

# The Integrated Assessment of Eco-environmental Vulnerability in China's Megacities

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# OUTLINE

1. Introduction
2. Method to assess the eco-environmental vulnerability
3. Case studies in China

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# Introduction



**Eco-environmental  
vulnerability!**

**Rapid industrialization**

**Waste Disposal**

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**Exponential population growth**



**Natural Disaster**



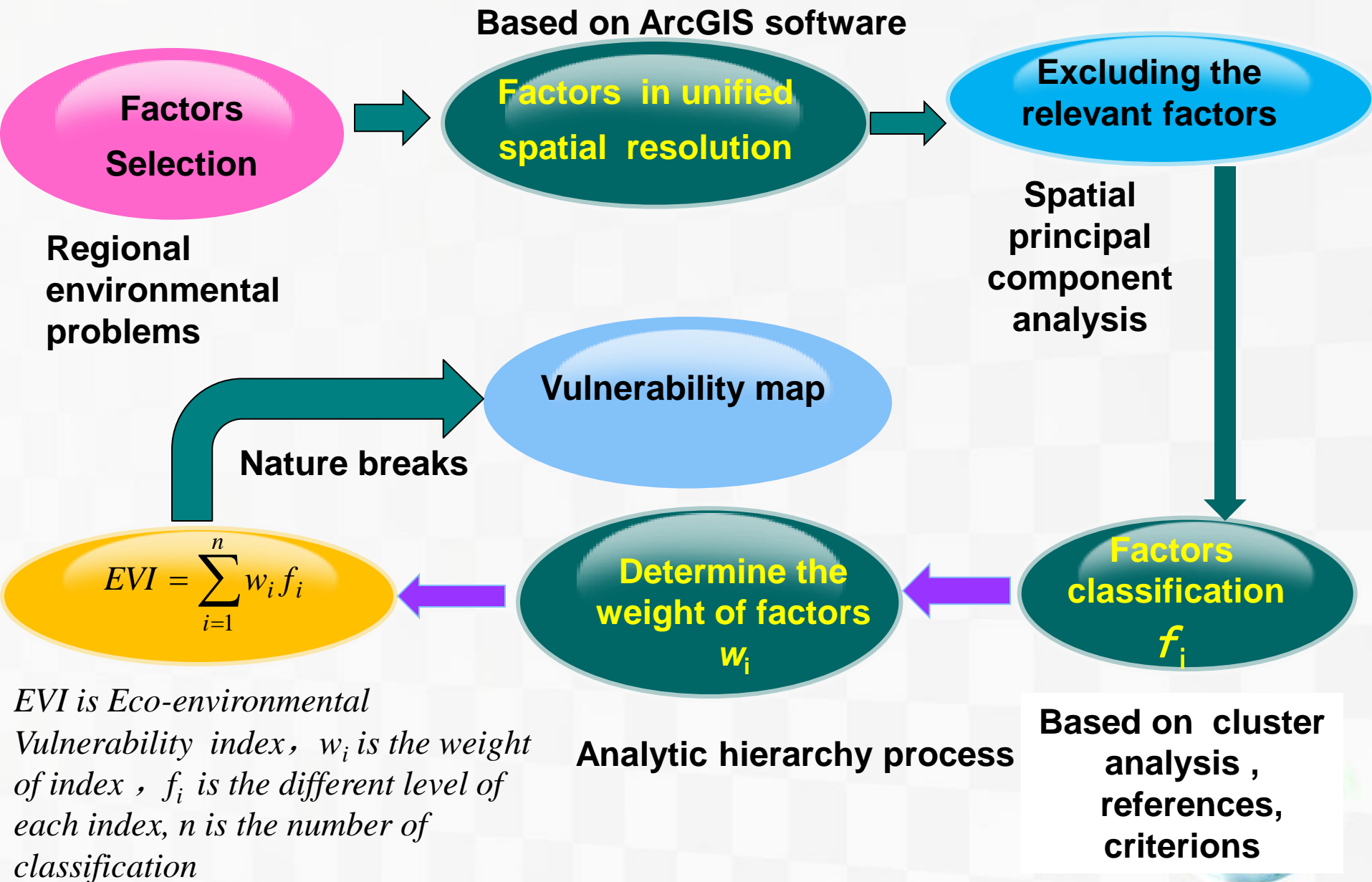
## QUESTIONS:

How to effectively analyze the eco-environmental vulnerability?

