Compendium of Good Practices on Control and Prevention of Transboundary Air Pollution

Ram M. Shrestha
Professor
School of Environment, Resources and Developement
Asian Institute of Technology
Thailand
E-mail: ram@ait.ac.th

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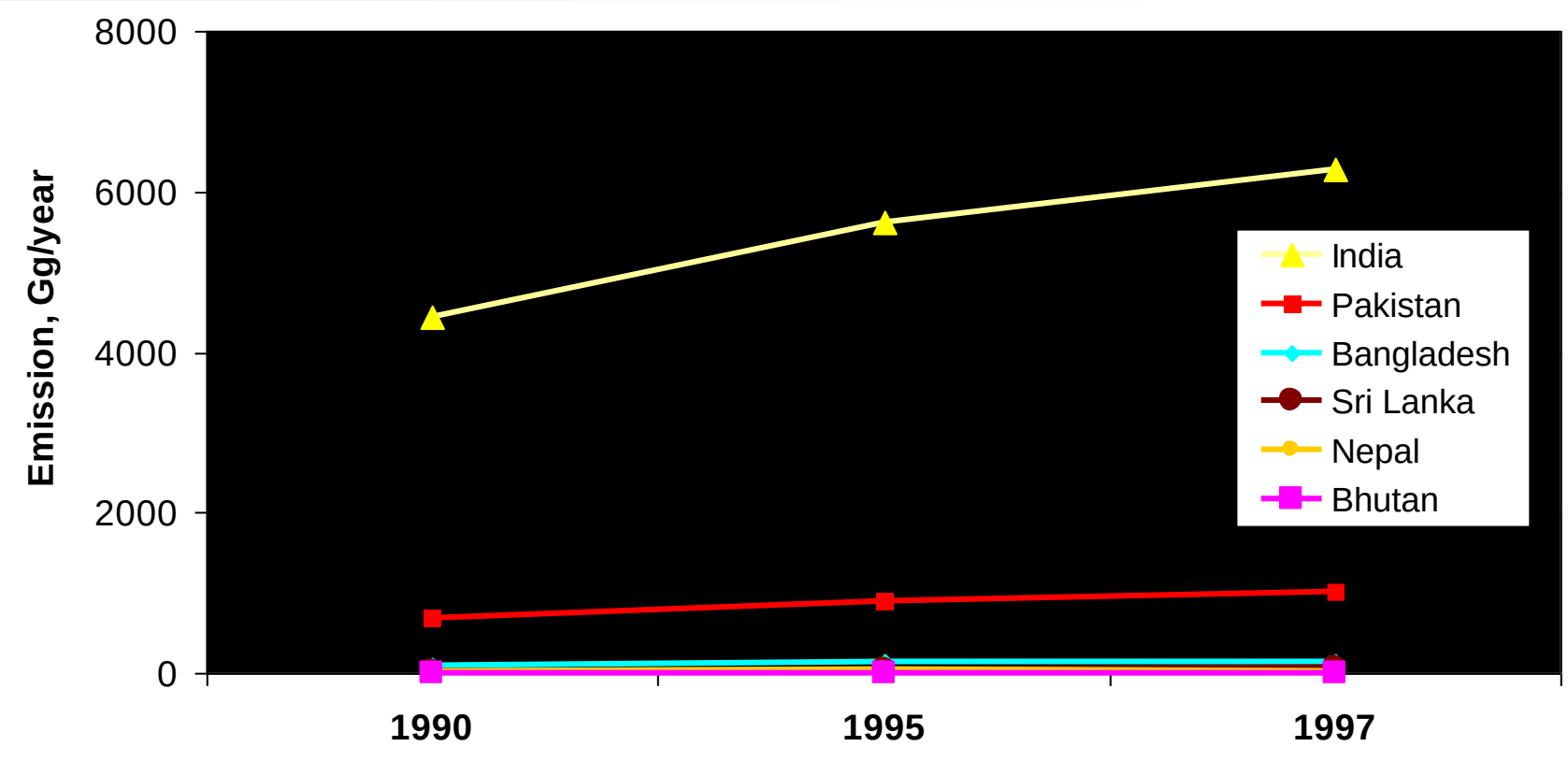
Presentation Outline

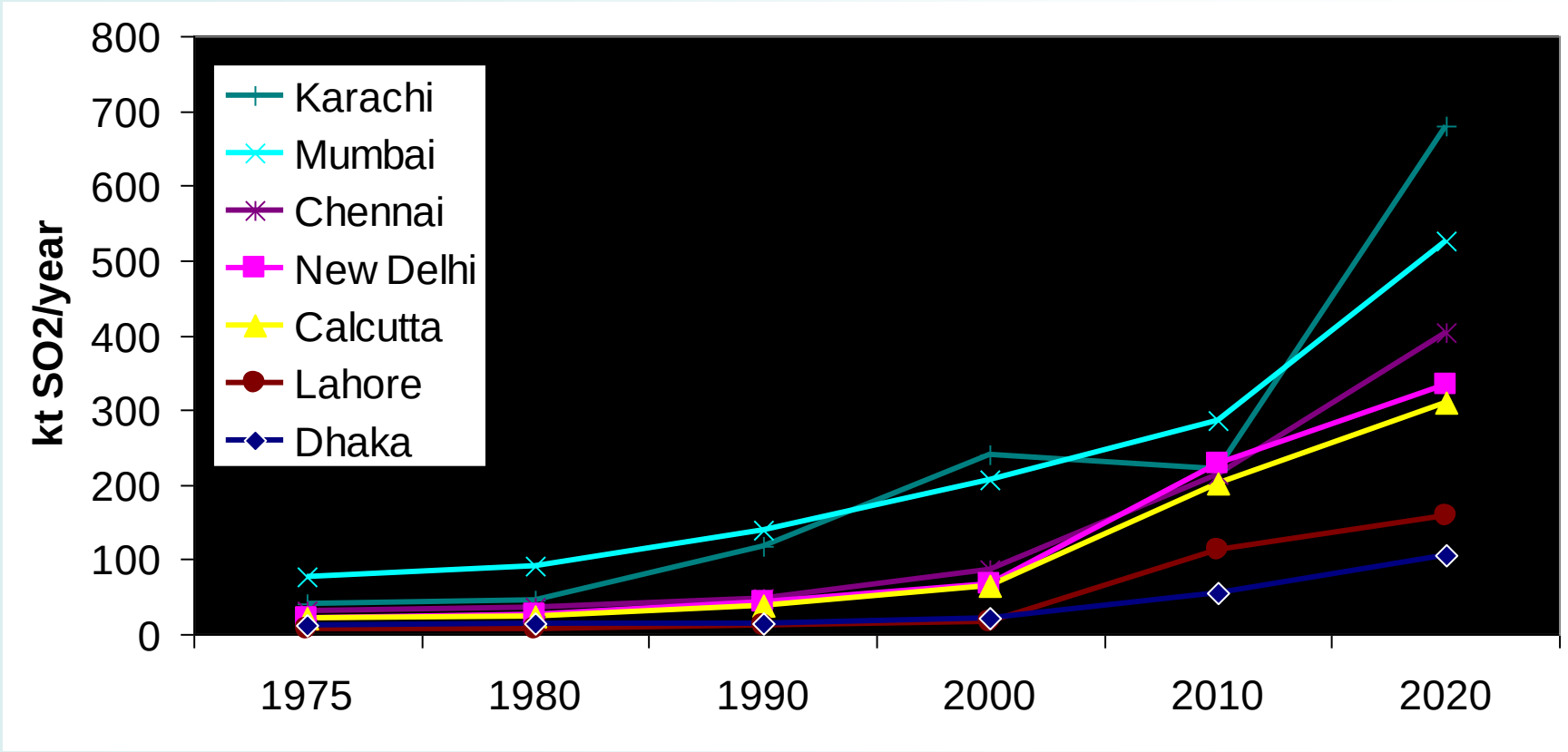
- Status and major issues of TAP in South Asia
- Approaches on prevention and control of TAP and good practices for reduction of TAP emissions
- Some prerequisites for adoption of good practices
- Concluding Remarks

SO_2 emission in Six Countries (South Asia)



