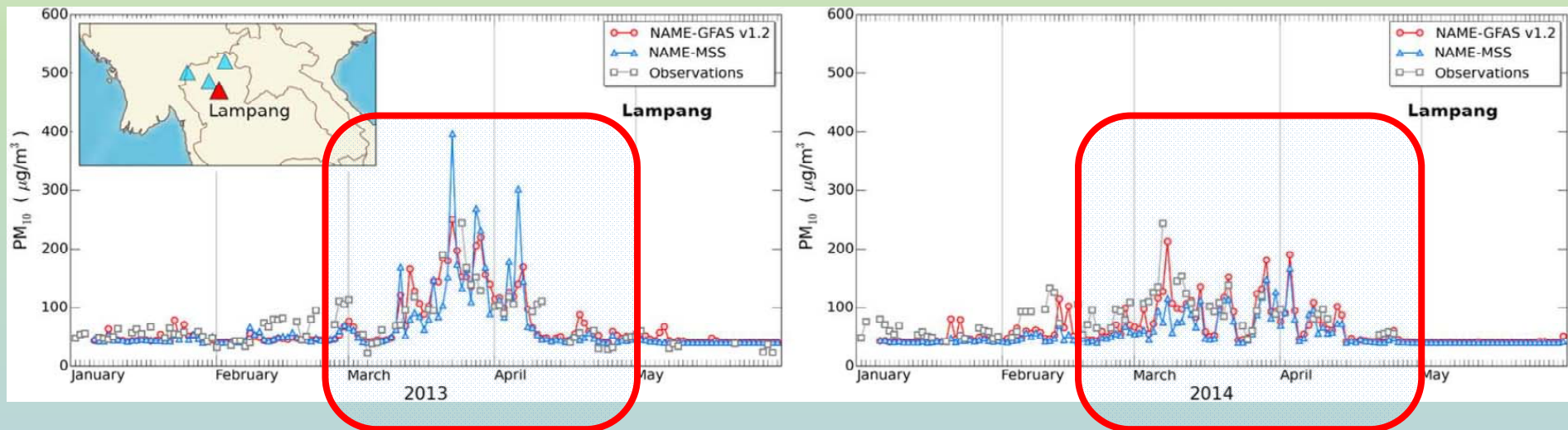
PM10 concentration Lampang, ppm





# Lampang

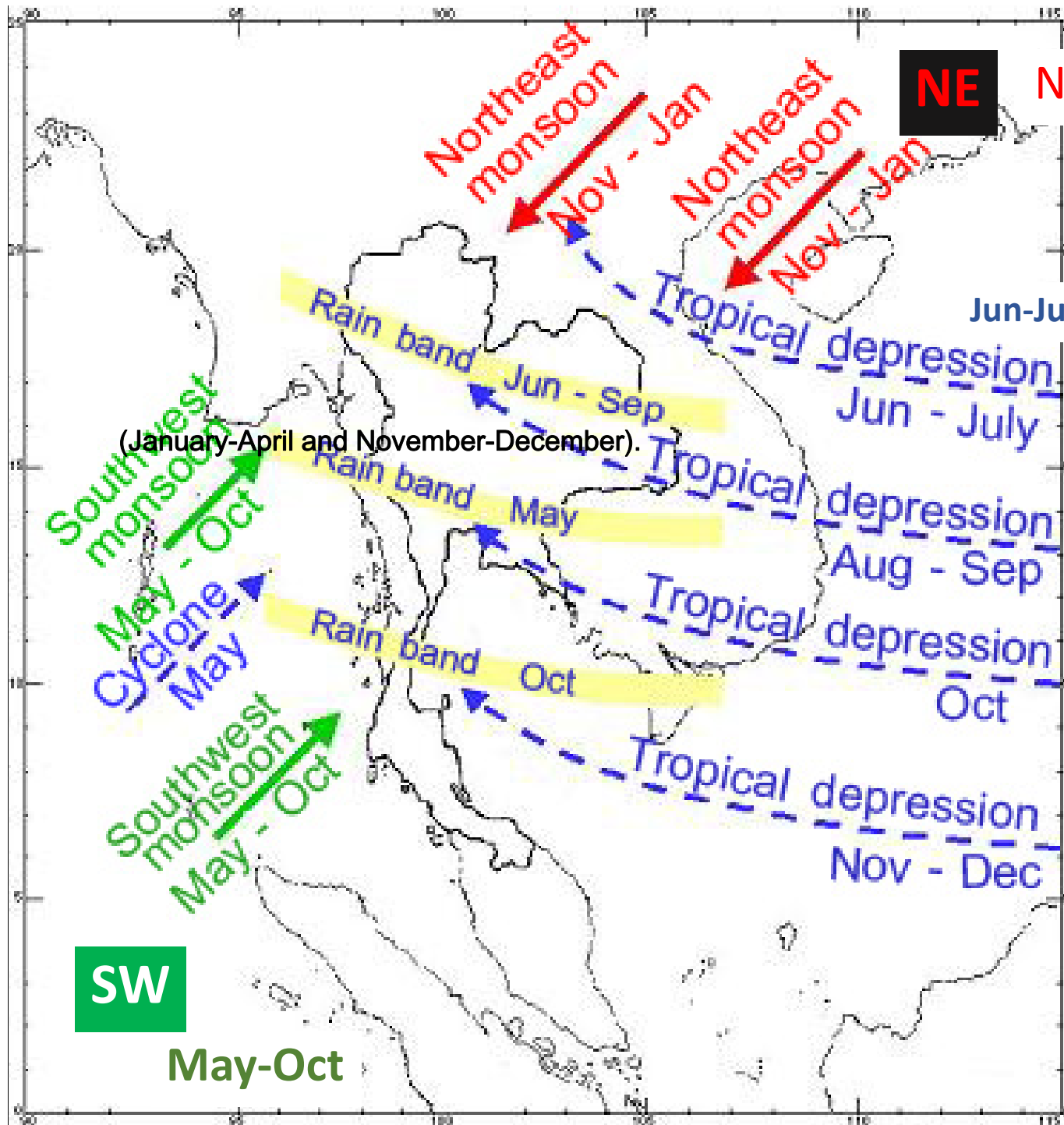
(March-April)



2013

2014

Why do we have haze episode only this period?



(January-April and November-December).

**NE** Nov-Jan

Jun-Jul-Aug-Sep-Oct-Nov-Dec

**Feb-Mar-Apr**

**SW**  
May-Oct

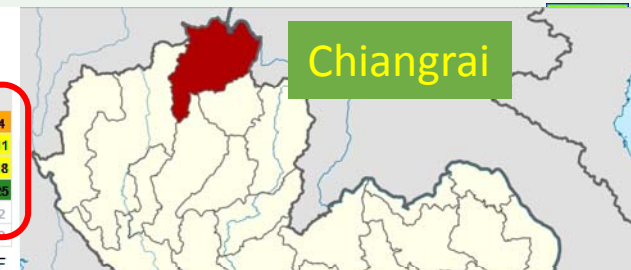
# Chiangrai

2013

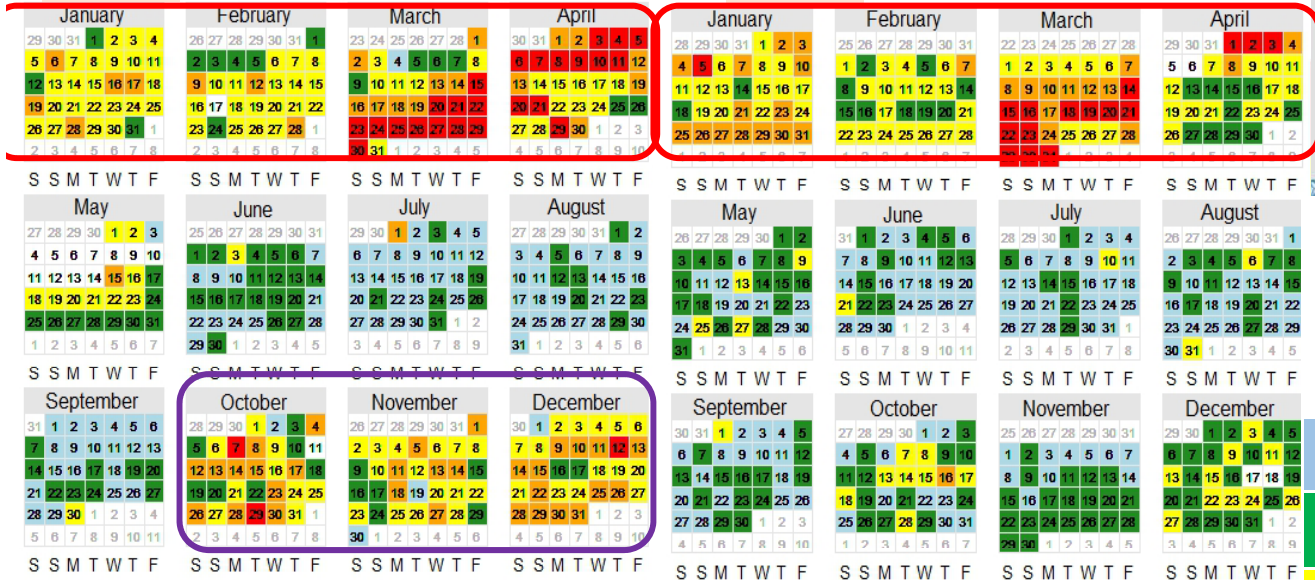
PM<sub>10</sub> in 2013

2014

PM<sub>10</sub> in 2014



Chiangrai



**Air Quality**

PM<sub>10</sub> concentration  
(24 hour)  
(microgram per cubic meter)

