International Forum on Sustainable Future in Asia
"Converting Aspirations to Actions"

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Monitoring of Atmospheric Environment in Asia

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Foul air hurting kids

Agency measures health effects as step toward solving problem

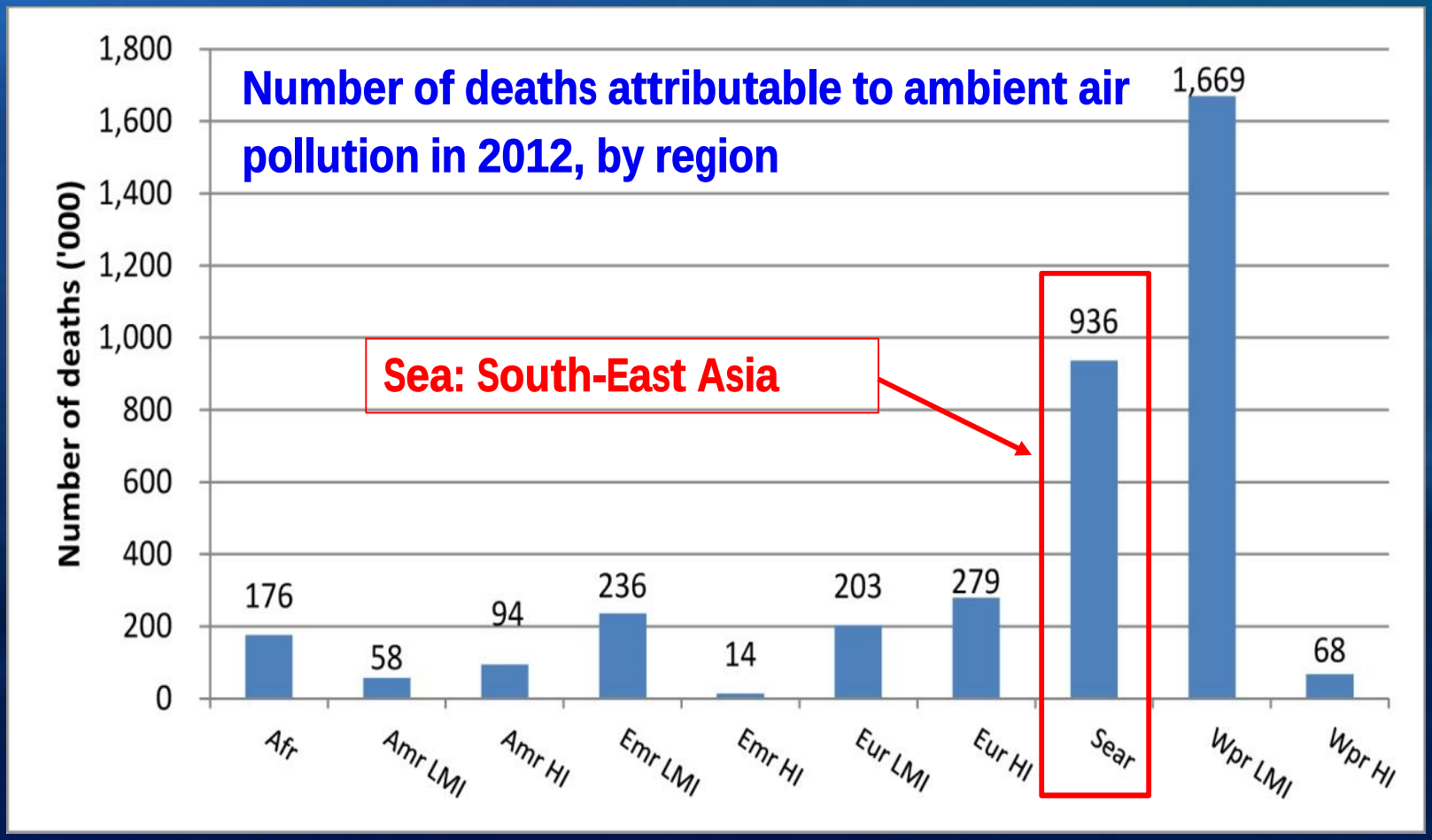
WHO - News release on 25 March 2014

WHO reports that in 2012 around 7 million people died - one in eight of total global deaths – as a result of outdoor and indoor air pollution exposure. This finding more than doubles previous estimates and confirms that air pollution is now the world's largest single environmental health risk. Reducing air pollution could save millions of lives.

Foul air hurting kids

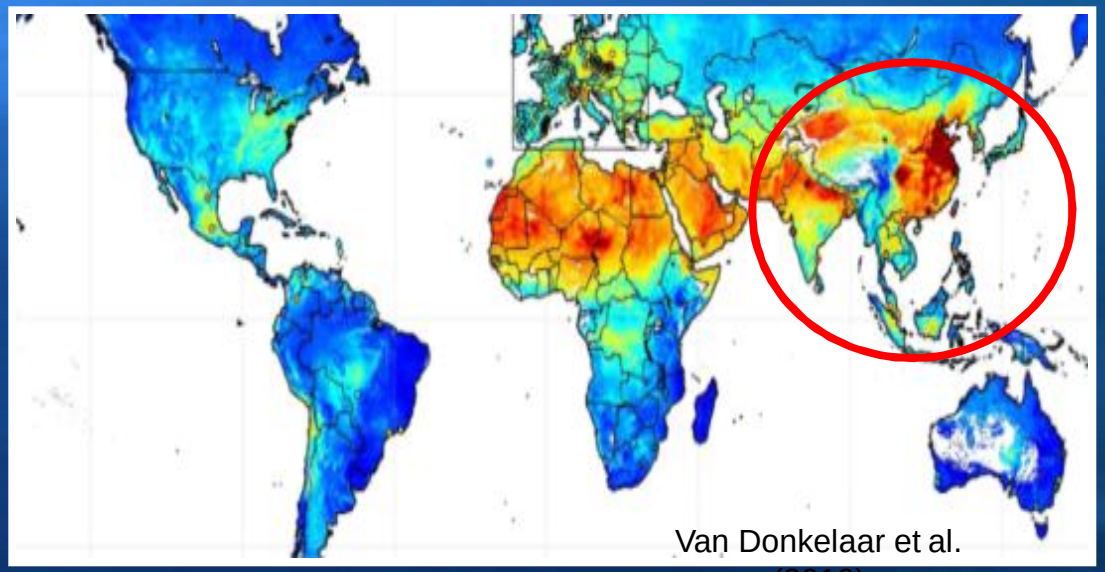
Agency measures health effects as step toward solving problem

World Health Organization



Amr: America; Afr: Africa; Emr: Eastern Mediterranean; Sea: South-East Asia; Wpr: Western Pacific; LMI: Low- and middle-income; HI: High-income

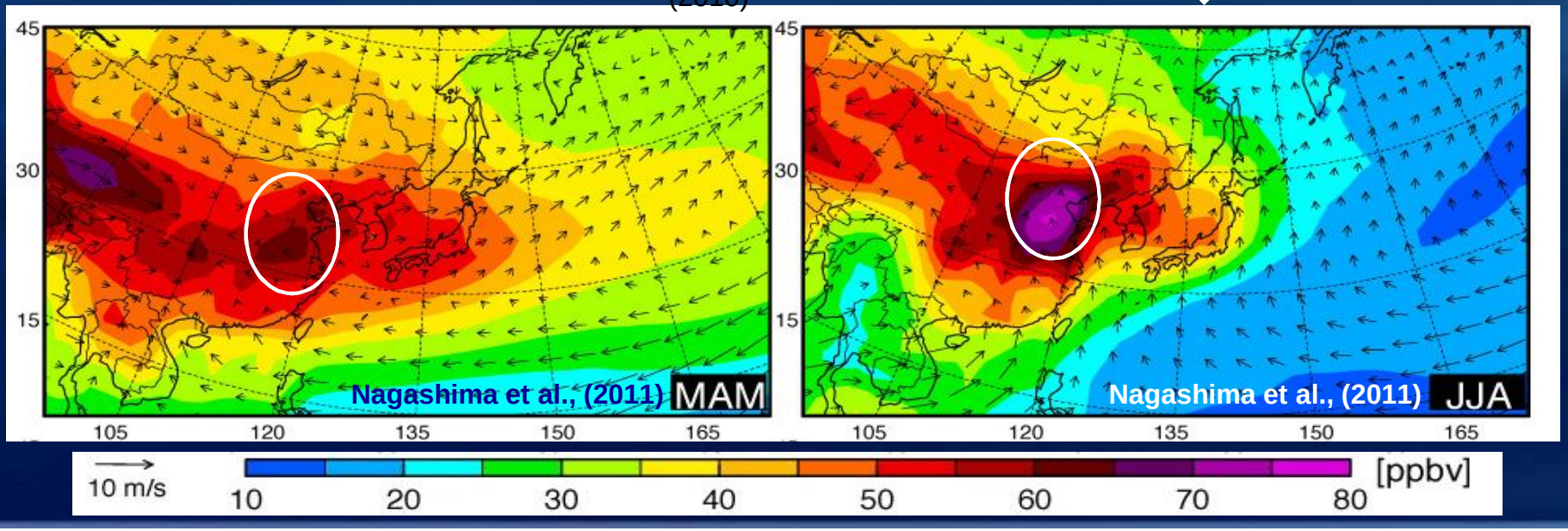
Air pollution in Asia reaching crisis levels, especially $PM_{2.5}$ and O_3