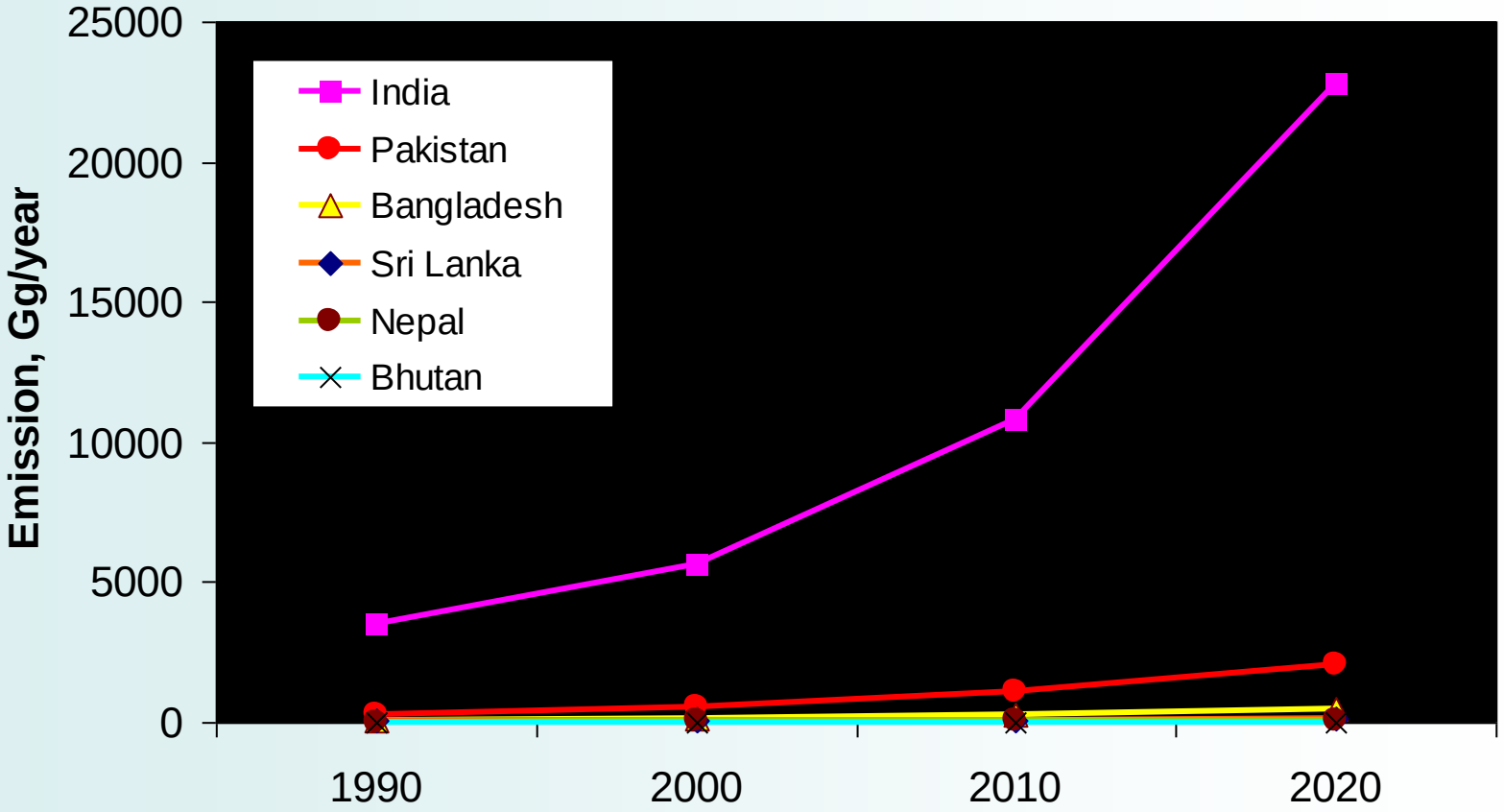
Source: Streets et al., 2003

SO_2 emission in South Asian Cities



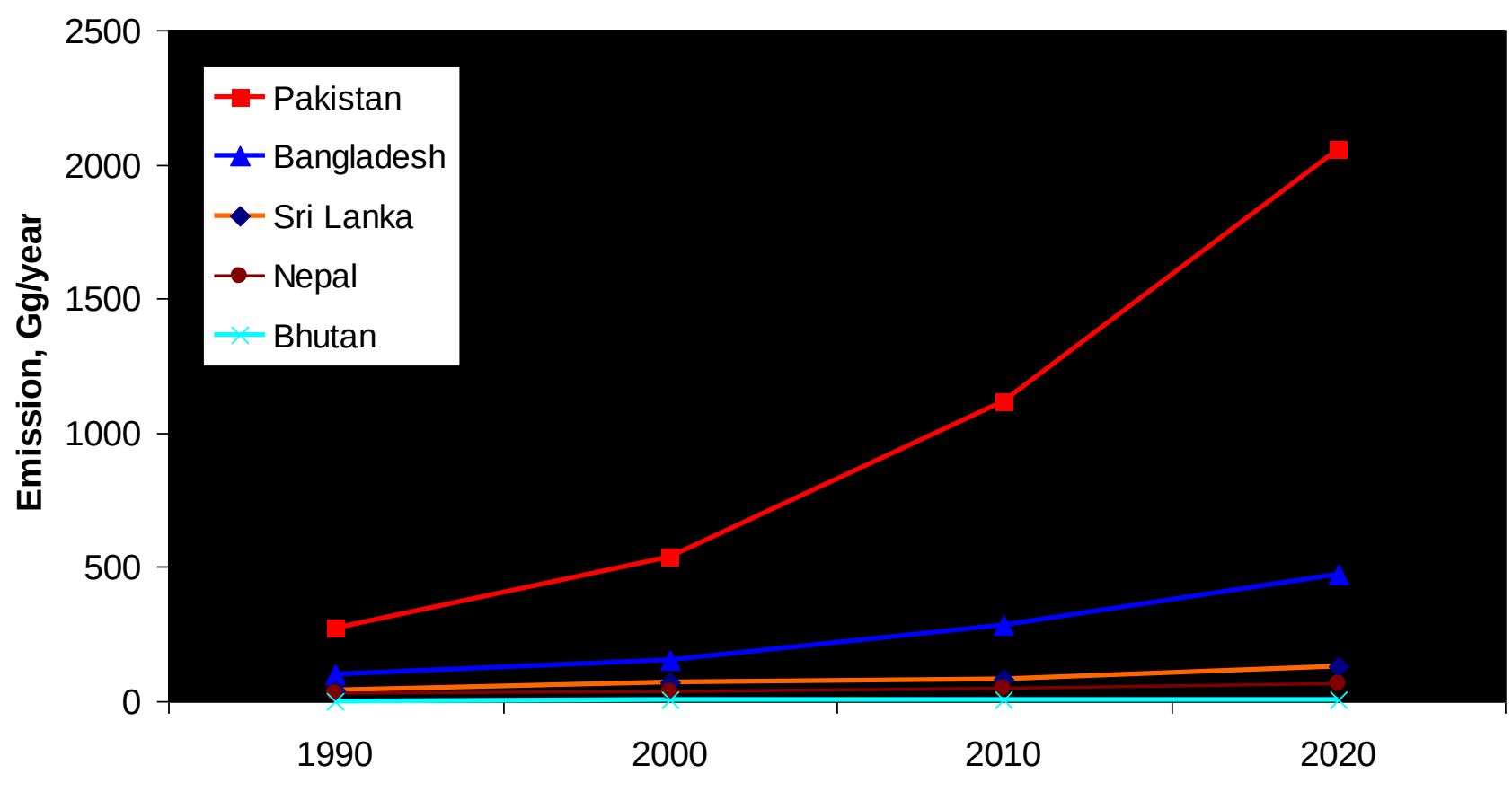
Source: Guttikunda et al., 2003

NOx emission in South Asia (1990-2020)



Source: Aardenne et al., 1999

NOx emission in South Asian countries excluding India (1990-2020)



Source: Aardenne et al., 1999

Major Factors Behind Air Pollution in South Asia

- growing thermal power generation and the role of coal
- low efficiency in power generation
- inefficient coal preparation/cleaning mechanism
- lack of emission control mechanism in power plants
- lack of regulations on industrial pollution and enforcement of existing regulations
- urbanization and growth of personal transport vehicles
- lack of land-use planning in urban development
- inefficient use of energy in demand side
- high dependence on biomass fuel burning in rural areas
- lack of effective regulatory and economic policies to improve air quality and

Growing Thermal Power Generation in the Region and the Role of Coal

India

- In South Asia as a whole, coal accounts for 72% (147,368 ktoe) of energy use in power generation. Out of it, nearly 99% (147,287 ktoe) is used by India. Coal based electricity generation accounts for 80% of total electricity generation in India in 2004 (IEA, 2004)
- The coal consumption in India had increased from 140 Mt in 1984 to over 400 Mt in 2004 with a growth rate of 5.4% (GOI, 2006). In this context, if coal import is to be avoided in future, India has to increase its domestic coal production in order to meet its growing coal demand (GOI, 2006)
- **Coal demand in India increases to 1020 million tonnes by 2030 from 441 million tonnes in 2004 in reference scenario (IEA, 2006).**
- **Government of India, under the various scenarios, has estimated its higher coal requirement from a low of 1580 Mt to high of 2555 Mt for year 2031/32 (GOI, 2006).**

Growing Thermal Power Generation in the Region and the Role of Coal

Pakistan

- Share of thermal electricity generation 80%
- coal may play major role in future with more discovery of low sulfur lignite.

