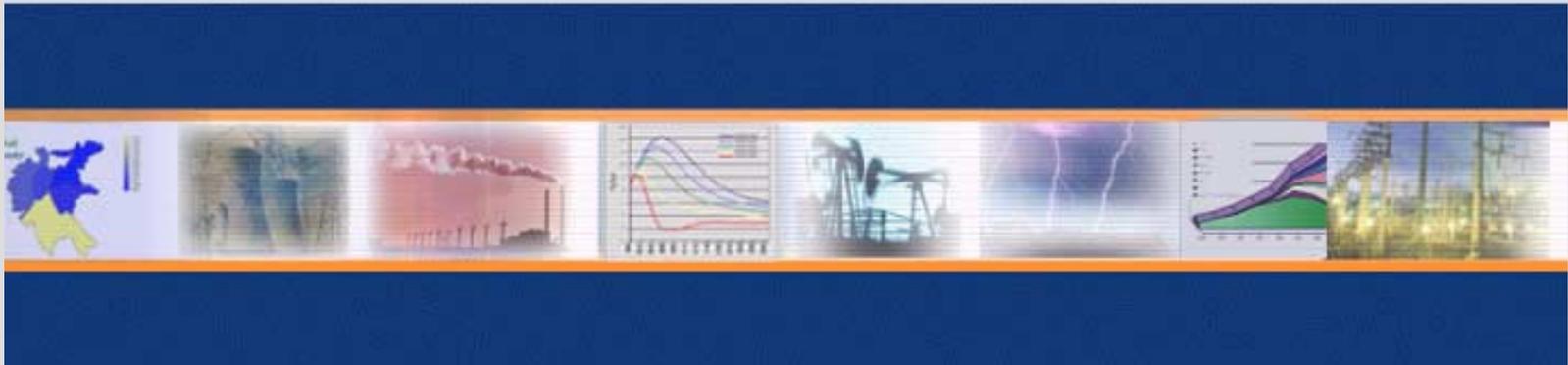




Application of AIM/Local Model for India

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ECONOMIC AND ENVIRONMENTAL MODELING WORKSHOP
19-20 January 2004, India Habitat Centre, New Delhi

Overview

- **AIM/Local Model**
- **India AIM/Local Application**
 - **Large Point Sources (LPS)**
 - **Area Sources**
- **Sub-regional AIM/Local Application (Ahmedabad District)**

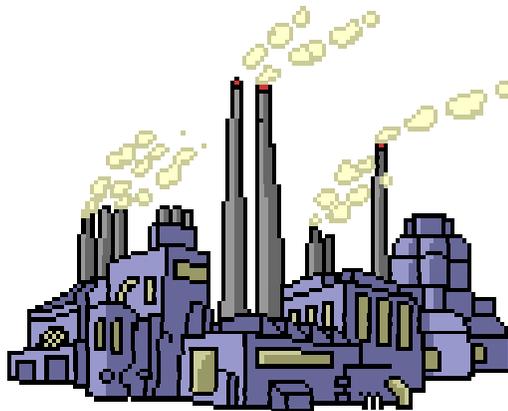


AIM/Local Model

Introduction

Modeling the dilemma of providing energy services and protecting the environment in a local region

$\text{CO}_2, \text{SO}_2, \text{NO}_x$



Energy Technology

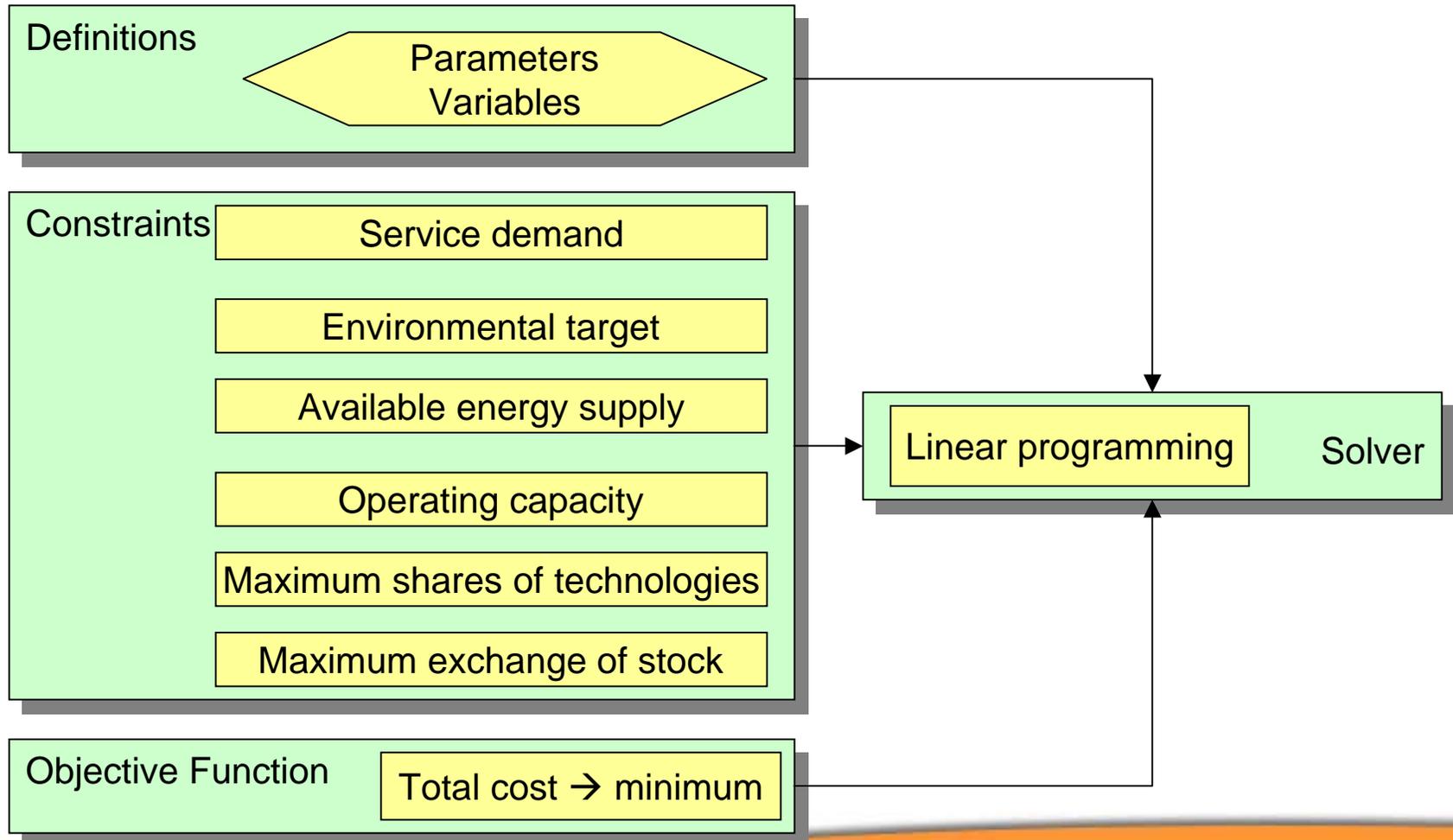


Energy Service Demand

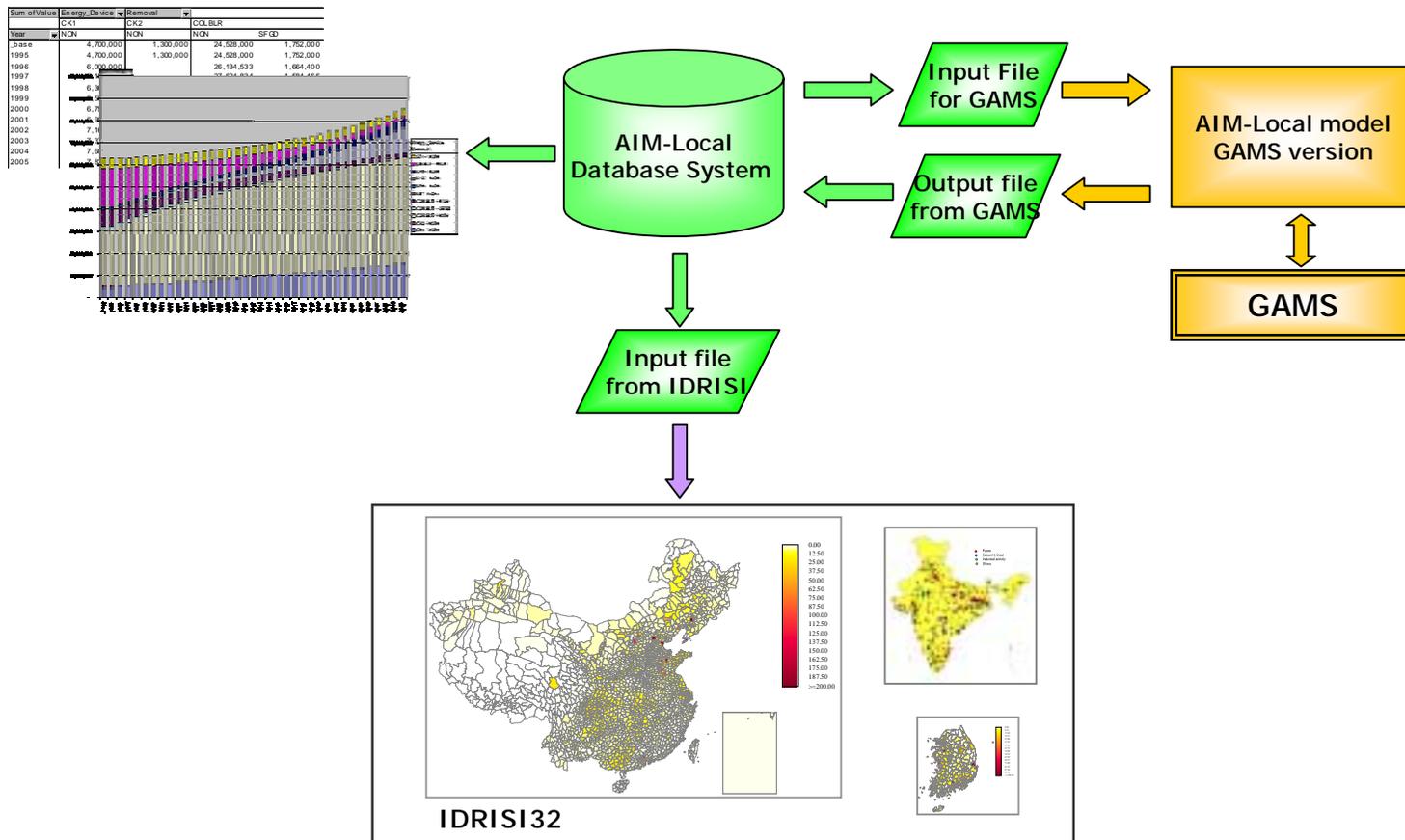
Features

- **Simplified Structure**
- **Modeling local environmental constraints**
- **Direct benefit and co-benefit of counter measures**
- **Flexible model structure to cope with various practical situation in different regions**
- **GAMS programming**
- **Separate representation of LPS and Area Sources**
- **GIS Interface**

