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Regional Air Pollution In Developing Countries

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Planning Phase III of the Male Declaration

Further details of potential activities and requirements for their implementation

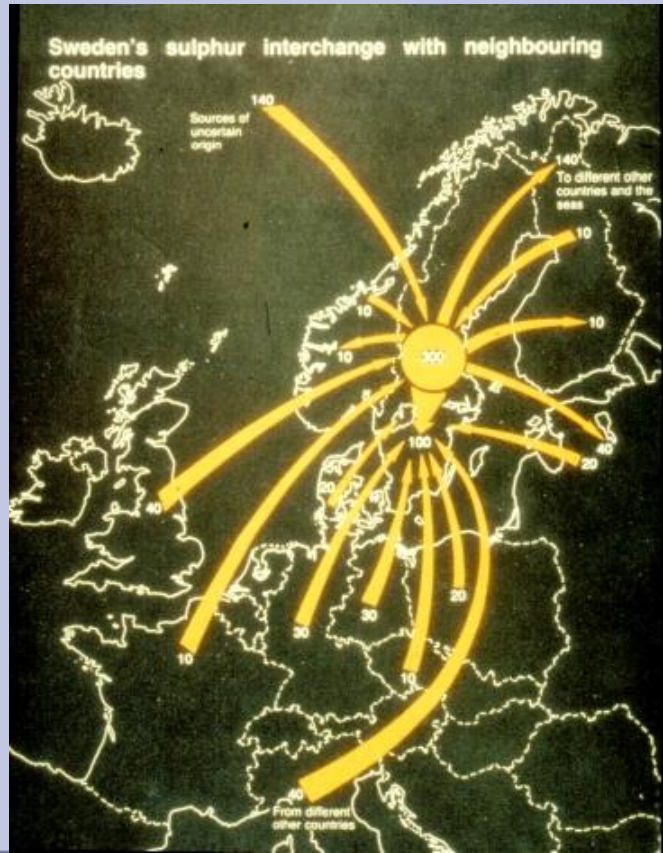
2.4 Studying the Movement of pollutants to monitoring sites

Trajectory analysis

Training workshops where trajectories are manually prepared to show methods

Training in trajectory analysis on Internet (e.g. NOAA) and application to monitoring sites for 365 days. Training also in analysis of results

Useful if meteorologists become involved. Training at same time as IAM and modelling



PM composition

PIXE analysis standard technique, but expensive. Chemical composition?

REQUIREMENTS FOR IMPLEMENTATION – Applying Trajectory Analysis	
Personnel	Meteorologist or other atmospheric scientist (preferably) with good computer skills Available for training sessions (x3) and activities back in countries
Equipment	Access to computer and good internet connection
Other	-

3. Emission inventories

Manual

Version 1 available. Continuous revision required – especially for emission factors. NIAs need to help improve manual

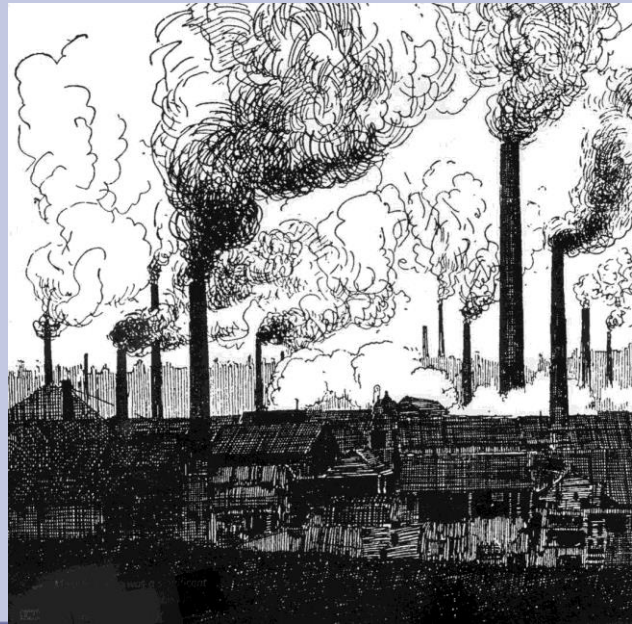
Manual upgrade to include VOCs, $PM_{2.5}$, (method also needed for natural VOCs and soil dust emissions)

Inventories

NIAs need to nominate people to undertake inventory. Data needs to be gathered and training workshops can help develop inventories based on data gathered.

Site visits: will they be necessary?

'We have first raised a dust and then complain we cannot see.'



3.2 Developing emission scenarios: 'Business as we expect it to be'

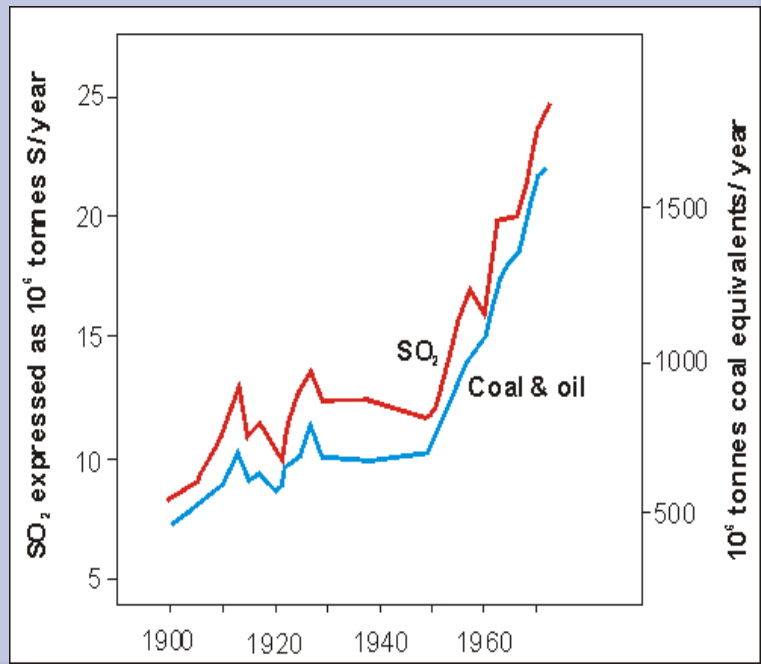
Developing the Methods

Initial discussion document developed and sent for comment to NIAs and discussed at training session.

Continuous revision of methods required. NIAs need to help improve methods and collect data (e.g. power sector generally has plans for 15 years)