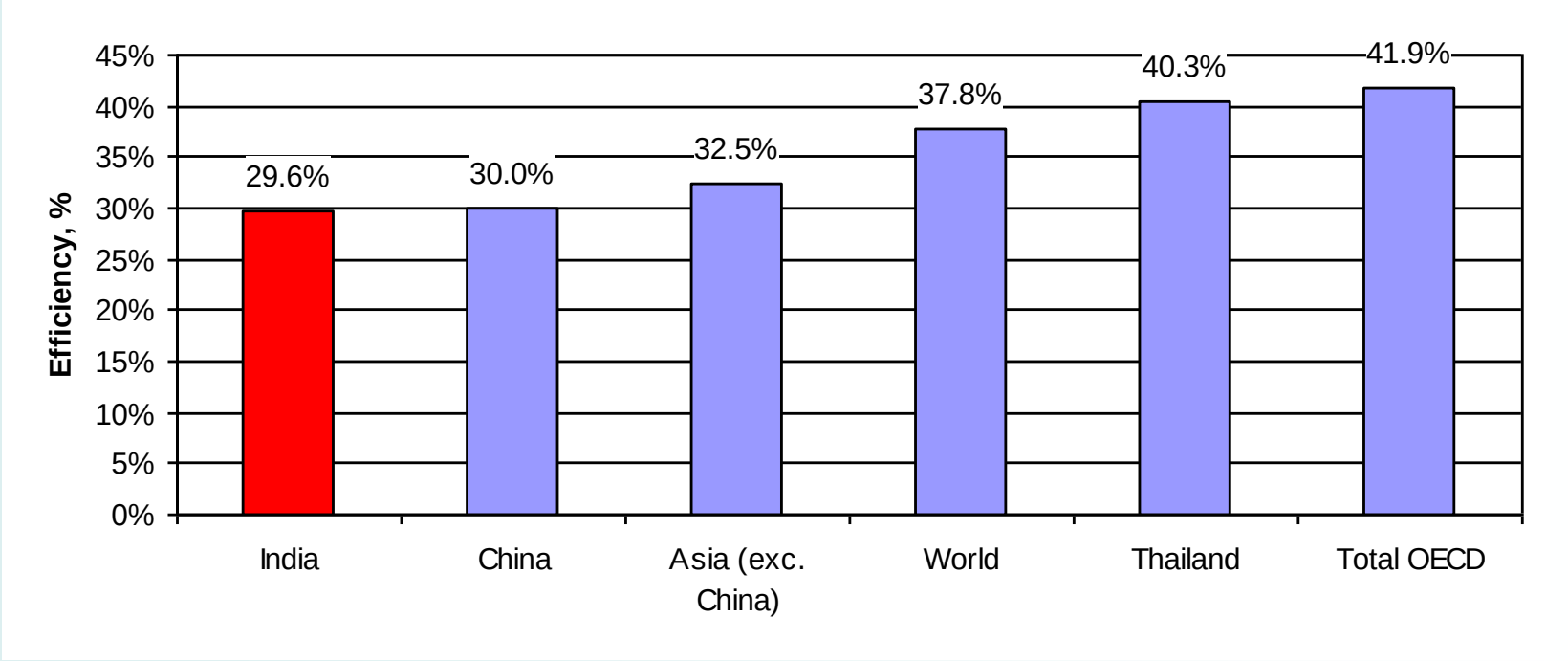
Bangladesh

- Heavily based on natural gas
- coal share likely to increase in future

Sri Lanka

- Gearing towards more thermal power generation (thermal electricity share has grown from 1% in 1990s to 30% in 2004)

Efficiency Gap in Coal Fired Power Generation in year 2004



- If the efficiency of coal fired power generation in India was improved to the level of the OECD in year 2004, the coal requirement and SO_2 emission would be reduced by 29.4%.
- Similarly, if the efficiency in India was improved to the level of Thailand, the coal requirement and SO2 emission would be reduced by 26.5%.

Approaches for Prevention and Control of Air Pollution

- Command and control
- Market/economic
- Others

Broad categories of Good Practices

- **Emission Reduction Credit Mechanism**
  - SO_2 trading in the US Acid Rain Program
  - NOx trading in the Netherlands
- **Emission Tax**
  - E.g., Emission taxes on VOCs from aircraft engines in Switzerland, Sweden, France and UK.
  - Refund based tax system in Sweden
  - NOx Tax in Norway
- **Standards on Emission, Technology and Fuel Quality**
  - Requirement to install flue gas desulfurization by coal fired utility (sulfur >1%) in Two Control Zone Program in China.
  - Delhi government vehicles requirement -- either be fitted with a catalytic converter -- or be converted to CNG.
- **Transport Demand Management**
  - Singapore
- **Cleaner and Energy Efficient Technology: Transfer, Development and Deployment**
  - VSBK, Electric Vehicles Program, Solar water heater program

Good Practices with Detailed Coverage in the Compendium

- NOx charges as feebate in Sweden
- Two Control Zone (TCZ) Plan and Program to control Sulfur pollution
- The Acid Rain Program in the US
- Urban Transportation Planning and Travel Demand Management in Singapore
- Compressed Natural Gas Conversion of Public Passenger Vehicles in Delhi
- Environmental Measures and NOx Tax System in Norway
- Solar Water Heater System (SHWS) Development and Promotion Policies
- Vertical Shaft Brick Kiln Technology Promotion in Asia
- Alternative Fuel Vehicle Promotion in Kathmandu Valley
- The OTC NOx Budget Program, the NOx SIP Call and NOx Trading Program in the Eastern States of the U.S.

Command and Control Approaches (1)

- **Setting standards**
  - Technology based standard (e.g. scrubber, catalytic converter, Low NOx burner)
    - Requirement to install flue gas desulfurization devices by coal fired utility (sulfur >1%) in Two Control Zone Program in China.
    - Delhi government vehicles requirement -- either be fitted with a catalytic converter -- or be converted to CNG.
  - Emission standard (e.g. NOx lb/mmbtu)
    - NOx emission standard for coal-fired electric utility boilers in the US Acid Rain Program (Title IV Clean Air Act Amendment 1990)
    - Clean Air Act 1970 required electric utilities:
      - either operate at SO_2 emission rate less than 1.2 lb per million Btu with 90% SO_2 removal of potential SO_2 emission;
      - or operate at SO_2 emission rate less than 0.6 per million Btu with 70% SO_2 removal of potential SO_2 emission.
  - Fuel quality standard (e.g. according to sulfur content)
    - Mandatory use of coal with sulfur content not exceeding 1% in new and renovated old coal fired power stations in Two Control Zone Program in China.

Command and Control Approaches (2)

- **Banning and phasing out of high polluting vehicles/technologies**
  - Banning of diesel 3 wheelers in Nepal in 1999.
  - Phasing out of public passenger transport to be converted to CNG vehicles in Delhi

- **Banning of dirty fuels**
  - phasing out of mining of coal containing 3% or more sulfur and mandatory use of coal with sulfur content not exceeding 1% in coal fired electric utilities in China.

Market Based Approaches (1)

Direct Instruments

- **Emission charge**
  - An emission charge is a fee or tax per unit of pollutant emission and is based on the polluters pay principle.
  - E.g., Emission taxes on VOCs from aircraft engines in Switzerland, Sweden, France and UK.
  - Refund based tax system in Sweden
  - NOx Tax in Norway
  - In Poland, Czech Republic, Estonia, Latvia, Lithuania, and Slovakia, SO_2 and NOx charges were introduced in conjunction with a permit system
    - A base charge rate is applied to all pollution within the permitted level and a penalty rate is added for pollution above that level

Market Based Approaches (2)

Direct Instruments

- **Emission Reduction Credit/Emission Trading System (Cap and Trade Mechanism)**
  - firms are issued emission permits or allowances, which are based on the desired emission target
    » set based either on ambient air standard in the region or on the necessity of the reduction from a reference emission level.
  - If a source reduces emission below the level ALLOWED, the difference is a credit earned by the source.
  - These credits can be used by the same or another firm to comply with the emission allowance. As the cost of pollutant abatement may be different for different firms, some firms may opt for buying the credits from other firms if the cost of abatement of the former is higher than that of the latter.
    - The SO_2 trading in the US Acid Rain Program
    - SO_2 emission trading in Slovakia
    - NOx emission trading in the Netherlands.

Market Based Approaches (3)

- **Indirect Instrument**
  - Environmental taxes/ Eco-taxes (carbon tax, sulfur tax etc), Fuel tax, Energy tax
    - Environmental taxes are indirect instruments - based on the users pay principle..
    - Environmental taxes are either charged om the fuels/goods used as an input in polluting activity or products associated with pollution or content of polluting substance contained in the inputs.
    - E.g.,differential fuel tax rates according to the sulfur content of fuel with higher tax applied for fuels having higher sulfur content in Finland, Belgium, Denmark, France, Norway, Portugal, Sweden, Switzerland and United Kingdom.
    - Sulfur tax in Sweden: 30 SEK/kg S ($ 3.3/kg S)
      -- applicable to fuel oils and coal having more than 0.1% sulfur.

Market Based Approaches (4)

- **Indirect Instrument**
  - Emission taxes as a pollution damage levy in Japan
    - charged to polluting firms, tax revenue used to compensate the victims of designated diseases.
    - It was implemented under a framework of the Pollution-Related Health Damage Compensation and Prevention Law, which was established in 1973. Under the framework, areas having a certain level of pollution were designated as Class I and people living in the area for certain period of time and suffering with designated diseases were defined as air pollution victims.
  - Feed-in tariffs
  - Green pricing etc.
    - E.g., promotion of renewable based electricity generation under Renewable Portfolio Standard in several European countries (e.g., Germany).

Approaches Based on Voluntary Actions

- **In these approaches, individuals or individual firms engage in pollution-control activities in the absence of any formal, legal obligation to do so.**
  - » In Poland, in addition to command and control approach, names of top 80 the worst national polluters are published. This has helped increase compliance of the standards in the country (Peszko et al, 2001).

  - Another example of voluntary action is the willingness on the part of some electricity users to buy green electricity (electricity from renewable energy technologies) at a premium price. This is also known as the concept of Green Pricing, which exists in Europe and the US.