Very good

0-25

Good

25-80

Moderate

80-120

Health impacts

120-180

Dangerous

>180

# Chiangmai

2013

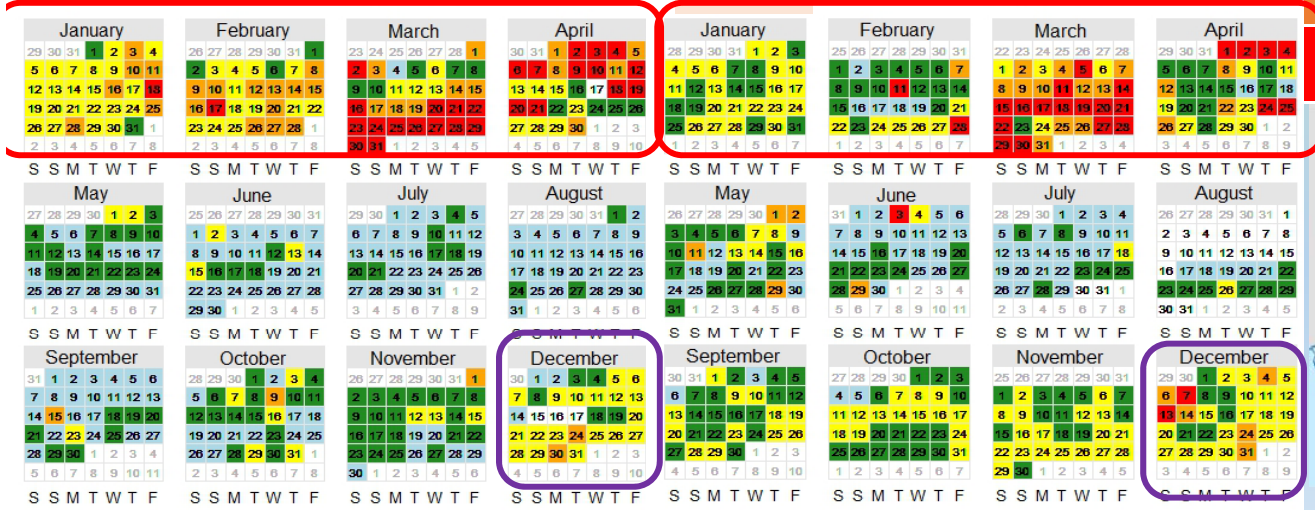
PM<sub>10</sub> in 2013

2014

PM<sub>10</sub> in 2014



Chiangmai





# Lumphun

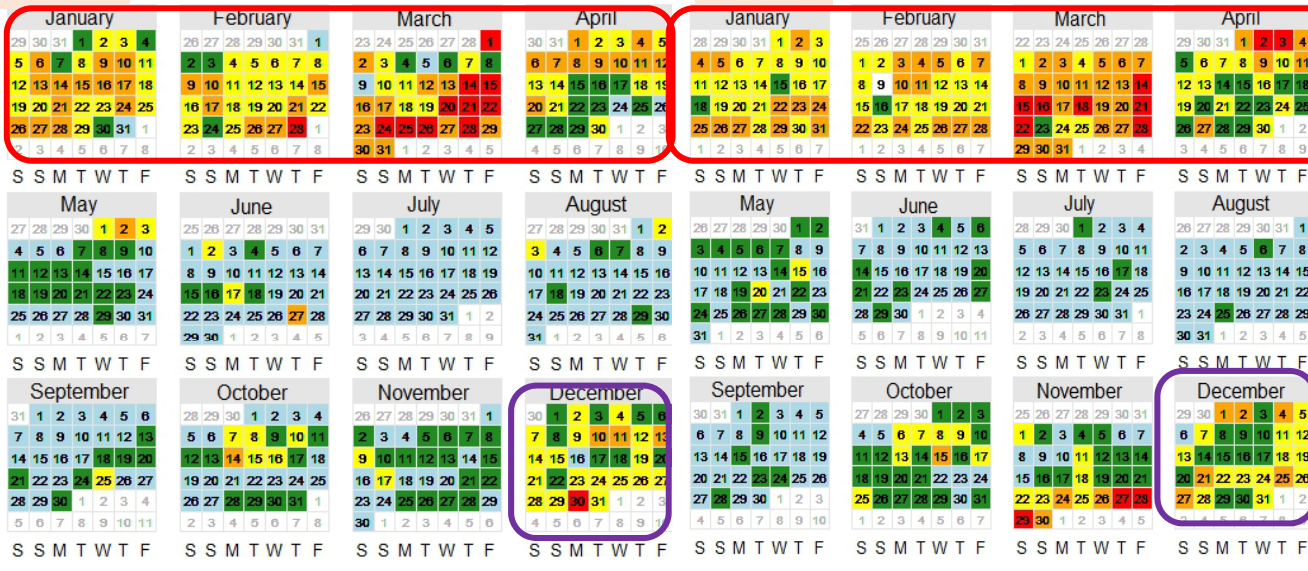


2013

PM<sub>10</sub> in 2013

2014

PM<sub>10</sub> in 2014



Air Quality

PM10 concentration (24 hour) (microgram per cubic meter)

Very good

0-25

Good

25-80

Moderate

80-120

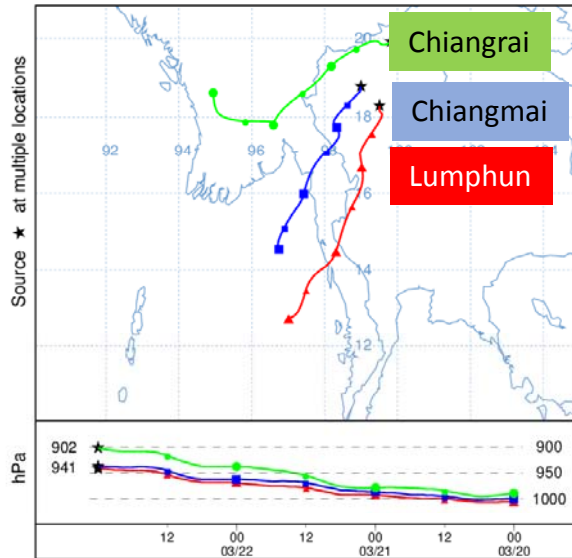
Health impacts

120-180

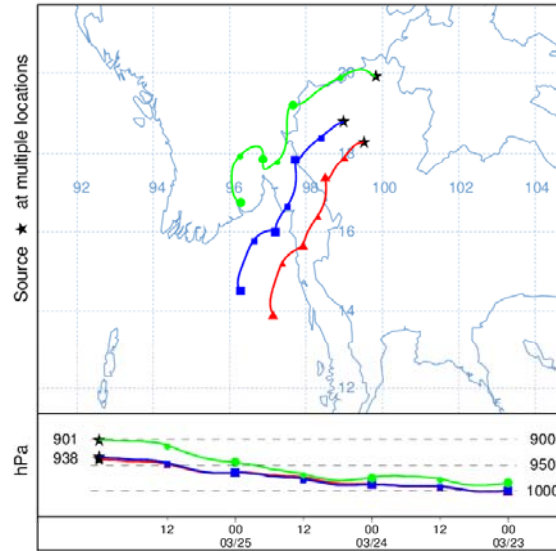
Dangerous

>180

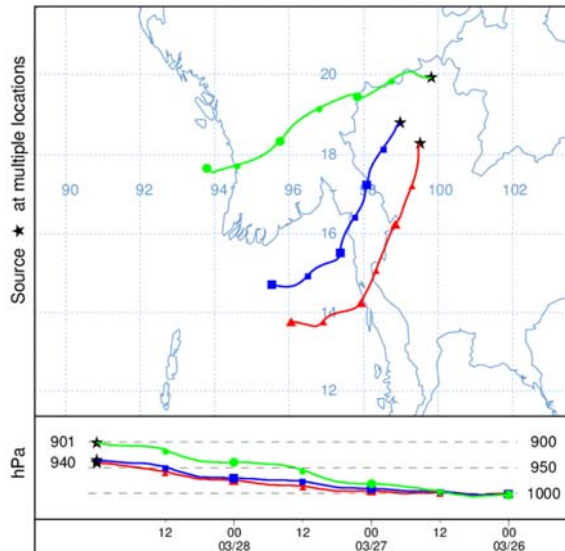
NOAA HYSPLIT MODEL  
Backward trajectories ending at 0000 UTC 23 Mar 13  
CDC1 Meteorological Data



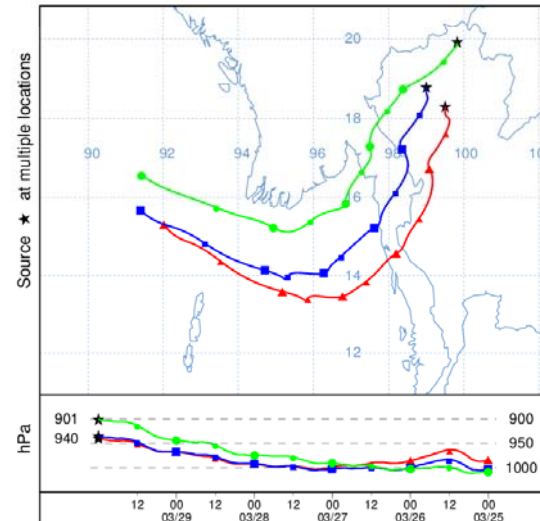
NOAA HYSPLIT MODEL  
Backward trajectories ending at 0000 UTC 26 Mar 13  
CDC1 Meteorological Data



NOAA HYSPLIT MODEL  
Backward trajectories ending at 0000 UTC 29 Mar 13  
CDC1 Meteorological Data



