RAPIDC
Regional Air Pollution In Developing Countries

SEI STOCKHOLM ENVIRONMENT INSTITUTE

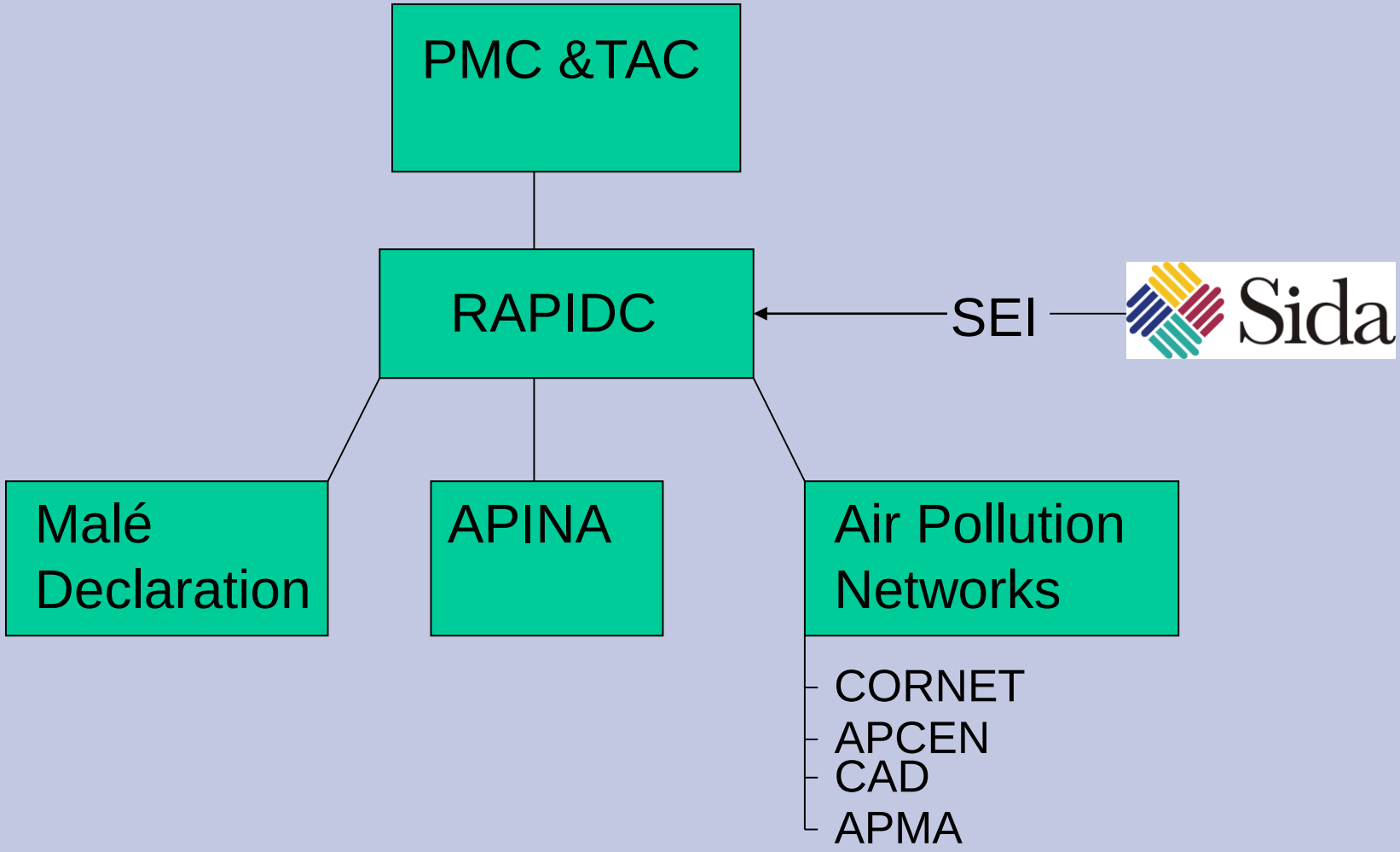
An overview of the RAPIDC (Regional Air Pollution in Developing Countries) Programme

Kevin Hicks, SEI

***Aspects covered*:**

- The aims and structure of the RAPIDC Programme
- Progress
- The Future (this will be saved for the CORNET meeting)

RAPIDC Structure



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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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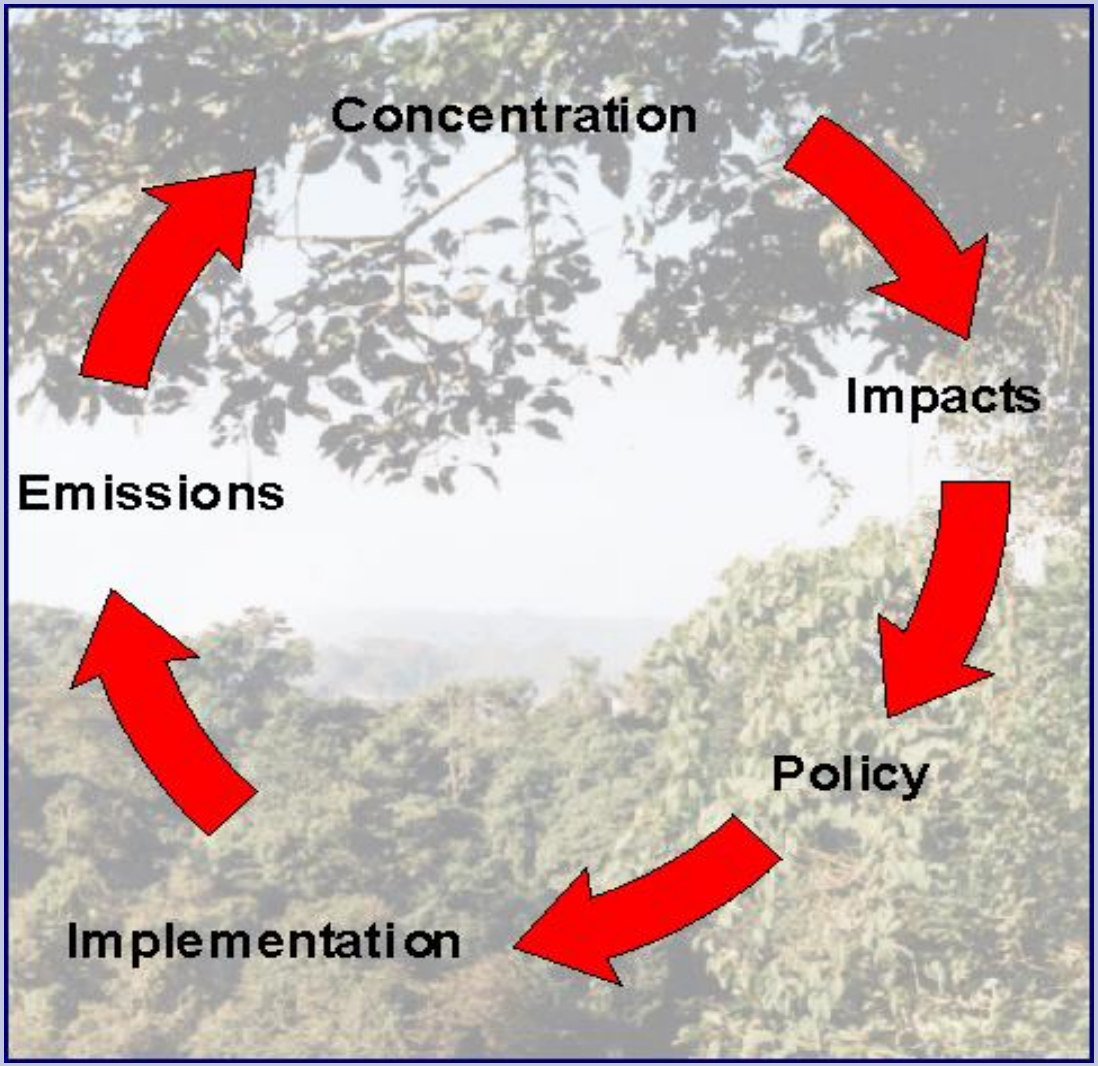
Knowledge Required by Policy Makers



