



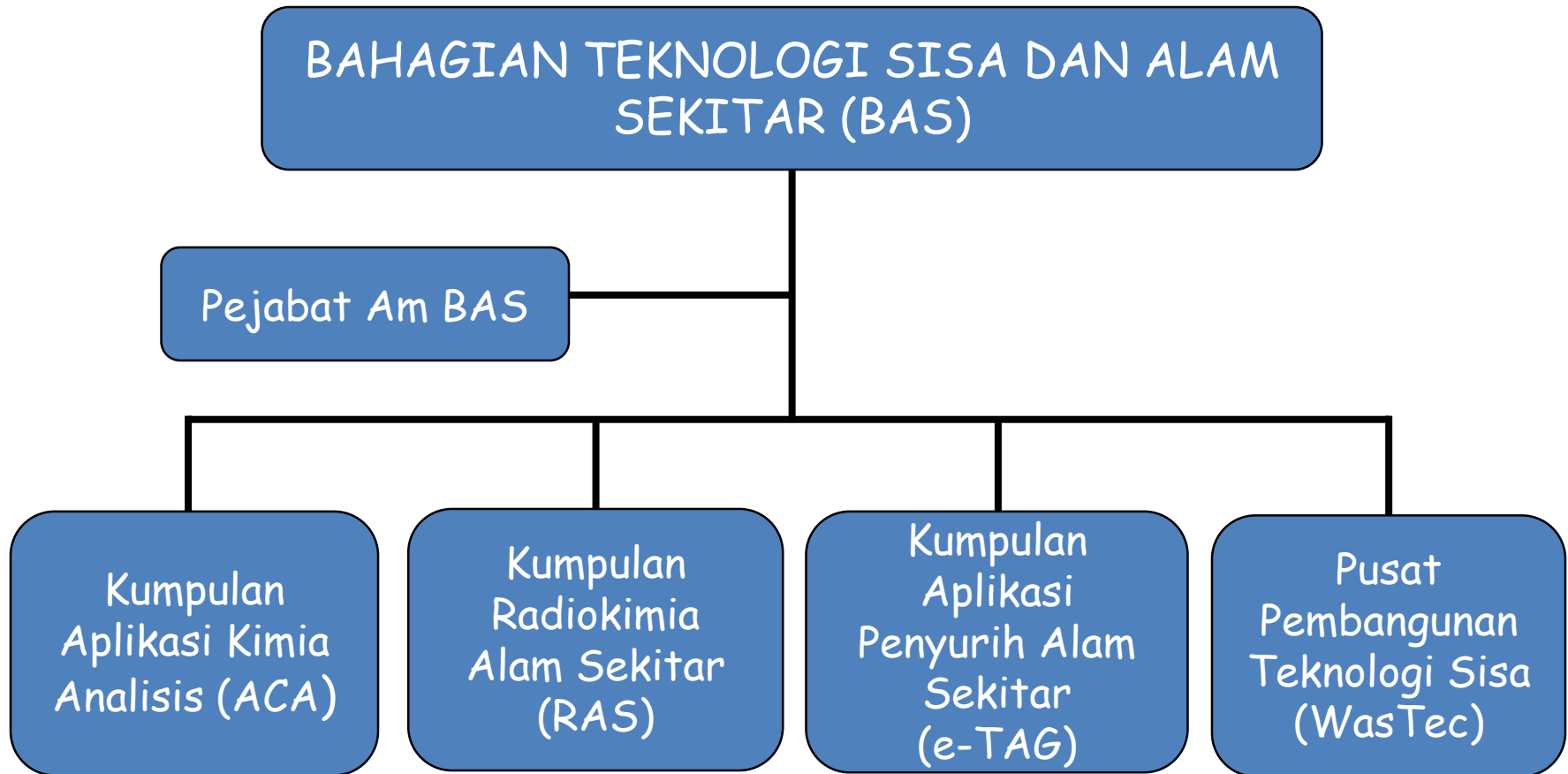
## PERKONGSIAN DATA

Agensi Nuklear Malaysia - Jabatan Alam Sekitar

29 Mei 2019

Shamsiah Abdul Rahman  
Bahagian Teknologi Sisa dan Alam Sekitar  
Agensi Nuklear Malaysia, Bangi

# Carta Organisasi Bahagian Teknologi Sisa dan Alam Sekitar (BAS)



# PERKONGSIAN DATA

## Agensi Nuklear Malaysia - Jabatan Alam Sekitar

- **Introduction:**
  - IAEA/RCA project on air pollution (1998-2018)
  - Objective
  - Methodology
- **Data Analysis (IAEA/RCA/Malaysia database)**
  - A-PAD (Asia - Pacific Aerosol Database)
  - ASFID (Asia- Pacific Source Finger print Database)
- **Identifying trans -boundary pollution event**
- **Conclusion**
- **Acknowledgements**

# INTRODUCTION

- IAEA/RCA project on air pollution (1998-2018)
- Objective
- Methodology

# INTRODUCTION

- IAEA/RCA project on air pollution (1998 - 2018 )

**RAS/8/082:** Isotopic and Related Techniques to Assess Air Pollution 9-13 Mac, 1998, MINT, Bangi, (1998-2002)

**RAS/7/013:** Improved information of urban air quality management in the RCA region, (2003-2006)

**RAS/7/015:** Characterization and Source Identification of Particulate Air Pollution in the Asian Region, 21-24 August, 2007, Goa, India (2007-2010)

**RAS/7/023:** Supporting Sustainable Air Pollution Monitoring Using Nuclear Analytical Technology , 9-13 Jul, 2012, Malaysian Nuclear Agency, Bangi, (2012-2015)

**RAS/7/029:** Assessing the Impact of Urban Air Particulate Matter on Air Quality , 9-13Nov, 2015, Rotorua, NZ (2016-2018)

# INTRODUCTION

## Objective:

- **1998 -2000:** To demonstrate the applicability of nuclear and related analytical techniques (mainly NAA, XRF, PIXE and ICP-MS) in studies of pollution caused by APM (airborne particulate matter)
- **2000-2007:** To obtain large set of high-quality regional data (multi-elemental data) in both fine and coarse airborne particle and to determine the contributing source of APMs (PMF2, EPA-PMF1, EPA-PMF3)
- **2008-2011:** To establish the elemental database for particulate air pollution in the Asian region - **A-PAD project**
- **2012-2016:** To establish the elemental database and source identification for particulate air pollution in the Asian region and source identification (PMF2 macro) - **ASFID project**
- **2016-2018:** To investigate the long range transport of pollution sources

# INTRODUCTION

- **Other activities:**

- 2008: OC- BC measurement, conducted by Prof Hopke, University Clarkson, USA.

Salako Gbenga Oladoyin, Philip K. Hopke, David D. Cohen, Bilkis A. Begum, Swapan K. Biswas, Gauri Girish Pandit, Yong-Sam Chung, Shamsiah Abd Rahman, Mohd Suhaimi Hamzah, Perry Davy, Andreas Markwitz, Dagva Shagjjamba, Sereeter Lodoysamba, Wanna Wimolwattanapun, Supamatthree Bunprapob. Exploring the variation between EC and BC in a variety of locations across the globe. *Aerosol and Air Quality Research 12 (2012), 1-7*

- 2011: Multi-elemental determination in Road dust with the help of Alam Flora Sdn Bhd.

S. A. Rahman M. S. Hamzah Md S. Elias, B.S. Wee, N.A.A. Salim and E. Sanuri, Elemental determination and source apportionment of road dust in Klang Valley, Kuala Lumpur. *Japan Association of Activation Analysis 29 (2013), 29-44*

- 2014 - 2017: Impacts of Air Particulate Matter (APM) Concentrations and Sources on Cultural Heritage co-operation with Jabatan Muzium, KL

Report: Evaluate and Assess Analytical Results on Gaseous Pollutants from Member State Cultural Heritage Site, Rene VAN GRIEKEN, University of Antwerp, Belgium, 2015

# INTRODUCTION

## Methodology

- Sampling station: Universiti Teknologi Malaysia (UTM), Kuala Lumpur (3° 10' 30"N, 101° 43' 24"E) - rooftop of a two storey building at approximately 10 meters height.
- Sampler: Gent stack sampler programmed to run automatically at flow-rate of 15L/min to collect fine (PM<sub>2.5</sub>) and coarse particle (PM<sub>2.5</sub> - 10),
- Sample collection: 1-2x/week
- Elemental analysis: NAA, ICP- MS, PIXE (NUS Singapore, GNS Science New Zealand)
- Mass measurement: Microbalance/ semi microbalance
- Black carbon (BC) measurement: Reflectometer



# INTRODUCTION

Station: Klang Valley, Kuala Lumpur

- Urban area/industrial area with estimated population of 7 millions
- Popular place for the migrants from other states within Malaysia and foreign workers

