RAPIDC
Regional Air Pollution In Developing Countries

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Progress in the Implementation of the RAPIDC Programme 2005-2009

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SEI, University of York UK

IG11, Dhaka, Bangladesh 20-21 January 2010

RAPIDC
Regional Air Pollution In Developing Countries

RAPIDC Programme Purpose

‘to facilitate the development of agreements and/or protocols to implement measures which prevent and control air pollution through promoting international cooperation and developing scientific information for the policy process’

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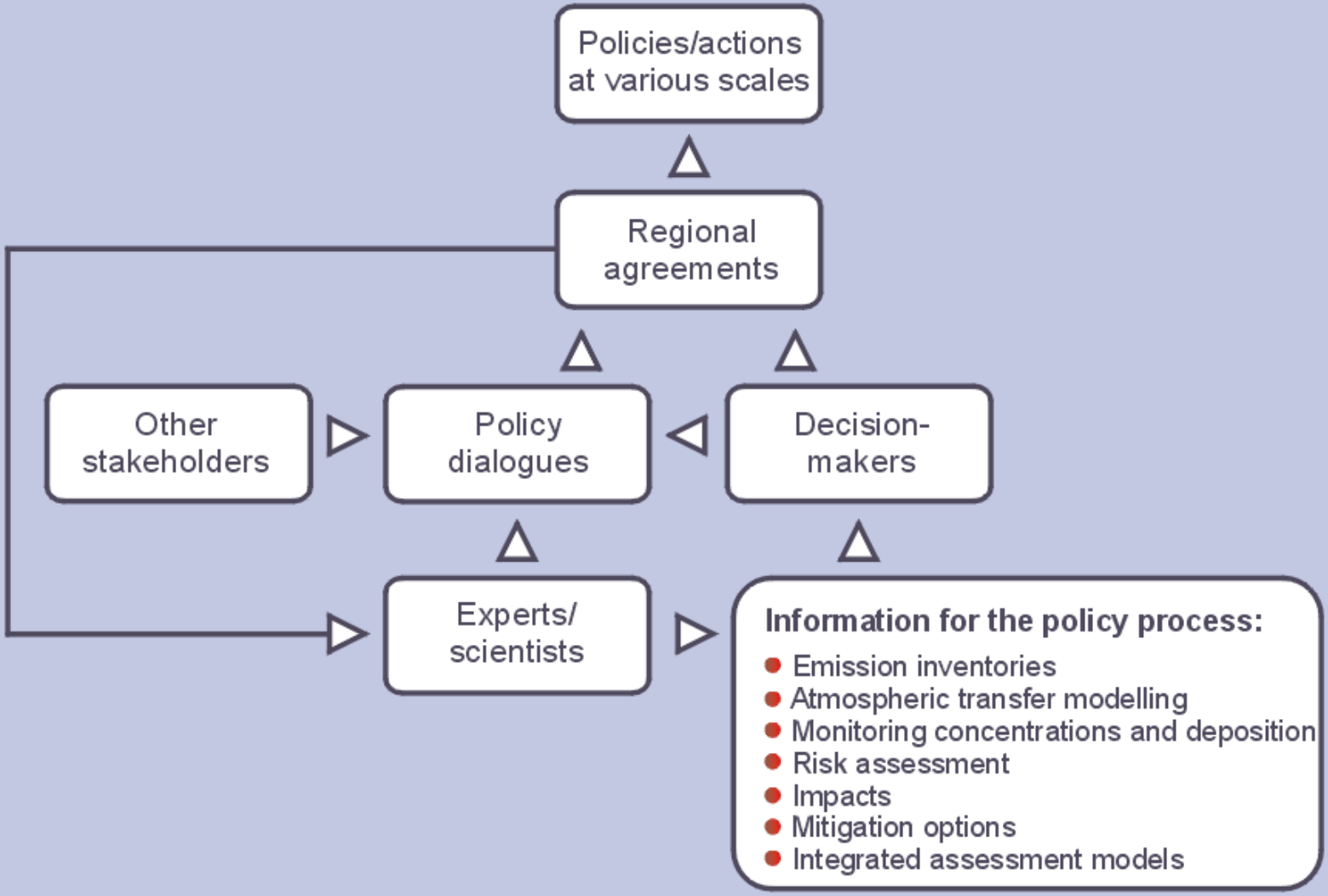
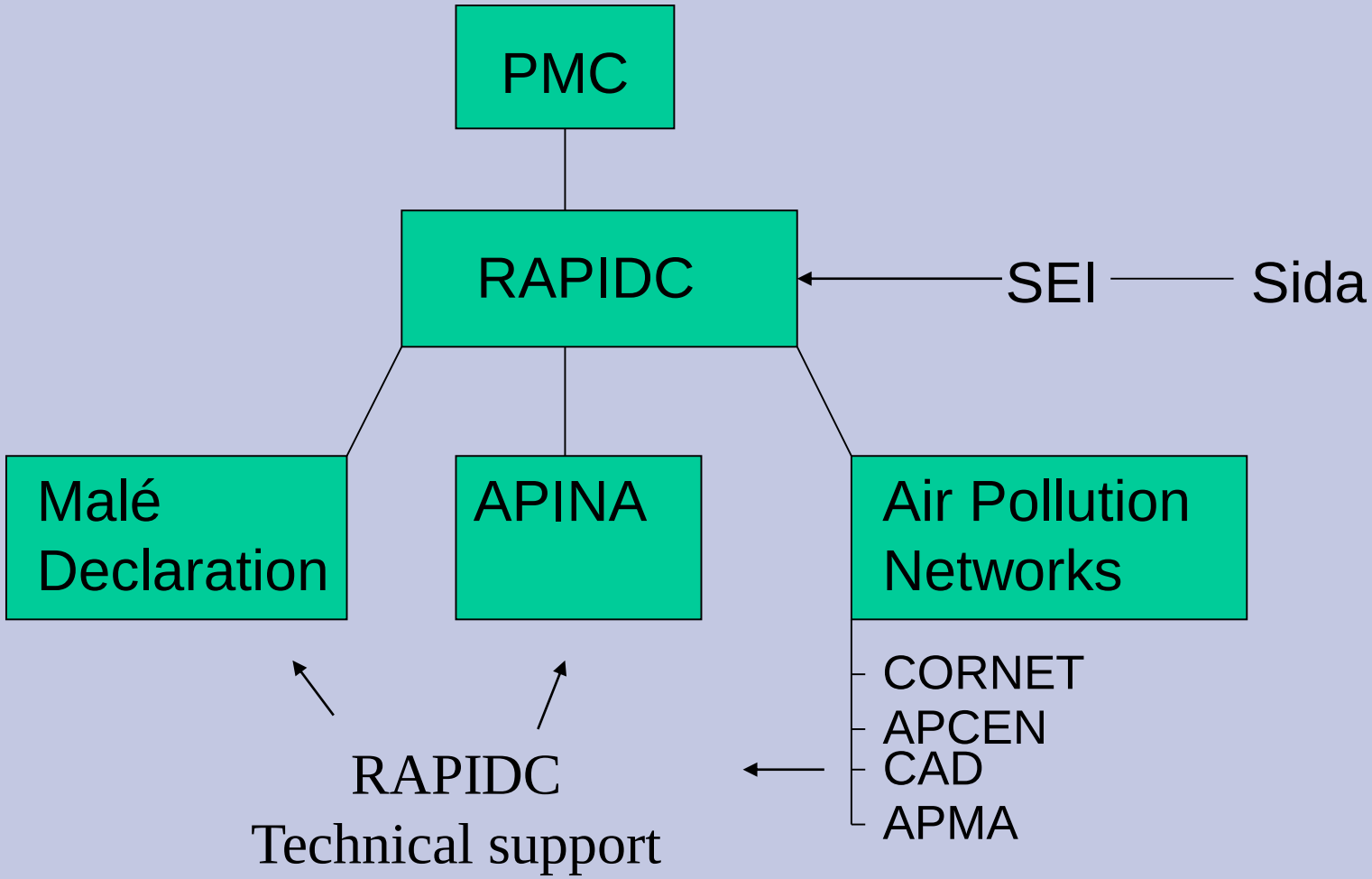
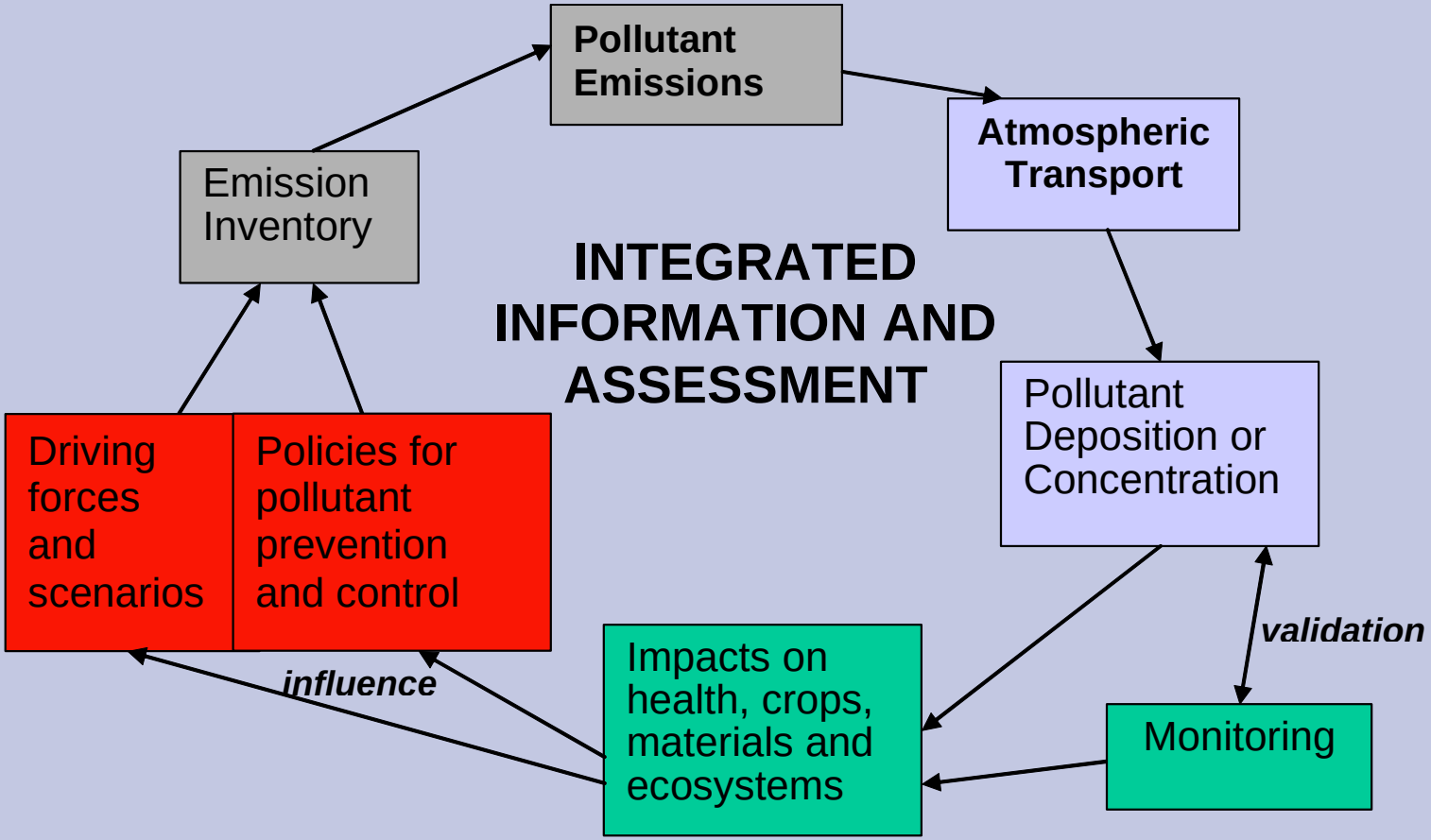
RAPIDC Approach



Phase III RAPIDC Structure 2005-2009




Pollutant Emissions
Atmospheric Transport
Emission Inventory
INTEGRATED INFORMATION AND ASSESSMENT
Pollutant Deposition or Concentration
Driving forces and scenarios
Policies for pollutant prevention and control
validation
influence
Impacts on health, crops, materials and ecosystems
Monitoring

Impacts of transboundary air pollution

Human health – are PM_{10} and $PM_{2.5}$ concentrations high enough in remote areas to cause impacts?

Crops – are ozone concentrations high enough to damage crop yields?

Ecosystems – is the deposition of Nitrogen and Sulphur compounds high enough to cause impacts?

Corrosion of materials – are rates high enough in South Asia to cause economic impacts?

