

# Integrated Assessment on Environmental Strategies & Health Impacts due to Air Pollution in China



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# The main topics

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- Dose-response relationship
- Application of AIM/Material model (CGE)
- Application of AIM/Local model (bottom-up)
- GIS analysis (Idrisi Kilimanjaro)

# What is air pollution?

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- Air pollution is the presence in the atmosphere of a mix of chemicals and particles which is harmful to human, animal and plant.

**Human health**

# What are the sources of air pollution?

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- Nature: volcanic eruption, forest fire....
- Man-made:
  - combustion: fossil fuels, etc
  - non-combustion: production process, road dust.....

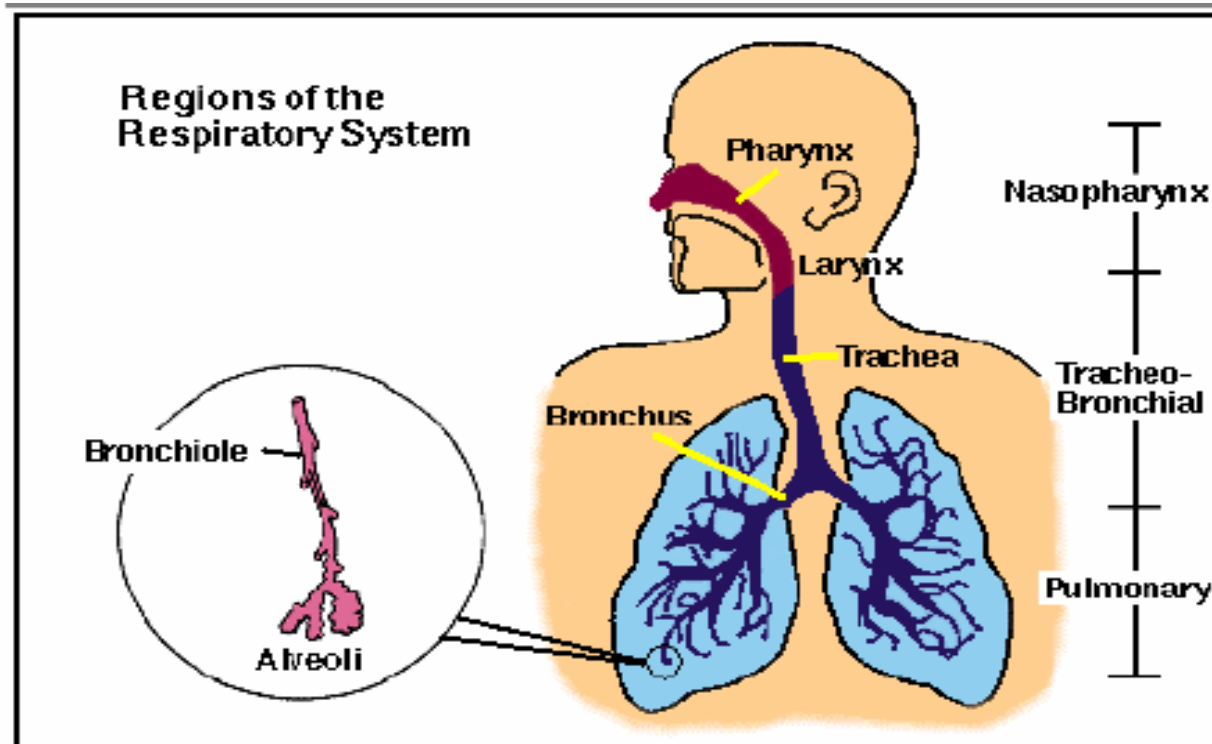
**Man-made air pollution**

# What are the components of air pollution?

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- Gaseity pollutants: SO<sub>2</sub>, NO<sub>x</sub>, CO, hydrocarbon
- Particulates: a mixture of solid particles and liquid droplets which toxicity vary in size and composition
  - Composition: Pb, Cd, Ni, Mn, Fe, Al, Br, PAH...
  - Carrier: gaseity pollutant, microorganism
  - Size: aerodynamic diameter

**Particulates less than 10um in diameter are most relevant to human health effects.**  
They can penetrate anywhere within the respiratory tract beginning with the nasal passages to the alveoli, deep within the lungs according to diameter size.



**PM<sub>10</sub> is the primary air pollutant in China at present**

# Quantification of health effects

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- ❑ The way we test the health effects of air pollution is to watch the time trend of the pollutants and see if it is similar to the time trend of health effects.
- ❑ Selection of air pollution indicator: PM<sub>10</sub> for China  
Independent negative impact, no-harvesting, no threshold  
Reference: WHO guidelines for air quality
- ❑ Selection of health outcomes
  - Sub-clinical health effects, lung function, immune function, low birth weight, intelligence quotient, et al. are excluded
  - Quantitative dose-response relationship between air pollution and health effects should have been established
  - Baseline disease data of the focused health effect in the target population should be available

# Selected health outcomes associated with PM<sub>10</sub> exposure in China

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- ❑ Non-accident mortality
  - Acute mortality
  - Chronic mortality
- ❑ Morbidity
  - Hospital visit (internal medicine & pediatrics)
  - Hospital admission (respiratory, cardiovascular & cerebrovascular)
  - Other diseases (acute upper respiratory tract infectious, chronic bronchitis )

**International Statistical Classification of Diseases (ICD)**



# Dose-response relationship

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$$E = POP \times M \times (e^{\beta \Delta C} - 1)$$

POP: the exposed population

M: baseline disease data of mortality or morbidity

$\beta$  : coefficient of dose-response relationship

$\Delta C$ : change of pollutant concentration

1. Deaths by age groups
2. Illness by age groups
3. Workday losses
4. Medical expenditure

Source of  $\beta$  :

-Local epidemiological studies are preferable

-Meta analysis (mean and 95% CI): refer to the manual of STATA, SAS

# How to value health impacts

## Two popular approaches in China

### 1. Human capital approach

The market value of a premature death equals the discounted flows of earning in the future if he had not died.