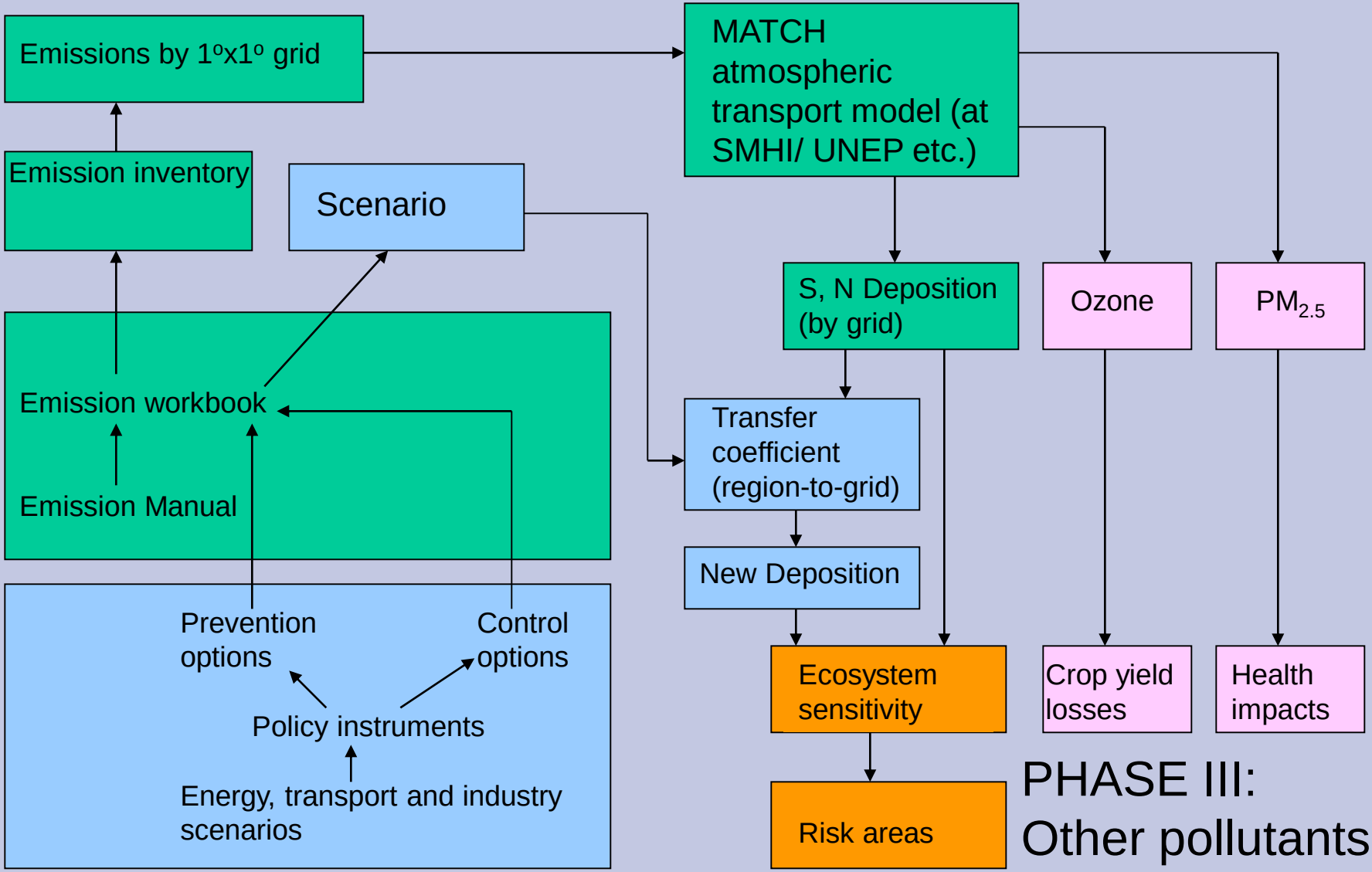
Scenario development

NIAs need to nominate people to undertake scenario analysis. In many cases it may be same person as emission inventory. Data needs to be gathered and reviewed in training workshops .



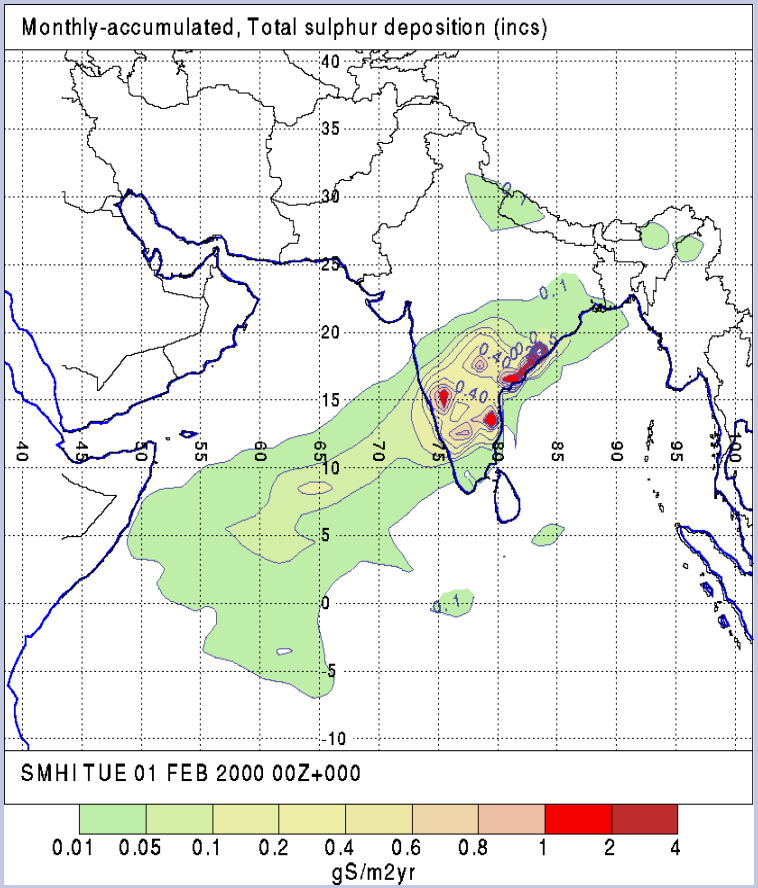
REQUIREMENTS FOR IMPLEMENTATION – Emission Inventory and Scenario Analysis	
Personnel	Person(s) with a technical background and good computer skills (esp. Excell) to undertake the data gathering emission inventory and scenario analysis. Planning experience useful. NIAs may wish to be involved in developing the scenario analysis.
Equipment	Access to computer
Other	4 training sessions are planned