Emissions

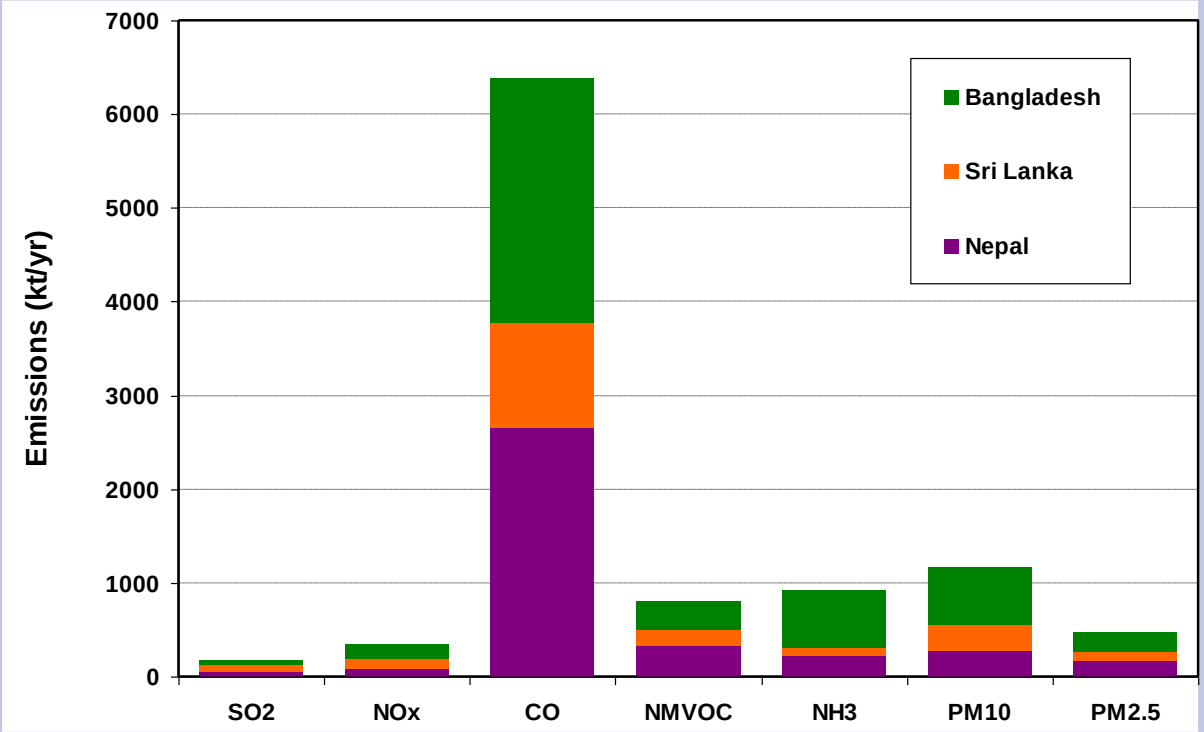


Figure 2.4 Draft emissions inventories combined for Bangladesh, Sri Lanka and Nepal for baseline year 2000 according to pollutant

Emissions

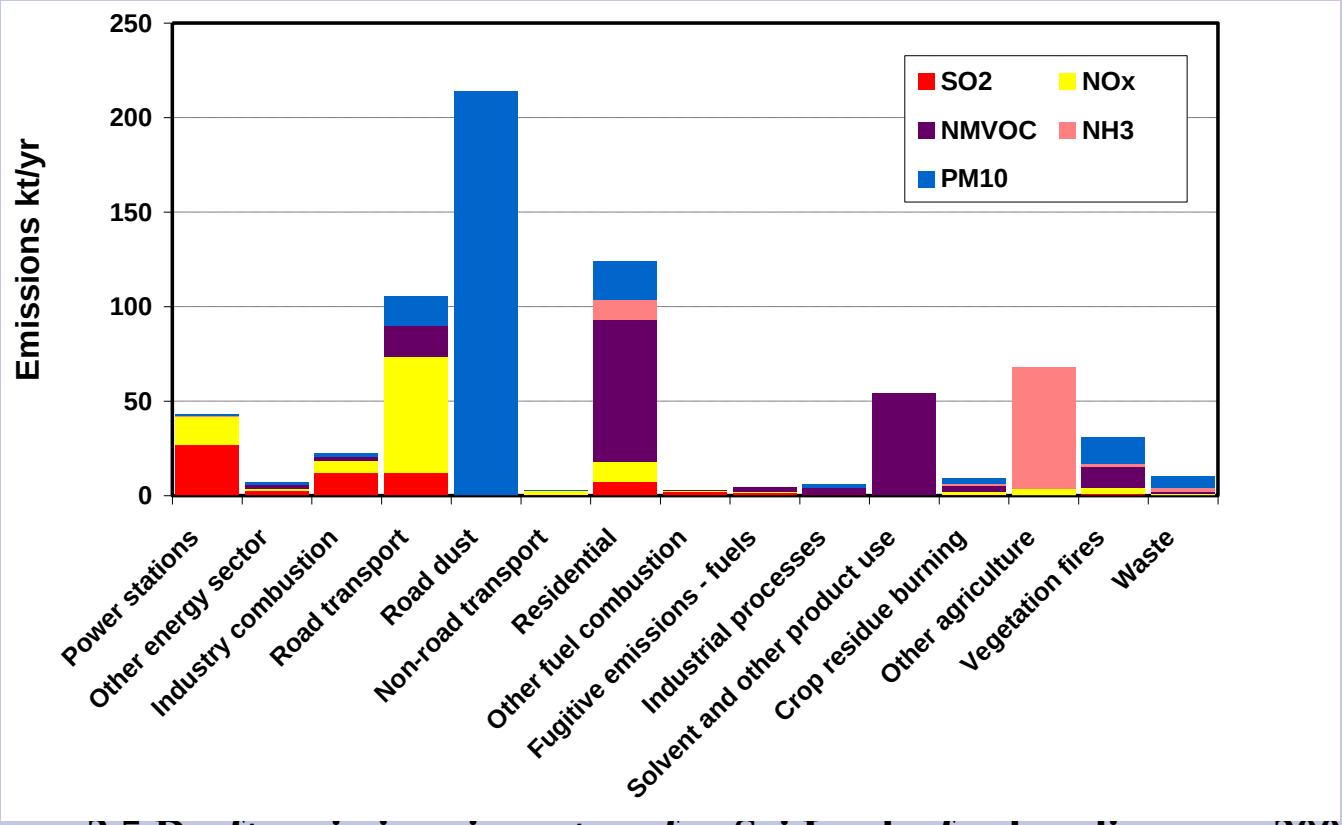


Figure 2.5 Draft emissions inventory for Sri Lanka for baseline year 2000

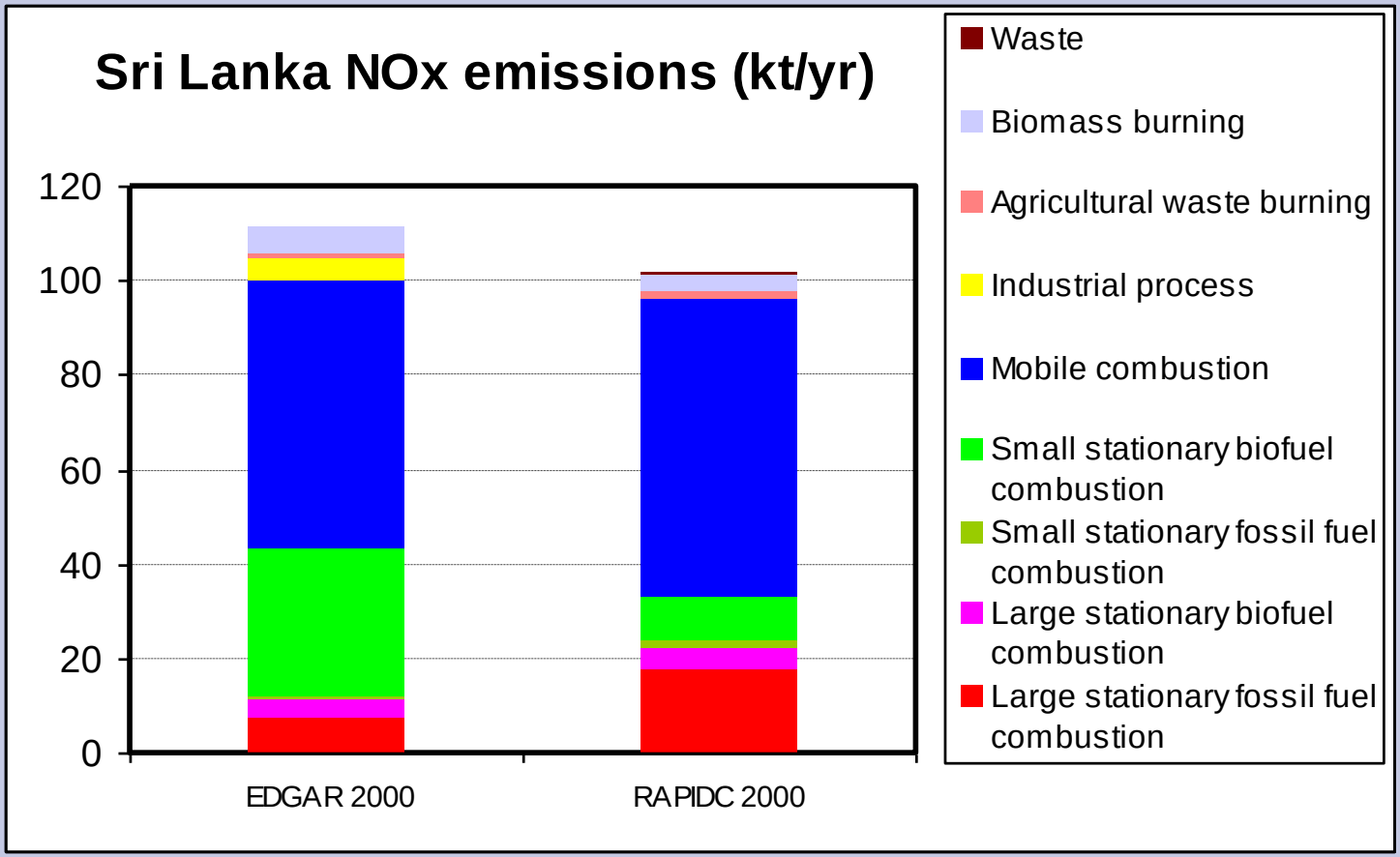


Figure 2.8 Comparison between EDGAR and RAPIDC emissions inventories for Sri Lanka NOx

Regional haze problem is increasing around the globe

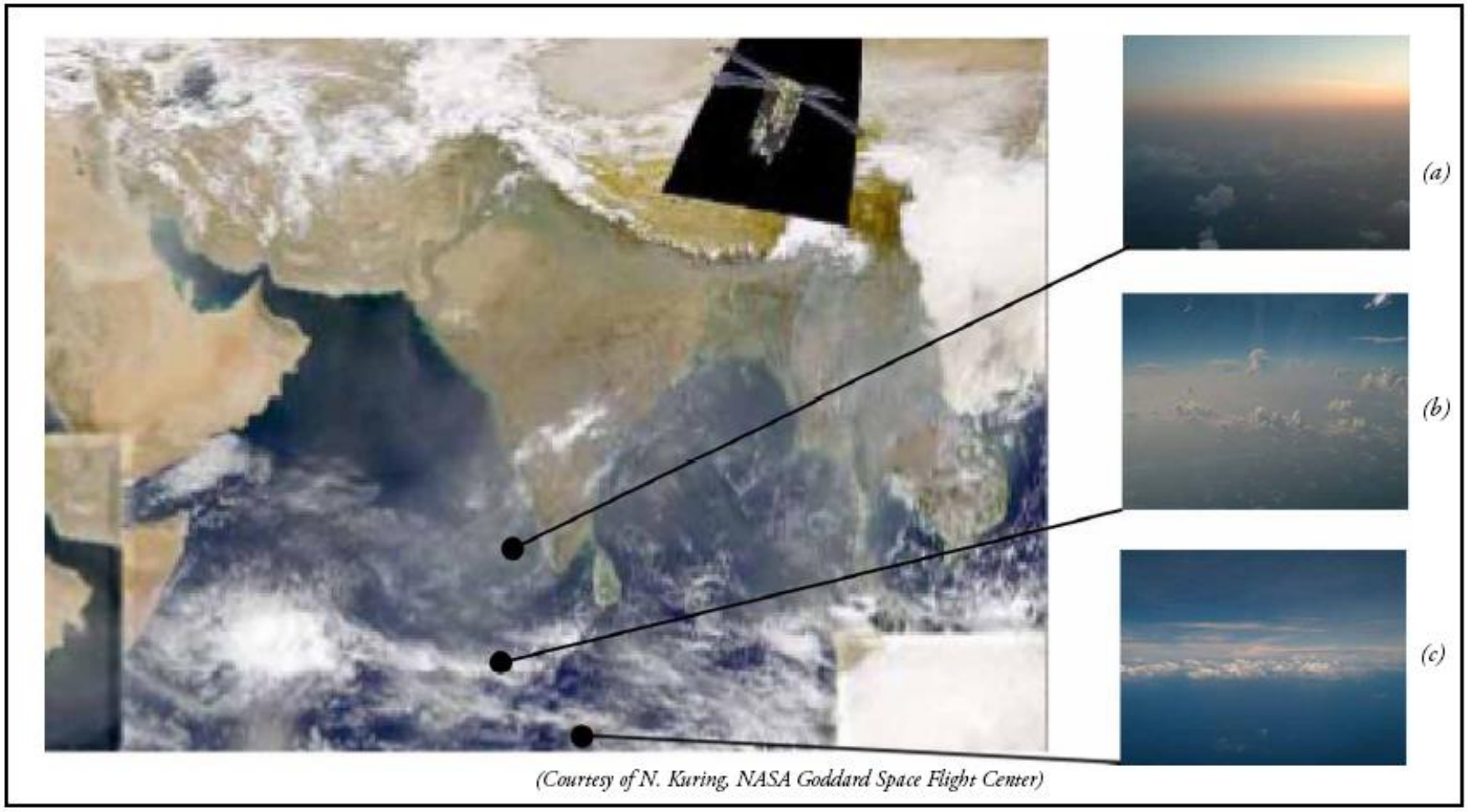
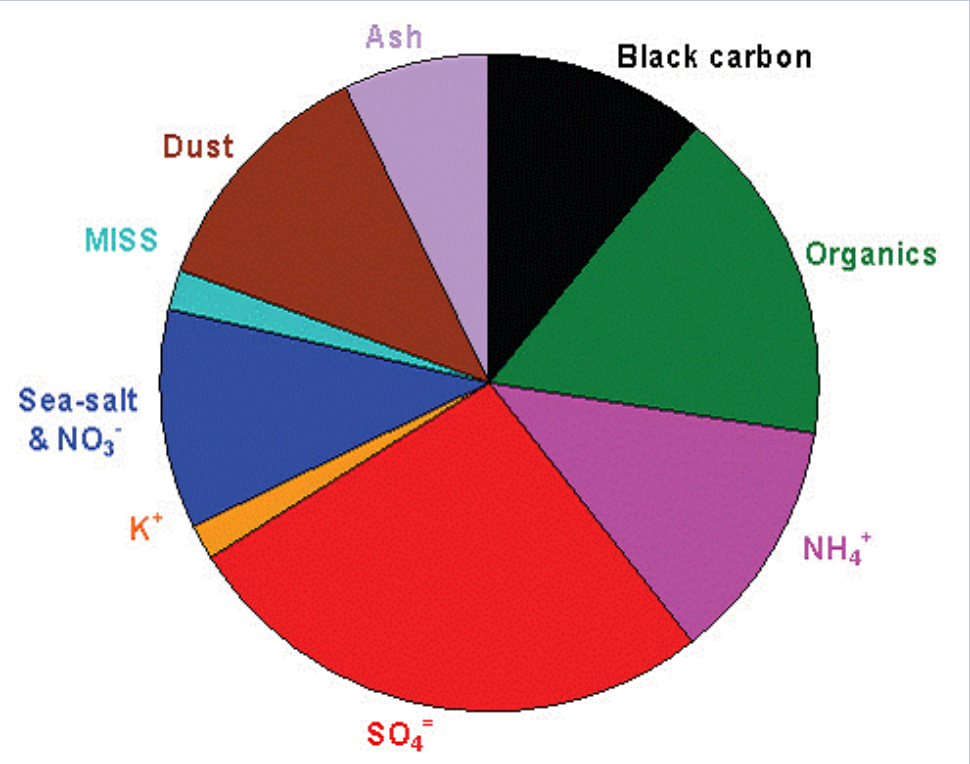