For a specific area, what factor cause the eco-environmental vulnerability?



# VULNERABILITY ASSESSMENT METHOD

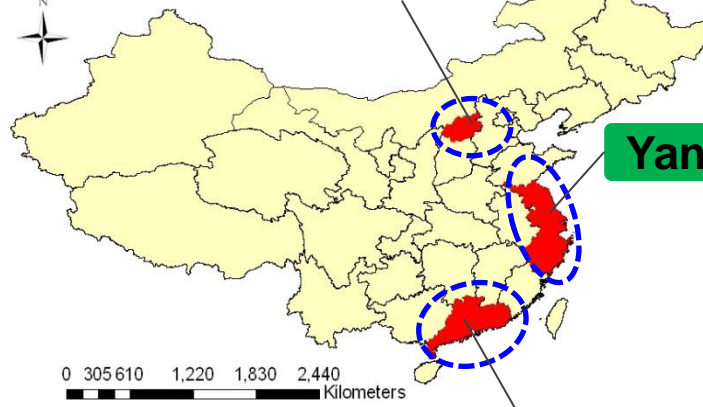


# STUDY AREA



fengjingtuplan.com

Northern Shanxi Province



Yangtze river delta

Pearl river delta



365JIA.CN

# 1 The Yangtze river delta

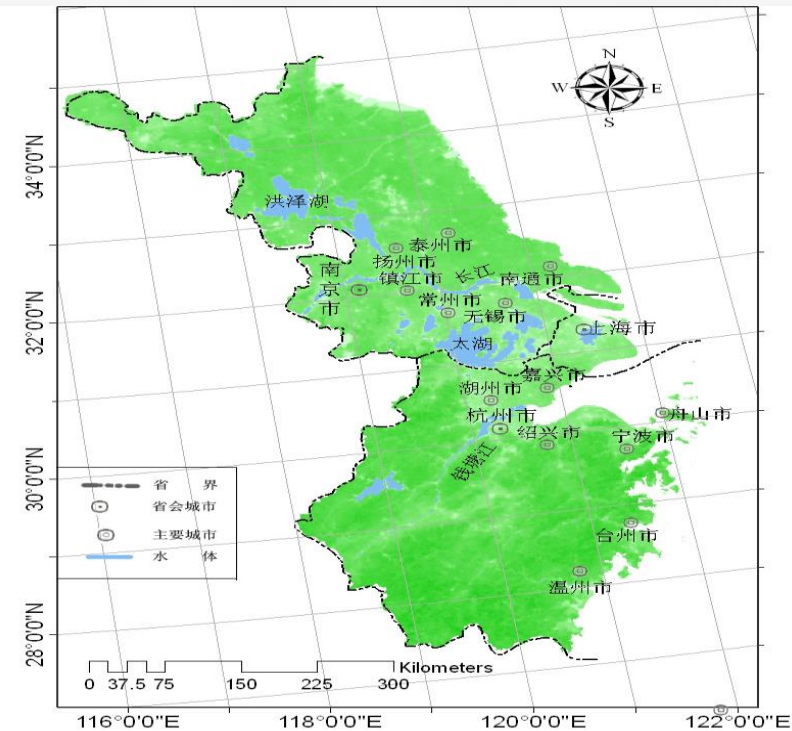
The Yangtze River Delta, being a place with the area of 2% of the country's total and the population of about 10% of the country's total, creating 21.8% of national total GDP and 22.8% of national revenue, which occupies a very important position in China's economy, it has become an important area to stimulate the economic growth in China.