NOAA HYSPLIT MODEL  
Backward trajectories ending at 0000 UTC 30 Mar 13  
CDC1 Meteorological Data

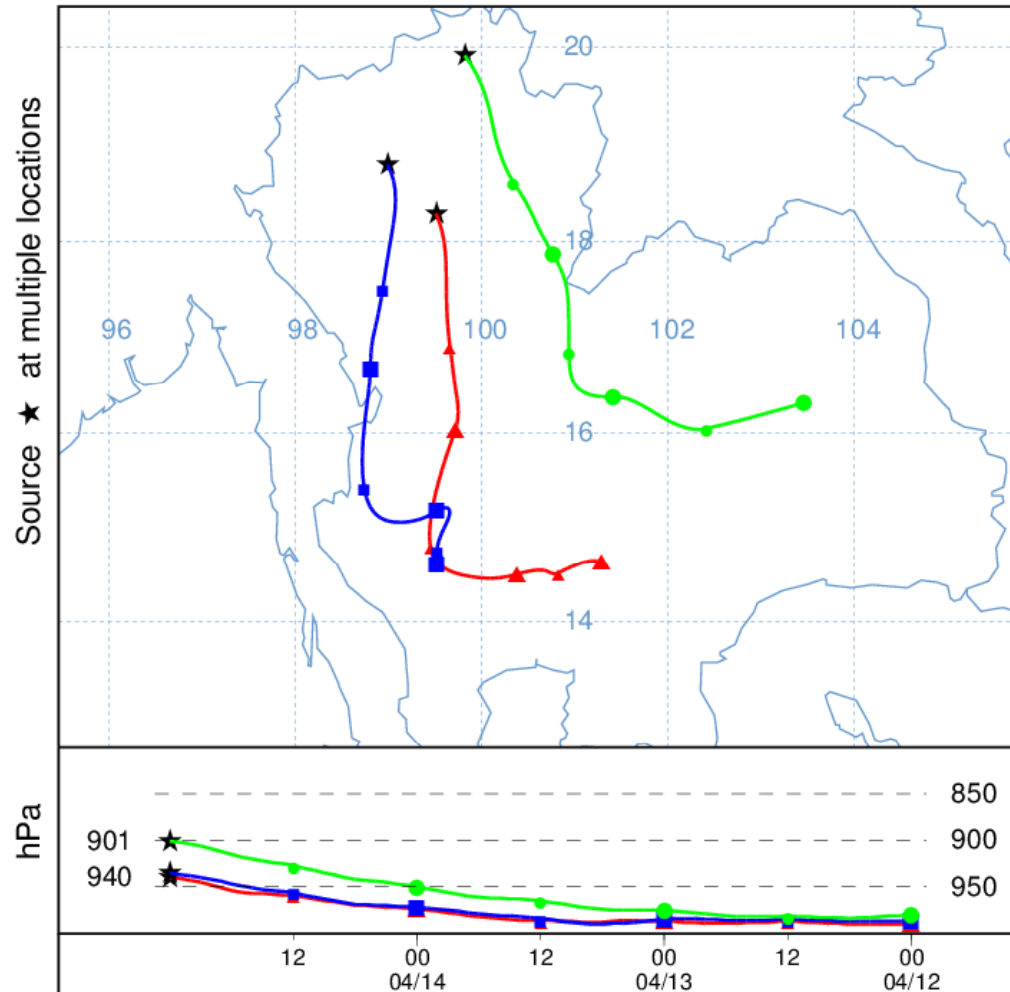


March

15 March 2013



NOAA HYSPLIT MODEL  
Backward trajectories ending at 0000 UTC 15 Apr 13  
CDC1 Meteorological Data



PM<sub>10</sub> in 2013

February			
29	30	31	1
5	6	7	8
12	13	14	15
19	20	21	22
26	27	28	1
5	6	7	8

T W T F

June			
28	29	30	31
4	5	6	7
11	12	13	14
18	19	20	21
25	26	27	28
2	3	4	5

T W T F

October			
1	2	3	4
8	9	10	11
15	16	17	18
22	23	24	25
29	30	31	1
5	6	7	8

T W T F

March						
23	24	25	26	27	28	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

S S M T W T F

July						
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

S S M T W T F

November						
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	1	2	3	4	5	6

S S M T W T F

April						
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	1	2	3
4	5	6	7	8	9	10

S S M T W T F

August						
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

S S M T W T F

December						
30	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
4	5	6	7	8	9	10