### 2. Contingent valuation approach

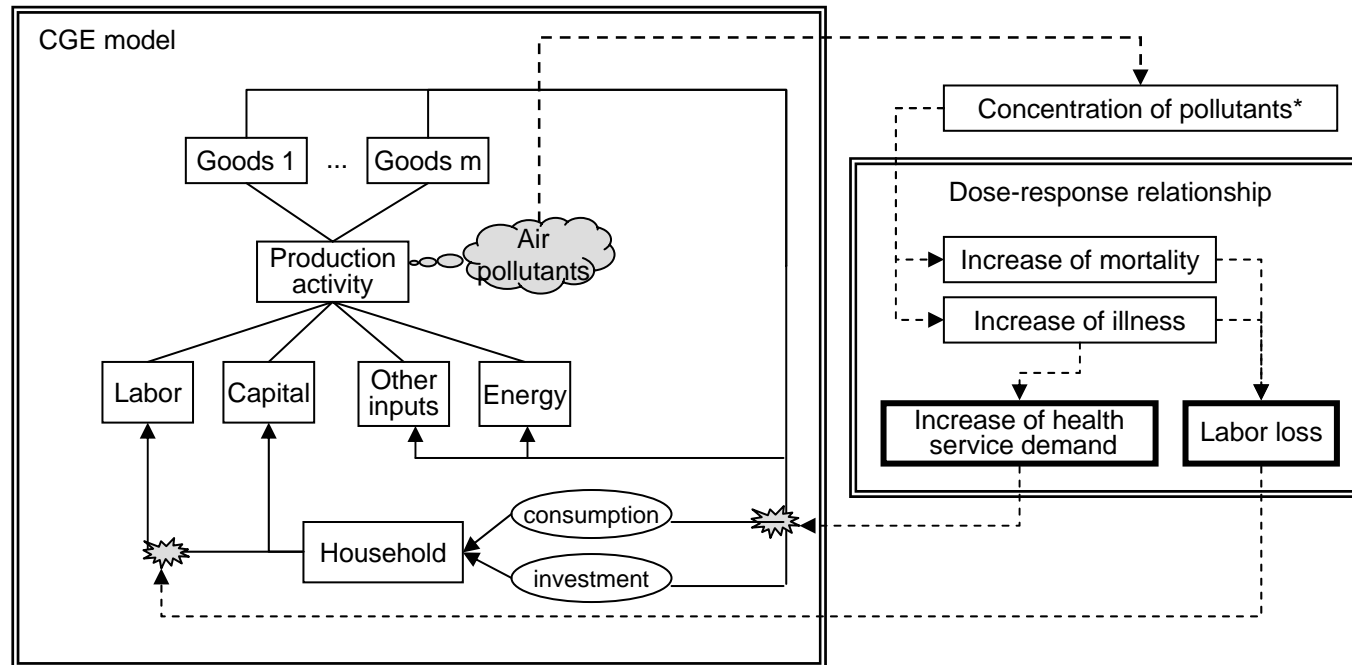
It is based on the personal subjective responses rather than actual behavior that how much an individual is willing to pay to reduce the risk of dying or illness.

**Implications: economic burden of disease from the point of view of people**

Reference: National burden of disease studies: a practical guide. WHO, 2001.