**With the high intensity human activities, the eco-environment of Yangtze River Delta shows tendency of vulnerability.**

- ◆ The increasing threatens of flood
- ◆ Geological disasters
- ◆ High frequency of acid rain
- ◆ Serious soil erosion
- ◆ Biodiversity is threatened

**The tendency of vulnerability will have great impacts on sustainable development in Yangtze River Delta.**

23 cities, 13 cities are megacities!





CC related problem 1: **Increasing frequency of flood and drought events**

1. Accumulated temperature over 10°C
2. Days with the temperature over 35°C,
3. The number of days with heavy precipitation
4. Drought and flood frequency
5. Altitude

Problem 2: **Ground subsidence and cracks in the ground**  
(Caused by pollution and over-exploitation of underground water).

Problem 3: **Acid rain**—caused by pollution

1. Per Capita Water Resources
2. Per capita wastewater emissions
3. Per capita exhaust emissions,
4. Per capita solid waste
5. The intensity of fertilizer
6. Population density







## **CC related problem 4: soil erosion, coastline retrogradation and biodiversity threatened**

1. The intensity of soil erosion
2. Landscape diversity index
3. Land use change
4. Normalized difference vegetation index(NDVI)

## **Regional economic development level and investment in environmental protection**

1. The production value of "three wastes" utilization
2. Gross Domestic product (GDP)
3. The per capita farmer's net income