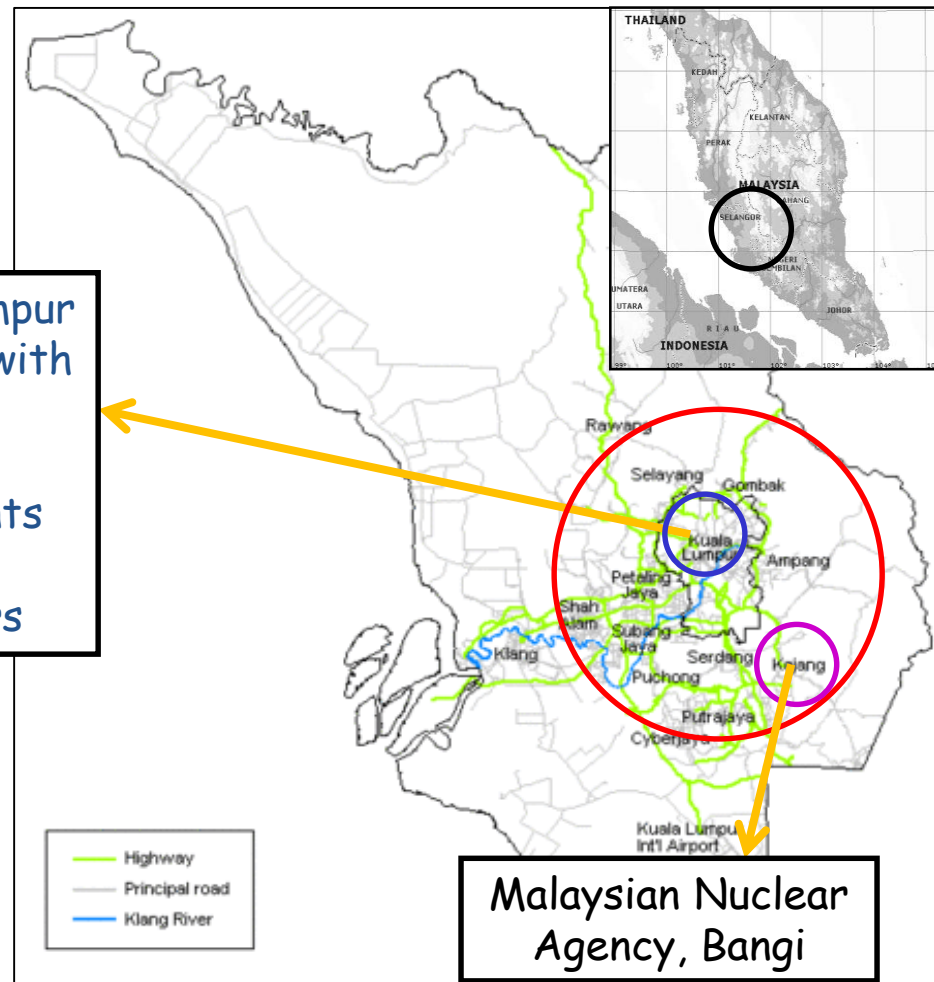


Fig 1: Location of sampling site at Klang Valley

# INTRODUCTION: METHODOLOGY



Fig 2. Gent sampling unit at UTM, Kuala Lumpur



Fig 3. Fine (KLF 591) and Coarse (KLC 591) sample collected in May 2010



Fig 4. Microbalance (METTLER Model MT5)



Fig 5. EEL Smoke Stain Reflectometer

# Data Analysis (IAEA/RCA/Malaysia database)

- A-PAD (Asia Pacific Aerosol Database) - elemental database
- ASFID (PMF Receptor Fingerprint database)

# Data Analysis (IAEA/RCA/Malaysia database)

- **A-PAD (Asia Pacific Aerosol Database) - Elemental database**
  - Multi-elemental characterisation database comprising both fine and coarse airborne particle data generated by 14 IAEA member states
  - Sample collection: 1-2 x/week for 24 hours
  - Malaysia has sampling data collected for 1,023 between Jan 2002 - Dec 2017

- The participating member states:

Australia (AUS)

Mongolia (MON)

Bangladesh (BAN)

New Zealand (NZ)

China (CHN)

Pakistan (PAK)

India (IND)

Philippines (PHI)

Indonesia (INO)

Sri Lanka (SRI)

Korea (KOR)

Thailand (THA)

Malaysia (MAL)

Vietnam (VIE)

**Japan, Laos, Myanmar, Nepal (not contribute any data)**

A. J. Atanacio, D. D. Cohen, B. A. Begum, B. Ni, G. G. Pandit, S. K. Sahu, M. Santoso, D.D.Lestiani, J. M. Lim, S. A. Rahman, M. S. Elias, D. Shagjjamba, A. Markwitz, S. Waheed, N. Siddique, P. C. Pabroa, F. L. Santos, M. C. S. Seneviratne, L. Handagiripathira, W. Wimolwattanapun, T. B. Vuong, A. Karydas (2016). The APAD and ASFID: Long-term fine and coarse ambient particulate matter and source fingerprint databases for the Asia-Pacific Region. *Air Quality and Climate Change* 50 (3), 41-49

Table 1 : IAEA/RCA elemental database @ 31 Jul 2015

SITE	START	STOP	Err=9	Mass>0	Al>0	Si>0	S>0	BC>0	No.Elts
AUS33	02-Jan-02	29-Dec-13	95	1,171	1,139	1,171	1,171	1,163	'22-22
AUS35	06-Jan-02	29-Dec-13	77	1,220	1,183	1,220	1,220	1,173	'22-22
BAN880	02-Jan-02	23-Feb-14	28	1,052	1,051	1,051	1,051	1,052	'1-29
CHN86	07-Jan-02	13-May-04	32	79	79	0	14	0	'22-36
CHN86a	23-Mar-04	09-Oct-06	29	133	114	0	41	0	'10-37
CHN86b	20-Nov-03	19-Jul-13	36	389	381	140	275	140	'10-37
IND91a	01-Jan-02	26-Dec-12	39	676	372	567	568	676	'1-30
INO62	13-Jan-03	31-Dec-13	100	742	692	569	569	738	'1-33
INO62a	13-Jan-03	25-Jun-09	151	573	547	425	427	566	1-33
INO62b	11-Sep-08	30-Dec-13	6	272	262	273	273	273	'10-25
KOR82	05-Jan-02	30-Nov-07	101	490	486	0	0	490	8-24
KOR82a	05-Jan-02	11-Dec-08	88	583	570	0	0	583	'11-24
MAL60	08-Jan-02	30-Dec-13	66	574	574	574	574	574	'21-21
MON73	25-Oct-04	14-May-15	16	775	784	786	786	786	'17-33
NZ64c	15-Jul-05	29-Jun-07	20	142	142	142	142	138	'32-32
NZ64b	05-Jul-02	10-Jan-04	10	77	77	77	77	77	'32-33
NZ64e	01-Sep-06	09-Dec-12	166	568	560	568	568	415	'32-32
NZ64f	09-Feb-10	15-Dec-10	29	100	100	100	100	100	'36-36
NZ64a	22-May-00	28-Jan-02	56	77	77	77	77	77	'33-33
PAK92	17-Apr-02	19-May-11	0	898	878	754	755	893	'54-54
PHI63	16-Jan-01	28-Apr-13	24	1,183	1,157	1,183	1,183	1,183	'21-21
SRI94	18-Jun-03	30-Mar-12	17	305	300	302	302	303	'28-41
SRI94a	04-May-00	15-Aug-07	37	237	225	233	233	234	26-38
SRI94b	23-Jun-12	01-Sep-13	2	73	73	73	73	73	'41-41
THA66	02-Jan-02	30-Dec-07	6	556	556	485	485	556	'19-26
THA66a	15-Jan-03	30-Dec-07	46	425	425	401	401	425	'19-25
VIE84	16-Jan-02	20-May-13	7	646	625	646	646	646	'21-22
		<b>Total</b>	<b>1,284</b>	<b>14,016</b>	<b>13,429</b>	<b>11,817</b>	<b>12,011</b>	<b>13,334</b>	
		<b>%</b>	<b>9.2</b>	<b>100</b>	<b>96</b>	<b>84</b>	<b>86</b>	<b>95</b>	