Other Approaches

Fuel Switching Options

- **Switching to the cleaner fuel**
  - Use of low sulfur content fuel (e.g. ultra low sulfur diesel)has been widely adapted in developed countries like USA and European countries
- **Switching to cleaner fuels like CNG and electric vehicles are some of the options in practice**
  - Public Passenger Transport Vehicle switching to Compressed Natural Gas Vehicles in Delhi
  - Electric Vehicles in Nepal (using electricity from hydro resources)

Renewable Portfolio Standards

Energy Efficiency Improvement (Demand and Supply Side)- Integrated Resource Planning

Land-use planning in urban region (compact city)

Other Approaches

- **Congestion Charge**
  - It is a charge applied to the vehicles using a designated region based on the degree of congestion. (e.g. Singapore and London).
  - Though the main purpose of this approach is to reduce traffic congestion in and around the charging zone rather than to obtain environmental benefit, it also is able to reduce NOx and particulate matters to a larger extent within the charging zone (Beevers et al., 2005).

- **License permits**
  - It is aimed at reducing the congestion related pollution from vehicles in designated time. These permits are used by Regulatory body in countries like Singapore and Chile for regulating the vehicular operation. A user requires a permit in order to run his/her vehicle.

Other Approaches

- **Banning of Vehicles**
  - imposing a regulation that ban cars running on designated day.
  - E.g. in Mexico, the day was determined by the last digit of the license plate (‘*Hoy No Circula*’: i.e. “One Day without a Car“);
  - Vehicles with certain ending numbers on their license plates are not allowed to circulate on certain days in an attempt to cut down on pollution and traffic congestion.

- **Restricting the vehicle operating days e.g., by using even and odd number of the license plates.**
  - E.g., In China, during Beijing Olympic

- **However, it is reported that, in Mexico, the practice was counterproductive with over investment in new vehicles in longer run.**

Prerequisites for Pollution Control Programs

- **Determination of Emission and desired reduction**
  - Scientific basis for determining critical load
    - Health based standard
    - Vegetation based standard
  - Regular monitoring of emissions
  - Source apportionment
  - Measuring Methods
- **Harmonizing of monitoring and measuring, calibration assessments to achieve comparable measurement throughout the region**
- **Reliable enforcement mechanism**

Treaties/Agreements and Protocols

- **Convention on Long-Range Transboundary Air Pollution (CLRTAP)**
  - Helsinki Protocol (SO_2 emission reduction)
    - At least 30% reduction from 1980-1993
  - Oslo Protocol (SO_2 emission reduction)
    - 70-80% (for western Europe), 40-50% for eastern Europe from 1980 levels by 2000
  - Sofia Protocol (NOx emission reduction)
    - Emission from 1994 onward does not exceed 1987 level
  - Geneva Protocol (VOC emission reduction)
    - 30% reduction with 1984-1990 base year by 1999
  - Gothenburg Protocol (SO_2, NOx, VOC, NH3 emission reduction)
    - Binding emission ceilings for four pollutants to be achieved by 2010

- **European Commission National Emission Ceilings Directive (2001/81/EC)**
  - Similar to Gothenburg Protocol but more stringent Target for SO_2, NOx, VOC, NH3
- **Malé Declaration in South Asia**
  - It does not have a protocol yet.

Thank you

Concluding Remarks

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- Decision Support System must be in place for the development of appropriate policy/program/ mechanism
- Capacity building should be an integral part of the pollution control strategy
- Cost and benefit analysis of pollution control program/mechanism is necessary for selection of the efficient control program/mechanism
- Adaptability of successful practices need to be carefully assessed before their implementation in a different country condition

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Steps on
Regional air pollution control strategy

A collective action in the region

- Regional Treaty/Agreement

A commitment through an agreement

Protocol
- Regional Emission Reduction
- National Emission Ceilings
- Time frame

Individual country formulates acts and appropriate measures/strategies/policies to attain the committed emission reduction targets.

- National Acts/Appropriate Measures/ strategies/ approaches

Command and Control Approach

- **Emission Standards**
- **Fuel standard**
- **Technology standards**

Market Based Approach

- **Emission Taxes**
- **Emission permits/Emission Trading (Bubble, Netting, Offsetting, Banking Mechanism)**
- **Fuel Taxes (Indirect)**

Other approaches

- **Voluntary Action**
- **Moral suasion**

Policy analysis of environmental policies/strategies

- **Should a good practice in a country be necessarily effective and good elsewhere?**
- **Answer lies on the outcome of policy analysis (based on various criteria):**
  - Cost of implementing a policy/strategy (economic efficiency, cost effectiveness)
  - Financial affordability
  - scientific, technical and managerial capacity to design implement the policy
  - administrative complexity (enforcement capacity)
  - political will and sensitivity
  - social acceptability
  - environmental effectiveness

Constraints in South Asian Countries

- **Lack of capacity to monitor and enforce the regulations/policies**
  - Environmental Acts alone not enough (e.g., Nepal)

- **Inadequate scientific/technical capacity to analyze emissions, assess impacts, and formulate appropriate policies/strategies**
  - Large share of small firms (more difficult to monitor and enforce)
  - Inadequate resource allocation for environmental protection activities

Two Control Zone (TCZ) Plan and Program in China

- **Two zones of control:**
  - Sulfur emission control in 64 cities with high ambient concentration of sulfur
  - acid rain control zone covering 12 provinces of southern and eastern China
  - Together the two zones covered about 2/3rd of sulfur emission in the country
- **Major Activities:**
  - Gradual phasing out of mining of coal containing 3% or more sulfur
  - Prohibition of coal fired power stations inside large and medium-sized cities and surrounding suburbs.
  - Regulation on coal quality: sulfur content of coal used in new and renovated power stations to be not more than 1%.
  - Use of flue gas desulfurization
  - Implementation of sulfur emission charges

Transport Demand Management in Singapore (1)

Major components:

- **Additional registration fee (ARF)**
  - an additional tax on new vehicles (ARF = 110% of open market value) (reduced ARF when an old vehicle of the same size is taken off the road at the time the new vehicle is acquired.)
- **Area license scheme (ALS) since 1975**
  - required vehicles a license to enter restricted zones (RZs) of the city initially during peak hours and later extended during 7:30 a.m. to 7:00 p.m. during working days in 1994.
  - ALS replaced by electronic road pricing (ERP) since 1998.
- **Electronic road pricing**
- **Vehicle quota system**
- **Flexible schemes (off-peak car scheme, park and ride schemes)**

Transport Demand Management in Singapore (2)

- **Electronic road pricing**
  - Similar to ALS but its enforcement is automatic
  - Electronic equipment like sensors, cameras with short-range radio communication system are utilized to sense the vehicle entry
  - Vehicles are equipped with an electronic in-vehicle unit (IU) (a smart card with positive cash balance) are inserted before the vehicles' entry to RZs.
  - Charges are different for motorcycles, cars, good vehicles, taxies and buses;
  - The ERP charge varies every half-hour of a day and varies by type of vehicle and by time of day (e.g. peak and off-peak).

Transport Demand Management in Singapore (3)

- **Vehicle quota scheme**
  - A quota on vehicles implemented since 1990.
  - Requires all prospective purchasers of new vehicles to own a Certificate of Entitlement (COE) to operate vehicles on the road.
  - COEs valid for 10 years and need to be purchased in an auction (open bidding process since 2002).

Transport Demand Management in Singapore (4)

- **Off-peak car scheme (OPC)**
  - Permits to operate cars only during off-peak hours;
  - Special permits to cars to run during weekends only under Weekend Car Scheme;
  - OPC aims at reducing car usage during work days;
  - Offers the new and existing car owners with OPC permits a rebate on car registration and road taxes.

Transport Demand Management in Singapore (5)

- **Other measures**
  - improvement in communication system
  - investments on and improvements to public transport system
  - traffic management schemes;
  - integrated transport and land-use planning

Singapore Example: Can it be Replicable?

- **The prerequisites:**
  - Provision of a good alternative public transport system
  - strong commitment of government on better air quality
  - Effective enforcement mechanism
  - Effective communication system
  - Better manageability of vehicle growth being a city state

CNG Conversion of Public Passenger Vehicles in Delhi

- **Major Activities**
  - The Supreme Court of India through its verdicts and directives played the major role in conversion of buses to CNG use in Delhi.
  - Judicial activism (or a judicial “good practice”).
  - Inadequacy of CNG filling stations and shortage were the initial hurdles.
  - By 2003, all buses and nearly all auto-rickshaws were reported to operate on CNG.
  - By 2006, 10,761 buses, 63,962 three wheelers, 19,351 private cars, over 5,229 taxis and 5,258 vans running on CNG.
  - More than 146 fueling stations have been established by 2006.
- **Impact**
  - SO_2 concentration drastically reduced to the safe level during 1998-2005.
  - NOx concentration within annual average national standard, but an increasing trend recently.
  - Suspended particulate matter far above the national standard.

Judicial Good Practices (?)