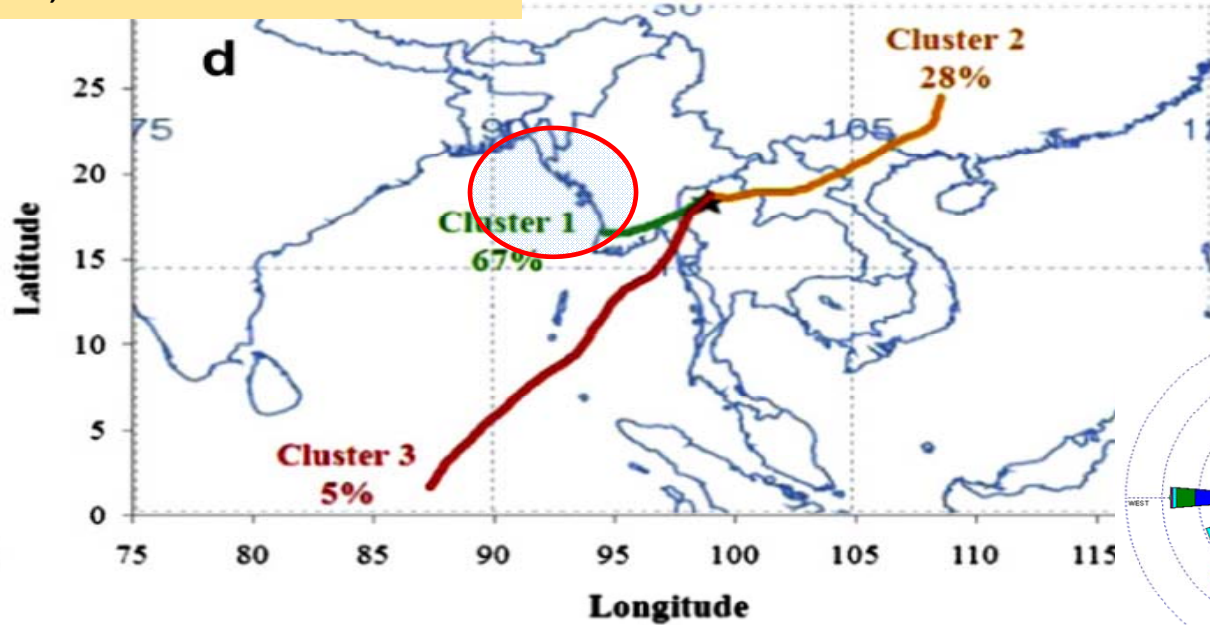
S S M T W T F



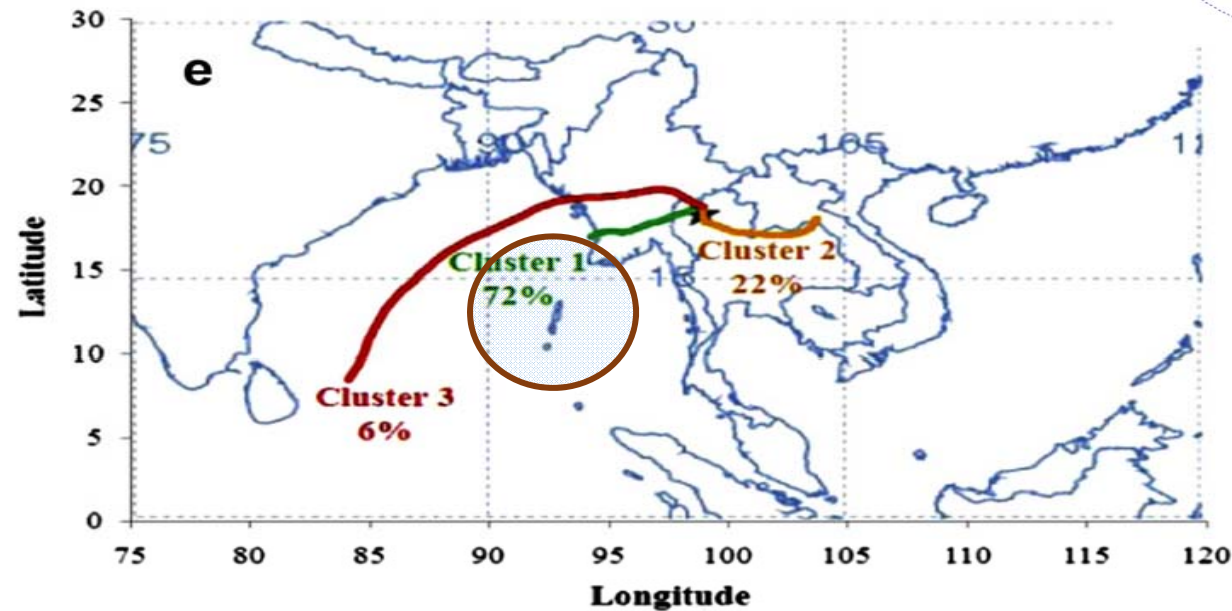
January -April, November-December



2008

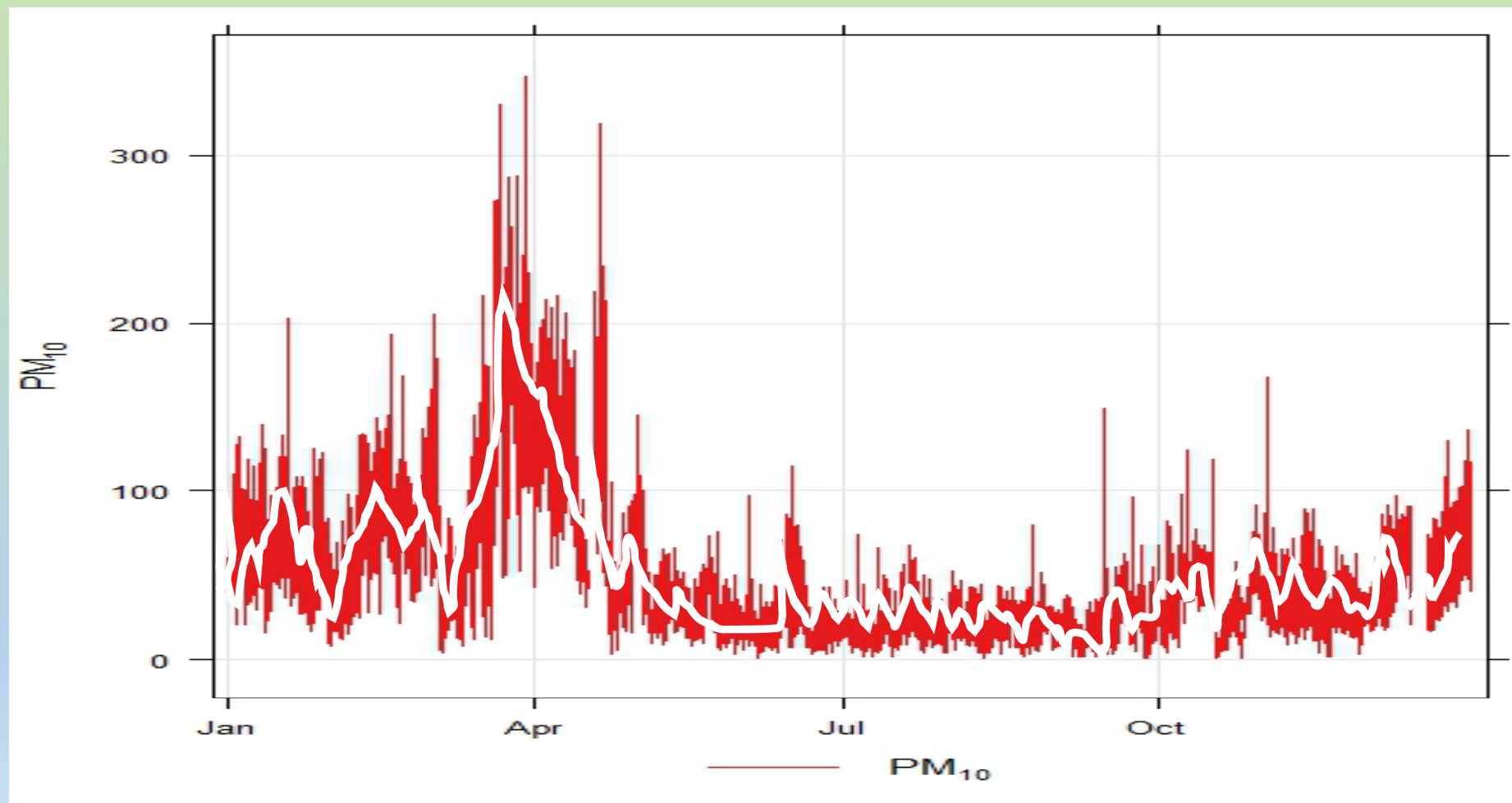


2009

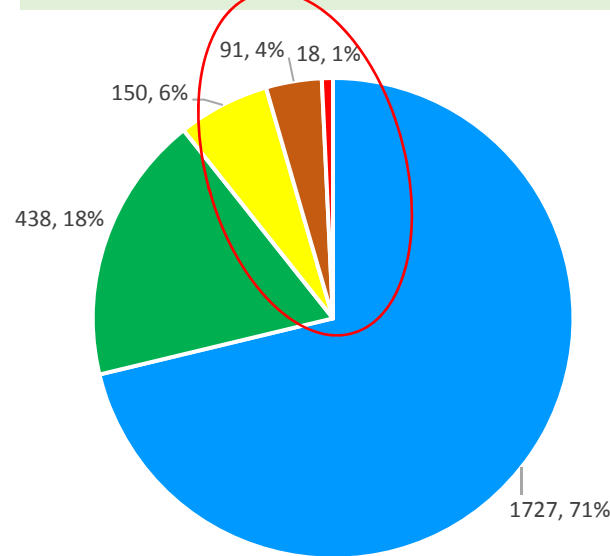




January	February	March	April	May	June	July	August	September	October	November	December
29 30 31 1 2 3 4	26 27 28 29 30 31 1	23 24 25 26 27 28 1	30 31 1 2 3 4 5	27 28 29 30 1 2 3	5 26 27 28 29 30 31	29 30 1 2 3 4 5	27 28 29 30 31 1 2	31 1 2 3 4 5 6	28 29 30 1 2 3 4	26 27 28 29 30 31 1	30 1 2 3 4 5 6
5 6 7 8 9 10 11	2 3 4 5 6 7 8	2 3 4 5 6 7 8	6 7 8 9 10 11 12	4 5 6 7 8 9 10	2 3 4 5 6 7	6 7 8 9 10 11 12	3 4 5 6 7 8 9	7 8 9 10 11 12 13	5 6 7 8 9 10 11	2 3 4 5 6 7 8	7 8 9 10 11 12 13
12 13 14 15 16 17 18	9 10 11 12 13 14 15	9 10 11 12 13 14 15	13 14 15 16 17 18 19	11 12 13 14 15 16 17	8 9 10 11 12 13 14	13 14 15 16 17 18 19	10 11 12 13 14 15 16	14 15 16 17 18 19 20	12 13 14 15 16 17 18	9 10 11 12 13 14 15	14 15 16 17 18 19 20
19 20 21 22 23 24 25	16 17 18 19 20 21 22	16 17 18 19 20 21 22	20 21 22 23 24 25 26	18 19 20 21 22 23 24	15 16 17 18 19 20 21	16 17 18 19 20 21 22	17 18 19 20 21 22 23	21 22 23 24 25 26 27	19 20 21 22 23 24 25	16 17 18 19 20 21 22	21 22 23 24 25 26 27
26 27 28 29 30 31 1	23 24 25 26 27 28 1	23 24 25 26 27 28 1	27 28 29 30 1 2 3	25 26 27 28 29 30 31	2 23 24 25 26 27 28	27 28 29 30 31 1 2	24 25 26 27 28 29 30	28 29 30 1 2 3 4	26 27 28 29 30 31 1	23 24 25 26 27 28 29	28 29 30 31 1 2 3
2 3 4 5 6 7 8	2 3 4 5 6 7 8	30 31 1 2 3 4 5	4 5 6 7 8 9 10	1 2 3 4 5 6 7	9 30 1 2 3 4 5	3 4 5 6 7 8 9 31	1 2 3 4 5 6	5 6 7 8 9 10 11	2 3 4 5 6 7 8	30 1 2 3 4 5 6	4 5 6 7 8 9 10
S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F	S S M T W T F



Air Quality Index Chiangmai : 2008-2014



# Why do we concern?

Air Quality Index Chiangrai : 2008-2014

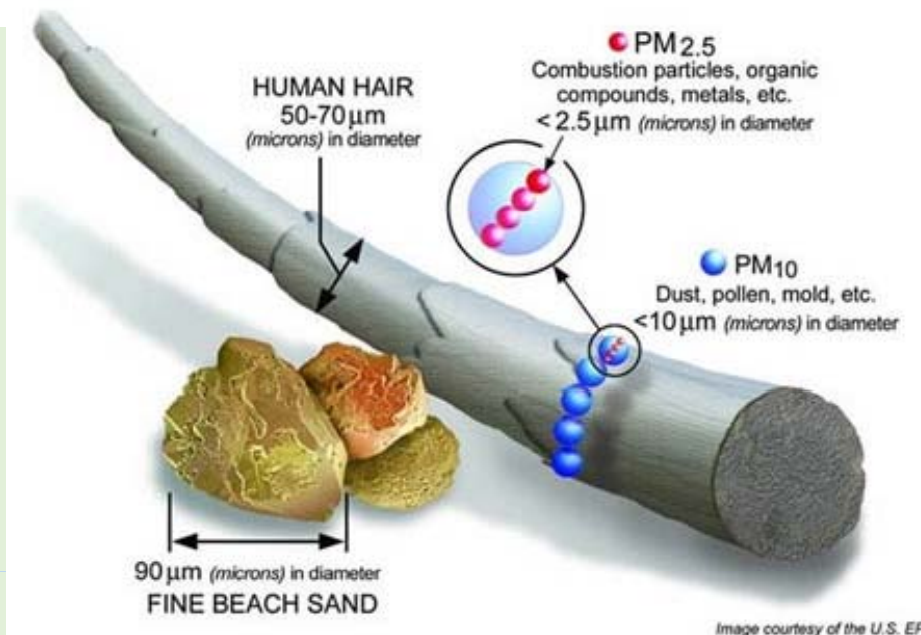
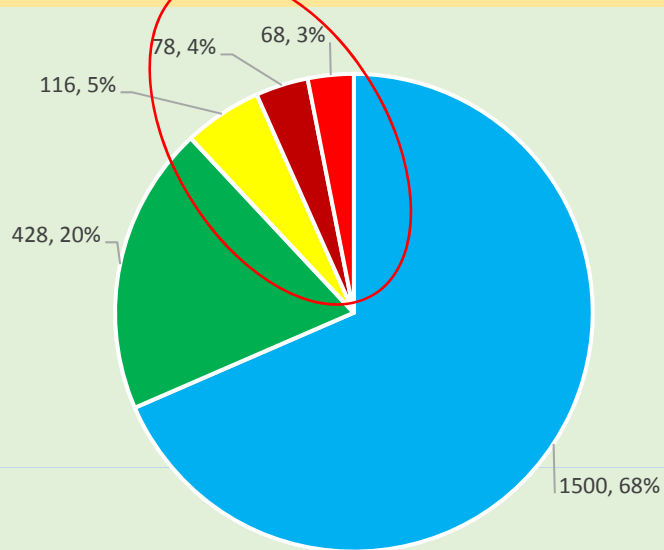