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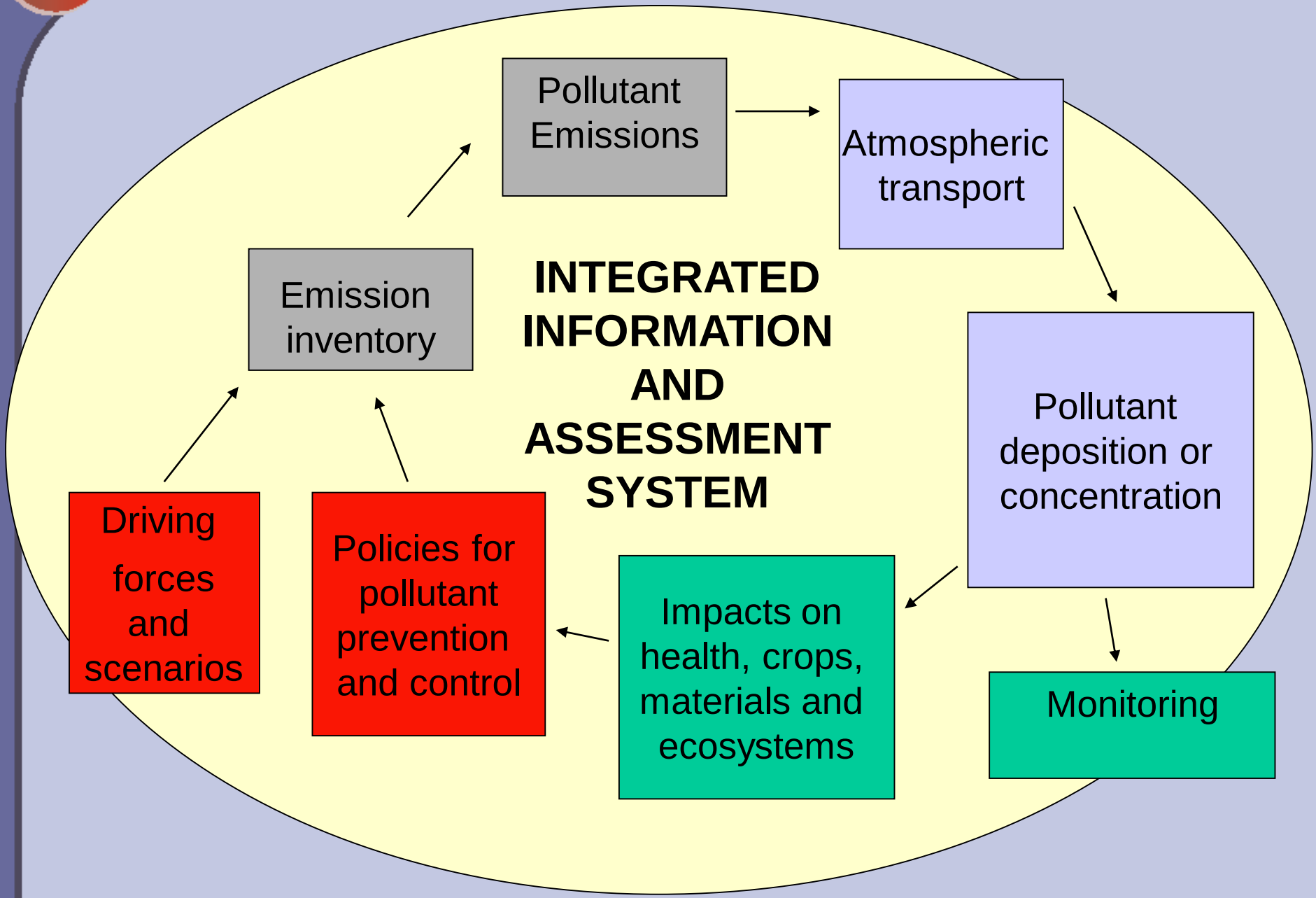
Scientific knowledge to underpin the policy process



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Policy Dialogues on Prevention and Control of Transboundary Air Pollution and its Likely Effects

1998 Malé Declaration – South Asia

1998 Harare Resolution – Southern Africa

1998 Canuelas Declaration – Latin America

2003 Maputo Declaration – Southern Africa

2008 Third APINA Policy Dialogue

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PROGRESS OF RAPIDC

Impact assessment projects

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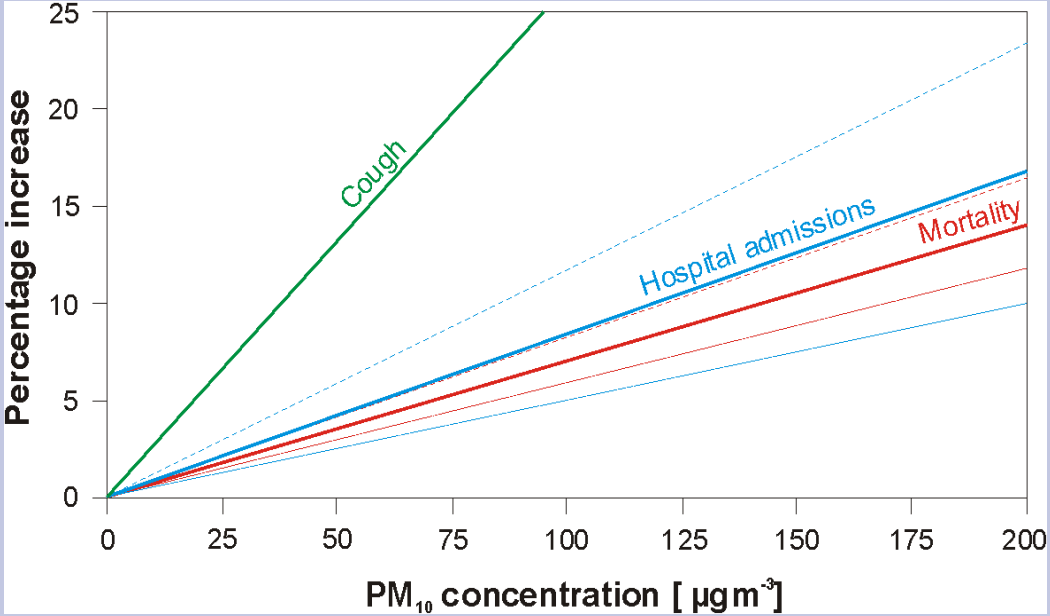
Impacts of Air Pollution at Different Scales

Household Urban Peri-urban Regional

Human health impacts

1. Setting up a group of health experts to assess the status of health impact studies in South Asia and southern Africa
2. Hold training workshops in assessment methods – learning by doing
3. Undertake a health study



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

Personnel: Epidemiologist, Nurse, Technicians recruited to run study

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

- 100 randomly selected asthmatic children chosen and 50 control
- 10 teachers chosen and trained
- Monitoring site near or at school
- Respirometer for all 150 children twice daily
- Personal samplers used 1 day per week
- All symptoms recorded, all data logged and analysed by epidemiologist/ statistician

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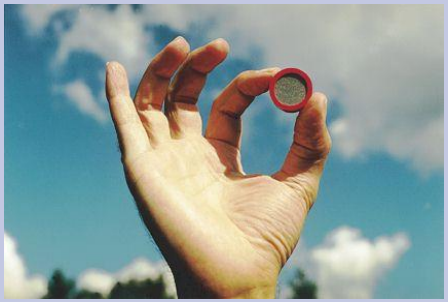
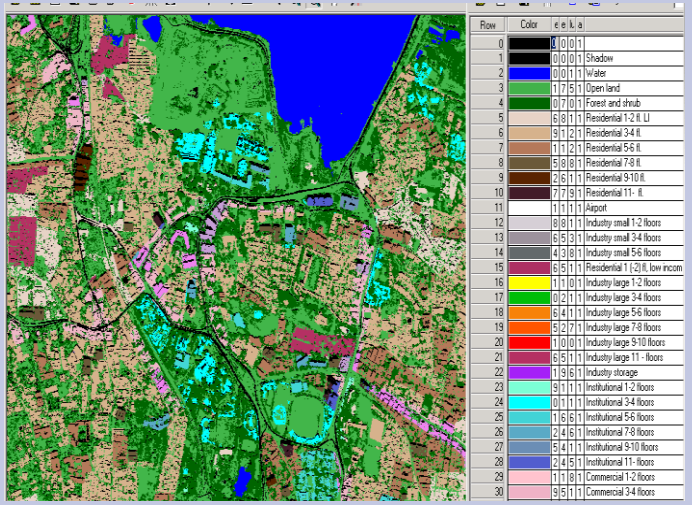
Rapid Urban Assessment (RUA)

Planned activities

- Training in methods for all countries
- Application of RUA in Kathmandu, Nepal, and Maputo, Mozambique, 2006/07
- Top-down emission inventory for city harmonized with Malé and APINA regional manuals
- Disaggregation of emissions using satellite data
- Dispersion modelling in urban area
- Monitoring campaign (PM/NO_2)