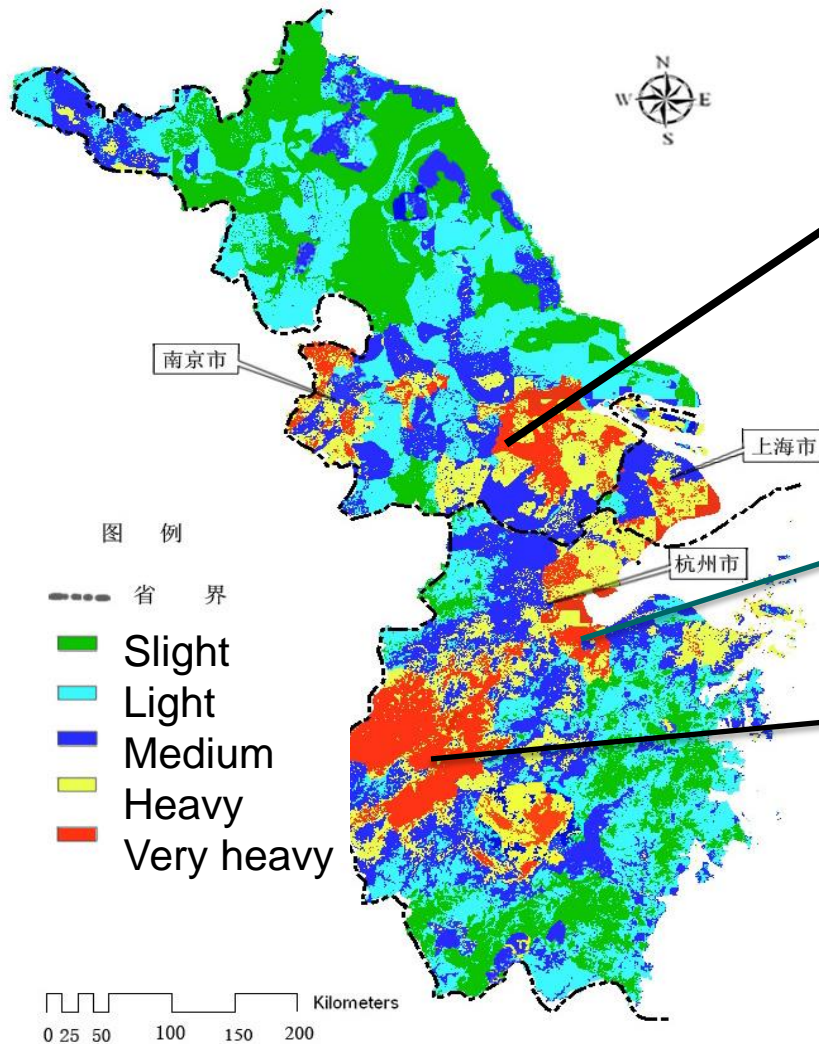


# FACTORS CLASSIFICATION AND WEIGHT CALCULATION

Factors	Classification					Weight
	1	2	3	4	5	
Days over 35° C (days/a)	<7.6	7.6-11.6	11.6-16.6	16.6-20.6	>20.6	0.138
Drought and flood frequency	slight	light	medium	heavy	Very heavy	0.196
Altitude (m)	>780	430-780	150-430	0-150	0	0.138
NDVI	>142	120-142	90-120	40-90	0-40	0.043
Landscape diversity index	>1.2	0.8-1.2	0.5-0.8	0.2-0.5	<0.2	0.014
Soil erosion intensity	slight	light	medium	heavy	Very heavy	0.020
arable land per capita (m <sup>2</sup> /p)	>1000	750-1000	450-750	320-450	<320	0.064
Per capita water resources (m <sup>3</sup> /p)	3500-8668	1850-3500	1200-1850	1000-1200	<1000	0.064
Per capita wastewater((t/p)	<18.5	18.5-53.5	53.5-106	106-207	>207	0.095
Per capita emissions(10 <sup>4</sup> m <sup>3</sup> /p)	<1. 3	1.3-3.6	3.6-6.6	6.6-15	>15	0.095
The intensity of fertilizer (g/m <sup>2</sup> )	<25	25-70	70-100	100-160	>160	0.028
Land use change	3, 4	1, 2	0	-1, -2	-3, -4	0.043
The production value of "three wastes" utilization (yuan/p)	>1800	900-1800	430-900	130-430	<130	0.028
Population density (p/km <sup>2</sup> )	<1900	1900-6300	6300-14000	14000-26000	>26000	0.020
GDP (10 <sup>4</sup> yuan /km <sup>2</sup> )	>133000	64300-133000	26950-64300	6000-26950	<6000	0.014

# RESULTS

## 1. Yangtze river delta



Taihu lake basin: frequent flood, high wastewater and exhausts emissions to cause water pollution. over-exploitation of underground water cause the ground subsided

Frequent flood , serious soil erosion, high emissions.

Drought, large forest area were changed to industrial use. serious industrial pollution.



The eco-environmental vulnerability Map in 2004

# RESULTS 1. Yangtze river delta




## Suggestions for decision maker in heavy vulnerability area

CC related flood and drought, as well as pollution is the main eco-environmental problem of this area.

- Construction of infrastructure to prevent natural disasters
- To cope with pollution, improve the utilization of industrial wastes, sewage and garbage
- Reduce human disturbance and destruction