3.3 Male Integrated Assessment Model: Next Phase

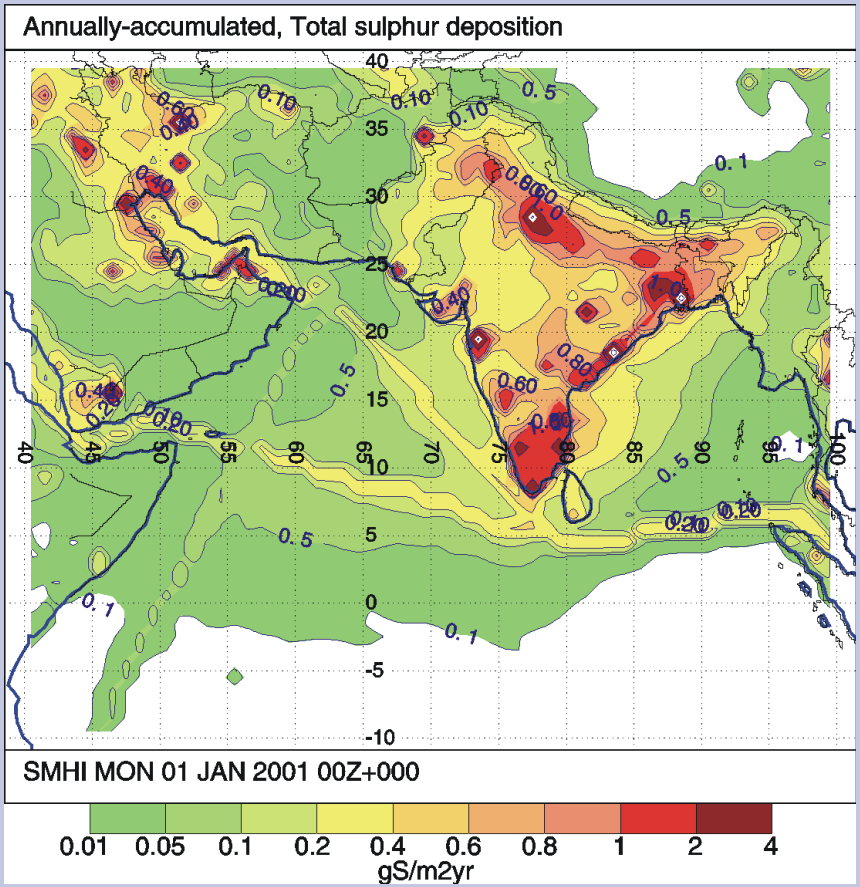


PHASE III: Other pollutants and impacts

3.3.3 Training in IAM and Atmospheric transfer processes and modelling

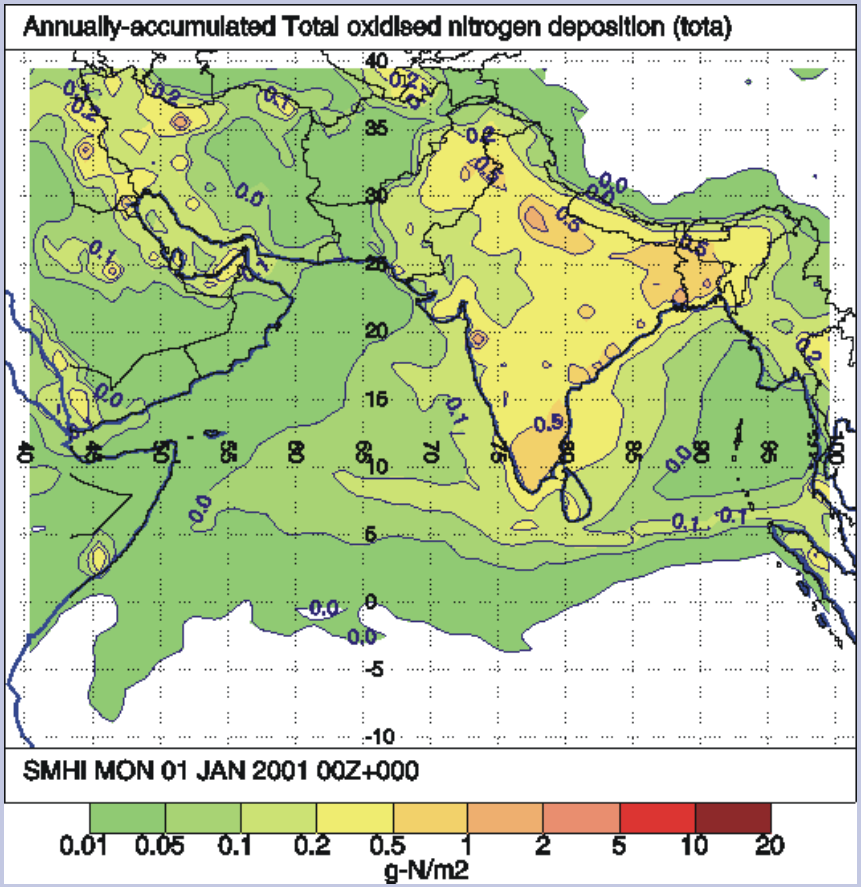


Monthly Sulphur Deposition due to emission from one region

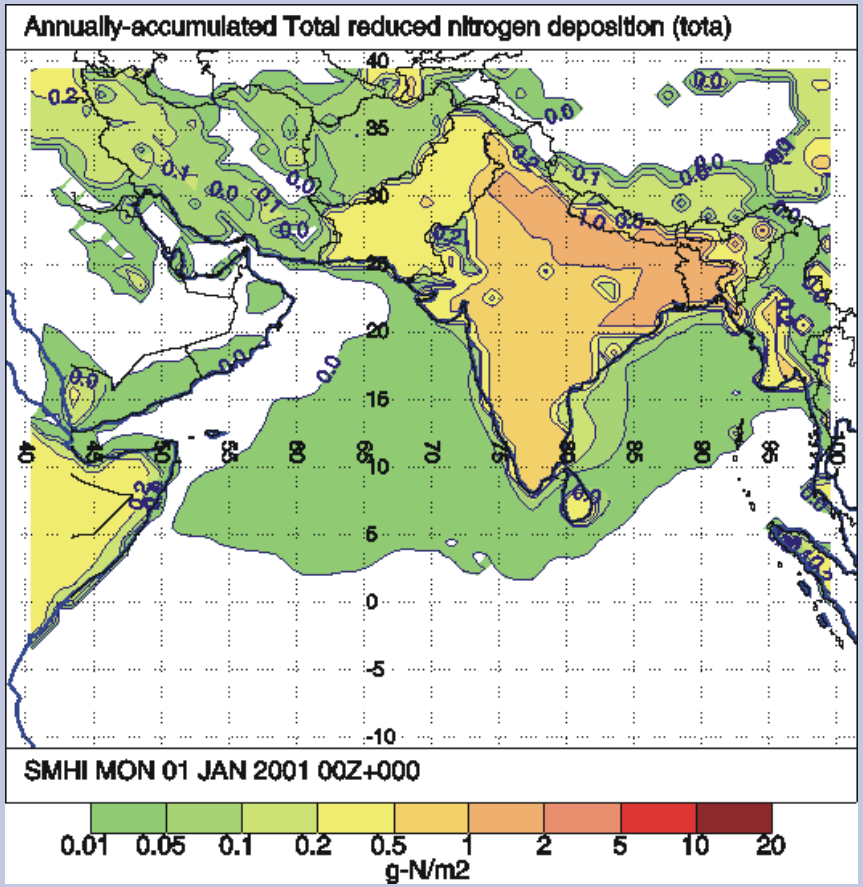


Annual Sulphur Deposition

3.3.2 Install MATCH model at UNEP to support Male Declaration



Oxidized Nitrogen



Ammonium

REQUIREMENTS FOR IMPLEMENTATION – IAM operation and atmospheric process training	
Personnel	IAM training – NIA personnel Atmospheric processes: Meteorologist preferably – same person as for trajectory analysis. Can develop questions to modellers as group of atmospheric scientists
Equipment	Computer on which IAM can be installed
Other	Training on IAM, atmospheric processes and trajectory analysis may be combined IAM should be considered preliminary

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3.4 Rapid Urban Integrated Assessment

i. Develop environmental database and top-down emission inventory for city using Male manual

ii. Geographical disaggregation of emissions using a land use classification based on satellite data

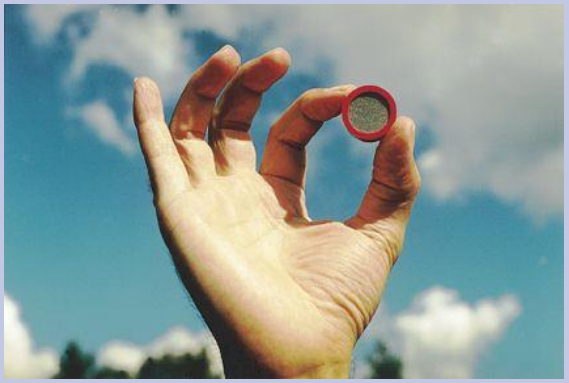
iii. Implement dispersion modelling in urban area using distributed emissions, weather data and a model (e.g. TAPM)

iv. Undertake monitoring campaign using passive samplers and cross-validate with modelled concentrations