Image courtesy of the U.S. EPA



Health

Socio-economics

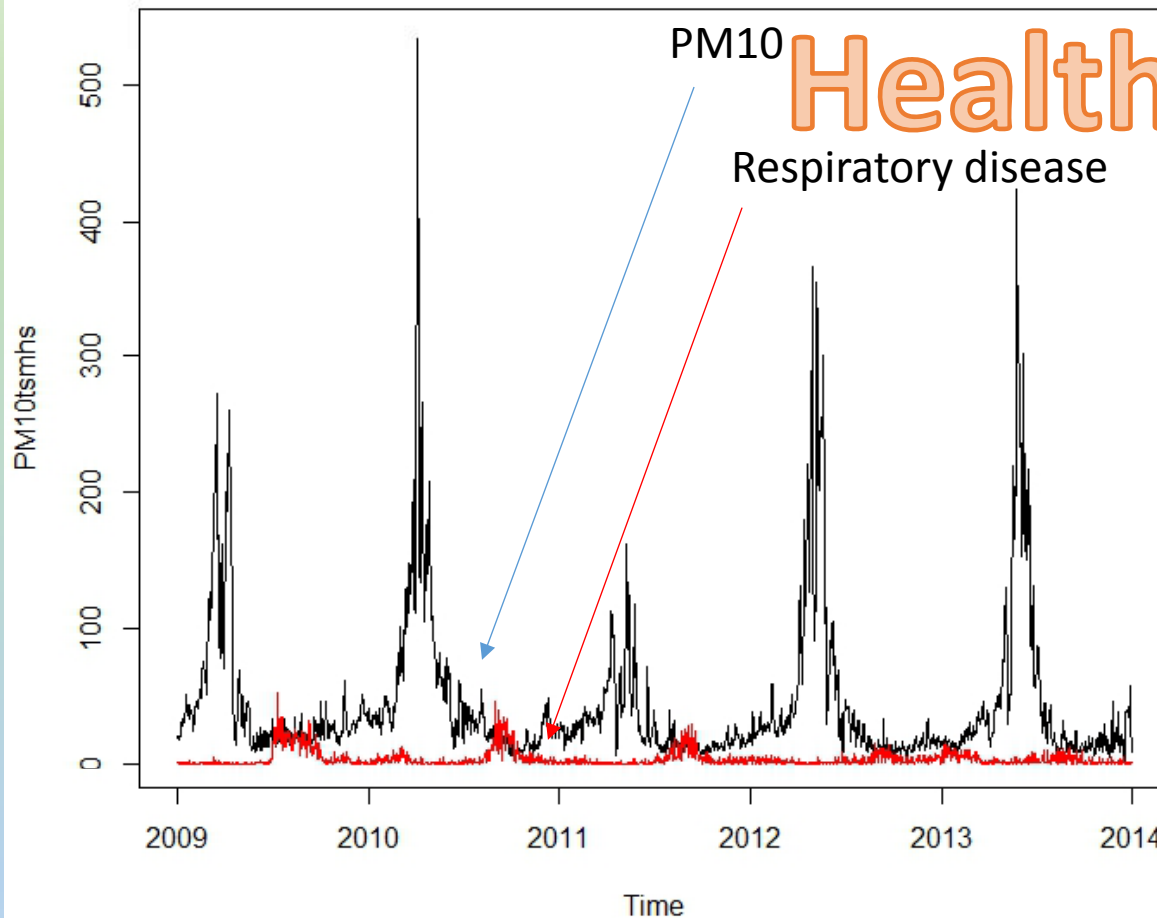
Tourism

Transportation

.....?

What are the consequences of haze episode?

PM10 concentration Mae Hong Son, ppm Versus Respiratory disease



# Health Impacts

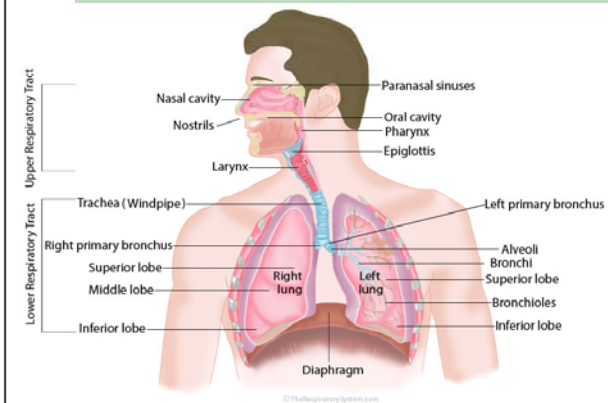
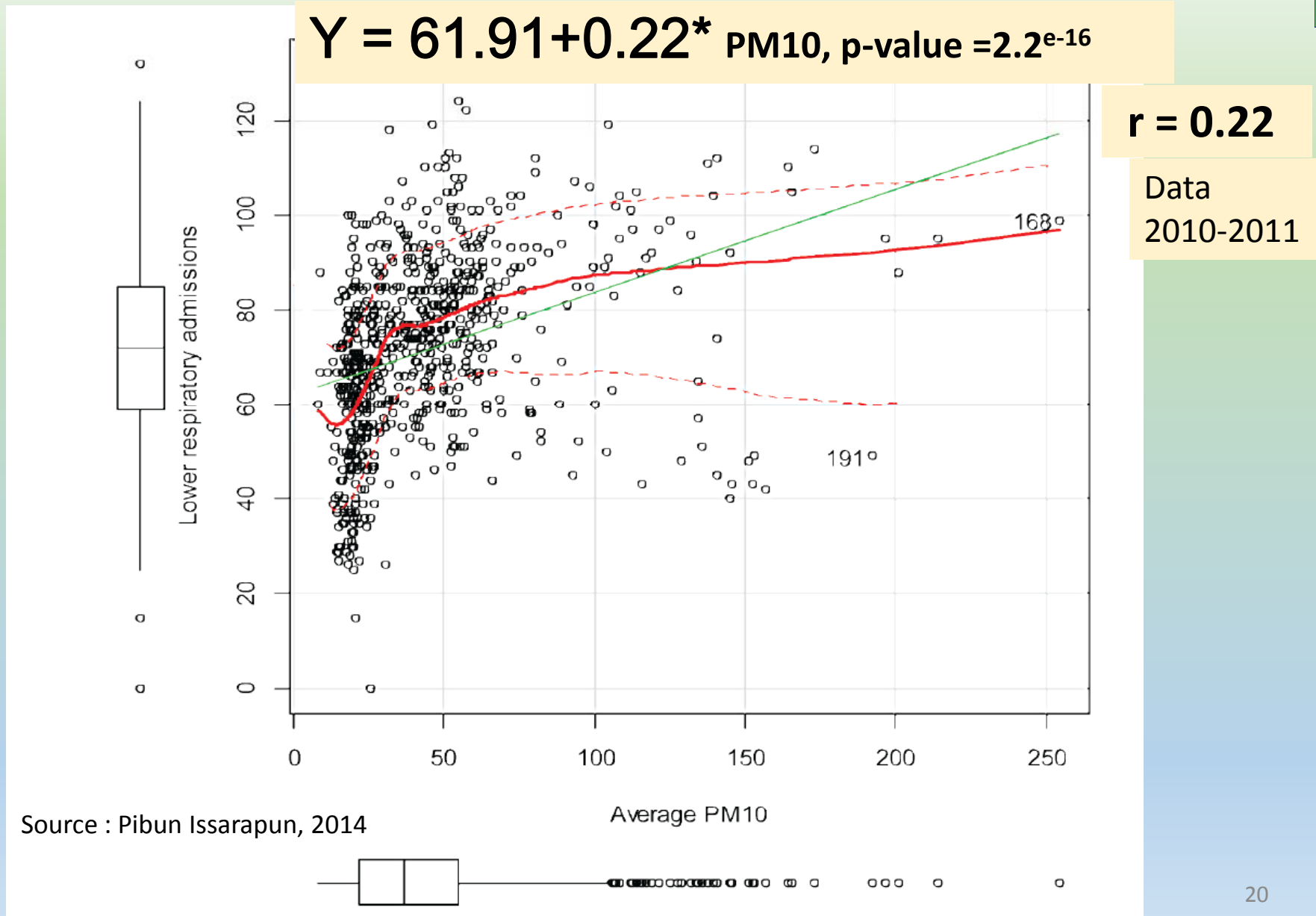


