Emissions Inventory

Past Experiences & Future Prospects

Dr. Ajay Ojha

Air Quality Management Cell of PMC

Pune

Why Pune???

Pune as a Pollution Indicator

➢ **13th *Most Polluted* city in India (16th Sept, TOI)**

➢ **Pune considered *Demonstration City* for Urban Air Quality Management / Eco Housing / City Development Scheme / many other…(USEPA, MOEF & GOI, 2002)**

➢ **We add approx. 1 km of vehicles everyday in Pune**

➢ **Specific Geographical location – *Heat Island*, Mixed land use, typical developing urban city**

➢ ***3.5 vehicles* per family – *Two-Wheeler capital* of the world**

➢ ***10000 tons* of PM10 being released every year**
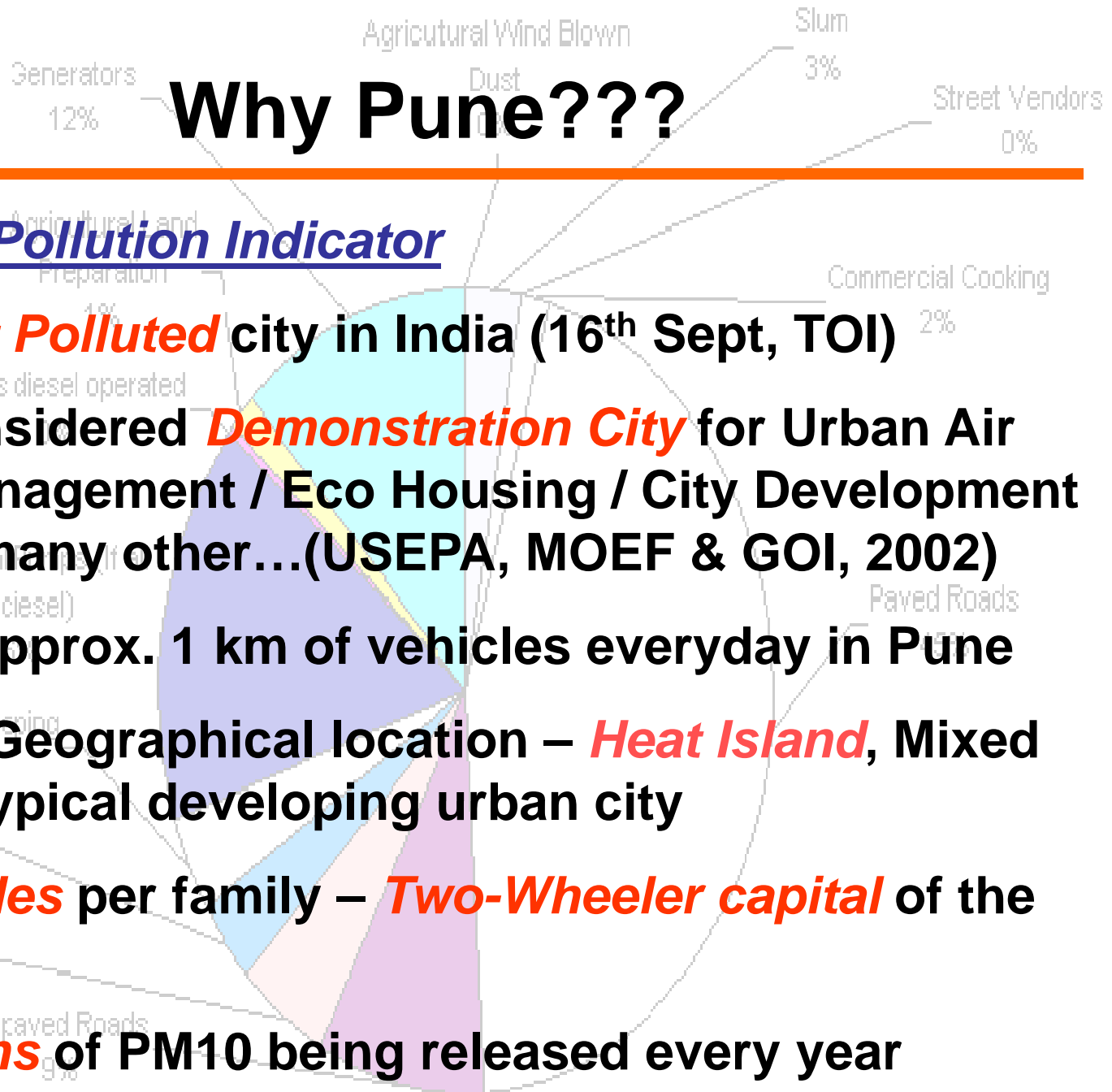
Why Pune???

Pune as a Potential Leader

➢ **Pune Municipal Corporation winning the Better Air Quality 2004 Award for *PROACTIVE* involvement for Urban Air Quality Management & again in 2006**

➢ ***Enormous efforts* in AQM by academic institutions, R&D Centers & individuals**

➢ ***Multi-stakeholder* participation at each stage of projects**

➢ ***Awakened media* - Self supported interface through various media options**

➢ ***International Agency* support – USEPA, WBI, ADB, USAID,EU and others…**

The Driving Force

- Awaked People – Public Interest Litigation filed in the Hon'ble Supreme Court
- Proactive approach of the civic agencies and responsible authorities
- Extensive stakeholder support
- Availability of in house expertise
- Giant market players
- Extensive Political Will
- Massive public and media support

The Policy Process Needs…

- Monitored data over a period of time for establishing the baseline condition
- Scientific evaluation of the present status of prevailing air quality (justification)
- Availability & Know-how for selection of control options
- Detailed technical and Financial viability of options
- Tools for Decision support system
- E.g. Health may form one of the key indicators for policy decision in air quality improvement
- Economic benefits / losses - SHAKING factor for policy makers

### CAN WE HAVE A SCIENCE BASED POLICY FOR PUNE???

Elements of EPA Urban Air Quality Management Training and Demonstration Project in India
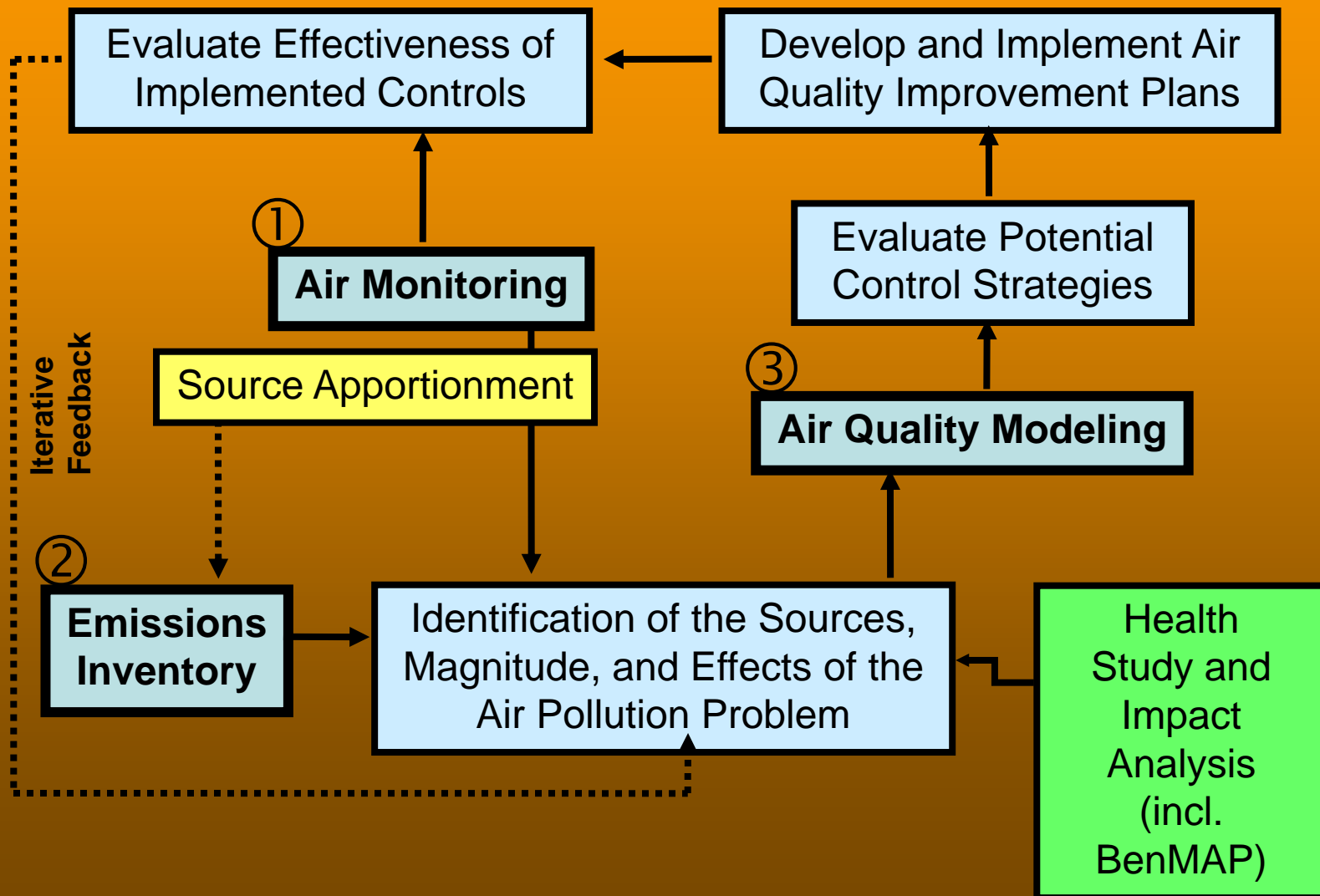
Emissions Inventory as a tool…

