Integrating Geospatial and Statistical Information for Geographical Conditions Monitoring of China

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Outline

1. Geographical Conditions Monitoring of China
2. Comprehensive Geo-statistical analysis for GCM
3. Experiments and discussions

1、Geographical Conditions Monitoring of China

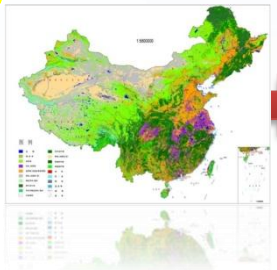
1.1 Concepts

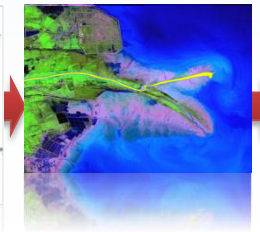
- **National condition,** refers to the combination of a country's socio-economic development, geographical conditions, cultural and historical traditions, and international relations.

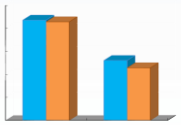
- **Geographical condition (GC)** is an important component of the national condition and closely connected with human activities.

  - ✓ Focuses on the analysis, study and description of the national situation from the aspects of spatial distribution, characteristics and relationship, etc.

Incorporating all types of geographic databases and geospatial technologies







Data acquisition

Information extraction

Statistics

Geographical conditions monitoring (GCM) means dynamic and quantitative monitoring of geographical features and statistical analysis as well as their changes in the quantity and frequency, distribution characteristics, regional differences and trends.

1.2 Why GCM?

- In the **next 20 years**, China will be witnessing a dramatic transformation, a large amount of construction and other big changes together with greater pressure to implement resource conservation and environmental protection.
- **GCM is critical** to optimal planning of industrialization and urbanization, development of land and promote key construction projects effectively.

1.3 Related activities

In recent years, Chinese government ministries have implemented thematic surveying in the fields such as agriculture and forestry, land use, water conservation, environmental protection, natural resources and ecological changes.

- Land use investigation
- Environment monitoring
- Agricultural condition monitoring
- Forest resources monitoring
- Disaster monitoring
- Mining resources monitoring
- Water resources census
- Weather monitoring

Similar Projects Worldwide.

- The USGS launched its five-year plan called “Geographic Analysis and Monitoring Program” (GAM) in 2002 and this has been running continuously since then.
- The EU launched the program called "Global Monitoring for Environment and Security (GMES)" in 2003.
- Japan has always attached importance to the basics of geographical conditions monitoring.
- …….

monitoring programs

- National Land and Water Resources Audit
- North Watch

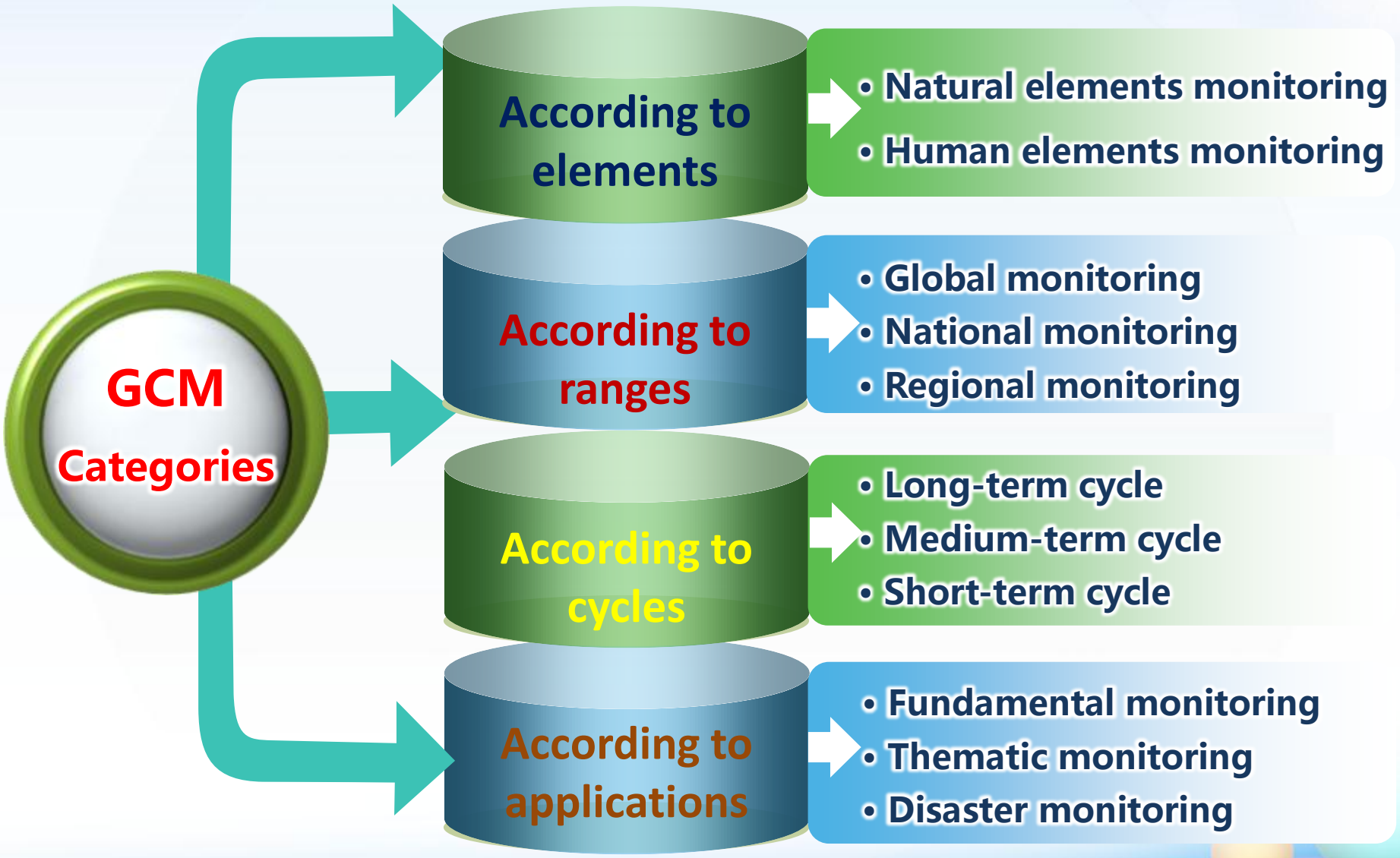
Problems Addressed by GCM

- **Inconsistency and discontinuity** in results of generated by of relevant ministries
- **Lacking of cutting edge technologies** in investigation and dynamic monitoring
- **Missing a comprehensive picture** that consists of authoritative, objective and accurate information related to geographical conditions.

1.4 Contents of GCM

- Categorized according to different perspectives.
  - ✓ Elements
  - ✓ Scope
  - ✓ Cycle
  - ✓ Applications
  - ✓ .....

Categories for GCM



Thematic monitoring

- ecological environment,
- urban development,
- the effects of implementing major engineering projects, land reclamation schemes,
- ……

Disaster monitoring

- earthquakes,
- floods,
- droughts,
- mud/rock-slides,
- land subsidence,
- ……

Fundamental monitoring

- topography,
- vegetation coverage,
- water and wetland areas,
- glaciers and permanent snow,

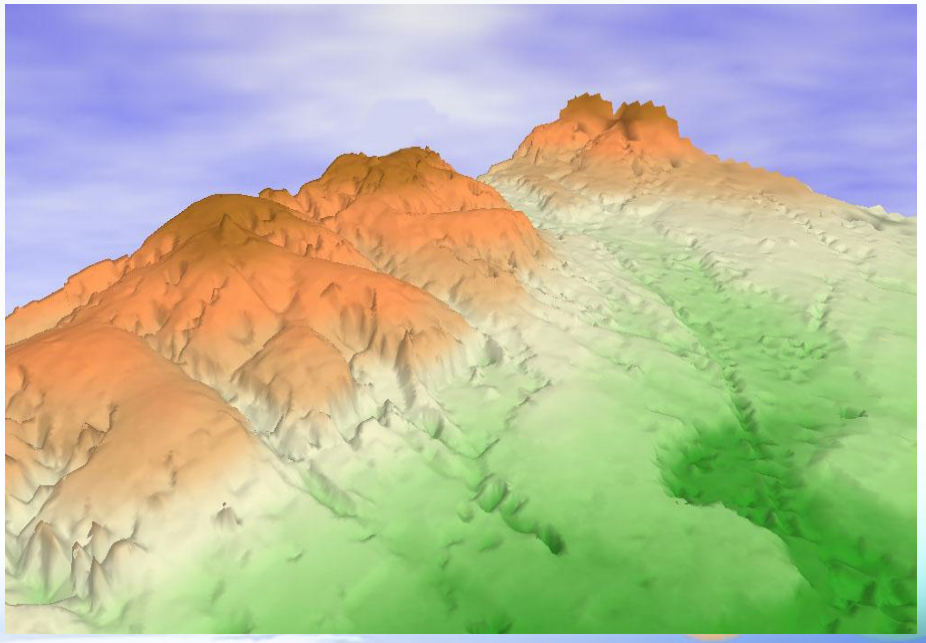
Basis

- desert and bare land,
- traffic networks,
- residential sites and facilities,
- geographical boundaries
- ……

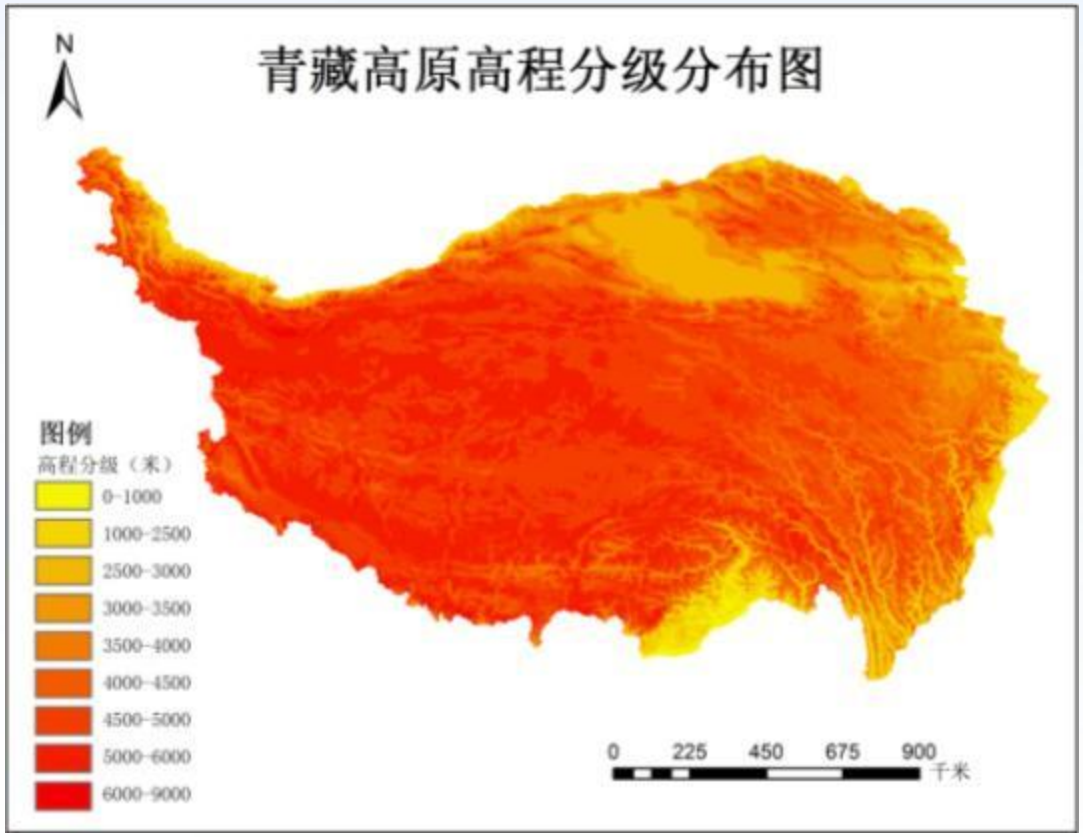
1.4.1 Fundamental monitoring

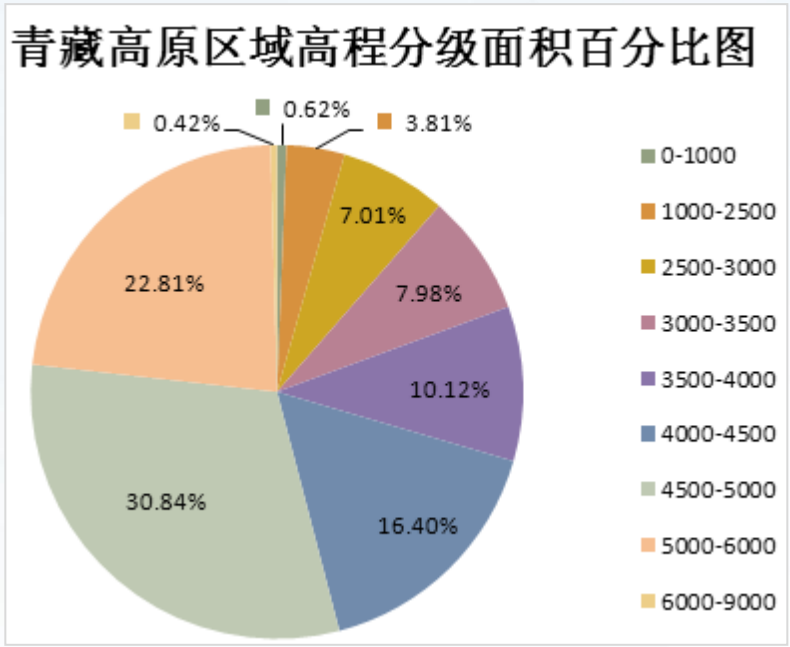
- To monitor the natural and human elements over the Earth's surface.
  - Including spatial distribution, characteristics and relationships, etc.
  - Belonging to a basic monitoring, the basis for thematic monitoring and disaster monitoring
- Fundamental monitoring refers to
  - **topography,**
  - **land cover,**
  - **geographical boundaries.**

- **(1) Topography**
  - Here ‘topography’ specifically means the identification of specific landforms, such as plains, plateaus, hills and mountains.
  - By using terrain units such as slope, elevation, and aspect, the range of national landform types can be obtained.