### 3. CGE model: health impacts on national economy

# Schematic Diagram of CGE model

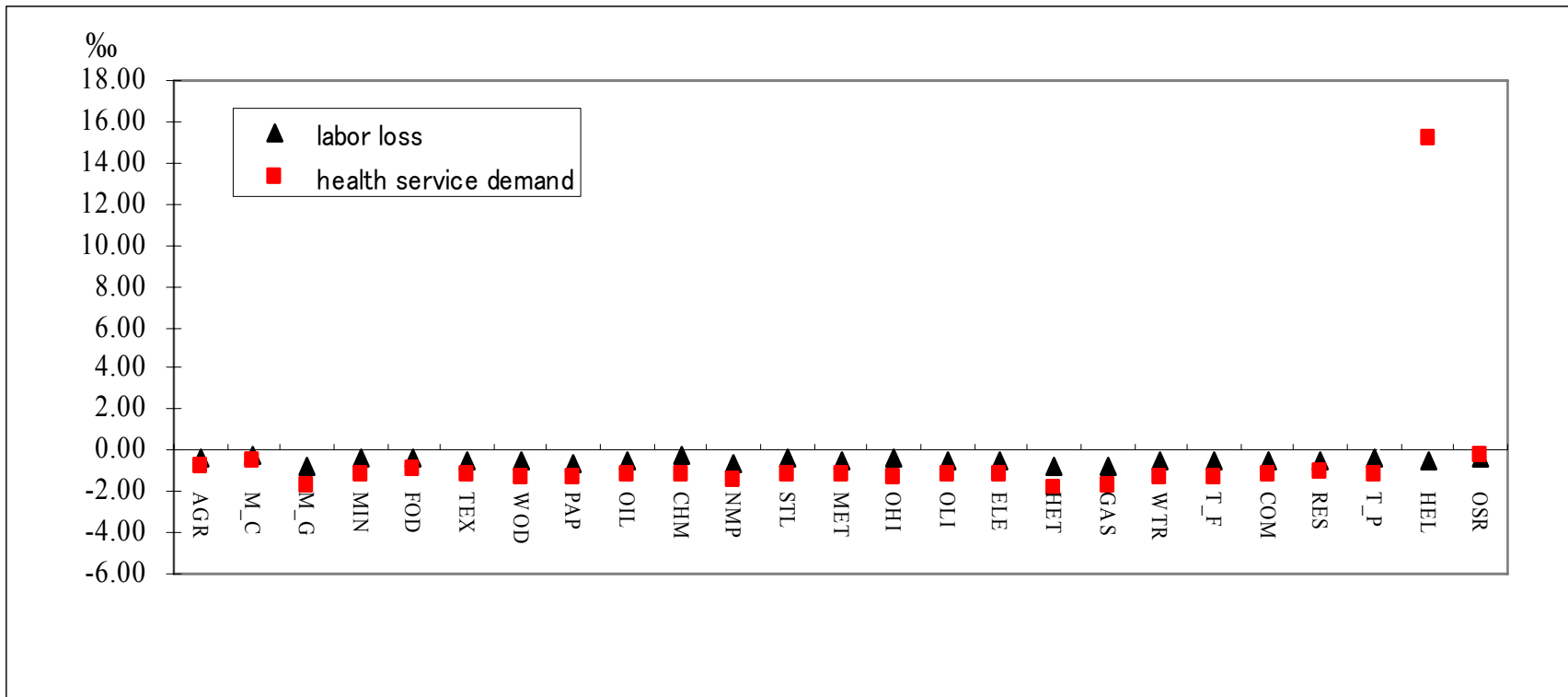


## **\$DEMAND:HOUSEHOLD**

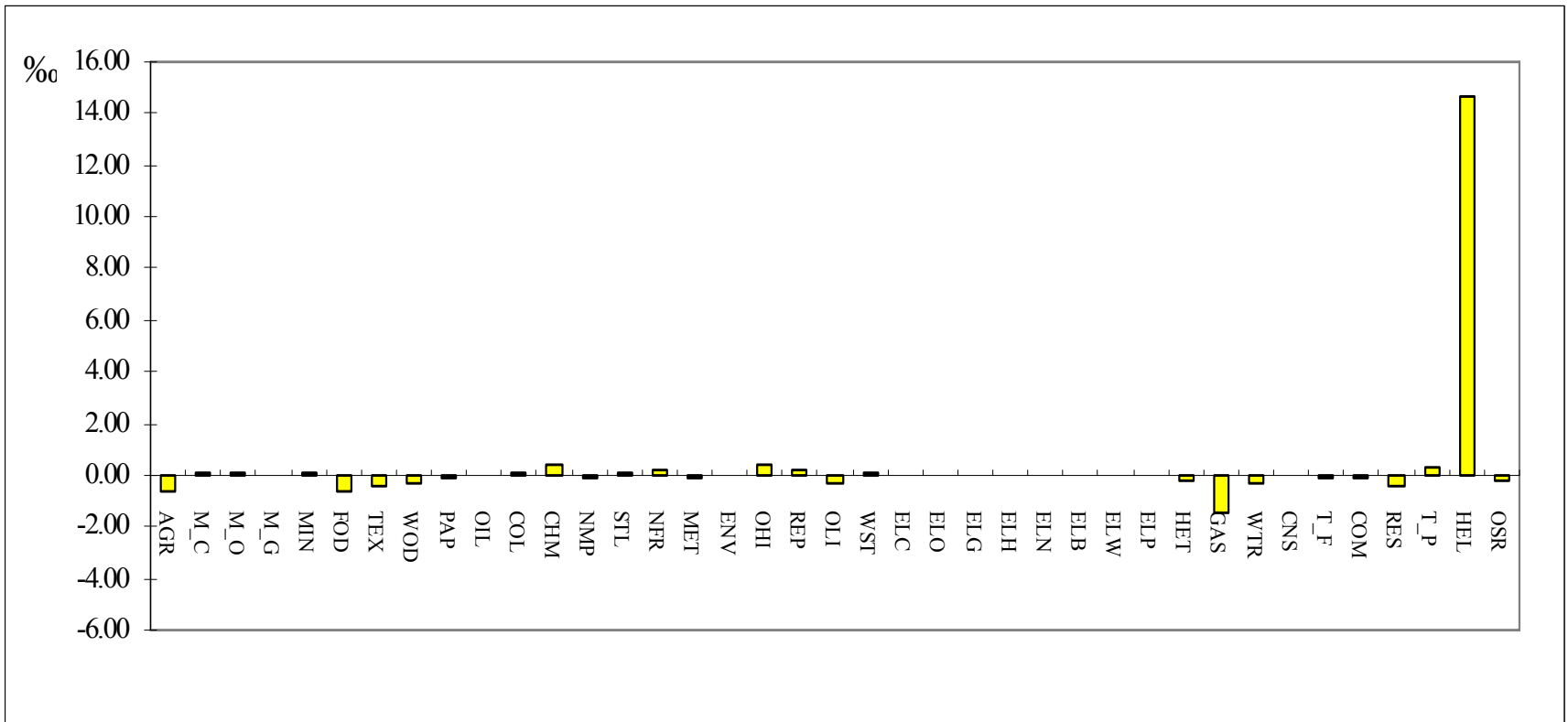
**Decrease in labor endowment**

**Medical expenditure should be treated as negative endowment**

# Impacts of labor loss and health service demand on the final consumption by commodities



# Impacts of health service demand on the output by sectors



# Structure of AIM/Material Model for health

Code	Sector and Commodity	Industry	
AGR	Agriculture, forestry, and fishery	I	
M_C	Coal mining		
M_O	Crude oil exploration		
M_G	Natural gas exploration		
MIN	Other mining		
FOD	Food and tobacco products		
TEX	Textile production		
WOD	Production of wood and wood products		
PAP	Paper and pulp production		
OIL	Oil refinery		
COL	Coking		
CHM	Chemical products		
NMP	Nonmetallic mineral products		
STL	Iron and steel		
NFR	Nonferrous metals		
MET	Metalworking machinery		II
OHI	Other machinery products		
REP	Maintenance and repair of machinery and equipment		
OLI	Other manufacturing products		
ELC	Coal-based power generation	ELE: Electricity	
ELG	Gas-based power generation		
ELO	Oil-based power generation		
ELH	Hydropower generation		
ELN	Nuclear power generation		
ELP	Photovoltaic generation		
ELW	Wind power generation		
ELB	Biomass power generation		
HET	Steam and hot water		
GAS	Gas		
WTR	Water		
CNS	Construction		
T_F	Freight transport	III	
COM	Commerce		
RES	Restaurants		
T_P	Passenger transport		
HEL	Health service		
OSR	Other services		

Inclusion of SO<sub>2</sub> and PM emissions as bi-products of economic activities in AIM/Material (data source: SEPA)