- EI – a scientific approach
- EI – most data is available from secondary sources
- EI – Inputs to models so needs to be comprehensive & sensitive
- EI - Assumptions are logical & scientific as done with other air quality tools
- EI – May be used as INDICATOR of air quality determining need for actions
- EI- First hand tool for decision making?

Emission Estimation Techniques
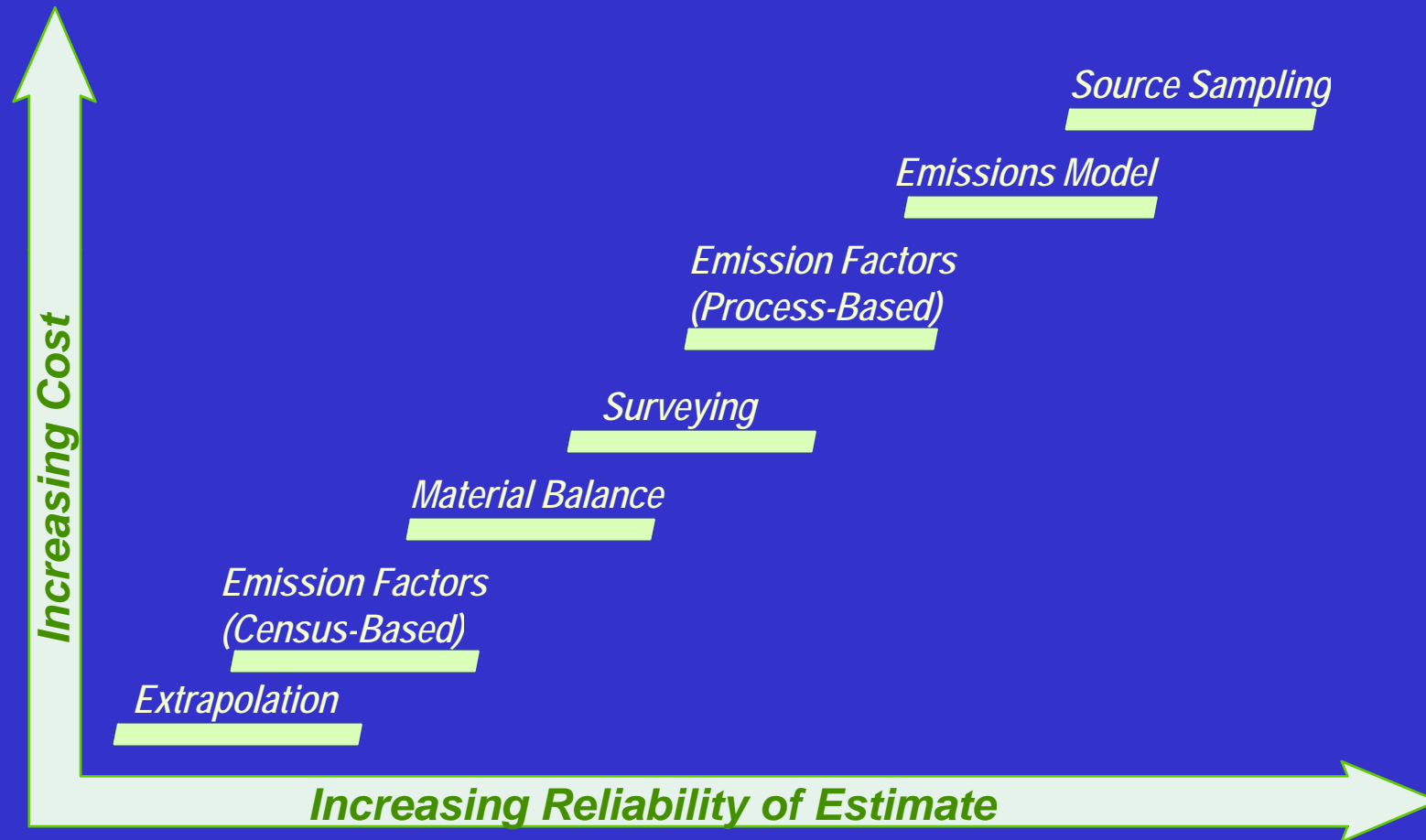
Emission Estimation Methods

Emissions Group

- Guidance on Emissions Estimation techniques

- Point, Area and Mobile Sources

- Identification of data needs and respective agencies

- Identification of Emissions estimation methodologies along with data gathering

- Peer Review Process for assumptions

- All methods and assumptions documented

- Emission estimates were performed using widely accepted

- Emission estimation methods were tailored to the conditions within Pune

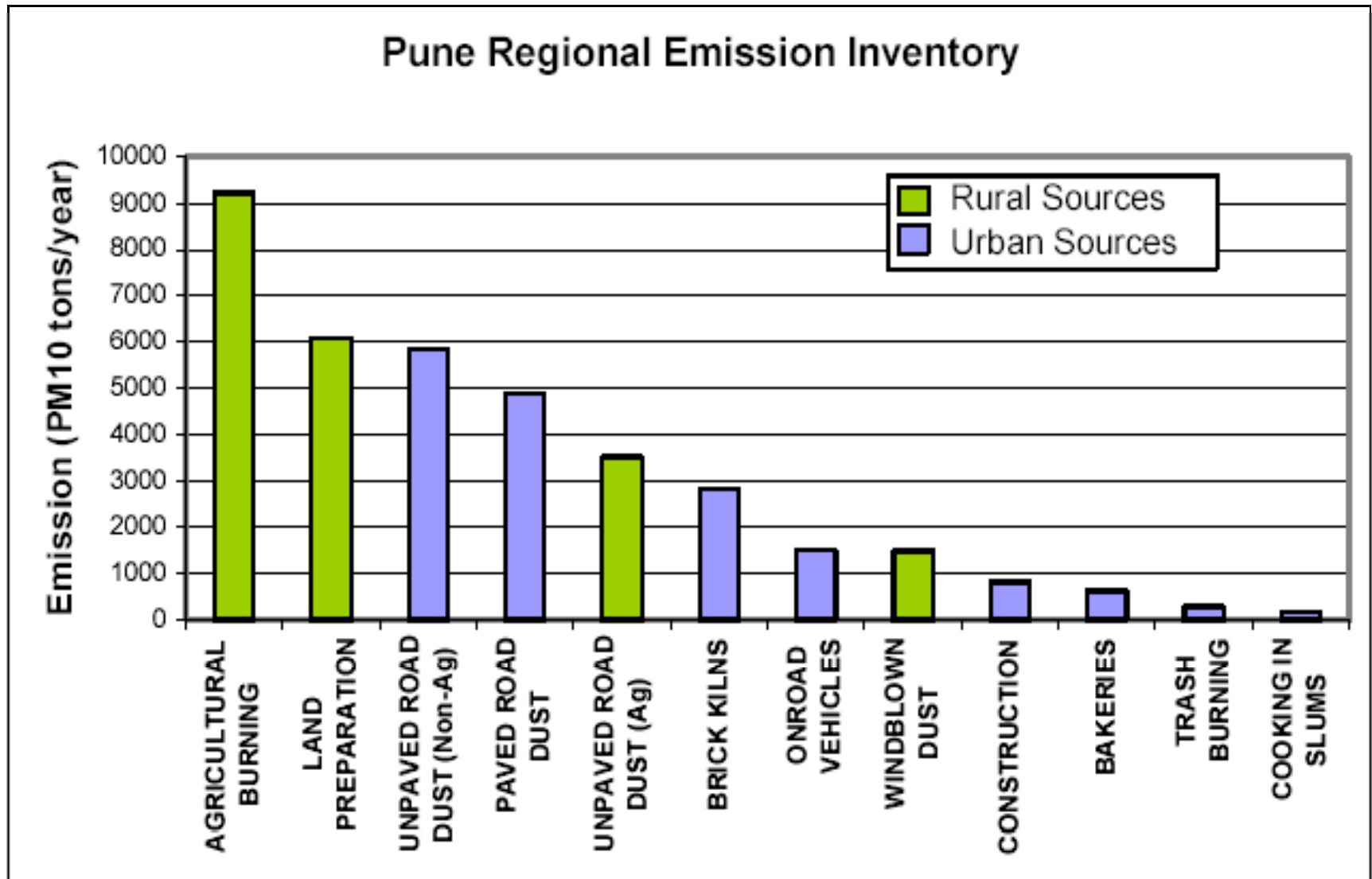- Project website: *www.unipune.ernet.in/dept/env*