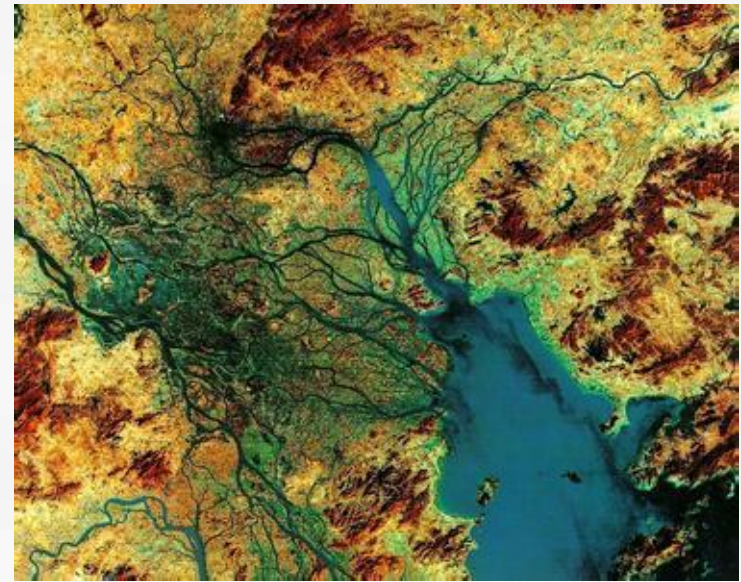
## 2. Pearl river delta

搜索 

**The Pearl River Delta is China's most developed and one of the fastest growing economic region.**

**During 1984-2004, Pearl River Delta region's gross domestic product ( GDP ) increased at an average rate of 20%.**

**It's area is about 0.4% of the country's total but it's GDP is nearly 10% of the country total.**



6 Megacities





CC related problem 1: **Sea level rise**

**Altitude**

CC related problem 2 : **Increasing frequency of flood**

1. Days of heavy precipitation
2. The area of arable land easy to be flooded
3. The intensity of soil and water losses
4. NDVI
5. Landscape index
6. Land use change

Problem 3: **Pollution**

1. **Waste discharge**
2. **Percentage of people possessing motor vehicles**
3. **Intensity of pesticide**
4. **Exhaust emissions**
5. **Index of environmental protection investment**
6. **Intensity of fertilizer**