Figure A: Synoptic view of the Asian during INDOEX, top left, from the SEAWiFS satellite. The three photographs on the right taken from the C-130 research aircraft show images of (a) the dense haze in the Arabian Sea, (b) the trade cumuli embedded in the haze and (c) the pristine southern Indian Ocean.

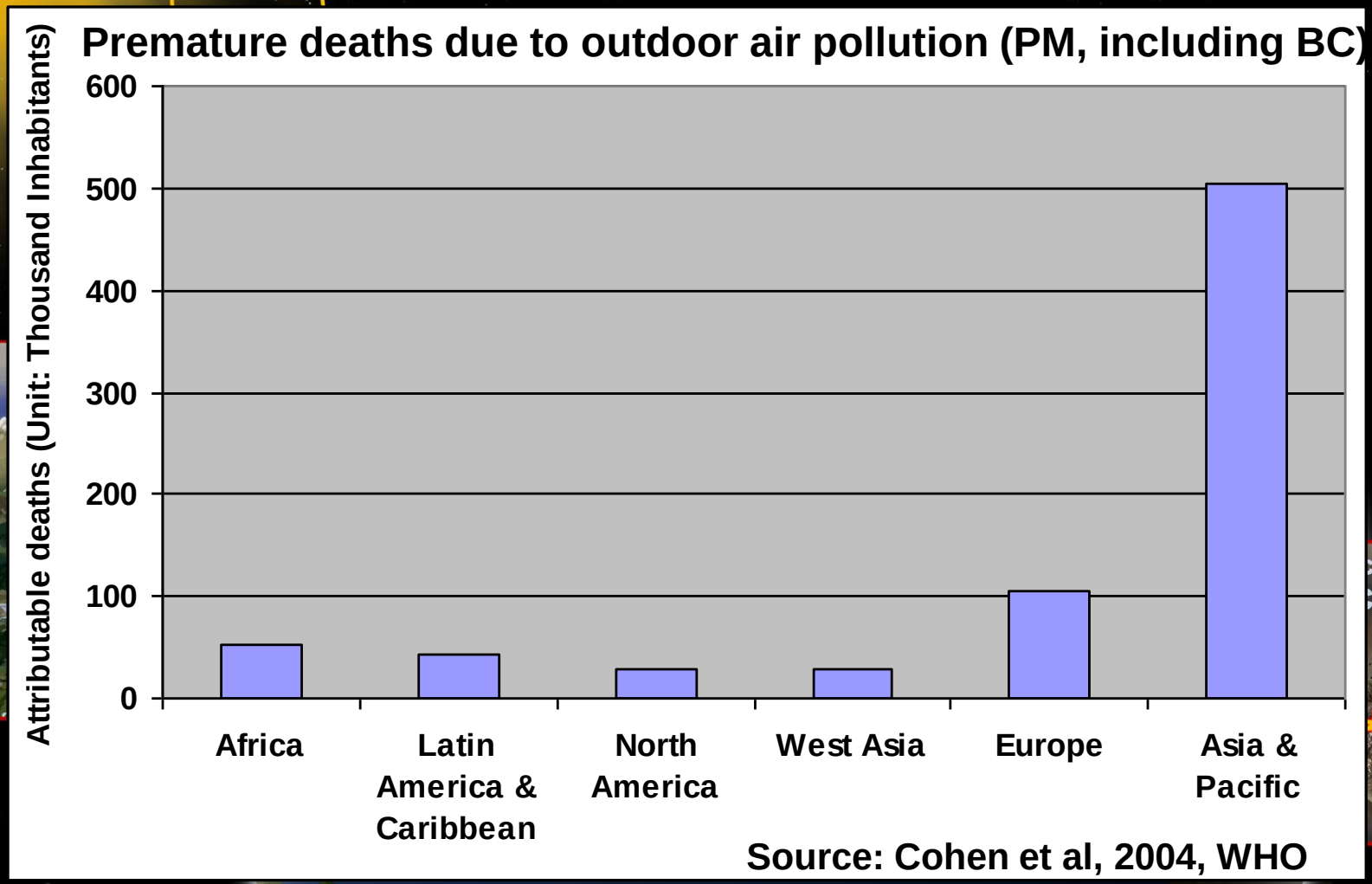
Measured composition of the Atmospheric Brown Cloud over South Asia from the ABC website: (http://www-abc-asia.ucsd.edu)

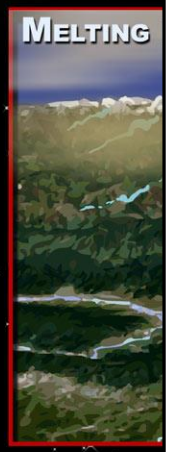


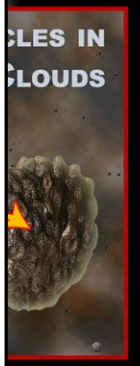
What are sources an effects of ABC particles?

Hindu Kush-Himalayan-Tibetan Glaciers: Water Fountain of Asia

Black Carbon has an important local effect melting these glaciers



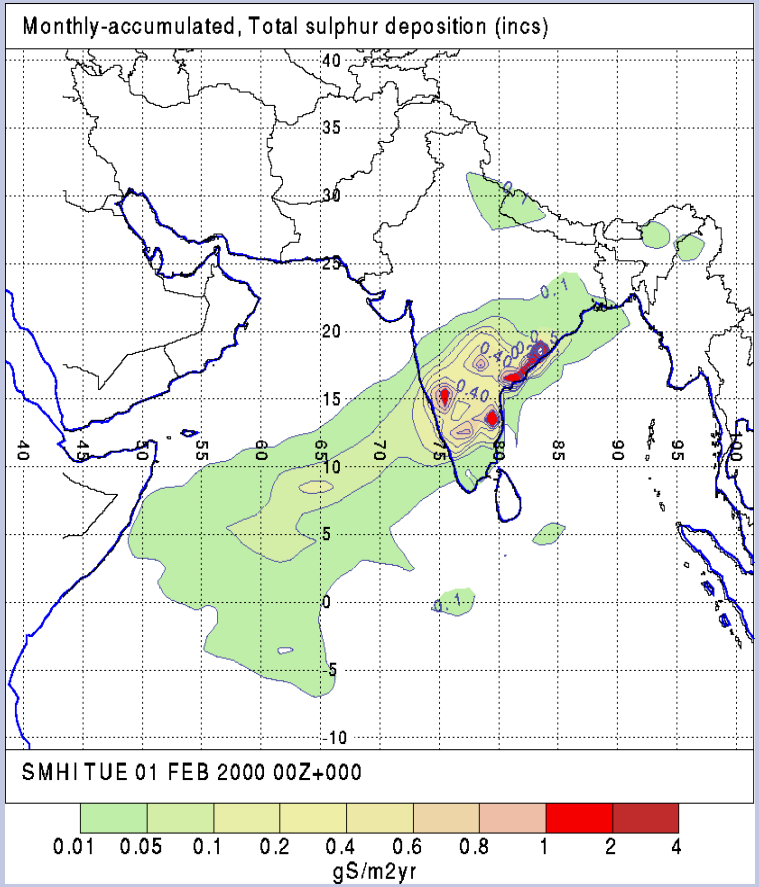




Atmospheric Transport of Pollutants

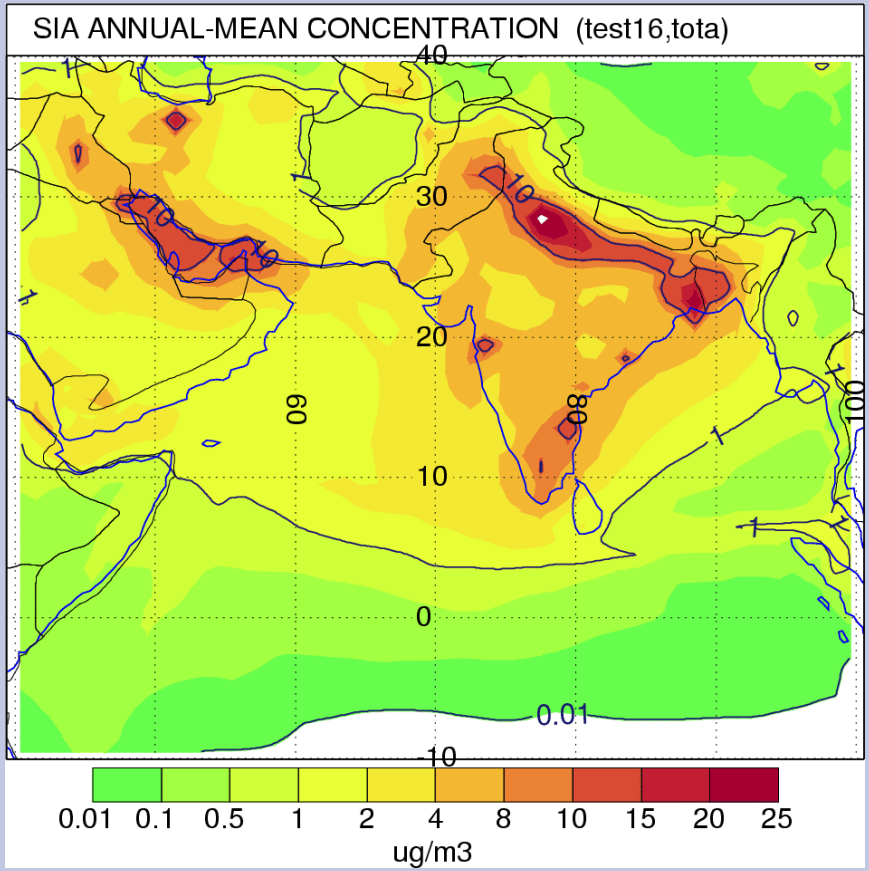
- MATCH model in Malé IIAS

  S, N, O_3, $PM_{2.5}$
- Training in principles of atmospheric transport
- MATCH model installed at Malé Secretariat