Table 2: IAEA/RCA site sampling times @ 31 Jul 2015

### IAEA/ RCA Site Sampling Times at 31 July 2015

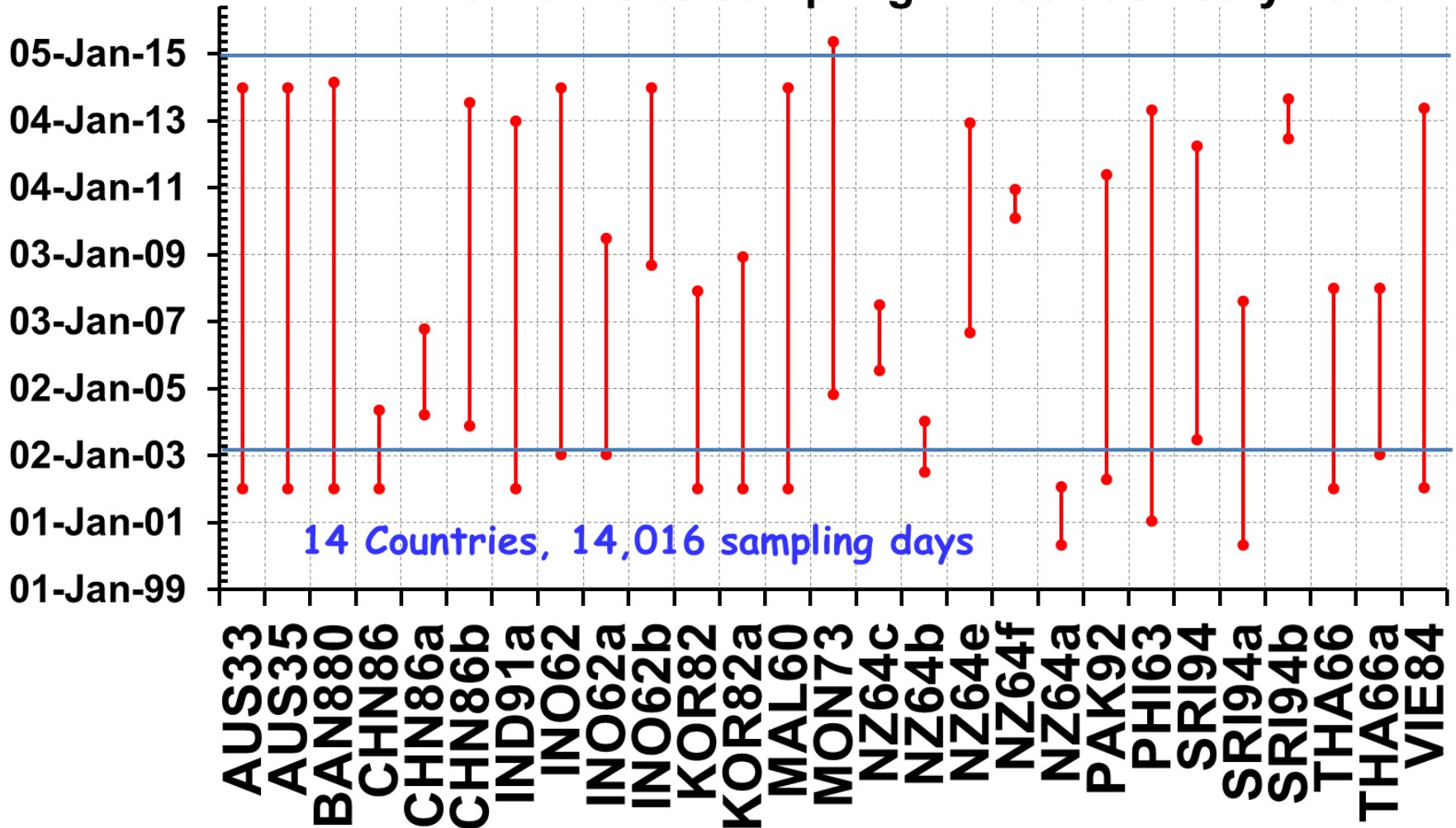


Table 3: Annual average of air particulate at Kuala Lumpur, Klang Valley, 2002-2013

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Year	PM <sub>2.5</sub> (µg m <sup>-3</sup> )	PM <sub>2.5-10</sub> (µg m <sup>-3</sup> )	PM <sub>10</sub> (µg m <sup>-3</sup> )
2012	25.5	25.4	50.9
2013	19.0	20.1	39.1
2014	22.7	18.6	41.3
2015	22.4	15.6	38.0
2016	16.4	12.2	28.6
2017	18.1	14.8	32.9
2018	23.8	19.9	43.8
<i>Average</i>	<i>21.2</i>	<i>24.4</i>	<i>46.5</i>
<i>Guidelines/ standard</i>	<i>USEPA NAAQS 15µg/m<sup>3</sup>(annually) 35 µg/m<sup>3</sup> (24 hour)</i>		<i>Malaysian AAQ 50 µg/m<sup>3</sup> (annually) 150 µg/m<sup>3</sup> (24 hour)</i>

KUALA LUMPUR MONTHLY MASS CONCENTRATION 2012-2018

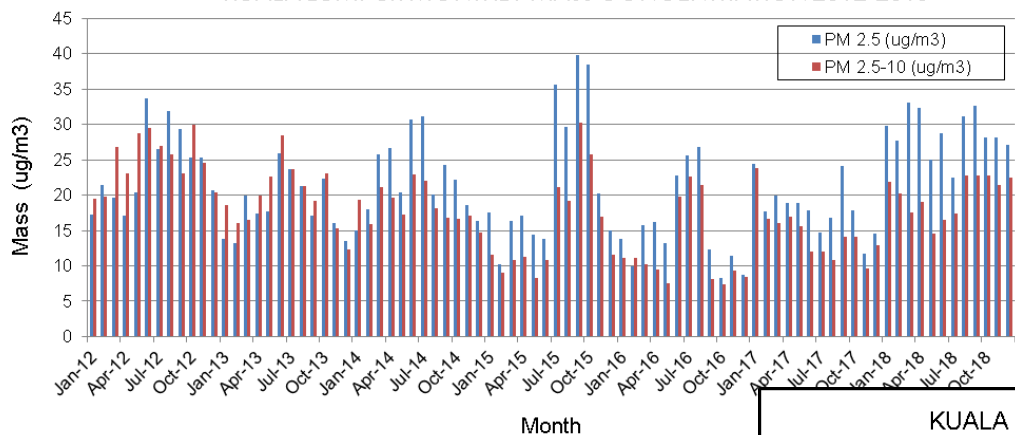
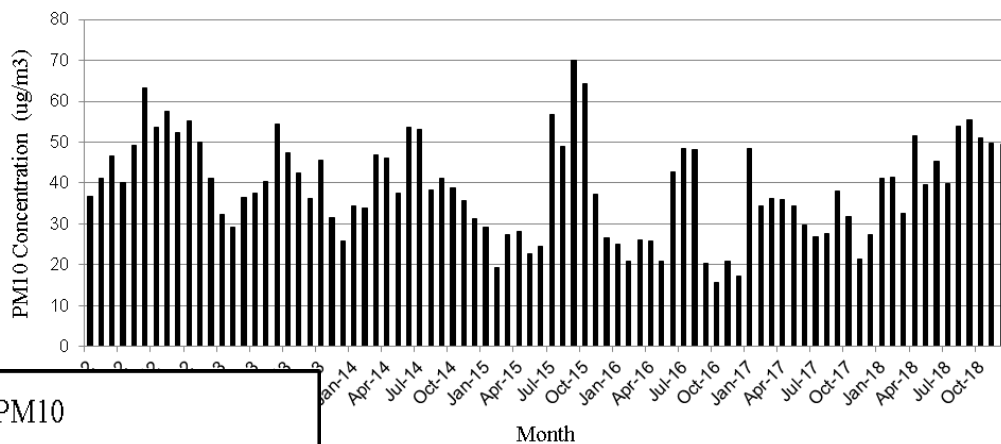


Fig 6: Monthly average of PM<sub>2.5</sub> and PM<sub>10-2.5</sub> mass 2012-2018

Fig 7. Monthly average of PM<sub>10</sub> mass, 2012-2018

KUALA LUMPUR MONTHLY PM10 CONCENTRATION 2012-2018



KUALA LUMPUR 2012-2018: PM2.5 Vs PM10

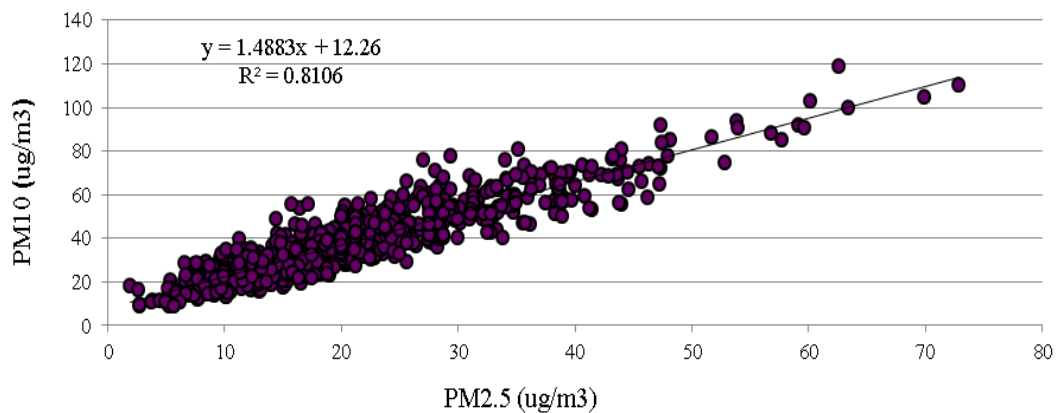


Fig 8. Plot of PM<sub>10</sub> versus PM<sub>2.5</sub>, 2012-2018

Fig 9. Annual average of  $PM_{2.5}$  and  $PM_{2.5-10}$ , Kuala Lumpur 2002-2018