Acidification and Eutrophication Studies

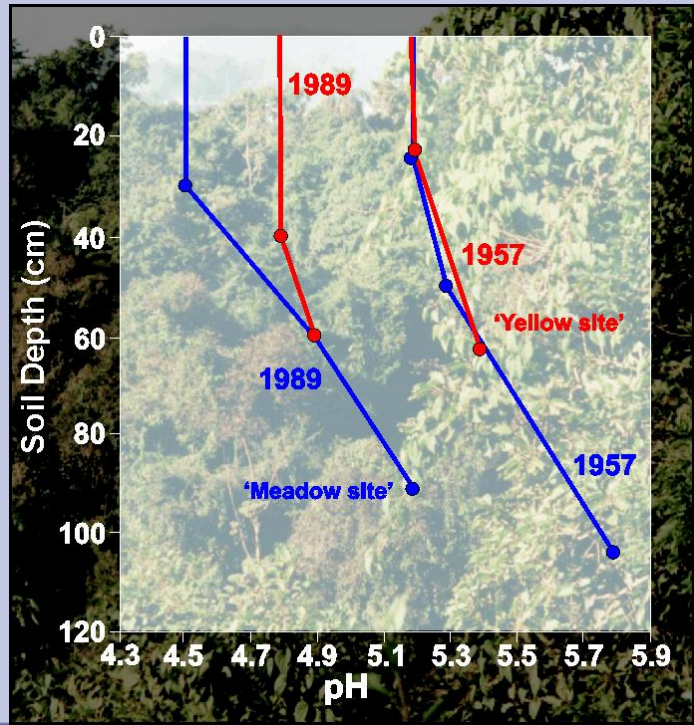
i. Mapping sensitivity of soils/ ecosystems to acidification

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

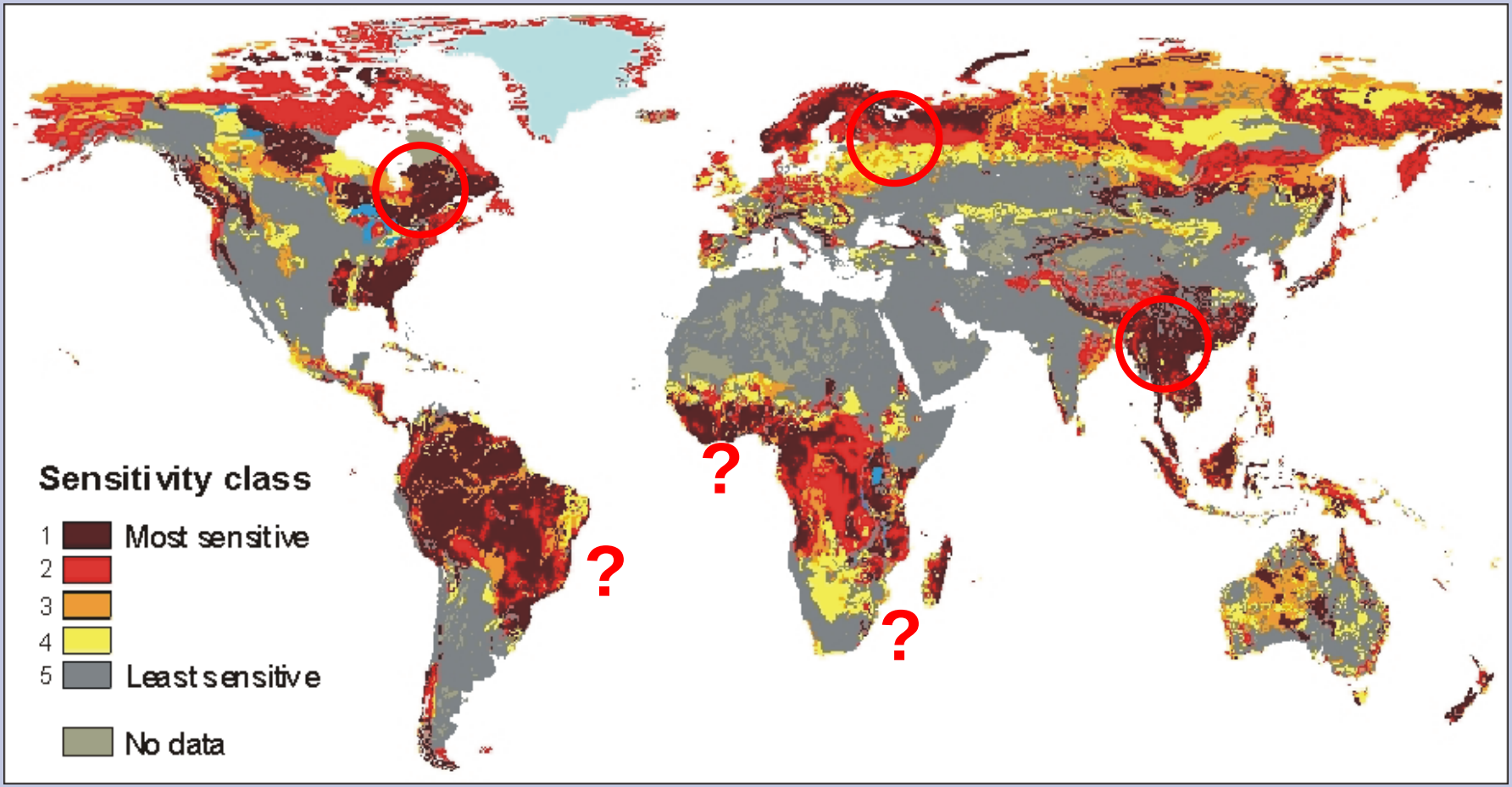
ii. Time development of acidification

- Apply methods in manual to soil data from monitored sites
- Training in 2007 for all countries

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

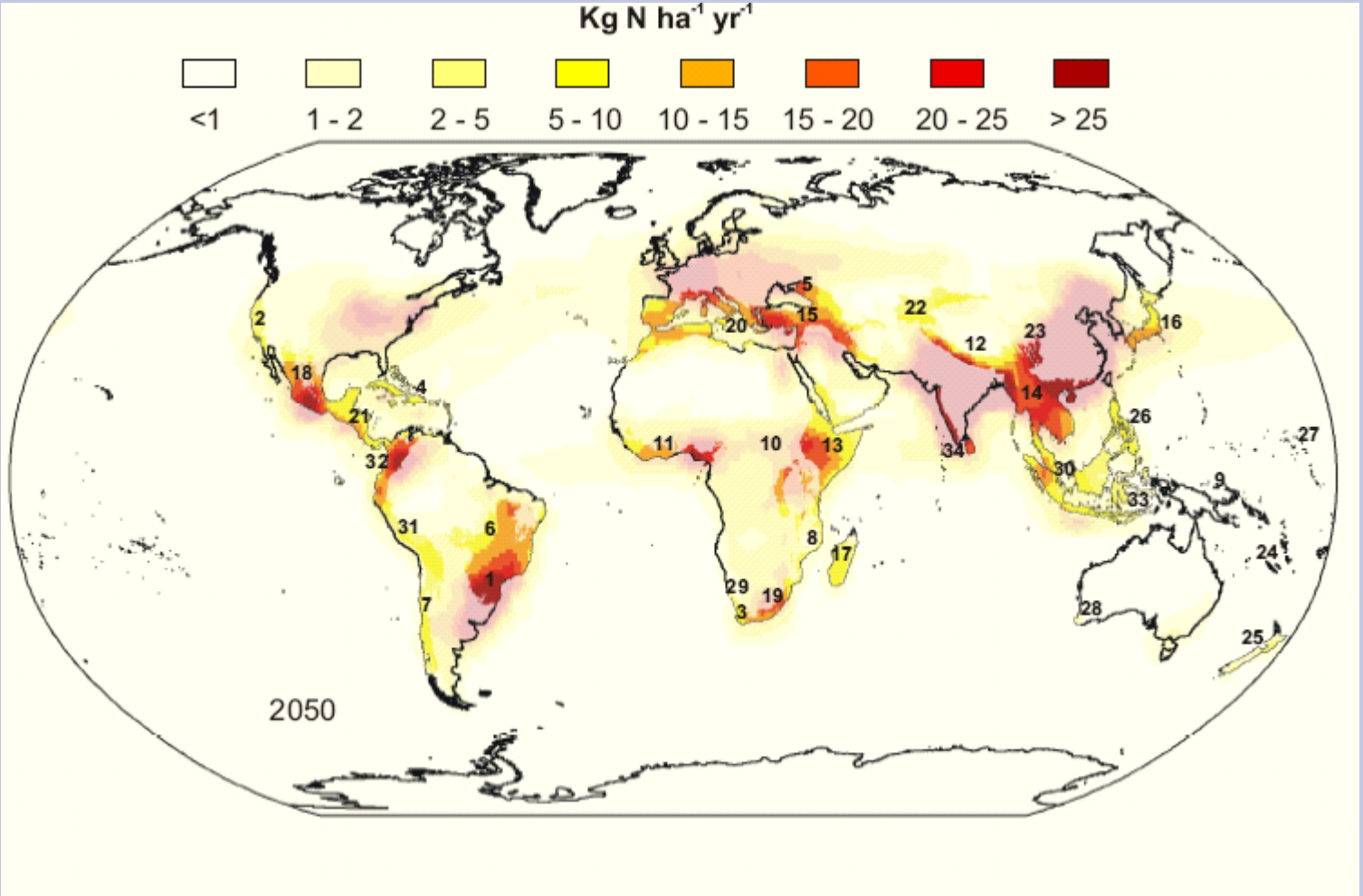


Global Map of Terrestrial Ecosystem Sensitivity to Acidic Deposition



Source: Kuylenstierna *et al*. 2001

Biodiversity hotspot approach



Source: Phoenix *et al*. 2006

RAPIDC Air Pollution Networks

APMA – Air Pollution in the Mega Cities of Asia

APCEN – Air Pollution Crop Effects Network

CAD – Composition of Asian Deposition

CORNET – Corrosion Network

APMA – Air Pollution in the Mega Cities of Asia

- Support AQM strategy formation in selected Asian cities is currently being identified.
- The benchmarking report prepared for publication and will be published by Earthscan in 2006.
- Development of an AQM information system (AMIS-Asia) for Asian cities. It will facilitate the transfer of AQM and best practice between countries and cities to support decision-making processes and strategy formation.