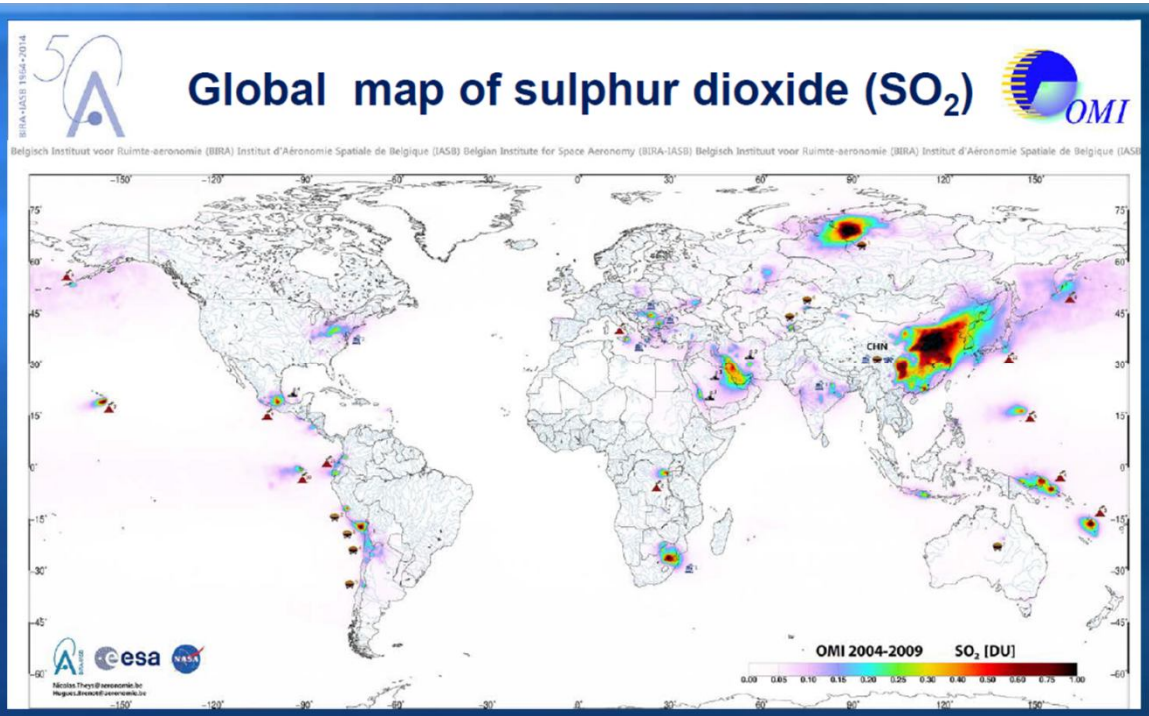
Van Donkelaar et al. (2010)

$PM_{2.5}$

Simulated O_3

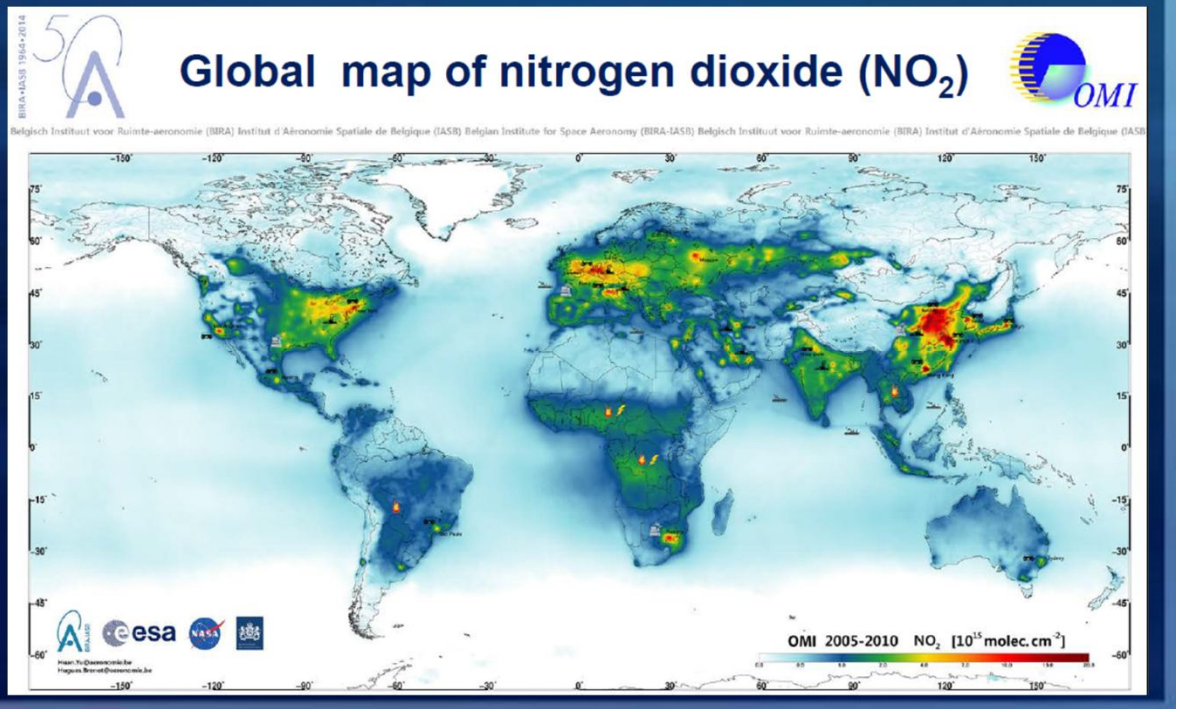


Haze in Asia


Global map of sulphur dioxide (SO_2)
OMI
CHN
OMI 2004-2009 SO_2 [DU]

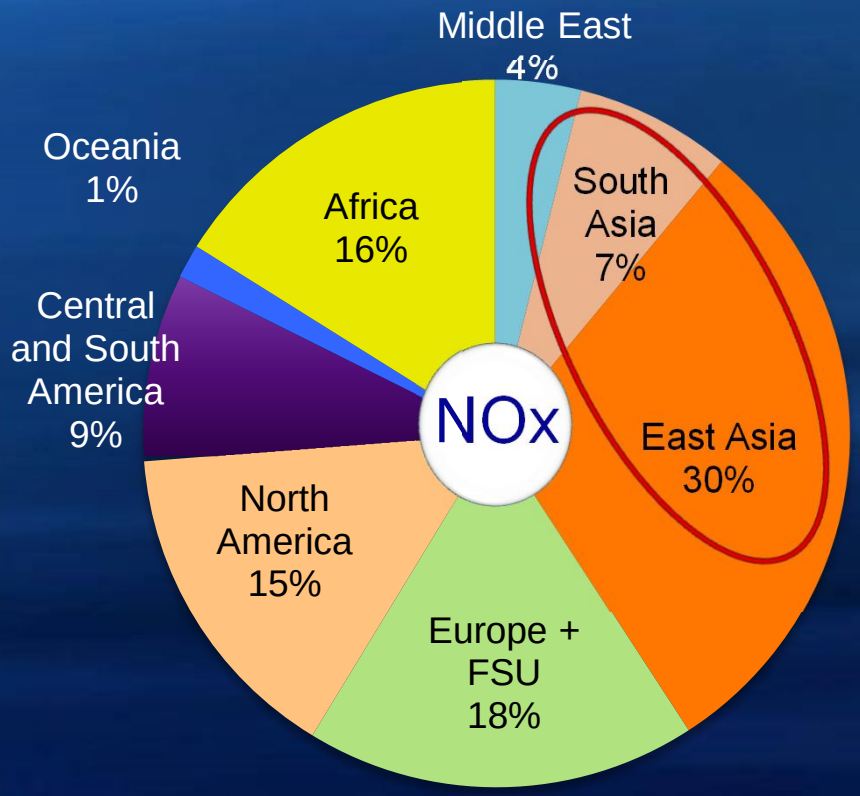
SO_2

NO_2

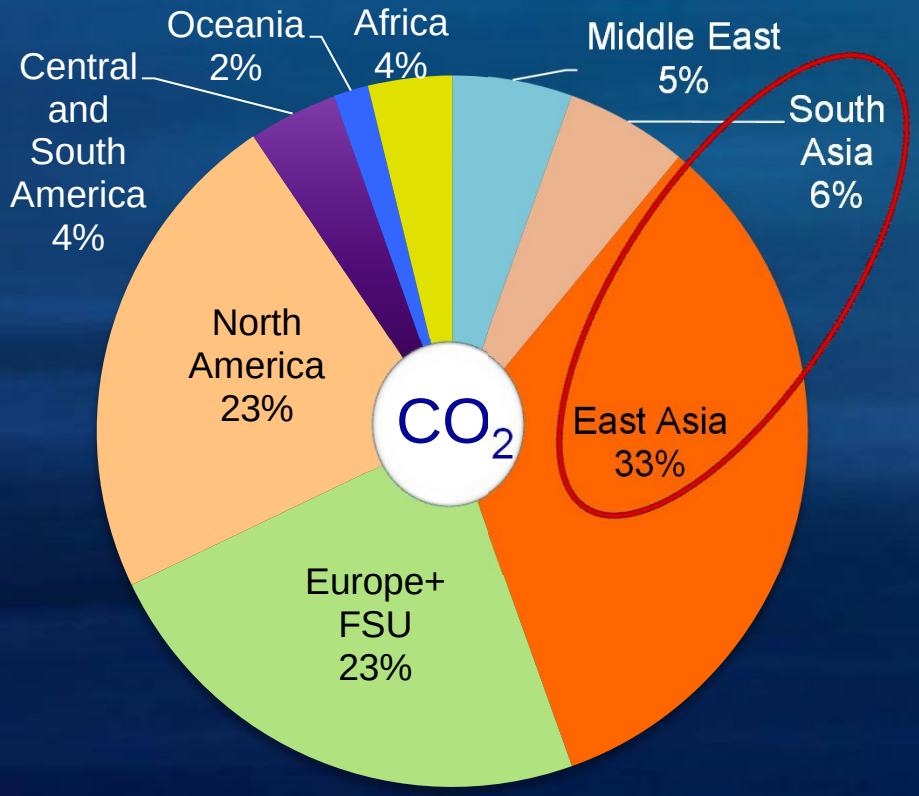

Global map of nitrogen dioxide (NO_2)
OMI
OMI 2005-2010 NO_2 [10^{15} molec.cm^{-2}]

Emissions of air pollutants (e.g. NOx) and CO_2 in Asia reaching 40% of the global total of each

2008



Based on EDGAR v 4.2



Based on CDIAC

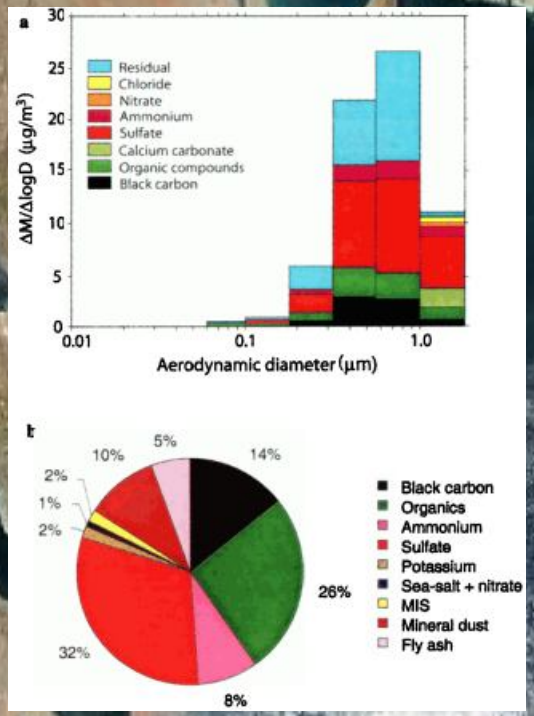
Regional Monitoring of Atmospheric Environment in Asia