v. Link with population distribution data and estimate health impacts

vi. Determine corrosion and crop yield estimates

vii. Undertake economic analysis



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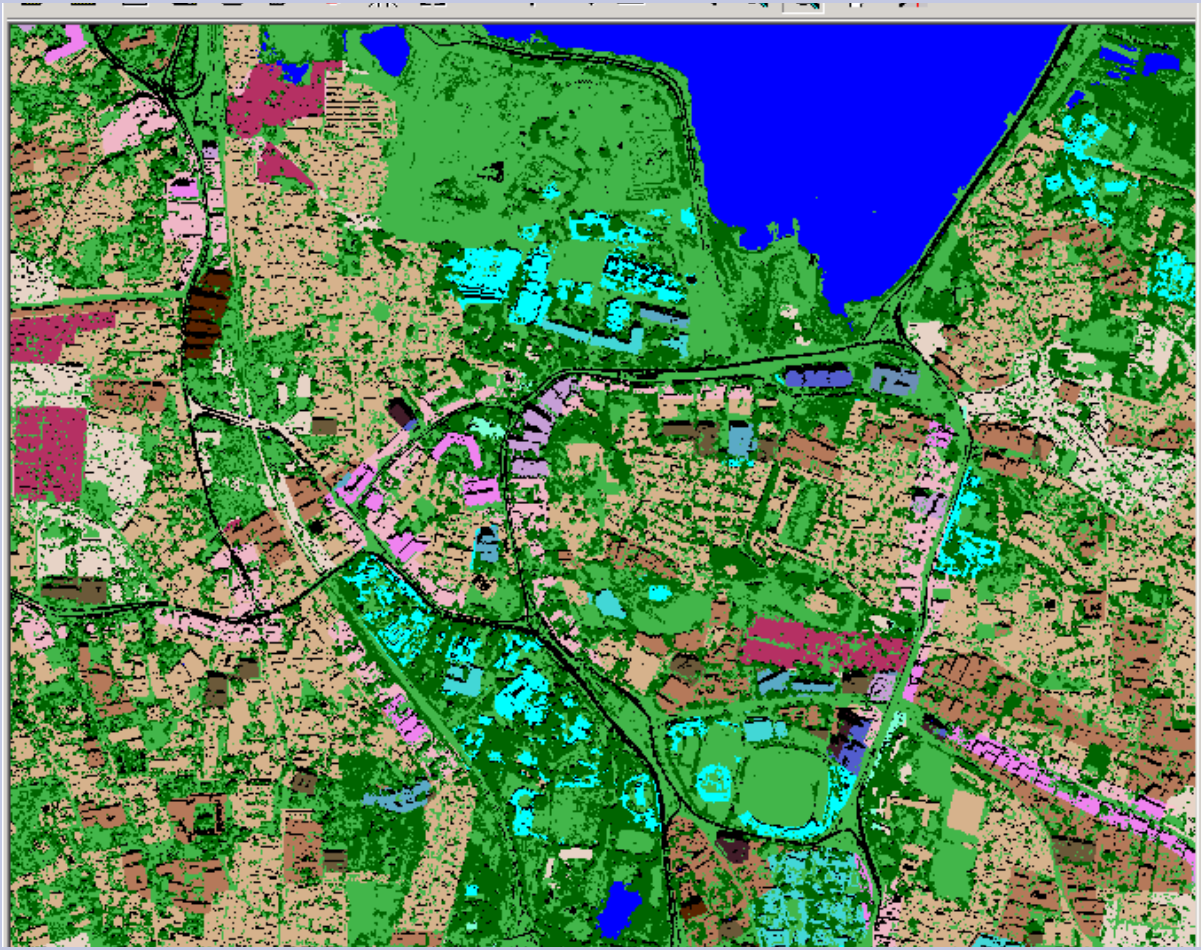
3.4 Rapid Urban Assessment: Land use classification Using Satellite data



Row	Color	e	e	lu	a	
0		0	0	0	1	
1		0	0	0	1	Shadow
2		0	0	1	1	Water
3		1	7	5	1	Open land
4		0	7	0	1	Forest and shrub
5		6	8	1	1	Residential 1-2 fl. LI
6		9	1	2	1	Residential 3-4 fl.
7		1	1	2	1	Residential 5-6 fl.
8		5	8	8	1	Residential 7-8 fl.
9		2	6	1	1	Residential 9-10 fl.
10		7	7	9	1	Residential 11- fl.
11		1	1	1	1	Airport
12		8	8	1	1	Industry small 1-2 floors
13		6	5	3	1	Industry small 3-4 floors
14		4	3	8	1	Industry small 5-6 floors
15		6	5	1	1	Residential 1 (-2) fl, low incom
16		1	1	0	1	Industry large 1-2 floors
17		0	2	1	1	Industry large 3-4 floors
18		6	4	1	1	Industry large 5-6 floors
19		5	2	7	1	Industry large 7-8 floors
20		1	0	0	1	Industry large 9-10 floors
21		6	5	1	1	Industry large 11 - floors
22		1	9	6	1	Industry storage
23		9	1	1	1	Institutional 1-2 floors
24		0	1	1	1	Institutional 3-4 floors
25		1	6	6	1	Institutional 5-6 floors
26		2	4	6	1	Institutional 7-8 floors
27		5	4	1	1	Institutional 9-10 floors
28		2	4	5	1	Institutional 11- floors
29		1	1	8	1	Commercial 1-2 floors
30		9	5	1	1	Commercial 3-4 floors