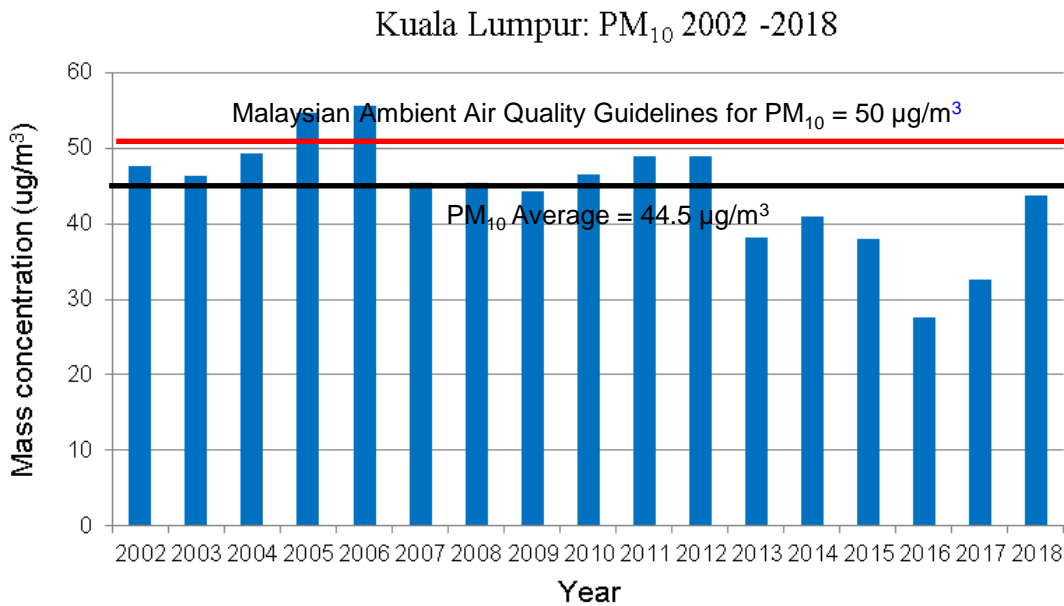
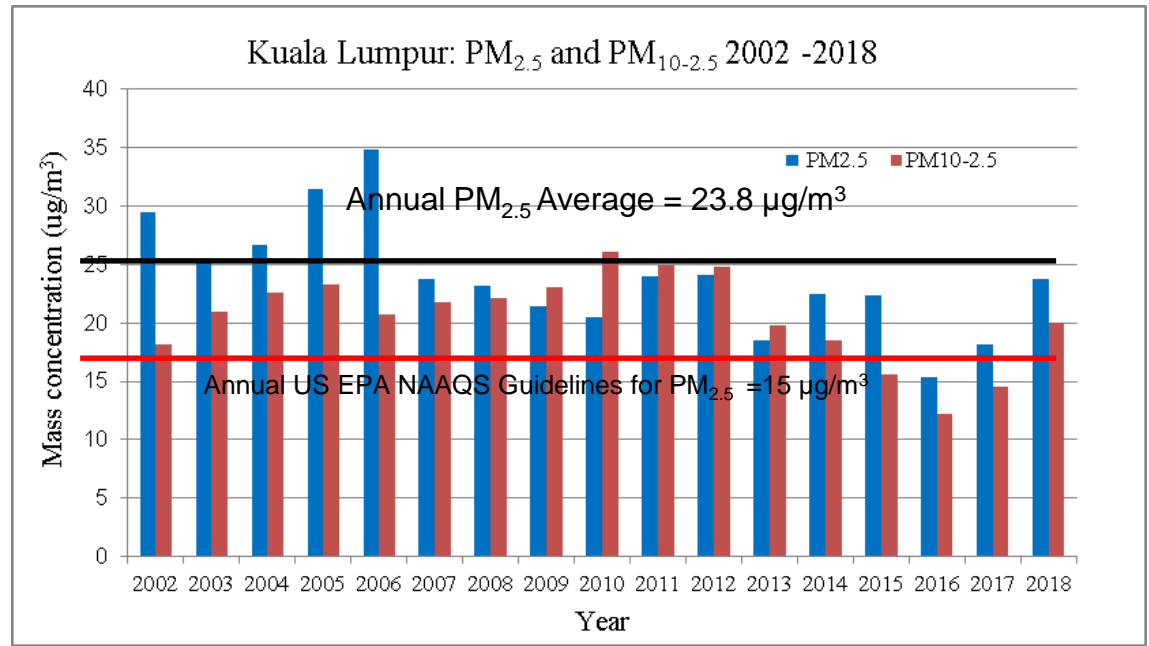


Fig 10. Annual average of  $PM_{10}$  mass, Kuala Lumpur 2002-2018

# Data Analysis (IAEA/RCA/Malaysia database)

- **ASFID (Asia Pacific Source Fingerprint Database)**
- Set of receptor source fingerprint and related apportionment generated from A-PAD using statistical the Positive Matrix Factorisation (PMF) technique.
- The IAEA master PMF database contains:
  - factor elemental fingerprint solution,
  - daily fingerprint concentrations (in ng/m<sup>3</sup>),
  - daily factor contributions (in % of total mass)
  - fingerprint errors

# DATA ANALYSIS: FACTOR PROFILES AND CONTRIBUTION (FINE)

SIX (6) factors PMF solutions were found for elemental composition of FINE particulate matter in Klang Valley, Kuala Lumpur. Soil dust (14.5%), 2ndry sulfate (34.3%), Smoke, (6.03%), Auto dust (5.14%), Ind metal (0.54%), Motor vehicles (39.5%),