Elevation classification: a case study of the Qinghai Tibet Plateau

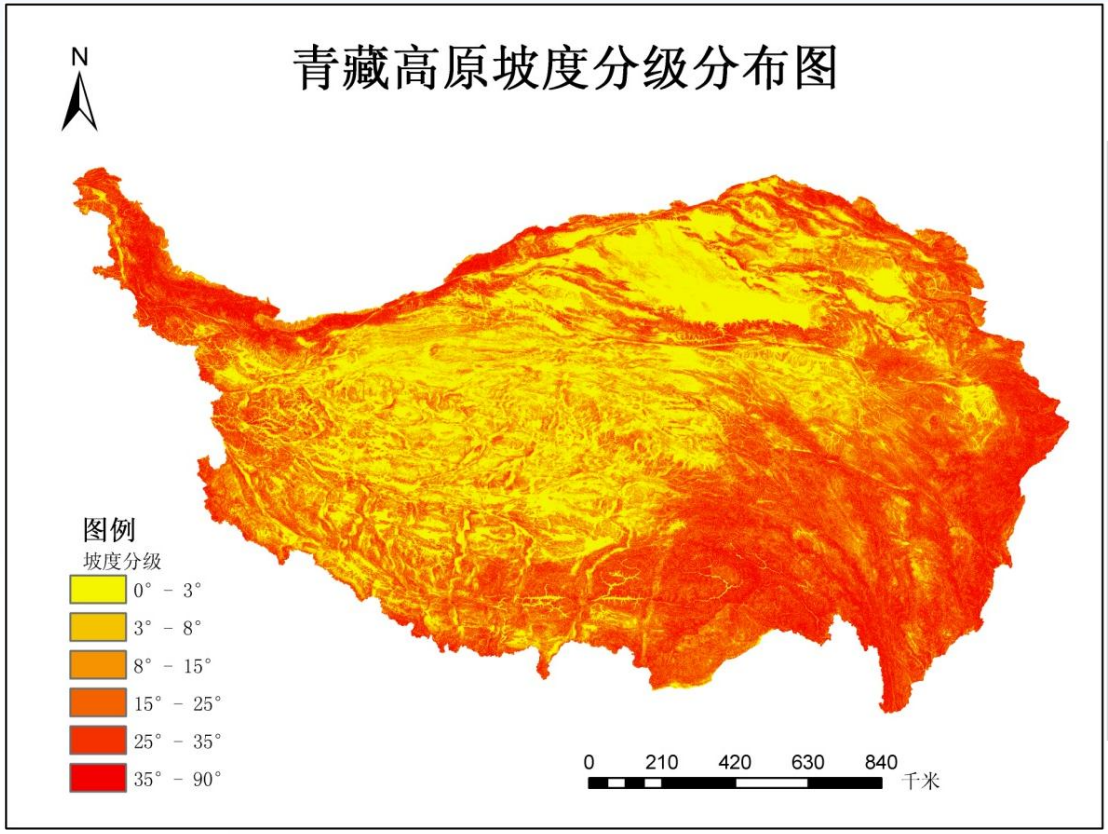


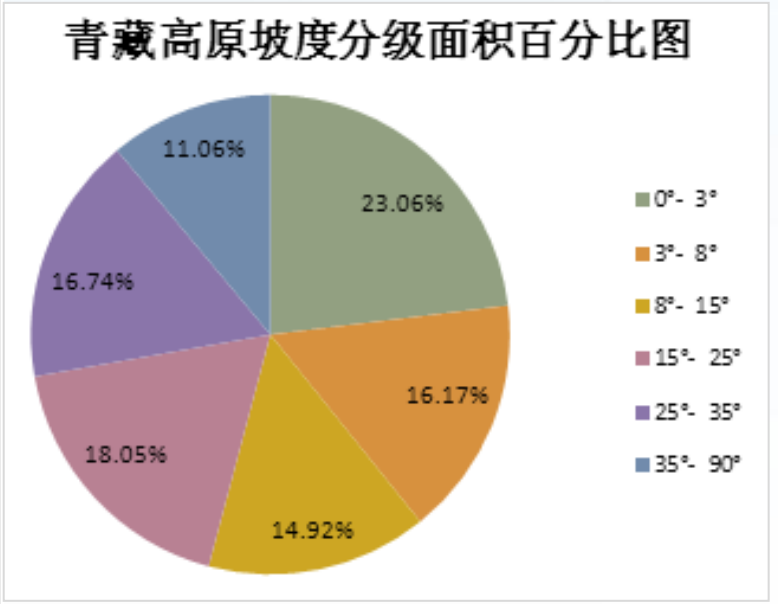


Elevation classification for the Qinghai–Tibet Plateau

Altitude (m)	Area (km^2)	Percentage
0-1000	16558.59	0.62%
1000-2500	101823.79	3.81%
2500-3000	187414.44	7.01%
3000-3500	213313.62	7.98%
3500-4000	270563.71	10.12%
4000-4500	438709.37	16.40%
4500-5000	824889.52	30.84%
5000-6000	609936.49	22.81%
6000-9000	11309.65	0.42%
Total	2674519.18	100.00%

Slope classification: a case study of the Qinghai Tibet Plateau

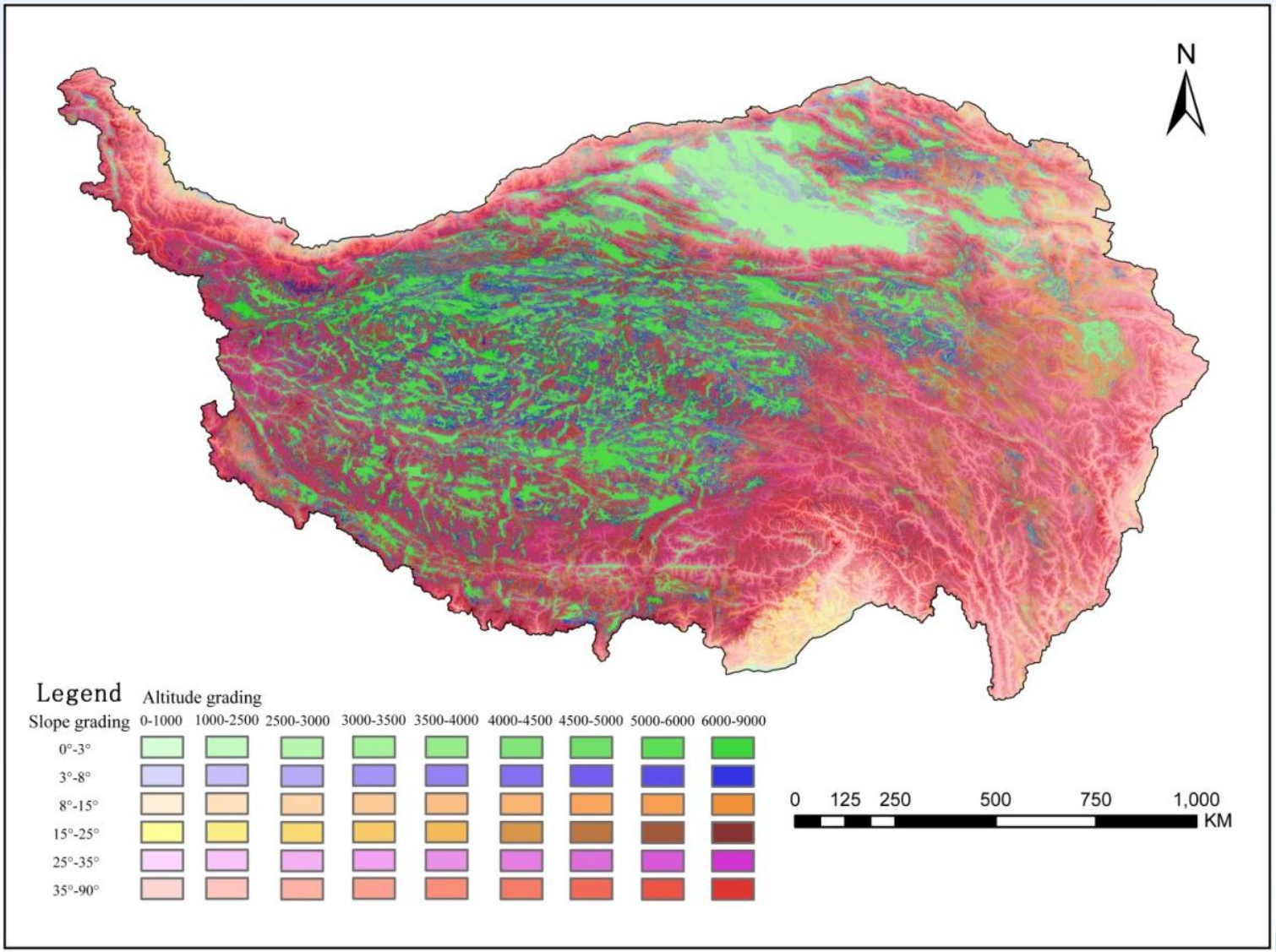




Slope classification for the Qinghai–Tibet Plateau

Slope (Degree)	Area（km2）	Percentage
0-3	616829.10	23.06%
3-8	432366.56	16.17%
8-15	398974.39	14.92%
15-25	482853.98	18.05%
25-35	447812.61	16.74%
35-90	295682.54	11.06%
Total	2674519.18	100.00%

By overlaying the elevation and slope classifications of the Qinghai–Tibet Plateau, spatial distribution was obtained.



The overlay analysis of the elevation and slope classification shows that:

- *the* elevation *and slope have opposite trends*. The area with high elevation and gentle slopes lies in the western and southwestern part of the plateau, while to the north and east the elevation gradually decreases to 1000 m. However to northwest and east there are slopes as steep as 35° or even higher.
- the area of low elevation and gentle slopes lies in the northeast, mainly in the Qaidam Basin; the area with low elevation and steep slopes lies in the southeast, east and the northern margin. The northwest corner and most parts of the southwestern edge are areas of high elevation and steep slopes.

- **(2) Vegetation coverage**
  - Vegetation coverage monitoring focuses on the location, range and area of, and changes in, agricultural land (dry land, paddy field), woodland (woodland, shrub woodland, sparse wood land, immature forest, nursery and cut-over land), plantations (orchards, tea plantations and other plantations) and grassland (ie. grassland with high, medium and low degrees of coverage, and other types of grassland).




- **(3) Water and wetlands**
  - Water and wetland monitoring includes the monitoring of rivers, lakes, reservoirs and channels.
    - River monitoring focuses on name of the river, location of its origin- and end-points, river flow, and its length and spatial patterns, as well as changes that occur in perennial rivers and seasonal rivers.
    - Lake monitoring focuses on name, volume, location, size, water quality and spatial pattern and also on changes in perennial lakes, seasonal lakes, pools beaches and wetlands.

- **(4) Glaciers and permanent snow**
  - Glacier monitoring focuses on name, location and surface area of a glacier, and changes in glaciers.
  - Permanent snow monitoring focuses on surface area covered, as well as snow elevation and changes in the area that is snow-covered.