# 2. Pearl river delta

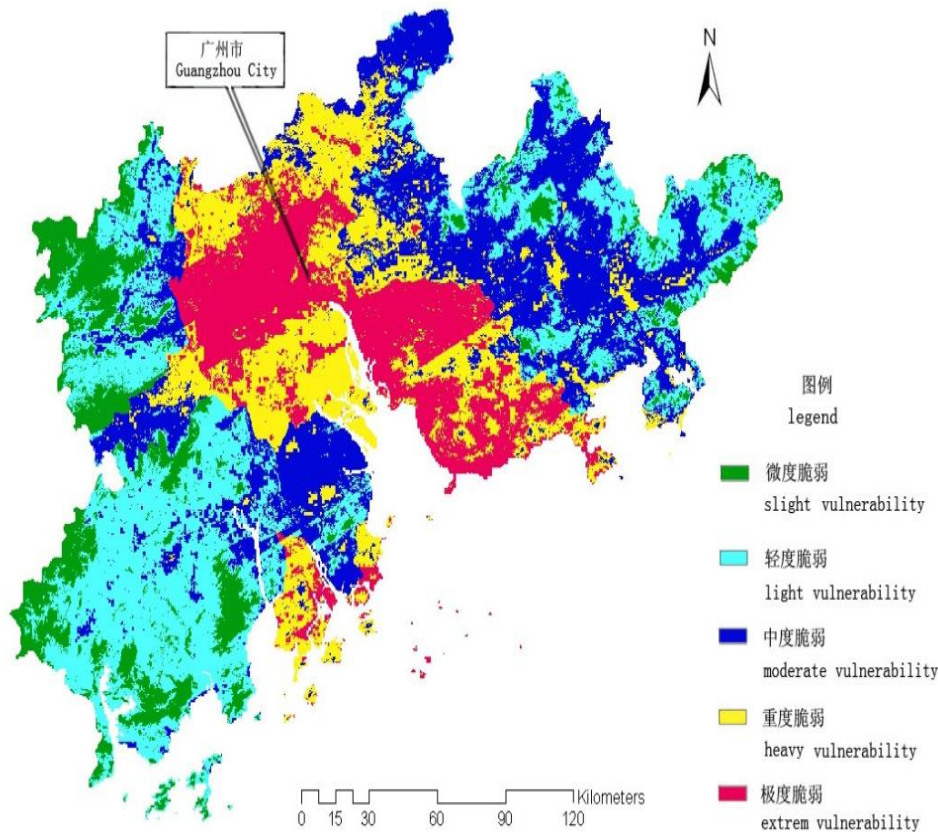


## FACTORS CLASSIFICATION AND WEIGHT CALCULATION

Factors	Classification					Weights
	1	2	3	4	5	
<b>I<sub>1</sub> Altitude (m)</b>	>596.4	356.6-596.4	189.3-356.6	66.6-189.3	<66.6	0.172
<b>I<sub>2</sub> Days of heavy rain/ (d/a)</b>	<53.5	53.5-54.0	54.0-54.7	54.7-55.4	>55.4	0.116
<b>I<sub>3</sub> Water and soil loss rate (%)</b>	<0.3	0.3-1.1	1.1-2.5	2.5-3.7	>3.7	0.076
<b>I<sub>4</sub> Flood arable land area (%)</b>	<20.8	20.8-40.8	40.8-54.2	54.2-68.9	>68.9	0.035
<b>I<sub>5</sub> NDVI</b>	>0.44	0.39-0.44	0.34-0.39	0.28-0.34	<0.28	0.051
<b>I<sub>6</sub> Landscape diversity index.</b>	>515.3	309.3-515.3	157.1-309.3	55.7-157.1	<55.7	0.012
<b>I<sub>7</sub> Population density/ (p/km<sup>2</sup>)</b>	<706.2	706.2-2439.7	2439.7-5521.5	5521.5-11235.7	>11235.7	0.116
<b>I<sub>8</sub> Waster water discharge / (10<sup>2</sup>t/km<sup>2</sup>)</b>	<51.8	51.8-200.4	200.4-467.1	467.1-666.3	>666.3	0.076
<b>I<sub>9</sub> Exhaust emissions/ (10<sup>4</sup>/km<sup>2</sup>)</b>	<2.9	2.9-15.0	15.0-51.8	51.8-68.2	>68.2	0.076
<b>I<sub>10</sub> Land use change</b>	3, 4	1, 2	0	-1, -2	-3, -4	0.035
<b>I<sub>11</sub> Intensity of fertilizer/ (kg/km<sup>2</sup>)</b>	<35.4	35.4-46.2	46.2-60.7	60.7-84.5	>84.5	0.023
<b>I<sub>12</sub> Intensity of pesticide/ (kg/km<sup>2</sup>)</b>	<1.4	1.4-2.6	2.6-4.1	4.1-6.4	>6.4	0.023
<b>I<sub>13</sub> Percentage of people possessing motor vehicle</b>	<14.5	14.5-19.5	19.5-24.6	24.6-30.5	>30.5	0.017
<b>I<sub>14</sub> Index of the environmental protection investment</b>	>2.30	2.08-2.30	1.75-2.08	1.70-1.75	<1.70	0.172