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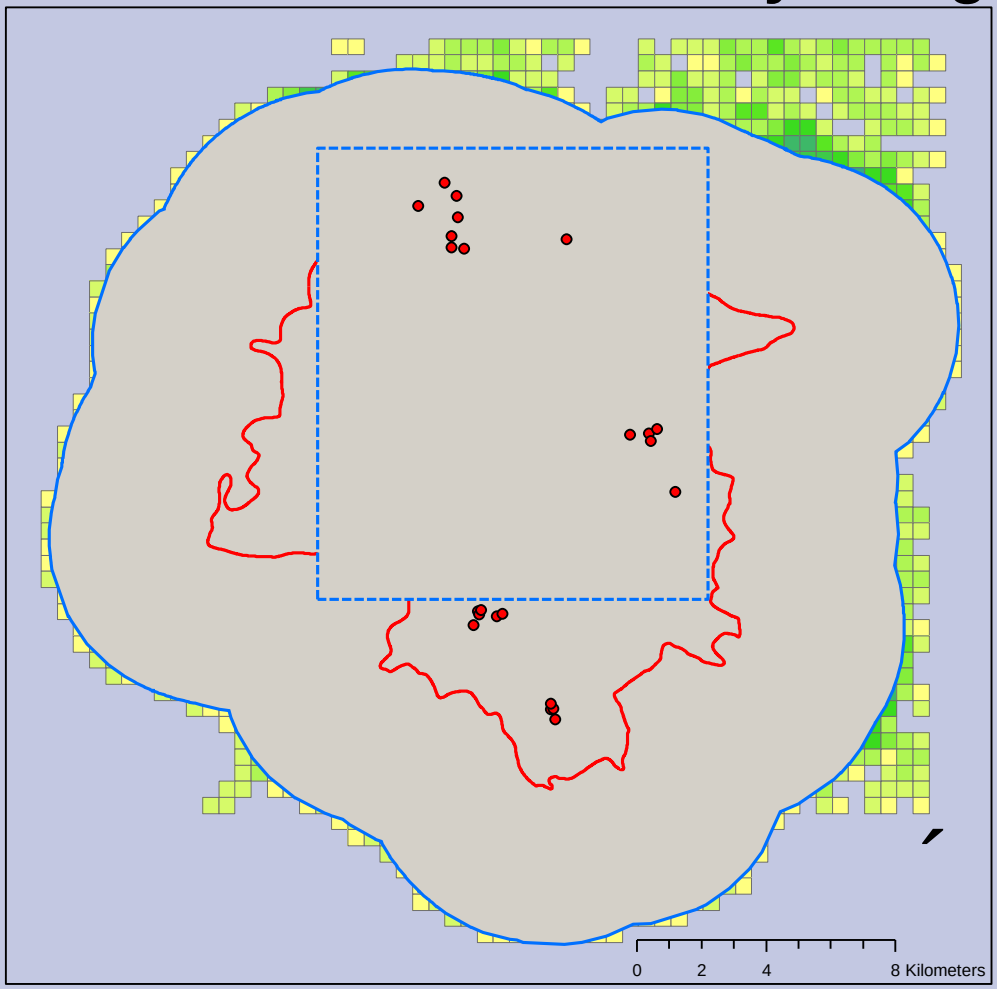
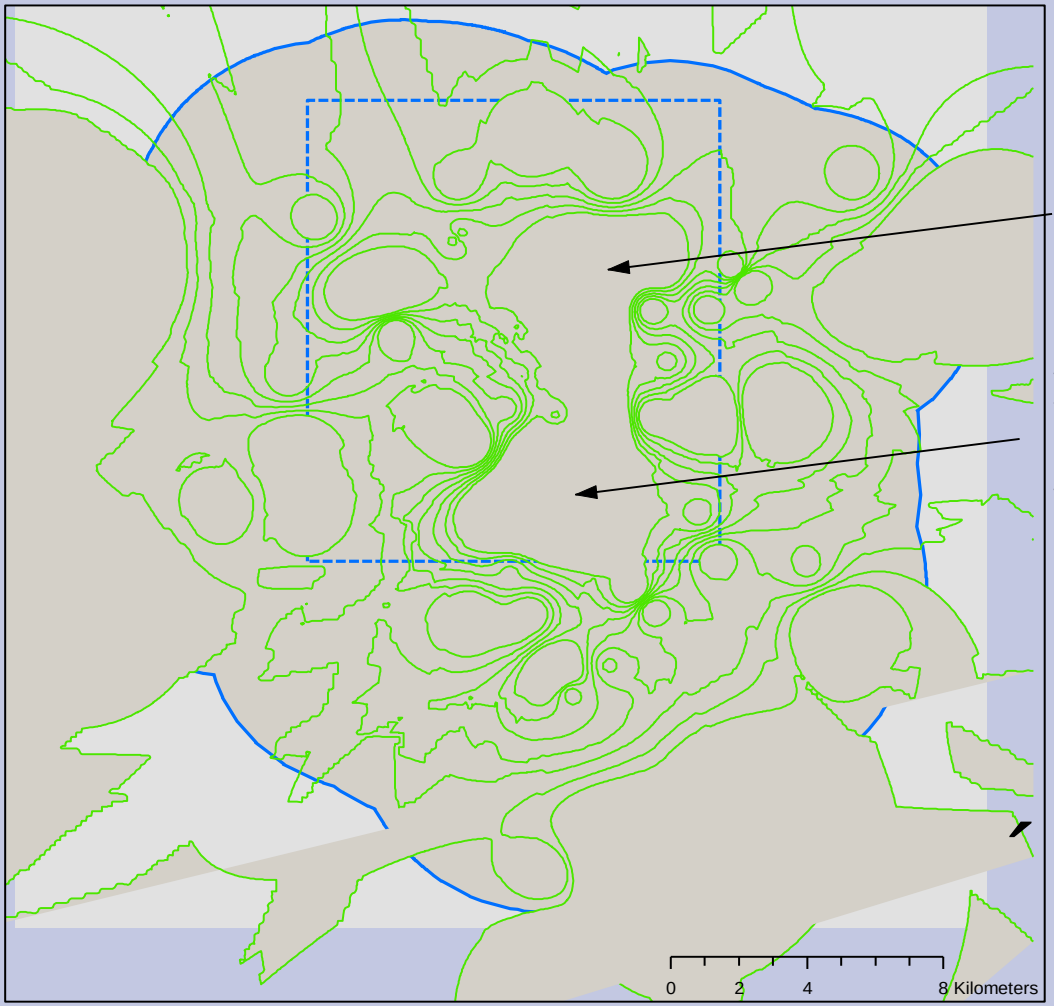
3.4 Rapid Urban Assessment: Distributing emissions across city using land use



CO emissions in Hyderabad

3.4 Rapid Urban Assessment: Combining Concentration data with population distribution



Emission Inventory Hyderabad

Exposure of NOX in Hyderabad.

26000 peoples exposed by more than 30 less than 40 micrograms NOX

165 000 peoples exposed by more than 30 less than 40 micrograms NOX.

17 000 peoples exposed by more than 40 micrograms NOX.

Population

- 0 - 25000
- 25001 - 50000
- 50001 - 75000
- 75001 - 100000
- 100001 - 125000
- 125001 - 150000
- 150001 - 175000
- 175001 - 200000
- 200001 - 225000
- 225001 - 250000
- 250001 - 275000
- 275001 - 300000
- 300001 - 325000
- 325001 - 350000
- 350001 - 375000

Contour levels of NOX in micrograms per cubic meter.