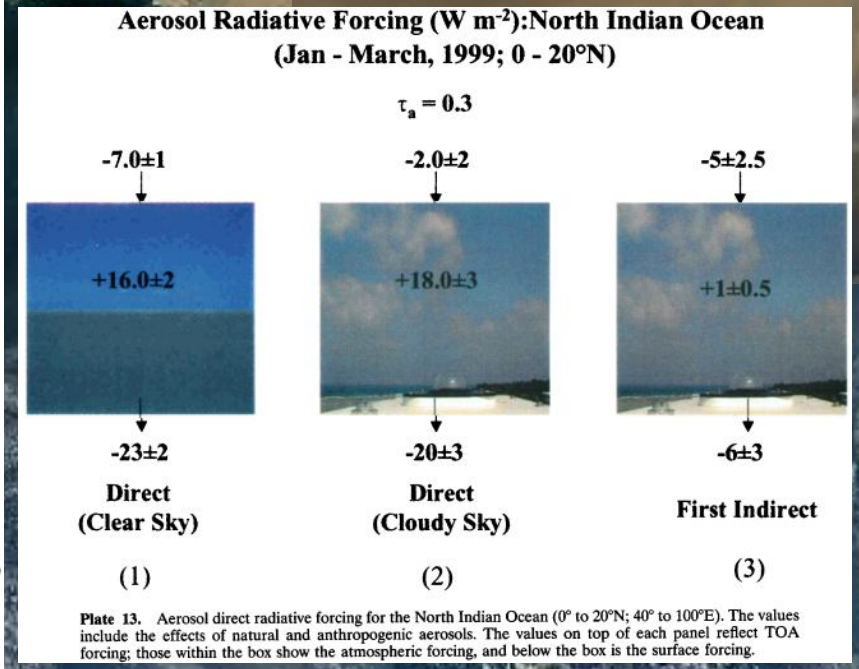
- Atmospheric Brown Cloud (ABC) Programme
- Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia (Malé Declaration)
- Acid Deposition Monitoring Network in East Asia (EANET)

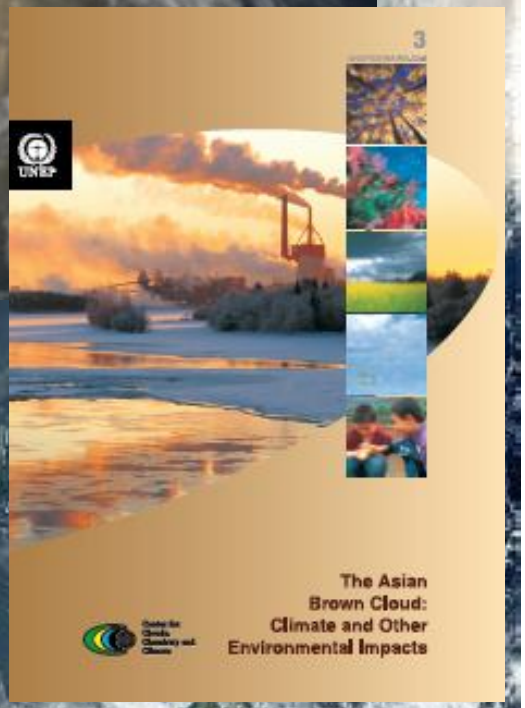
Atmospheric Brown Clouds (ABCs) Issue

ABCs are widespread layers of brownish haze of regional scale plumes of air pollutants, consisting of mainly aerosol particles (e.g. BC and others) and precursor gases which produce aerosols and ozone in the atmosphere. INDOEX (1998-99) was the first study discovered the ABCs layers.

Light absorbing components of the ABCs reduces incoming solar radiation to Earth surface by 10-20 %, resulting a significant heating of the atmosphere and dimming at Earth surface. Thus, the change in radiation budget of the Earth impacts regional climate, rain patterns and levels (e.g. Indian Monsoon), agriculture, glaciers , etc.







Atmospheric Brown Cloud (ABC)

Integration of Air Pollution and Climate Science to Assess the Impacts on environment and society

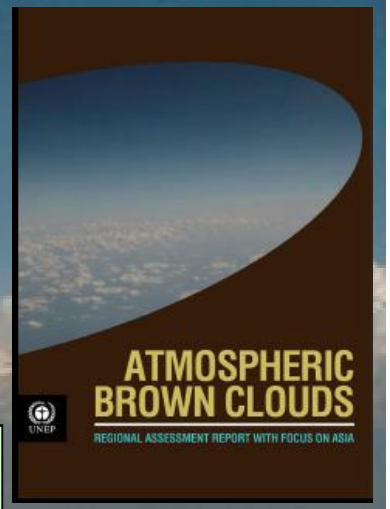
Recognizing seriousness of the ABCs issues, ABC program was established in 2002:

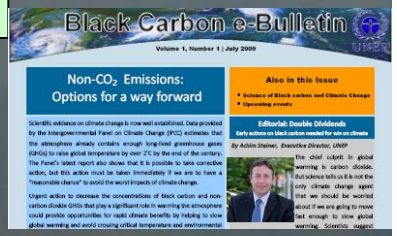
- **To further investigate the impacts of ABCs on climate, precipitation, agriculture, and health, etc.**
- **To equip the policy makers with science-based information for mitigations measures and tackle the climate and health issues.**

Monitoring & Modeling

Assessment of impact on crop, health and water budget

Awareness & Mitigation



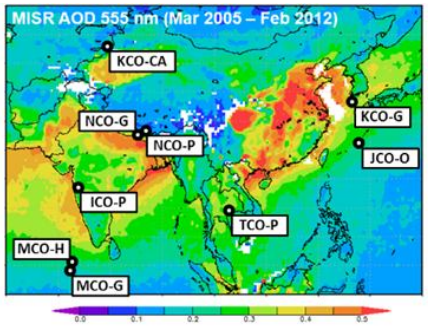


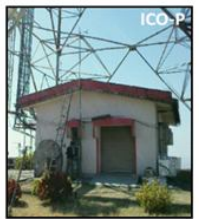
ABC has 3 major components:

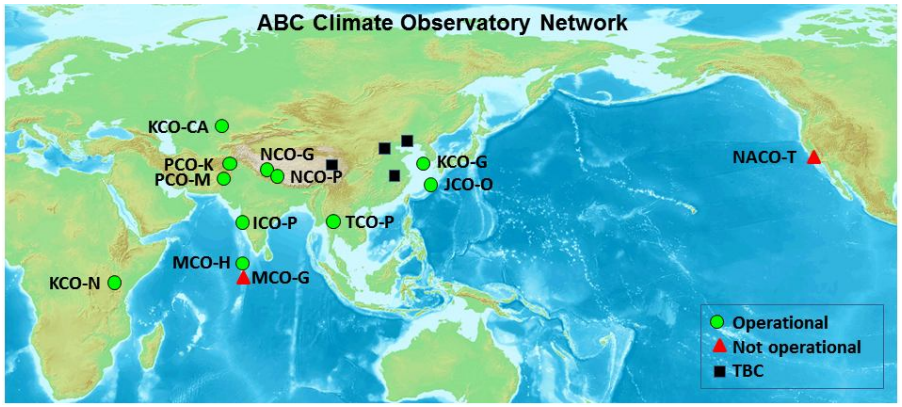
- **Observation and Modeling: A network of ground based Climate Observatories across the Asia and Pacific region for the measurement of ABCs parameters, including solar radiation and meteorology.**
- **Impact Assessment: Impact assessment of ABCs on climate, agriculture, water, and health, etc. using observatories data and models.**
- **Awareness and Mitigation: Dissemination of science-based information for policy makers to underpin the ABCs issue.**

More than 200 scientific articles by the ABC Science Team

ABC Climate Observatory Network

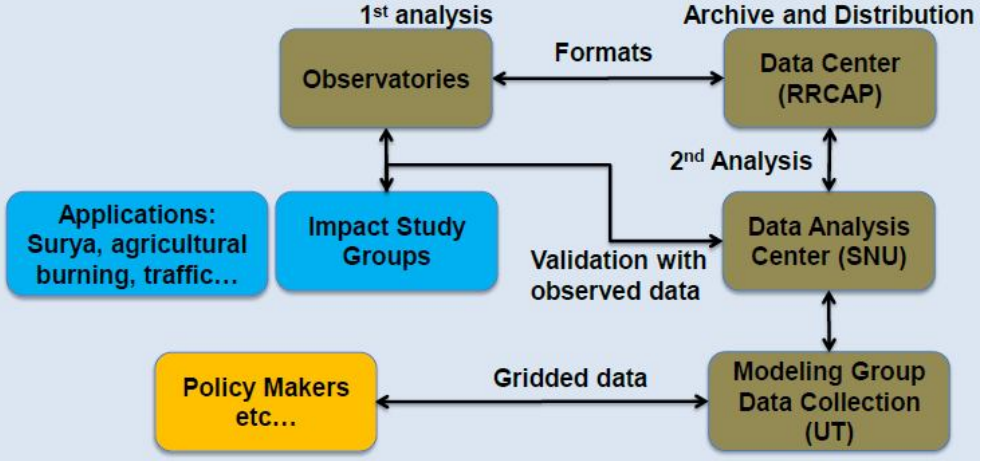






Data Measured

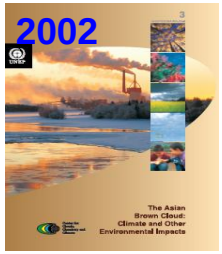
- *Aerosol Components (BC, OC, Inorganics, etc.)*
- *Aerosol Mass (PM_1, $PM_{2.5}$, PM_{10})*
- *Aerosol Numbers (CPC),*
- *Aerosols Size Distribution*
- *Trace Gases (NOx, SO_2, CO, O_3, and others)*
- *Solar Radiation and AOD*
- *Aerosols Vertical Profiles*
- *Meteorological Parameters*

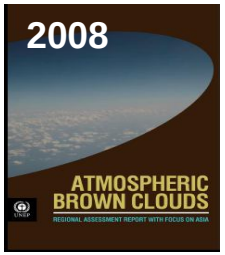


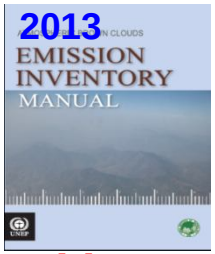
- **These observatories are located at strategic locations in Asia-Pacific region**
- **Advanced facilities for measurements of aerosols and precursor gases, radiation and meteorological parameters**