APCEN – Air Pollution Crop Effects Network

Project activities:

- Using Indicator Plants to assess risk of ozone pollution
- Chemical protectant studies

APCEN – Biomonitoring training workshops

APINA

Venue: Potchefstroom, South Africa, September 19-21 2006

Host: Prof. Gert Krüger, North West University

Malé Declaration

Venue: Varanasi, India, November 2006

Host: Prof. Madhoolika Agrawal, Banaras Hindu University

APCEN – Status of pilot studies

Southern Africa

Biomonitoring study in Potchefstroom, South Africa, using ozone-sensitive and ozone-resistant genotypes of white clover completed in April 2006

Main results: Clover plants grew well in southern African

climate and showed no ozone-induced foliar injury but reduced yield

South Asia

Chemical protectant study using EDU and mung bean is currently running in Varanasi, India

Clover biomonitoring study severely delayed due to problems with plant import permit

Countries: Definite Pakistan, India and Bangladesh, 2 others to be decided

CAD – Composition of Asian Deposition

The CAD project is divided into two components:

1) Network development and best practice
2) Training scientists from Asia

Activities:

- Linkages with DEBITS, Malé Declaration, EANET, and ABC
- Inter-calibration with EANET program
- Passive sampler inter-comparison study
- CAD Workshop at IICT, Hyderabad (Dec 2006)

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AIR POLLUTION IMPACTS ON CORROSION

Estimation of Losses due to Corrosion

Dose Response Relationships

Mass Loss = {f[SO_2].fRH-fT+fRain[H+]}.
fTime of Wetness

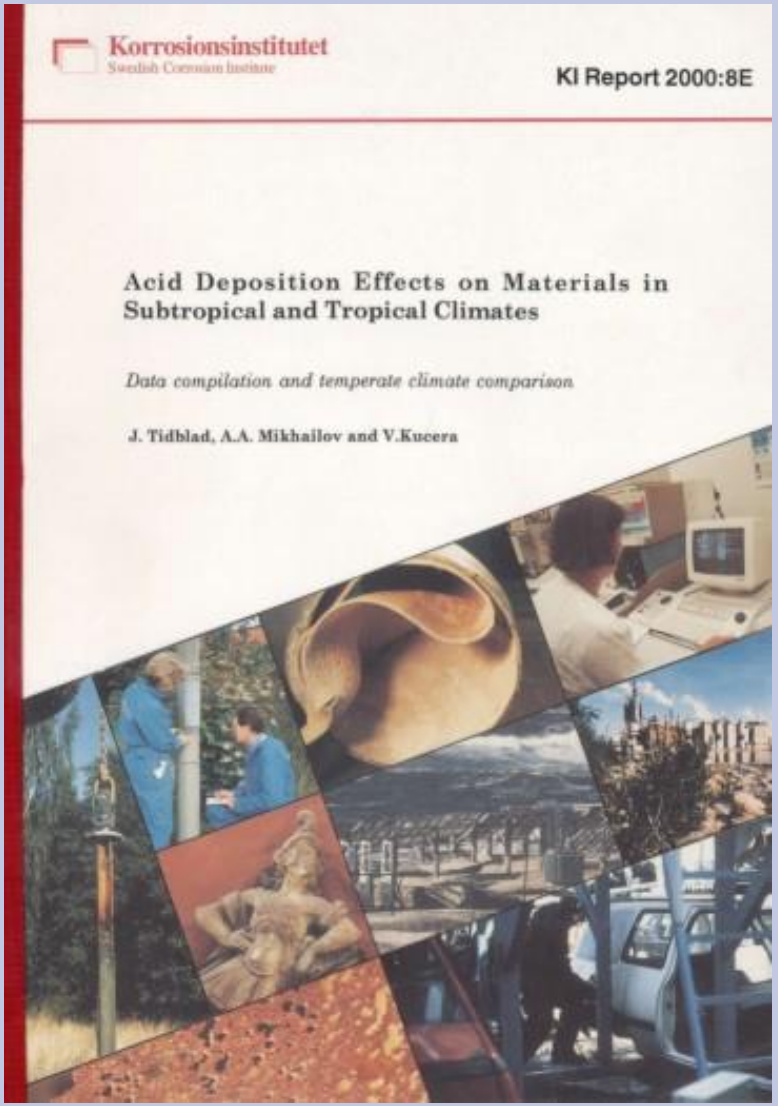
Economic Evaluations

Link dose-response to Stock at Risk and cost of maintenance/replacement

European Experience

Damage per Tonne SO2 emitted between $86-$1614

Savings estimated at $9000 Million per year when 2nd S protocol achieved



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RAPIDC Corrosion Impact Activities in Asia/Africa

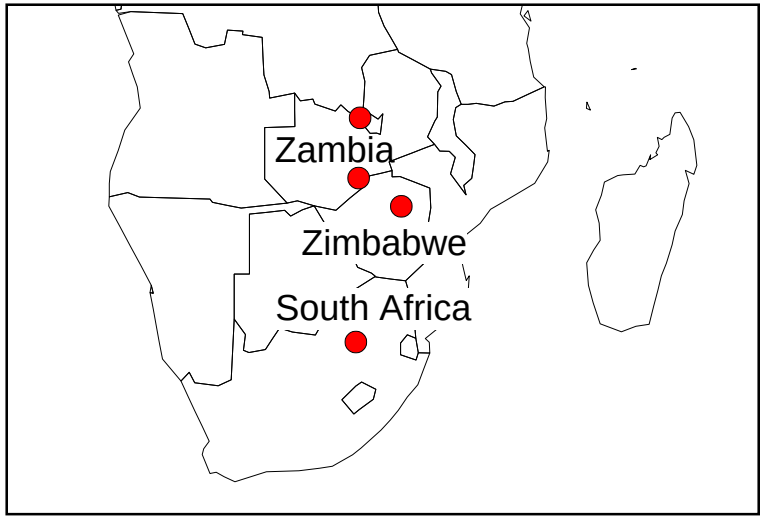
No	Country	Location	Type
1	India	Jamshedpur	Urban
2	India	Howrah, Kolkata	Urban
3	India	Bhubaneswar	Urban
4	India	Bhubaneswar	Rural
5	Thailand	Bangkok	Urban
6	Thailand	Phrapradaeng	Industrial
7	Vietnam	Hanoi	Urban
8	Vietnam	Ho Chi Minh	Urban
9	Vietnam	Tien Giang province	Rural
10	China	Chongqing	Urban
11	China	Tie Shan Ping	Rural
12	China	Hong Kong	Urban
13	Malaysia	Kuala Lumpur	Urban
14	Malaysia	Tanah Rata	Rural
15	South Africa	Johannesburg	Urban
16	Zambia	Kitwe	Urban Industrial
17	Zambia	Magoye	Rural Industrial
18	Zimbabwe	Harare	Urban

Exposures to develop the dose-response relationships for standard materials relevant to tropical and subtropical conditions