- **Pro-environmental/pro-public health judicial interventions (through public interest litigations) in India.**

- **Supreme court verdicts/directives on CNG buses in New Delhi and polluting industries around Agra.**

- **Similar judicial interventions in other countries.**

CNG Vehicles in Other Countries

- Over 900,000 CNG vehicles in Pakistan
- Examples of Bangladesh
- CNG taxis and micro-buses in Bangkok

The US Acid Rain Program (1)

- **Title IV of the Clean Air Act has set a goal of reducing annual SO_2 emissions by 10 million tons below 1980 levels by 2010.**
  - Phase I: started in 1995, initially affected 263 large mostly coal fired plants; additional 182 joined in 1997, total units 445.
  - Phase II: started in 2000, tightened the annual emissions limits - set restrictions on smaller, cleaner coal, oil, and gas fired plants fired – altogether it affected 2000 units.
  - The program affects existing utility units with an output capacity of greater than 25 megawatts and all new utility units.

The US Acid Rain Program (2)

- **Major Activities**
  - Uses a market based (“cap and trade”) approach.
  - Plants or units that emit below their allowed level can trade the surplus allowances with other units in their system (within the same utility) or
  - sell them to other utilities or
  - bank them to meet emission reduction obligations in future years
  - Some allowances (2.8%) are auctioned annually by USEPA.
  - Typically, environmental groups acquire them for different purposes including permanent retirement of the allowances (which would lower the emission limit permanently).

The US Acid Rain Program (3)

- **Major Activities**
  - The Acid Rain Program has a provision to promote renewable energy and energy conservation initiatives. A reserve of 300,000 SO2 allowances is provided as the Conservation and Renewable Energy Reserve (CRER).
- **NOx Reduction**

The US Acid Rain Program (4)

- **Major Activities**
  - Uses a market based (“cap and trade”) approach.
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The US Acid Rain Program (5)

NOx Reduction

- **Major Activities**
  - The Clean Air Act Amendment 1990 had also set a target to reduce 2 million tons of NOx emission below the 1980 level by year 2000.
  - The program focuses on one set of sources that emit NOx --coal-fired electric utility boilers.
  - Implemented in 2 phases,
  - Phase I started in 1996 and Phase II in 2000.
  - Emission standards (expressed in pounds of NOx per million Btu of heat input) were put as emission limitations for the NOx boilers of electric utilities.
  - The program has set a penalty of $2,000/ton sulfur in 1990, which is adjusted annually as per the inflation rate.

The US Acid Rain Program (6)

The program

- has a fixed upper limit on total annual sulfur emissions from the utilities;
- allows anyone to lower the limit by acquiring the allowances; and
- facilitates real time emission monitoring and real time online allowance trading mechanism.
- has a mechanism of penalty for non-compliance and it is adjusted with inflation rate.

The US Acid Rain Program (7)

- **Utilities have adapted one or more options including:**
  - blending low-sulfur coal,
  - installing SO_2 and NOx controls (such as scrubbers and low-NOx burners),
  - purchasing allowances from the market or using banked allowances in order to meet the emission reduction requirements
  - increased use of efficient advanced combined gas cycle units based on natural gas.

NOx charge as Feebate in Sweden

- **Implemented since 1992 and administered by the Swedish Environmental Protection Agency (SEPA).**
- **Large energy combustion plants charged on the basis of their actual NOx emission**
- **But NOx revenue redistributed to the plants according to the level of energy production**
- **Plants with less NOx emission per unit of energy production benefit more from the scheme.**
  - incentive to reduce emission
- **Offers flexibility on technology choice:**
- **Utilities/firms are free to choose the means to reduce the emission.**
- **The 1995 target of a 35% reduction from the 1990 emission level was already achieved by 1993.**
- **Average cost to reduce NOxis reported as SEK10/kg NOx.**

NOx Tax System in Norway

- **Tax Policy on NOx emission**
  - Tax of NOK 15 per kg of NOx (US $ 2.5/kg) emitted from ships, fishing vessels, air traffic and diesel railways, and also engines, boilers and turbines in the manufacturing industries.
  - The tax is applicable on large units.
  - Large units capacity > 10 MW for boilers and 750 kW for propulsion engines.
  - In addition, NOx tax is also imposed on flaring of gas offshore and on oil and gas installations on shore.
    The tax covers approximately 55 % of the total Norwegian NOx emissions (NPCA, 2008).
- **The tax is calculated based on 3 principles:**
  - a) according to actual emission; or
  - b) according to a fixed source specific emission factor; or
  - c) based on the maximum rotations per minute (rpm) template if ‘a’ and ‘b’ are non-existent.

Solar Water Heater Development and Promotion Policies

- **Direct grants, subsidies**
- **tax incentives for SWHs import and their components**
- **Accelerated depreciation schemes for commercial and public applications**
  - In India deployment of a further one million SWHs is aimed for domestic use by 2012 (Refocus, 2004).
- **New construction of government-owned housing in Namibia are not allowed to install water heaters other than SWHs (Refocus, 2004).**

Solar Water Heater Development and Promotion Policies

- **In Mexico, policy targeted towards creating an enabling environment with roundtable talks between the sellers and potential users and developing a virtual marketplace.**

- **In Australia, SWH are promoted through the Renewable Portfolio Standard (RPS), under which, all SWHs replacing electrical water heaters are allowed to have marketable green certificates.**
  - Electricity suppliers are obliged to purchase a certain share of electricity from renewable energy sources and they can buy these green certificates to meet their obligation. (Refocus, 2004).

- **In Nepal, market growth has given an impetus to the SWHs growth**
  - more than 200 local manufacturers are in commercial business (REDP/UNDP/AEPC, 2002).
  - More manufacturers get into the business during the winter season (approx 4 months) when the sale of SWHs is high (OGARTA and Himal Energy, 2004).

Vertical Shaft Brick Kiln Technology Promotion Policies in Asia

India

- **Enforcement of Emission Standard by Government of India in April 1996:**
  - limited stack emission to 1,000 mg/Nm^3 of emissions for small capacity kilns and 750 mg/Nm^3 for medium and larger kilns.
  - Banning of fixed chimney type Bulls' Trench Kiln (BTKs) after June 2002.
  - While kilns with the higher production levels had the option to switch to fixed chimney type BTKs, small and medium capacity brick makers are required other options to meet the enforced standards on SPM emissions (APEIS, 2003a).
  - Major activities carried out under the research phase: training, developing technology options to suit different regions of the country and conducting awareness seminars, and study tours.
  - In India there were 45 VSBK installations by 2004 and it was reported that the installations are over 100 by 2007 (SDC, 2008).

Vertical Shaft Brick Kiln Technology Promotion Policies in Asia

Vietnam

- **Regulation on phasing out of the traditional brick kilns.**
- **Introduction of VSBK under UNDP Project funded by the Small Grant Programme of the Global Environment Fund.**
- **The adoption of the new VSBK was growing rapidly all over the Vietnam. Approximately, around 200 VSBKs were already constructed in Vietnam by 2004 (Kim et. al, 2004).**
  - It is reported that over 300 VSBKs are constructed in Vietnam (SDC, 2008).
- **Raising awareness among the local authorities on the possibility of air pollution reduction while retaining the livelihood of the brick-makers was one of the major achievements of the project.**
  - involved local policymakers from the beginning of the project.
- **However, some VSBKs failed due to the dissemination of wrong information about VSBKs and managerial problems.**

Vertical Shaft Brick Kiln Technology Promotion Policies in Asia

Nepal

- **joint efforts between the government and local entrepreneurs have boosted the development of VSBK technology**
  - banning of BTK as a result of strong lobby from local community citing heavy air pollution in the nearby vicinity.
  - VSBK was introduced in Nepal in 1992 as a demonstration project. SDC, through its VSBK Program, has been providing technical support to interested entrepreneurs to install VSBK.
  - Over 10 VSBKs are in operation in the Kathmandu Valley.
- **Establishment of VSBK Entrepreneurs Forum was one of the major achievements of the program: establishes good network among all VSBK entrepreneurs (VSBK Nepal, 2007)**

In Pakistan and Bangladesh, some pilot projects are ongoing in VSBK technology transfer.

Alternative Fuel Vehicle Promotion in Kathmandu Valley

- **ban on further registration of diesel three wheeler in 1992 as a result of growing problem of air pollution and public outcry.**
- **In 1995, use of these vehicles were banned.**
  - An incentive provided to the owners to replace their diesel three-wheelers, in the form of a 75 % customs holiday on the import of 12- to 14-seater public transportation vehicles (Dhakal, 2004).
- **A combined effort of the government, the private sector and civil society (mainly NGOs and advocacy groups) produced synergy effects to promote and expand the use of battery-operated electric three-wheelers on a commercial basis in the valley, to fill the vacuum created by the restriction on diesel three-wheelers.**
- **These vehicles were promoted as zero-emission vehicle.**
- **Currently over 600 electric vehicles (popularly named as 'Safa ' tempo) are running inside the Kathmandu Valley.**

Alternative Fuel Vehicle Promotion in Kathmandu Valley

- **Major institutional efforts**
  - emission standards
  - Environmental Protection Act 2056
  - phase out of non-complying vehicles
  - ban on further registration of diesel three wheeler in 1992
- **Public pressure and creating awareness on the environment**
  - The non-governmental sectors fueled the anti-diesel three-wheeler movement.
  - The movement led to street protests and road blockades against three-wheelers.
- **Demonstration of technological and economic feasibility of electric three-wheelers**
  - Global Resource Institute conducted a pilot project for the demonstration of the technological feasibility of an electric vehicle, which was converted from a diesel three-wheeler. By 1995, a total of eight electric three-wheelers had been designed and pilot-tested on one of the major routes in the valley for six months (Dhakal, 2004).