Database Group

- <u>Database Design</u>: Relational database System in MS Access using VB for Query & Report Screen

- <u>Database Coding</u>: PEIC to categorize source by geographic region and source category

  <u>10 digit PEIC – describes Source type, Process & Material or Fuel</u>

- <u>GIS and GPS</u>: Feasibility Assessed - Locations of stationary sources and landmarks done

- <u>Project Web design and Development</u>: Provide access to PREIS, facilitate further development, information dissemination to general public
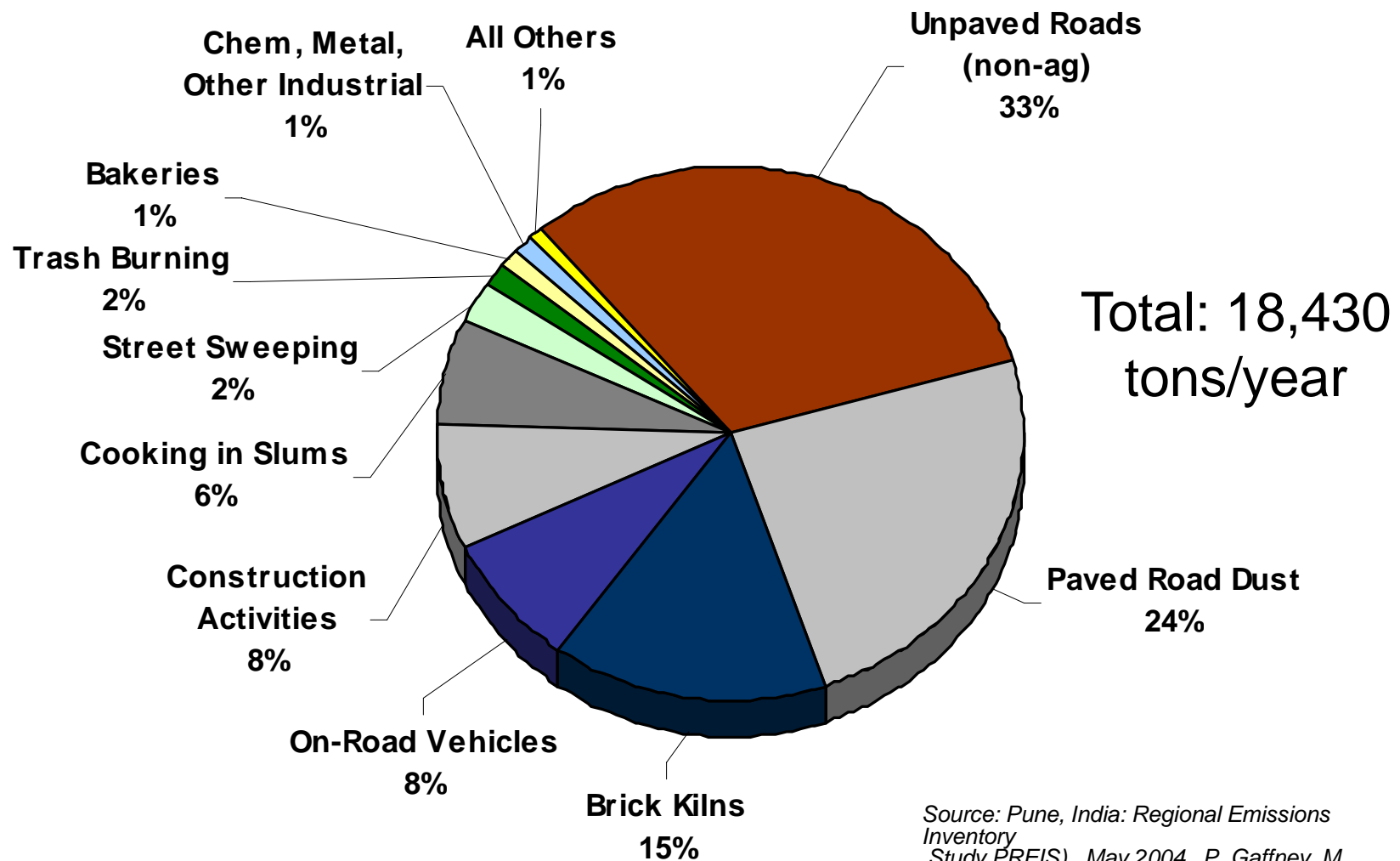
Interim 2003 PM$_{10}$ Emissions
for Pune Regional Emission Inventory Study

SOURCE CATEGORY	PM10 (tons/year)	% Total	Cumulative % Total
AGRICULTURAL BURNING	9223	24.7	24.7
LAND PREPARATION	6065	16.2	40.9
UNPAVED ROAD DUST (Non-Ag)	5834	15.6	56.5
PAVED ROAD DUST	4877	13.0	69.5
UNPAVED ROAD DUST (Ag)	3505	9.4	78.9
BRICK KILNS	2814	7.5	86.4
ONROAD VEHICLES	1502	4.0	90.4
WINDBLOWN DUST	1487	4.0	94.4
CONSTRUCTION	821	2.2	96.6
BAKERIES	627	1.7	98.3
TRASH BURNING	277	0.7	99.0
COOKING IN SLUMS	171	0.5	99.4
INDUSTRIAL FUEL COMBUSTION	55	0.1	99.6
INFRASTRUCTURE- ROADS	47	0.1	99.7
WILDFIRES	41	0.1	99.8
FARM EQUIPMENT - TRACTORS	32	0.1	99.9
TRAINS	9	<0.1	99.9
BURNING - CREMATORIUMS	4	<0.1	100.0
NONINDUSTRIAL FUEL COMBUSTION	3	<0.1	100.0
FUEL COMBUSTION - STREET VENDORS	2	<0.1	100.0
FUEL COMBUSTION - HOTELS & RESTAURANTS	1	<0.1	100.0
ALL SOURCES Total PM$_{10}$ (tons/year)	37,410	100.0	100.0

Preliminary Findings

Pune Regional Emission Inventory

Emission (PM10 tons/year)

Legend:
- Rural Sources
- Urban Sources

Categories: AGRICULTURAL BURNING, LAND PREPARATION, UNPAVED ROAD DUST (Non-Ag), PAVED ROAD DUST, UNPAVED ROAD DUST (Ag), BRICK KILNS, ONROAD VEHICLES, WINDBLOWN DUST, CONSTRUCTION, BAKERIES, TRASH BURNING, COOKING IN SLUMS

Urban PM$_{10}$ Sources Pune 2004

Chem, Metal, Other Industrial 1%

All Others 1%

Unpaved Roads (non-ag) 33%

Bakeries 1%

Trash Burning 2%

Street Sweeping 2%

Cooking in Slums 6%

Construction Activities 8%

On-Road Vehicles 8%

Brick Kilns 15%

Paved Road Dust 24%

Total: 18,430 tons/year

Source: Pune, India: Regional Emissions Inventory
Study PREIS). May 2004. P. Gaffney, M. Benjamin

Food For Thought

- Substantial emissions from agricultural burning and geologic dust

- Sources such as paved and unpaved roads within the Pune region to be considerable