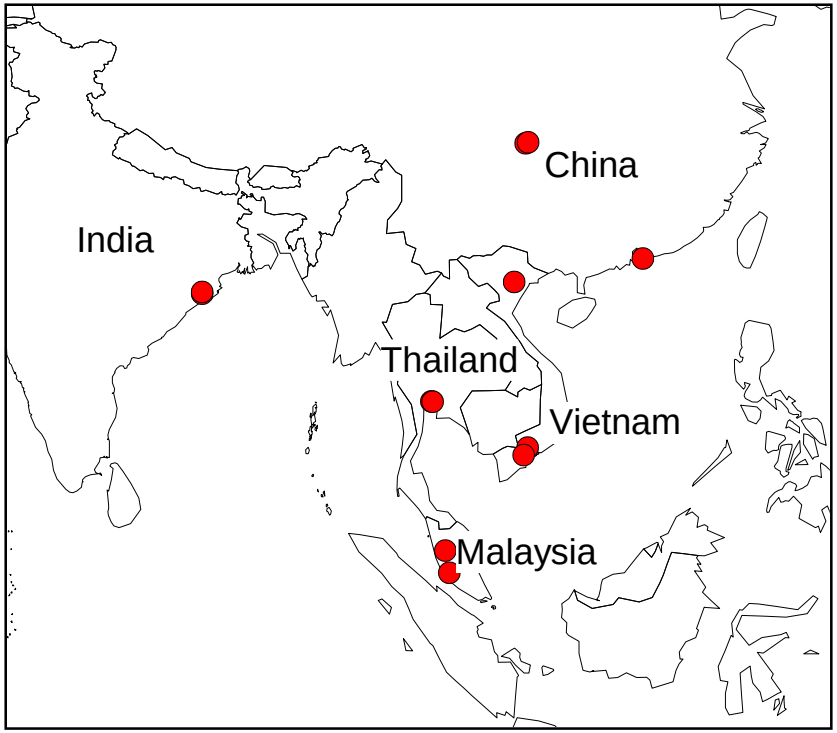
Korrosionsinstitutet
Swedish Corrosion Institute

Maps of test sites

Africa (4 sites)

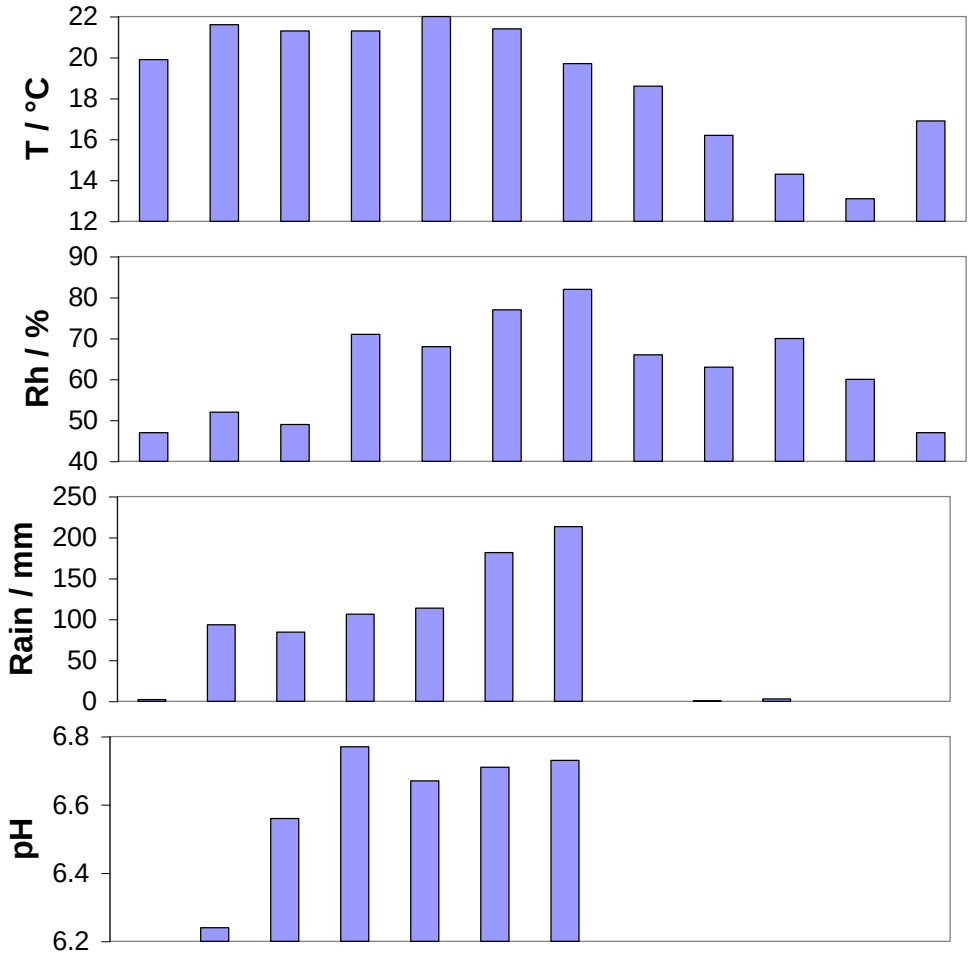


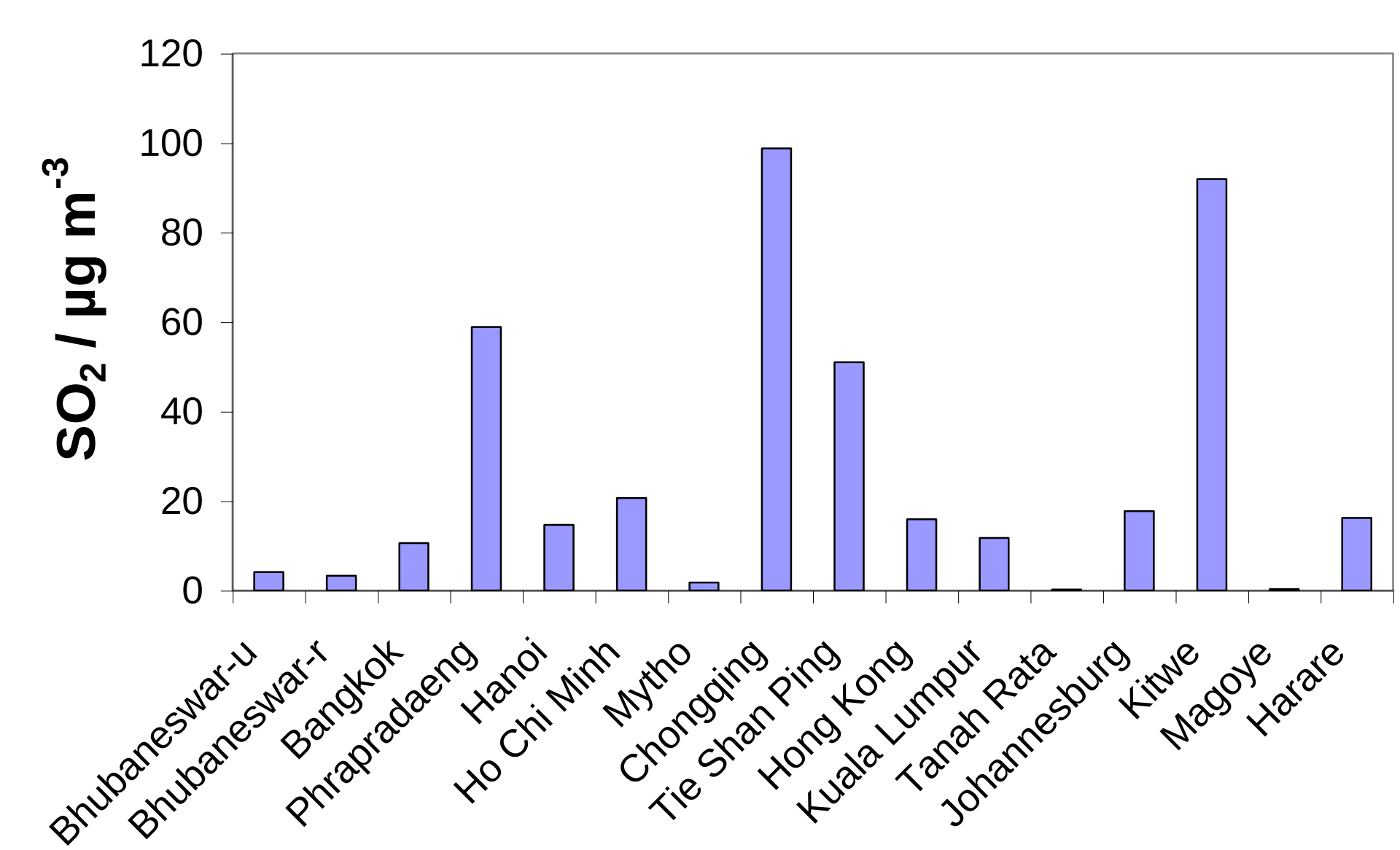
Asia (12 sites)