- total amount constraint on SO<sub>2</sub> and PM
- impose SO<sub>2</sub> tax

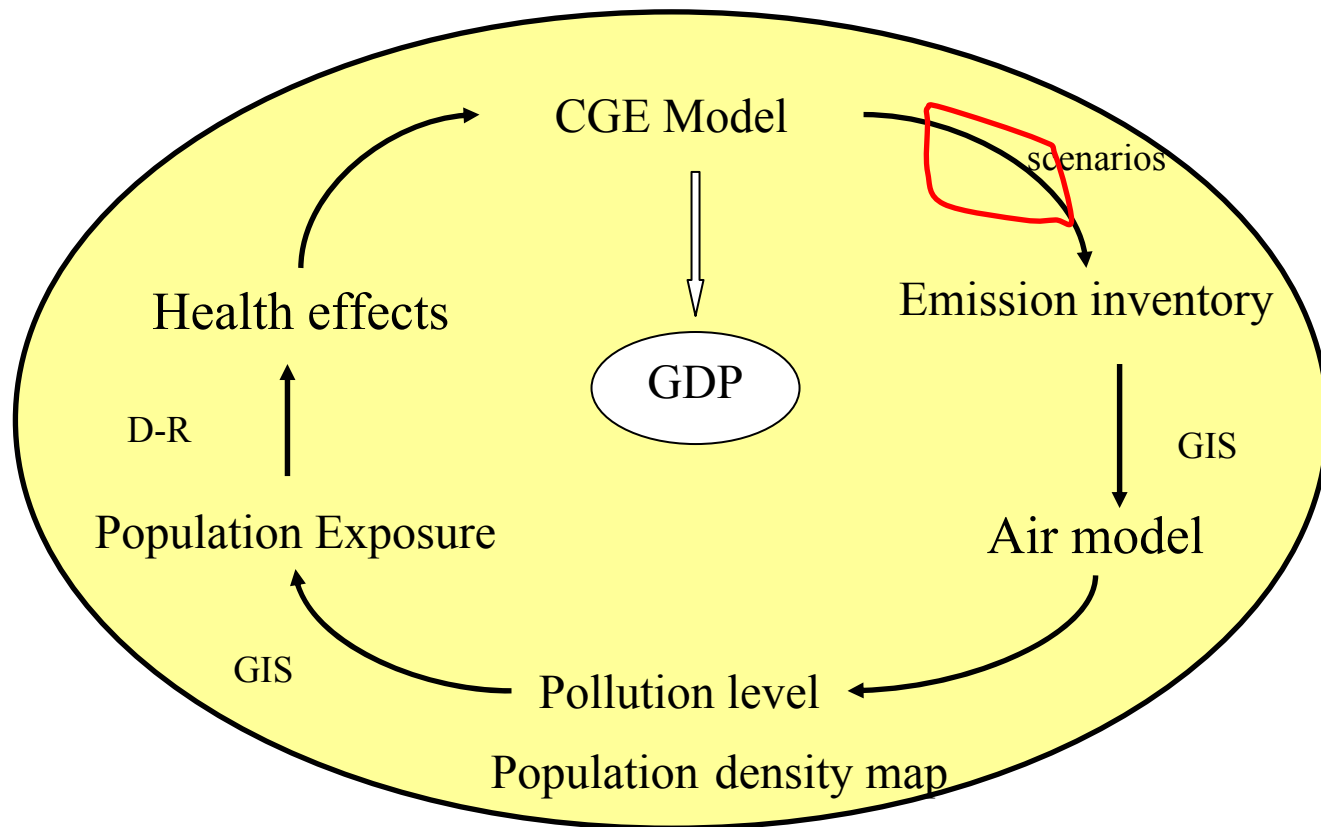
Household → rural /urban

Final consumption  
Investment  
Labor and capital endowments } rural/urban

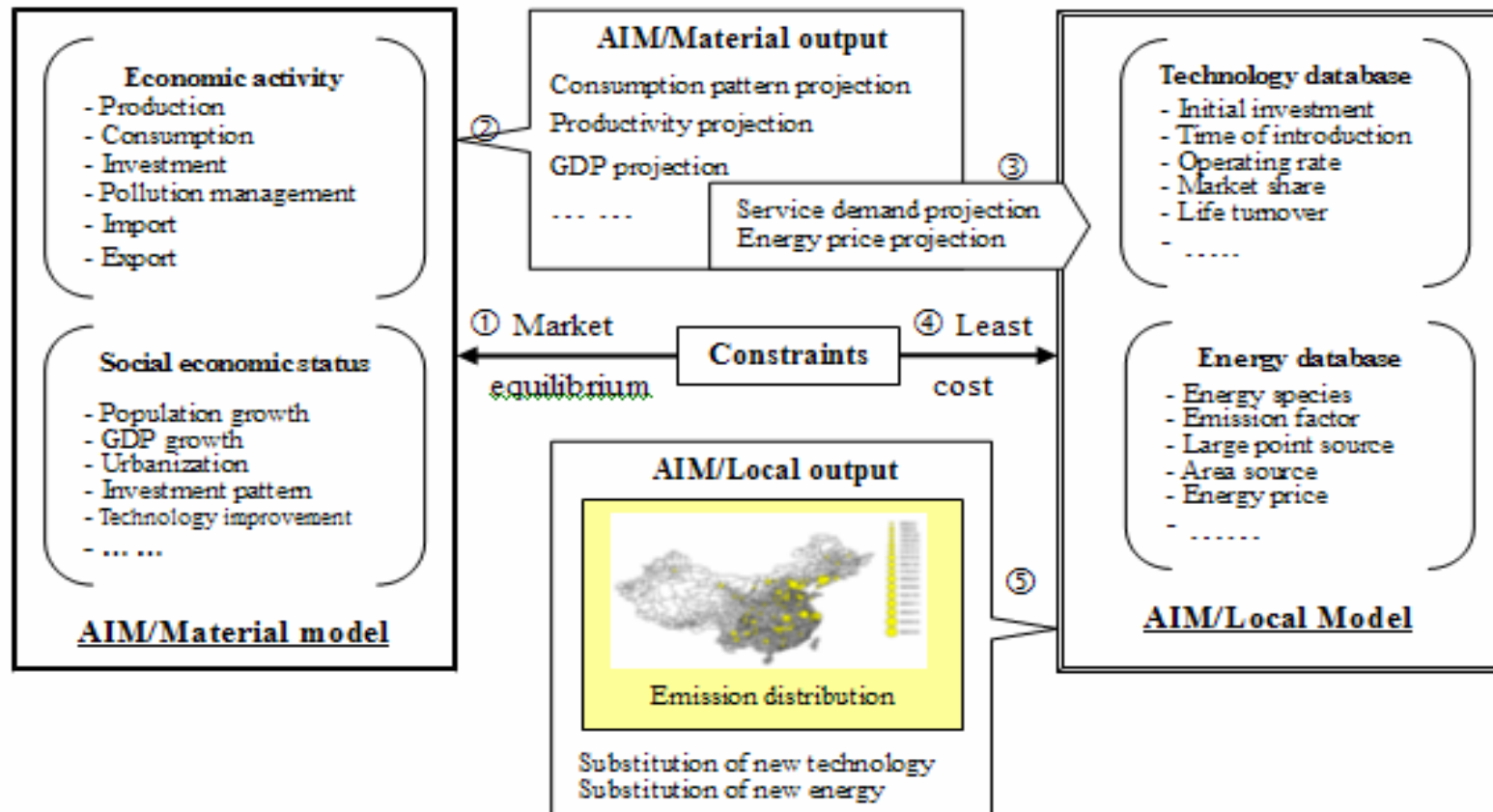
- different problem of air pollution
- change of energy structure in rural areas

# Schematic Diagram of Integrated Assessment

Environmental strategies — ? → Health effects — ? → National Economy



# Linkage between AIM/Material Model and AIM/Local Model





# Structure of AIM/Local Model of China

## Sectors classification

- ❑ Power generation
  - ❑ Cement production
  - ❑ Steel production
  - ❑ Nonferrous production
  - ❑ Other industries
  - ❑ Transport
  - ❑ Commerce and service
  - ❑ Urban household
  - ❑ Rural household
- Future demand is based on the projection on total output of commodities from AIM/Material
- Future demand is based on the projection on final consumption from AIM/Material