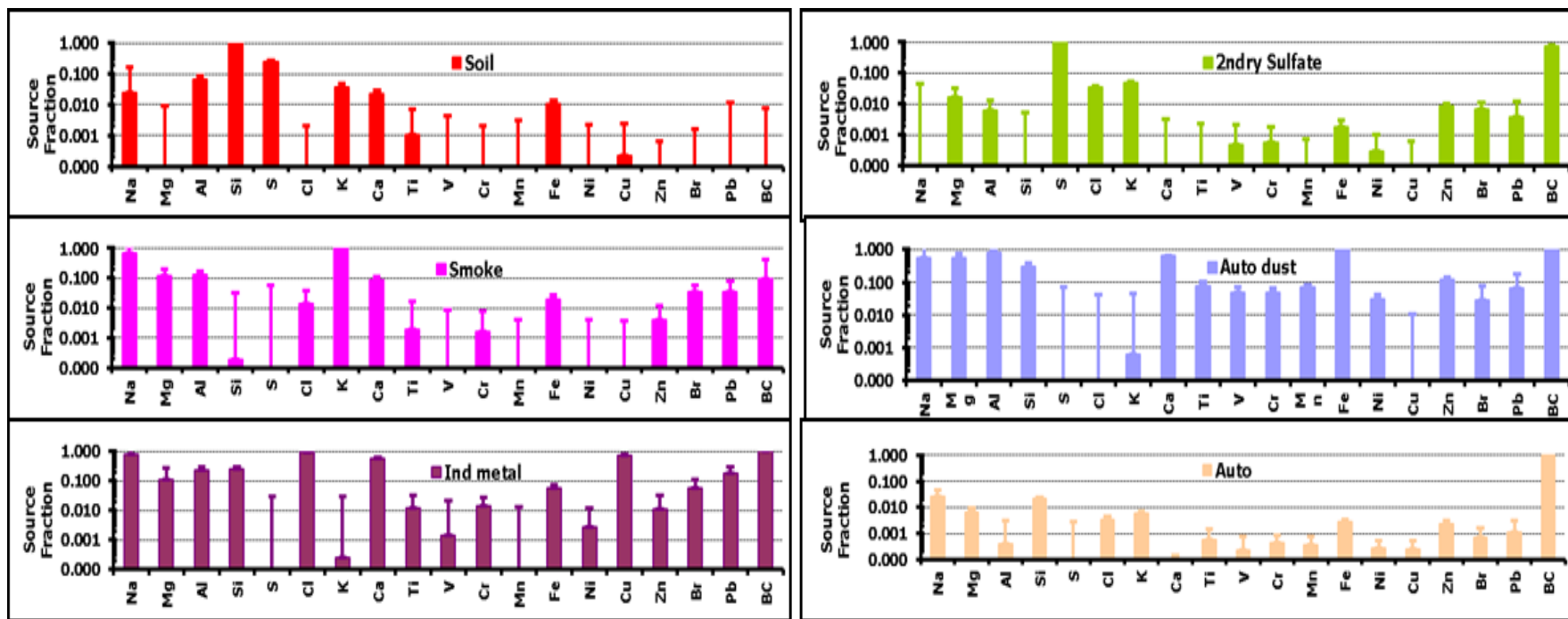


Fig 11: Source profiles plot for the fine particles 2002-2017

# DATA ANALYSIS: FACTOR PROFILES AND CONTRIBUTION (FINE)

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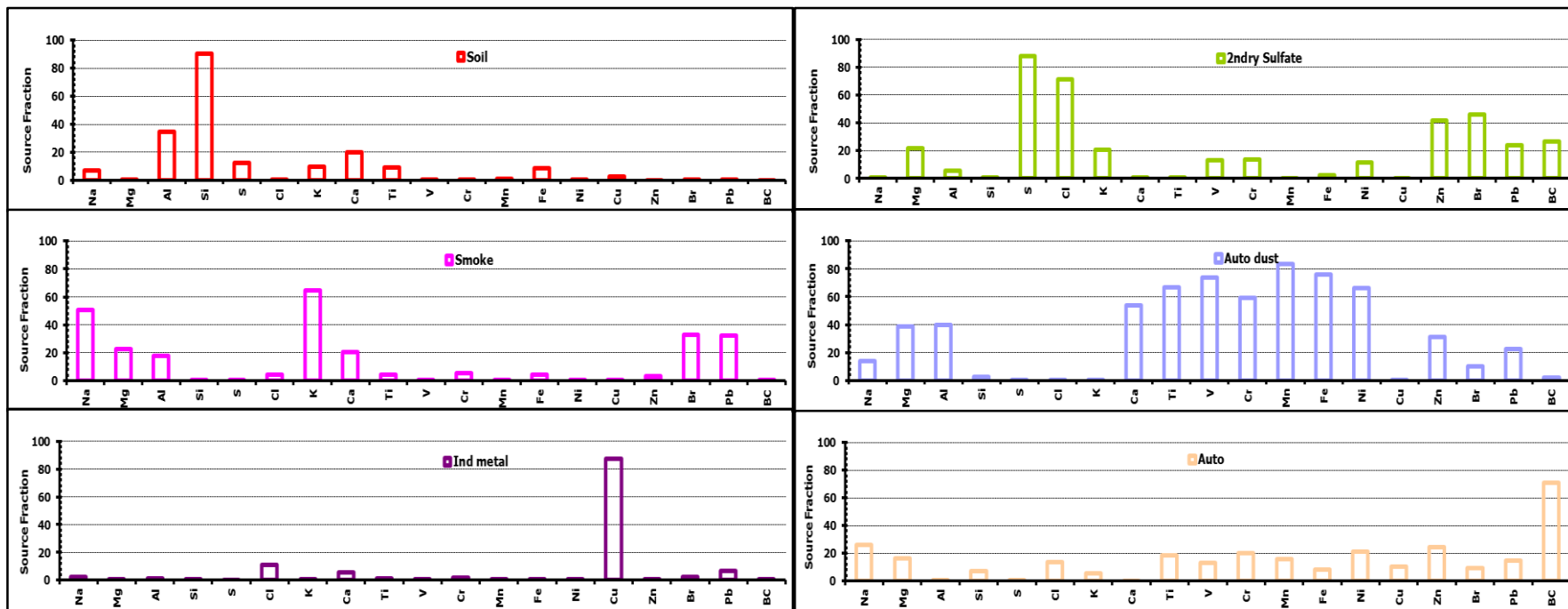


Fig 11: Percent plots for the fine particles 2002-2017

# DATA ANALYSIS: FACTOR PROFILES AND CONTRIBUTION (COARSE)

FIVE (5) factors PMF solutions were found for elemental composition of COARSE particulate matter in Klang Valley, Kuala Lumpur. The sources identified as: Soil (7.2%), IndCl ( 7.5%), Auto 1 (29.9%) Soil Construction (20.6%), Auto 2 (34.7%)

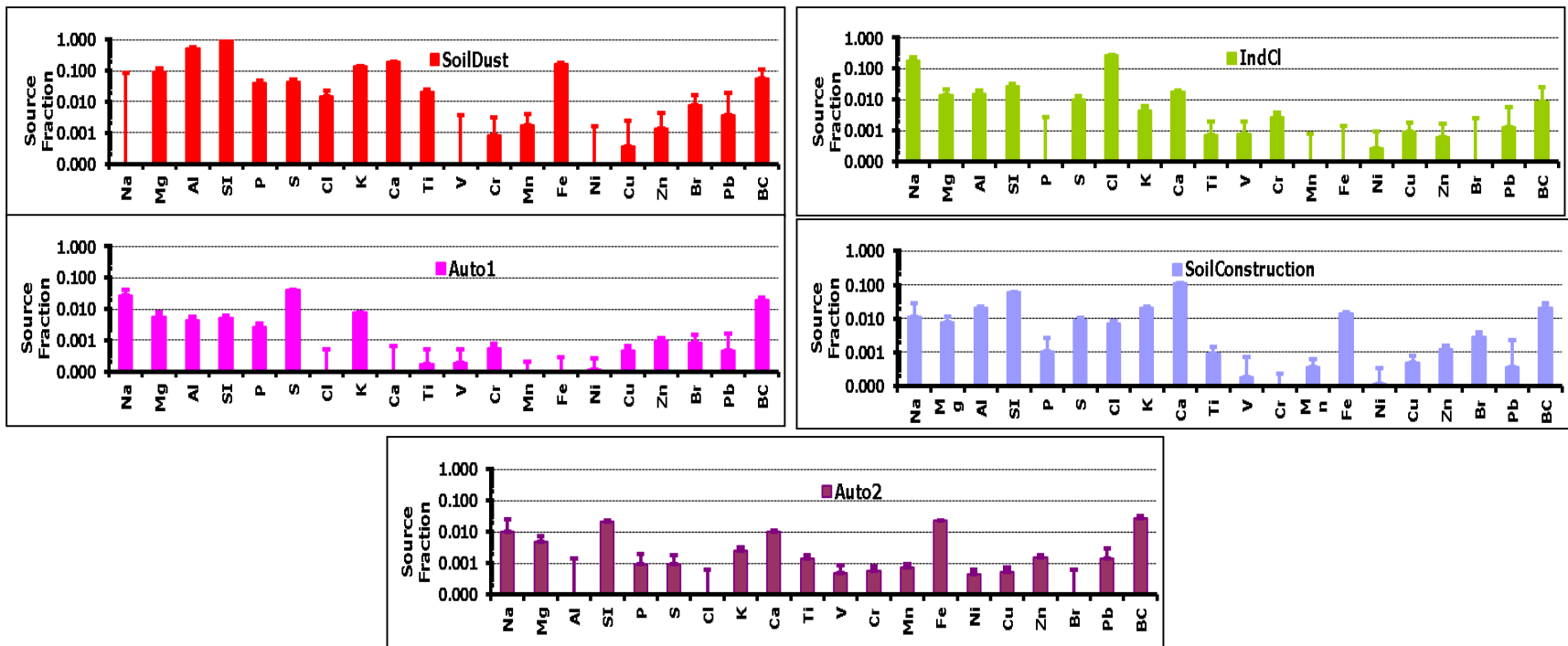


Fig 12: Source profiles plot for the coarse particles, 2002-2017

# DATA ANALYSIS: FACTOR PROFILES AND CONTRIBUTION (COARSE)

FIVE (5) factors PMF solutions were found for elemental composition of COARSE particulate matter in Klang Valley, Kuala Lumpur. The sources identified as: Soil (7.2%), IndCl ( 7.5%), Auto 1 (29.9%) Soil Construction (20.6%), Auto 2 (34.7%)