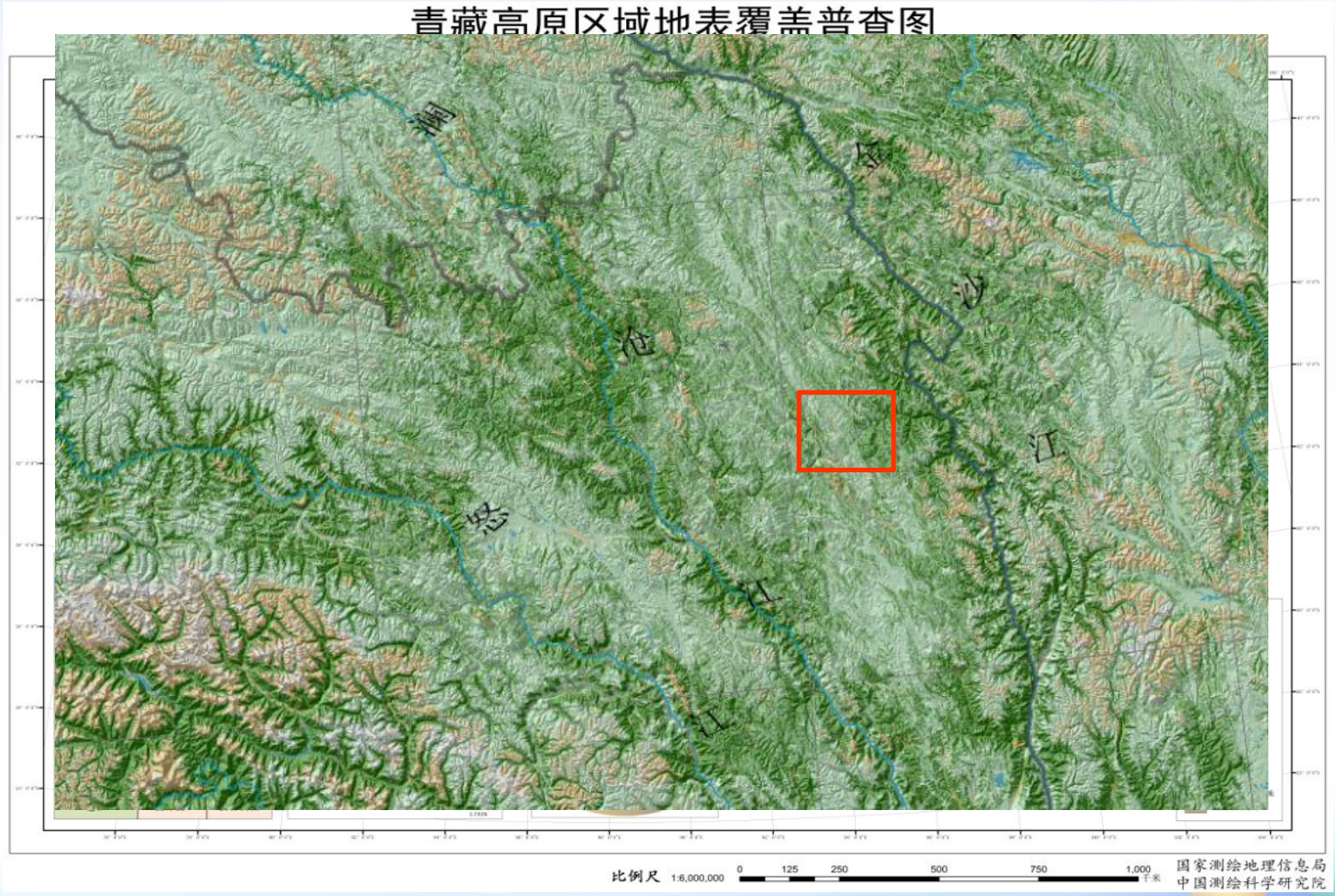
- **(5) Desert and bare land**
  - Focuses on name, location, and size of a desert and also changes.
  - This type of monitoring includes monitoring of gobi, soil deserts, salt deserts, saline areas, bare rock, bare soil and other exposed places.



- **(6) Transportation networks**
  - Includes the monitoring of railways, highways and transport facilities.
- **(7) Built up areas and facilities**
  - Focuses on location, scope and size of residential, industrial and mining sites, tourism sites, religious facilities, and on related changes, etc.

The aforementioned *vegetation coverage, water and wetland areas, glaciers and permanent snow, desert and bare land, traffic networks, residential sites and facilities* together form **land cover.**

Land cover classification: a case study of the Qinghai Tibet Plateau

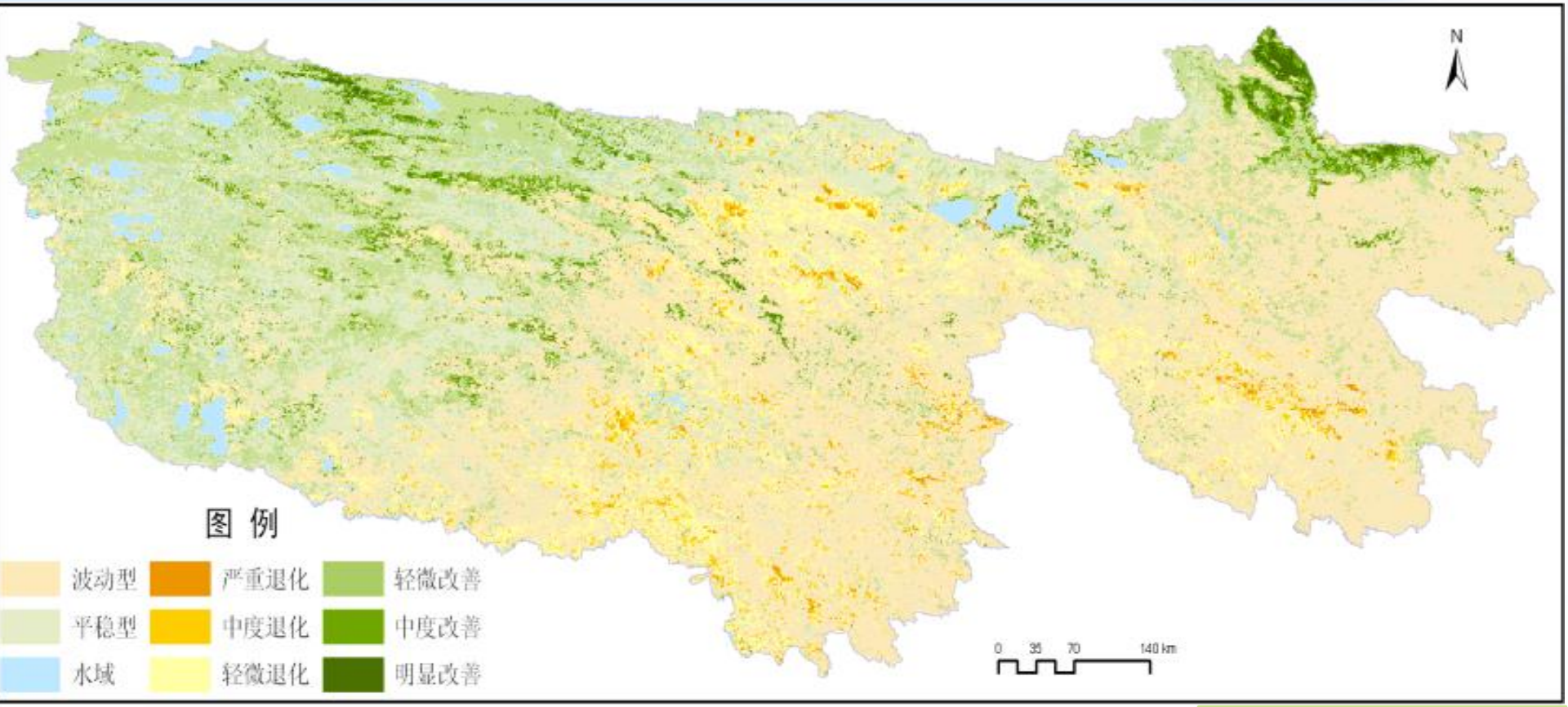


- **(8) Geographic units**
  - Administrative division unit
  - Socio-economic regional unit
  - Natural geographical unit
  - Urban integrated functional unit

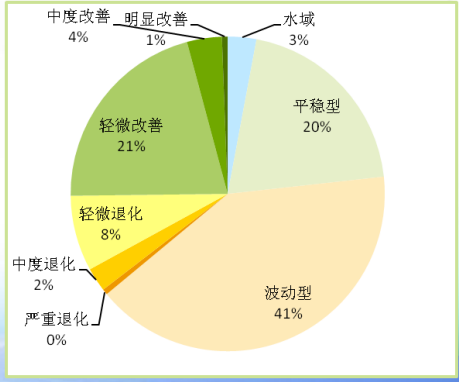
1.4.2 Thematic monitoring

- a special type of designated subject monitoring that government especially concerns.
- **concentrate features including:**
  - **Desert, vegetation, glacier change,**
  - **urban development,**
  - **effects of implementing major engineering projects,**
  - **etc.**
- extension of fundamental monitoring in relevant areas.

Vegetation coverage change trend monitoring (from 2000 to 2011) in Three-river source region, Qinghai province, China

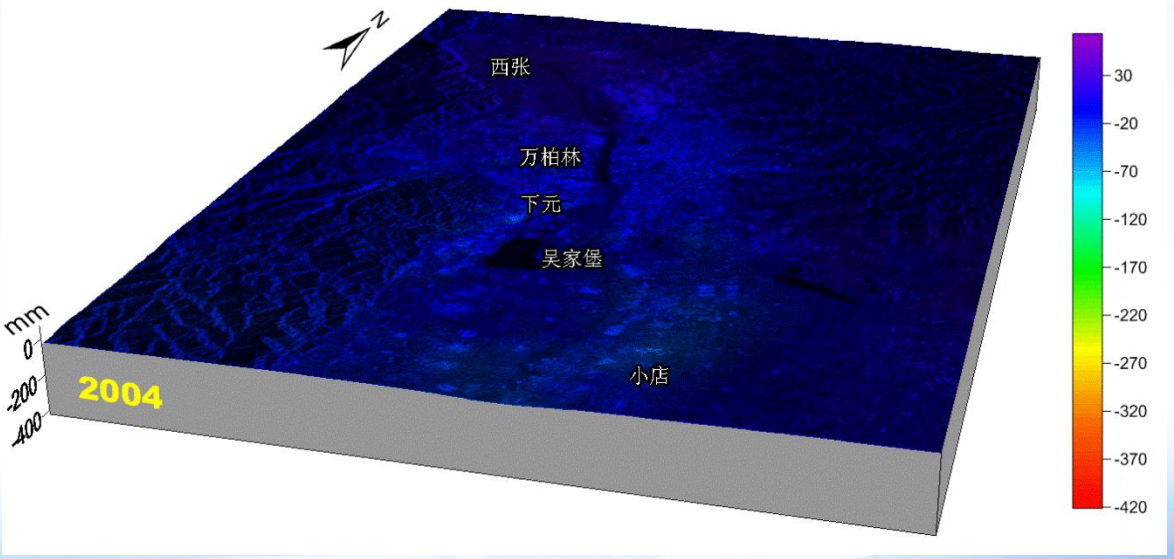


2000-2011年三江源区植被覆盖度变化以波动变化和平稳状态为主。其中波动变化区域面积最大，占总面积41%；平稳状况面积占22.98%。三江源区植被覆盖度改善主要表现为轻微改善，占总面积的21%，退化主要表现轻微退化，占全区面积8%。



1.4.3 Disaster monitoring

- Disaster monitoring is the monitoring of major disasters such as
  - earthquakes,
  - floods,
  - droughts,
  - mud/rock-slides,
  - land subsidence, etc.



Wenchuan Earthquake occurred on Monday, May 12, 2008 in Sichuan province. After the earthquake, UAV remote sensing system quickly acquired high-resolution images (better than 0.2 meters). After the fast building of disaster analysis and monitoring system, plenty of information has been provided for earthquake relief and post-disaster reconstruction.

3D landscape model after earthquake of Beichuan

3D landscape model of new Beichuan

1.5 GCM in China

1.5.1 Overall objective

- To carry out national GC census by taking advantage of all kinds of fundamental geographic information resources,
- Continuously to monitor the GC spatially and quantitatively,
- To build national GCM information system,
- To carry out Geo-statistical analysis and form the regular reporting and monitoring mechanisms,
- To provide basis for creating and carrying out national development plans and facilitating the country's ecological conservation efforts.

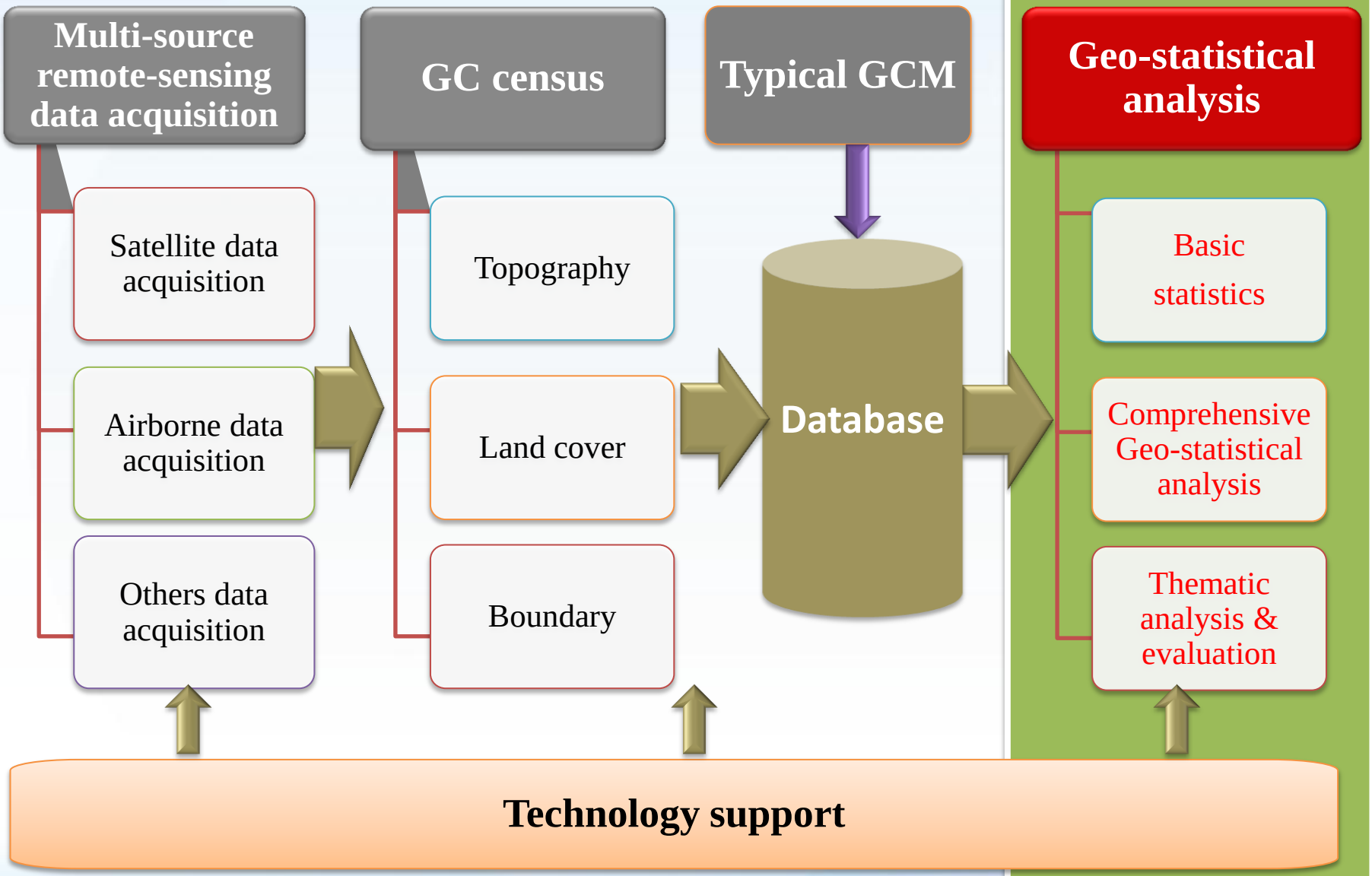
1.5.2 The stage goals

Census

Typical Monitoring

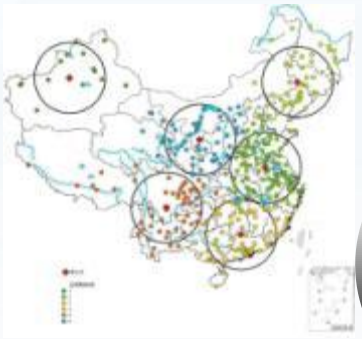
Routine Monitoring

1.5.3 Framework design：the components of GCM and its internal relationship



1.6 Geo-statistical analysis

Based on the Statistical units of geographical conditions monitoring, the use of comprehensive analysis, simulation and prediction, information mining, comprehensive analysis of the inner space characteristics of geographical conditions monitoring objects, relationships, distribution and development trend.