- Significant emissions from motor vehicles, brick kilns, and construction

- Some estimates for City and some for District

- Emissions split into Rural and Urban sources

- This needs to be considered when evaluating the emissions and their impacts

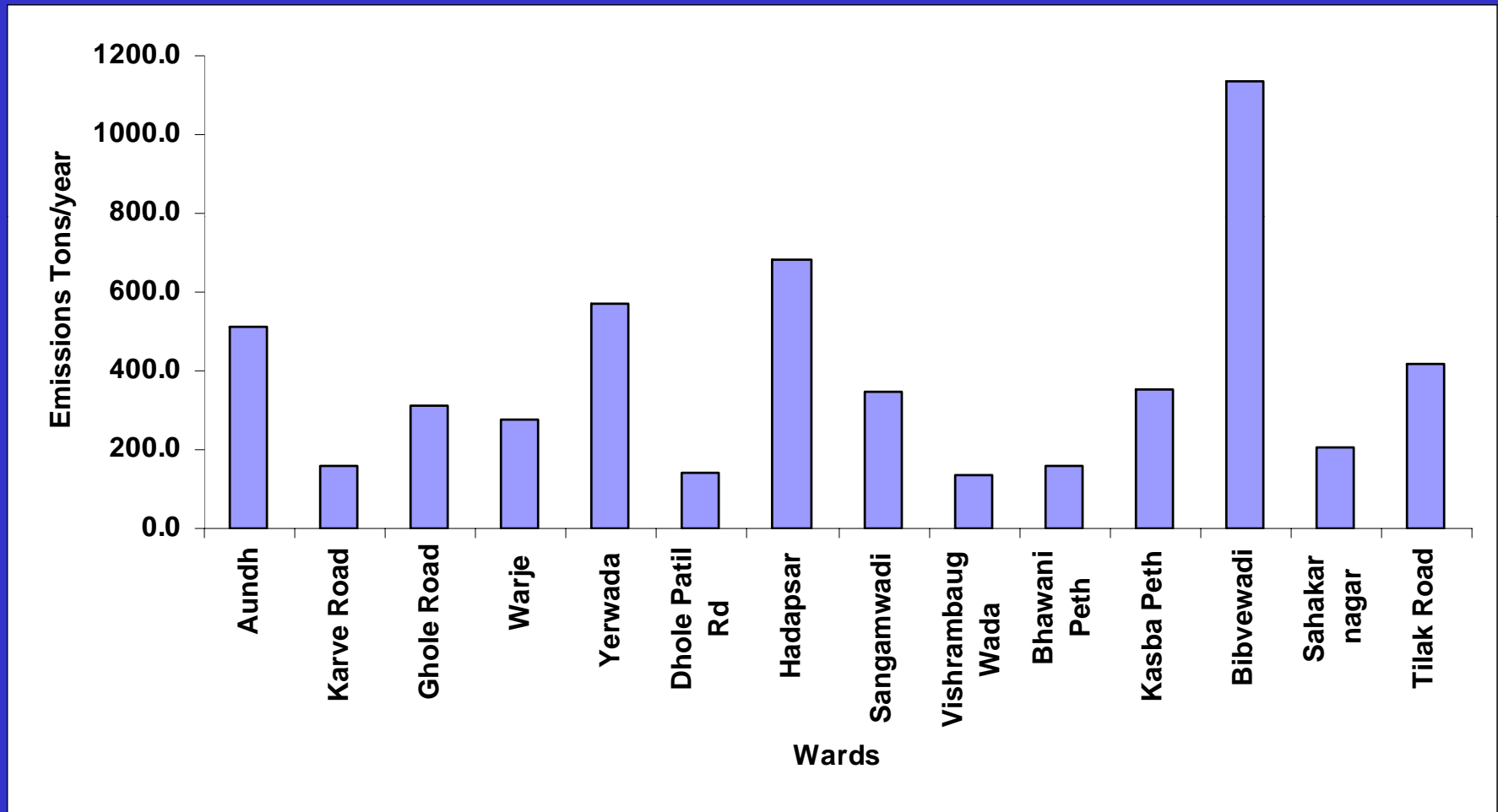- *Further refinement and enhancement needed*

Future Actions Required…

- Emission Factors to be locally available and/or modified
- _Continual improvement and updating_ EI is the need of hour
- QA/QC for data availability, sources & estimates
- Emissions to be supported using other methods such as CMB, Modeling, SA and others
- GIS based interpretation for spatial allocation
- Forecasting functionality to support source specific control strategy development
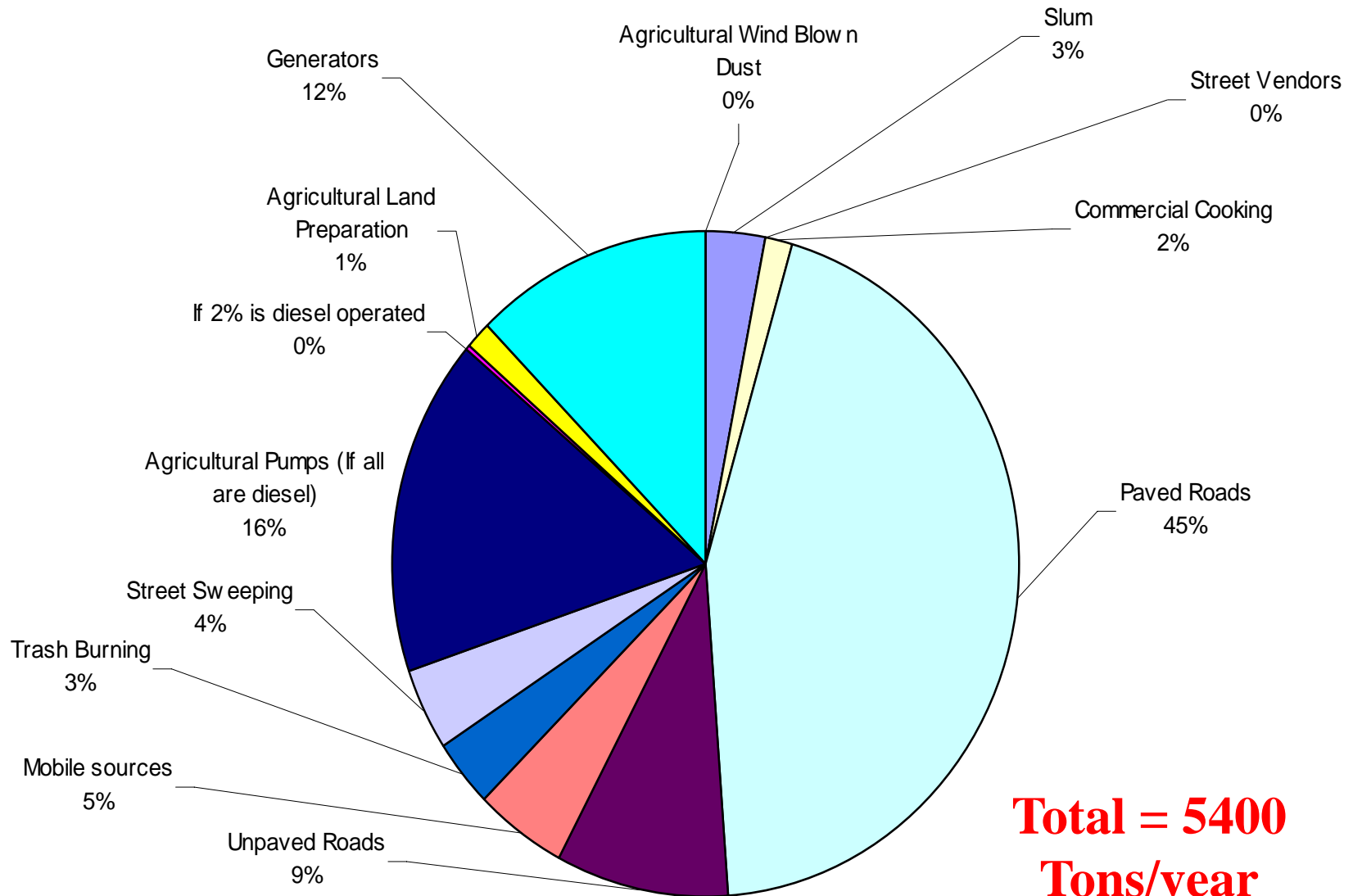
Taking a Step Further… April '05

- City specific database being generated
- 30 x 30 km domain specified
- 21 different sources selected
- Protocols for data collection formulated
- Students and PMC private team continuously working
- Data gap analysis being constantly done
- Data acquisition QA/QC being implemented through collection of authenticated data

Ward-Wise data collected for sectoral impact identification and management options