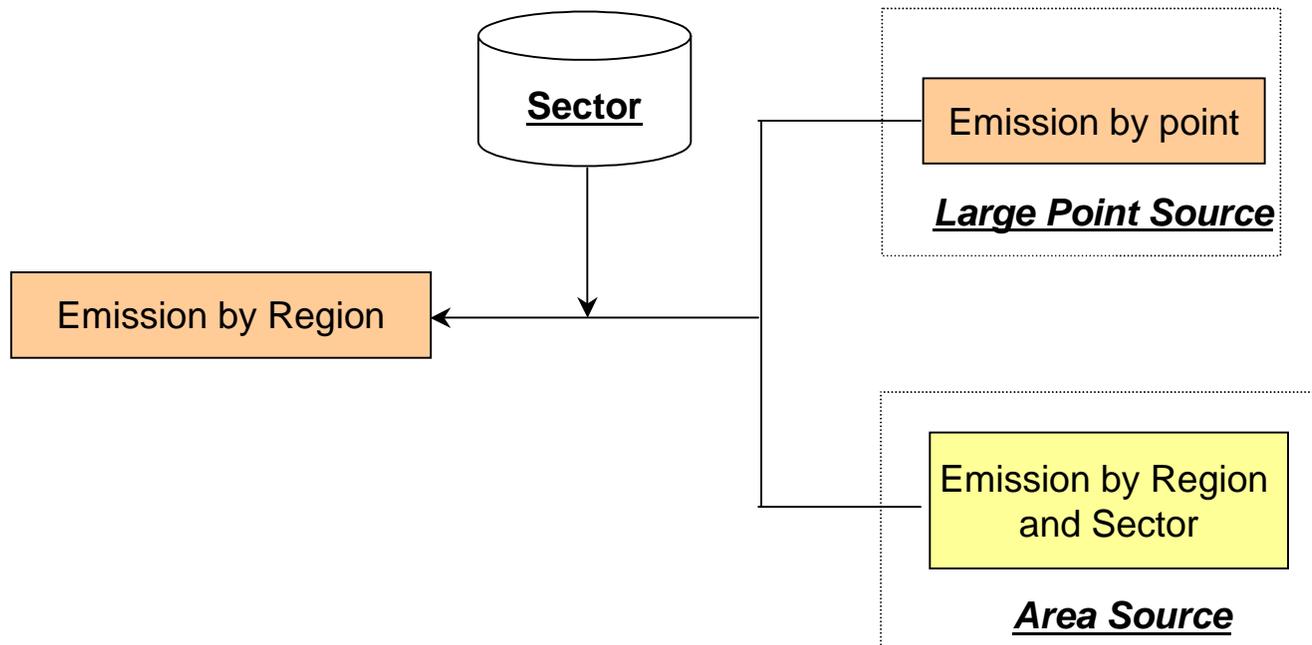
Methodology



AIM-Local Database System



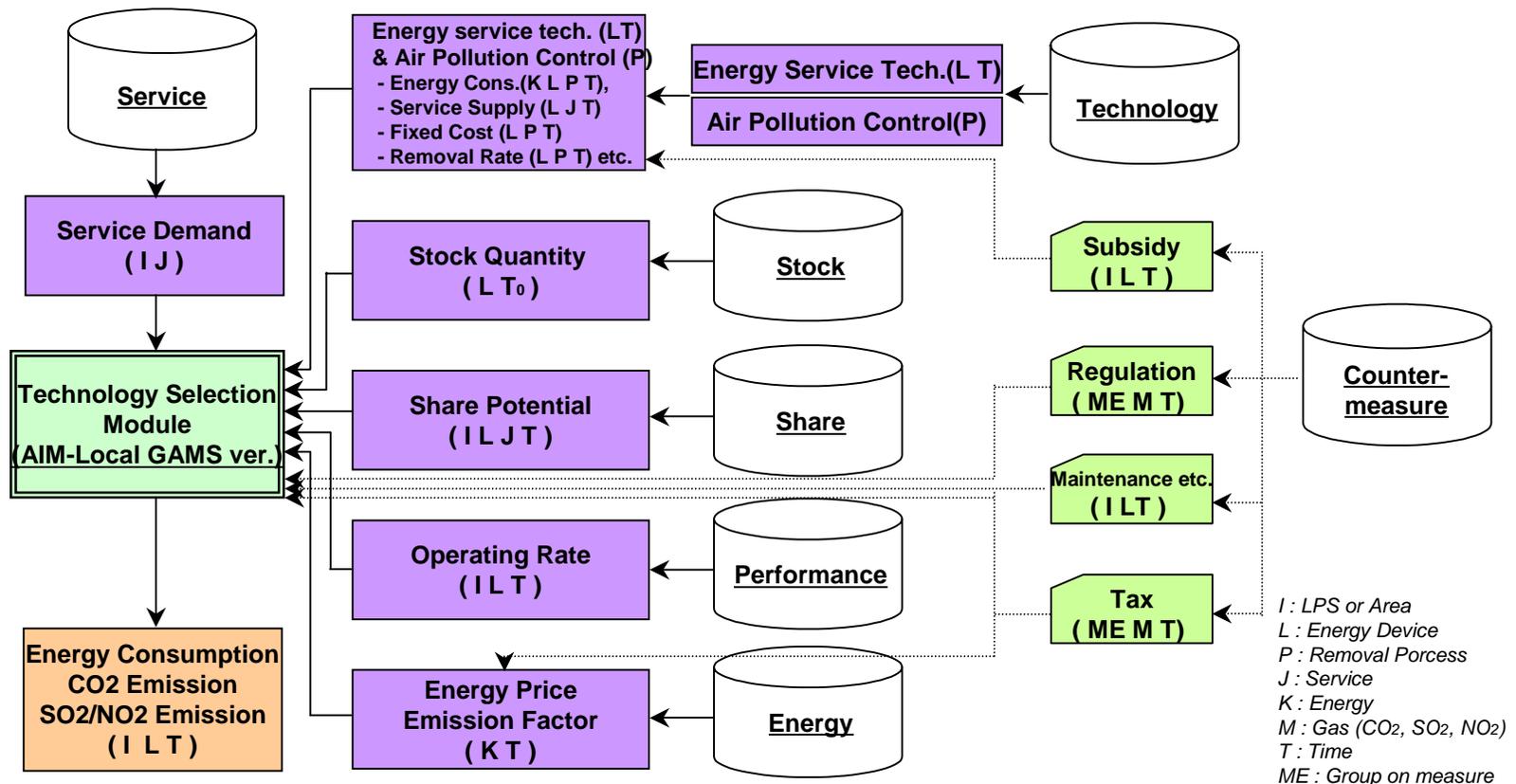
Large Point Source and Area Source



Sub-regional emissions are calculated as:

Emissions from LPS in the sub-region + Allocated Area Source Emissions

Structure of AIM-Local Database



Data requirements are similar to AIM/Enduse but more extensive, due to LPS data and GIS information requirements