Statistical units

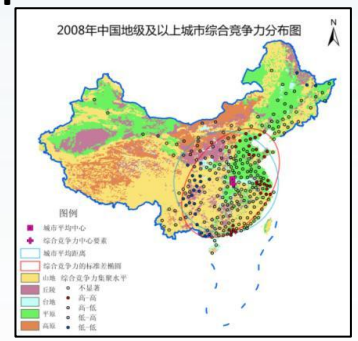
Geographical conditions information mining

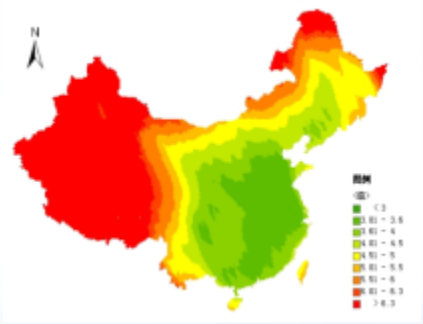
Geo-statistical analysis

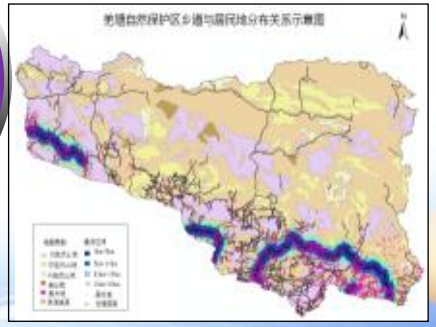
Geographical conditions information statistics

Simulation and prediction of geographical conditions information

Information analysis of geographical conditions monitoring







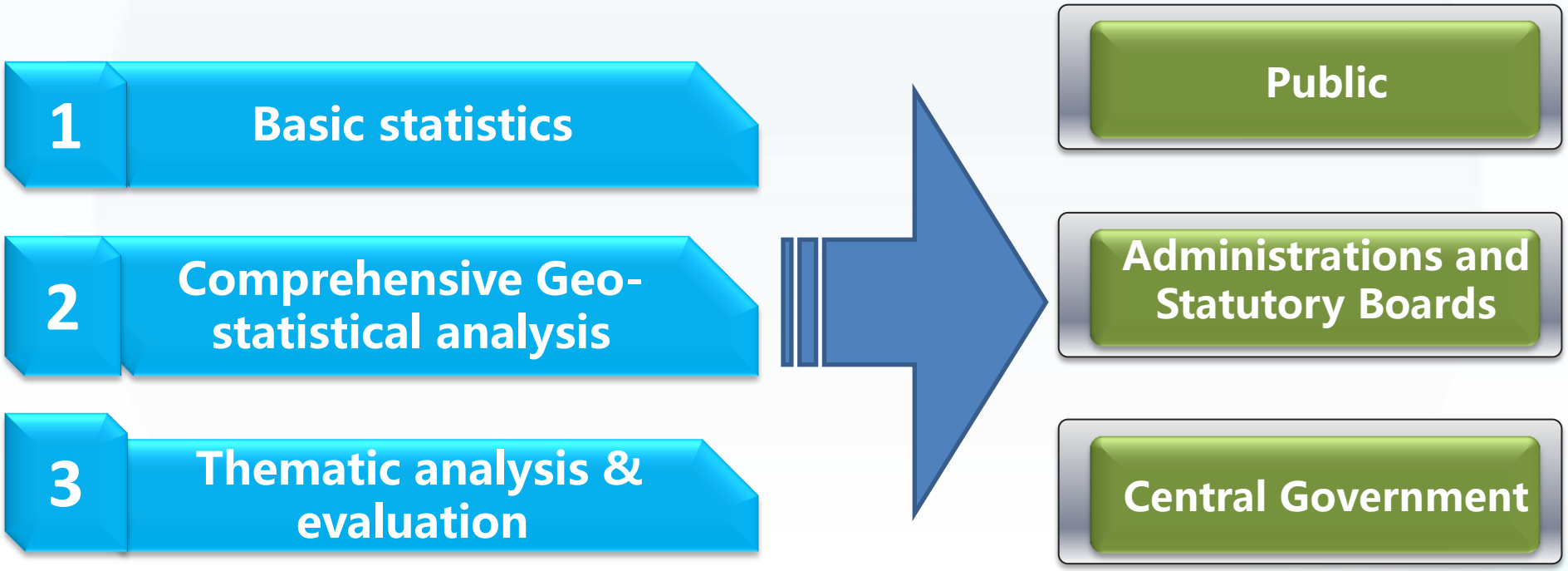
1.6 Geo-statistical analysis

To analyze natural and human elements based on geographical conditions database by integrating social and economic data.

- To analyze fundamental geographical conditions information including topography, land cover, and geographical boundaries;
- To construct geographical conditions index;
- To report geographical conditions information.

1.6 Geo-statistical analysis

Three levels of Geo-statistical analysis:



1.6 Geo-statistical analysis

1.6.1 Basic statistics

To measure the fundamental geographical conditions information of point, line, area and feature based on the geographical elements.

① Topography statistics
② Vegetation coverage statistics
③ Water and wetland areas statistics
④ Desert and bare land statistics
⑤ Traffic networks statistics
⑥ Residential sites and facilities statistics
⑦ Geographical boundaries statistics

Fundamental GC information

1.6 Geo-statistical analysis

1.6.2 Comprehensive statistics

To analyze the physical structure, spatial relationship and difference of geographical features by integrating socio-economic and geographical data. It reflects :

1) spatial distribution pattern
2) landscape pattern
3) coverage extent
4) accessibility
5) infrastructure configuration level
6) spatial correlation

To construct geographical conditions index

1.6 Geo-statistical analysis

1.6.3 Thematic analysis & evaluation

To evaluate the current status and change of natural and human geographical conditions elements from resources distribution, ecological harmoniousness, regional economic development, social development based on the results of basic statistics and comprehensive statistics by integrating socio-economic statistical data.

- **resources distribution**
- **ecological conservation**
- **regional economic development**
- **livability**
- **social development**

Analysis and evaluation reports

2、Comprehensive Geo-statistical analysis

(1) Principles

- Revealing national spatial layout of land resources, ecological harmoniousness, and regional economic and social development.
- Pinpointing general trends of spatial distribution, structure, relationships and interaction of geographic conditions among regions.
- Employing comprehensive statistics for thorough investigation of geographic phenomenon.

2、 Comprehensive Geo-statistical analysis

(2) Targets

- Geographical Conditions Indexes including Resources distribution and utilization index, Ecological coordination index, Geographical equity of basic public service index, Regional economic potential index and Urban development index.

- Provides concrete support to scientific decision making.

- Facilitates national development strategies and planning, land usage optimizing and resources configurations, resource-saving and environment-friendly society, and provide important reference information.

2、Comprehensive Geo-statistical analysis

(3) Units

Regular geographic grid unit

- 10KM*10KM Grid
- 1KM*1KM Grid
- 100M*100M Grid

Natural geographic unit

- Topographic unit
- Geomorphic unit
- Watershed unit
- Wetland Reserve
- Marshes

Administrative and management unit

- Provincial administrative division unit
- Municipal administrative division unit
- County administrative division unit
- Township administrative division unit
- City center
- Other special administrative

Social-economic unit

- Main functions of the district
- Development Zone, the bonded area
- Cultural and natural protection area
- Natural and cultural heritage area
- Scenic spots, tourist areas
- Forest park
- Geo-park
- Line, storage, flood detention area

2、Comprehensive Geo-statistical analysis

(3) Units

Topographic unit

- **Elevation zone**

National elevation classification (<50m、[50m , 100m) 、[100m , 200m) 、[200m , 500m) 、[500m , 800m) 、[800m , 1000m) 、[1000m , 1200m) 、[1200m , 1500m) 、[1500m , 2000m) 、[2000m , 2500m) 、[2500m , 3000m) 、[3000m , 3500m) 、[3500m , 5000m) 、[5000m-) elevation classification (level 14) 。

- **Slope zone**

National slope classification[0° , 2°) 、[2° , 3°) 、[3° , 5°) 、[5° , 6°) 、[6° , 8°) 、[8° , 10°) 、[10° , 15°) 、[15° , 25°) 、[25° , 35°) 、[35°-) slope classification (level 10) 。

Combined with regional topographical features, divided elevation or slope with the situation according to the actual area do subdivision.

2、 Comprehensive Geo-statistical analysis

(4) Data sources

GCM Data

- DEM data
- Land cover data
- Important geographic features data
- Geographic unit data

Basic geospatial data

- Topography statistics data
- Vegetation coverage statistics data
- Water and wetland areas statistics data
- Desert and bare land statistics data
- Traffic networks statistics data
- Residential sites and facilities statistics data
- Geographical boundaries statistics data

2、Comprehensive Geo-statistical analysis

(4)Data sources

Social-economic data

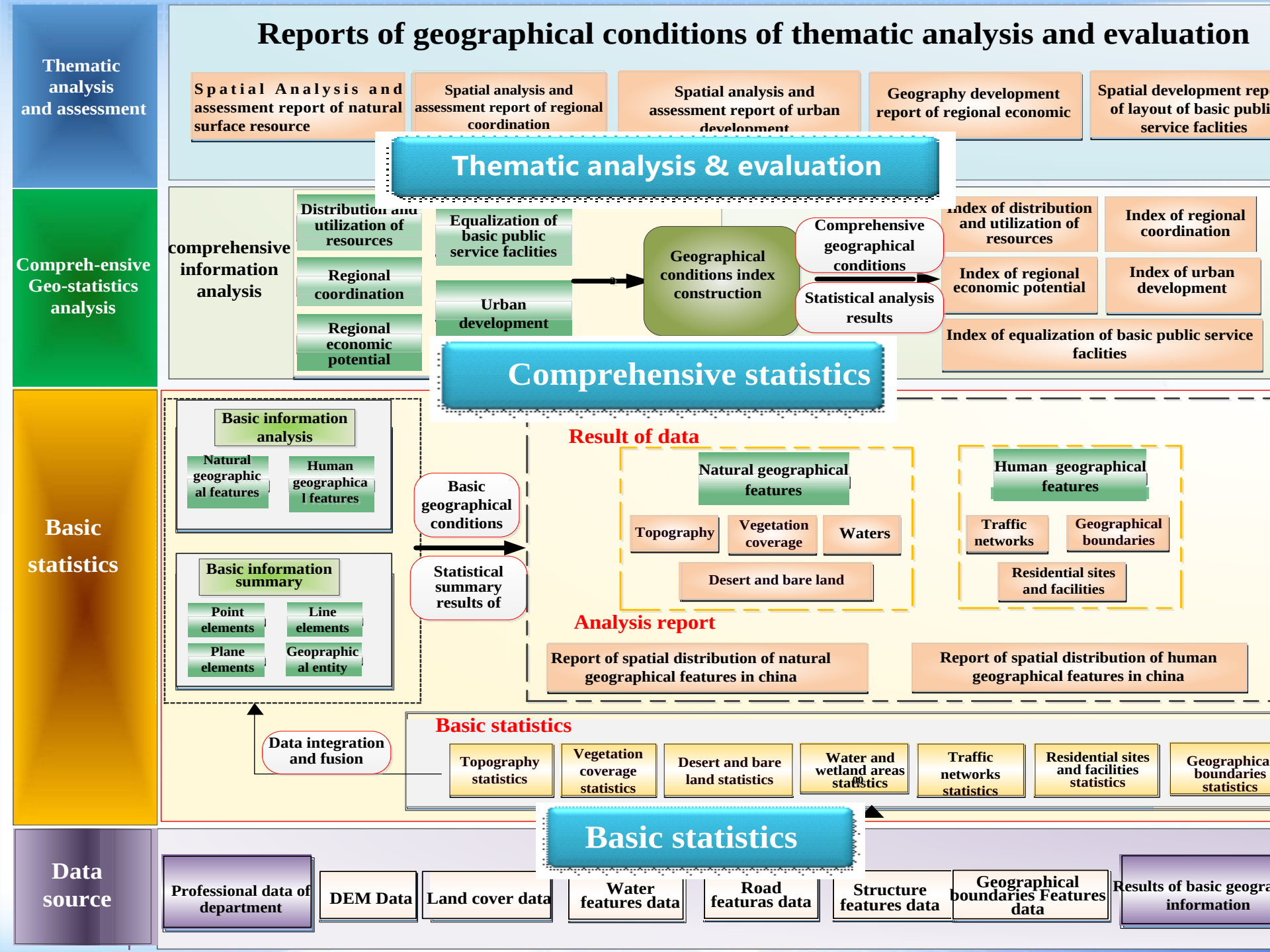
- **Population Census Data**: Resident population, Mobile population, ages-group population, risk for healthy people, census area range, total number of Population Census Area, and so on.
- **Economic Census Data**: above the county level administrative region GDP, agriculture, industry and service , fixed-asset investment, Agriculture, forestry, animal husbandry and fishery, and so on.
- **China City Statistical reports** : Resident population, household register population, GDP output, Number of employees, research and development funding, R & D personnel number , and so on.