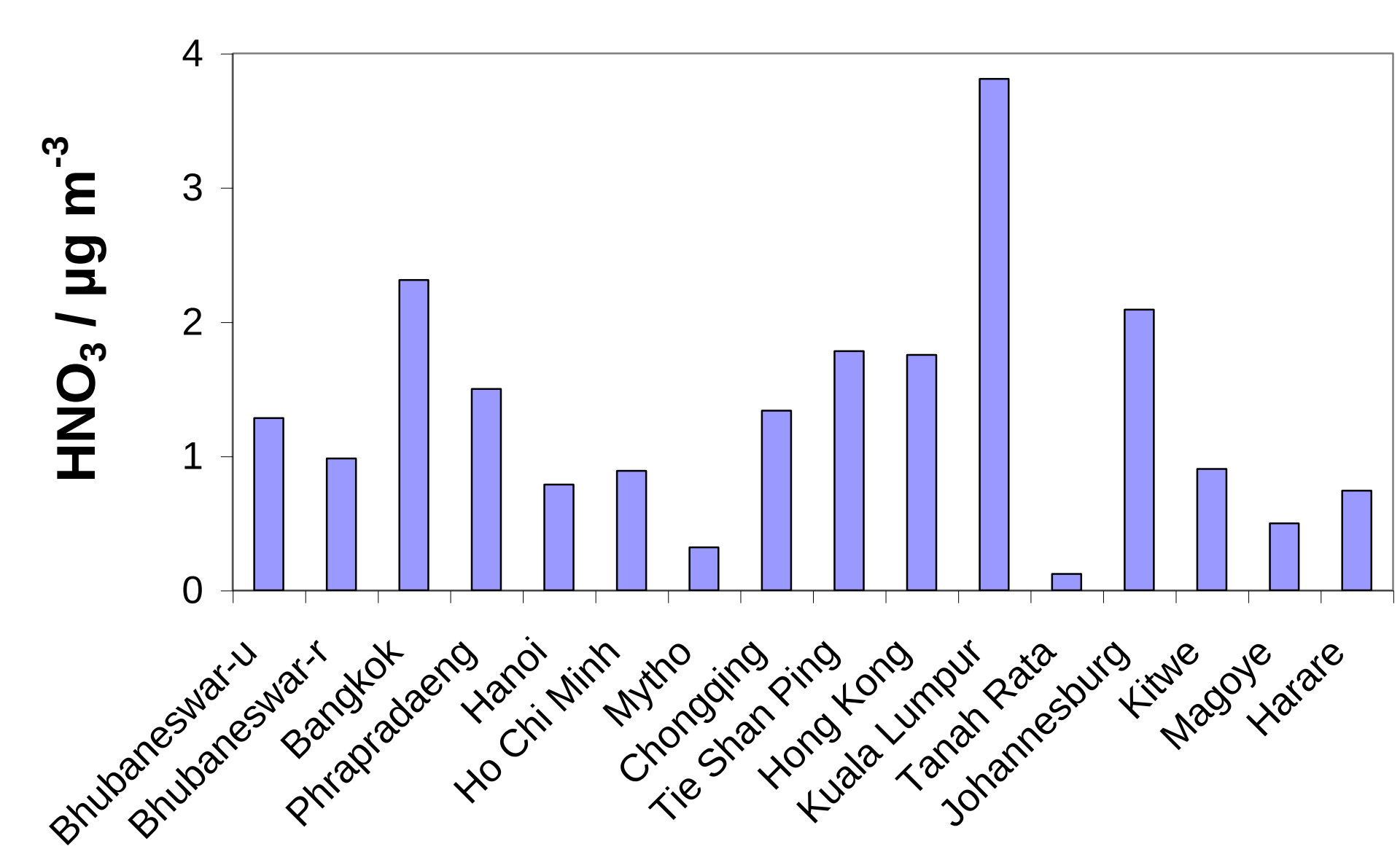


Collection at Harare, Zimbabwe

Month	T °C	Rh %	Rain mm	pH
Sep 2002	19.9	47	2	-
Oct 2002	21.6	52	93	6.24
Nov 2002	21.3	49	85	6.56
Dec 2002	21.3	71	106	6.77
Jan 2003	22.0	68	114	6.67
Feb 2003	21.4	77	182	6.71
Mar 2003	19.7	82	213	6.73
Apr 2003	18.6	66	0	-
May 2003	16.2	63	0	-
Jun 2003	14.3	70	3	-
Jul 2003	13.1	60	0	-
Aug 2003	16.9	47	0	-
Average	18.9	63	798	6.61