Alternative Fuel Vehicle Promotion in Kathmandu Valley

- **Emergence of a new industry**
  - private sector has been the main impetus for the growth of the electric vehicles in Kathmandu
  - There were 600 safa tempos operating in Kathmandu, servicing 100,000 people daily in 17 routes and employ over 70 women drivers by 2004. There were also 37 charging stations. These safa tempos were assembled in Kathmandu using body and chassis parts from India and electronic parts and batteries from the other countries (e.g., United States).
  - The government has been providing tax incentives on vehicle parts importation and annual registration of electric vehicles.

- **Some factors**
  - Role of private sector association
  - Donors' Interest
  - Lower electricity tariff and tax benefit

The OTC NOx Budget Program, the NOx SIP Call and NOx Trading Program in the Eastern States of the U.S.

- **Establishment of Ozone Transport Commission (OTC)**
  - a regional cap (budget) on NOx emissions was set for emissions from electric power generating facilities, large industrial boilers and turbines during the “ozone season” (from May 1st through September 30th) beginning in 1999.
  - the sources were required to reduce emissions significantly below the 1990 baseline levels
  - Each state within the OTC was allowed to design and implement its own trading program consistent with the state conditions and needs.
    - » All participating states have agreed to adopt guidelines for applicability, duration of the control period, targeted NOx emissions monitoring and record-keeping, and electronic reporting.
    - » States have the authority to establish individual enforcement procedures and penalties.
    - » Accurate monitoring of all emissions and timely reporting ensured that a ton of NOx emitted from one budget source is equal to a ton from any other source.
    - » This has maintained the integrity of the budget and the states have accurate and comprehensive compliance information.

The OTC NOx Budget Program, the NOx SIP Call and NOx Trading Program in the Eastern States of the U.S.

- **EPA´s NOx SIP Call**
  - EPA issued a regulation in 1998 to reduce the regional transport of ground level ozone since the OTC NOx Budget Program did not bring the region (the Northeast and Mid-Atlantic) into compliance, due to the transboundary flow of NOx across state boundaries. The regulation was commonly known as State Implementation Plans (NOx SIP Call)
    - reduce seasonal NOx emissions in 22 states and the District of Columbia by 2003 and
    - to create a Federal NOx Budget Trading Program.
  - The NOx SIP Call did not mandate which sources must reduce emissions; rather, it required states to meet an overall emissions budget and gave them flexibility to develop control strategies to meet the budget.
  - All affected states chose to meet their NOx SIP Call requirements by participating in the NOx Budget Trading Program.

The OTC NOx Budget Program, the NOx SIP Call and NOx Trading Program in the Eastern States of the U.S.

- **The NOx Budget Trading Program**
  - Under the SIP Call, EPA developed NOx trading program known as the OTC NOx Budget Trading Program.
    - budget sources were allocated allowances by their state government.
  - these allowances could be bought, sold, or banked.
  - Any person was allowed to acquire allowances and participate in the trading system.
  - electricity generating units with output capacity of 15 MW or more are involved -- large industrial units with fossil fuel fired boilers or indirect heat exchangers having maximum rated heat input capacity of 250 million British thermal units per hour or more (USEPA, 2007e).
  - States were given broad discretion as to how they could allocate allowances from their trading budget to affected sources.

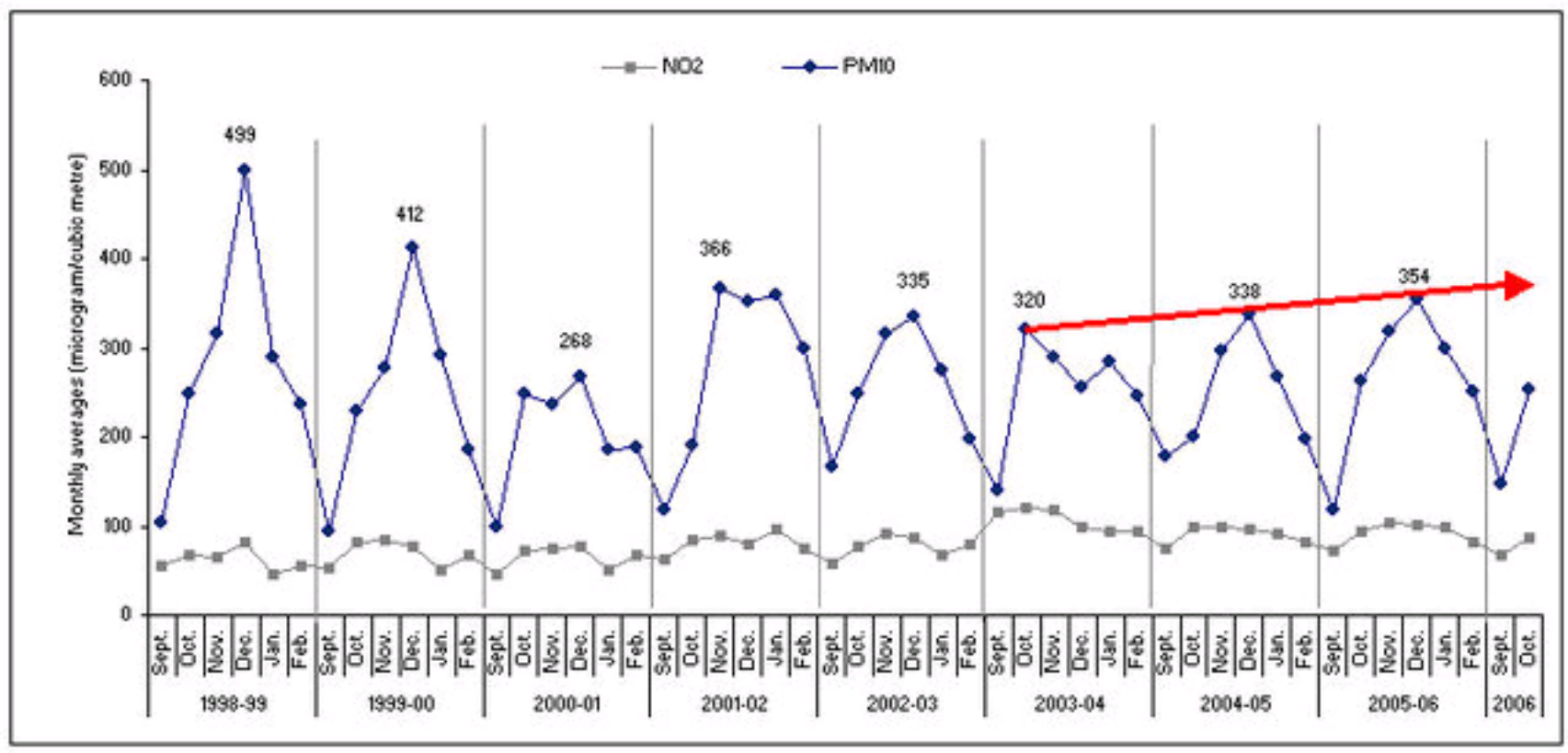
Population in South Asia

Items	World	South Asia	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Srilanka
Population (millions)	**6,438**	**1,470**	**141.8**	**636.6** thousands	**1,094.6**	**329.2** Thousand	**27.1**	**155.8**	**19.6**
Urban population (% of total)	**48.8**	**28.5**	**25.1**	**11.1**	**28.7**	**29.6**	**15.8**	**34.9**	**15.1**
Urban population growth (average annual %, 1990–2005)	**2.2**	**2.7**	**3.6**	**3.3**	**2.5**	**3.7**	**6.2**	**3.3**	**0.9***
Total population growth (average annual %, 1990–2005)	**1.4**	**1.9**	**2.1**	**0.4**	**1.7**	**2.8**	**2.3**	**2.4**	**1.0**