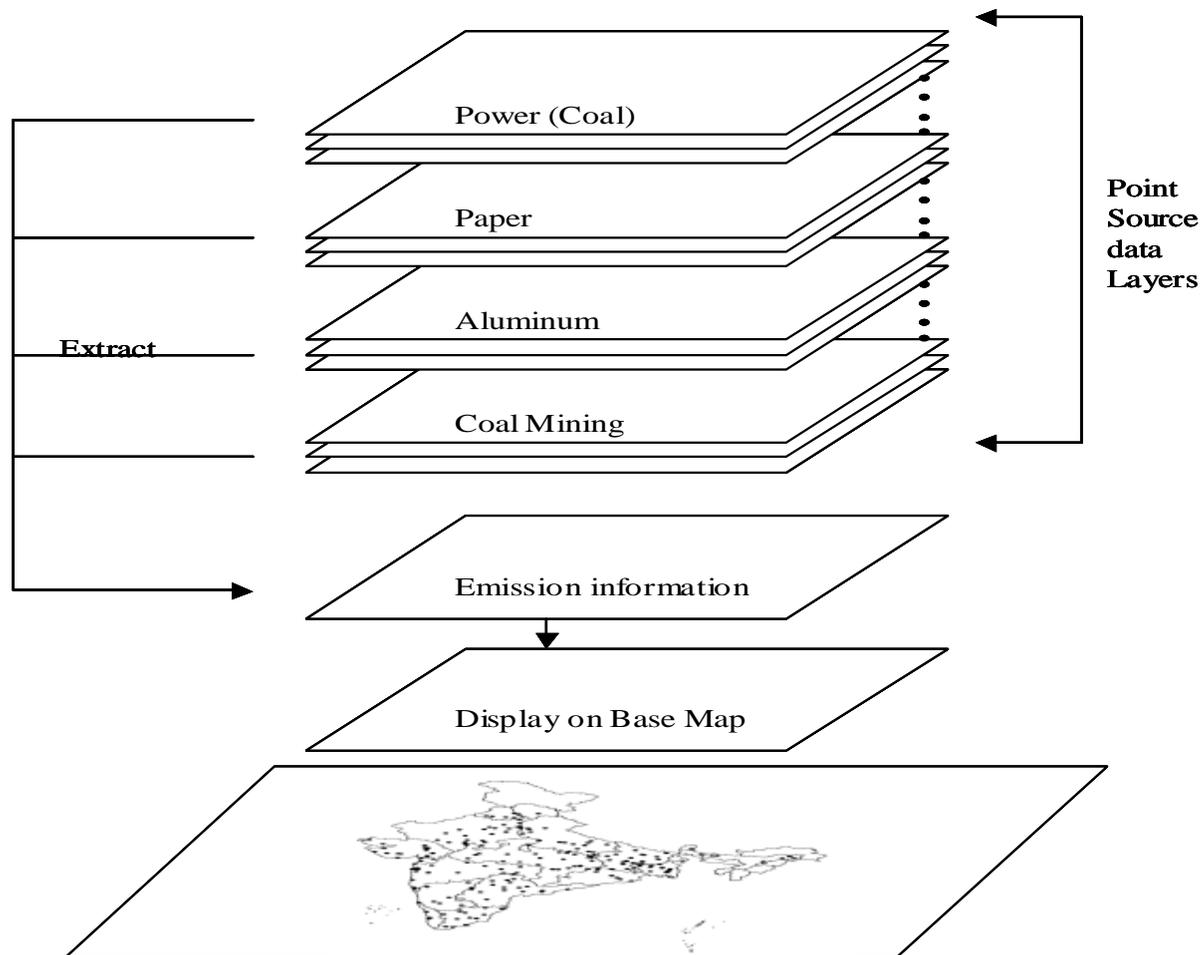


GIS Application

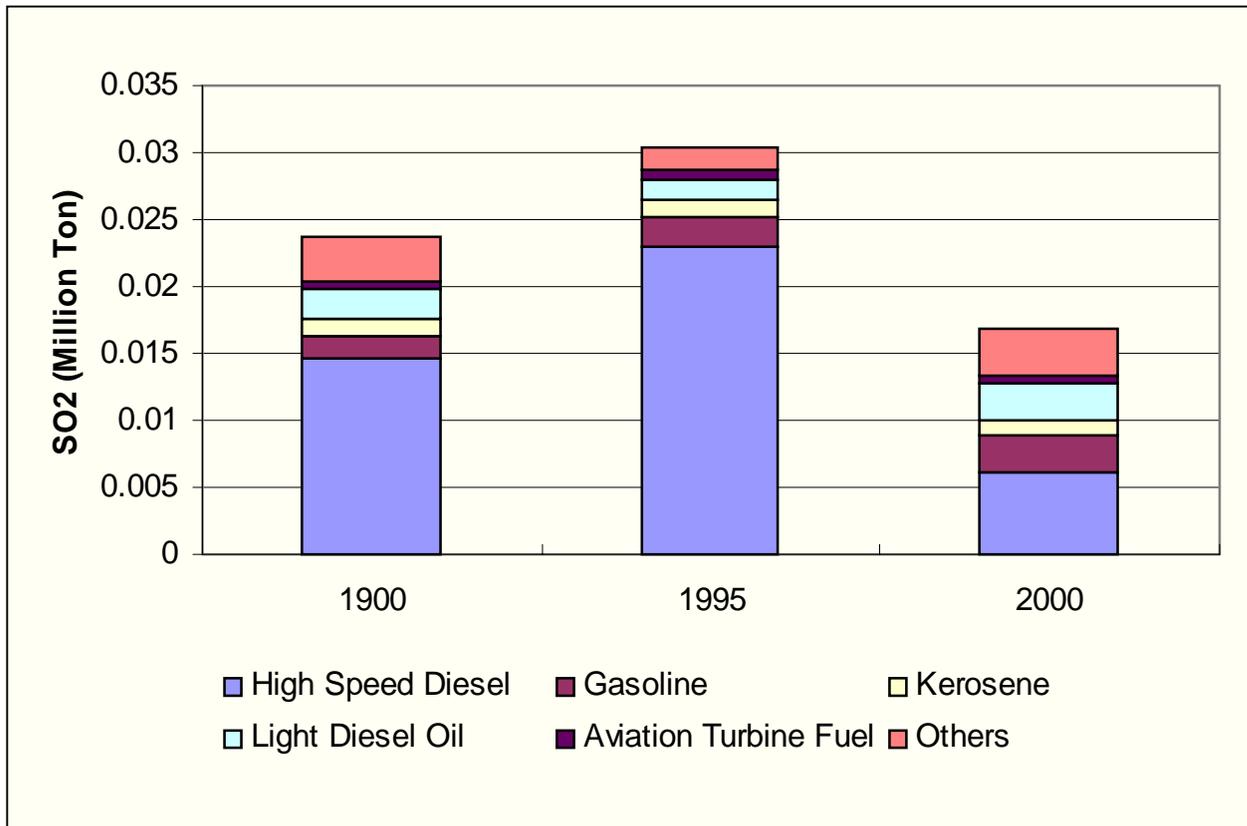
- **Capture location sensitivity**
- **Layered information**
- **Time slices**
- **Integrating location and time information in a consistent framework**



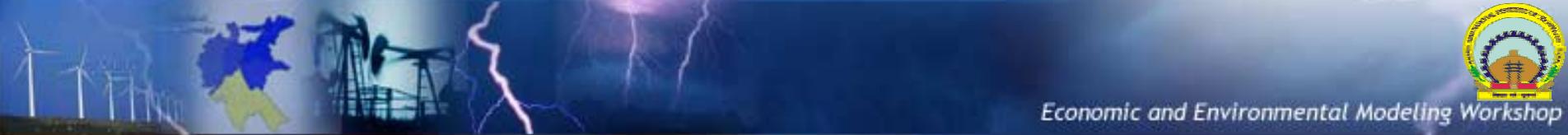
GIS Layers



Delhi SO₂ Emissions from Oil

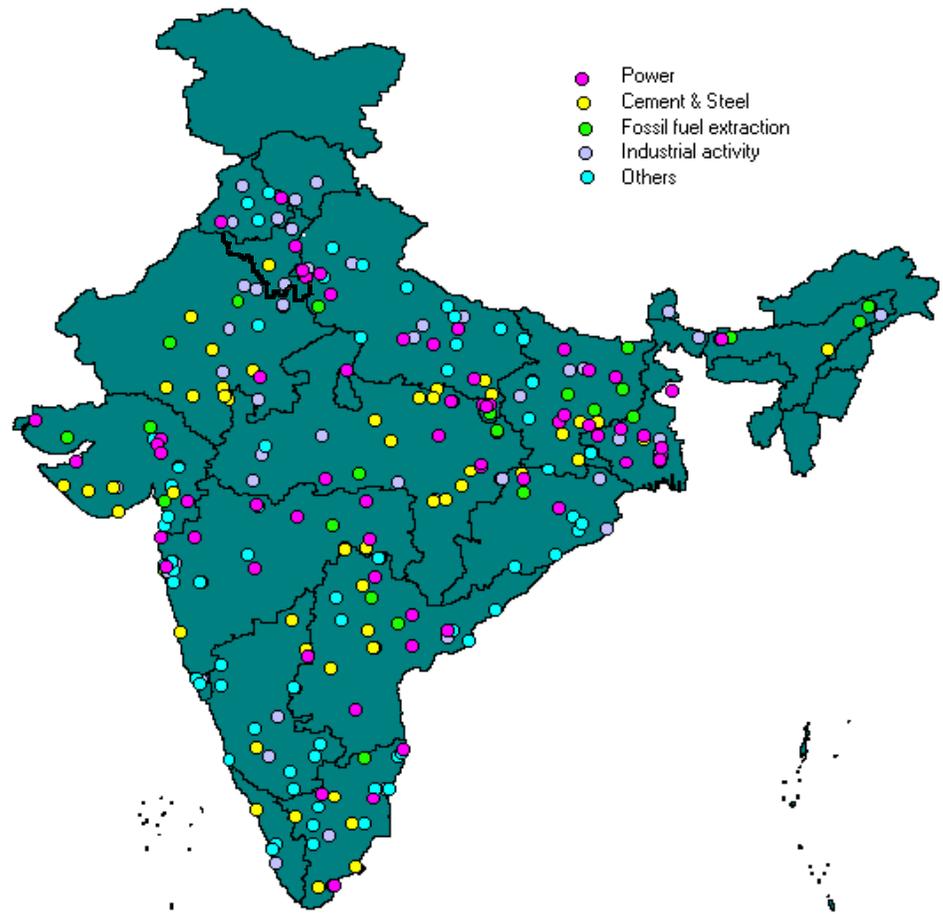


Sulfur Coefficient decrease for Diesel over 1995-2002 has resulted in substantial SO₂ emission reduction in Delhi