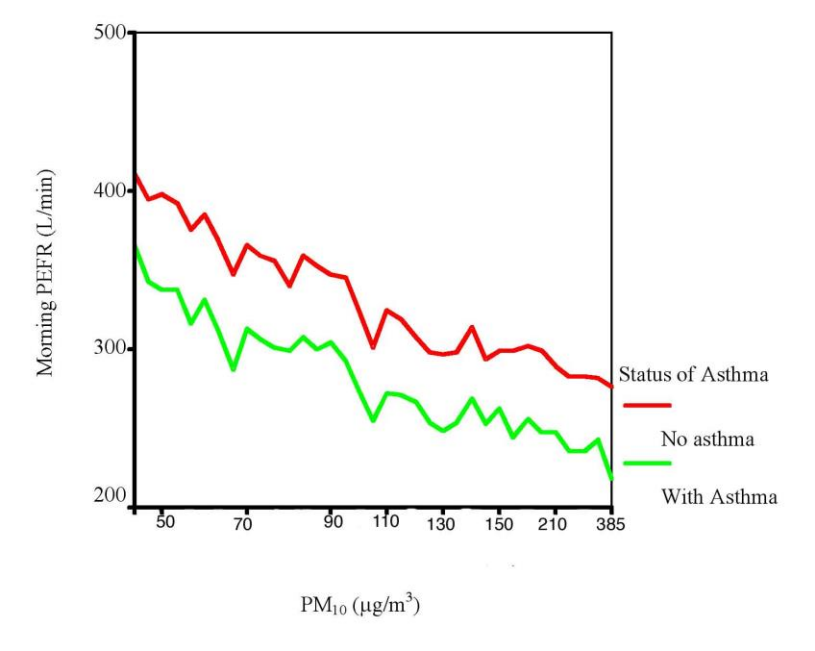
IIAS - Integrated Information and Assessment System

Calculated annual-mean concentration of secondary inorganic aerosols (SIA) – sulphate, nitrate and ammonium (all within the $PM_{2.5}$ size category)

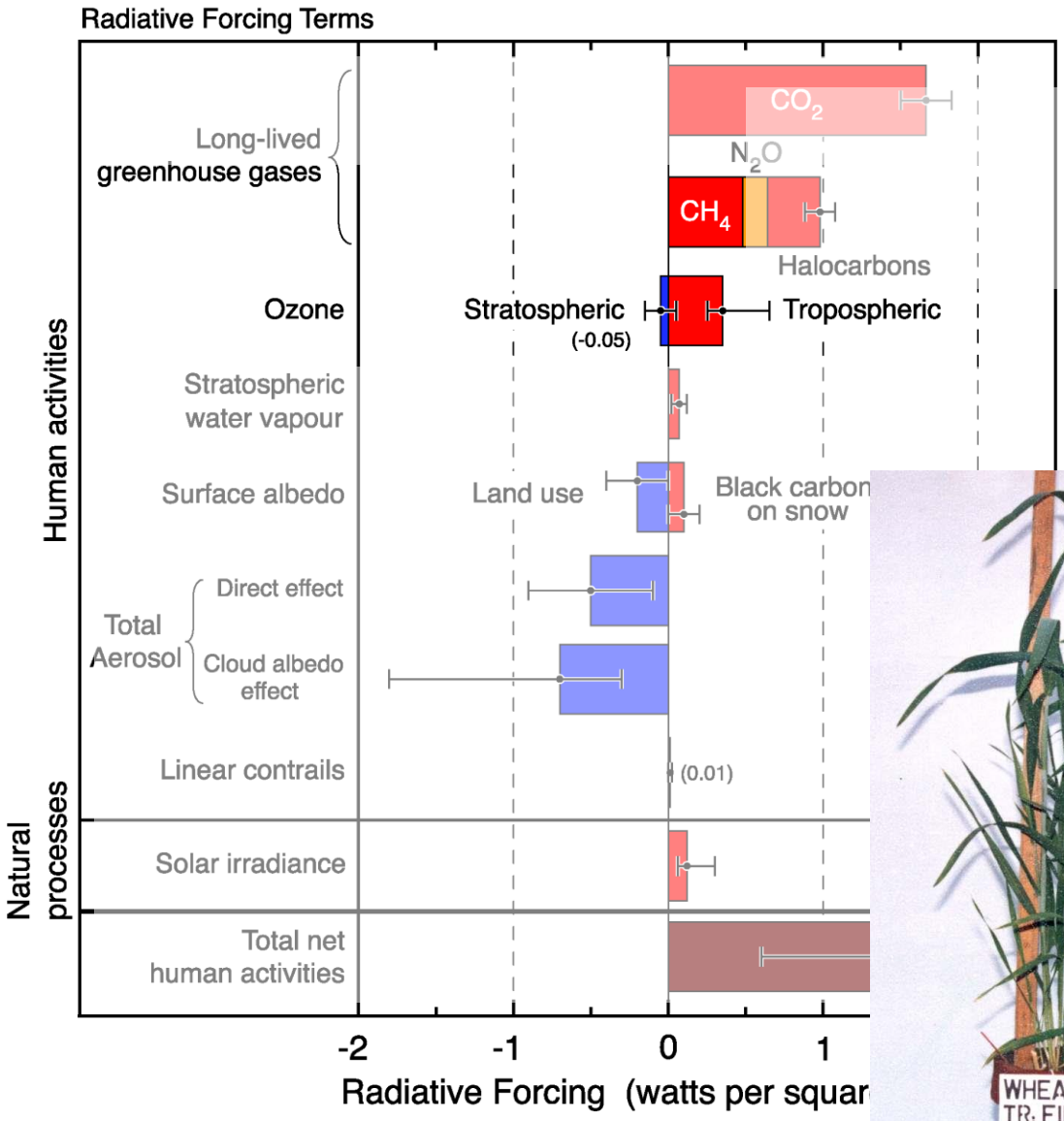


10 µg m^{-3} $PM_{2.5}$ would result in a 10% increase in the risk of cardiopulmonary mortality and a concentration of 20 µg m^{-3} in a 20% increase in adults more than 30 years old

School Children Study Dhaka, Bangladesh



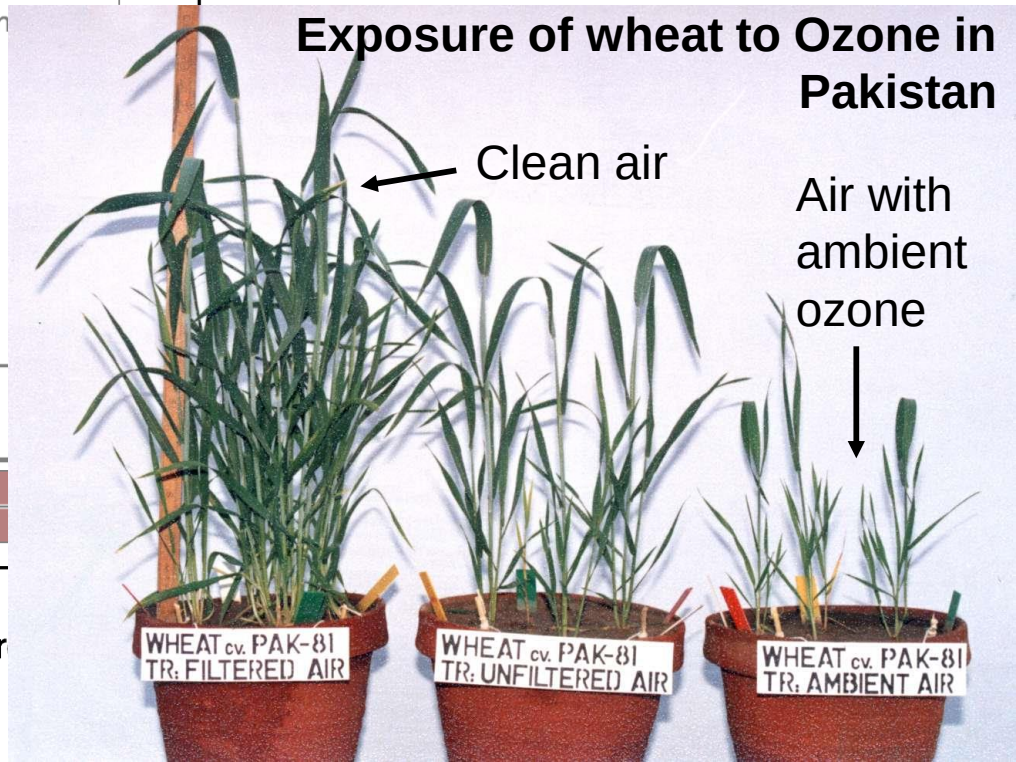
Multiple benefit of reducing ground-level / tropospheric ozone



Source: IPCC 2007

i. Ozone – an important GHG;
short residence time – immediate climate benefits from reductions

ii. Ozone – reduces crop yields in Asia by up to 40%



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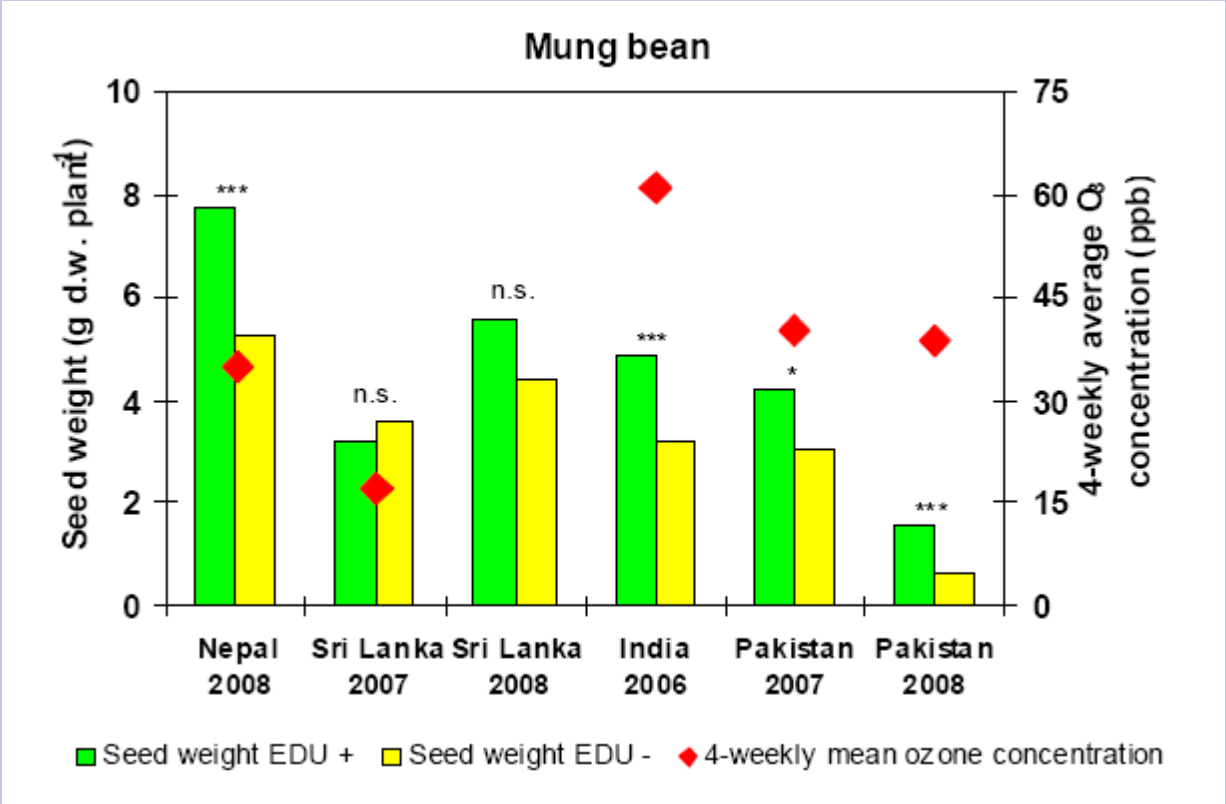
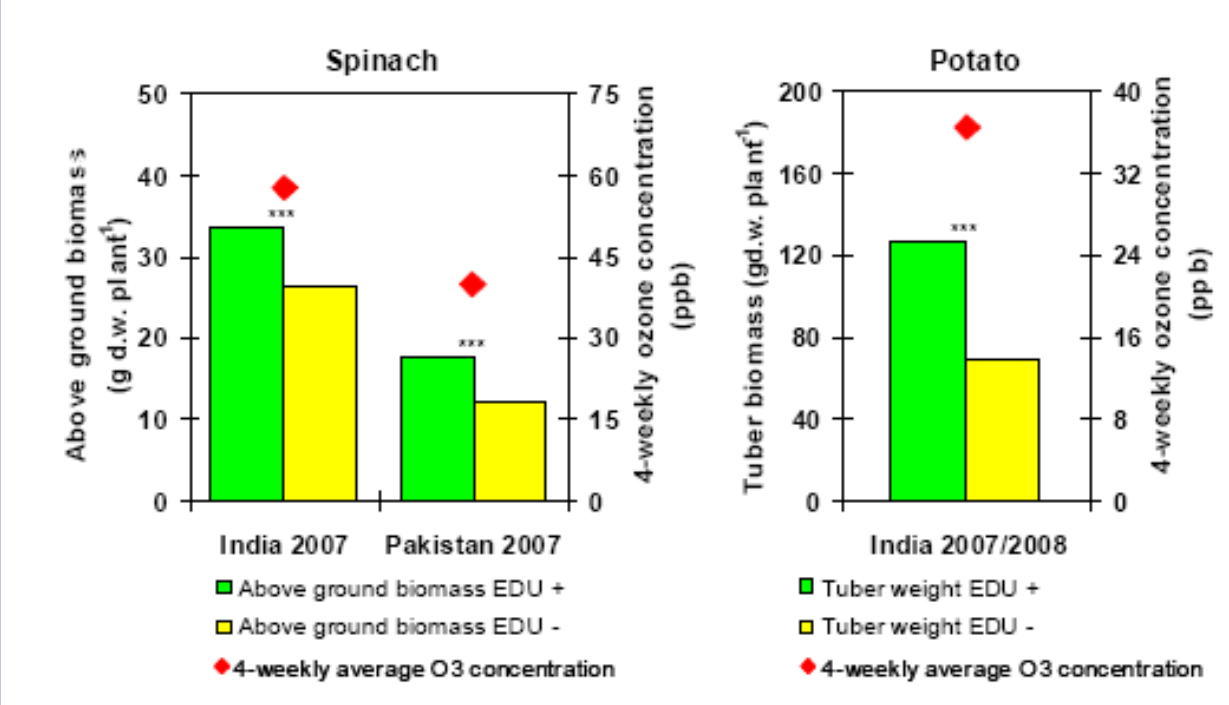