Atmospheric Brown Cloud (ABC)

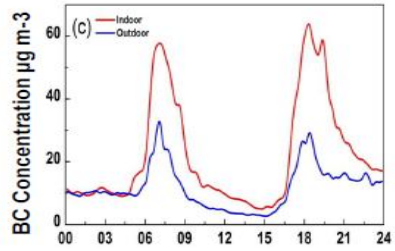
Awareness





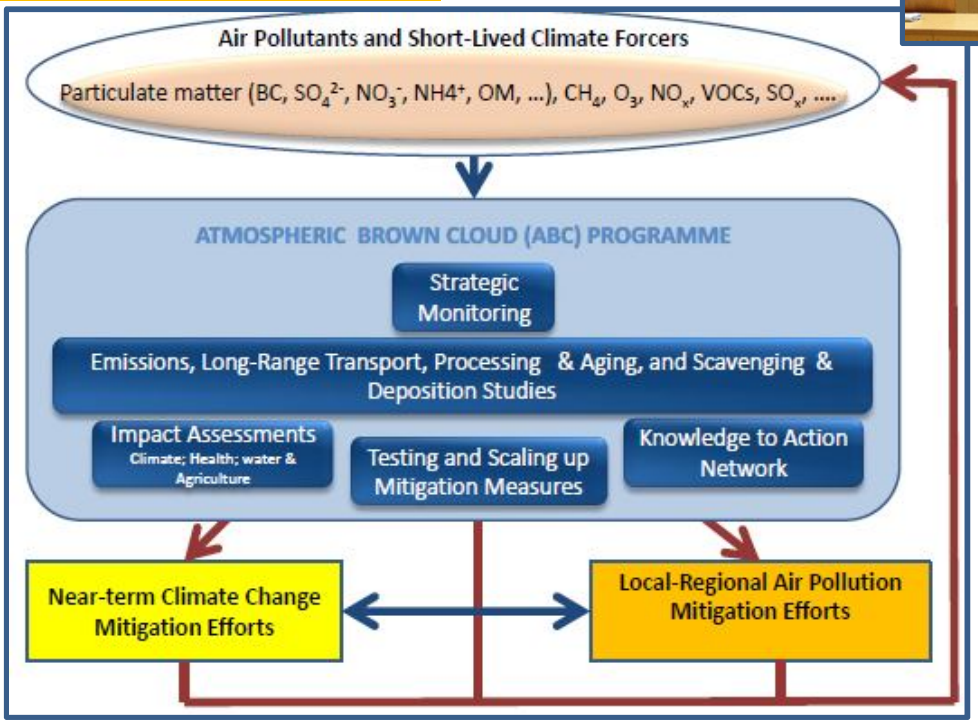


Life improvement [Project Surya]



Science Team and Scientific Networking

Future Plan



Share ideas & partnership

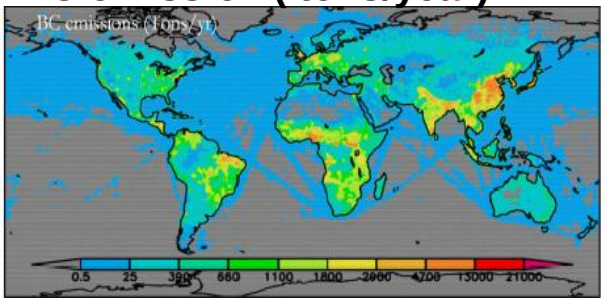
CCAC
Science Advisory Panel
Chair: Drew Shindell
Ramanathan...

data

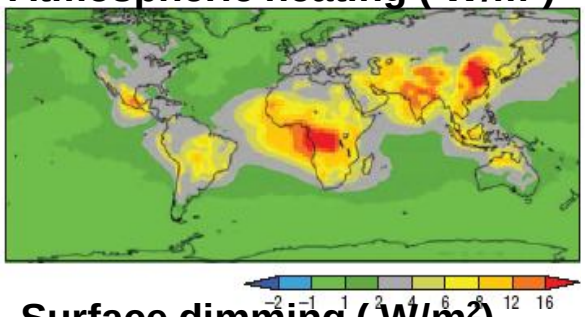
ACCMIP/AC&C/IGAC-SPARC, APCAP
AEROCOM, EANET, AERONET&SKYNET, MPL, ADNET-lidar nets, Various national projects

Impacts of ABCs [Some Research Findings]

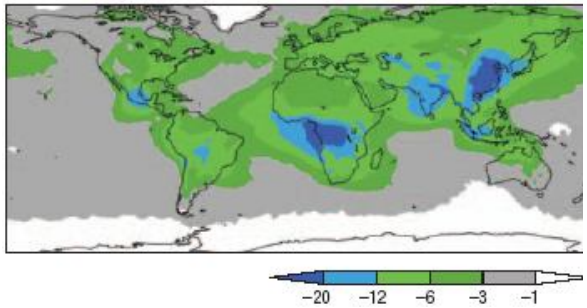
BC emission (tons/year)

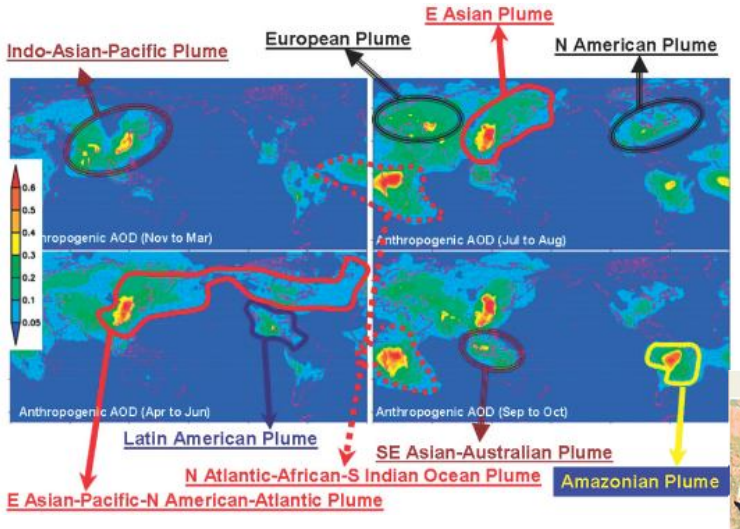


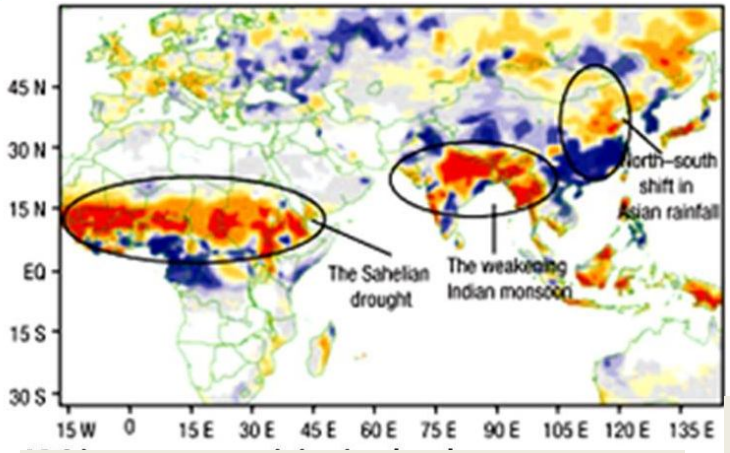
Atmospheric heating (W/m^2)



Surface dimming (W/m^2)



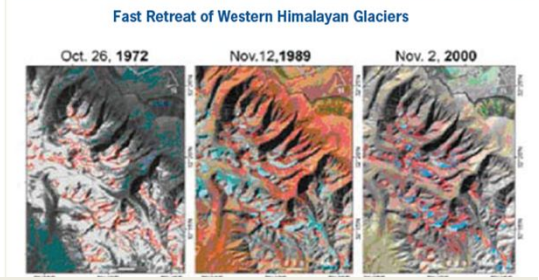




7% weakened of Asian Monsoon causing 20% decrease in rainfall over South Asia since 1980s. North-South shift in China

ABC hot spots

- Indo Gangetic
- East Asia,
- Indonesian Region,
- Southern Africa, and
- Amazon basin



ABCs deposition on snow and atmospheric solar heating contributes at least 30% to snow melting in the Himalayas during 1900-2000

Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia (Malé Declaration)

Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia (Malé Declaration)

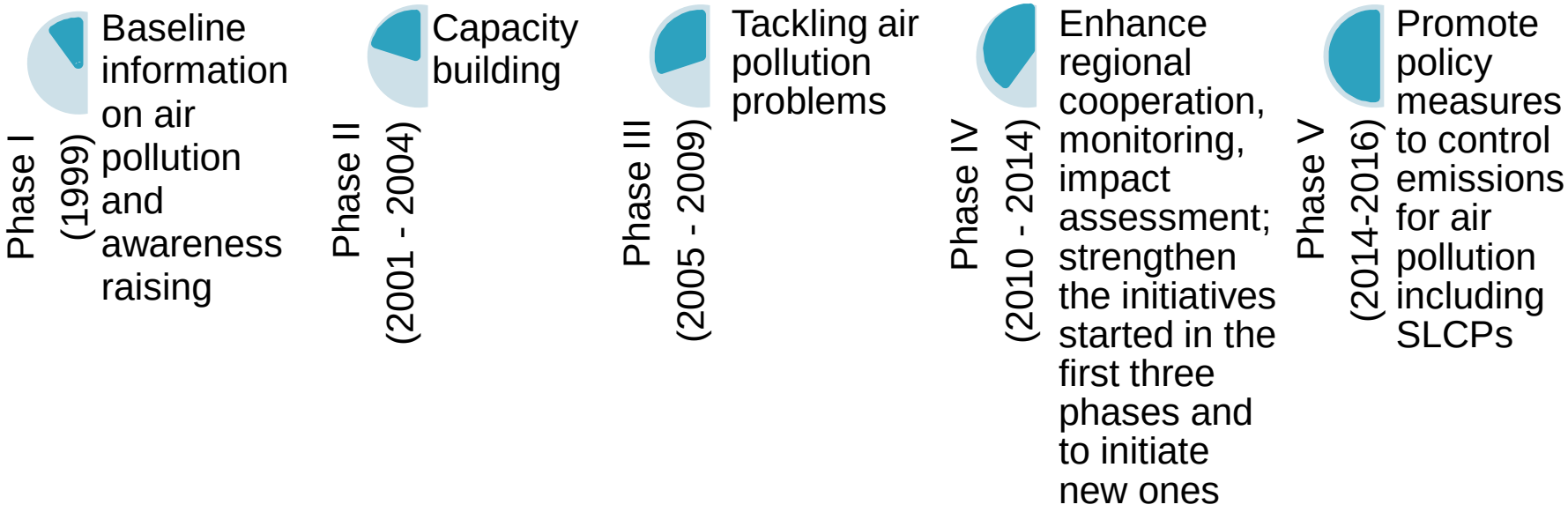
Background:

In 1998, UNEP together with the Stockholm Environment Institute (SEI) drew attention to the possibility of the impacts of transboundary air pollution in South Asia. This initiative led to the adoption of the Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia (Malé Declaration).