## Energy types

Raw Coal  
Briquette  
Coke  
Electricity  
Natural gas  
Crude oil  
Heavy oil  
Gasoline  
Kerosene  
Diesel oil  
LPG  
Town gas  
Heat  
Firewood

Future price is based on the projection from AIM/Material

## Emission factors

combustion and non combustion process

Database source : Energy Research Institute, China

# Data modification in AIM/Local model

## Change in Energy Data

No.	Energy *	Energy Price or Emission Factor *	Energy Factor *					
			Year1	Value1	Year2	Value2	Year3	Value3
1	[COAL1] Coal1(S content less than 1.0)	[Price] (Yuan/Gcal)	2000	54	2010	58.69	2020	
2	[HOIL] Heavy Oil	[Price] (Yuan/Gcal)	2000	126.5	2010	157.46	2020	
3	[ELE] Electricity(industry)	[Price] (Yuan/Gcal)	2000	558	2010	577.32	2020	
4	[NGS] Natural Gas	[Price] (Yuan/Gcal)	2000	187	2010	208.1	2020	
5	[COK] Coke	[Price] (Yuan/Gcal)	2000	78.5	2010	93.51	2020	

## Service Demand(Area Source)

No.	Region 1 *	Service *	Service Demand *					
			Year1	Value1	Year2	Value2	Year3	Value3
1	[BJ] Beijing	[STE] Crude Steel (1000 ton)	2000	1	2010	1	2020	
2	[TJ] Tianjin	[STE] Crude Steel (1000 ton)	2000	4	2010	4	2020	
3	[HB] Hebei	[STE] Crude Steel (1000 ton)	2000	1707	2010	1607	2020	
4	[SHX] Shanxi	[STE] Crude Steel (1000 ton)	2000	663	2010	663	2020	
5	[NMG] Neimengl	[STE] Crude Steel (1000 ton)	2000	311	2010	311	2020	

# Emission map (vector)

**Export for GIS**

Display Type for Emission:  Emission  Emission Instensity

Display Type for LPS and Area:  LPS added to Area  Divided between LPS and Area

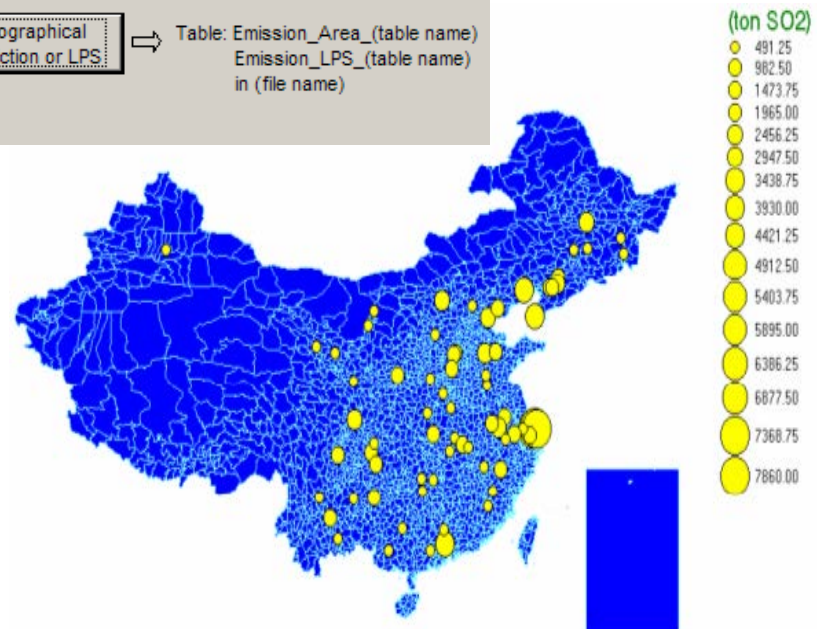
by region classification 2 or LPS → Table: Emission\_Area\_LPS in current database