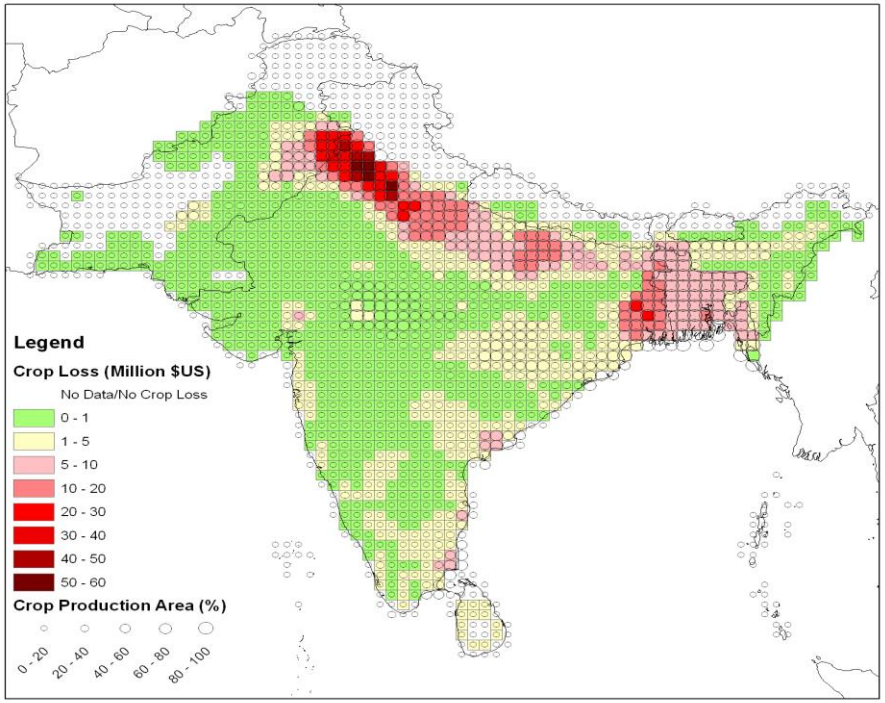
RAPIDC

Regional Air Pollution In Developing Countries



Spinach grown in Lahore, Pakistan, with and without EDU

Provisional economic loss estimates for South Asia



Wheat, Rice, Soybean, Potato

European AOT40 dose-response relationships

FAO crop production, distribution and producer price data for 2000

MATCH modelled O_3 concentrations for 2000

Loss estimated at US$ 3.9 Billion

India (US$ 3.1), Pakistan (US$ 0.35) and Bangladesh (US$ 0.4)

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CORNET – Corrosion Network

Global network of scientists looking into the impact of air pollution on the corrosion of materials

i. **Exposing standard samples on racks**
Network of sites across Asia and southern Africa

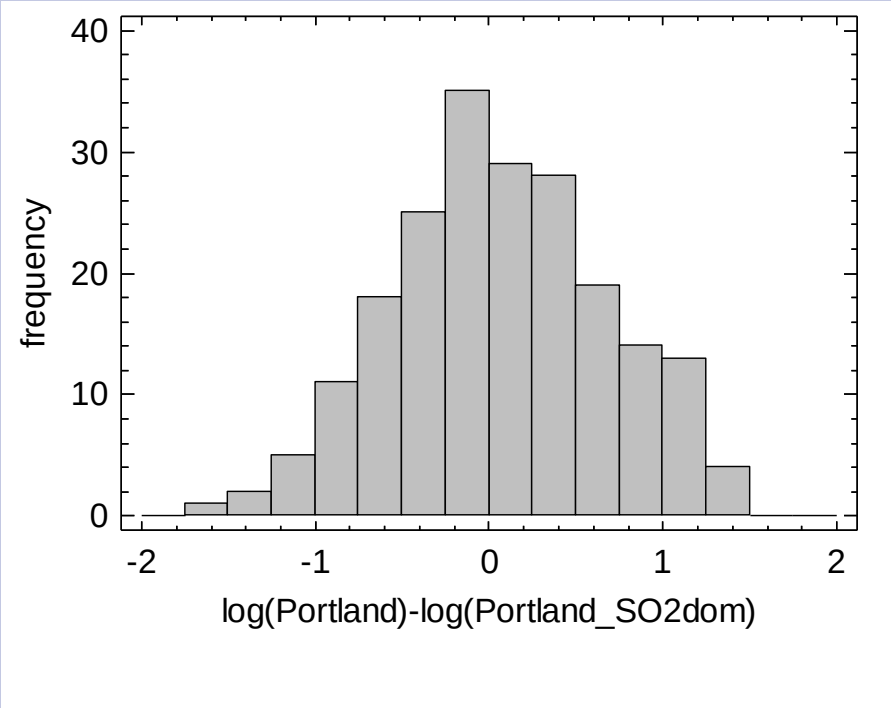
ii. **Exposure of kits**

iii. **Stock at risk study**

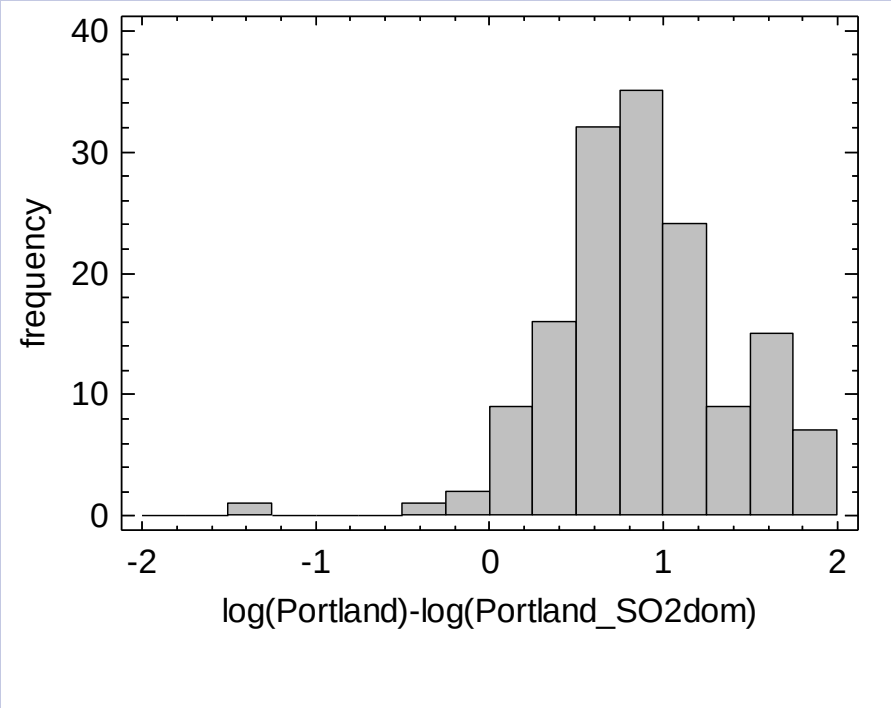
iv. **Heritage impacts**

Prediction using Dose Response Functions from Europe: Portland RAPIDC values higher than expected (256%)

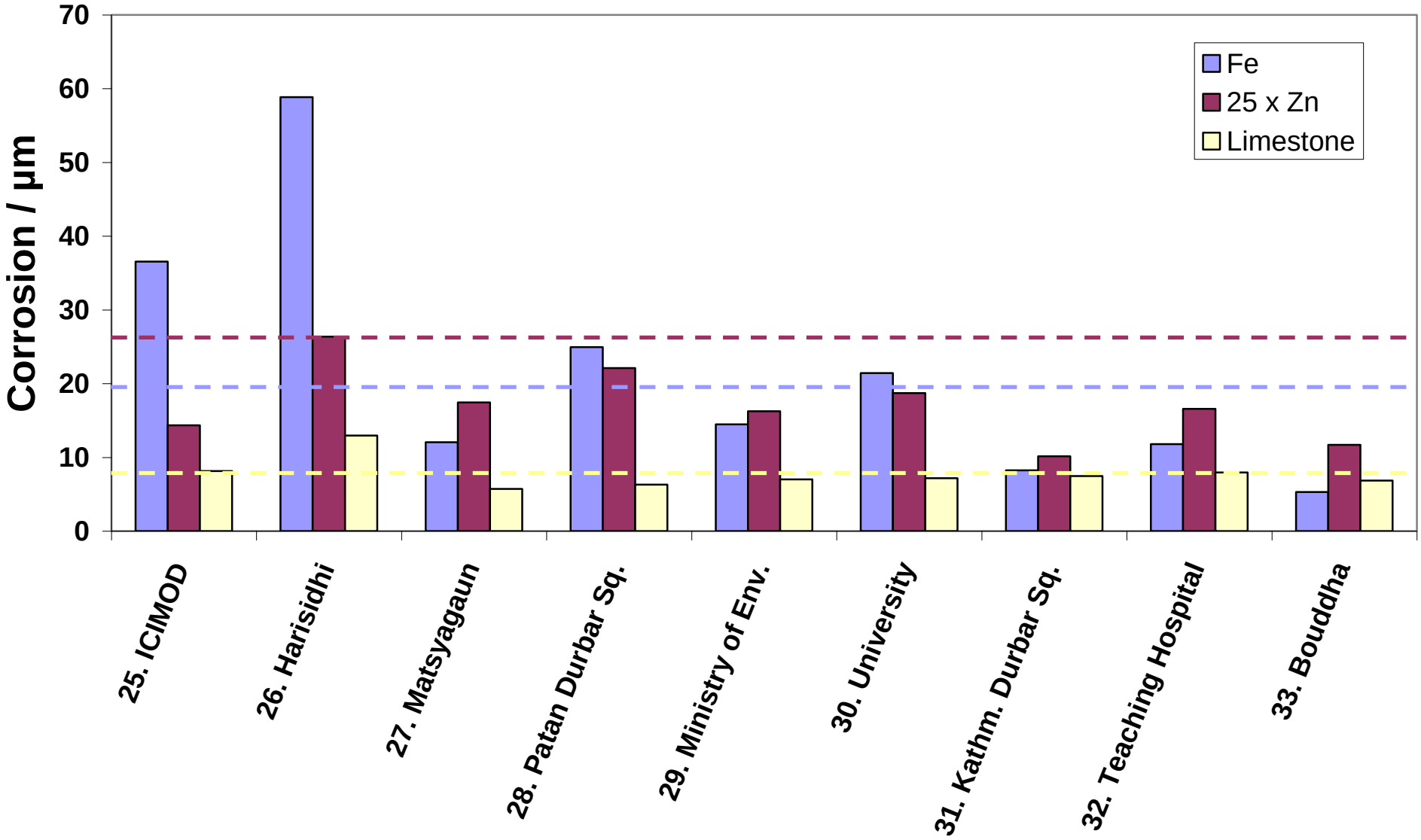
ICP Materials data



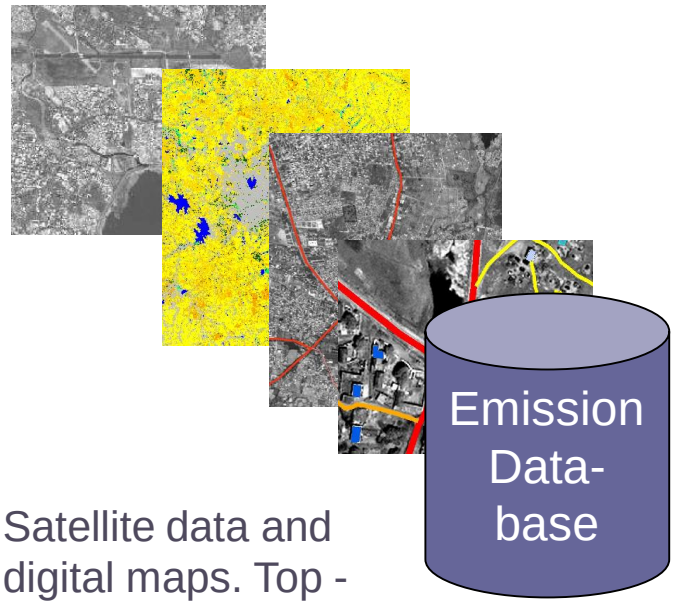
RAPIDC data



Kathmandu corrosion kits and tolerable levels for corrosion

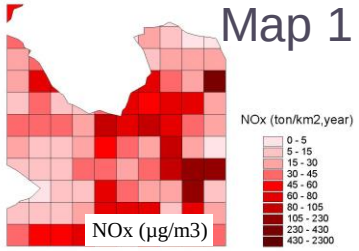


Rapid Urban Assessment - the Process



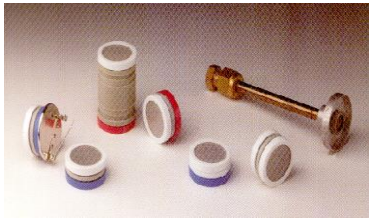
Satellite data and digital maps. Top - down and bottom-up approach for the establishment of an emission database.