India AIM/Local Application

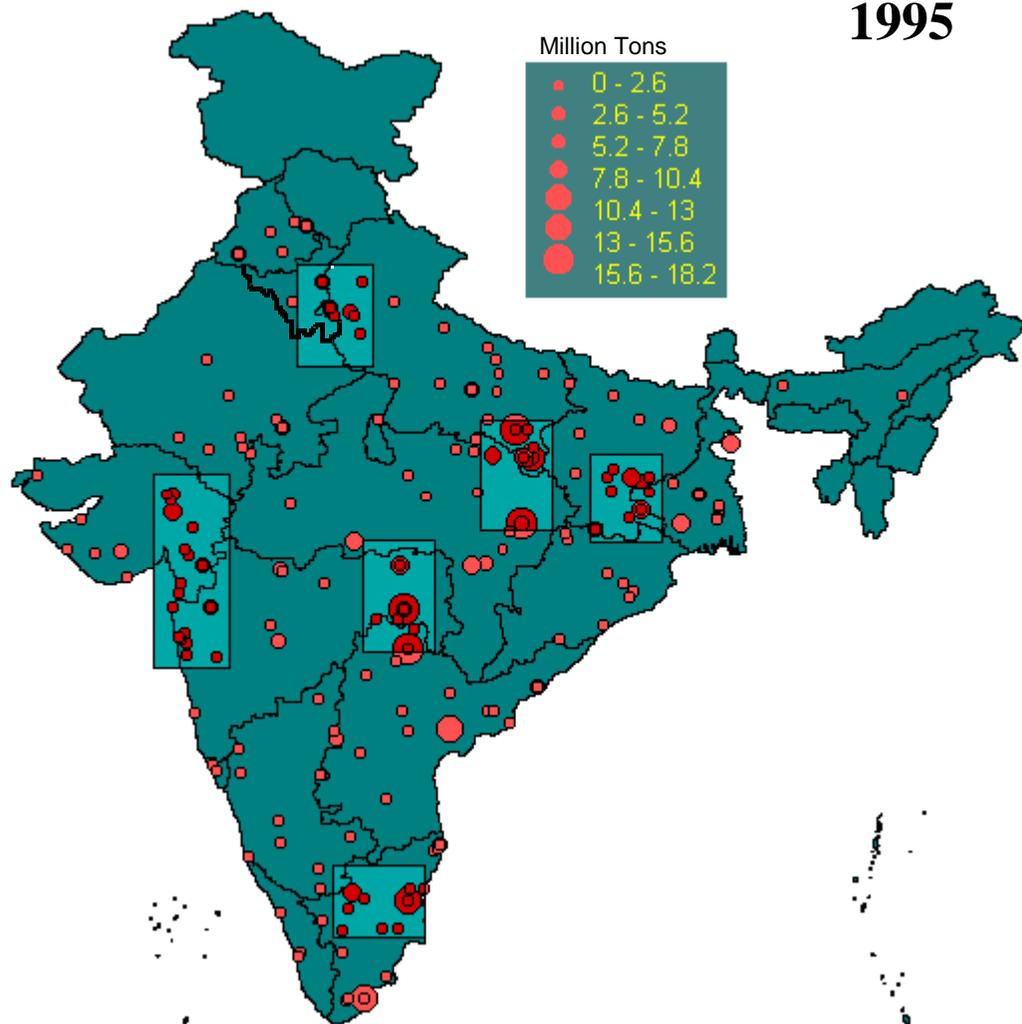
1995

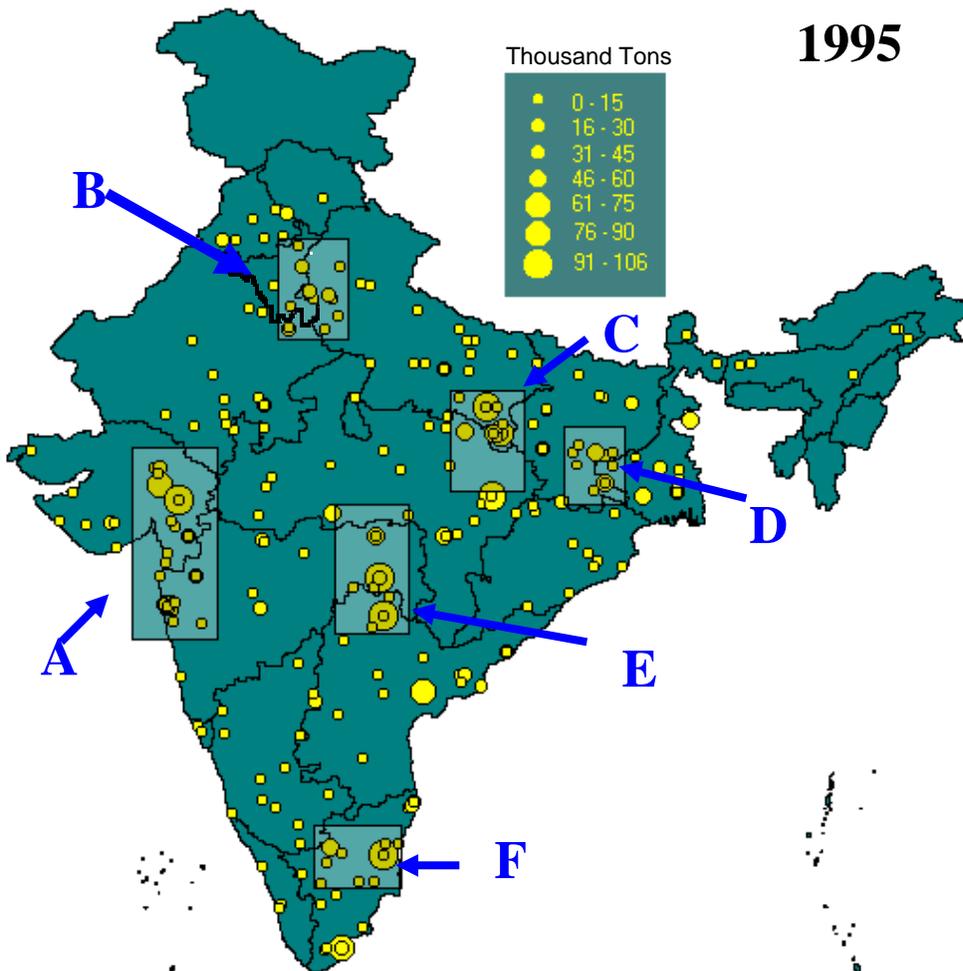


Sectors	LPS covered
Power	94
Steel	11
Cement	85
Fertilizer	31
Paper	33
Sugar	28
Caustic Soda	19
Crude refinery	12
Petrochemical	14
HNO ₃ manufacturing	5
H ₂ SO ₄ manufacturing	63
Aluminum	3
Copper smelting	8
Lead smelting	5
Zinc smelting	3
Alcohol production	14
Coal mining	32
Natural gas production	9
N. gas transportation	12
Crude oil production	7
Municipal solid waste	14
Other industries	7
Total	509

1995

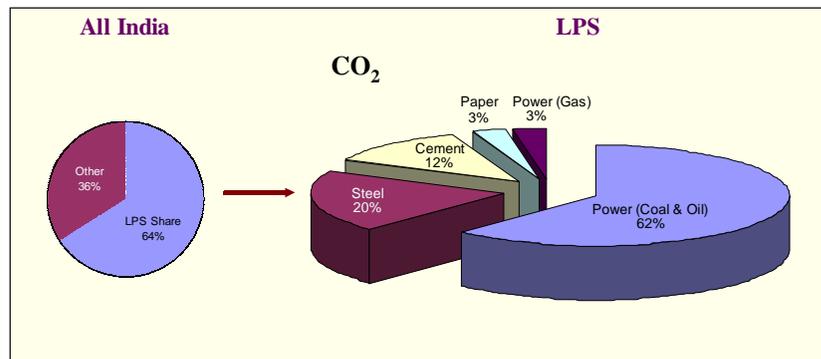
Sectors	No. of LPS	CO ₂	
		LPS (Tg)	LPS/Total
Power	94	365	47
Steel	11	48	6
Cement	85	68	9
Fertilizer	31	14	2
Sugar	28	0.7	0.09
Paper	33	2.9	0.37





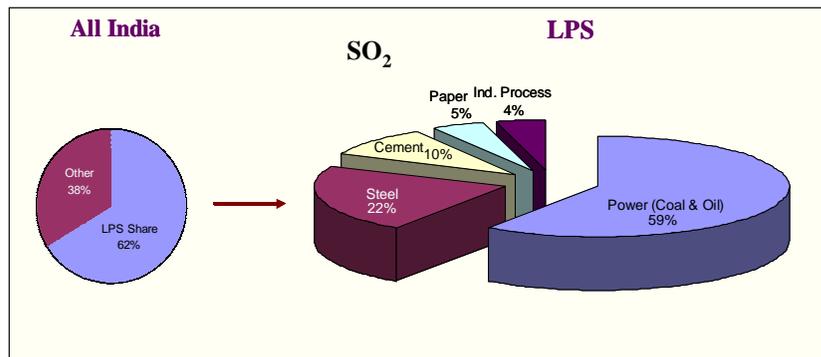
	Region Details	No. of LPS	LPS/Total SO ₂ (%)	Main Sources
A	Golden corridor	32	6.1	Power, H ₂ SO ₄
B	Delhi	20	2.4	Power, Cement
C	Northeast India coal mine	21	7.9	Power, Cement
D	East India coal mine	18	5.5	Power, Steel, Cement
E	Central India coal mine	16	6.1	Power, Steel
F	Southern region	13	3.9	Power, Cement

Sectoral LPS share for CO₂ and SO₂ 2000



➤ Emission control policies should focus on

- Power, Steel and Cement industries
- 3 coal mining regions and 3 industrial belts



➤ While the emissions originate from a large number of sources cost effective emission mitigation is possible through LPS management.