File Name: C:\AIM-enduse\DATA\A-GIS.mdb

Table Name: cem

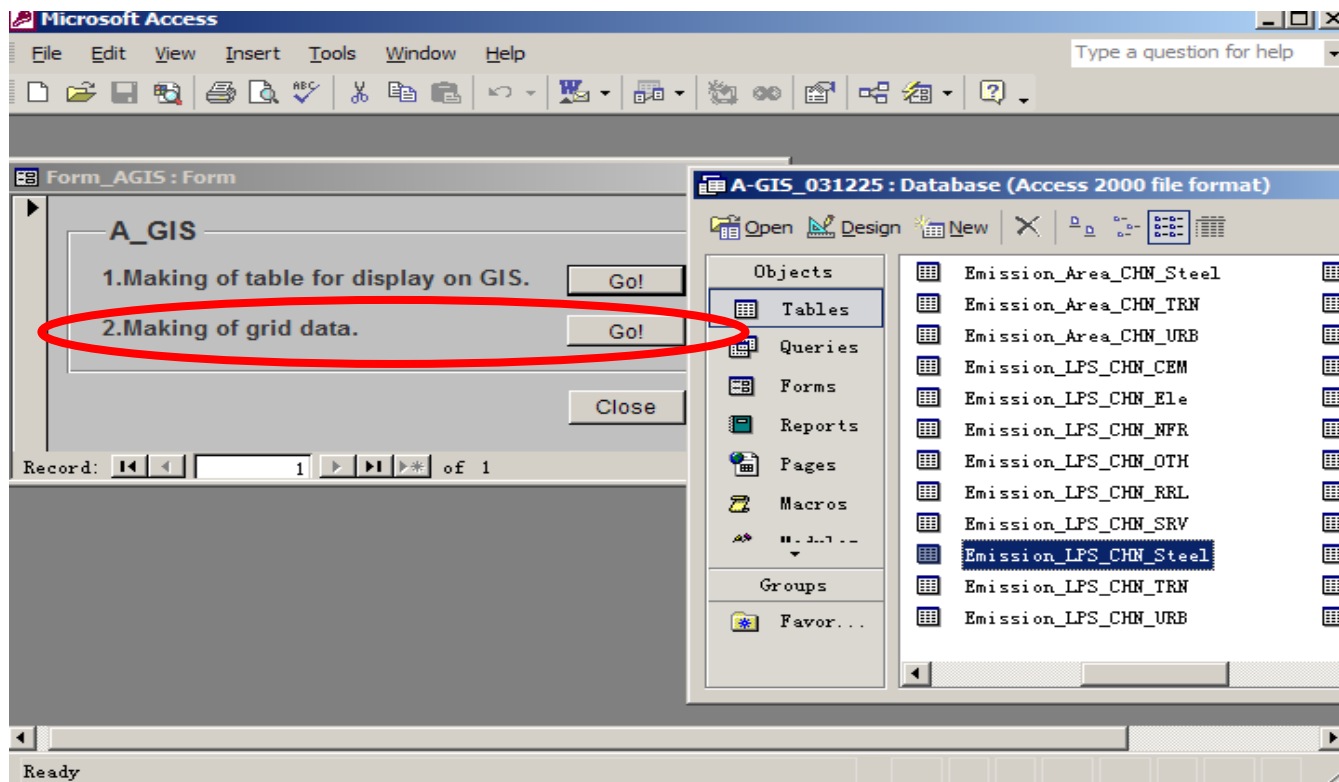
by geographical classification or LPS → Table: Emission\_Area\_(table name) Emission\_LPS\_(table name) in (file name)

[Correspondence of region classification 2 to geographical classification on GIS](#)



# A-GIS

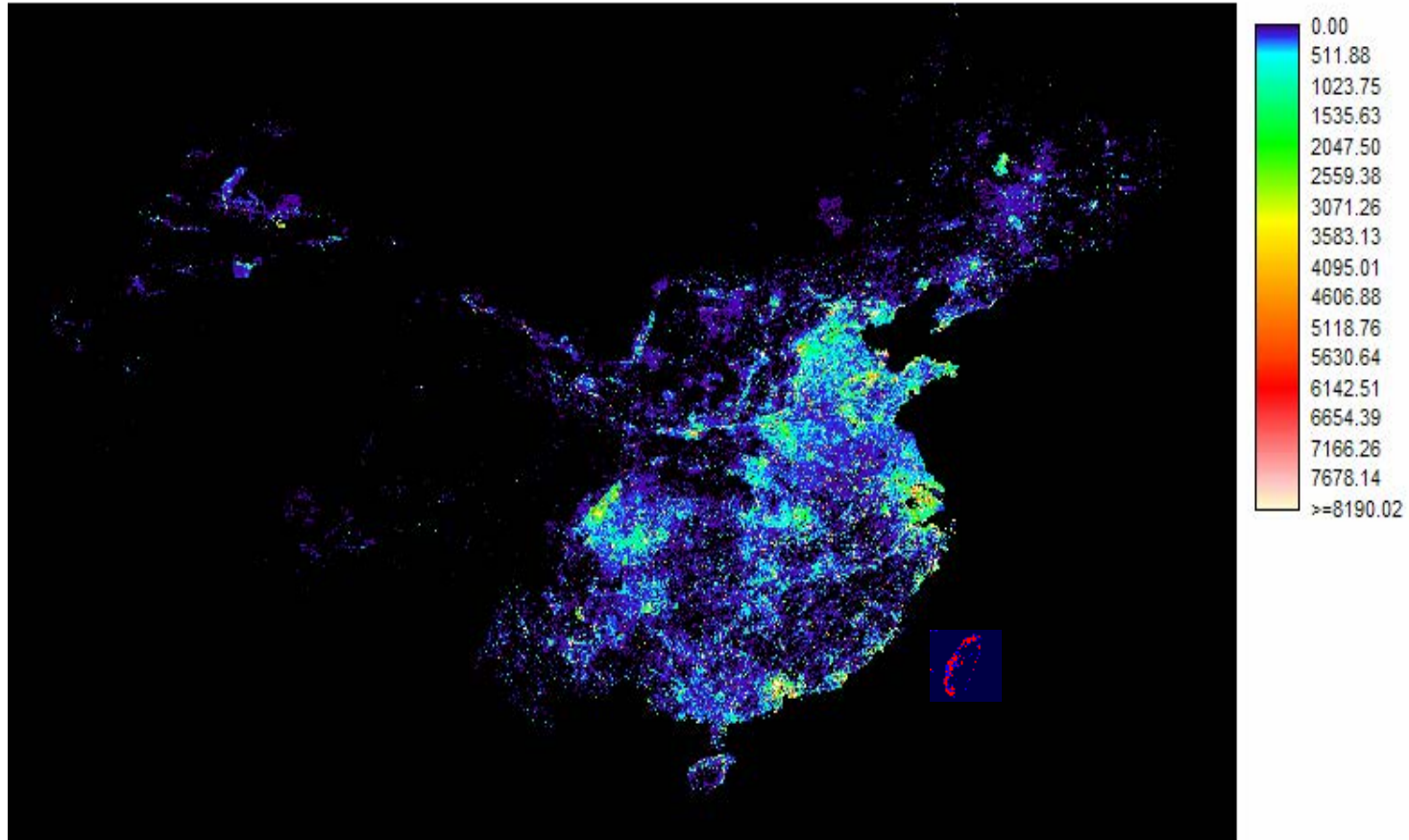
Convert the results of AIM/Local to grid data that will be the input of air model