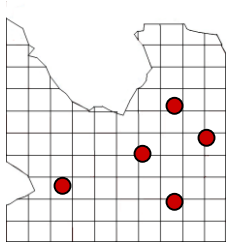
Dispersion Modelling



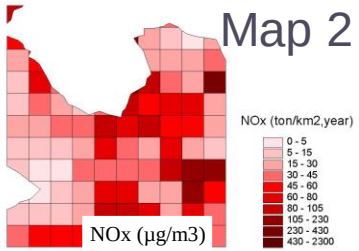
Emission analysis & modelling

Two parallel processes - monitoring and modelling.

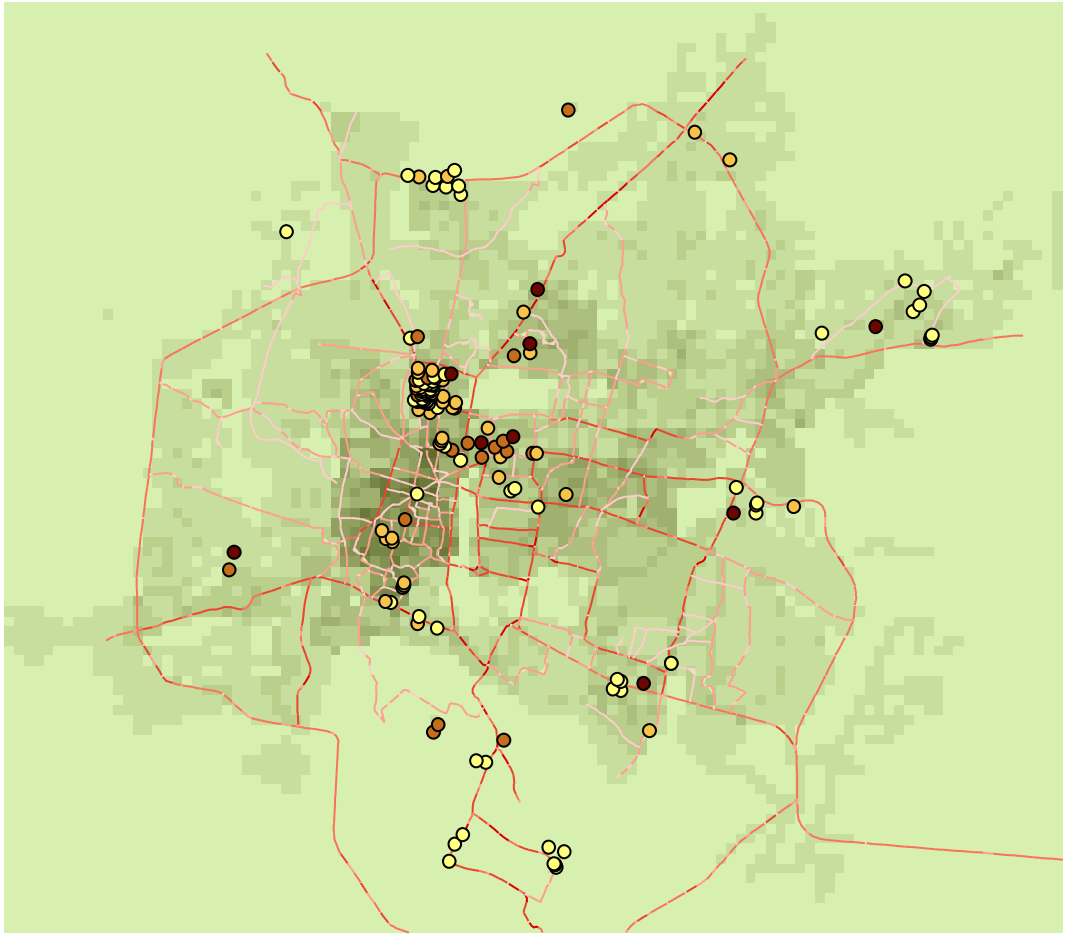




Monitoring



Compiled source emissions of $S0_2$ from area sources, line sources and point sources of Kathmandu.



Legend

SO2 ton/year

- 0.03
- 0.04 - 0.06
- 0.07 - 0.15
- 0.16 - 0.29

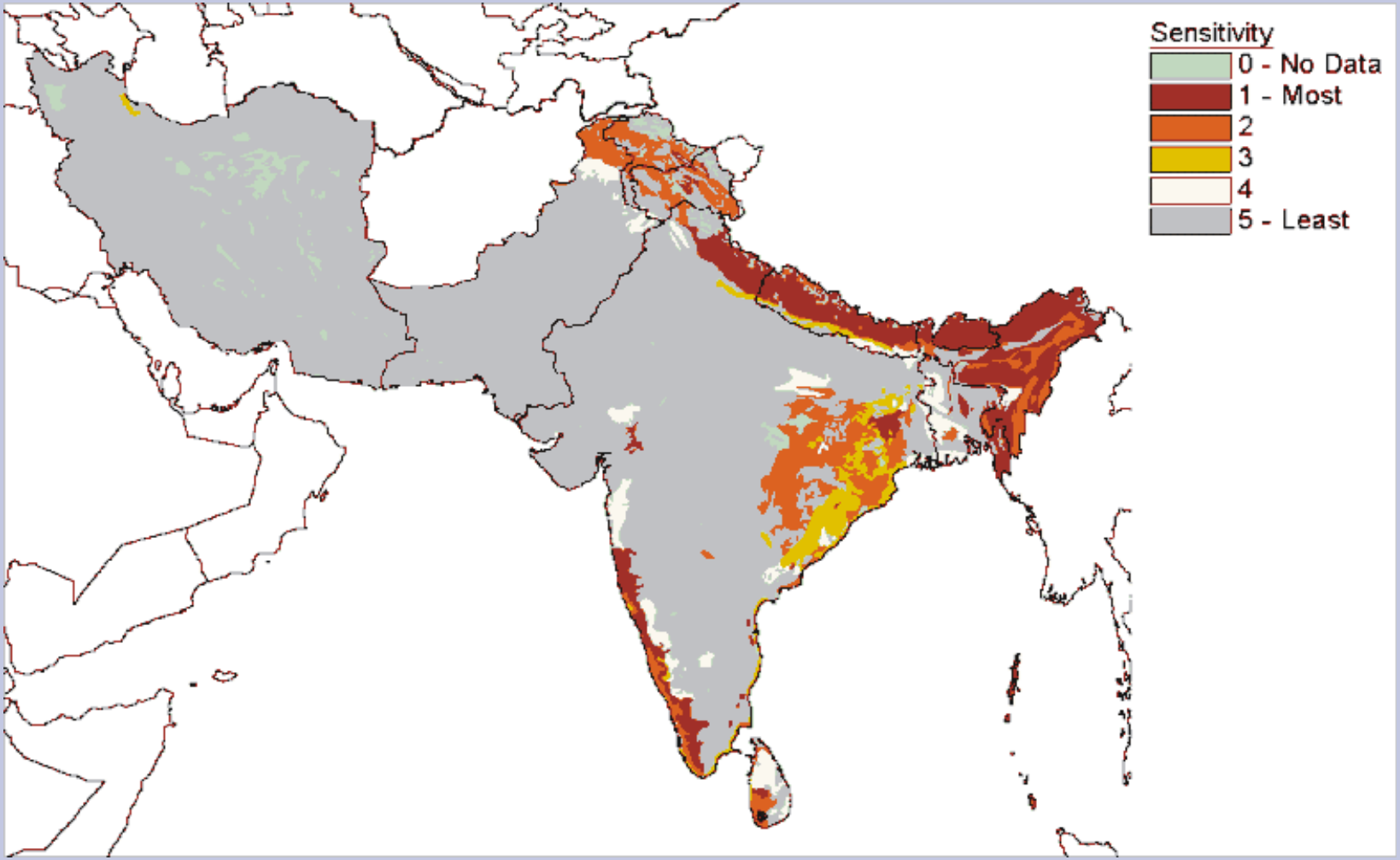
SO2 ton/year Grid cell

- 0.00000 - 0.00015
- 0.00016 - 0.00040
- 0.00041 - 0.00069
- 0.00070 - 0.00089
- 0.00090 - 0.00129

SO2 ton/year Grid cell

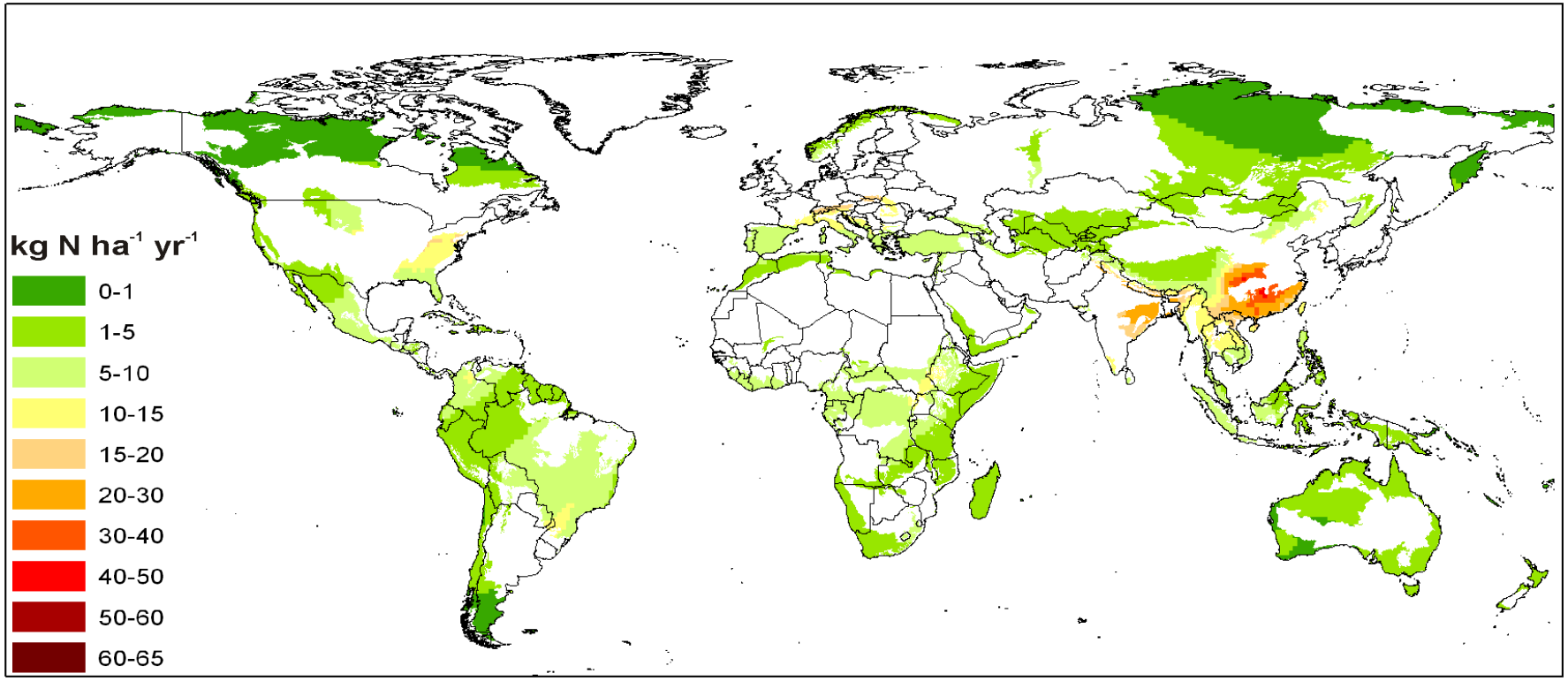
- 0.00 - 0.06
- 0.07 - 0.19
- 0.20 - 0.39
- 0.40 - 0.71
- 0.72 - 1.31
- 1.32 - 2.31
- 2.32 - 3.66
- 3.67 - 5.26
- 5.27 - 9.63
- 9.64 - 18.93