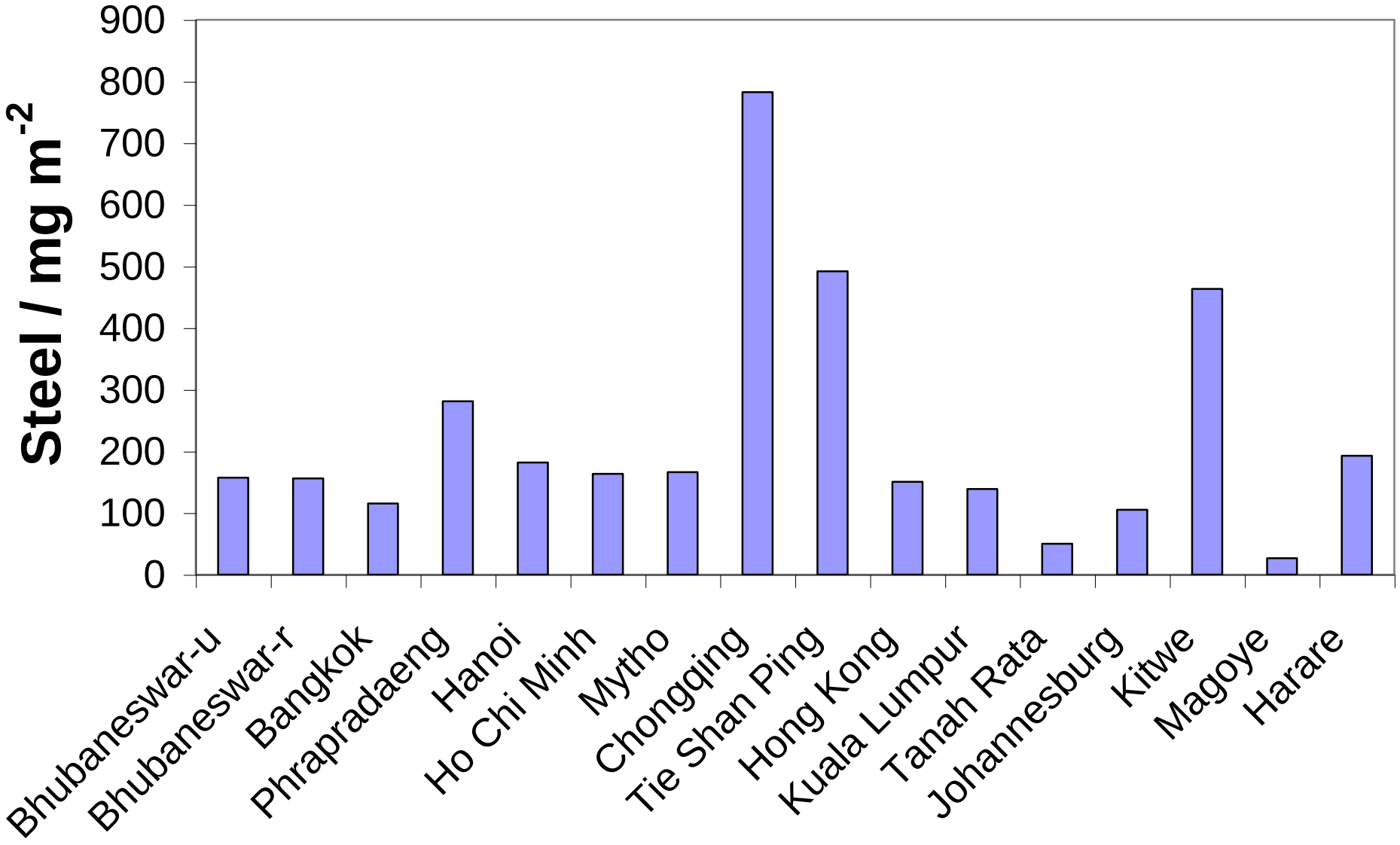


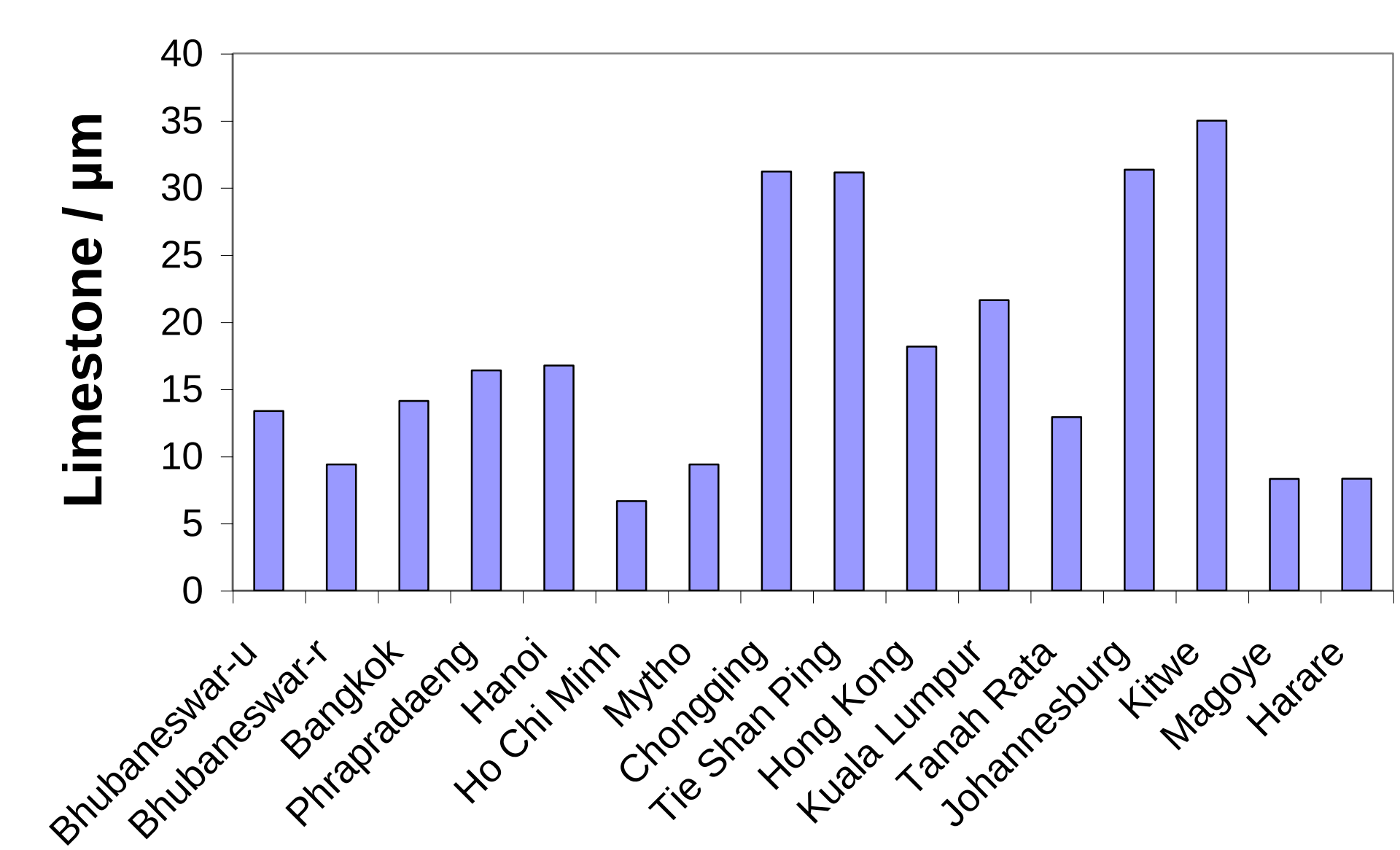

120
100
80
60
40
20
0
SO2 / µg m-3
Bhubaneswar-u
Bhubaneswar-r
Bangkok
Phrapradaeng
Hanoi
Ho Chi Minh
Mytho
Chongqing
Tie Shan Ping
Hong Kong
Kuala Lumpur
Tanah Rata
Johannesburg
Kitwe
Magoye
Harare


HNO3 / µg m-3
0
1
2
3
4
Bhubaneswar-u
Bhubaneswar-r
Bangkok
Phrapradaeng
Hanoi
Ho Chi Minh
Mytho
Chongqing
Tie Shan Ping
Hong Kong
Kuala Lumpur
Tanah Rata
Johannesburg
Kitwe
Magoye
Harare

Environmental database

Country	Name	T	Rh	Rain	pH	HNO3	SO2	NO2	O3	m	Cl	NO3	SO4
India	Bhubaneswar-u	26.5	69	425	6.0	1.3	4	11	63	164	5.79	2.38	3.1
India	Bhubaneswar-r	26.5	69	425	6.0	1.0	3	5	63	70	1.73	1.02	1.4
Thailand	Bangkok	29.3	76	1371	6.8	2.3	11	39	38	35	0.32	2.18	1.6
Thailand	Phrapradaeng	29.3	73	1335	6.2	1.5	59	24	54	64	0.9	1.88	6.6
Vietnam	Hanoi	24.7	79	1556	5.8	0.8	15	18	49	57	0.38	1.08	3.4
Vietnam	Ho Chi Minh	28.3	74	1441	6.2	0.9	21	18	47	39	0.39	0.82	2.4
Vietnam	Mytho	27.0	81	1222	6.4	0.3	2	9	36	62	2.85	0.62	1.3
China	Chongqing	18.5	70	1162	4.5	1.3	99	45	52	162	0.66	1.46	18.5
China	Tie Shan Ping	18.5	90	1133	4.2	1.8	51	10	71	61	0.17	1.25	7.2
China	Hong Kong	22.9	78	2092	4.6	1.8	16	50	31	36	0.78	1.98	1.6
Malaysia	Kuala Lumpur	28.0	78	2776	4.3	3.8	12	47	42	26	0.16	1.42	1.0
Malaysia	Tanah Rata	18.1	91	2433	5.1	0.1	0	1	35	10	0.13	0.25	0.3
South Africa	Johannesburg	17.2	78	417	4.8	2.1	18	28	51	21	0.08	0.62	0.7
Zambia	Kitwe	22.6	58	1083	4.7	0.9	92	11	72	64	0.21	0.52	6.5
Zambia	Magoye	22.2	62	826	7.0	0.5	0	2	53	24	0.11	0.20	0.1
Zimbabwe	Harare	18.9	63	798	6.6	0.7	16	15	65	31	0.09	0.36	1.3

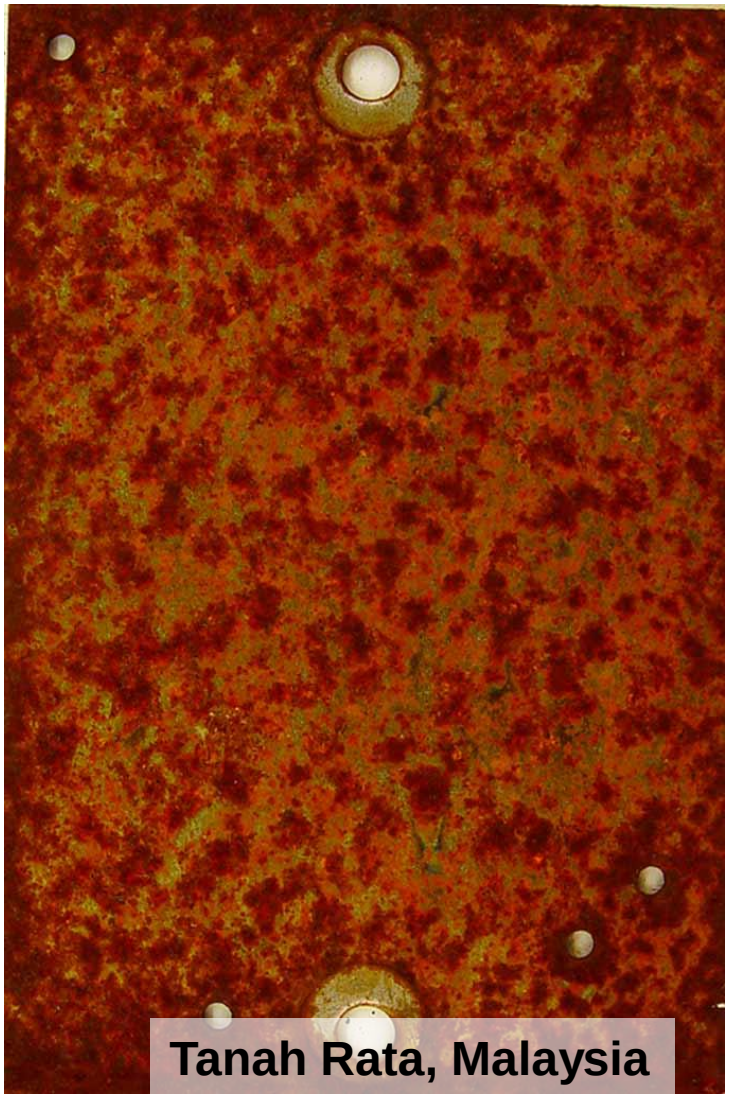

Steel / mg m-2
900
800
700
600
500
400
300
200
100
0
Bhubaneswar-u
Bhubaneswar-r
Bangkok
Phrapradaeng
Hanoi
Ho Chi Minh
Mytho
Chongqing
Tie Shan Ping
Hong Kong
Kuala Lumpur
Tanah Rata
Johannesburg
Kitwe
Magoye
Harare