## 2. Pearl river delta



Low altitude, frequent flood disaster, large waterlogged farmland

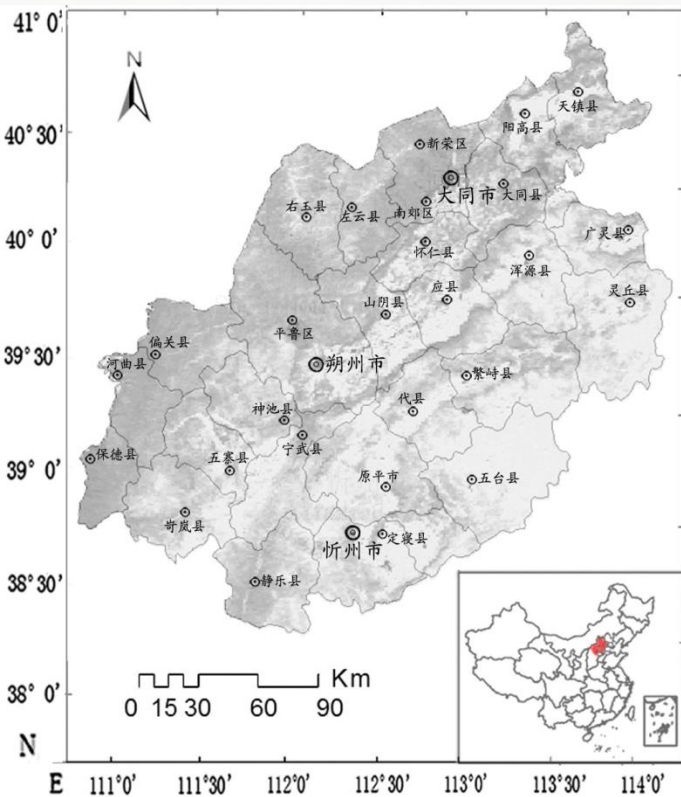
vegetation destroyed  
serious pollution  
insufficient environmental protection investment

The eco-environmental vulnerability Map in 2005





# 3. Northern Shanxi Province



The study area is located in the agriculture-pasture ecotone of northern China. It's ecosystems are very fragile to climate change.

It has rich mineral resources, coal, non-ferrous metals.

The large-scale, high-strength development of mineral resources have been conducted in this area.

The human disturbance will change the area greatly. So it is essential to evaluate the eco-environmental vulnerability of this area.





CC related problem 1: **Drought, big wind, water and soil losses, land degradation**

1. **Dryness index**
2. **Strong wind days**
3. **The intensity of soil and water losses**
4. **NDVI**
5. **Landscape index**
6. **Land use change**
7. **Per capita water resources**

Problem 2 : **Intensity human activity**

1. **The percentage of second industry to GDP**
2. **Population density**
3. **Index of environmental protection investment**
4. **Intensity of fertilizer**