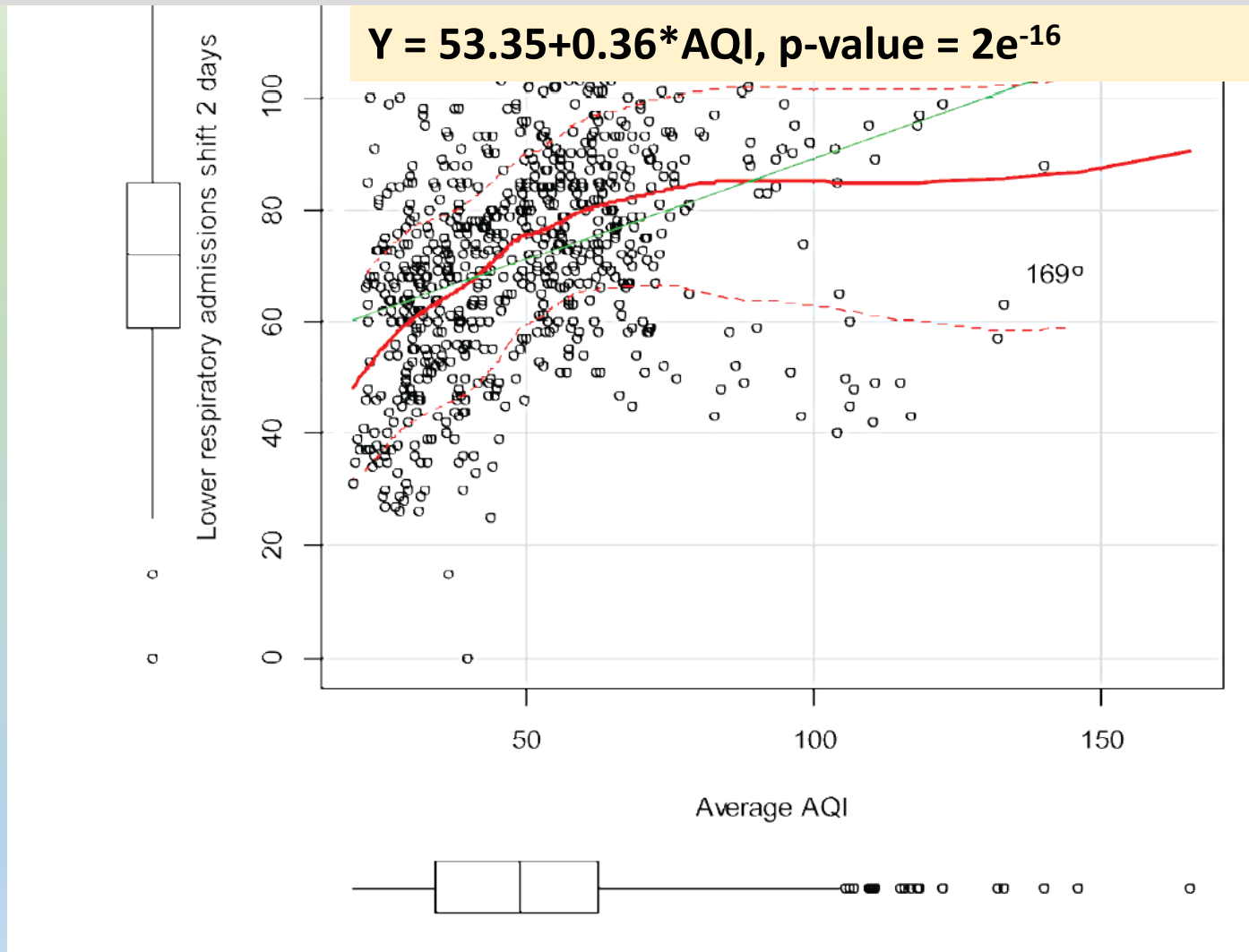
Photo source:www.google.com

# Scatter diagram " average PM10 and all respiratory diseases (in-patient)





# Scatter diagram “ average AQI and lower respiratory diseases(J4) ,in-patient

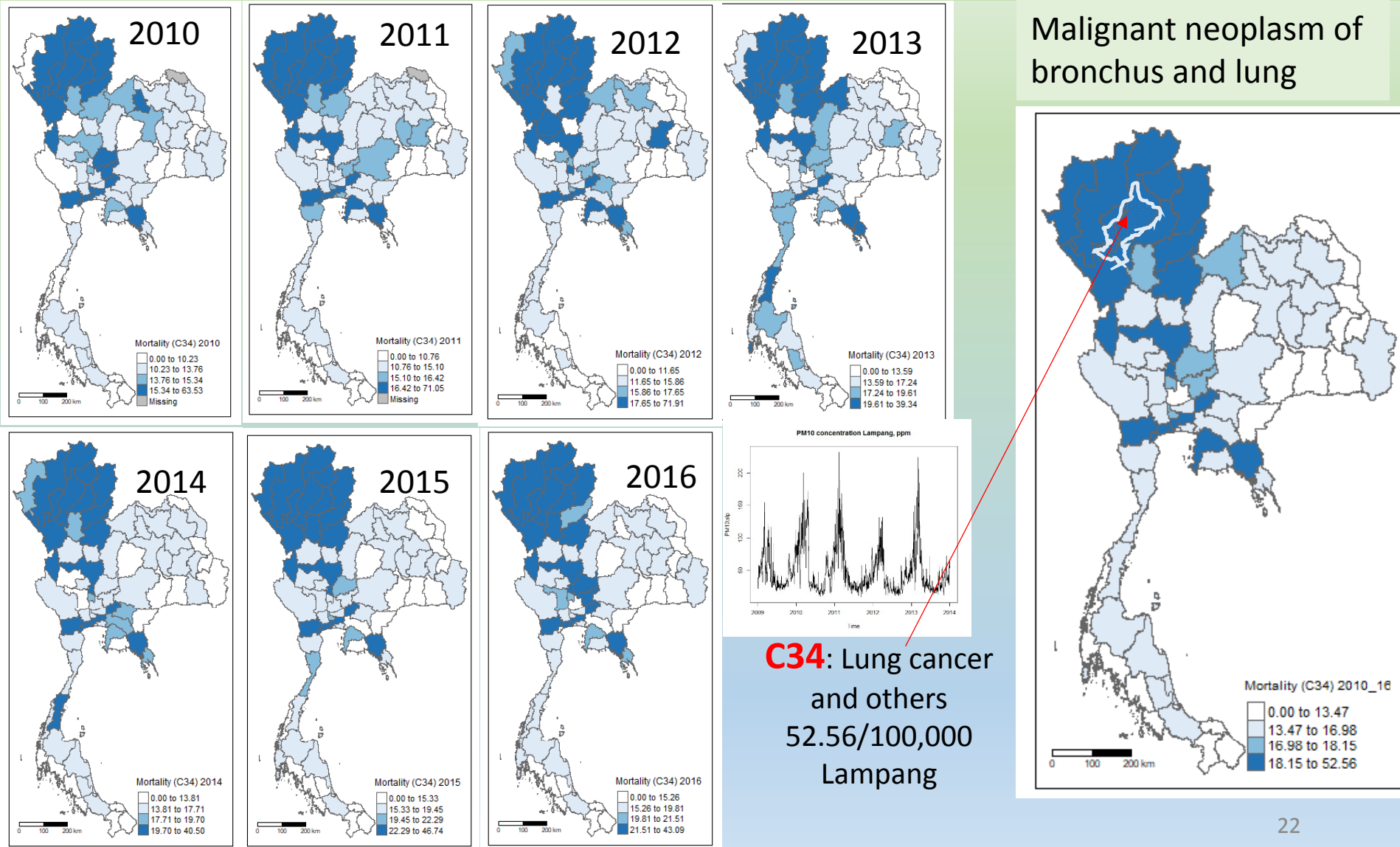


**r = 0.36**

Data  
2010-2011

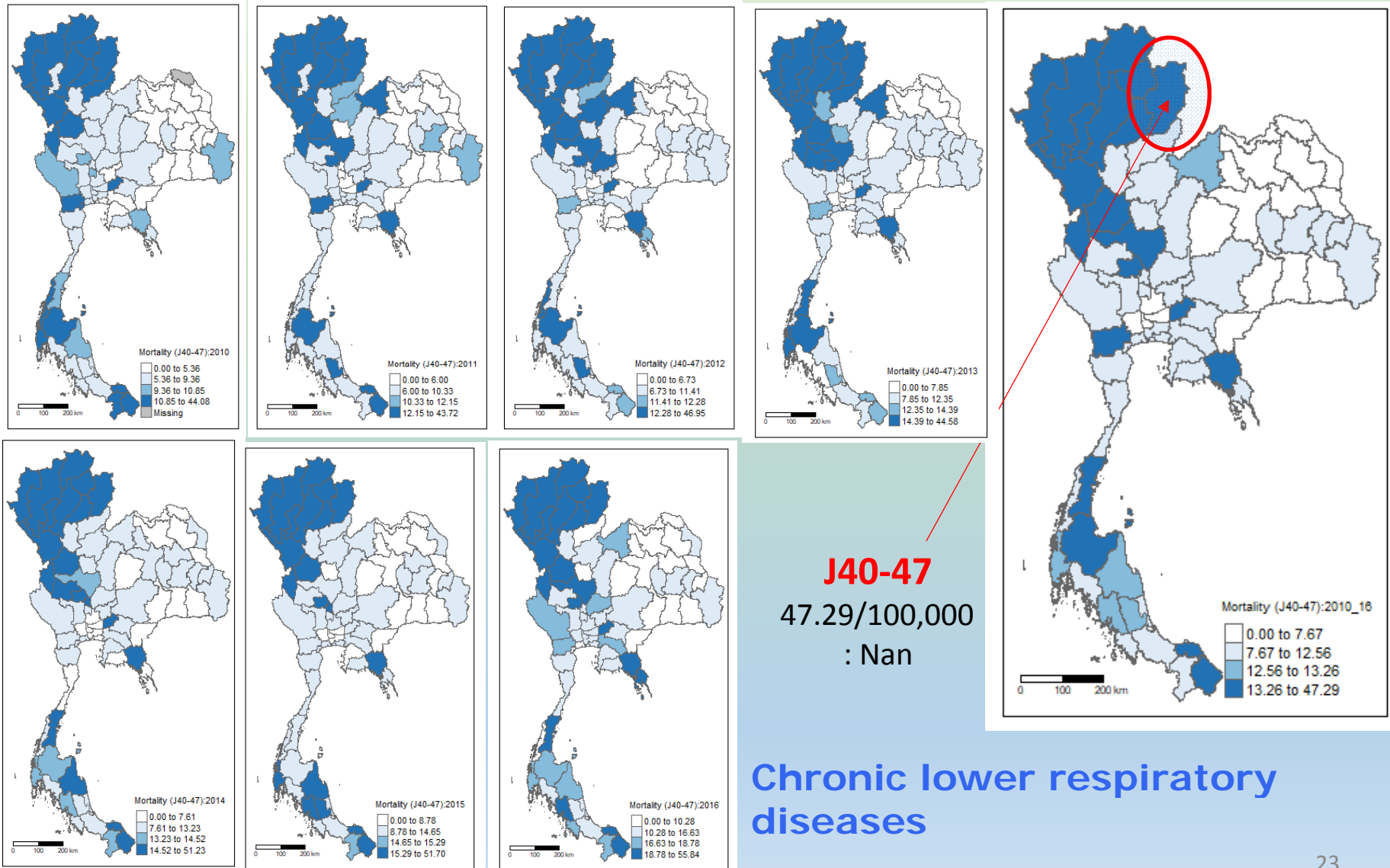
With 2 days  
latent period

# Mapping of mortality of related diseases





# Mapping of mortality of related diseases



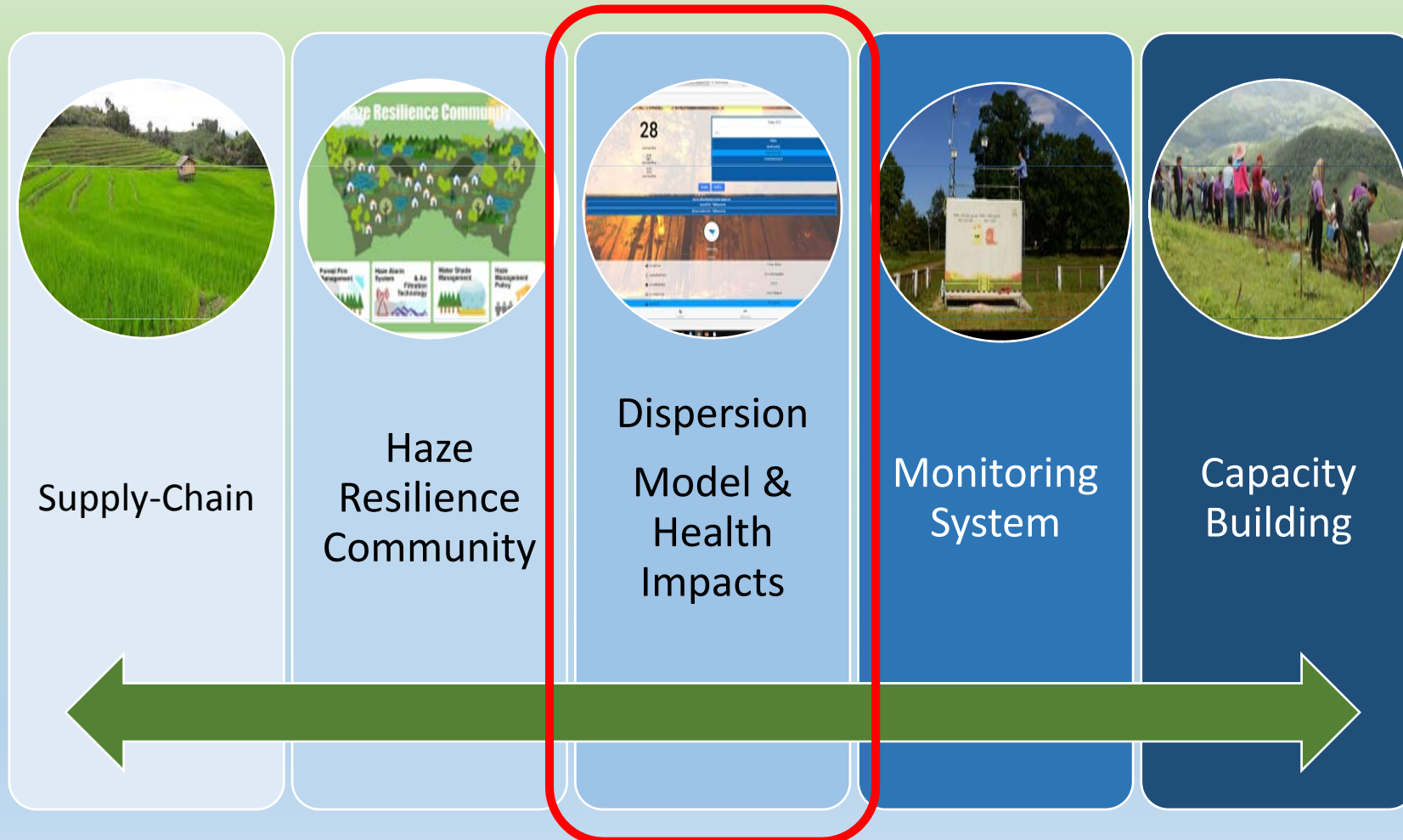


# Mitigation measures



**Many approaches**

# Integrating approach for Haze solution





# Model concept

- Is it possible to predict the situation in advance.
- Benefits .....
- Preparedness and response for health sector
- Management of agricultural residues burning
- Warning system for local municipality and provincial levels
- Tourism activities
- .....



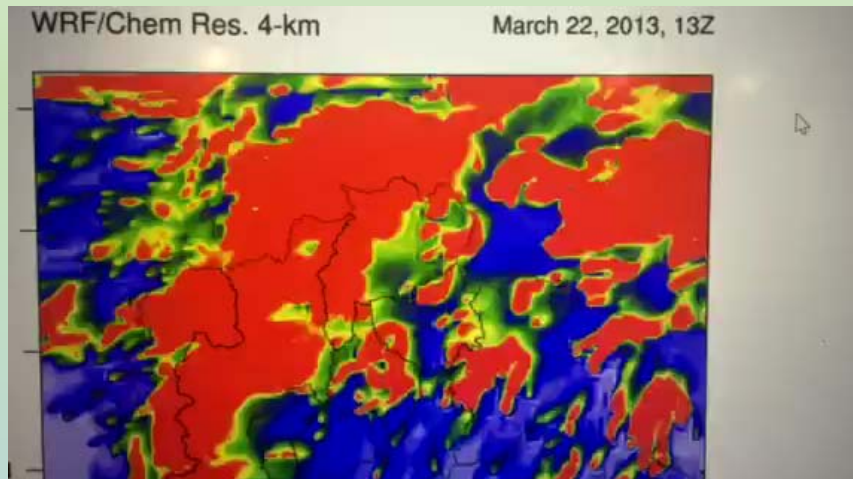
# Concept of predictive modeling

- Predict the  $PM_{2.5}$ ,  $PM_{10}$  concentration and other concern parameters
- Predict the weather data
- Providing the related information for publics
- Accessibility concept for all



IOS and ANDROI system  
Smart Phone

# Haze dispersion modeling and health Impacts



## First year job

- Predict for PM<sub>2.5</sub> and PM<sub>10</sub>