2、Comprehensive Geo-statistical analysis

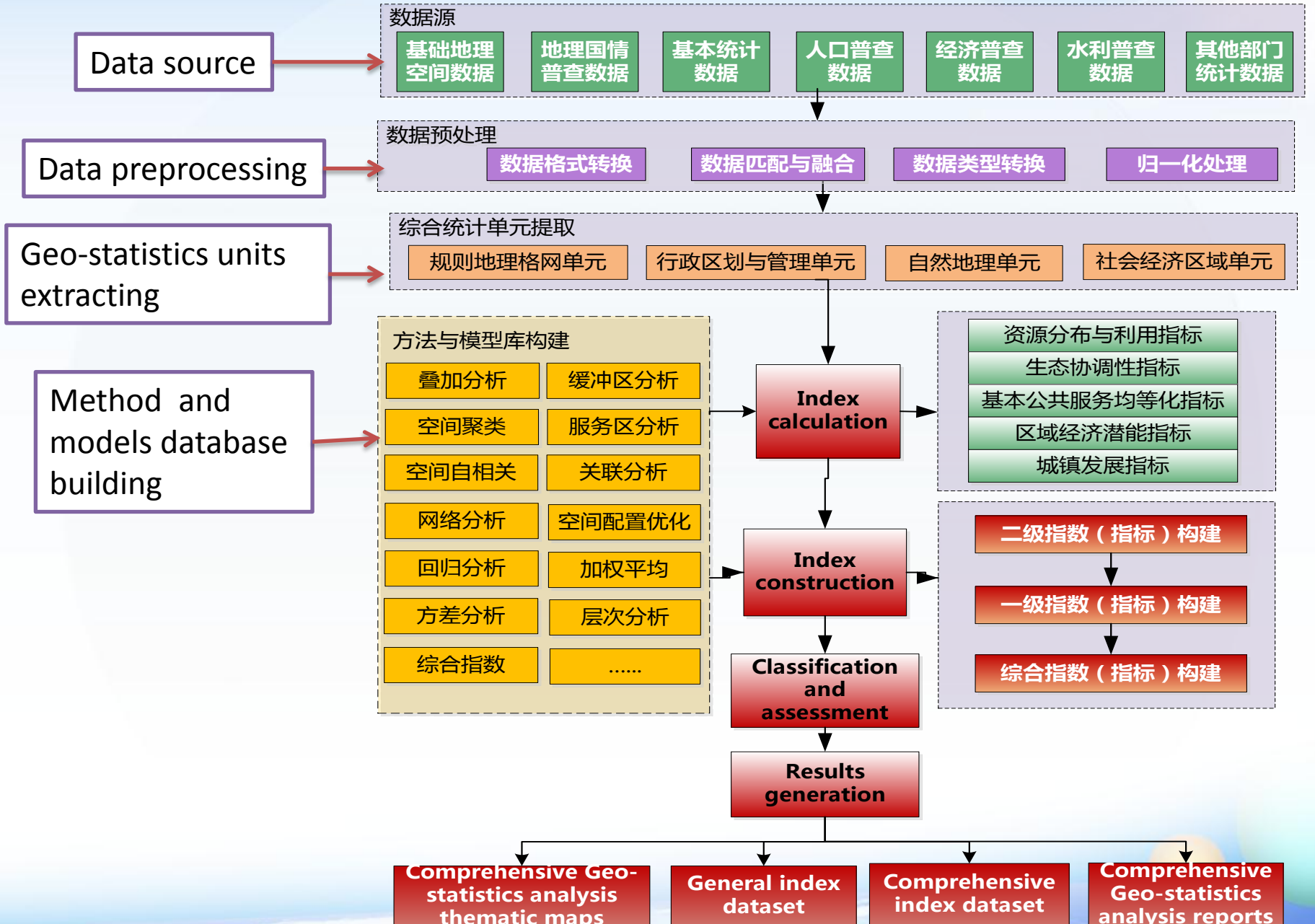
(4)Data sources

Social-economic data

- **Data from Ministry of Education**: School spatial location and related information，include location, name, type, number of teacher, number of student, Teachers titles, and so on.
- **Data from Ministry of Health**: health agencies spatial location and related information， include location, name, type, industry sector, rank, number of health care workers, number of beds, number of titles, Outpatient amount, annual hospital volume, and so on.


Thematic analysis and assessment
Reports of geographical conditions of thematic analysis and evaluation
Spatial Analysis and assessment report of natural surface resource
Spatial analysis and assessment report of regional coordination
Spatial analysis and assessment report of urban development
Geography development report of regional economic
Spatial development rep of layout of basic publi service facilities
Thematic analysis & evaluation
Compreh-ensive Geo-statistics analysis
comprehensive information analysis
Distribution and utilization of resources
Regional coordination
Regional economic potential
Equalization of basic public service facilities
Urban development
Geographical conditions index construction
Comprehensive geographical conditions
Statistical analysis results
Index of distribution and utilization of resources
Index of regional coordination
Index of regional economic potential
Index of urban development
Index of equalization of basic public service facilities
Comprehensive statistics
Basic statistics
Basic information analysis
Natural geographic al features
Human geographica l features
Basic information summary
Point elements
Line elements
Plane elements
Geopraphic al entity
Basic geographical conditions
Statistical summary results of
Result of data
Natural geographical features
Topography
Vegetation coverage
Waters
Desert and bare land
Human geographical features
Traffic networks
Geographical boundaries
Residential sites and facilities
Analysis report
Report of spatial distribution of natural geographical features in china
Report of spatial distribution of human geographical features in china
Data integration and fusion
Basic statistics
Topography statistics
Vegetation coverage statistics
Desert and bare land statistics
Water and wetland areas statistics
Traffic networks statistics
Residential sites and facilities statistics
Geographica boundaries statistics
Basic statistics
Data source
Professional data of department
DEM Data
Land cover data
Water features data
Road featuras data
Structure features data
Geographical boundaries Features data
Results of basic geogra information

(6) General technical process



2、Comprehensive Geo-statistical analysis

(7) Content and index

Resources distribution and utilization

Spatial land layout

Ecological civilization

Ecological harmoniousness

Regional economic development

Social development

regional economy

urban development

society and livelihood

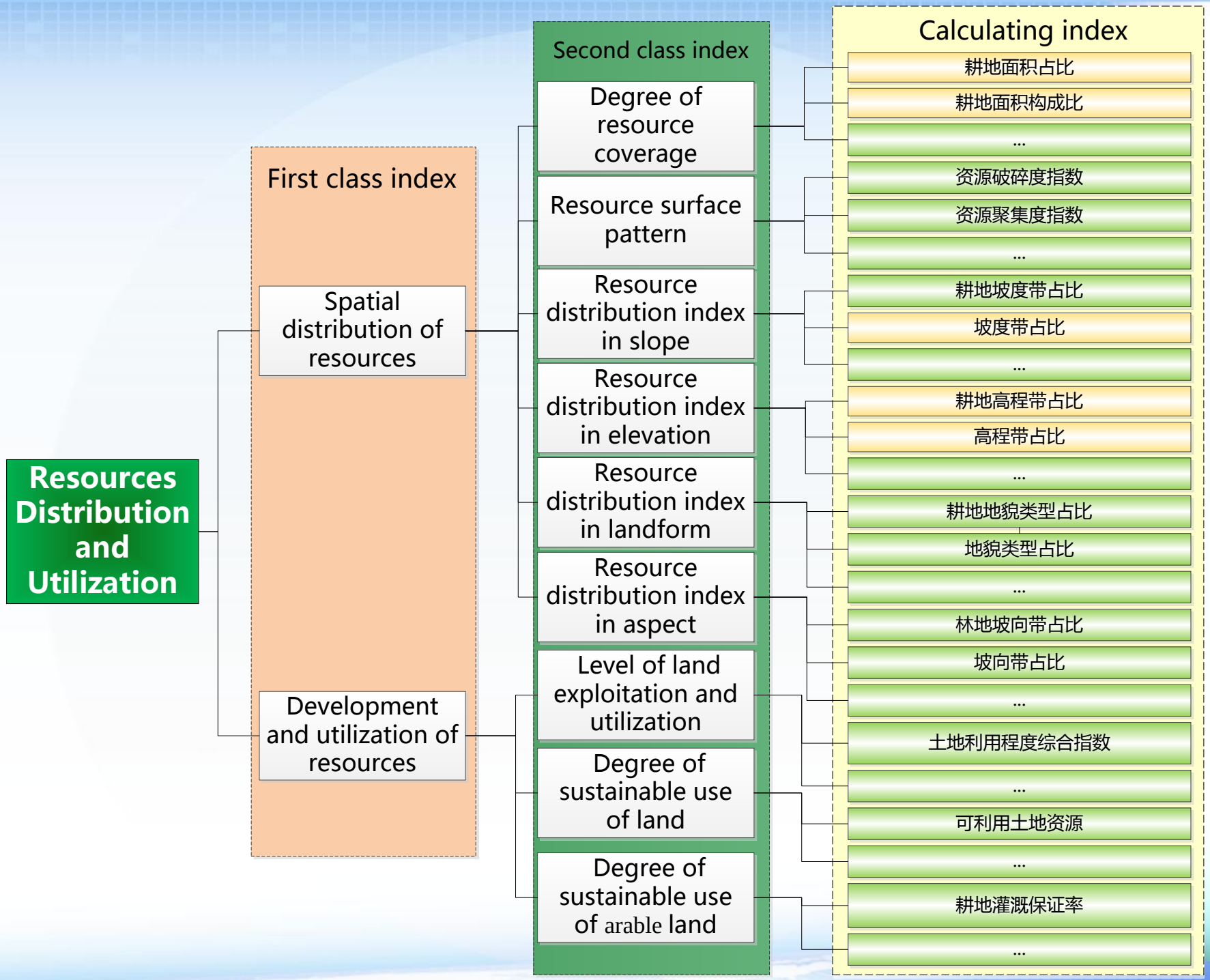
2、Comprehensive Geo-statistical analysis

(7-1) Content and index—*Resources distribution and utilization*

Explicitly proposed to optimize the spatial pattern of land development, comprehensively promote resource conservation through the development and utilization of land resources, protection and management strategy, comprehensively promote resource conservation, to promote the transformation of resource utilization.

Distribution and utilization of resources can be divided into

- Spatial distribution of resources
- Development and utilization of resources


Resources Distribution and Utilization
First class index
Spatial distribution of resources
Development and utilization of resources
Second class index
Degree of resource coverage
Resource surface pattern
Resource distribution index in slope
Resource distribution index in elevation
Resource distribution index in landform
Resource distribution index in aspect
Level of land exploitation and utilization
Degree of sustainable use of land
Degree of sustainable use of arable land
Calculating index
耕地面积占比
耕地面积构成比
...
资源破碎度指数
资源聚集度指数
...
耕地坡度带占比
坡度带占比
...
耕地高程带占比
高程带占比
...
耕地地貌类型占比
地貌类型占比
...
林地坡向带占比
坡向带占比
...
土地利用程度综合指数
...
可利用土地资源
...
耕地灌溉保证率
...