# 3. Northern Shanxi Province

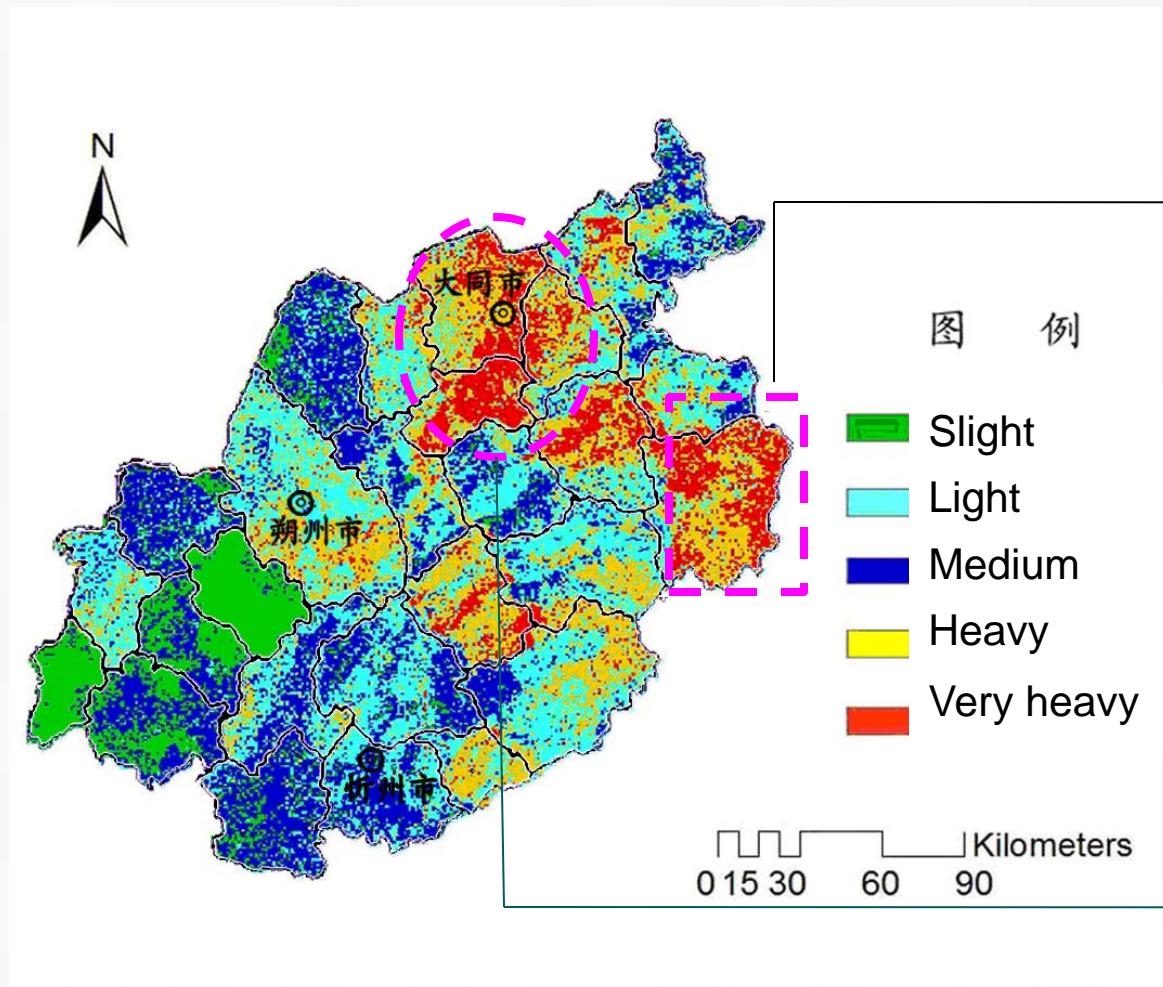


## FACTORS CLASSIFICATION AND WEIGHT CALCULATION

Indexes	Classification					Weights
	1	2	3	4	5	
<b>Dryness</b>	<1	1-1.25	1.25-4	4-4.54	>4.54	0.21
<b>Strong wind days/(d/a)</b>	<33	33--54	54--87	87-129	>129	0.05
<b>Soil erosion</b>	No erosion	Mild erosion	Moderate erosion	Severe erosion	Serious erosion	0.09
<b>Yield /((kg/ha)</b>	>6853	3364- 6853	2257-3364	1321-2257	<1321	0.03
<b>NDVI</b>	>0.41	0.34-0.41	0.29-0.34	0.24-0.29	<0.24	0.13
<b>Land use</b>	water area	forestland、 high coverage grassland	open forest, mild coverage glassland,shrub	Low coverage grassland, paddy, dryland	Urban land, rocky, saline- alkali land	0.21
<b>The second industry percentage of GDP/(%)</b>	<0.20	0.20-0.32	0.32-0.50	0.50-0.60	>0.60	0.13
<b>Per capita water resources/(km<sup>2</sup>)</b>	>196.3	96.4-196.3	41.2-96.4	8.5-41.2	<8.5	0.04
<b>Population density/(P/km<sup>2</sup>)</b>	<22	22-2662	2662-7296	7296-13508	>13508	0.02
<b>The index of environmental protection investment</b>	>2.67	1.7-2.67	1.00-1.7	0.42-1.00	<0.42	0.09



# RESULTS 3. Northern Shanxi Province



Large percentage of the second industry , insufficient environmental protection investment  
Sever drought

low vegetation coverage, high intensity of soil erosion, irrational land use, water shortage

The eco-environmental vulnerability map





## Conclusion

Assessment of vulnerability is important as it enables identification of areas or resources at risk, and the threats posed by the diminution or loss of such resources that will threaten future sustainable development. The methods developed in this study were useful.

### Uncertainties:

- >> Data transformation
- >> Factors selection
- >> Weight calculation



# Thanks!