Ward wise Emissions of PM10 in Pune

Relative percentage of PM10 in Pune

Generators 12%
Agricultural Land Preparation 1%
If 2% is diesel operated 0%
Agricultural Pumps (If all are diesel) 16%
Street Sweeping 4%
Trash Burning 3%
Mobile sources 5%
Unpaved Roads 9%
Agricultural Wind Blown Dust 0%
Slum 3%
Street Vendors 0%
Commercial Cooking 2%
Paved Roads 45%

Total = 5400 Tons/year

Gridded Emissions Inventory

- 1.6km^2 grids – effective data collection / use in models

- In all 189 imaginary grids spread over 240 sq.kms

- Allocation of sources based on actual addresses collected

from various departments and government offices

Industries, hotels and restaurants and bakeries – by their actual addresses

Industrial generators equally distributed

Non industrial generators distributed according to commercial area

Street vendors mostly in the central portion of the city

STILL USING SECONDARY AVAILABLE DATABASE

- Slums marked exactly as per maps of Pune
- Agricultural land in the fringe areas
- Agricultural pumps in the agricultural areas only
- Street sweeping is based on the road length on each grid

Mobile Sources

- Comprehensive Traffic and Transport Study' in 2003-04
- 32 junctions and other corridors
- No at junctions equals no of vehicles in that grid
- Adjacent grids in all direction has same nos. of vehicles
- Others have approximately related nos.

Resuspended Dust – Important to be Reconsidered

- Growing concern for resuspended dust in all the inventory studies
- Related to the vehicular movement
- Other than actual unpaved roads, 10% of the paved road I.e. SHOULDERS are considered unpaved
- Distribution of major roads is actual through GIS map of Pune
- Minor roads is equally distributed in all grids

Activity Data

Point sources

- Industrial data taken from MPCB industrial Emissions Inventory

- Major hotels and restaurants have been surveyed for fuel consumption

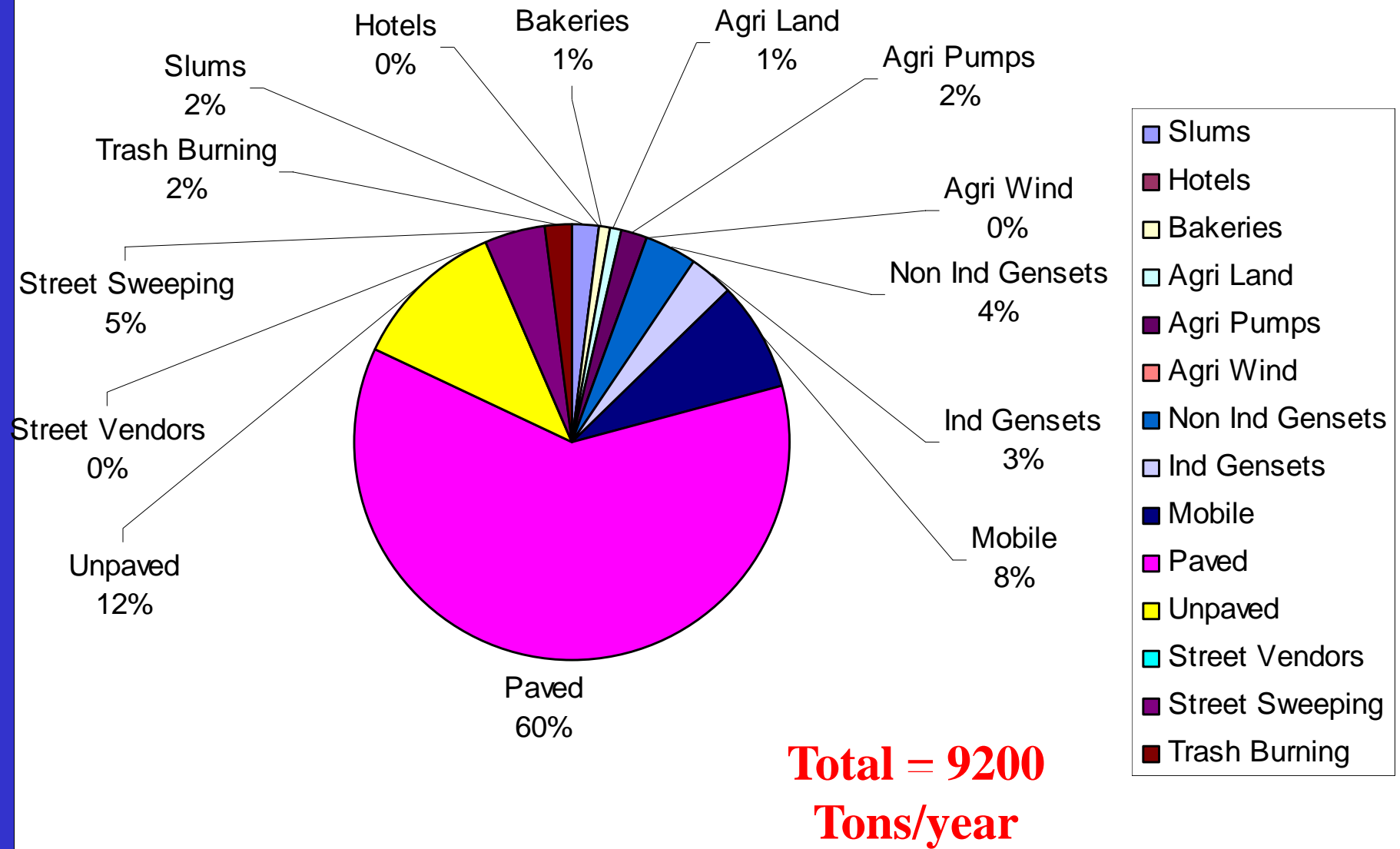- For Bakeries actual survey was carried out in 2004 which has been used here

Area Sources

- Slums – per capita fuel consumption from National Sample Survey, fuel usage is approx. (references from PMC)

- Acreage pass 8.32 from Agricultural University – Agricultural Land Preparation

- Power rating for Agri. Pumps, Generators from Inspector of Generators.

- 80% of pumps are in 3 – 5 HP, 4 hours of operation and

- Street Sweeping – distribution of job to employees

- Trash burning – 5% of uncollected waste in grids whereas 5% of collected trash at dumping yard