- Predict weather data
- Cover the north of Thailand (any location)




# WRF-Chem Air Quality Forecasting System

-Fires location (MODIS)  
-Ground survey (Optional)

Gridded meteorological data (GFS, NCEP)

Land use  
Land cover  
DEM  
etc.

Brazilian Biomass Burning Emission (3BEM)

WRF  
Pre-processing System)

WRF-Chem

Validation

-MODIS 1km Land use  
-Emission Factor (Akagi et al.)

-Air Pollutants Dispersion and Concentration (PM10, PM2.5, O3, Etc.)  
-Air Quality related Meteorological indices (Ventilation index, PBLH etc,)

Observation data  
-PCD  
-Satellite  
-Low cost sensors



PM2.5 aerosols dry mass over Northern Thailand

WRF-Chem-GRUWRF PCD/PCD/PCD May 11, 2016 11:00:00 (UTC)

PM2.5 concentration (ug/m3)

0 20 40 60 80 100 120 140



**ระบบการพยากรณ์คุณภาพอากาศ รายชั่วโมง**

การพยากรณ์คุณภาพอากาศราย ชั่วโมง เป็นการแสดงผลการพยากรณ์คุณภาพอากาศ ราย 1 ชั่วโมง ล่วงหน้า 3 วัน ซึ่งแสดงข้อมูลมลพิษทางอากาศและตัวแปรทางอุตุนิยมวิทยา

Click

**One hour forecasting**



**แอปพลิเคชันการพยากรณ์คุณภาพอากาศ**

แอปพลิเคชันการพยากรณ์คุณภาพอากาศ คือ แอปพลิเคชันที่นำผลการพยากรณ์คุณภาพอากาศ แสดงผ่านทั้งเว็บแอปพลิเคชันบน **บราวน์เซอร์** ต่างๆ รวมทั้งระบบ **iOS** และ **Android** โดยแสดงผลรายวันและรายชั่วโมงล่วงหน้า 3 วัน