Standard dataset: polygon map and grid map for Asia countries

# Grid map of emission (raster, 30sec)

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# GIS statistics (Idrisi)

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Pollutant concentration in each grid (real number file)

Reclass module →



Same reference system

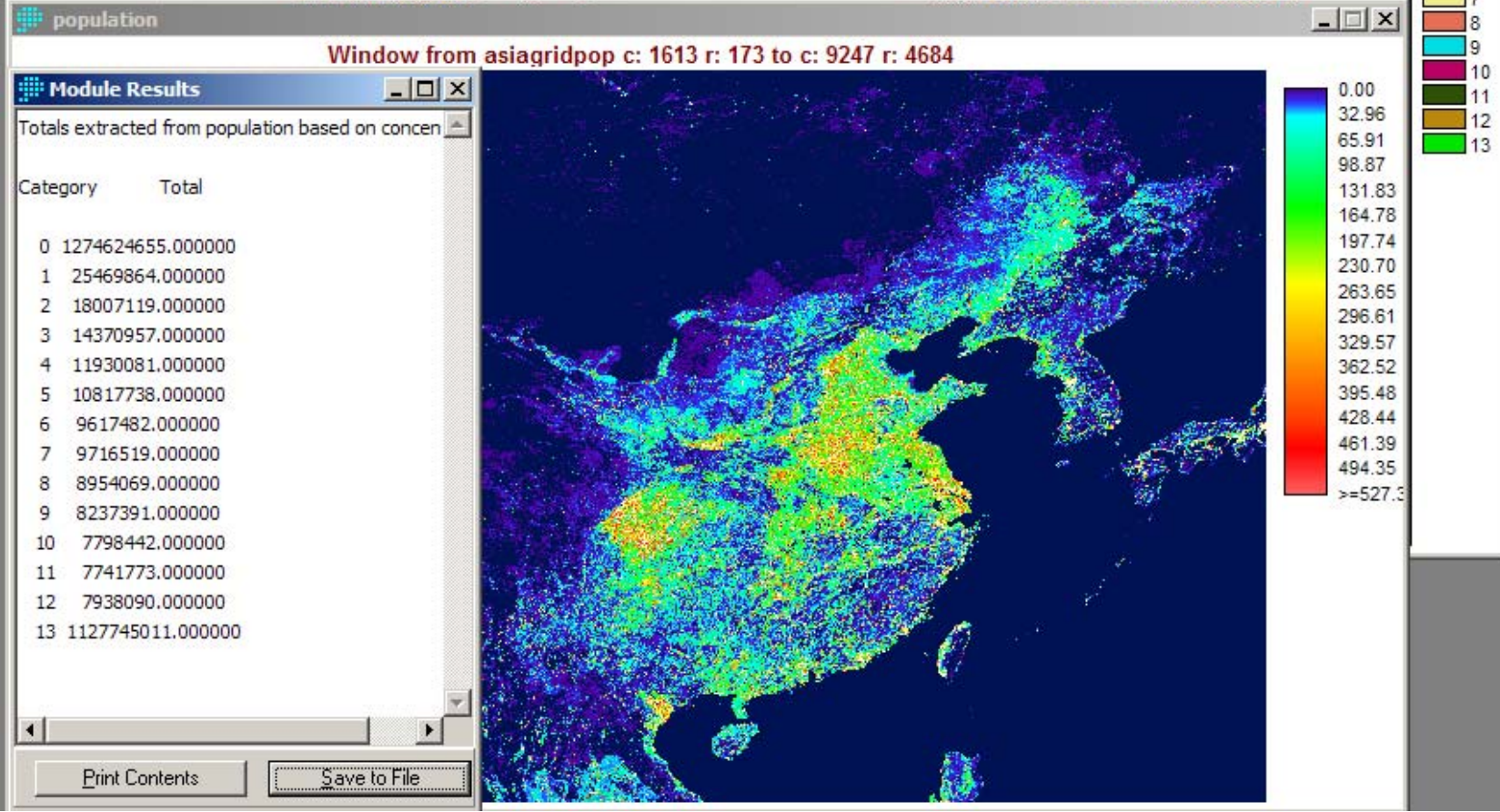
{ Pollutant level in each grid (integer file)  
Population in each grid

Extract module →



Numbers of population expose to certain pollution level





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Save to File





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Thank You!

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