Source: The Little Green Data Book 2007/ The World Bank, * UNICEF, 2007

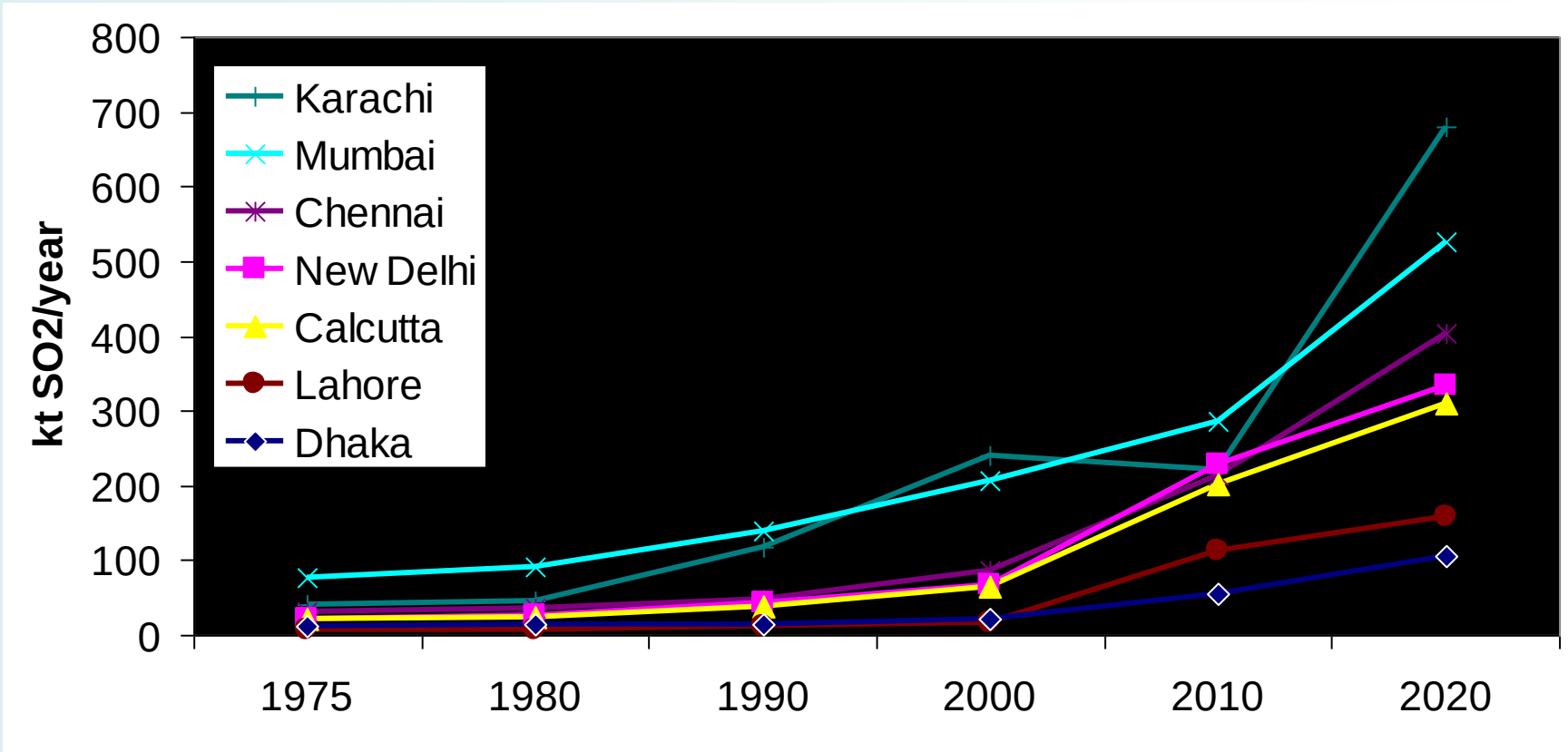
Trends of NOx and PM_{10} in Delhi

In Delhi, after introducing CNG vehicles, reduced PM concentration was achieved. However, recent trend shows increasing trend of PM_{10} .



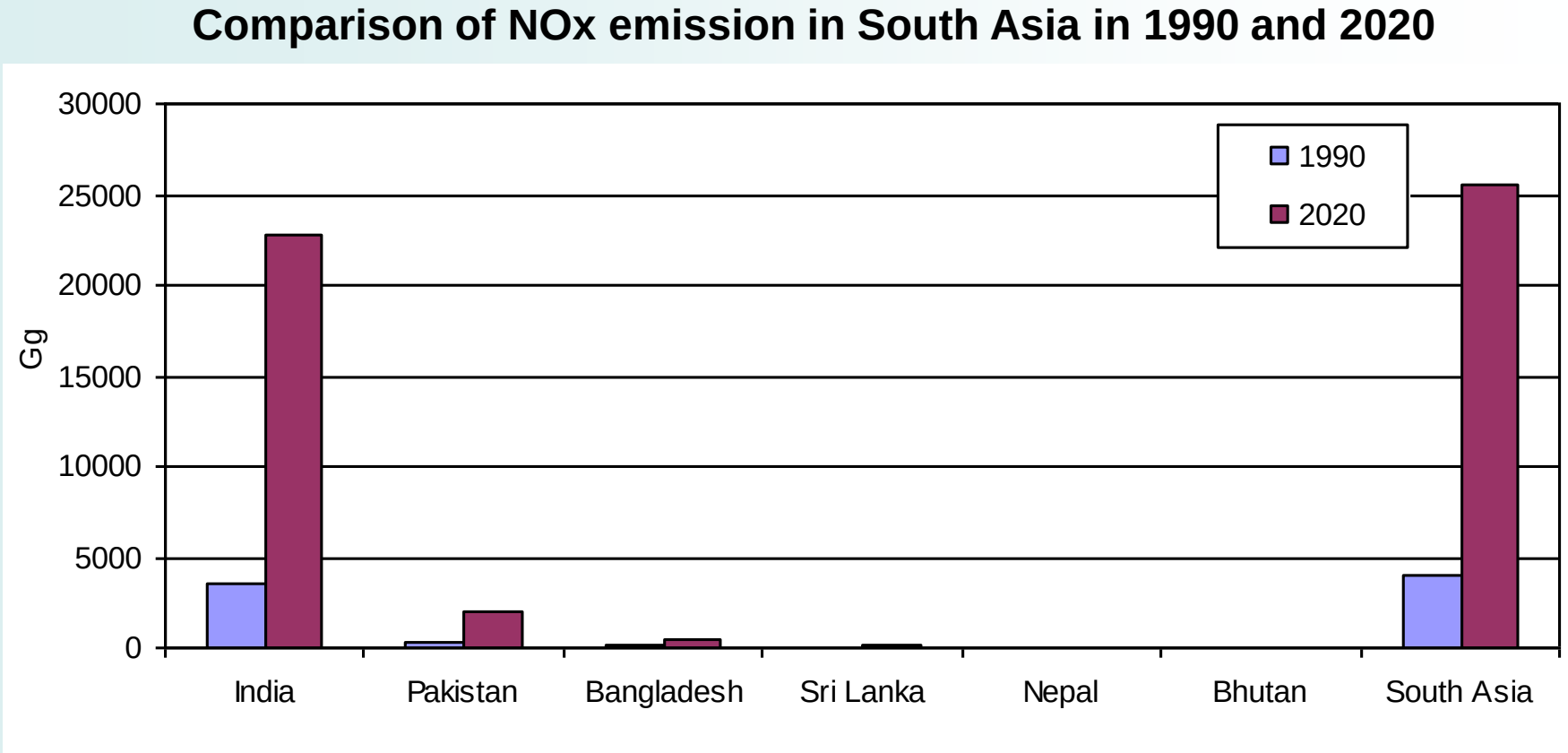
Source: Greencarcongress, 2006 (quoting CSE, India)

Emission of Major Transboundary Air Pollution



Source: Guttikunda et al., 2003

Emission of Major Transboundary Air Pollution



- NOx emission in South Asia will grow by a factor of 5 in 2020

Source: Aardenne et al., 1999

Growing Exposure to Increasing SO_2 Concentration in Future

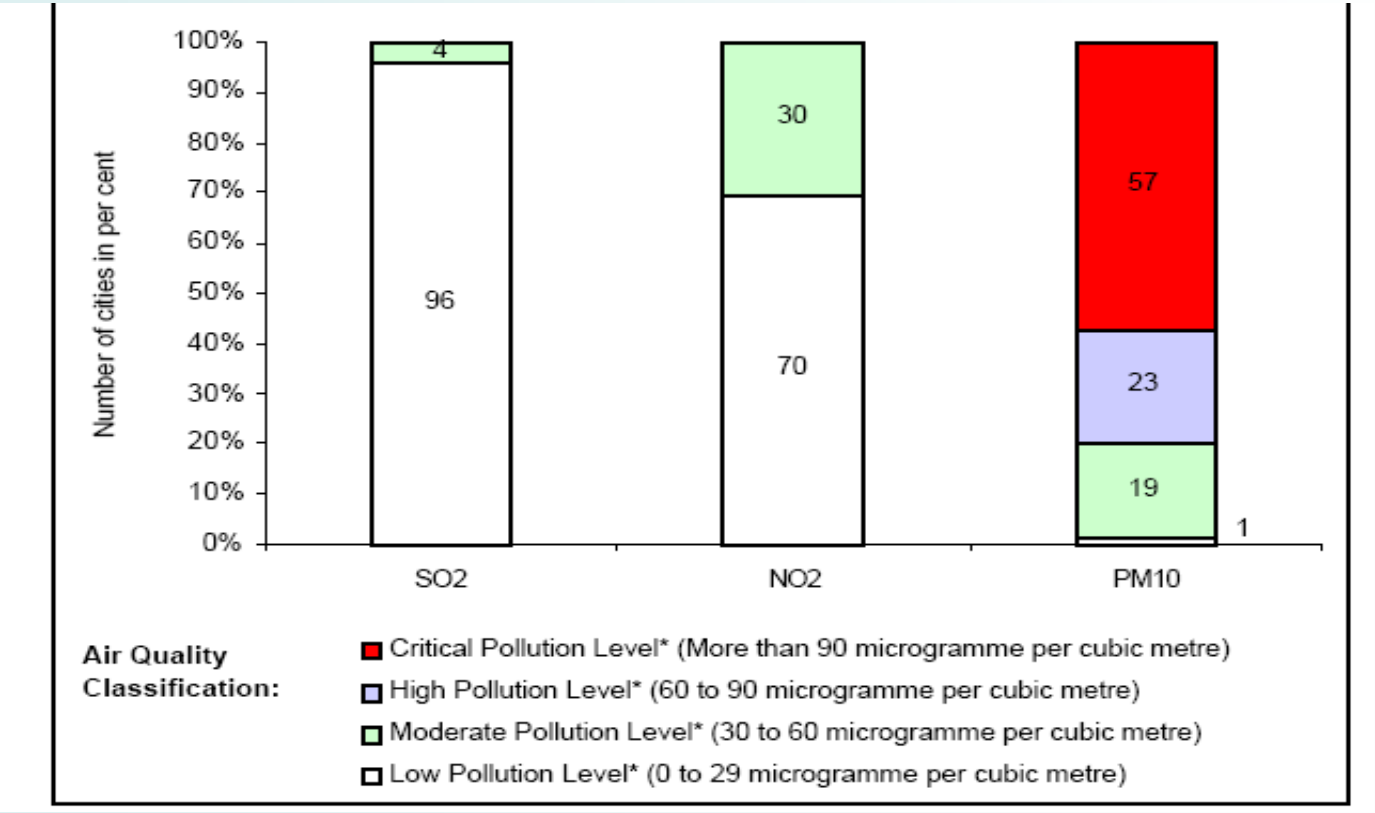
- **In 2020, peak SO_2 concentrations would reach 226 mg/m^3 (average concentration 33 mg/m^3)for Mumbai.**