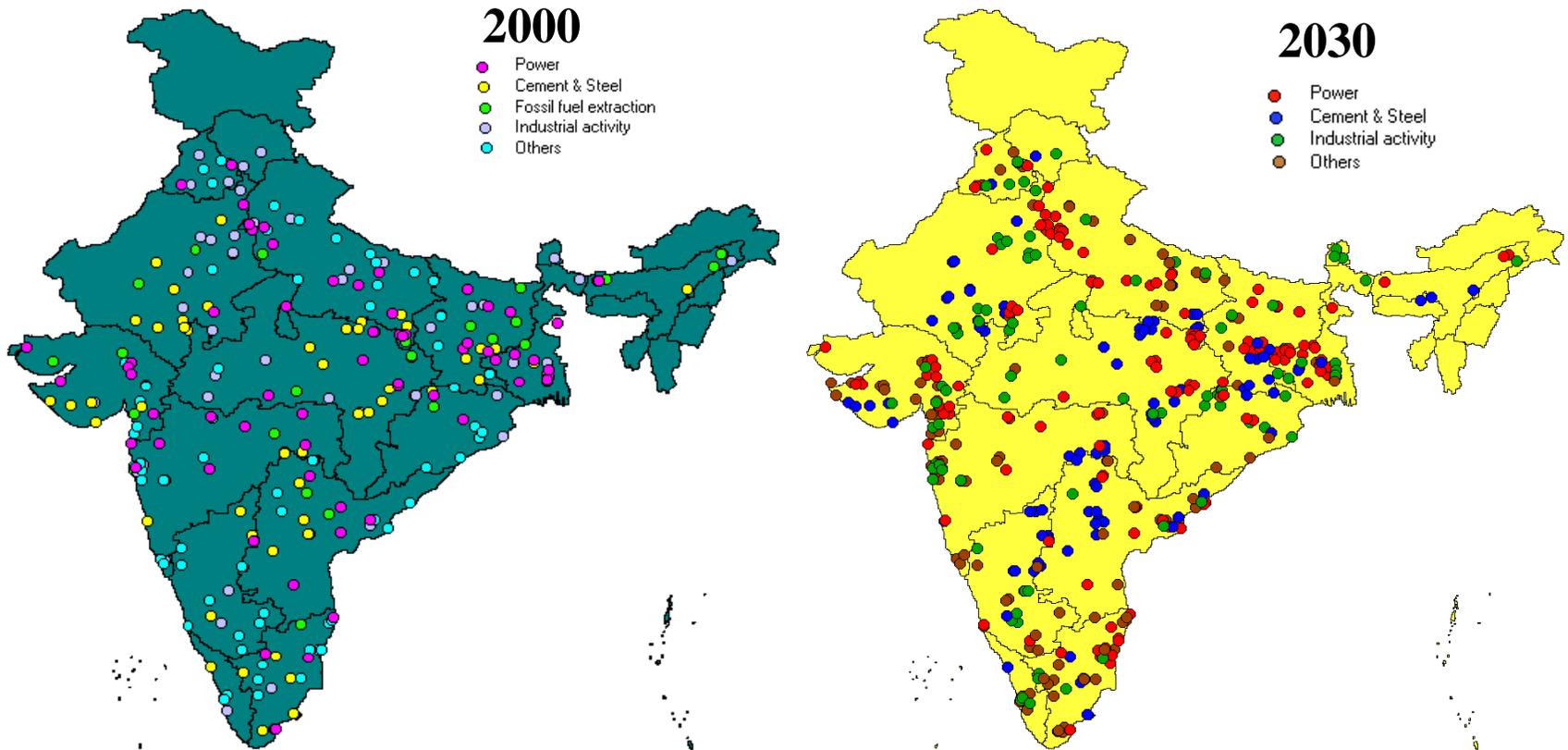
LPS Database

- **LPS number increases in future**
- **Coverage of gases: CO₂ and SO₂**
- **Indianised emission coefficients (to the extent possible)**
- **Projections up to year 2030**

LPS Coverage for India

Sector	Subsectors	LPS covered			
		2000	2010	2020	2030
Energy	Power (coal & Oil)	82	111	131	150
	Power (natural gas)	12	17	20	23
	Steel	10	16	22	28
	Cement *	85	98	110	123
	Fertilizer	31	41	52	62
	Paper	33	38	43	48
	Sugar	28	28	29	30
	Caustic Soda	19	21	23	26
Industrial processes	H ₂ SO ₄ manufacturing	63	64	66	68
	Aluminium (Al)	3	4	5	5
	Copper ore smelting (Cu)	8	9	10	11
	Lead ore smelting (Pb)	5	6	7	8
	Zinc ore smelting (Zn)	3	4	5	5
Total		382	457	523	587

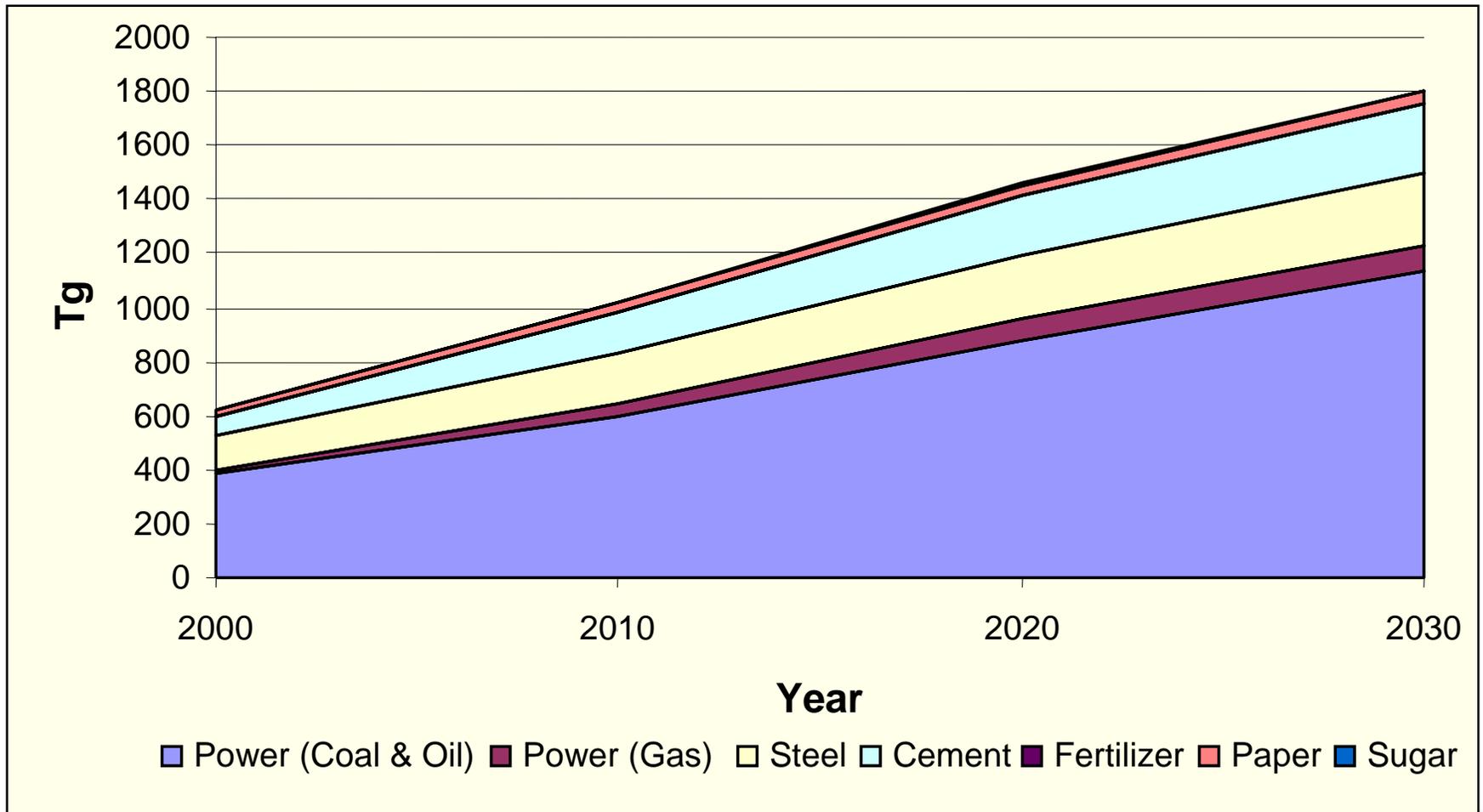
LPS Locations



Database Generation

- **Sectoral demand projections on the basis of macro-economic parameters**
 - Thirty year time series GDP
 - Government projections
 - Expert opinion
- **LPS demand on the basis of sectoral demand elasticity and past production trends**
- **Demand over and above LPS capacities assigned to Area Sources**