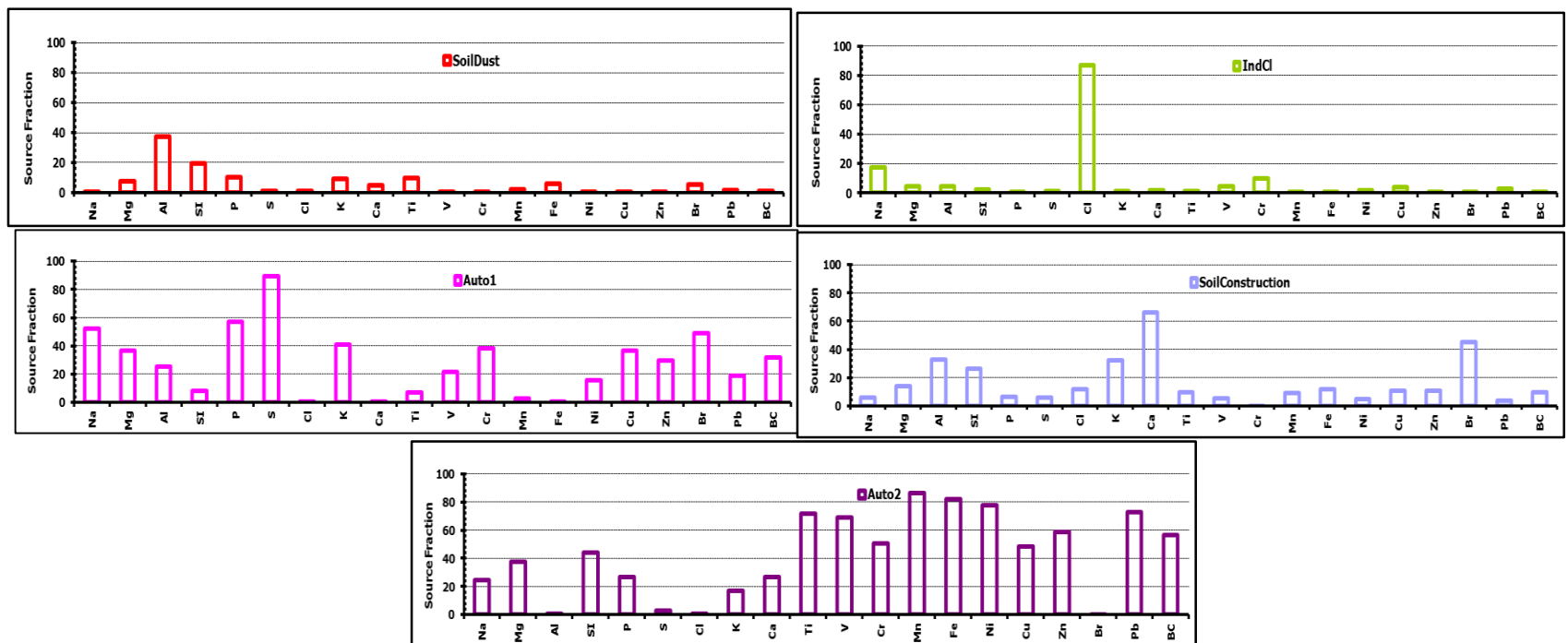


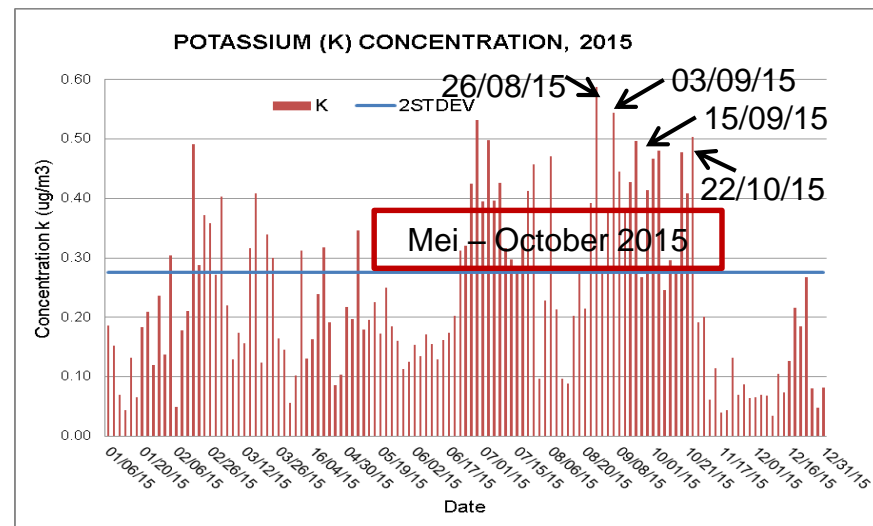
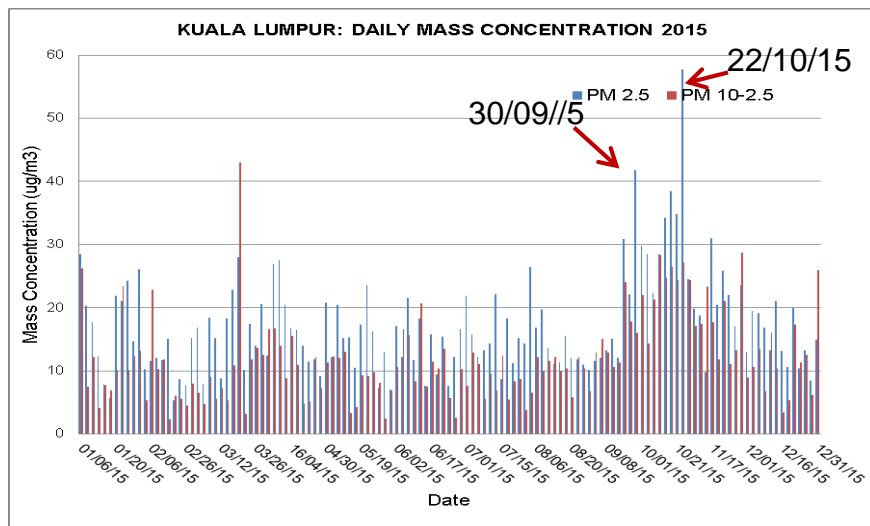
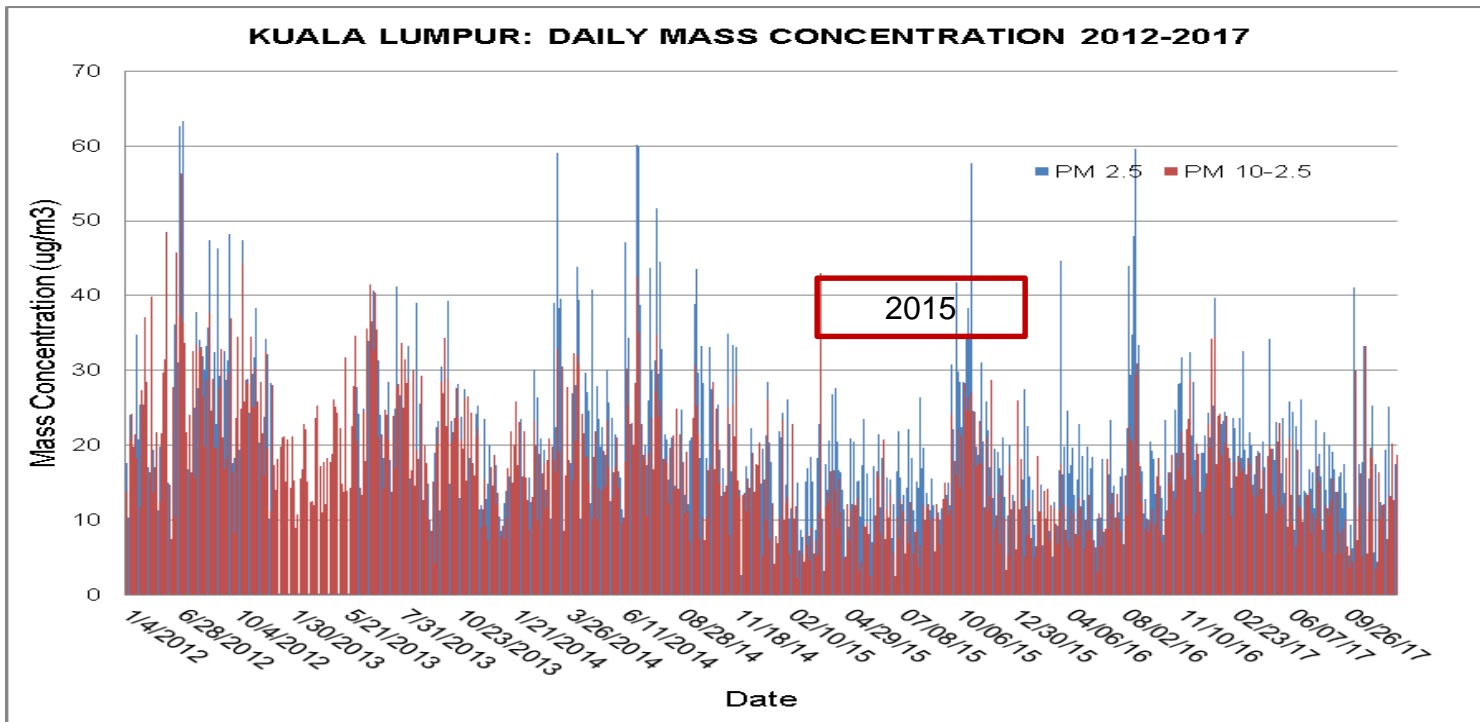
Fig 12: Percent plots for the coarse particles, 2002-2017

Identifying  
trans -boundary pollution  
event

## DATA ANALYSIS: LONG RANGE TRANSPORT/TRANS-BOUNDARY POLLUTION

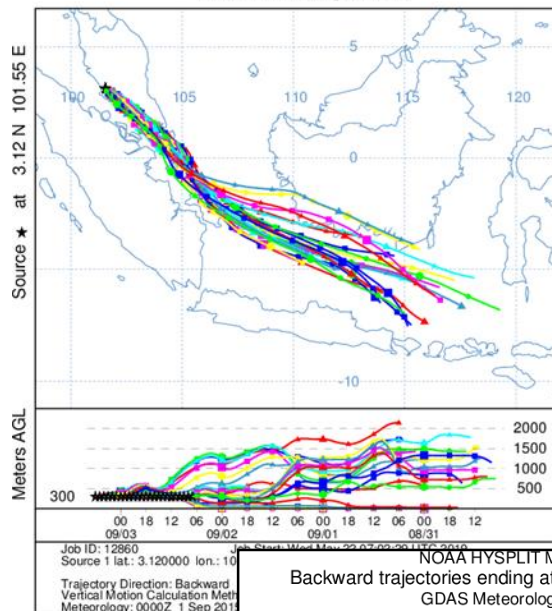
- Fine potassium (K) is an accepted indicator for smoke
- Potassium is released especially under high temperatures in fires mostly as potassium chloride and potassium sulfate and has been often used as indicator of biomass burning
- Therefore smoke can be calculated as:

$$\text{Smoke} = [\text{K}] - 0.6 [\text{Fe}]$$

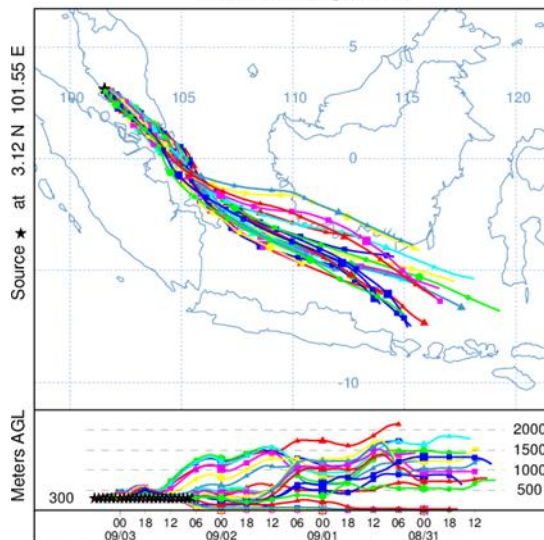


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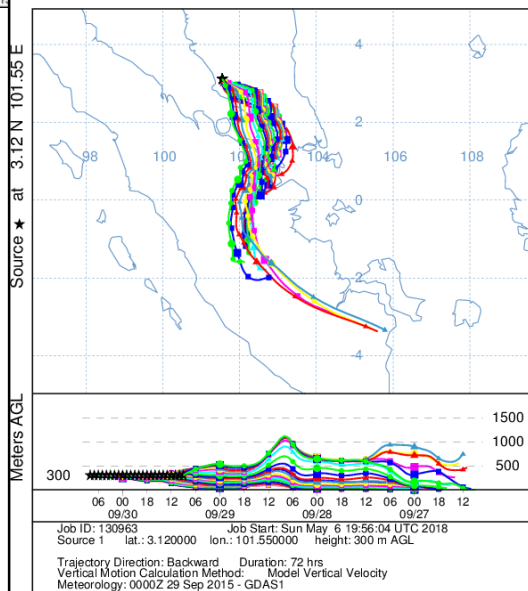
NOAA HYSPLIT MODEL  
Backward trajectories ending at 0600 UTC 03 Sep 15  
GDAS Meteorological Data