Terrestrial Ecosystem Sensitivity to Acidic Deposition in South Asia



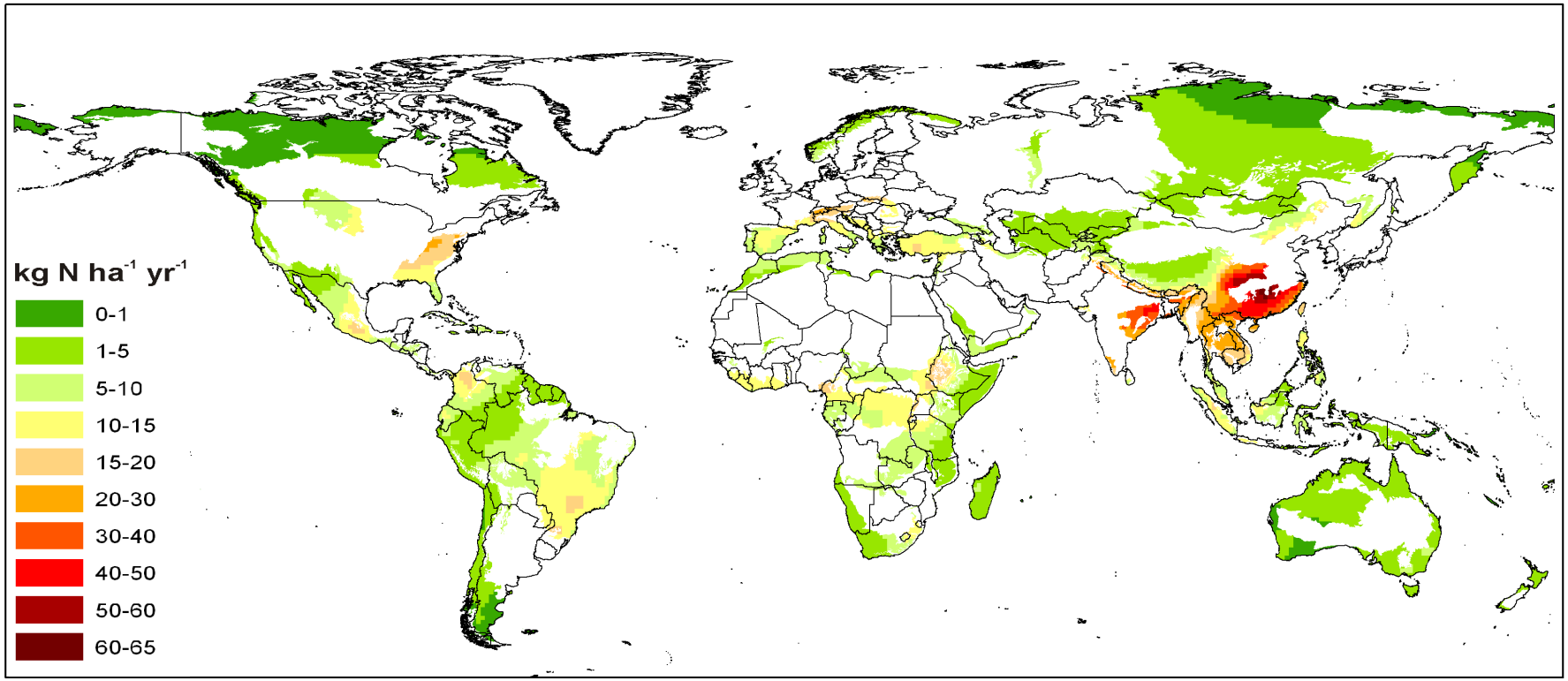
Source: Kuylenstierna *et al*. 2001

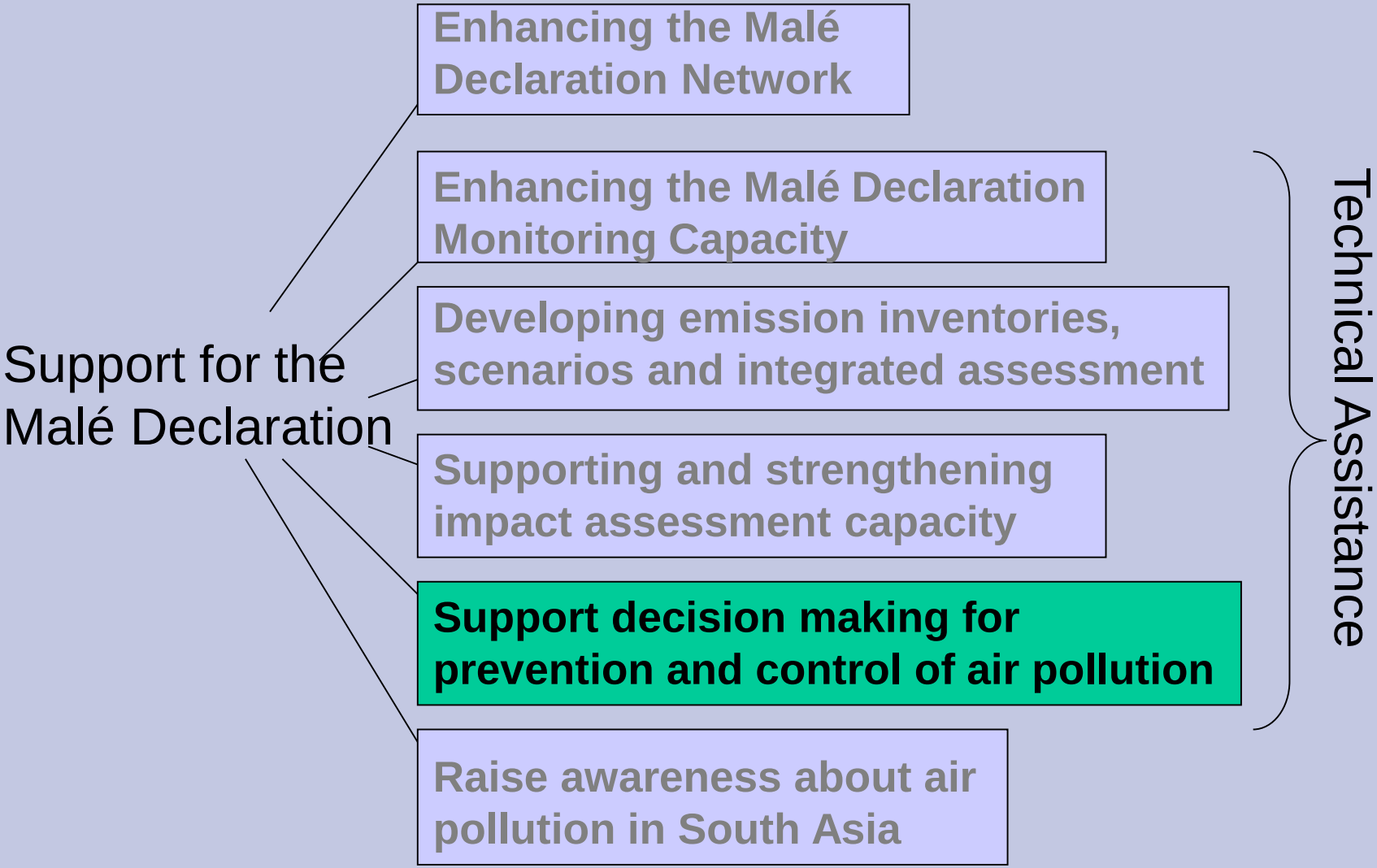
Overlay G200 Ecoregions with Total N Deposition for 2000 Baseline



Total N = NOy ($NO + NO_2 + HNO_3 + HNO_4 + NO_3 + 2xN_2O_5$ + PAN + organic nitrates) + NHx ($NH_3 + NH_4$)

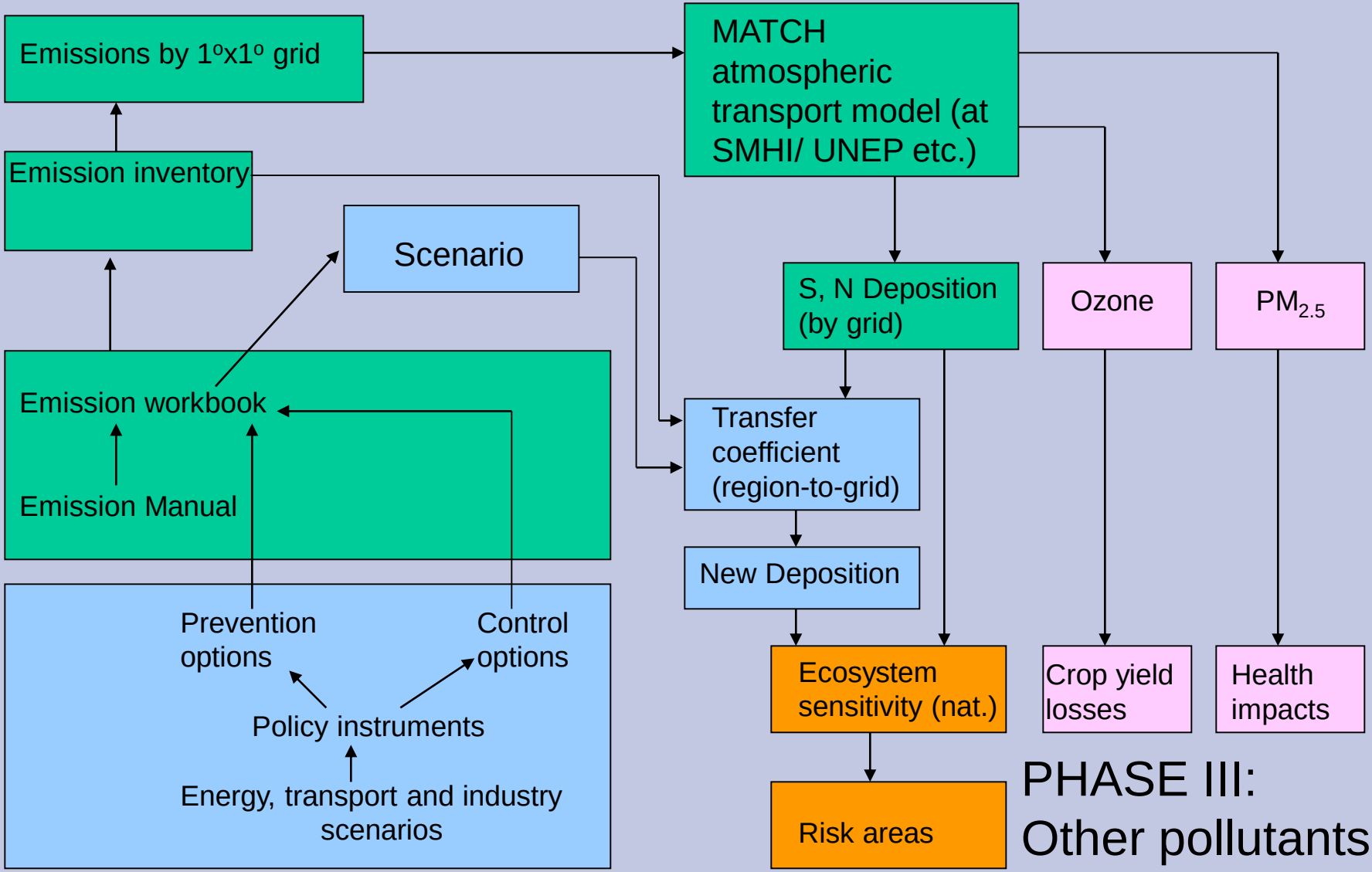
Overlay G200 Ecoregions with SRES A2 for 2030




Support for the Malé Declaration
Enhancing the Malé Declaration Network
Enhancing the Malé Declaration Monitoring Capacity
Developing emission inventories, scenarios and integrated assessment
Supporting and strengthening impact assessment capacity
Support decision making for prevention and control of air pollution
Raise awareness about air pollution in South Asia
Technical Assistance

Malé Declaration IIAS

Integrated Information and Assessment System



PHASE III: Other pollutants and impacts

Policy Options

- Policy case study manual by IIIEE: '*Policy Options for Air Pollution Prevention and Control' in South Asia*
- Complemented by 'Compendium of best practices on Prevention and Control of Air Pollution' by Ram Shrestha (AIT)
- Perspectives on implementation of international and regional good practice in different Malé countries by SEI
- Three training courses held in 2006, 2007 and 2008

SEI Project: Perspectives on Air Pollution Control Policy in South Asian Countries

- **Case Study Countries:**
  - **Bangladesh**
  - **India**
  - **Nepal**
- **Qualitative Research:**
  - **18 Interviews with AQM experts**
  - **Literature Reviews**
  - **Qualitative data analysis using NVivo software**

City/Country	Interview Examples
Delhi, India	• CPCB • MOEF • CSE • TERI
Dhaka, Bangladesh	• DOE • NIPSOM • BCAS • BAEC
Kathmandu, Nepal	• MOEST • Kathmandu Municipality • ENPHO

Effects of emission control measures on emissions (Amman, 2009)

	Reduced emissions	**Increased emissions**
Structural Measures		
Energy savings, efficiency improvements, banning of activities	All pollutants	
Increased use of natural gas	CO_2, SO_2, VOC, NO_2, PM	CH_4
Biomass	CO_2	VOC, PM, CH_4, N_2O
Stationary Sources		
Fluidised bed combustion	SO_2, NO_X	N_2O
Combined heat and power	All pollutants	
Selective and non-selective catalytic reduction	NO_X, CO	NH_3, N_2O
Mobile Sources		
EURO Emission standards	NO_X, VOC, PM, CO	NH_3, N_2O