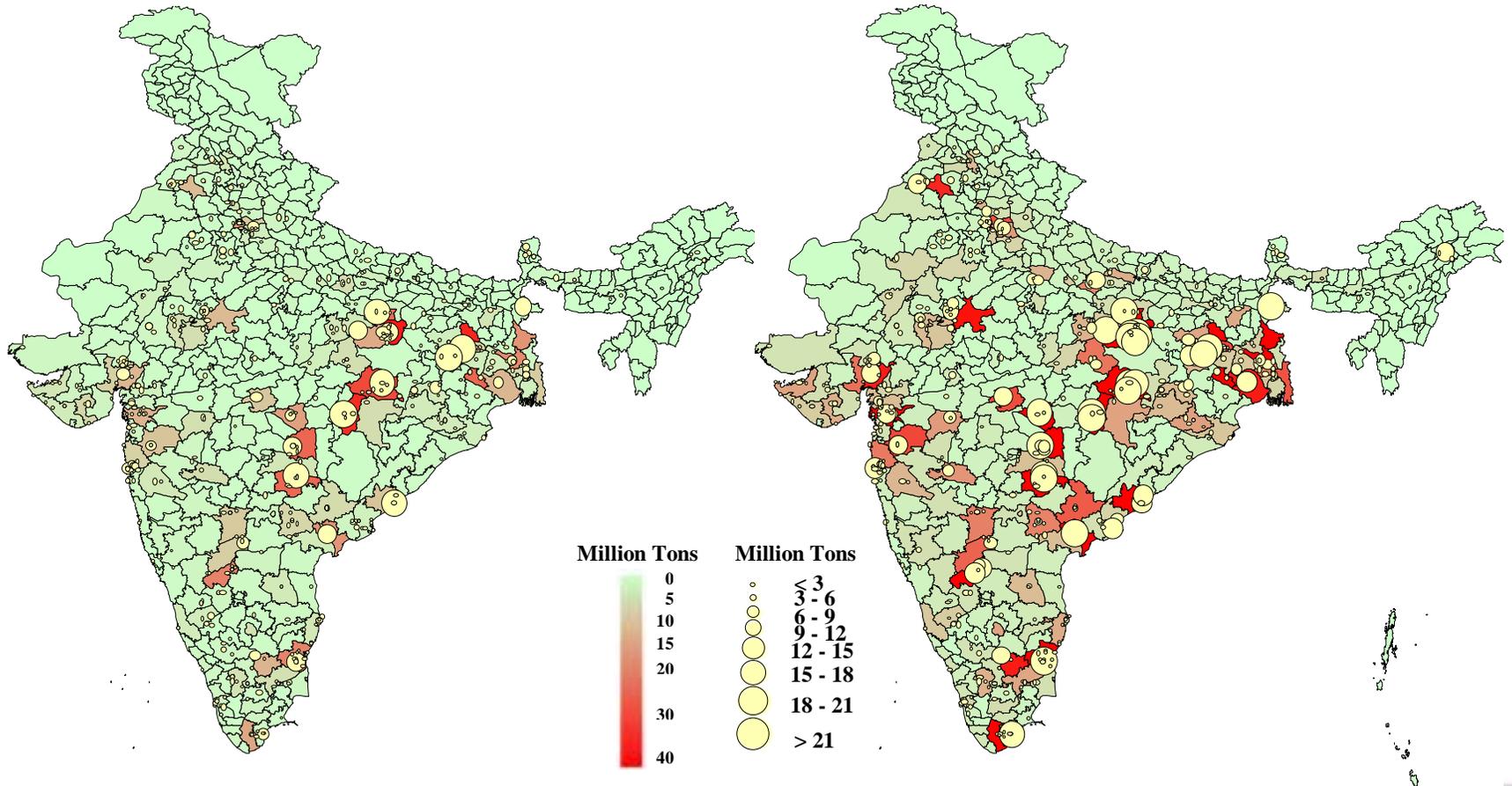
CO₂ from Energy Sector LPS



CO₂ Emission Distribution

2000

2030

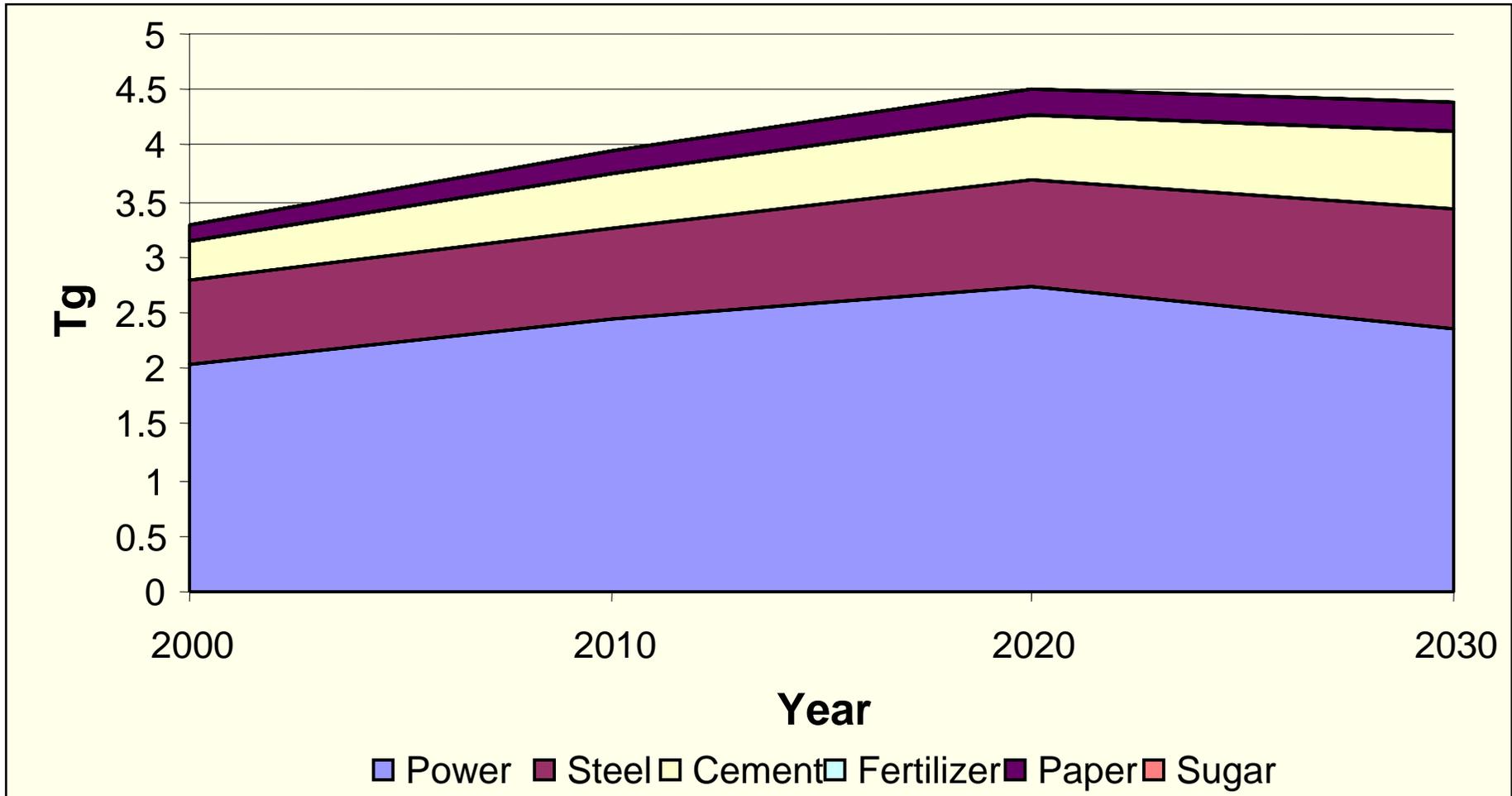




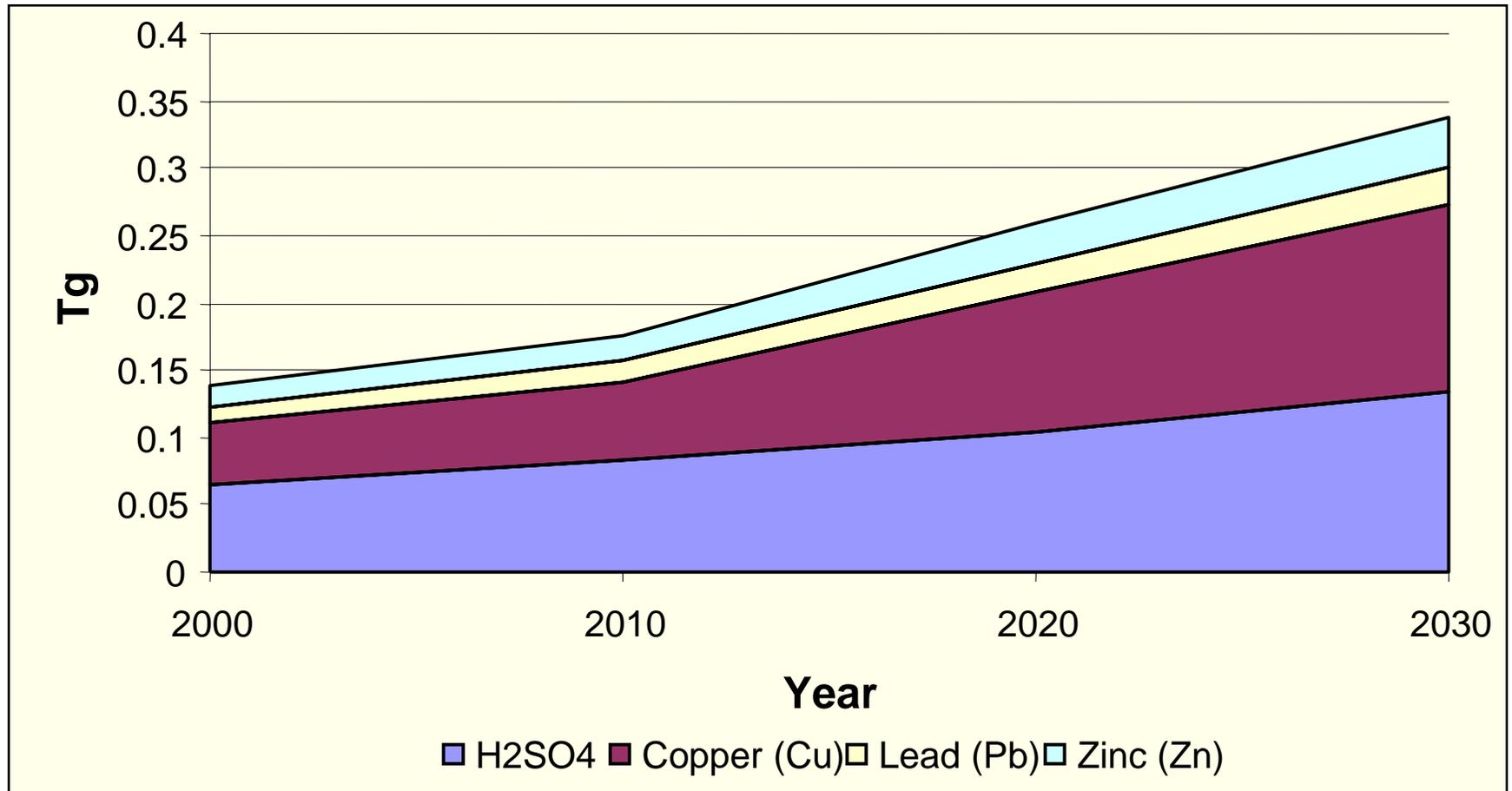
LPS contribution to CO₂

Largest LPS	Percentage CO ₂ Emissions			
	2000	2010	2020	2030
1 to 25	35.2	32.5	31	31.5
26 to 100	20.9	20.3	20.7	20.8
101 to 200	6.7	7.8	8.6	8.7
All other LPS	1.3	2.7	3	3.9
Total LPS Share	64.1	63.3	63.3	64.9