Mobile Sources

- Distribution on Major and minor roads
- VKT is no. of vehicle multiplied by road length in each grid
- 20% of the vehicles ride on the minor roads
- 80% of Passenger cars are gasoline
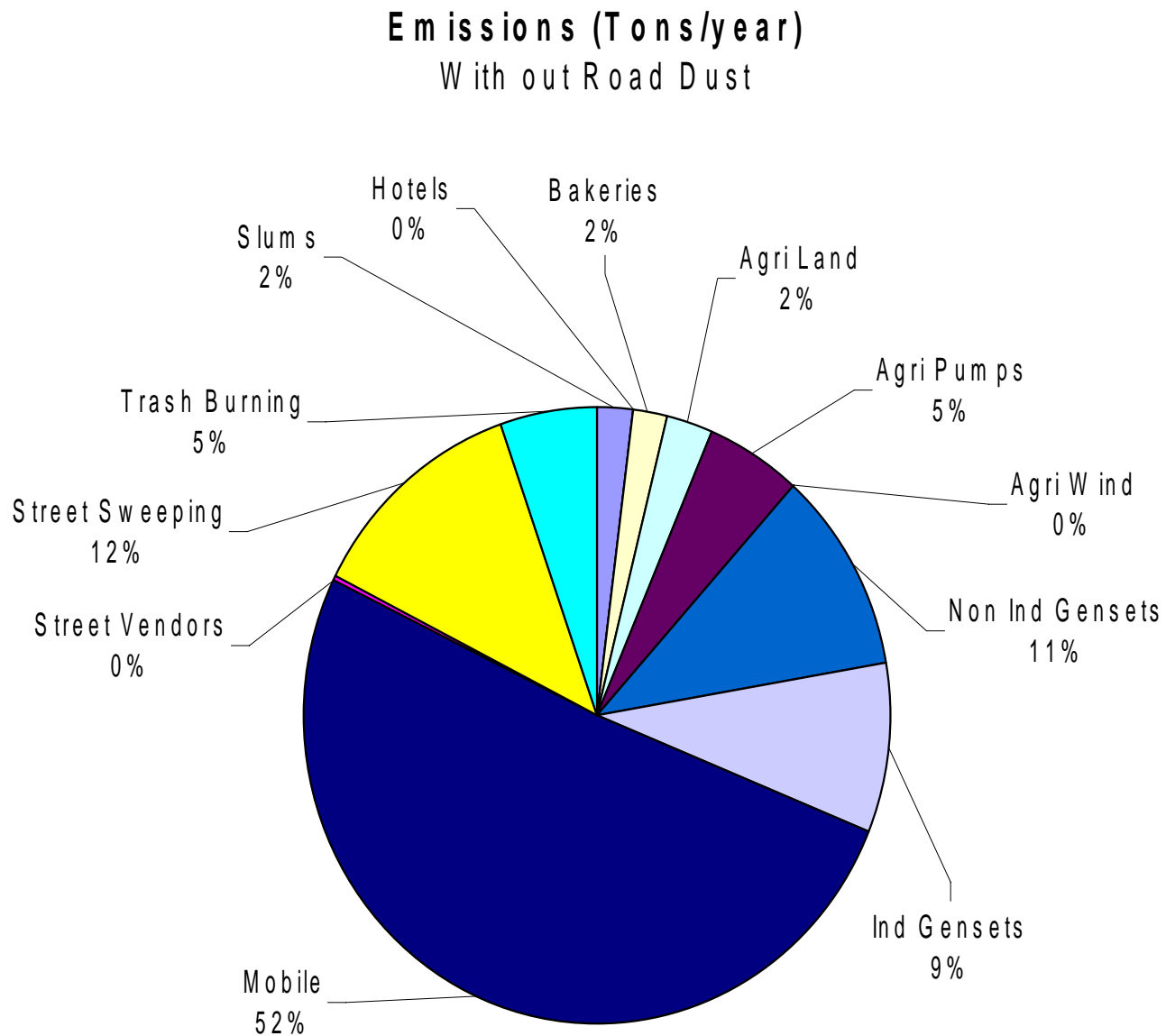- Resuspended dust – VKT, Average weight as weighted mean, Rainy days accounted for.
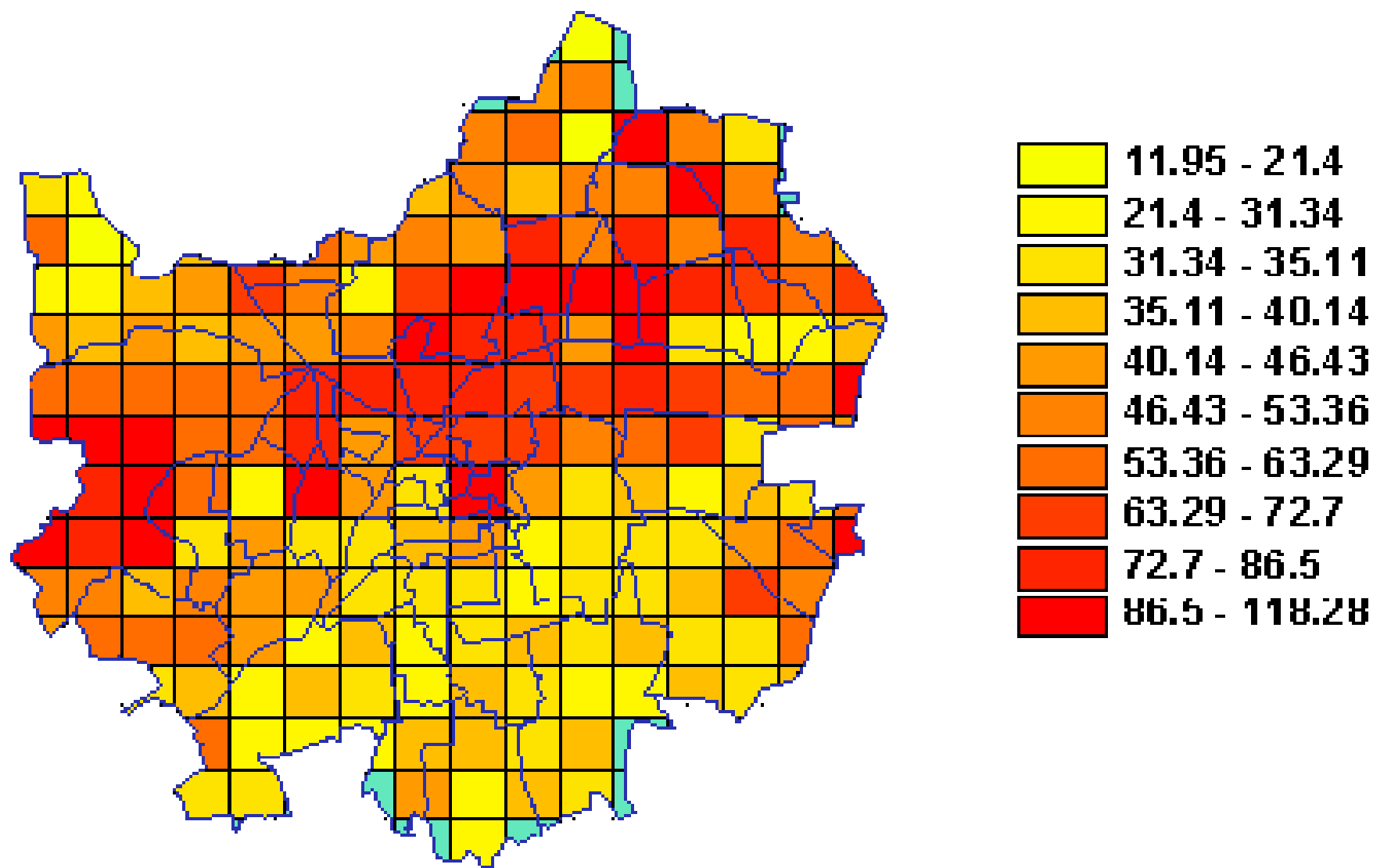
Pune Regional Emissions Inventory (Nov 2005)

Hotels 0%
Bakeries 1%
Agri Land 1%
Agri Pumps 2%
Slums 2%
Trash Burning 2%
Agri Wind 0%
Street Sweeping 5%
Non Ind Gensets 4%
Street Vendors 0%
Ind Gensets 3%
Unpaved 12%
Mobile 8%
Paved 60%

Legend:
- Slums
- Hotels
- Bakeries
- Agri Land
- Agri Pumps
- Agri Wind
- Non Ind Gensets
- Ind Gensets
- Mobile
- Paved
- Unpaved
- Street Vendors
- Street Sweeping
- Trash Burning