Calculation methods, sources and significance of spatial distribution of resources

Measuring dimension	Index	Definition	Calculation Method	Data sources
Spatial distribution of resources	Proportion of arable land	Reflect the amount of cultivated land resources	(cultivated land area/ total area of land)*100%	Basic statistical results
	Constituent ratio of arable land	Reflect the coverage of all kinds of cultivated land	(all kinds of cultivated land area/ total area of cultivated land)*100%	Basic statistical results
	Proportion of woodland	Reflect the amount of woodland resources	(woodland area/total area of land) *100%	Basic statistical results
	Constituent ratio of woodland	Reflect the coverage of all kinds of woodland	(all kinds of woodland area/total area of woodland)*100%	Basic statistical results
	Proportion of garden plot	Reflect the amount of garden plot resources	(garden plot area/total area of land) *100%	Basic statistical results
	Constituent ratio of garden plot	Reflect the coverage of all kinds of garden plot	(all kinds of garden plot area/total area of garden plot)*100%	Basic statistical results
	Proportion of meadow	Reflect the amount of meadow resources	(meadow area/total area of land) * 100%	Basic statistical results
	……	……	……	……

2、Comprehensive Geo-statistical analysis

(7-2) Content and index—*Ecological harmoniousness*

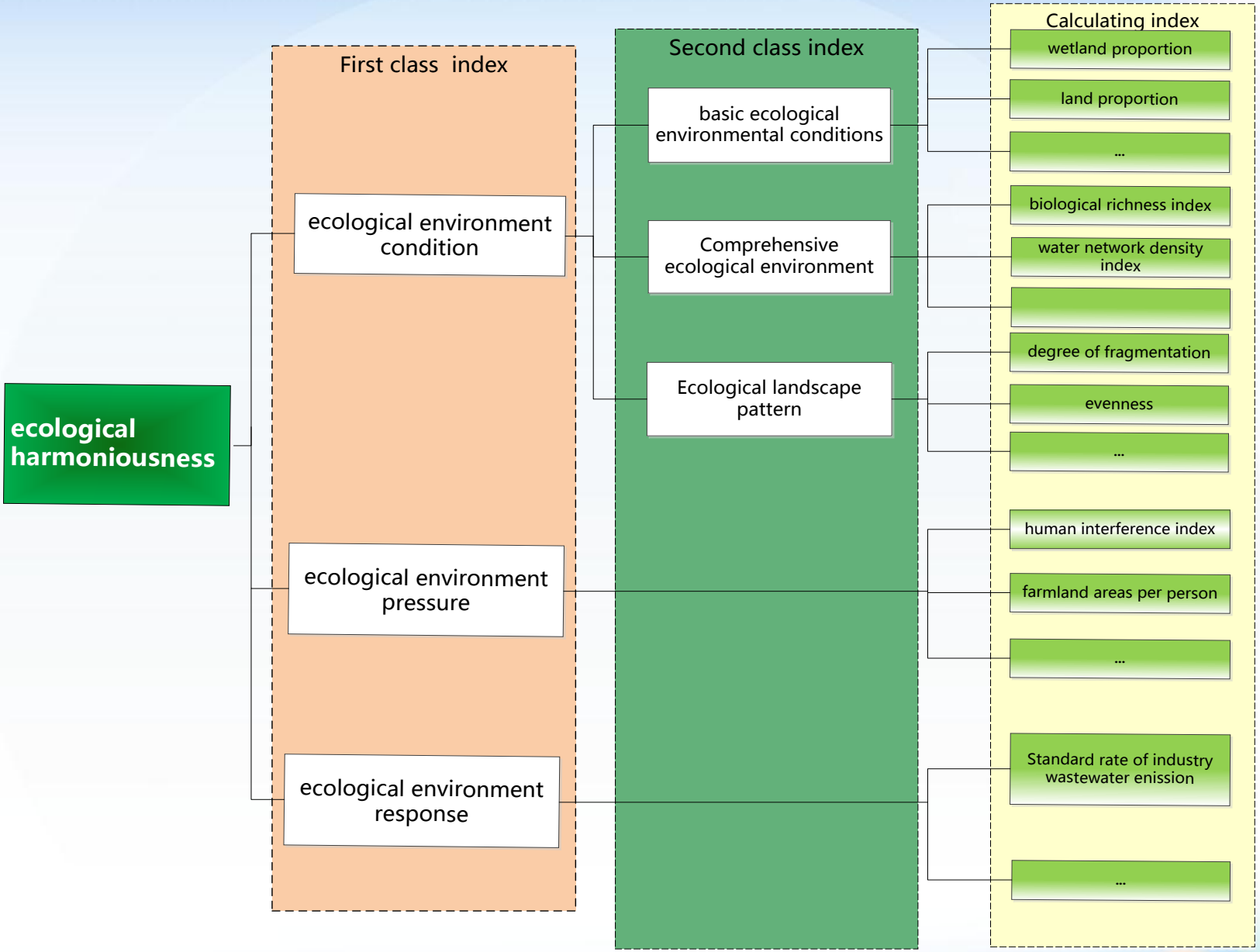
Analysis and evaluation of ecological environment is the quality evaluation for the ecosystems in an area .

In order to reflect the interaction relationship between human and environment, ecological harmoniousness can be divided into three levels, and analyze the influence factors of each measure .

1 ecological environment condition

2 ecological environment pressure

3 ecological environment response


ecological harmoniousness
First class index
ecological environment condition
ecological environment pressure
ecological environment response
Second class index
basic ecological environmental conditions
Comprehensive ecological environment
Ecological landscape pattern
Calculating index
wetland proportion
land proportion
...
biological richness index
water network density index
degree of fragmentation
evenness
...
human interference index
farmland areas per person
...
Standard rate of industry wastewater enission
...

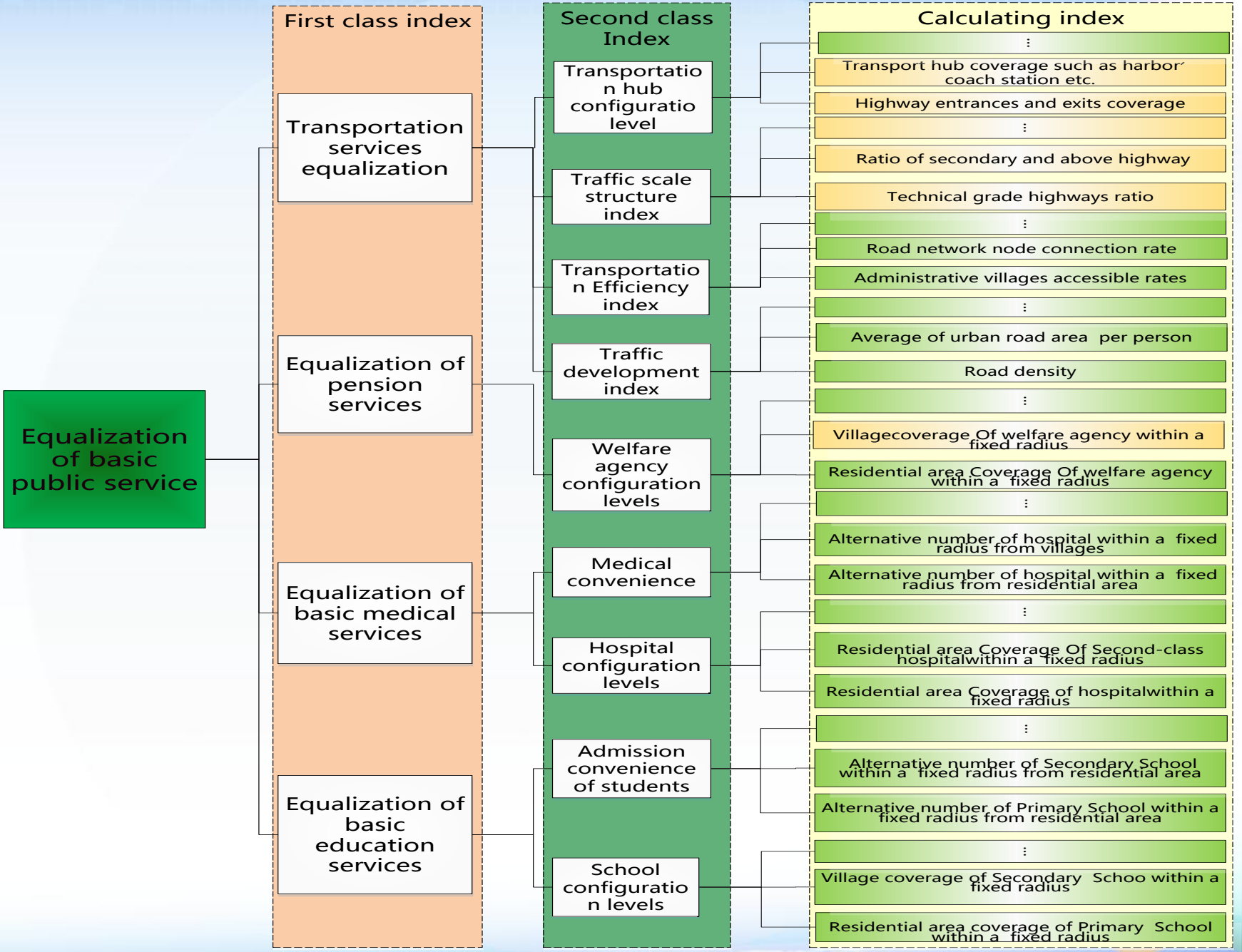
Ecological factors distribution index calculation method, the sources and index table

Measure the dimensions	index	Index connotation	method	data source
ecological environment condition	Vegetation Index	Refers to the proportion of woodland, grassland, farmland, construction land and unused land area in evaluation .It is used to reflect degree of evaluation of regional vegetation. Vegetation index which is closer to one indicates vegetation is good , close to zero is bad.	Vegetation index＝Aveg×（0.38×woodland＋0.34×grassland＋0.19×farmland＋0.07×construction land ＋0.02×unused land ）/regional area	Basic statistical results
	Land degradation index	Refers to the proportion of degradation in the area of land .It is used to reflect land quality. The index which is closer to one indicates that the condition of land is good, close to zero is bad.	land degradation index=Asum×(0.7×Light erosion area+0.25×Moderate erosion area+0.05×Severe erosion area) /regional area.Asum is the sum of degradation area weighted /area normalization coefficient.	Basic statistical results 、 statistical yearbook
	Environmental quality index	Refers to the proportion of regional environmental quality in evaluation area .It is used to reflect the condition of environment. The index which is closer to one indicates that regional environmental quality is good, close to zero is bad.	Environmental quality index ＝0.4*（100-ASO2*SO2 emissions / regional area）＋0.4*（100－ACOD×COD emissions / regional annual average rainfall）＋0.2*（100－ASOL×Solid waste emissions / regional area）	Basic statistical results 、 statistical yearbook
	……	……	……	……

2、 Comprehensive Geo-statistical analysis

(7-3) Content and index—*Equalization of basic public service*

From the perspective of geographical conditions , the research will be limited to public service designed to protect the right of the residents to development, the four basic public services, including education, basic health care, pension services and commute。


Equalization of basic public service
First class index
Transportation services equalization
Equalization of pension services
Equalization of basic medical services
Equalization of basic education services
Second class Index
Transportation hub configuration level
Traffic scale structure index
Transportation Efficiency index
Traffic development index
Welfare agency configuration levels
Medical convenience
Hospital configuration levels
Admission convenience of students
School configuration levels
Calculating index
Transport hub coverage such as harbor、coach station etc.
Highway entrances and exits coverage
Ratio of secondary and above highway
Technical grade highways ratio
Road network node connection rate
Administrative villages accessible rates
Average of urban road area per person
Road density
Villagecoverage Of welfare agency within a fixed radius
Residential area Coverage Of welfare agency within a fixed radius
Alternative number of hospital within a fixed radius from villages
Alternative number of hospital within a fixed radius from residential area
Residential area Coverage Of Second-class hospitalwithin a fixed radius
Residential area Coverage of hospitalwithin a fixed radius
Alternative number of Secondary School within a fixed radius from residential area
Alternative number of Primary School within a fixed radius from residential area
Village coverage of Secondary Schoo within a fixed radius
Residential area coverage of Primary School within a fixed radius

Equalization of basic medical services

Index calculation methods, sources and targets significance table

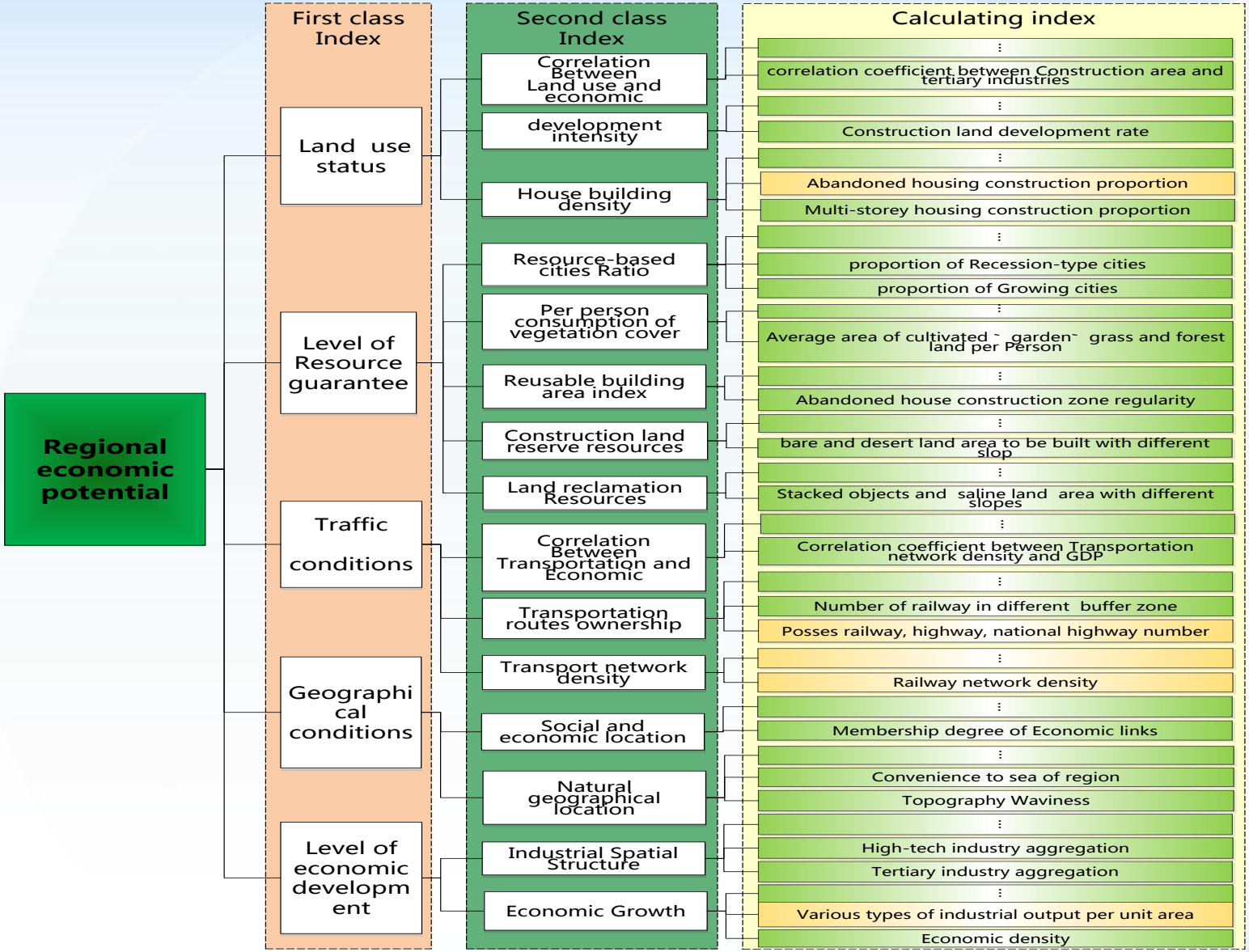
	Index	Index connotation	Calculation methods	Data sources
Equalization of basic medical services	The village coverage of hospital within a fixed radius	Reflect the uniformity of rural residents for medical treatment.	Take the Hospital as center, statistics Total number of administrative villages within a radius of 3,000 meters of covered services/ all villages	Basic statistics achievements
	The residential area coverage of second-class Hospital within a fixed radius	Reflect the uniformity of residents for second-class medical treatment.	Take the second-class Hospital as center, statistics Total number of residential areas within a radius of 5,000 meters of covered services/ all residential areas	Basic statistics achievements
	The residential area coverage of third-class Hospital within a fixed radius	Reflect the uniformity of residents for third-class medical treatment.	Take the third-class Hospital as center, statistics Total number of residential areas within a radius of 20,000 meters of covered services/ all residential areas	Basic statistics achievements
	The ratio of health risk population of hospital within a fixed radius	Reflect the scale of the health risk population of hospital services.	Take the Hospital as center, statistics Total number of health risk population within a radius of 1,000 and 3，000 meters of covered services/ The total population	Basic statistics achievements ,The sixth census data
	The ratio of health risk population of second-class hospital within a fixed radius	Reflect the scale of the health risk population of second-class hospital services.	Take the second-class Hospital as center, statistics Total number of health risk population within a radius of 5,000 meters of covered services/ The total population	Basic statistics achievements ,The sixth census data
	The ratio of health risk population of third-class hospital within a fixed radius	Reflect the scale of the health risk population of third-class hospital services.	Take the third-class Hospital as center, statistics Total number of health risk population within a radius of 20,000 meters of covered services/ The total population	Basic statistics achievements ,The sixth census data
	The alternative number of hospital within a fixed radius from residential area	Reflect convenience of urban residents for medical treatment .	Take the residential area as center, statistics Total number of hospital within a radius of 1,000 meters of covered services	Basic statistics achievements
	……	……	……	……