- **In 2020, the population exposed to SO_2 pollution levels above WHO standard (industrial area limit = 80 mg/m^3) is 10.8 million for Mumbai city alone.**

Source: Guttikunda et al., 2003, The contribution of megacities to regional sulfur pollution in Asia, Atmospheric Environment 37 (2003) 11–22

Urban Regions Suffer with PM_{10}

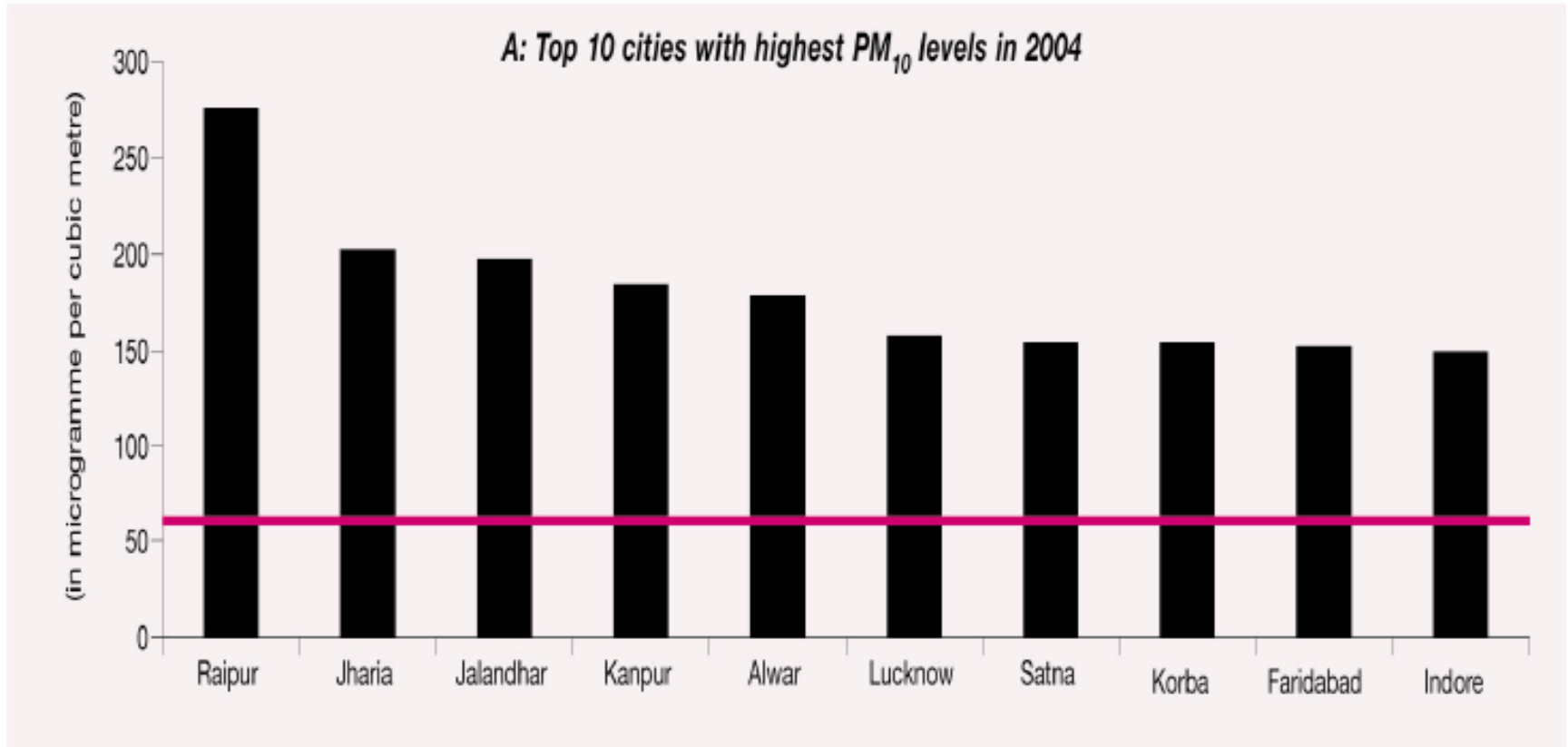
In India, half of the cities monitored during 2004 show critical level of PM_{10}



Source: CSE, 2006

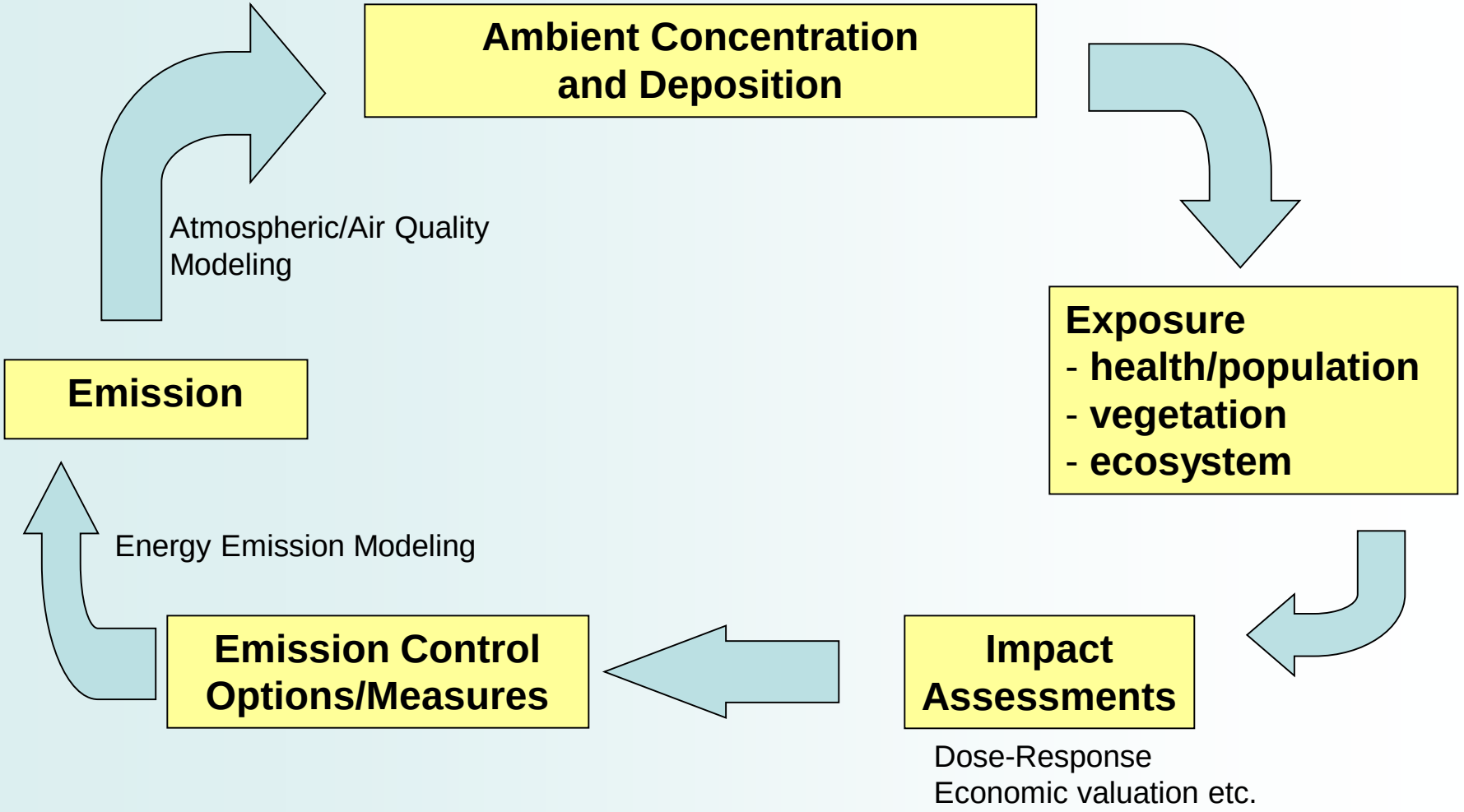
Small Cities also have PM_{10} Problem

In India, smaller towns displace megacities in the dubious list of ten most polluted cities of the country



Source: CSE, 2006

Schematic Cycle of Decision Support System in Air Pollution Control



Status and Major Issues in South Asia