Total = 9200 Tons/year

We still had a long way to go…

- Construction activity needs to be included
- Brick Kilns needs to be considered
- More rigorous & continual Survey for vehicle no.
- Emission Factor detailing essential
- Activity data can be made more precise
- Geographical area of influence can also be considered
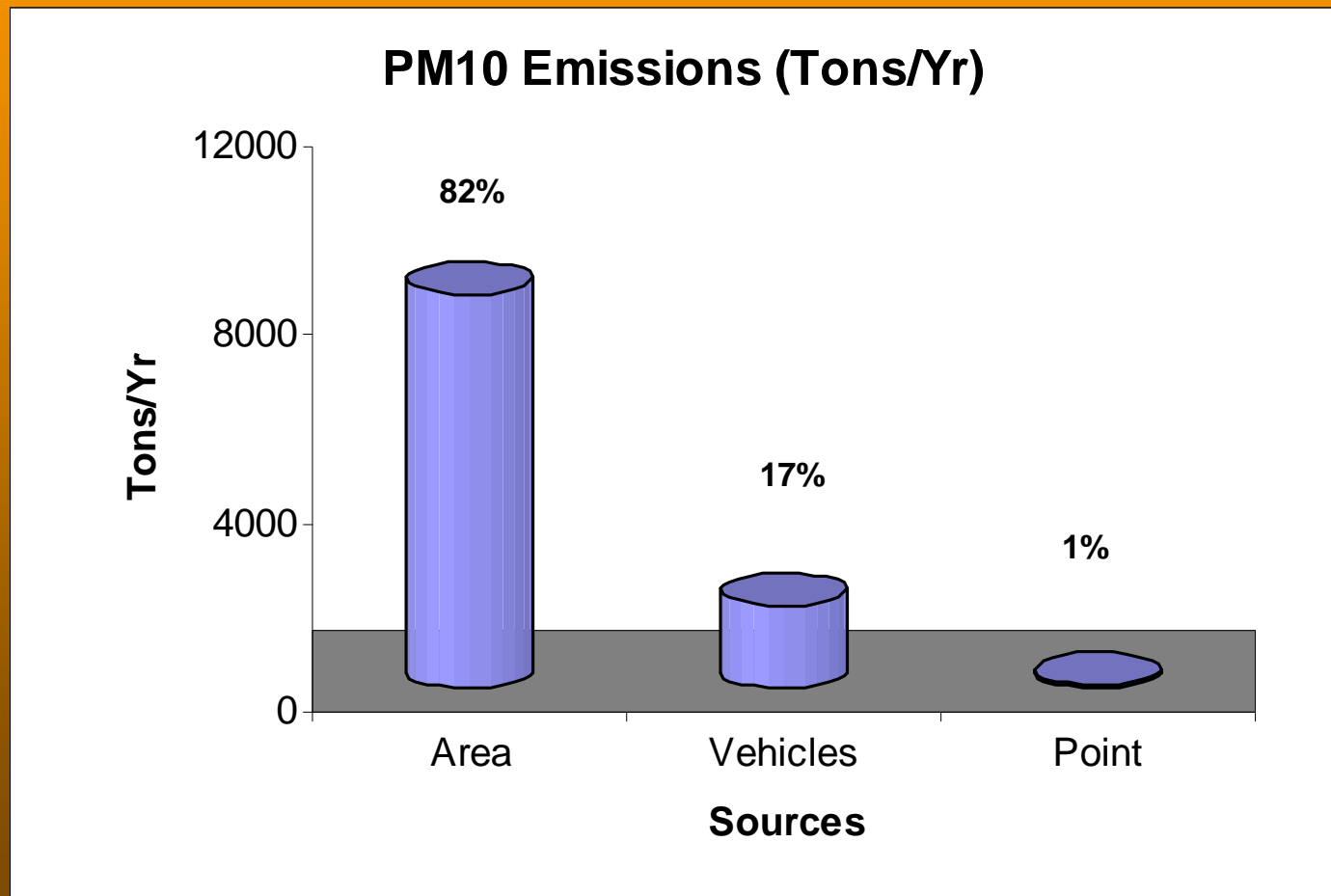- Supporting with SA, MODELS, IVEM & others

# Pune Regional Emissions Inventory (Jun 2007)

Emissions (Tons/year)
With out Road Dust

Hotels
0%

Bakeries
2%

Slums
2%

Agri Land
2%

Agri Pumps
5%

Trash Burning
5%

Agri Wind
0%

Street Sweeping
12%

Non Ind Gensets
11%

Street Vendors
0%

Ind Gensets
9%

Mobile
52%

Know our City (PM10 tons/yr)

■	11.95 - 21.4
■	21.4 - 31.34
■	31.34 - 35.11
■	35.11 - 40.14
■	40.14 - 46.43
■	46.43 - 53.36
■	53.36 - 63.29
■	63.29 - 72.7
■	72.7 - 86.5
■	86.5 - 118.28

Share of Pollution Potential by Source Categories

PM10 Emissions (Tons/Yr)

Transportation Footprint

- Registered vehicles – **14,45,364**
- Carry only
- Leading to increase in private vehicle - **3.3 vehicles per family**
- Registrations per day- **600 to 800 vehicles**
- Every Km of vehicle (4W) produces 0.25 and 2W produces 0.028 tons of CO_2
- Vehicle kms traveled in Pune - **1,86,47,367** /day
- GHG emissions –

  6,57,445 tons/year
- GHG addition per day -

  5000 tons
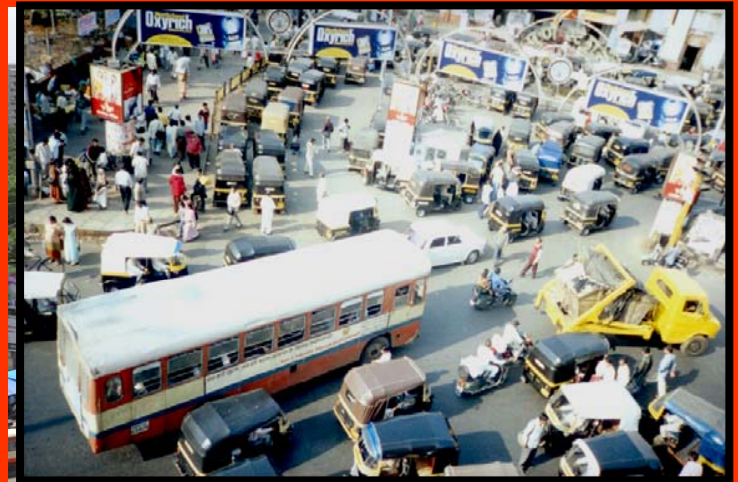
Pune's Initiatives - Transport

- 200 Kms BRT & Plans for Metro
- Pay & Park Policy, free parking
- Modal Shift leading to…
  2 Lakh tons/year reduction
    Assuming that the modal shift is 30% 2 w, 30% autos and 10% cars
- 200 Kms Cycle track
- Pedestrian walkways

The Solid Waste Statistics

- **1000 tons of waste generated per day**
- **Segregation – issue at individual and disposal level**
- **GHG emissions from Solid waste – 65,80,000 tons/year**
- **CH_4 capture potential from landfill site – 1 Million tons (Only 40% managed Landfill)**
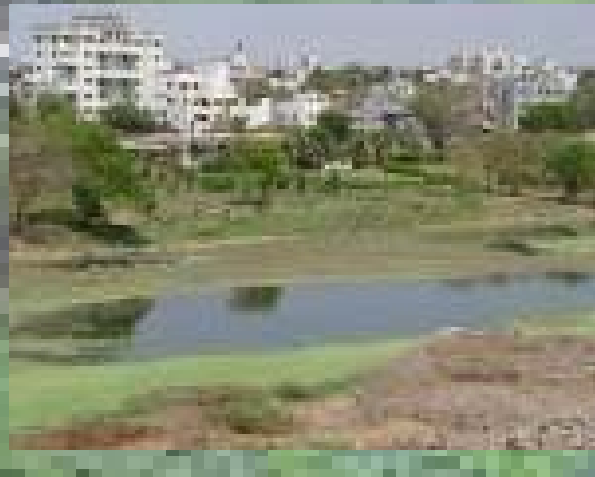
Pune's Initiatives - SWM

- **Public Private Partnership – Acres of land allotted by PMC**
- **50% Private taxation rebate for recycling waste**
- **Mailhem project - 10TPD**
- **Svachata Abhiyan**
- **Biomethanation - 10 Plants**
- **Rag picker association**

Pune at the Sewage Treatment Front

- **600 MLD wastewater generated**
- **150 MLD of wastewater untreated flowing into the river**
- **COD load of the sewage – 1,80,000 tons/day**
- **Potential GHG emissions from sewage sector – 68,98,500* tons of CH_4**

* Considering 50% recovery only

Pune's Initiatives - Sewage

- **150 MLD sewage treatment on way**
- **Expected to *reduce 17,24,625 Tons/year* GHG**
- **Including navigation projects**
- **Waste to Energy project at STP – Bhairoba**
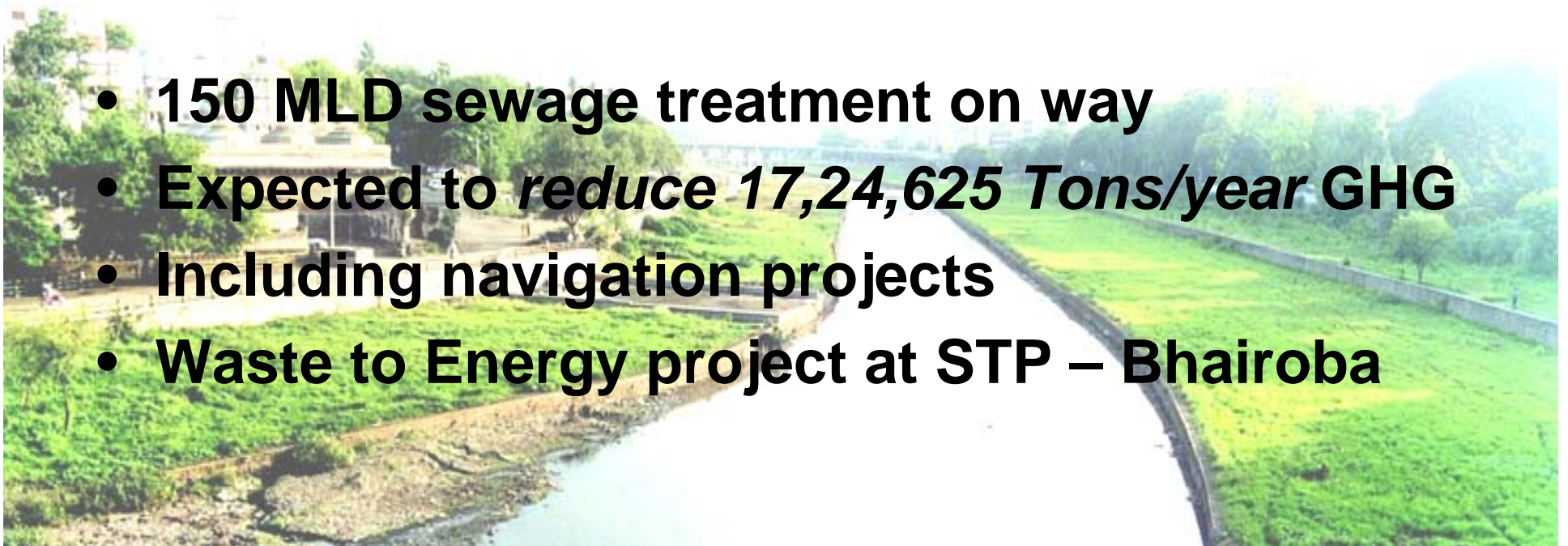
Tanajiwadi sewage treatment plant