2、Comprehensive Geo-statistical analysis

(7-4) Contents and indexes—*Regional economic potential*

Production complex generated from interaction between internal factors and external conditions in certain areas of economic development.

Integrated closely with regional economic development entities and distribution.


Regional economic potential
First class Index
Land use status
Level of Resource guarantee
Traffic conditions
Geographical conditions
Level of economic development
Second class Index
Correlation Between Land use and economic
development intensity
House building density
Resource-based cities Ratio
Per person consumption of vegetation cover
Reusable building area index
Construction land reserve resources
Land reclamation Resources
Correlation Between Transportation and Economic
Transportation routes ownership
Transport network density
Social and economic location
Natural geographical location
Industrial Spatial Structure
Economic Growth
Calculating index
correlation coefficient between Construction area and tertiary industries
Construction land development rate
Abandoned housing construction proportion
Multi-storey housing construction proportion
proportion of Recession-type cities
proportion of Growing cities
Average area of cultivated、garden、grass and forest land per Person
Abandoned house construction zone regularity
bare and desert land area to be built with different slop
Stacked objects and saline land area with different slopes
Correlation coefficient between Transportation network density and GDP
Number of railway in different buffer zone
Posses railway, highway, national highway number
Railway network density
Membership degree of Economic links
Convenience to sea of region
Topography Waviness
High-tech industry aggregation
Tertiary industry aggregation
Various types of industrial output per unit area
Economic density

Geographical conditions

Index calculation methods, sources and targets significance table

	Index	Index connotation	Calculation methods	Data sources
Geographical conditions	Ratio of Landforms area	Reflects the topography of the region, including plains, mountains, hills and terraces of composition.	Calculate the area accounting for various types of landforms, as follows: Plains area proportion = Plain area / total area Mountain area proportion = Mountain area / total area Hilly area proportion = hilly area / total area Mesa area proportion = Mesa area / total area	Basic statistics achievements
	Convenience to sea of region	It can reflect advantage in the sea of region, and is embodied saving transportation costs.	Wherein: (X, Y) coordinates is the centroid of the geometric area, (x, y) is the distance from the nearest port area.	The basic census results
	Membership degree of Economic links	Reflect the core urban areas surrounding radiation, Also reflect the acceptance of the area around the core city of radiation. The larger the value, the stronger the spatial economic ties, the greater the economic hinterland; Conversely, the weaker, smaller.	$D = \sqrt{(X-x)^2 + (Y-y)^2}$ Regional economic ties strength $R_{ij} = \sqrt{P_i G_i} \times \sqrt{P_j G_j} / D_{ij}^2$ Among them, the regional GDP (G), the resident population of the region (P), inter-regional transport distance (D); $F_{ij} = R_{ij} / \sum_{j=1}^{n} R_{ij}$ Economic ties membership is the ratio of strength of economic ties between the two regions representing the sum of regional economic ties .	Local Statistical Yearbook、The sixth census data、Basic statistics achievements
	Area within the region accounting for various types of main functional areas	Through the area accounting for various development zone, reflecting the potential of the area can be developed.	Optimization Zone area proportion = Optimization Zone area / total area of the region the area of focus Zone proportion = focus Zone area / total area Restricted zone area in the region proportion = restricted zone area / total area Prohibited Zone area proportion = prohibited Zone area / total area	Basic statistics achievements
	……	……	……	……

2、Comprehensive Geo-statistical analysis

(7-5) Contents and indexes—*Urban development*


Economic development


Development of traffic

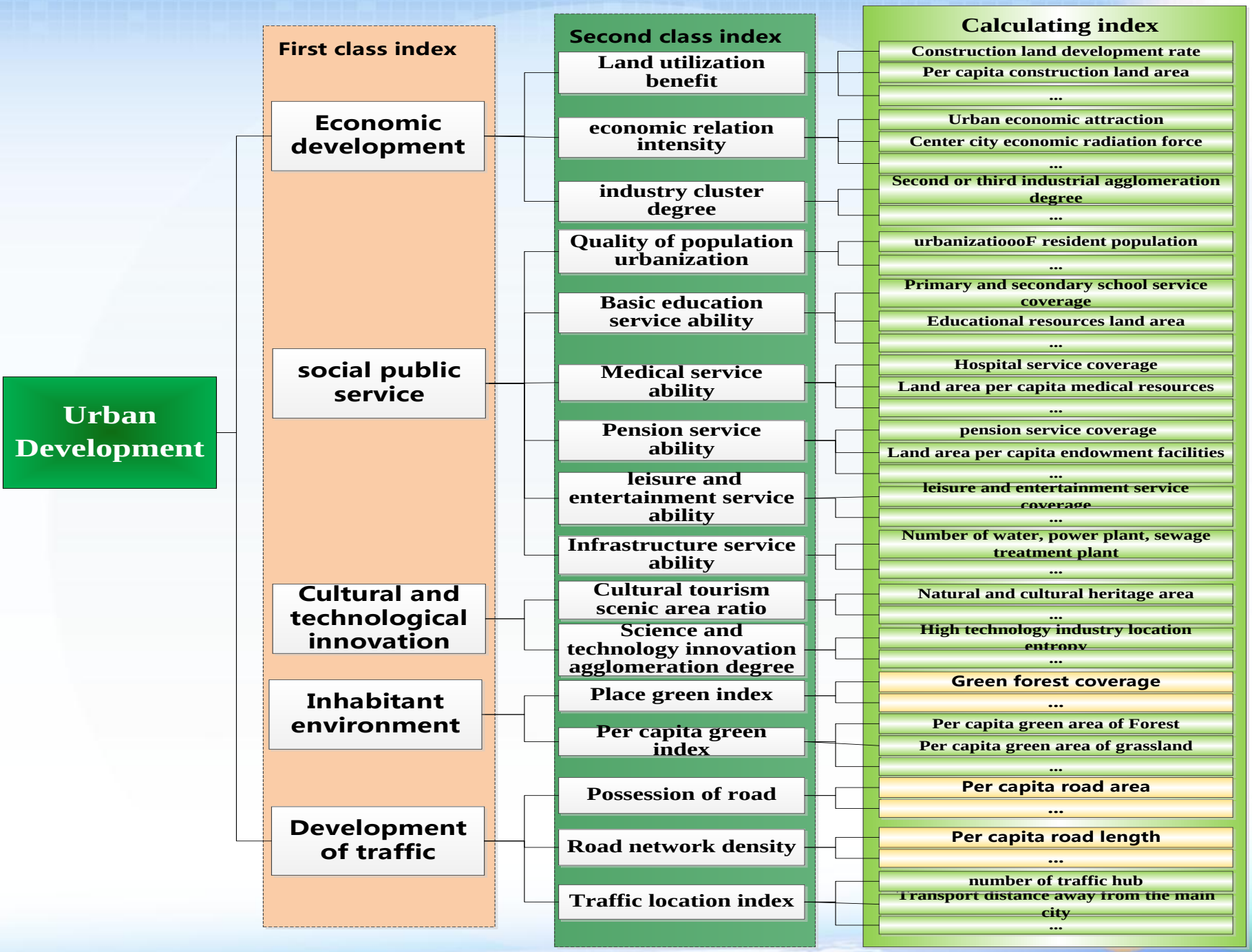

social public service

From five aspects of urban society, measuring the level of urban development


Traffic


Innovation and R & D

Urbanization is a pressing process of economic and social development. China is at a stage of rapid development of urbanization. It is significant to promote new urbanization strategy of our country, realize the transformation of development modes, make full use of geographic conditions census data and establish universal index of urban comprehensive development.


Urban Development
First class index
Economic development
social public service
Cultural and technological innovation
Inhabitant environment
Development of traffic
Second class index
Land utilization benefit
economic relation intensity
industry cluster degree
Quality of population urbanization
Basic education service ability
Medical service ability
Pension service ability
leisure and entertainment service ability
Infrastructure service ability
Cultural tourism scenic area ratio
Science and technology innovation agglomeration degree
Place green index
Per capita green index
Possession of road
Road network density
Traffic location index
Calculating index
Construction land development rate
Per capita construction land area
...
Urban economic attraction
Center city economic radiation force
...
Second or third industrial agglomeration degree
...
urbanizatioooF resident population
...
Primary and secondary school service coverage
Educational resources land area
...
Hospital service coverage
Land area per capita medical resources
...
pension service coverage
Land area per capita endowment facilities
...
leisure and entertainment service coverage
...
Number of water, power plant, sewage treatment plant
...
Natural and cultural heritage area
...
High technology industry location entropy
...
Green forest coverage
...
Per capita green area of Forest
Per capita green area of grassland
...
Per capita road area
...
Per capita road length
...
number of traffic hub
Transport distance away from the main city
...

Computational methods, sources and significance of the index of social public service capacity table

	Index	Connotation index	Computational methods	Sources
Public service capacity	Land level of educational resources	The investment proportion of land for educational construction in the planning of town , reflect the educational resources in the construction land or house building land using and investment in the case.	The total area of land used for primary school/Regional 6-12 years old population The total area of land used for secondary school/Regional12-15years old population	Basic statistic result , The sixth census data,
	Reachability d egree of basic education service	Measure the situation which children reach school and accept the service ability of basic education, that is one of the indexes to evaluate the urban basic education service ability.	$A_i = \sum_j \frac{S_j}{d_{ij}}$ Among them, i mean a region, S_j means school service ability (School Teachers), between schools and residential traffic distance d_{ij}	Census data、The sixth census data, School of thematic data
	Hospital service coverage	Reflect the Scope and capabilities of hospital coverage and service to residents in the geography space, that is one of the indexes to measure the hospital coverage ability of residents.	Community hospital services within a 250m radius of the total population living/The total number of urban resident population The second level of hospital service within a 500 meters radius of total population living/The total number of urban resident population The third level of hospital service within a 2000 meters radius of total population living/The /The total number of urban resident population	Census data, The sixth census data
	Pension service coverage	Reflect the scope and capabilities of pension facilities coverage and service to population on the geography spatial, that is one of the indexes to measure the pension facilities coverage ability to residents.	The 10km service radius of nursing home resident population age 65 or older/The total number of urban resident population	Census data, The sixth census data
	Number of water, power plant, sewage treatment plant	Reflect the situation of infrastructure resources in the construction with the using and the investment.	The area of water, power plant sewage treament plant/The total area of land used for construction	Basic statistic result
	……	……	……	……