SO₂ from Energy Sector LPS



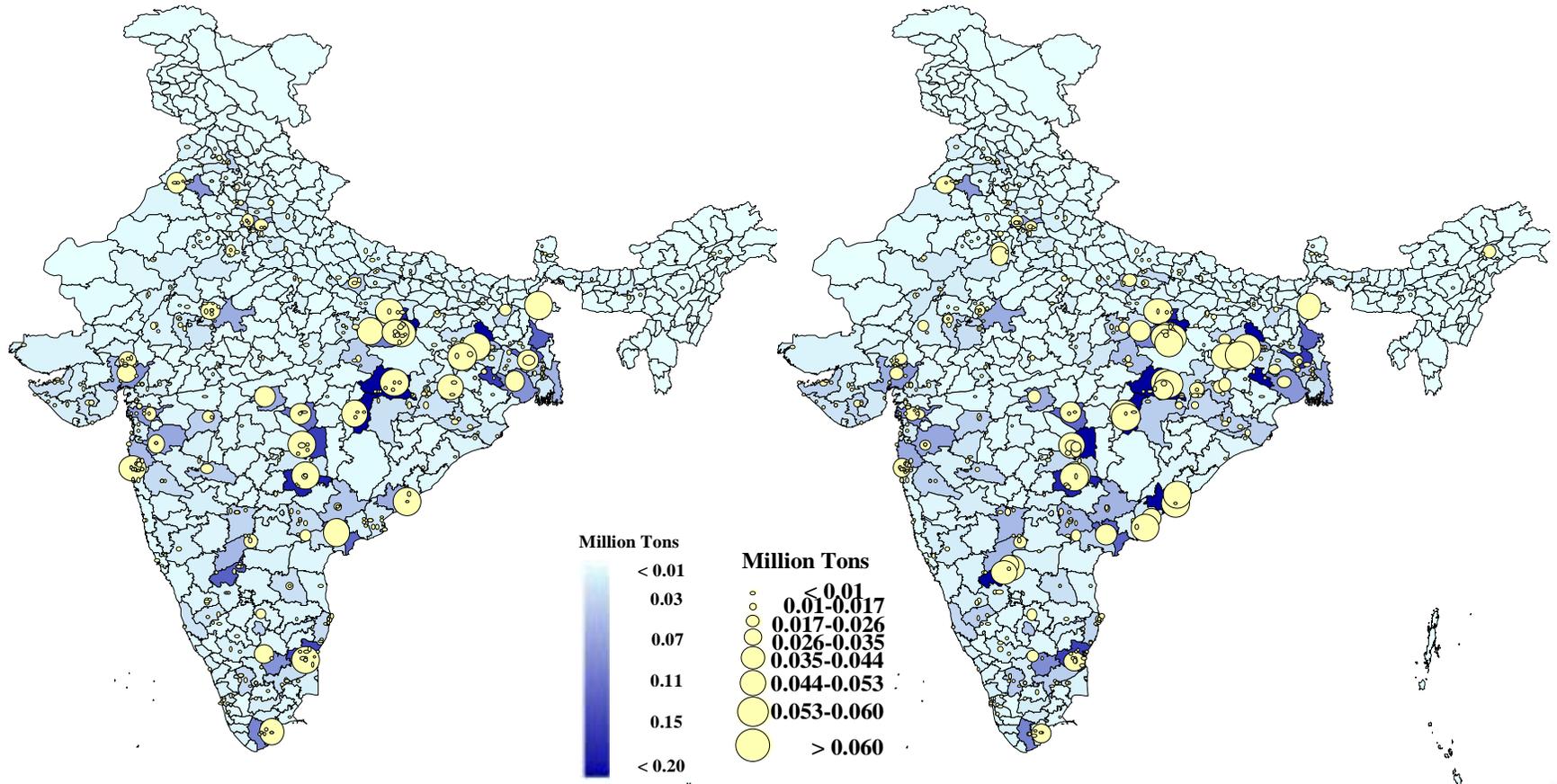
SO₂ from Industrial Processes LPS



SO₂ Emission Distribution

2000

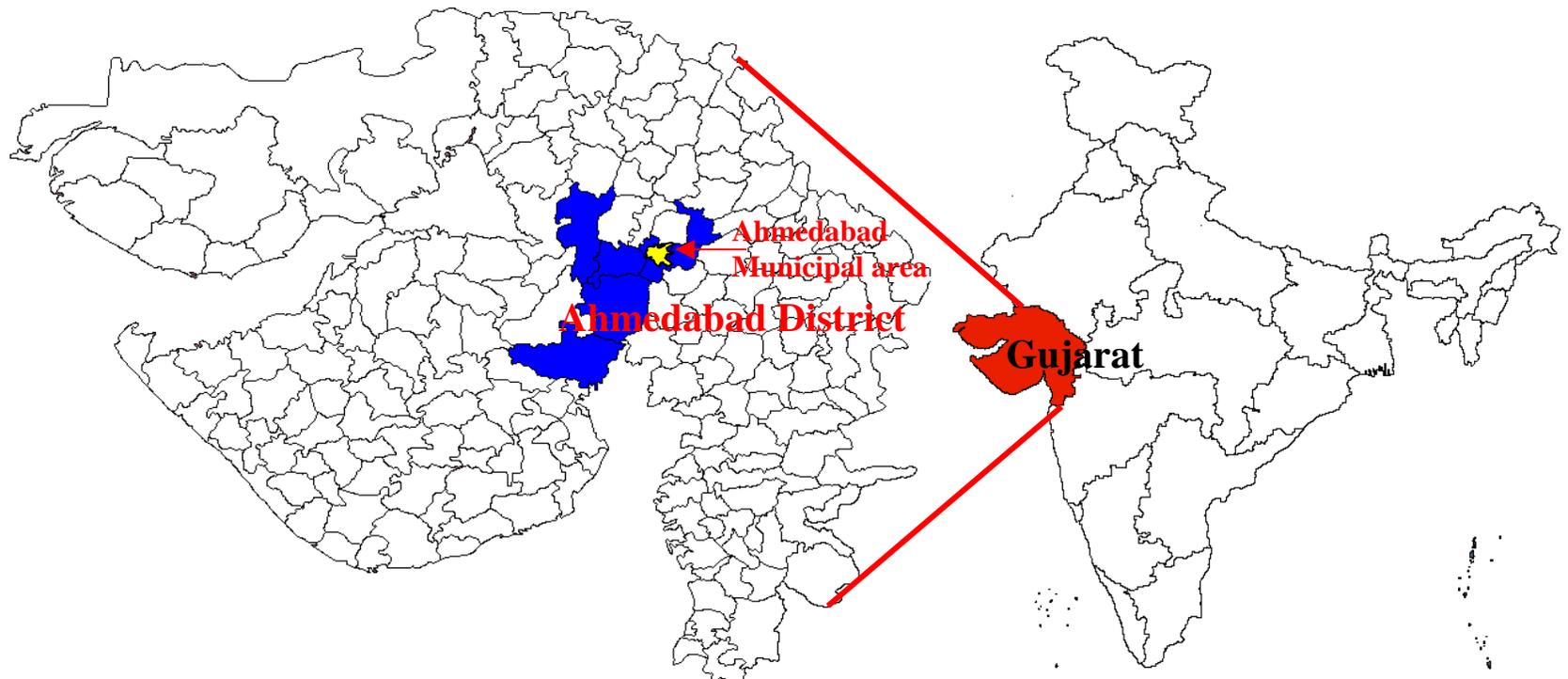
2030





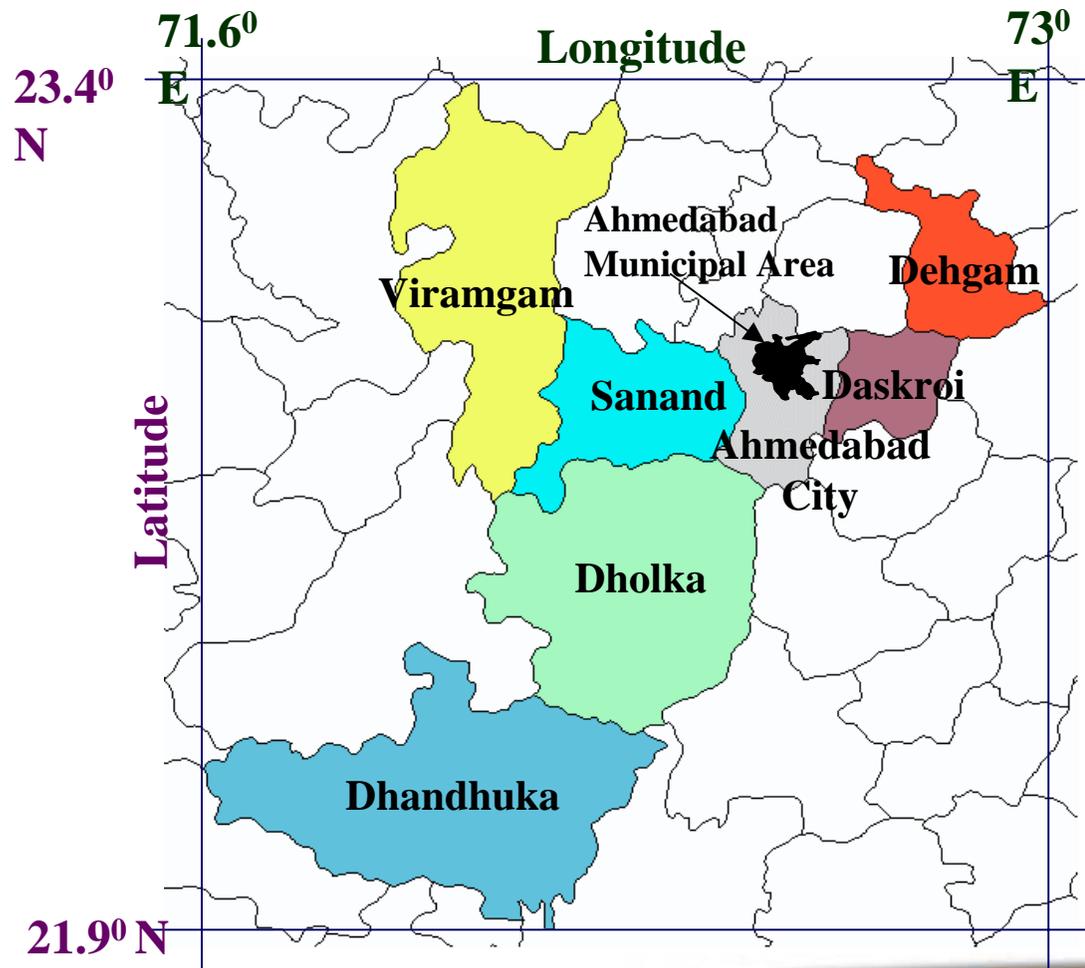
Sub-regional AIM/Local Application (Ahmedabad District)

Gujarat State & Ahmedabad District



	Villages	Taluka	Area	Population
			Sq. Km.	Thousands
Gujarat	18509	184	196024 (3)	41310 (34)
Ahmedabad Dist.	648	7	8707 (6)	4802 (75)