CONTOUR

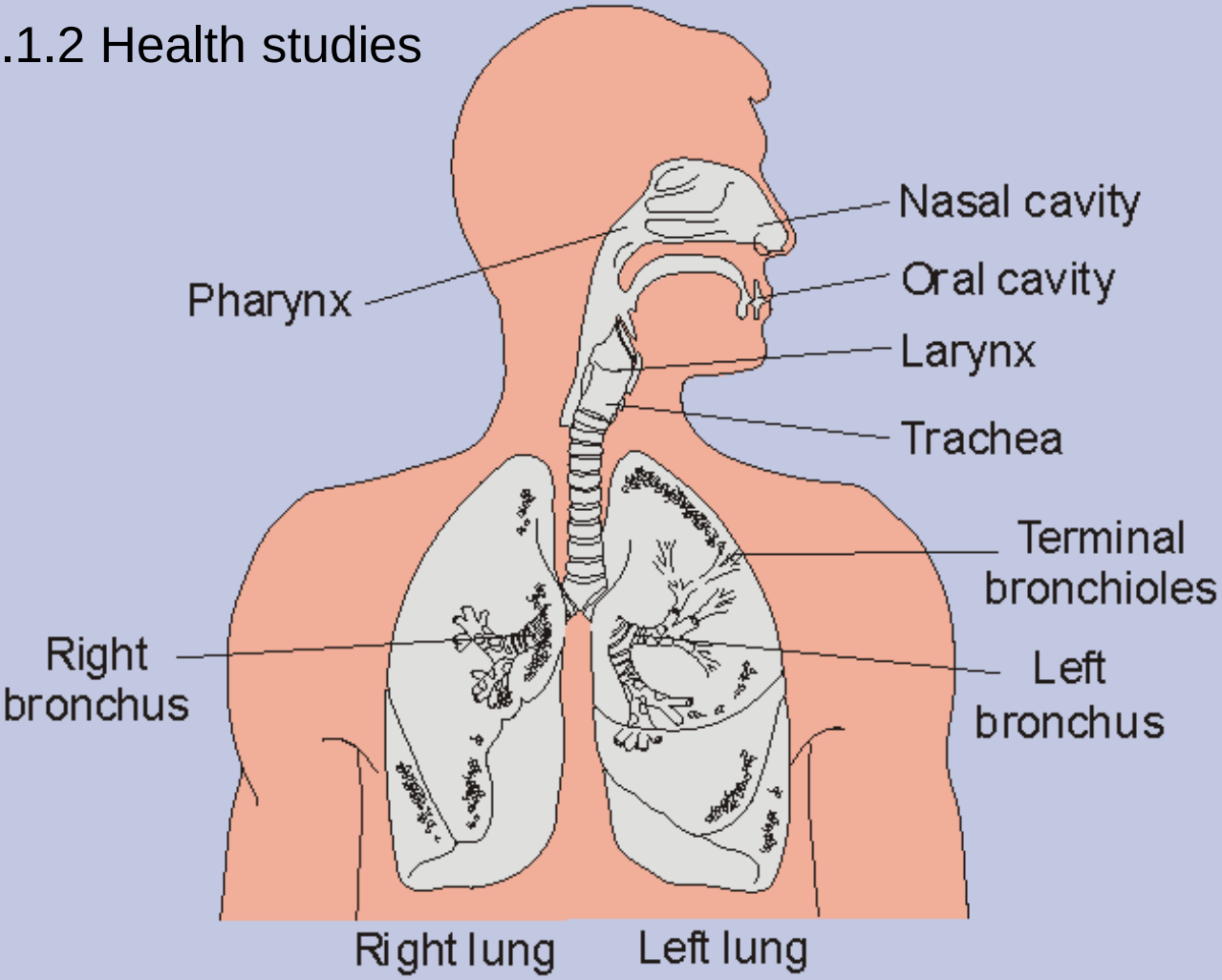
- 6 - 29
- 30 - 39
- 40 - 44

REQUIREMENTS FOR IMPLEMENTATION – Rapid Urban Integrated Assessment	
Personnel	GIS Technician – Arc Info user to classify satellite image etc (6 Months) Technician to apply top-down emission inventory, do traffic counts and run TAPM model Technician for passive sampler campaign Health/ corrosion specialists to estimate impact
Equipment	Computer with Arc Info installed Passive samplers
Other	Satellite image for chosen city (1m data for city centre, 5m for suburbs Population distribution data

4.1 Human health impacts

4.1.1 Estimating total impact

4.1.2 Health studies

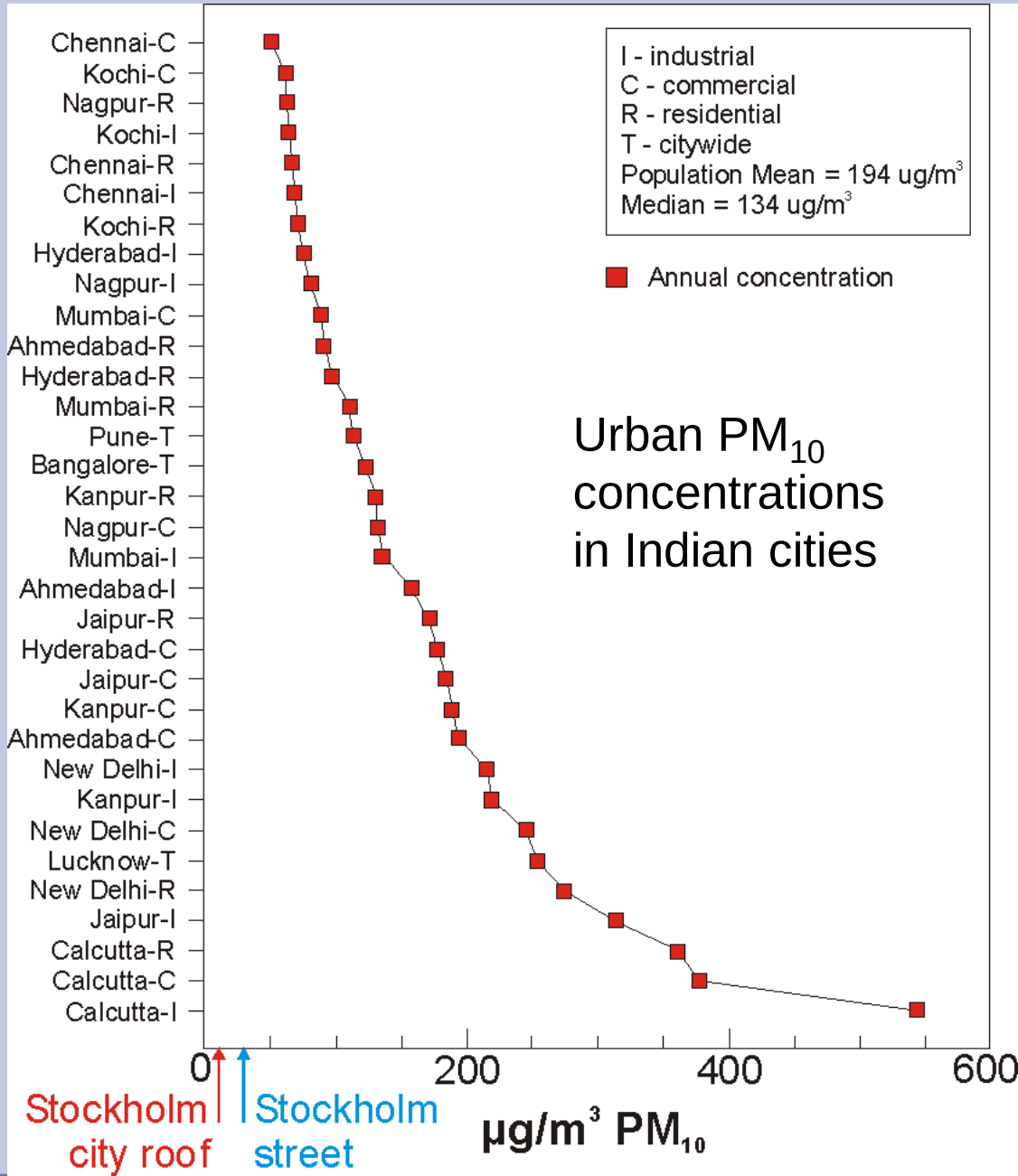


4.1 Estimating Overall Impacts on Health

How many people suffer – crude calculation of exposure of population to urban, outdoor air pollution

Take population and monitoring data from cities and use WHO guidelines to estimate health burden

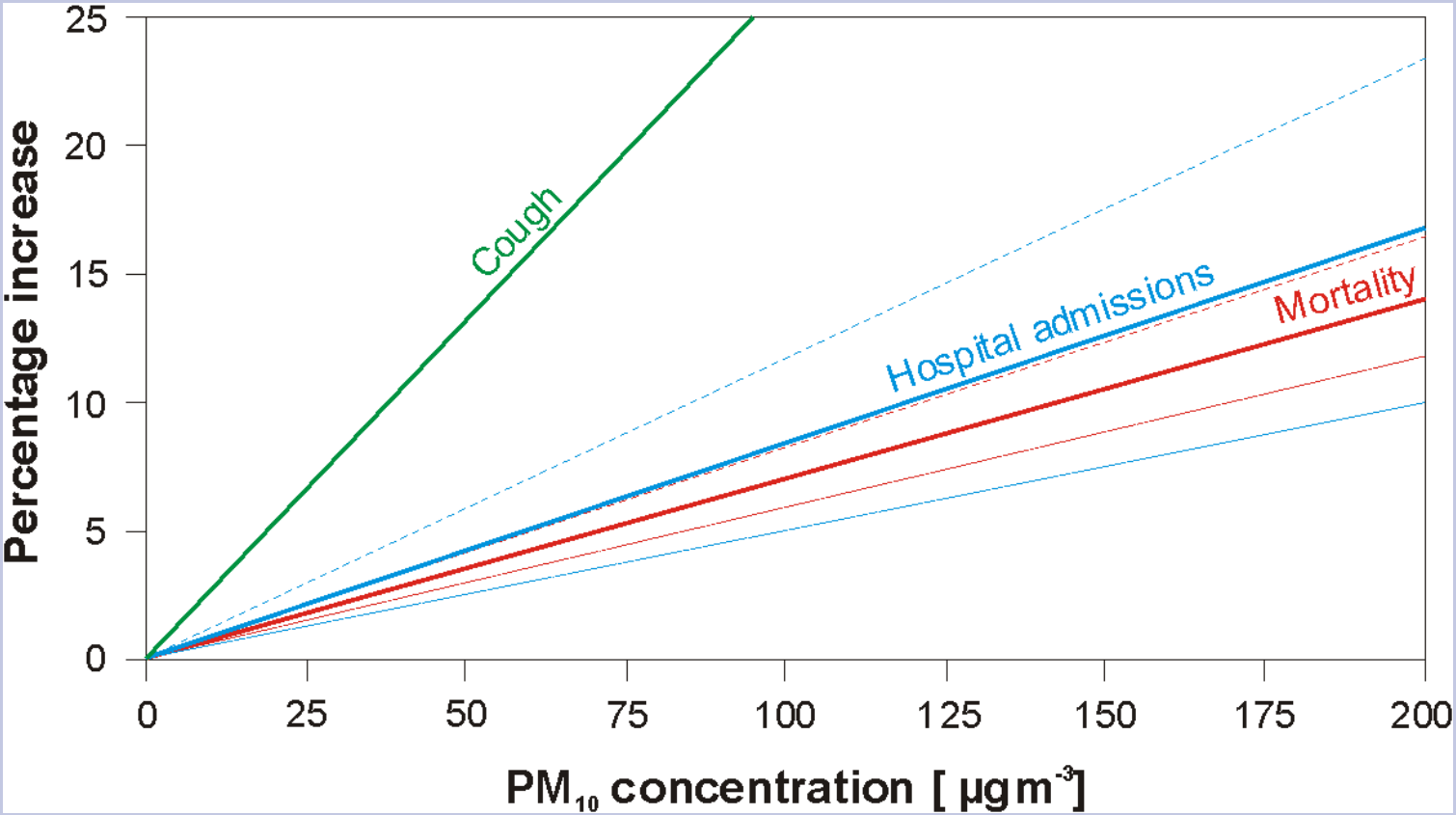
Economic assessment methods need to be tailored to S Asia