Eight Participating countries

1. Bangladesh
2. Bhutan
3. India
4. Iran
5. Maldives
6. Nepal
7. Pakistan
8. Sri Lanka

Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia



Malé Declaration OUTCOMES

1. Strengthened regional cooperation on tranboundary air pollution,
2. Strengthened monitoring (SO_2, NO_2, O_3, $PM_{2.5}$,PM_{10} and TSP) and capacity building programmes,
3. Enhanced capacity on emission inventory and Integrated Assessment Modeling,
4. Enhanced analytical and impact assessment capability at the national level through integration of findings from local pollution studies and conducting assessment studies, (e.g. crop impact assessment. health impact assessment studies),
5. Enhanced policy formulation and air pollution prevention,
6. Awareness raised on transboundary air pollution in South Asia region, and
7. Establishment of 8 Regional Centers.

Recent event:
Fourteenth Session of the Intergovernmental Meeting (IG14) held on 25 November 2015 in Bangkok, Thailand

Monitoring stations

Malé Declaration Results

Monitoring is the backbone of all other activities and must be stable and long-term and organized in a robust network of monitoring sites. The Malé Monitoring Network was established in 2003 with at least one regional monitoring site established in each of the 8 Malé Declaration countries, further sites have subsequently been added and there are currently 15 sites in the network.

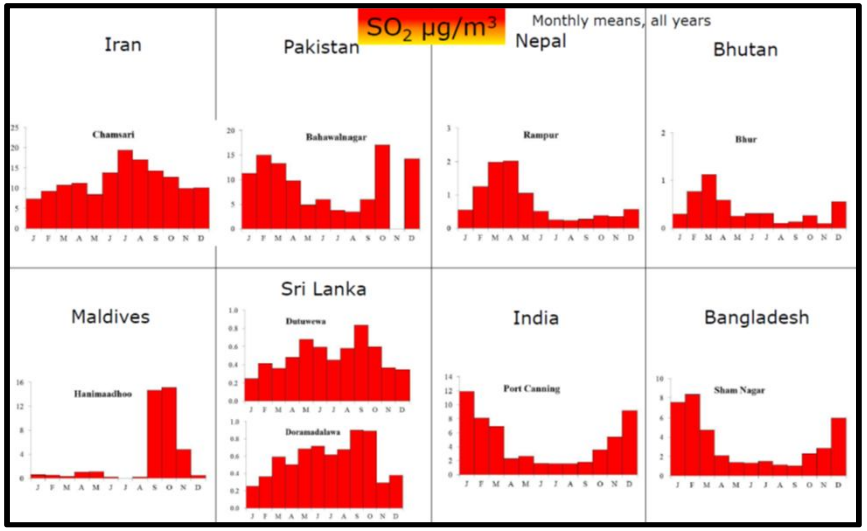
Malé Declaration Monitoring

The equipment located at the monitoring sites are as follows:

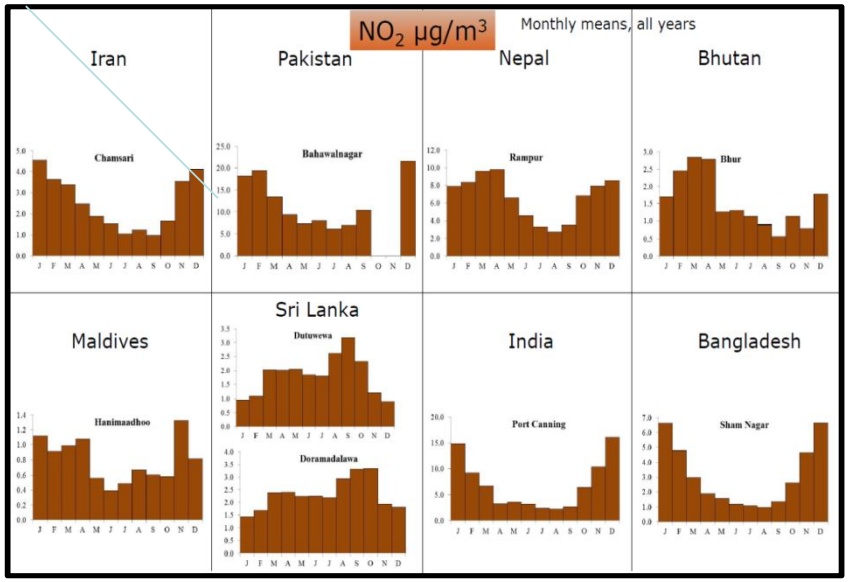
- Passive samplers for SO_2, NO_2 and O_3;
- Total Suspended Particles (TSP) and PM_{10} are being measured using high volume samplers (HVS) (regionally sourced);
- Two bulk samplers (funnel and bottle) at each site;
- Wet-only collector at each site with solar panel;
- Meteorological measurements.

Results of the Malé Monitoring Network

Passive samplers have proved the most useful monitoring method for the Malé Declaration to date, giving consistent and reliable results. Throughout Phase II, III and IV. For a large part of the region, SO_2 and NO_2 levels are highest in winter months and lowest during the summer period. The WHO guidelines (WHO 2005) are currently 40 µg/m^3 annual mean for NO_2 and 20 µg/m^3 24-hour mean SO_2. Comparison with the mean monthly values for these pollutants shown in Figures indicates that in most Malé Declaration countries these pollutants are not a health risk at these sites, although the situation is likely to be very different in urban areas or near point sources of pollution.

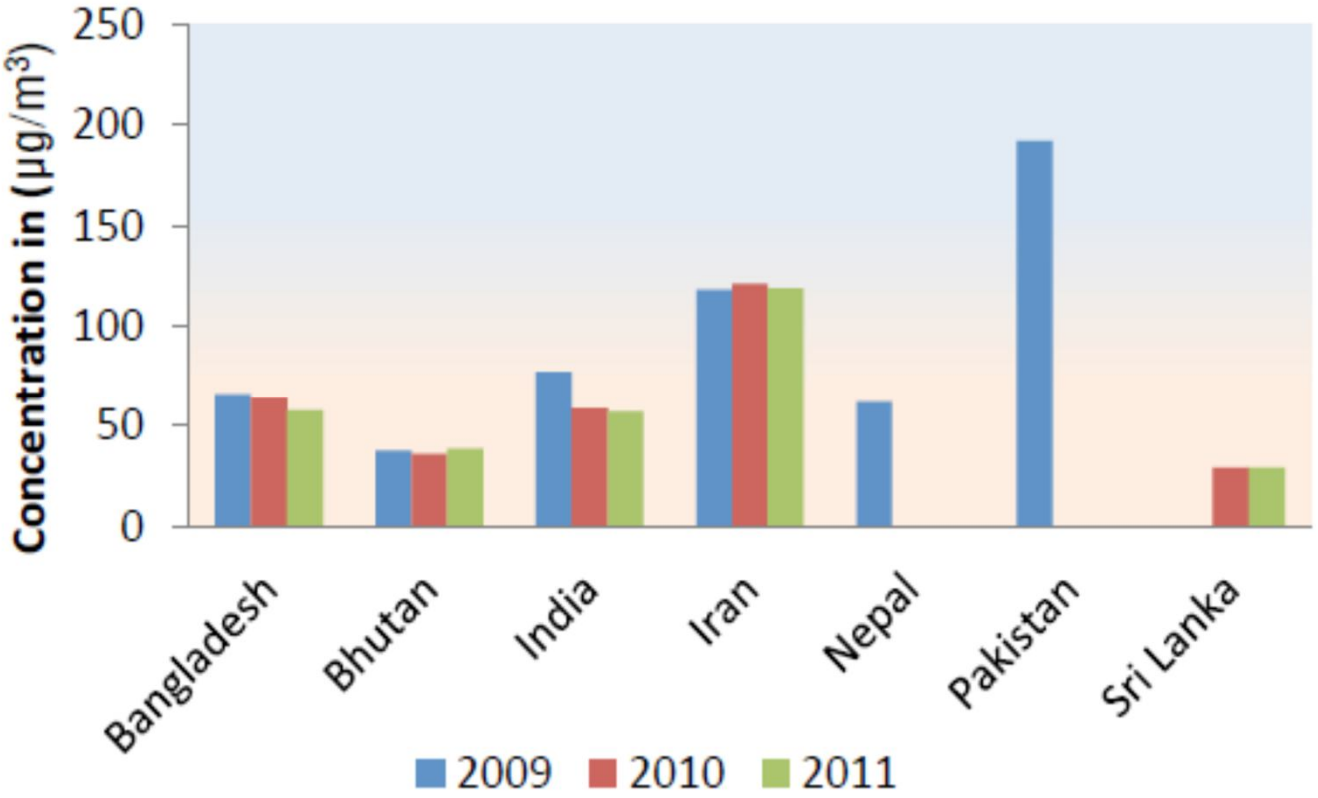


Sulphur dioxide concentrations at Malé Declaration regional sites, monthly means 2003-2012



Nitrogen dioxide concentrations with Passive Samplers at Malé Declaration regional sites, monthly means 2003-2012

Results of the Malé Monitoring Network



Annual average particulate matter concentrations (PM_{10}) at Malé Declaration Sites 2009-2011 using High Volume Samplers. Note: All countries exceed the WHO (2005) guideline for annual mean PM_{10} concentration of 20 µg/m^3.