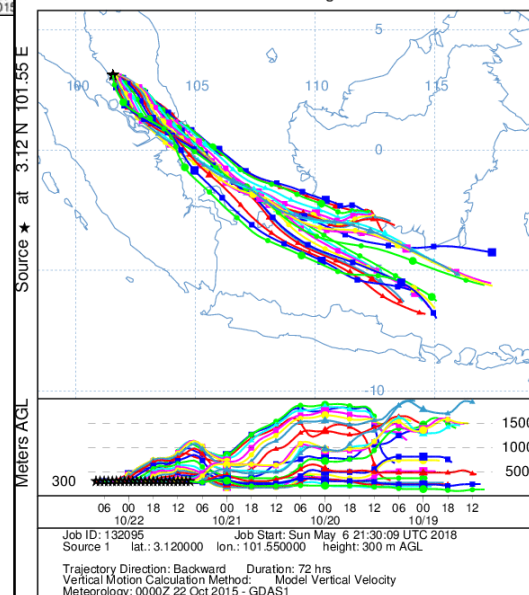
NOAA HYSPLIT MODEL  
Backward trajectories ending at 0600 UTC 03 Sep 15  
GDAS Meteorological Data



NOAA HYSPLIT MODEL  
Backward trajectories ending at 0800 UTC 30 Sep 15  
GDAS Meteorological Data



NOAA HYSPLIT MODEL  
Backward trajectories ending at 0800 UTC 22 Oct 15  
GDAS Meteorological Data



Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT)  
(<http://www.arl.noaa.gov/ready.php>)

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# Identifying Trans-boundary Air Pollution Events Across Asia Pacific

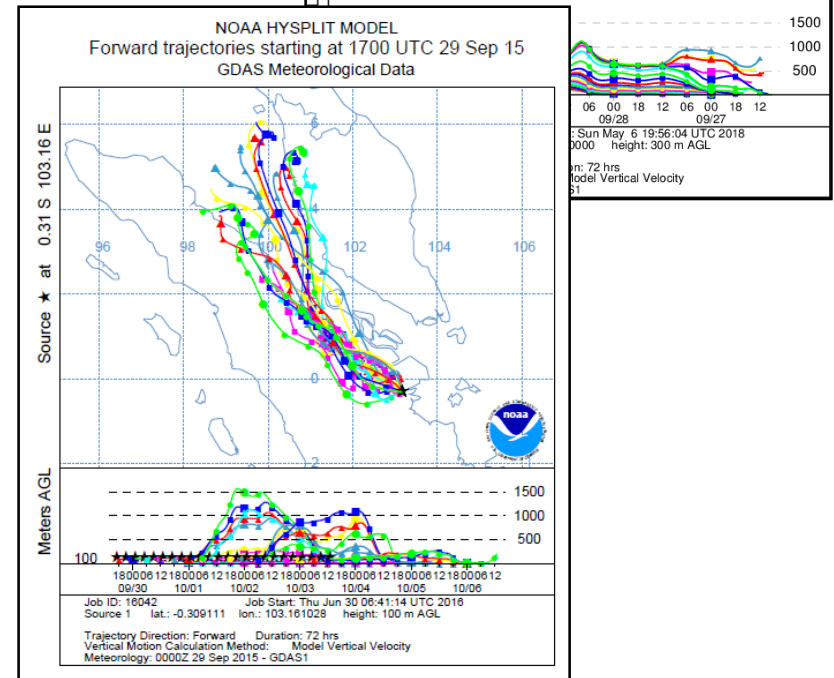
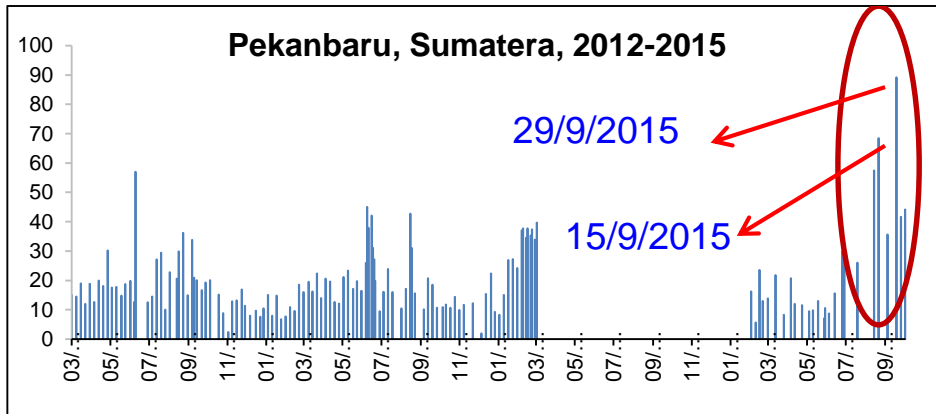
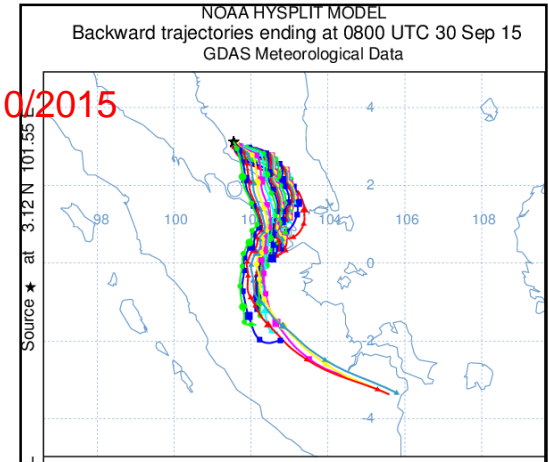
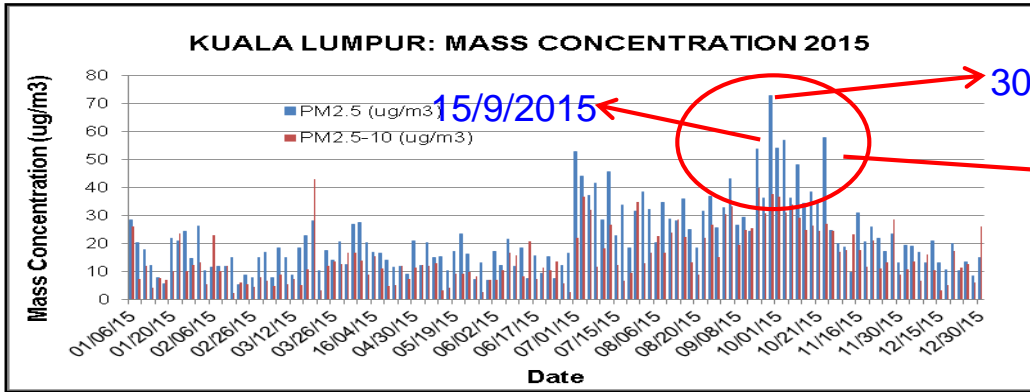
- Based on the possible source, countries were divided into 3 working groups:

Group 1: Korea, China, Mongolia, Vietnam, Japan - identified some possible joint events which are soil, smoke and secondary S.