Air pollutants	Direct radiative forcing	Indirect radiative forcing (clouds, ecosystem feedbacks etc.)	Effects to human health	Ecosystem effects
Primary particles (black carbon)	●	???	●	
Secondary organic particles	●	●	●	?
Secondary inorganic particles (sulphates, nitrates)	●	●	●	●
Methane (through trop. ozone)	●	●	●	●
NOx (through trop. ozone)		●	●	●
(Ozone)	●	●	●	●
NOx (methane destruction)		●		
NH3 and NOx (N deposition, C seq. and biodiversity effects)	-	●		●
NH3 and NOx (N deposition and N2O em.)	-	●		●

After P. Grennfelt, IVL, Sweden

Conclusions

- We now have the building blocks for further development of agreements and policies in the Malé region
- Serious impacts on health, crop yields and corrosion have been demonstrated
- We can now move confidently into Phase IV where regional frameworks to discuss emission prevention and control can be developed
- Economic analysis and progress on policy development now needs to be a greater focus

THANK YOU

Remember

Your region's staple diet……..DAL

D – Diligence

A – Accuracy

L - Linkages

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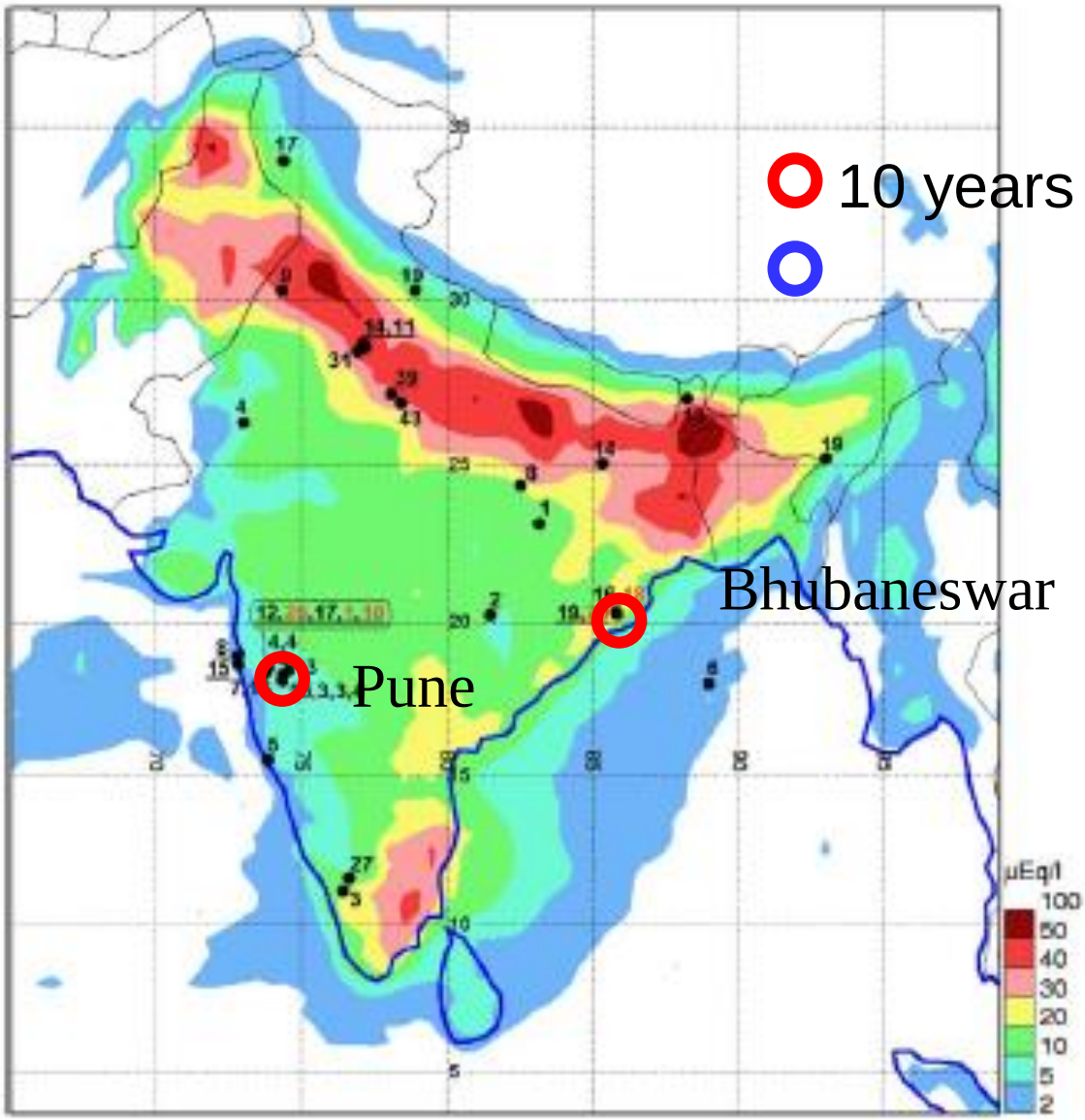
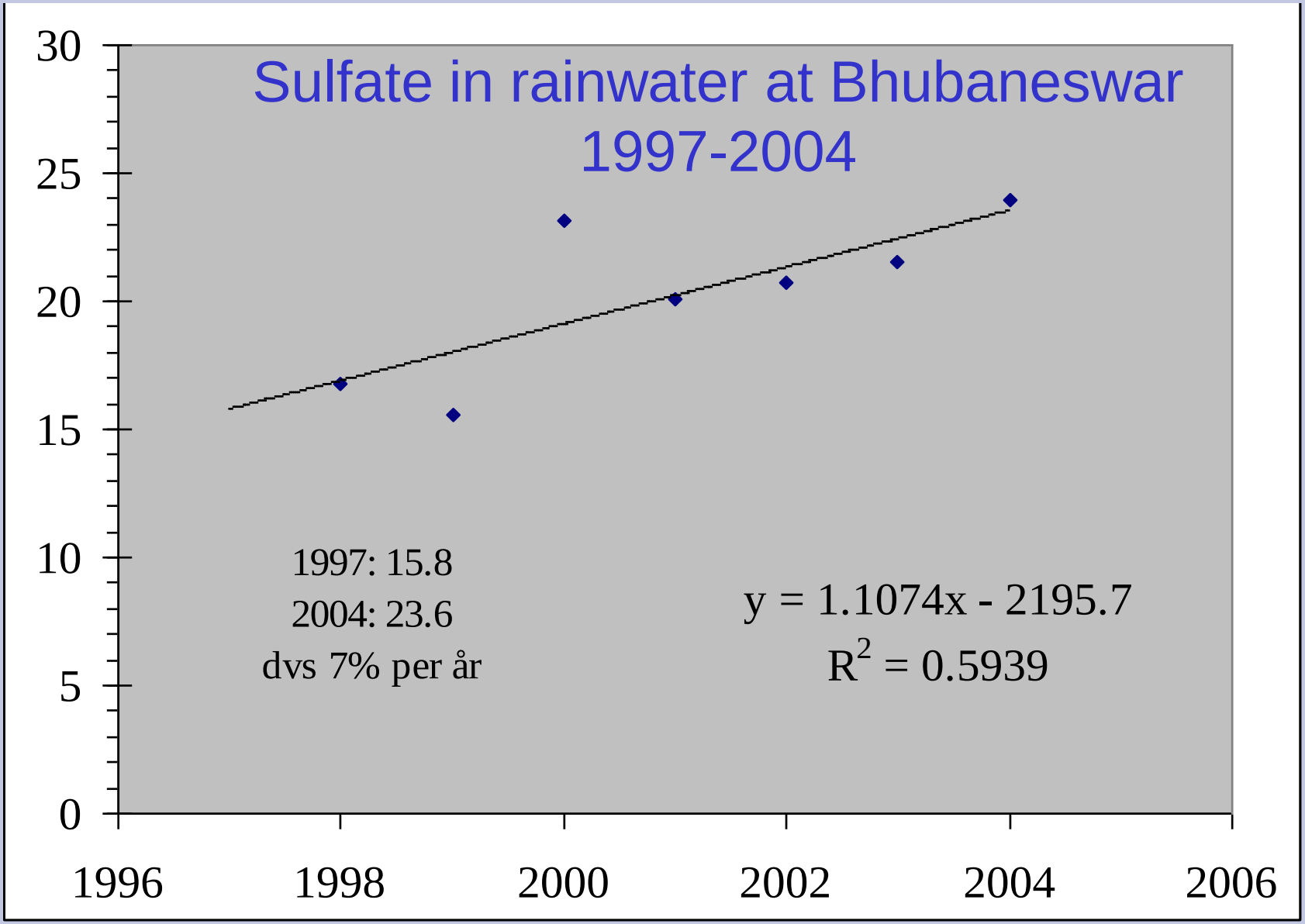
Indian CAD stations

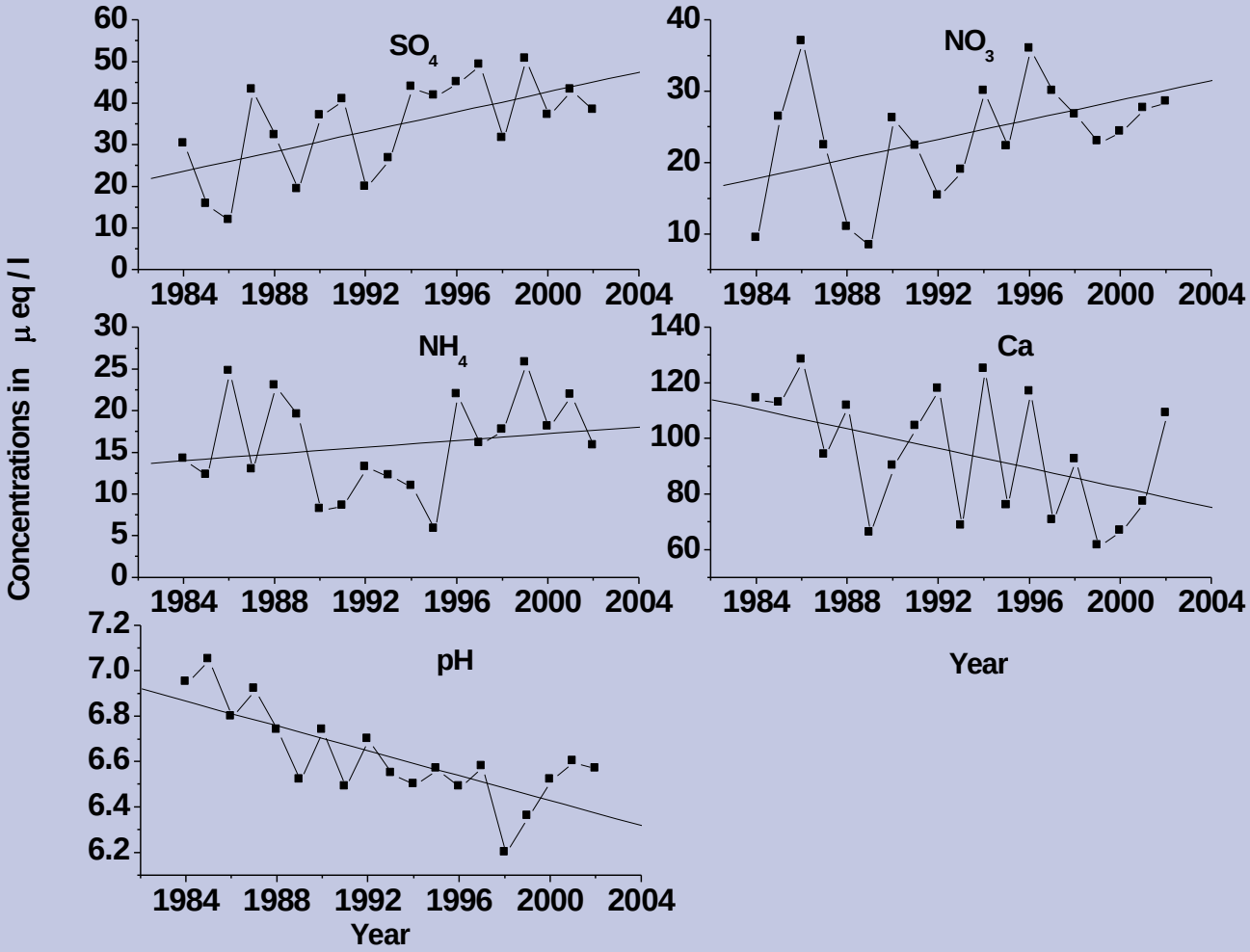


Monitoring – Long-term trends



Monitoring – Long-term trends

Temporal variations of pH, SO_4, NO_3, Ca and NH_4 in rain water at Pune urban sites during 1984 – 2004 from the CAD network (source: Rao et al.)



CAD Inter-comparison of passive samplers for SO_2 and NO_2 measurements for the Malé Declaration

CAD Inter-comparison of passive samplers for SO_2 and NO_2 measurements for the Malé Declaration