Establishment of Acid Deposition Monitoring Network in East Asia (EANET)

- **Network of 13 participating countries in East Asia regularly monitoring acid deposition including wet, dry, soil, vegetation, inland aquatic and catchment monitoring.**
- **The 12th Session of the Intergovernmental Meeting in 2010 adopted the Instrument for Strengthening the Acid Deposition Monitoring Networks in East Asia (EANET).**
- **Objectives**
  - **to create a common understanding of the state of the acid deposition problems in East Asian region.**
  - **to provide useful inputs for decision-making at local, national and regional levels aimed at preventing or reducing adverse impacts on human health and the environment due to acid deposition.**
  - **to contribute to cooperation on the issues related to acid deposition among the participating countries.**

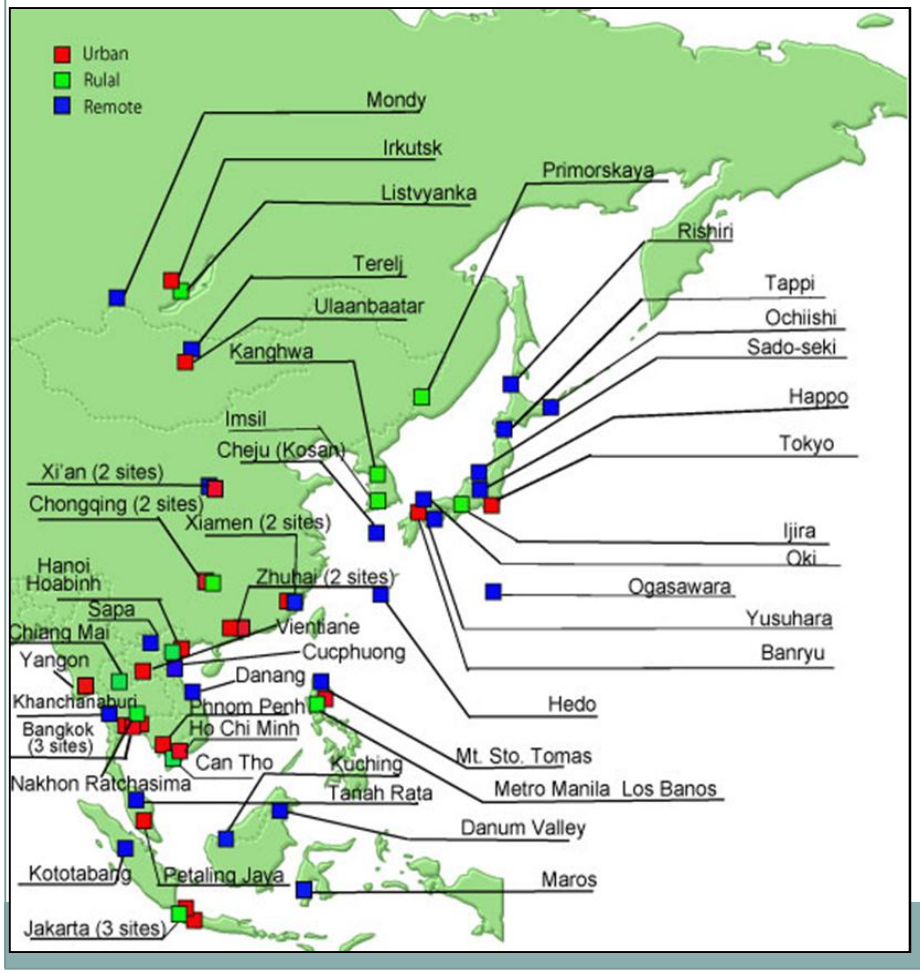
EANET Monitoring Sites in 2015

	Number of Monitoring Sites			
	Total	Urban	Rural	Remote
Wet Deposition*	54 (57*)	21 (22)	13 (14)	20 (21)
Dry Deposition*	47 (50*)	17 (18)	12 (13)	18 (19)
Soil	19 areas 28 forests			
Vegetation	18 areas 24 forests			
Inland Aquatic Environment	18 lakes/rivers	(5)	(7)	(6)
Catchment**	1		(1)	

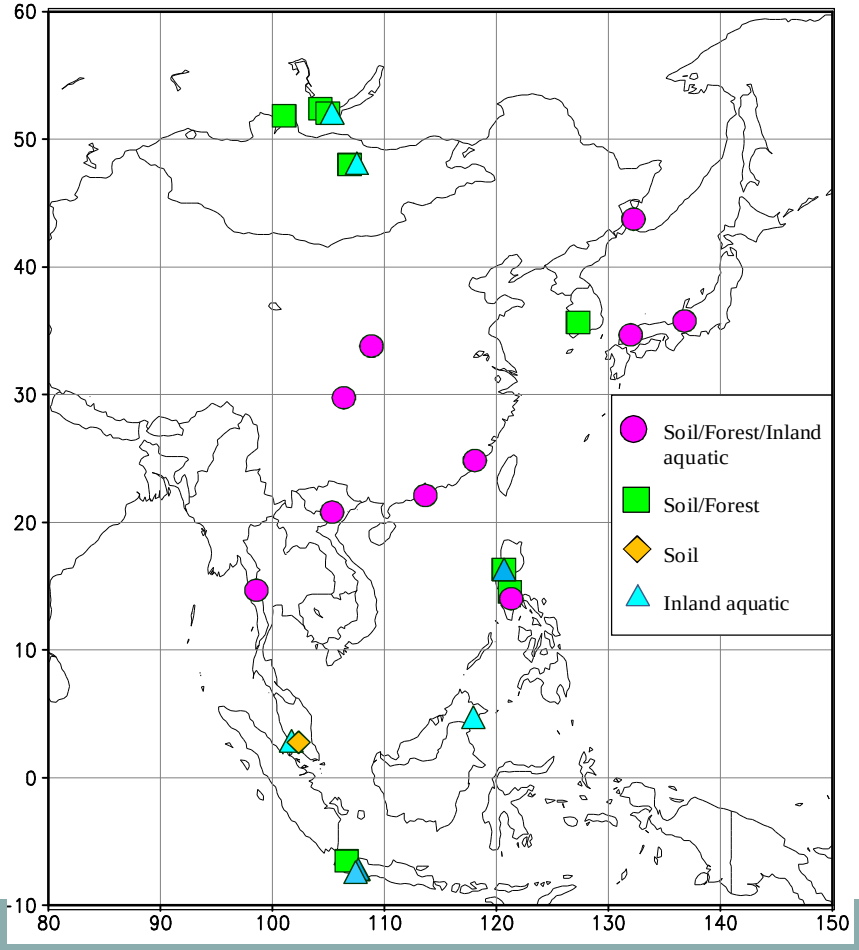
* Vietnam will establish 3 wet/dry deposition monitoring sites.
** Philippines is preparing to establish a new catchment site.

EANET Monitoring Site in 2015

Wet/Dry Deposition Monitoring
(including planning sites in Vietnam)



Soil, Vegetation, Inland Aquatic Monitoring



Photographs of EANET Wet/Dry Depsition Monitoring Sites

Cambodia

China

Indonesia

Japan

Lao PDR

Malaysia

Mongolia

Myanmar

Philippines

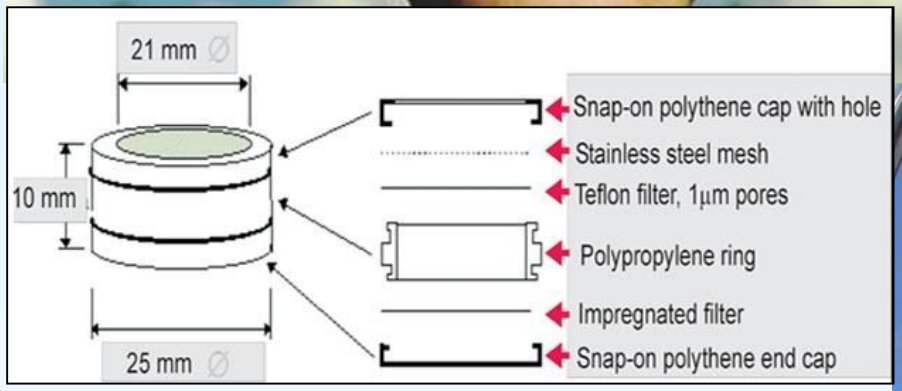
R. of Korea

Russia

Thailand

Vietnam

Various instruments used to monitor wet deposition



Methods used to monitor dry deposition (Automatic monitor, filter-pack and passive sampler)

Filterpack

Photographs of EANET Monitoring Sites

(Soil/Vegetation, Inland Aquatic Environment)