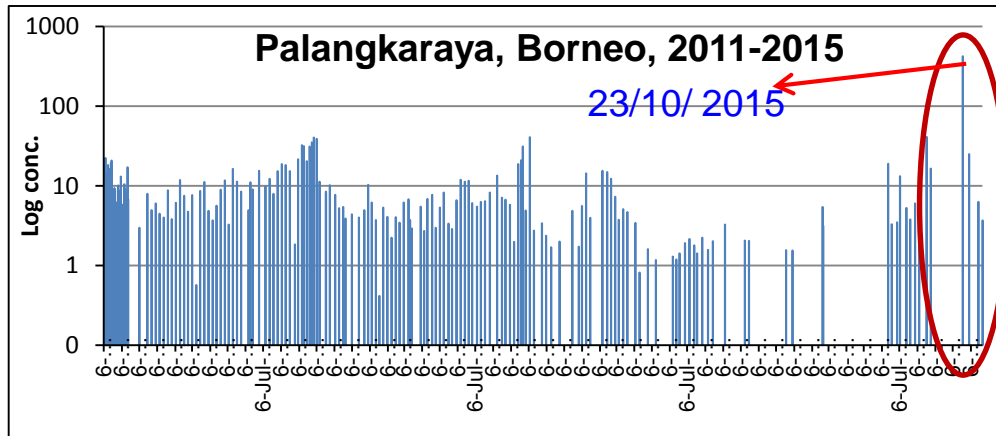
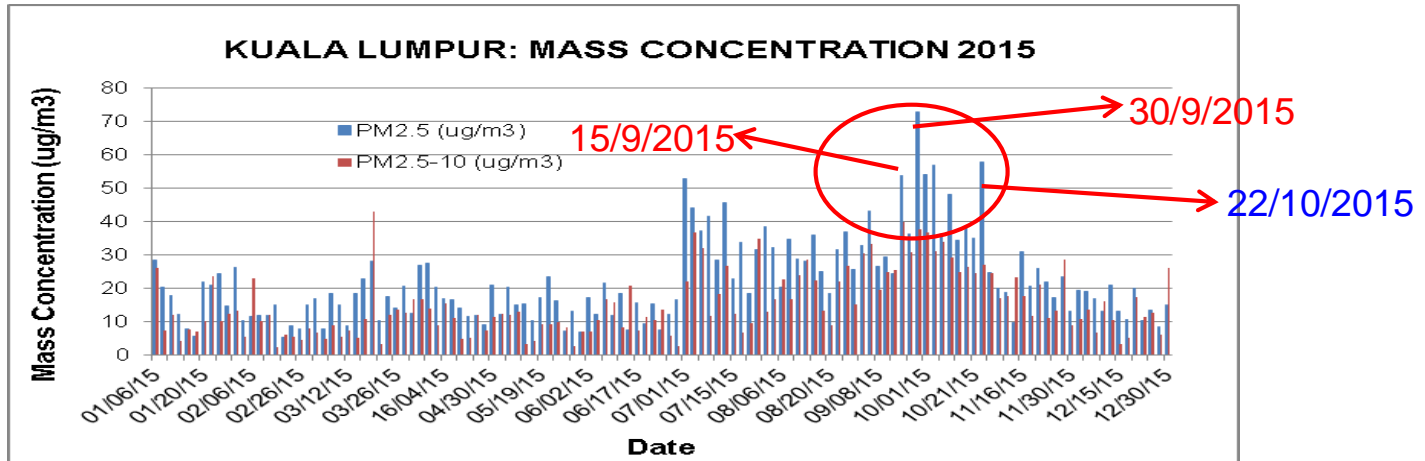
Group 2: Malaysia, Indonesia, Australia, Thailand, New Zealand, Laos and Philippines - Malaysia and Thailand identified smoke from forest fires in Indonesia, while Indonesia get affected by smoke travelled from northern territory of Australia.

Group 3: Bangladesh, India, Pakistan, Myanmar, Sri Lanka - identified 2 events, soil and smoke BC

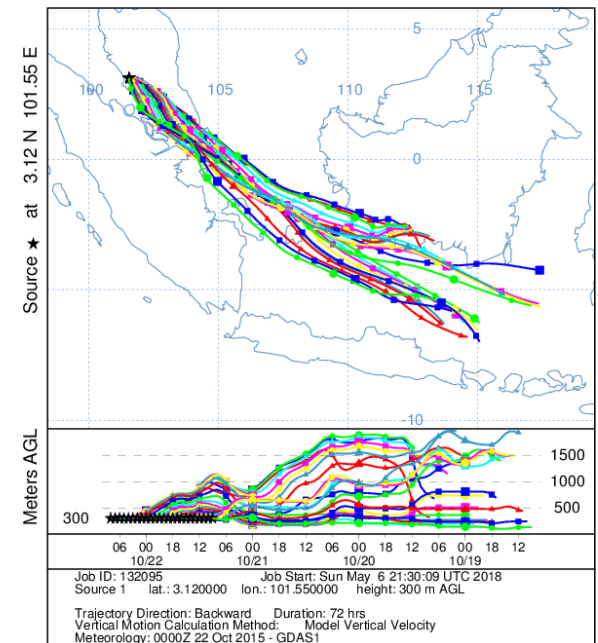
# LONG RANGE TRANSPORT (LRT)



# LONG RANGE TRANSPORT (LRT)



NOAA HYSPLIT MODEL  
Backward trajectories ending at 0800 UTC 22 Oct 15  
GDAS Meteorological Data

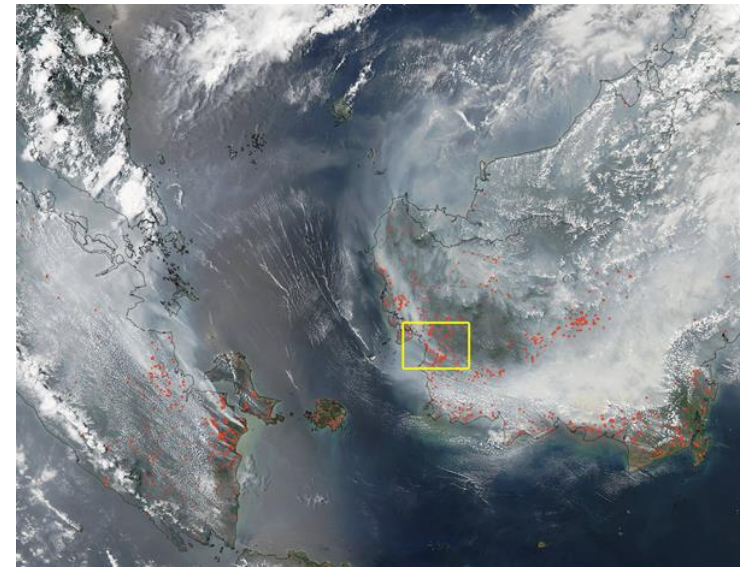


Three (3) days backward (top) and forward (down) trajectories to/from Sumatera Island

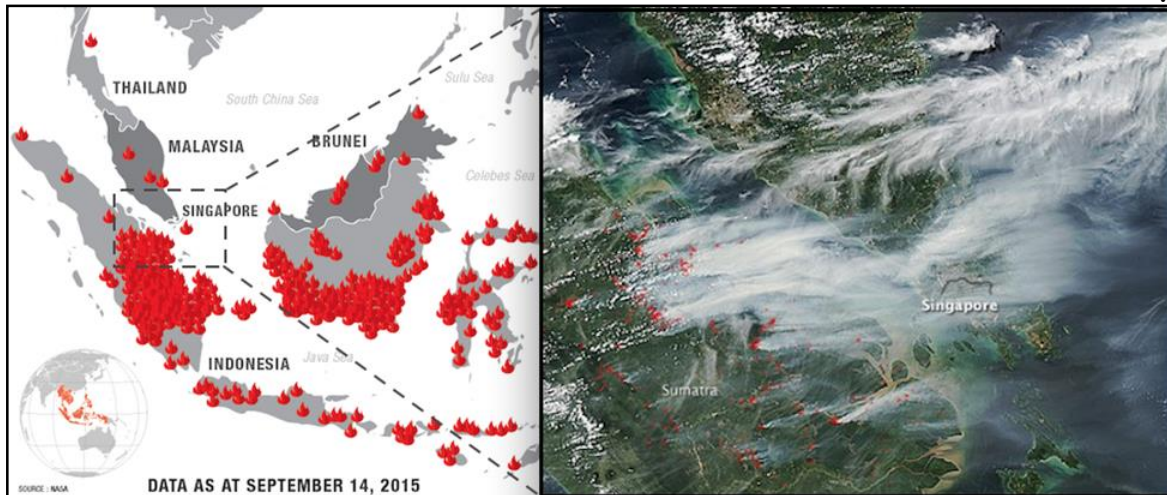
# EVIDENCE



NASA -satellite data showing multiple fires in mid-September 2015 in the eastern part of the Sumatra island and the southern part of Kalimantan island of Indonesia



Actively burning areas, detected by MODIS's thermal bands, in Sumatra Island and Southern part of Kalimantan, 22 Sep 2015



A map of active fire in Indonesia as of September 2015 and satellite image of South East Asia haze

# CONCLUSION

- Base on this study:
- Air particulate level: **PM 10** (44.5 ug/m<sup>3</sup>) is still below the Malaysian guideline of **50 ug/m<sup>3</sup>** and **PM 2.5** (23.8 ug/m<sup>3</sup>) is considerably high as compared to USEPA standard of **15 ug/m<sup>3</sup>**
- There are five (5) major factors PMF solution were found for elemental composition of fine and coarse particulate matter in the Klang Valley area: **Auto**, **2ndryS**, **Ind** (IndCl, Ind Metal), **Smoke** and **Soil** (SoilDust, AutoDust, Soil Construction)
- **Smoke** has been identified as transboundary smoke haze pollution in Malaysia from the neighbouring country which normally occurred during the hot season (southwest monsoon) between May-Sep
- The project has been the first step towards the establishment of the database and source identification for particulate air pollution in the country (Klang Valley, Kuala Lumpur) - especially for PM<sub>2.5</sub>

# ACKNOWLEDGEMENT

- Malaysian Nuclear Agency
- International Atomic Energy Agency (IAEA)
- GNS Science, New Zealand for helping us in the samples analysis
- All member states for the useful discussion, suggestions and comments on the data set during RTC /workshop
- Analytical Chemistry Laboratory staffs of Malaysian Nuclear Agency for their help and support in sampling and laboratory work through out this research project.

Thank you



Let us save our planet