WHO-recommended Dose-response Relationships for PM_{10} and health impacts

which can be linked to monitoring data

Conclusions in Delhi and Hyderabad – they are good enough to be used for rough estimates until regional data is available



REQUIREMENTS FOR IMPLEMENTATION Health studies	
Personnel	Epidemiologist or other health expert to assess and modify and apply methods and estimate health impacts Economist to help develop the economic implications of health impacts
Equipment	-
Other	-

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4.1.2 Schools study to determine air pollution impacts on children's health

Epidemiologist, Nurse, Technicians recruited to run study

2 schools, 3-9 grade (1500-2000 pupils) in area with high PM involved in study

Questionnaire sent to parents of all children – 80% response rate needed

100 randomly selected asthmatic children chosen and 50 control (written consent needed)

10 teachers chosen and trained

Monitoring site near or at school

Respirometer for all 150 children every morning and evening by teachers (90% of days required)

Personal samplers used 1 day per week for all children for total exposure estimate

All symptoms recorded

All data logged and analysed by epidemiologist

REQUIREMENTS FOR IMPLEMENTATION	
Personnel	Epidemiologist to coordinate studies (part-time for 2 years Nurse to oversee and take part in activities (12 months) Monitoring technician (6 weeks) Data logger/ statistician (6 months) 10 teachers from schools
Equipment	Monitoring station (PM_{10}, SO_2, NO_2) up to 2km away Personal PM monitors Passive samplers for exposure assessment (?) Met station (within 2km)
Other	-

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4.2 Impacts on crops

4.2.1 Mapping Risk and Using Indicator Plants

1. Risk – use thresholds and agricultural data with monitored or modelled concentrations to identify risk areas
2. Undertake biomonitoring study using plants sensitive to ozone

i. Grow cuttings in pots with standard soil and wicks to keep moist

ii. Tend plants

iii. Assess damage to plants

iv. Analyse data at training workshop

Ozone induced injury on clover

REQUIREMENTS FOR IMPLEMENTATION	
Personnel	GIS researcher to assess potential areas at risk from pollutant concentrations Agricultural researchers to grow, harvest and assess indicator plants
Equipment	Cuttings of plants sent to each site Plants in standard soils Watering system (wicks)
Other	Meteorologist

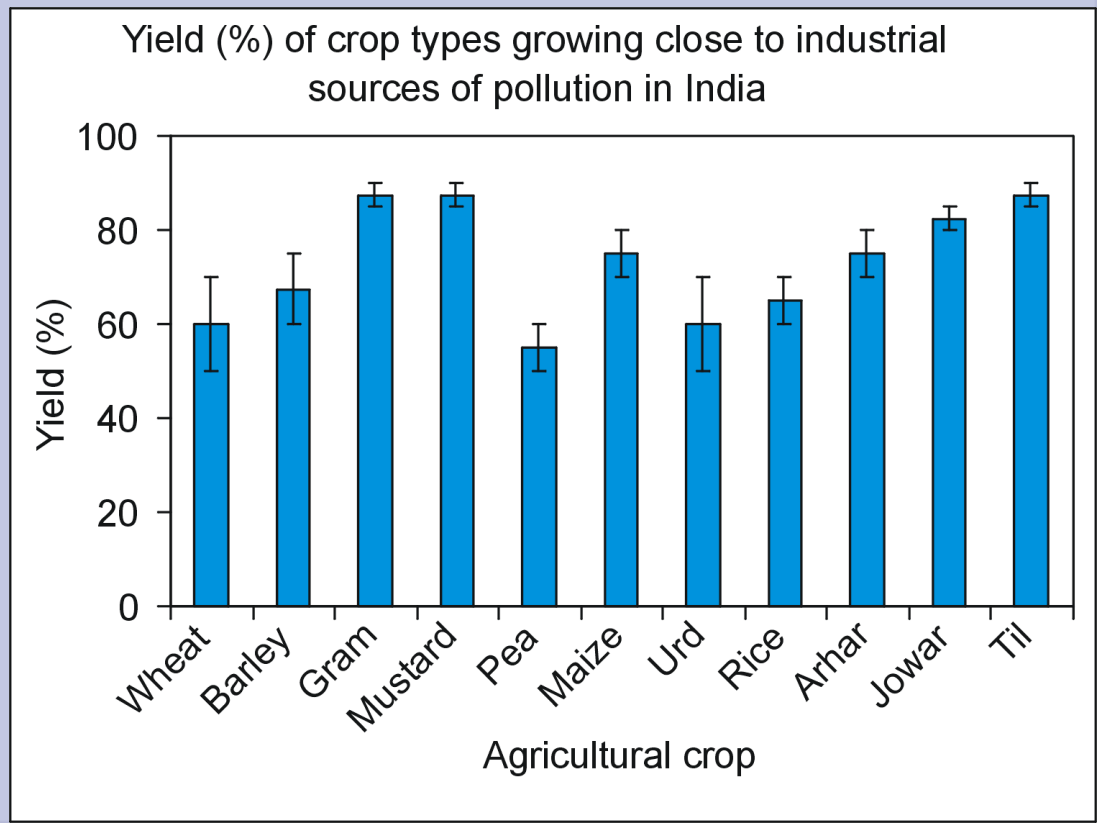
4.2.2 Assessing Yield Reductions

1. Chemical protectant studies

i. Establish sites with crop plants grown in pots with standard soils and wicks to keep plants at standard moisture
ii. Spray soil of some pots with EDU (ethylene di-urea) and control pots not sprayed. EDU protects plants from ozone.
iii. Harvest plants and compare yields of protected and un-protected crops

2. Transect studies

Grow plants in a transect away from point sources of SO_2 in pots with standard soil and moisture and compare yields after growing season



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Open Top Chamber Facilities. Lahore, Pakistan

Equipment exists in some countries. Could be used in future development. Also spare chambers exist in Europe and could be shipped.