Mongolia

Thailand

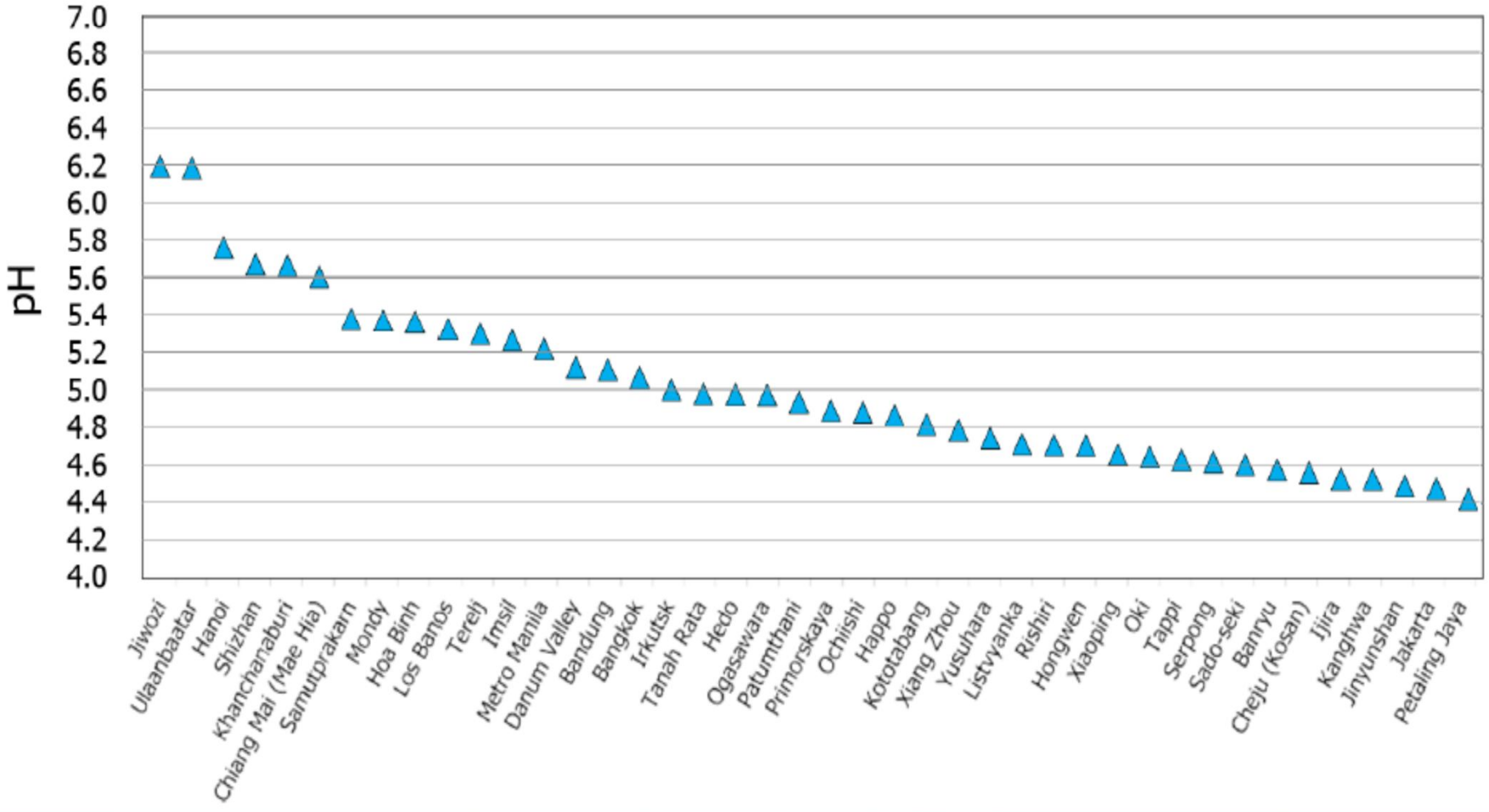
Japan

Philippines

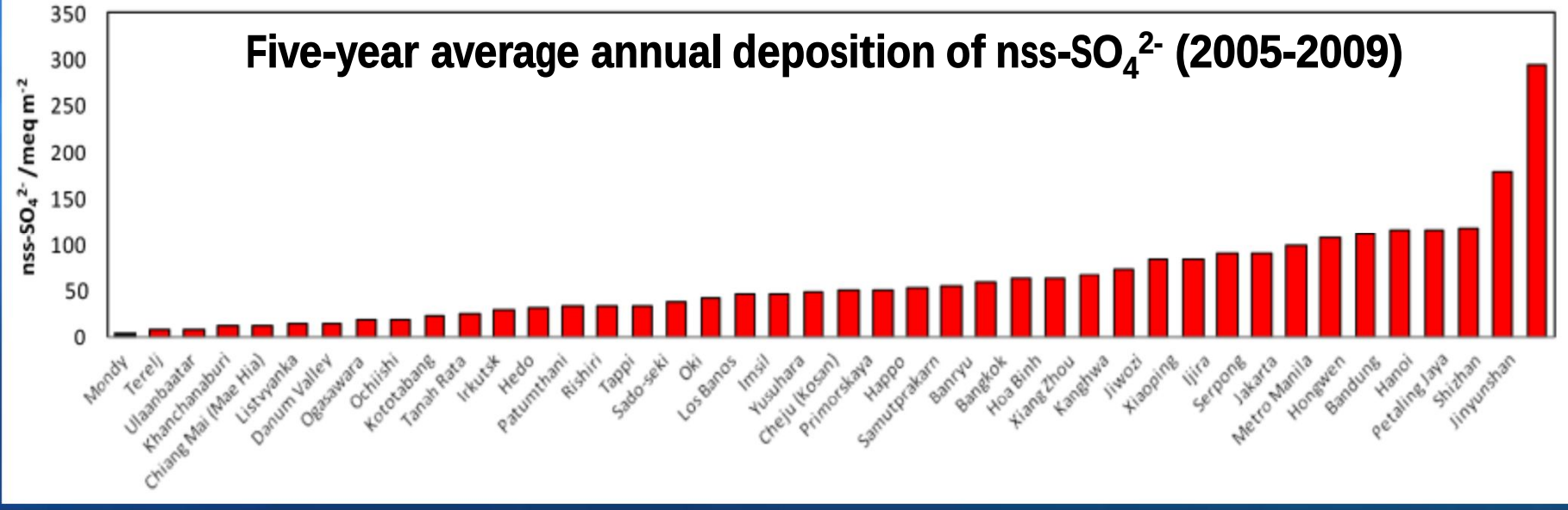
Recent EANET Major Publications

- **The Second Periodic Report on the State of Acid Deposition in East Asia (2011)**
- **Third Report for Policy Makers (2014)**
- **Review on the State of Air Pollution in East Asia (2015)**

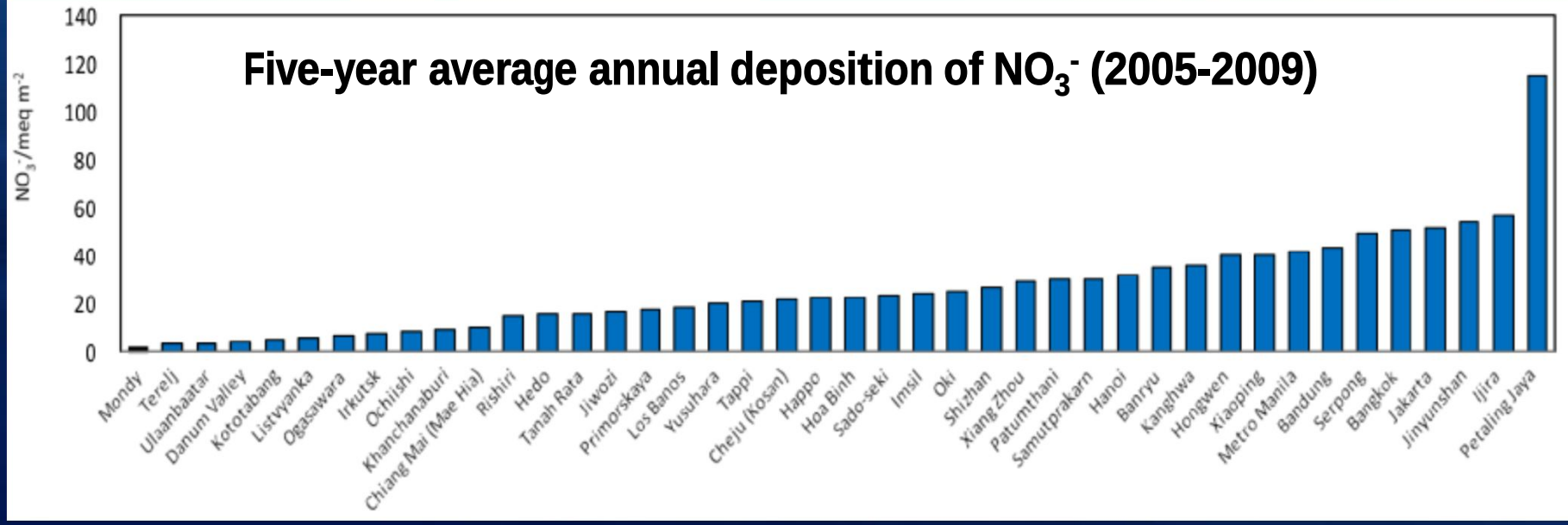
Five-year average annual mean pH values for 42 EANET sites (2005-2009)



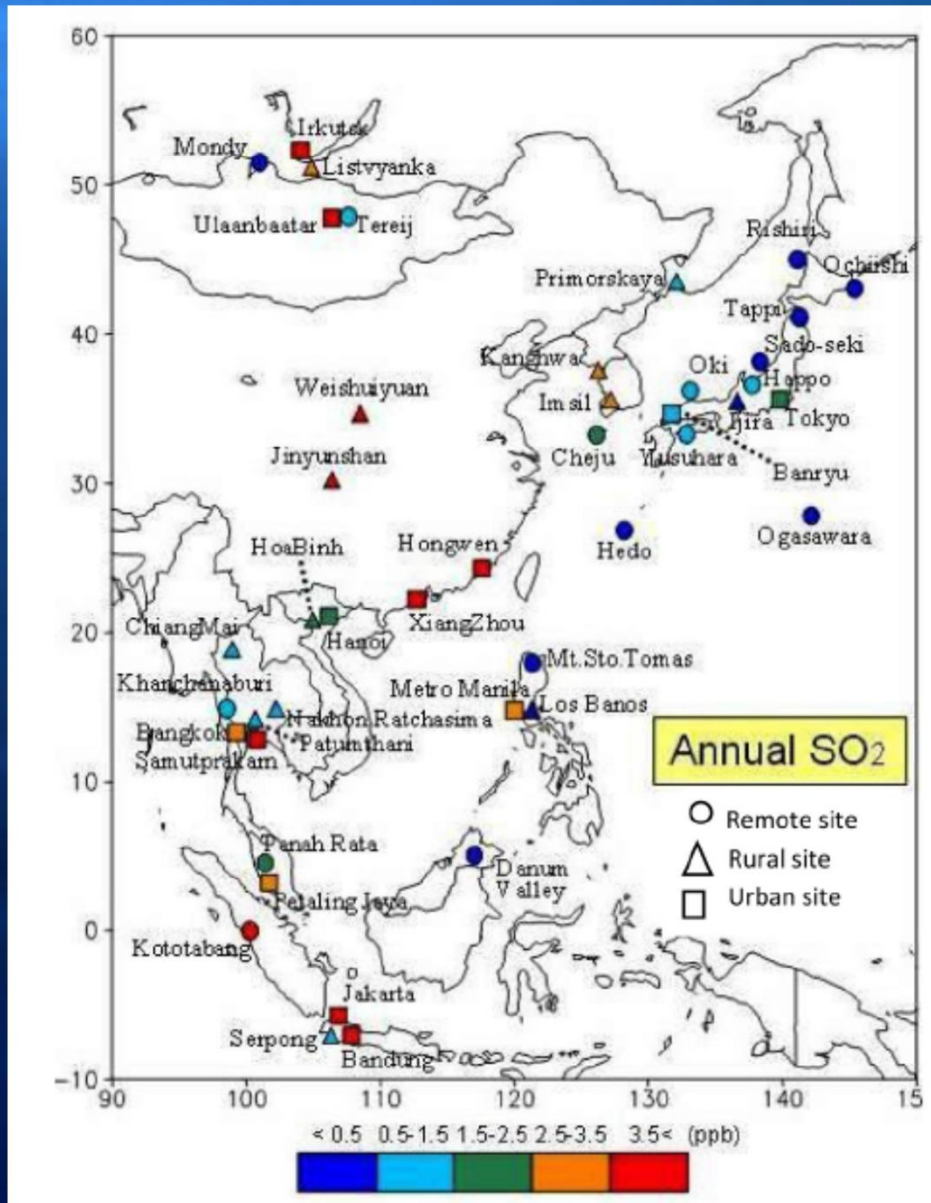
Five-year average annual deposition of nss-SO_4^{2-} (2005-2009)