Ahmedabad District



Ahmedabad District Profile

Taluka	Area Sq. Kms.	Population Thousands	Households Thousands
Ahmedabad City	292 (83)	3250 (99)	629 (99)
Daskroi	664 (5)	338 (28)	68 (29)
Dholka	1788 (2)	307 (26)	57 (25)
Dhandhuka	2683 (4)	252 (21)	42 (22)
Sanand	791 (5)	162 (16)	30 (16)
Viramgam	1714 (4)	278 (22)	54 (22)
Dehgam	620 (4)	214 (15)	41 (15)

Note: Figures in brackets show % Urban share

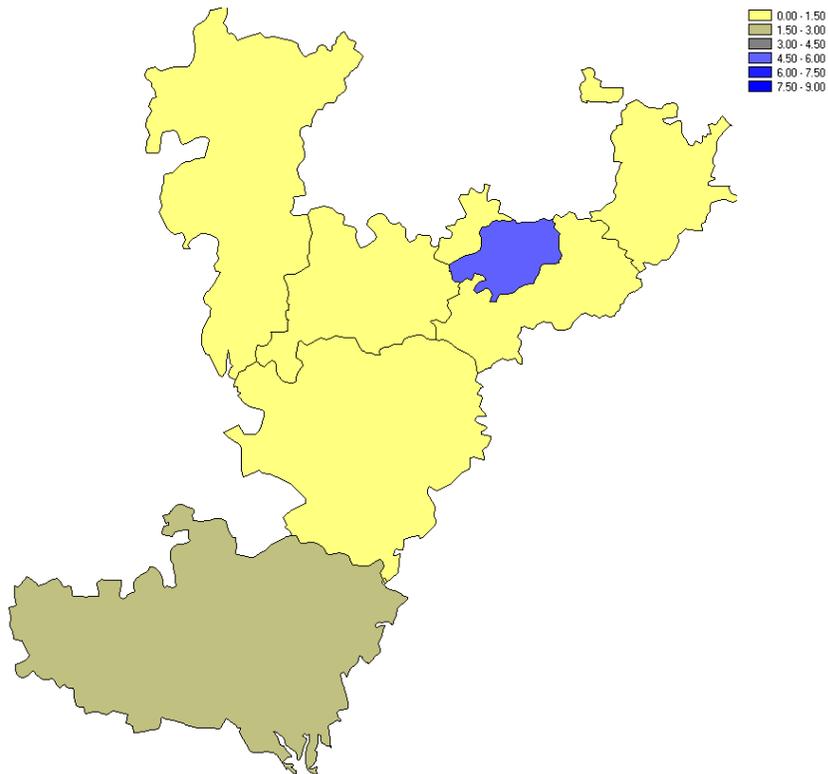


LPS Coverage for Ahmedabad

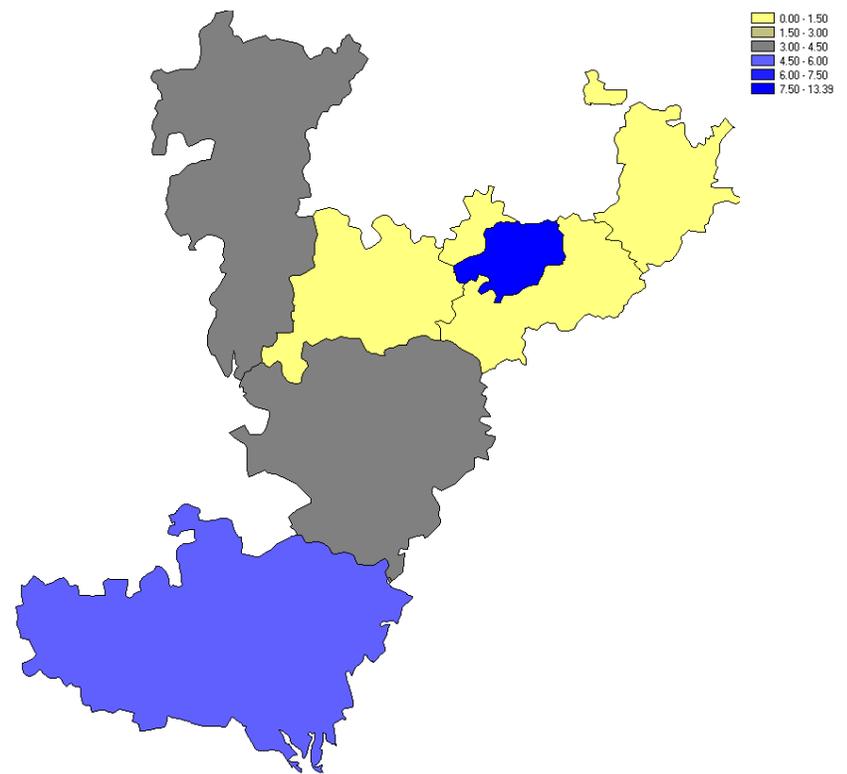
Industry	LPS Covered	Major Emissions
Chemicals Manufacturing	66	CO ₂ , SO ₂ , NO _x
Dyes Manufacturing	25	CO ₂ , SO ₂
Others Industries	9	CO ₂ , SO ₂
Pharmaceuticals	2	CO ₂ , SO ₂ , NO _x
Steel Foundries and Fabrication	94	CO ₂ , SO ₂
Textile Mills	4	CO ₂ , SO ₂ , NO _x
Textile Processing and Dyeing	17	CO ₂ , SO ₂

CO₂ Emissions

2000



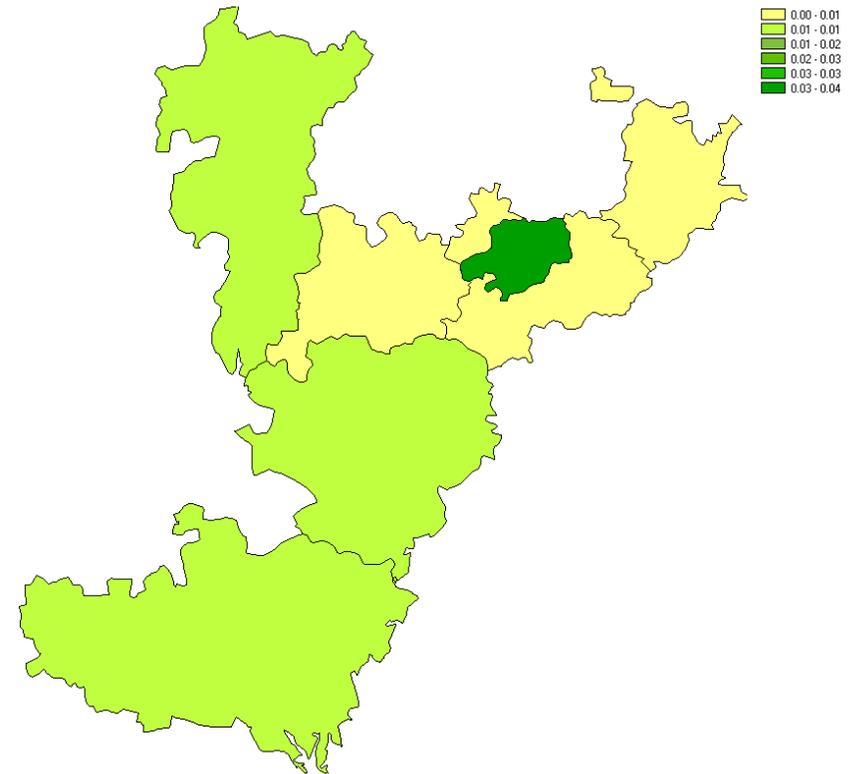
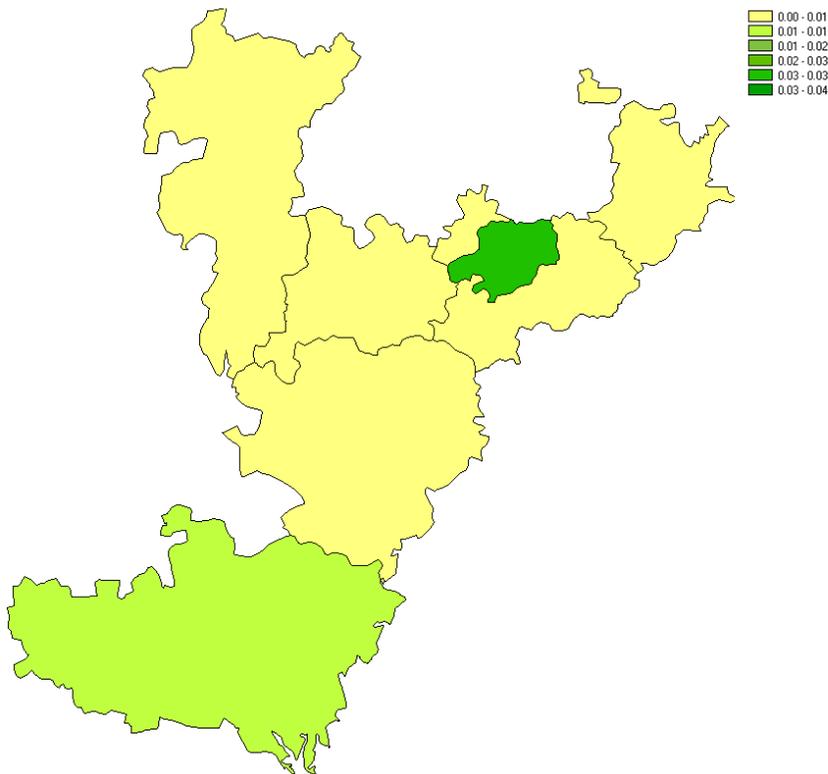
2030



SO₂ Emissions

2000

2030





Conclusions

- **The future trends indicate that**
 - **Point sources continue to dominate, thus providing focused mitigation possibilities**
 - **Coal remains main stay of energy system**
 - **Power sector largest contributor with highest growth**
- **Disjoint between future GHG and local emissions although the origin of the two is same in coal consumption**
 - **Options for mitigation of local and global pollutants have different cost structures.**
 - **The policies and their effects thus are de-linked.**
- **AIM/Local a suitable tool for District/City level emission analysis**