REQUIREMENTS FOR IMPLEMENTATION	
Personnel	Agricultural specialist to grow, tend and harvest plants, apply EDU and analyse results
Equipment	Monitoring for ozone and SO_2
Other	Training workshops for all crop methods held over the three years

4.3 Potential Corrosion Impact Activities

i. Exposing standard samples on racks

- to determine an absolute measure of corrosion
- Need to assemble rack and expose samples pre-prepared by SCI
- Need to monitor SO_2, NO_2, O_3, HNO_3 and PM (total deposited) on bi-monthly sample time
- rain pH (weekly measurements) and amount
- Need a met station measuring T^oC and RH

- Expose for 1, 2 and 4 years
- Can expose local materials
- Training in analysis can be given.
- Most samples to be sent to SCI for analysis
- Exposures to develop the dose-response relationships

4.3 Potential Corrosion Impact Activities

ii. Exposure of kits

-to determine a relative measure of corrosion in sites with different levels of pollution absolute measure of corrosion
-Expose for 1 year
-5 sites per city (city centre, near heavy traffic, near industrial site, suburb, peri-urban site)
-E.g. 2 metals and one stone sample per site
-Passive monitoring of gases only

iii. Stock at risk study

-identify materials in typical buildings (random inventory of 100s of buildings)
-Generalise occurrence of buildings across city
-Include street infrastructure and vehicle fleet
-Estimate economic losses for materials where have D-R relationships

REQUIREMENTS FOR IMPLEMENTATION	
Personnel	Technical person with interest in corrosion, preferably materials institution Technician to tend monitoring site
Equipment	Rack (supplied by SCI) Samples (supplied by SCI) Weighing and lab. Facilities Site for rack Monitoring equipment (passive samplers and rainwater collection) Met station in city
Other	-

4.4 Acidification studies

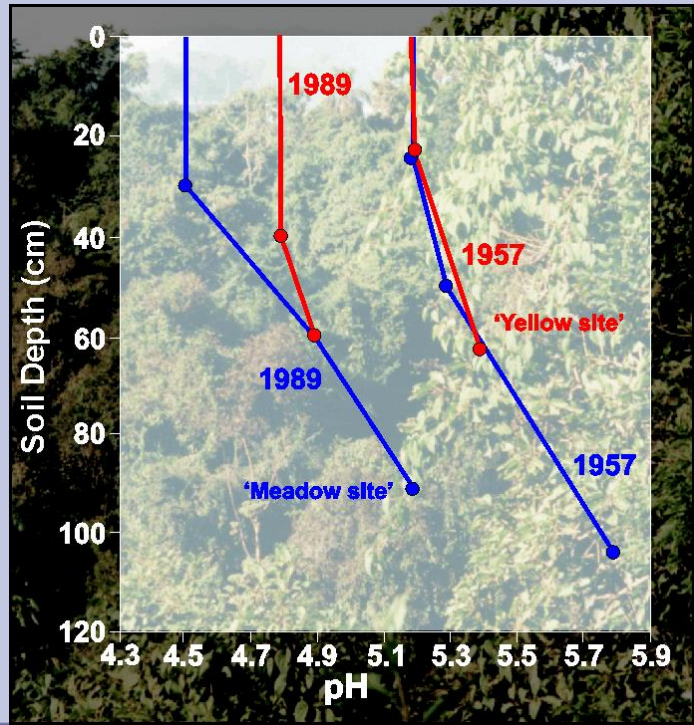
i. Mapping sensitivity of soils/ ecosystems to acidification

- Using soil map – reclassify into relative sensitivity classes according to manual
- Compare to deposition

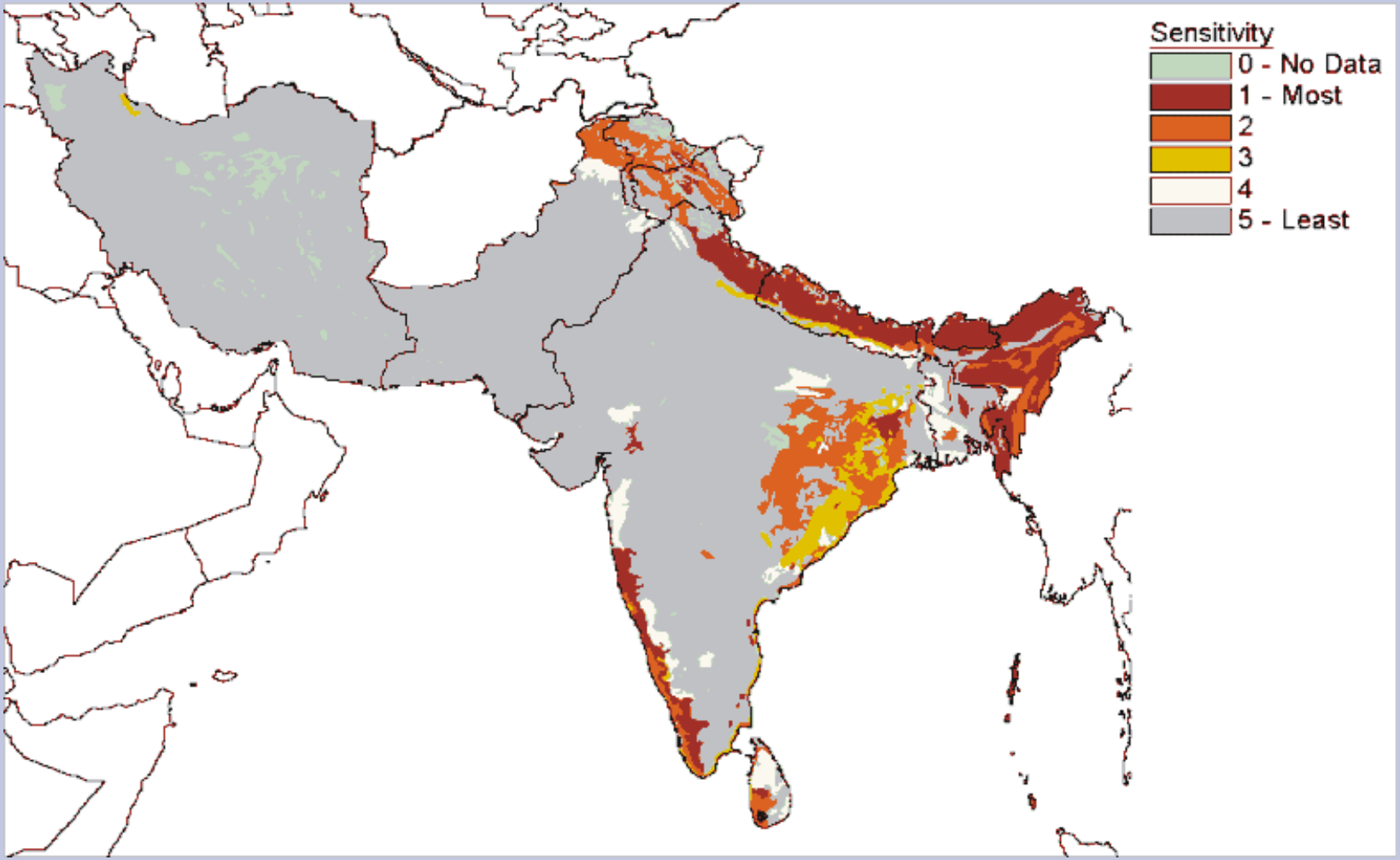
ii. Time development of acidification

- Apply methods in manual to soil data from monitored sites

Soil acidification at Mt. Lu in southern China (Zhao, 1996)



Terrestrial Ecosystem Sensitivity to Acidic Deposition in South Asia (preliminary assessment



Source: Kuylenstierna *et al*. 2001

REQUIREMENTS FOR IMPLEMENTATION	
Personnel	Soil scientist Ecologist GIS technician
Equipment	Soil maps (preferably digitised) Soil physical and chemical data for soil types and soil profiles
Other	-