The urbanization Footprint

- Saturation potential being reached – 2.6 crore built up area

- Reducing green area in Pune

- GHG emissions from land use changes – **5000 tons annual** loss due to loss in canopy area from air pollution

- **550 tons/year** PM10 emissions from construction activities
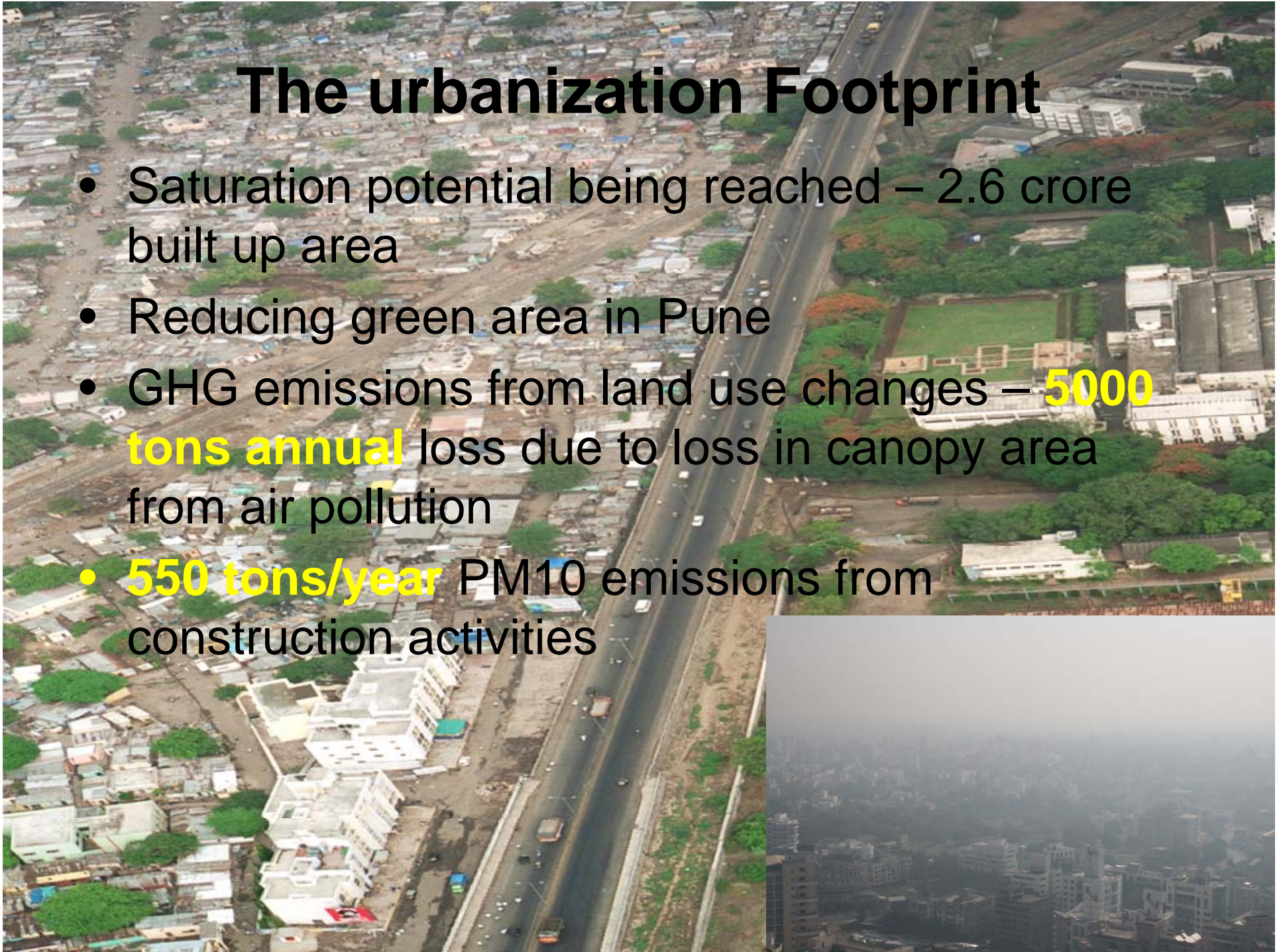
Sectors to be Accounted For…

- Agricultural activities - **11,364 tons/year**
- Electricity – **55,375 tons/year**

- **Lifestyle** – **10 tons of direct emissions**, including our home, car and air travel, but a whopping **24 tons of CO_2 per capita** when includes impacts from purchasing clothes, food, using roads and all the other emissions throughout the economy annually

A step Ahead - The Carbon Emissions...

Impacts

- Public Transport

- SWM – Waste unsegregated & limited processing

- Sewage – 150 MLD untreated

- Individual Lifestyle changes

Mitigation

- Additional Buses on hire already 450 added, BRT & Metro – 200,000 tons/year GHG reduction

- Segregation compulsory, tax rebate, rag pickers notified, house to house collection, Biomethanation – 1 Million ton reduction

- Expected Treatment resulting in reduction of 1.7 million tons

- 1 Million Tons/year expected reduction through optimizing resources

Emissions Inventory Updates

- **<u>2004</u>** - The first attempt – 40 participants across India first ever inventory framework within limited time& resources
- Continuous updates for 2 years
- **<u>2005</u>** - Combined efforts for integrating inventory with modeling in Pune with USEPA & local experts with stakeholders
- **<u>2006</u>** - Multi city emissions inventory workshop – 8 cities with more than 45 participants
- **<u>2007</u>** – Emissions inventory & modeling teams bought together again & plans formulated

<u>Every workshop formulated plans but lacked follow-ups</u>

The Subsequent Plan…

- Develop database formats for structured inputs to emissions model including library of emission factors and best applicable ones

- Develop framework for Emission Inventory in India accounting for diversity in activity profiles

- Initiate Capacity Building in each state for pollution control boards as well as local educational institutions, NGOs etc… working in this area

- Establish regular data building system, Data building and dissemination of the information on yearly basis

- Policy analysis and Action Plan implementation through guide user interface accommodating scenario analysis

- Development of Emissions Index based on sector and/or source specific scenarios for air quality modeling & management strategies

What do we Intend to do then…???

- Agencies having database to tie up together – MC's, TO, SPCB's & others
- May be online transmission
- State Pollution Control Boards for point sources
- Area sources from local bodies integrating ESR
- Centralized information – methodologies & tools
- Feedback mechanism – Query based information system
- GIS based platform for data representation
- Incentive based data management, QA/QC, Wiki kind of information system

National Emissions Inventory

- To be used as background for methodology and scope
- Lot of data is already available
- Will help establish best available formats & EF's rationalizing their use
- An attempt being made by AQM Cell of PMC
- Data gathered at state & city level
- Extrapolation possible with the past experience & available estimates of Class I & II cities
- Transport, thermal power plants, agricultural areas, & many others available through SoER & websites

Inventory Special…

- First degree of analysis of air quality
- The base / first step in air quality management
- When integrated with modeling & SA may form effective decision making tool
- Most cities have data available & can be used effectively for EI
- Gridded Emissions model can help represent the city status effectively though not perfect!!!
- In smaller cities EI may be used as stand alone system for AQM
- EI based action plans can also help guide city for air quality management initiatives

Thank You