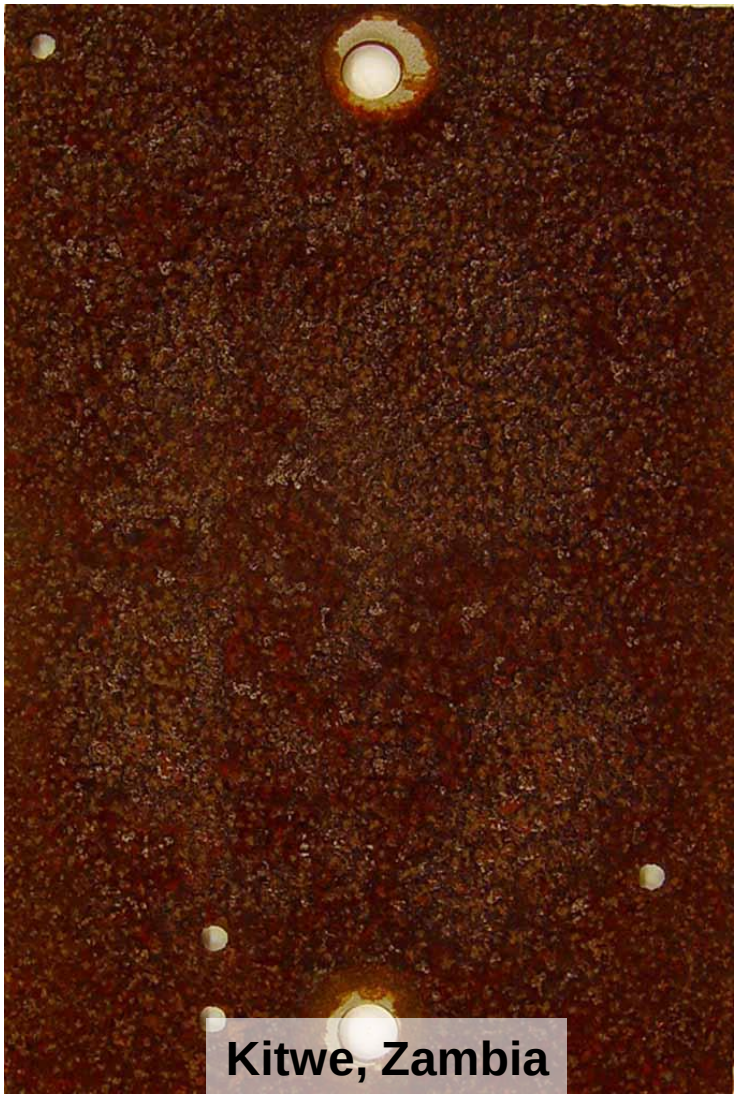

Limestone / µm
40
35
30
25
20
15
10
5
0
Bhubaneswar-u
Bhubaneswar-r
Bangkok
Phrapradaeng
Hanoi
Ho Chi Minh
Mytho
Chongqing
Tie Shan Ping
Hong Kong
Kuala Lumpur
Tanah Rata
Johannesburg
Kitwe
Magoye
Harare

Corrosion database

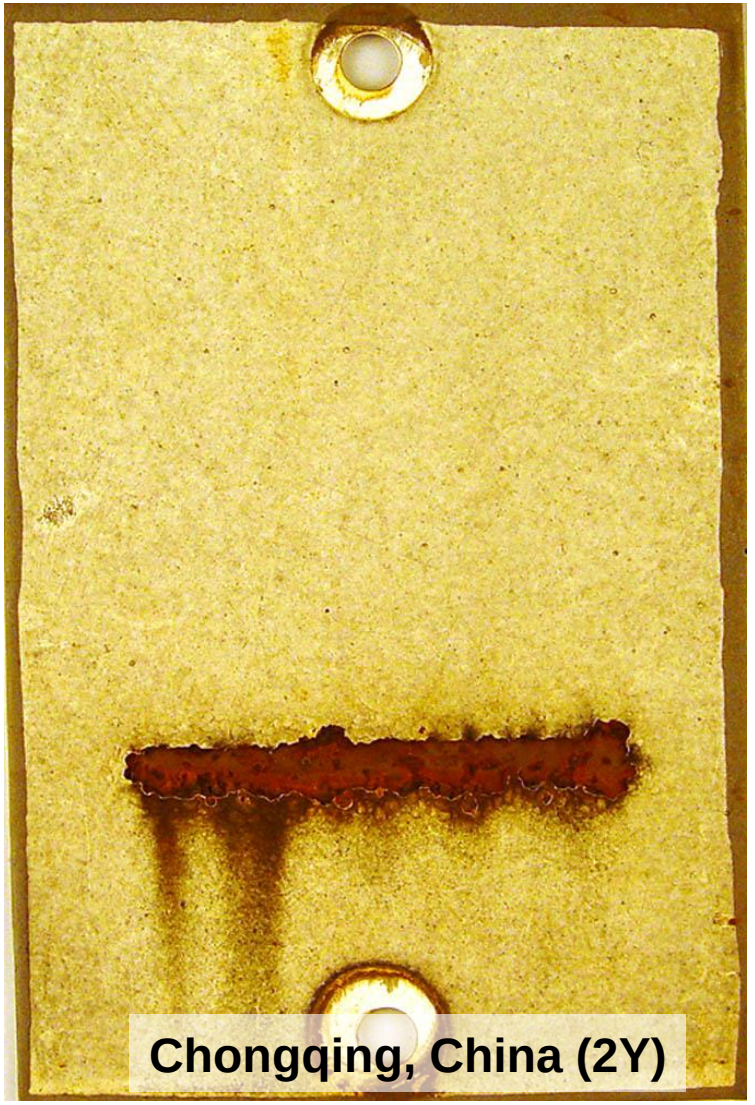
Country	Name	Steel		Zinc		Copper		Paint coated steel			Limestone		
				mg m^{-2}				*mm*			*µm*		
		#1	**#2**	**#1**	**#2**	**#1**	**#2**	**#1**	**#2**	**#3**	**#1**	**#2**	**#3**
India	Bhubaneswar-u	157	157	4.2	4.3	8.4	8.1	0.6	0.6	0.7	13.2	14.3	12.5
India	Bhubaneswar-r	157	155	3.4	3.7	12.3	11.5	0.6	0.8	0.7	7.7	8.9	11.5
Thailand	Bangkok	116	115	4.3	4.8	14.3	15.6	0.8	0.6	0.7	13.2	13.9	15.2
Thailand	Phrapradaeng	280	282	5.5	5.9	16.8	17.4	0.6	0.5	0.6	28.9	3.0	17.3
Vietnam	Hanoi	181	182	5.9	6.2	5.5	5.2	1.0	1.4	1.1	23.1	5.4	21.8
Vietnam	Ho Chi Minh	162	165	6.4	7.3	7.7	8.3	0.8	0.9	0.8	5.3	7.6	7.1
Vietnam	Mytho	166	167	4.4	4.3	11.3	12.8	1.2	0.9	1.0	9.3	7.4	11.5
China	Chongqing	789	776	9.1	9.0	24.6	23.7	4.0	5.3	4.4	17.5	38.7	37.4
China	Tie Shan Ping	490	494	10.8	12.4	17.7	18.0	4.0	4.2	3.1	30.1	29.4	33.8
China	Hong Kong	148	153	6.4	6.4	6.6	6.8	0.7	0.7	0.7	18.2	17.8	18.5
Malaysia	Kuala Lumpur	139	139	7.8	8.4	9.2	9.9	0.7	0.7	0.6	22.9	21.0	20.9
Malaysia	Tanah Rata	49	52	7.3	7.7	10.2	10.8	0.7	0.6	0.7	10.1	19.3	9.4
South Africa	Johannesburg	101	109	1.9	2.1	4.5	4.6	0.4	0.4	0.4	34.1	20.6	39.4
Zambia	Kitwe	464	463	26.8	27.3	12.7	12.7	4.2	3.6	3.5	32.8	35.8	36.4
Zambia	Magoye	25	28	1.9	2.0	4.7	5.4	1.1	0.4	0.5	8.4	8.8	7.8
Zimbabwe	Harare	194	192	3.4	3.5	4.2	3.9	0.5	0.4	0.6	8.8	8.1	8.1

Field exposure (Carbon steel after 2Y)





Field exposure



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Conclusions

- Air pollution affects health of poor people disproportionately. Indoor air pollution is a poorly quantified problem
- Crop yield losses will be felt more acutely by poor people. The extent is poorly quantified
- Health, crop yield losses and corrosion have significant, but poorly quantified economic consequences
- Regional policy processes are proving useful for a for scientific information transfer