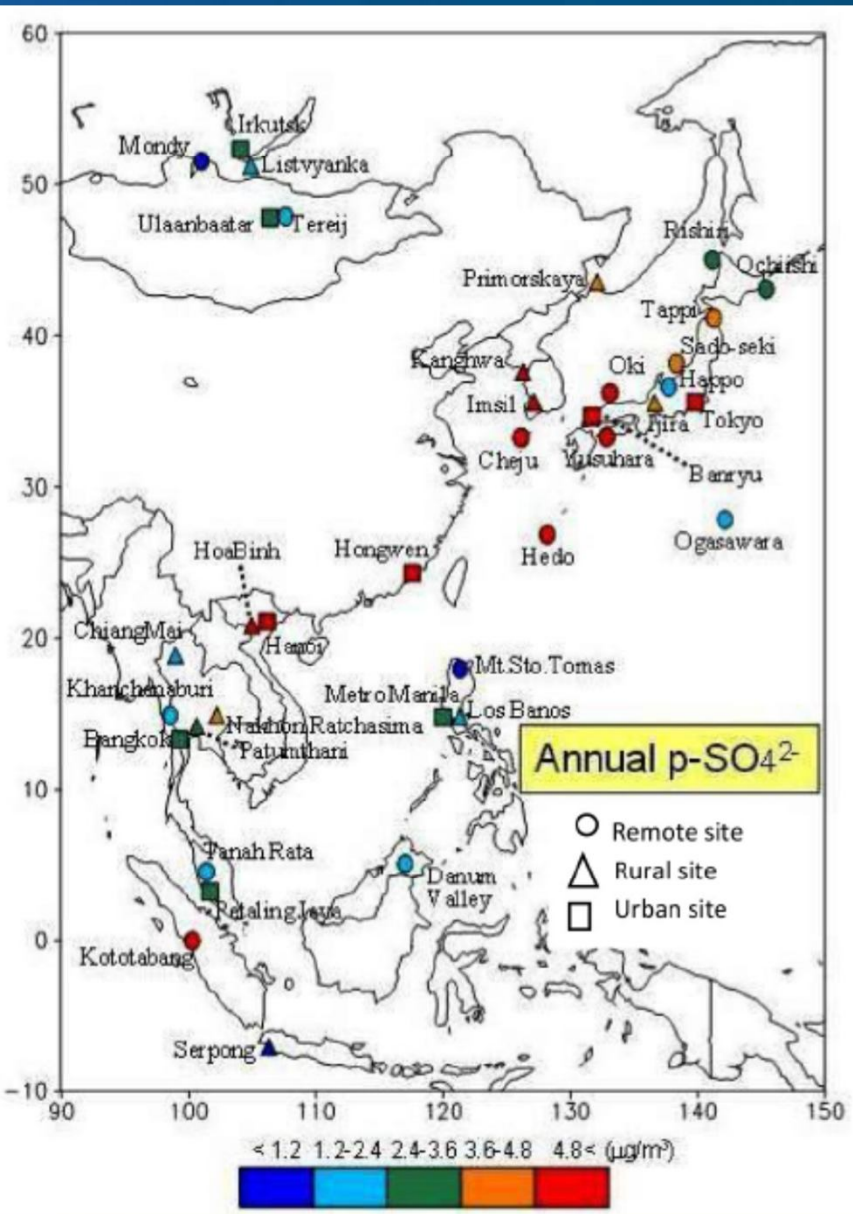


Five-year average annual deposition of NO_3^- (2005-2009)

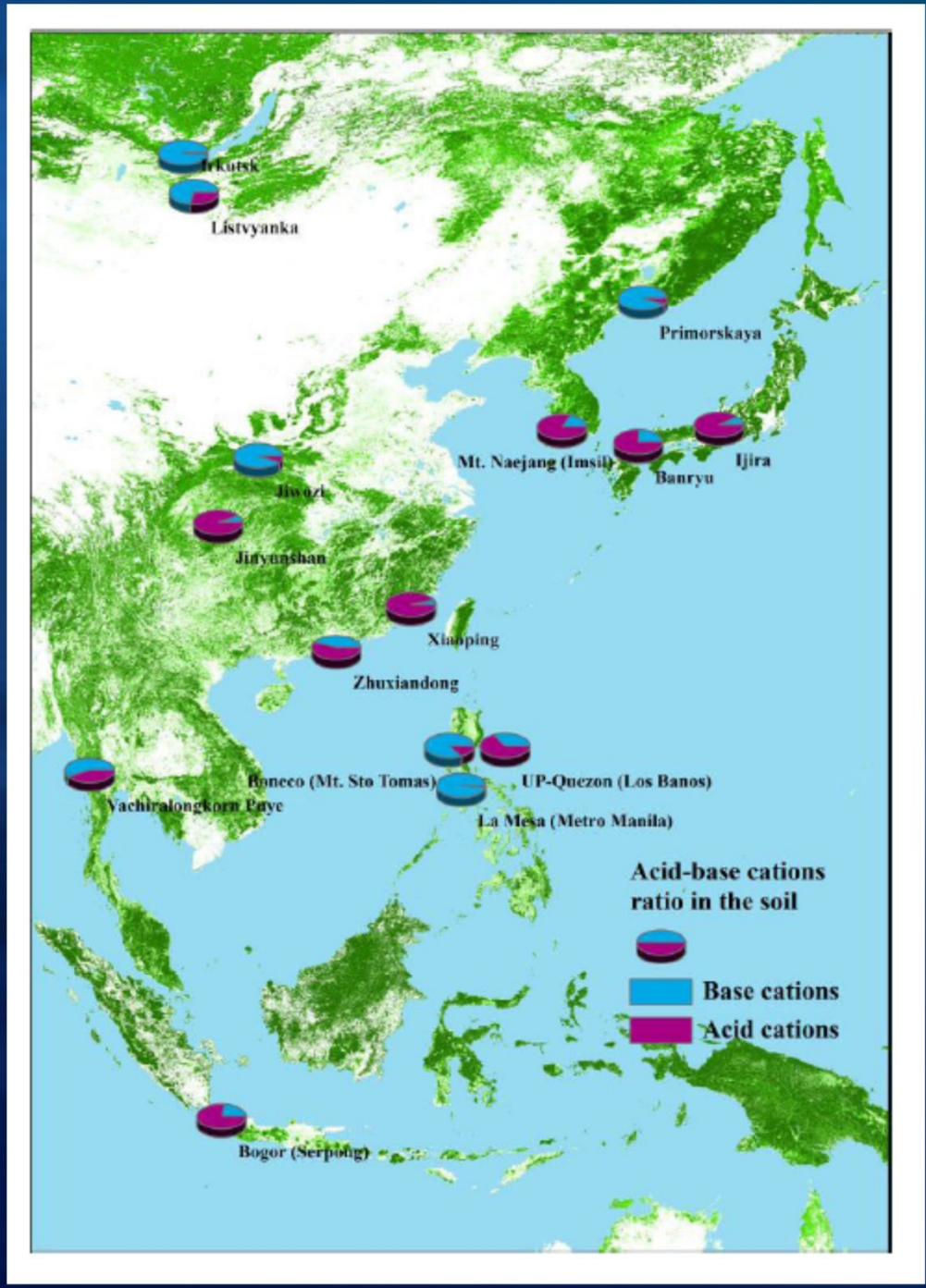


Spatial variation in concentrations of SO_2 and SO_4^{2-} at EANET Sites (annual average of 2005-2009)





- Ratio between base cations (Ca^{2+} + Mg^{2+} + Na^{+} + K^{+}) and acid cations (H^{+} + Al^{3+}) on a negative charge of 0-10 cm soils (average in 2000-2009).
- Only representative site in each area were displayed.
- Dense green color shows tree cover.



Trends of inland water chemistry

Pink- and blue-colored cells indicate significant declining and increasing trends, respectively and yellow-colored cells indicate no trend

Country	site	pH	EC	Alkalinity	SO_4^{2-}	NO_3^-
China	Jinyunsyan Lake	Declining	Increasing	Declining	Increasing	Increasing
	Xiaopin Dam	Declining			Increasing	
	Jiwozi River	Declining	Increasing	Increasing	Increasing	
	Zhuxiandong Stream				Declining	
Indonesia	Patengang Lake	Declining			Increasing	
Japan	Ijira Lake			Increasing		Declining
	Kamagatani River flowing river to Ijira Lake	Increasing		Increasing		
	Kobara River flowing river to Ijira Lake	Increasing		Increasing	Increasing	
	Banryu Lake		Increasing			Increasing
	Banryu Lake 3		Increasing			
Malaysia	Semenyih Dam	Declining			Increasing	
Mongolia	Terelj River			Increasing		
Phillipines	Pandin Lake				Increasing	Increasing
Russia	Pereemnaya River		Increasing		Increasing	Increasing
	Komarovka River			Declining	Increasing	
Thailand	Vachiralongkorn Dam 1 Ban Pong Chang		Declining		Declining	
	Vachiralongkorn Dam 2 Ban Pang Pueng		Declining			Increasing
Vietnam	Hoa Binh Reservoir					

Conclusion: State of Acid Deposition in East Asia

From the 2nd Periodic Report on the State of Acid Deposition in East Asia

- **Acid rain remains prevalent across East Asia.**
- **The annual average pH of rainwater is lower than 5.0 (the threshold for acid rain) at 60% of monitoring sites, and values of less than 4.6 have been recorded in several locations.**
- **H_2SO_4 remains the primary contributor to acid rain across the region, therefore, the regional sulphur emission control is still needed to be improved.**
- **Contribution of HNO_3 to acid rain is almost equal to that of H_2SO_4, hence the control of nitrogen emission is also important in the region.**
- **However, despite continued acidification in the region, the impact of acid deposition on eco-system functions still appears limited.**

Conclusion: State of Acid Deposition in East Asia

From the 2nd Periodic Report on the State of Acid Deposition in East Asia

- **No decline in tree growth or in the number of species in understory vegetation has been observed during monitoring, and overall forest functions and structures apparently remain sound.**
- **Tree decline symptoms observed at some sites were generally considered to stem from pest infestation as a direct cause.**
- **Declining trend in lake/stream water pH with corresponding increase in sulphate concentration was also observed at several sites during the same period.**

Conclusion: State of Acid Deposition in East Asia

From the 2nd Periodic Report on the State of Acid Deposition in East Asia

- **Results of soil and inland water monitoring in some regions showed symptoms of nitrogen saturation/eutrophication due to excess deposition of nitrogen species (nitrate and ammonium). Deposition loads of S and N were very high in these areas.**
- **O_3 concentrations monitored in Japan, R. of Korea, Thailand and Russia demonstrated common seasonal variations – highest in spring, lowest in summer, and second-highest in autumn. Monthly average O_3 concentrations from 2005-2009 were higher than those for the previous 5-year period (2000-2004).**

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Thank You for Your Attention

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