Click

**Applications  
IOS  
ANDROINED**



**แผนที่คุณภาพอากาศและข้อมูลอุตุนิยมวิทยา**

แผนที่คุณภาพอากาศและข้อมูลอุตุนิยมวิทยา รายวัน คือแผนที่ที่แสดงความเข้มข้นของ PM10, PM2.5, O3 และตัวแปรทางอุตุนิยมวิทยาที่เกี่ยวข้อง ซ้อนทับบนแผนที่ Google ง่ายต่อการระบุพื้นที่

Click

**Meteorological  
forecast  
On Map**



**พยากรณ์คุณภาพอากาศรายตำบล เพื่อสนับสนุนการตัดสินใจในการจัดการปัญหาหมอกควัน**

ระบบสนับสนุนการตัดสินใจ เป็นระบบการพยากรณ์คุณภาพอากาศล่วงหน้า 3 วัน รายตำบล ครอบคลุมพื้นที่ 10 จังหวัดภาคเหนือของประเทศไทย

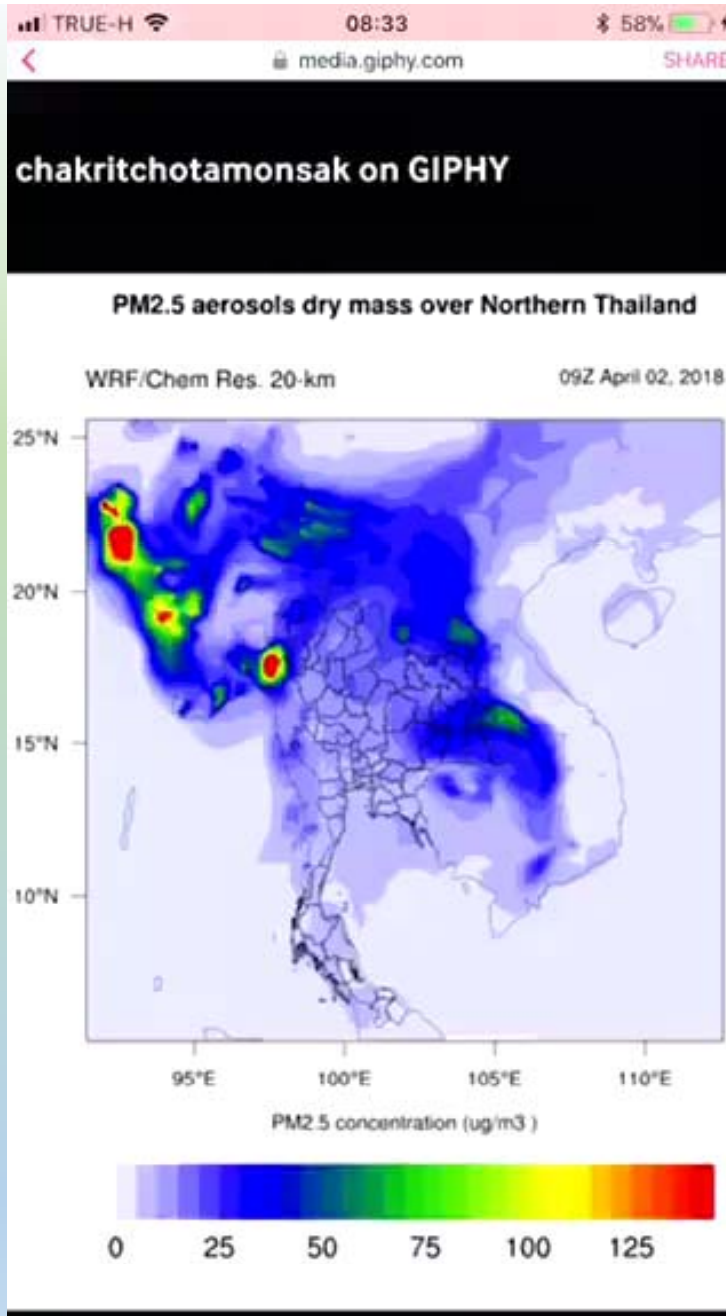
Click

**Prediction in sub-district  
For Decision making**





Any location in Thailand, Myanmar, Laos, Vietnam and Cambodia



24 May 2018

Time	Air Quality	PM10	PM2.5
17	Moderate	37	23
18	Moderate	37	23
19	Moderate	37	24
20	Moderate	38	24
21	Moderate	38	24
22	Moderate	38	23
23	Moderate	37	23

25 May 2018

Time	Air Quality	PM10	PM2.5
------	-------------	------	-------

24 May 2018 17:29 Vientiane Vientiane Prefecture Laos



Air Quality: Moderate  
Ventilation: Moderately

PM10 37 ug/m<sup>3</sup> PM2.5 23 ug/m<sup>3</sup>

Preventive Measures



General  
None



Asthma  
Reduce prolonged or heavy outdoor exertion.



Weather Information

Min 22 °C  
Max 33 °C

29 °C

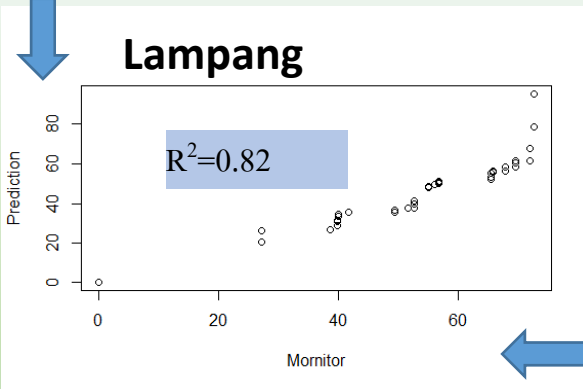
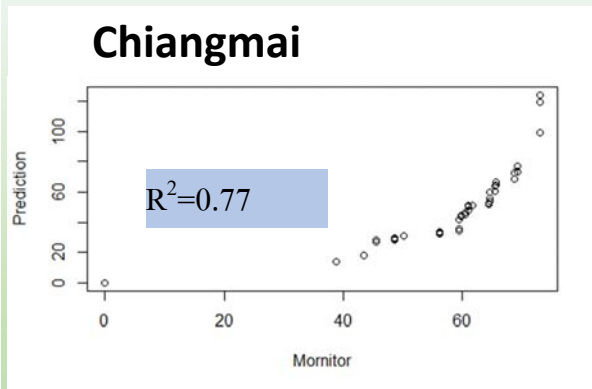
6 km/hr  
23 °C  
70%  
1006 mb.



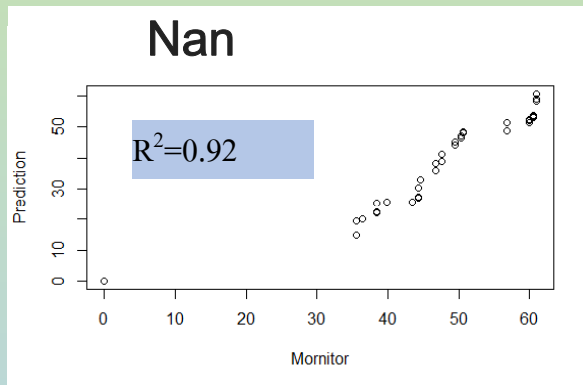
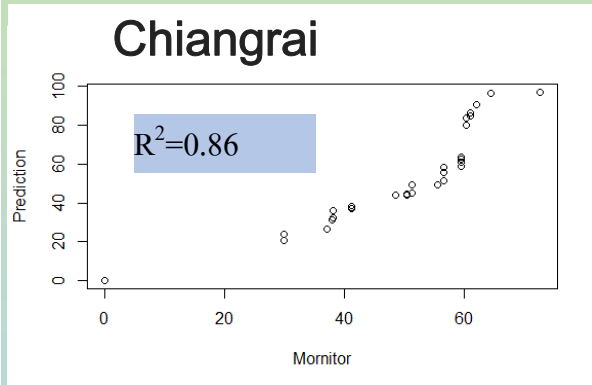
Mostly clear  
Light Rain



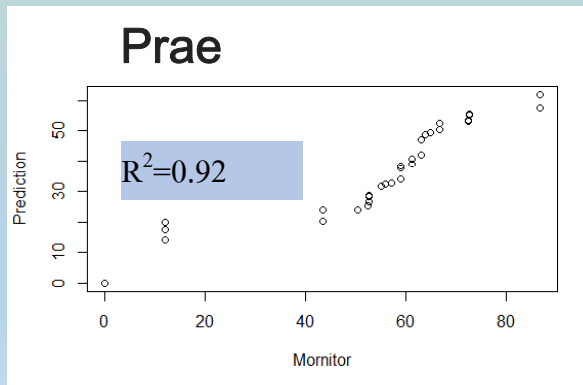
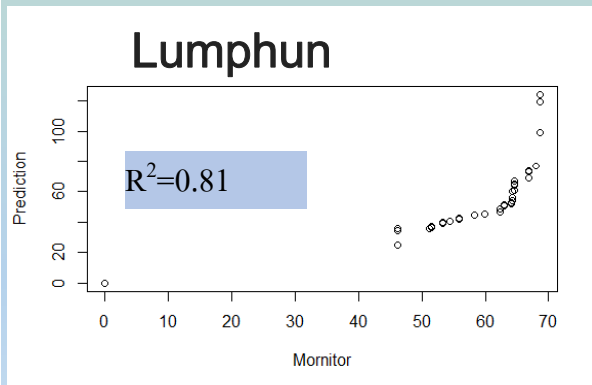
Prediction data



Monitoring data



- COMPARISON OF PREDICTED FROM MODEL AND PCD (POLLUTION CONTROL DEPARTMENT) MEASUREMENT



We need more monitoring station for validation of the model

# Thank you for your attention

## Khob Khun Krub



SAWAS DEE Kha  
Sawas DEE Krub