2、Comprehensive Geo-statistical analysis

Grading evaluation

resources distribution and utilization

ecological harmoniousness

Equal basic public services

Regional economy

Urban development

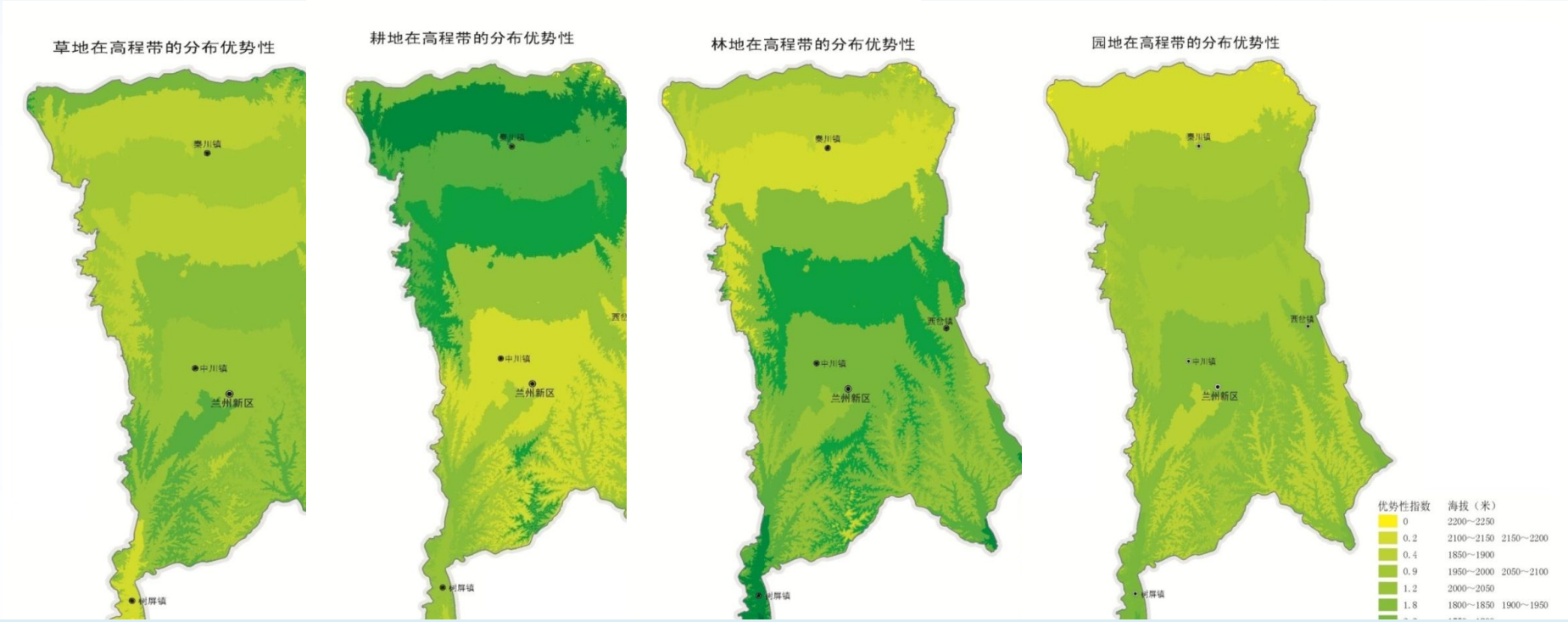
Comprehensive Geo-statistical analysis form comprehensive index of each thematic, grading evaluation of the comprehensive index for each topic,

3. Experiments and discussions

Discussions

Topographic unit: elevation zone

——the farmland, forest land, garden land and grassland resources distribution

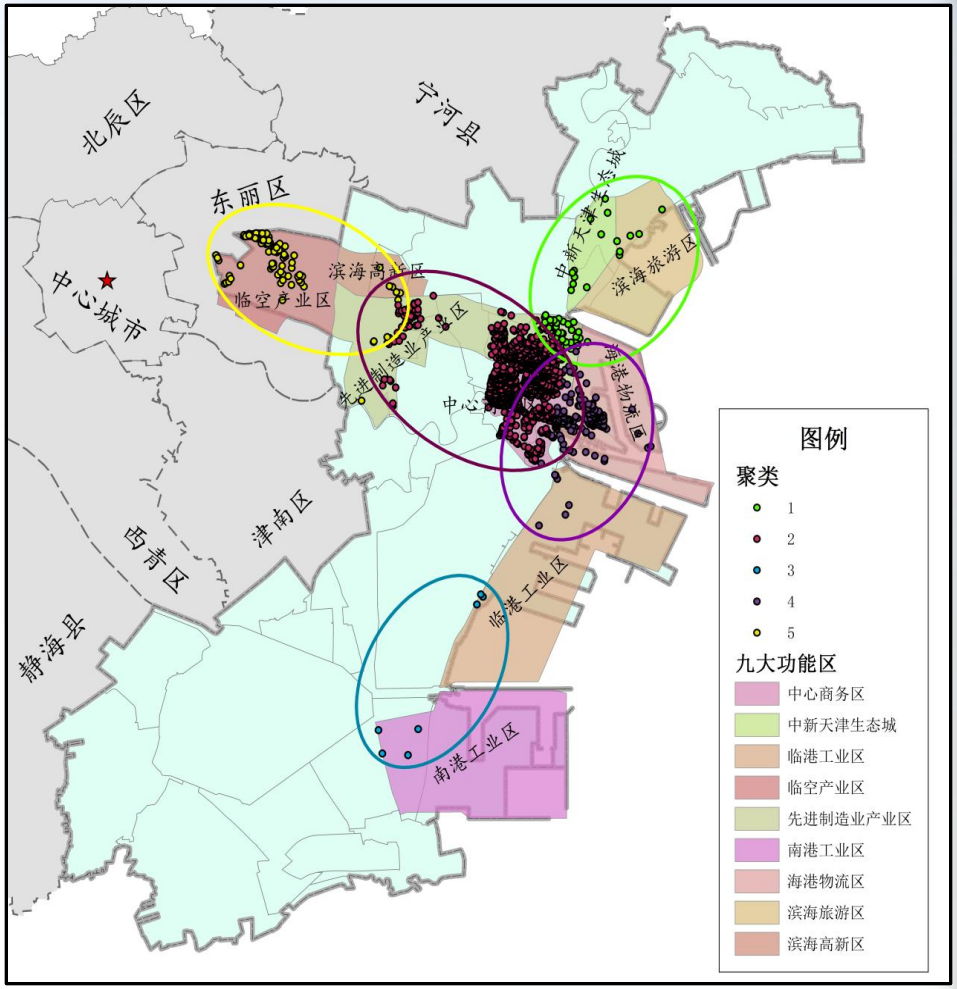


The conclusions:

- 2200-2250: the grassland dominates the land
- 1800-2150: farmland is the most concentrated.
- 2200-2250: the closer to main arterial , the more dominant farmland land is, but the value is 0.
- 1700-1750: woodland dominates the land and decreases as the elevation grows.
- Distributions of Garden and forest land are correlated to each other.

Social-economic unit: Main functions of the district

Spatial distribution: Industrial and commercial enterprises

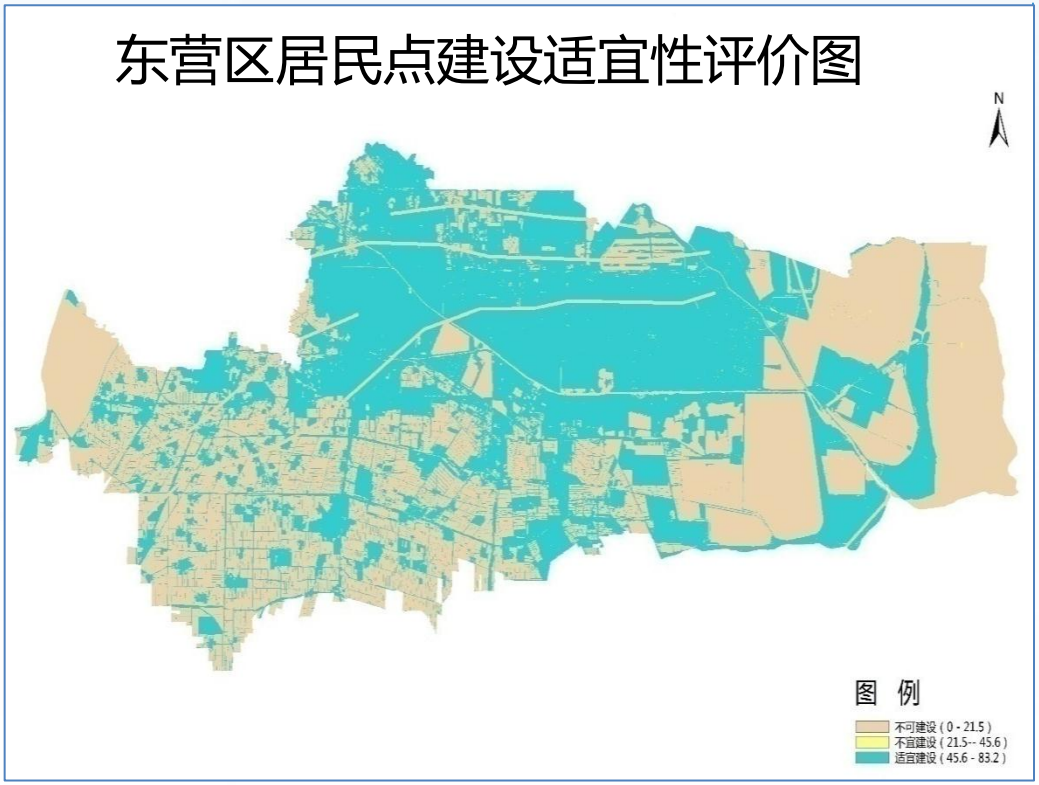


- Concentrated in the **advanced manufacturing industry area, central business district ,international airport etc**. The number of central business district is the largest. Distribution of industrial and commercial enterprises is **clusters**. **Overall, the distribution of industry in binhai new area is along the shaft.**
- **Aix** is the coastal river and Jing-Jin-Tang highway in urban development and the main shaft, airport industry park etc. concentrated on the shaft. **Urban development along the coastal belt, the belt is the main part of the development of the eastern region of Tianjin Binhai.**

Binhai New Area, Tianjin

Administrative division and management unit:

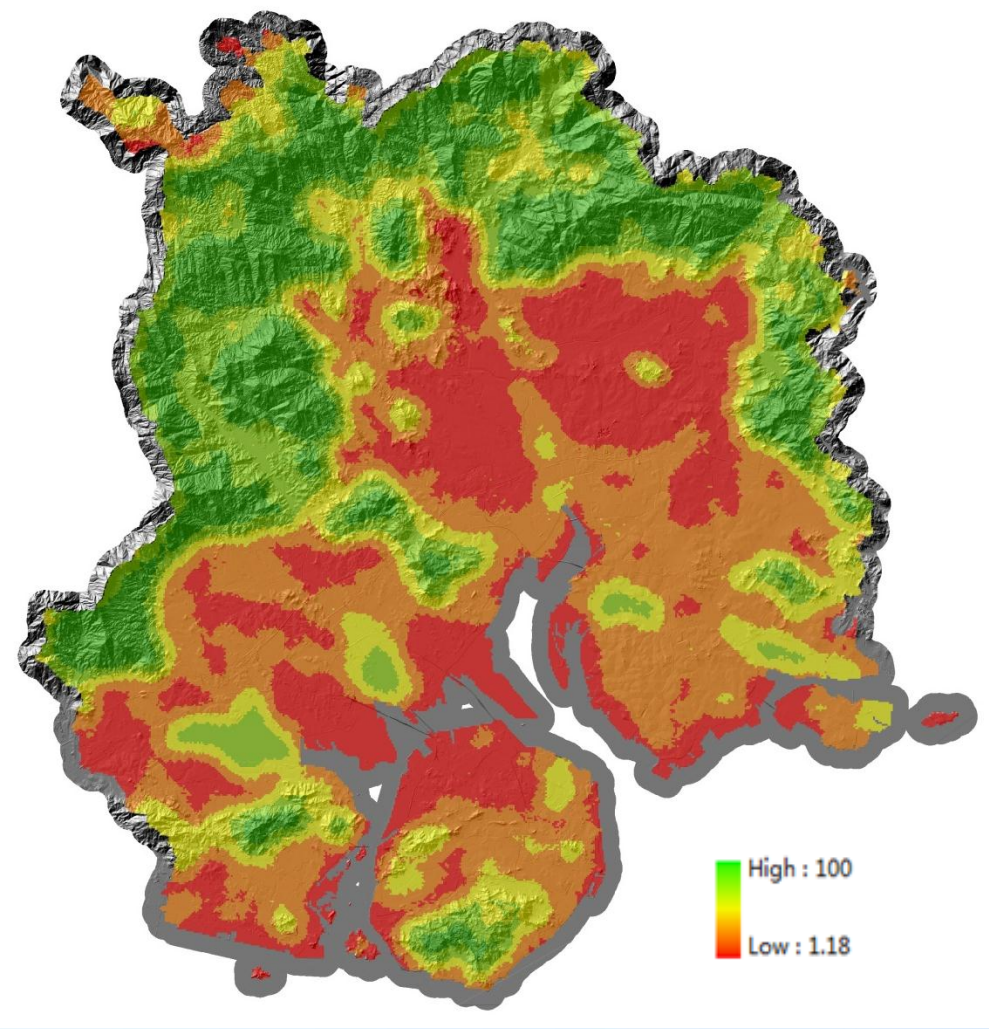
Resources distribution and utilization——land use suitability evaluation of urban and rural residents



- Non-residential construction accounts for about 50.69% of the total area .
- the western floodplain, basic farmland protection areas south of Bohai Sea, the aquaculture area and the eastern part of the reservoir are all non-built-up areas.
- Unfavorable construction land account 0.26% for the region's construction area.
- the land suitable for the construction area is about 49.05% ,mainly in urban areas, while the vast majority of residential land in rural areas is within the range suitable for building.

Geographic grid unit：100*100m cells

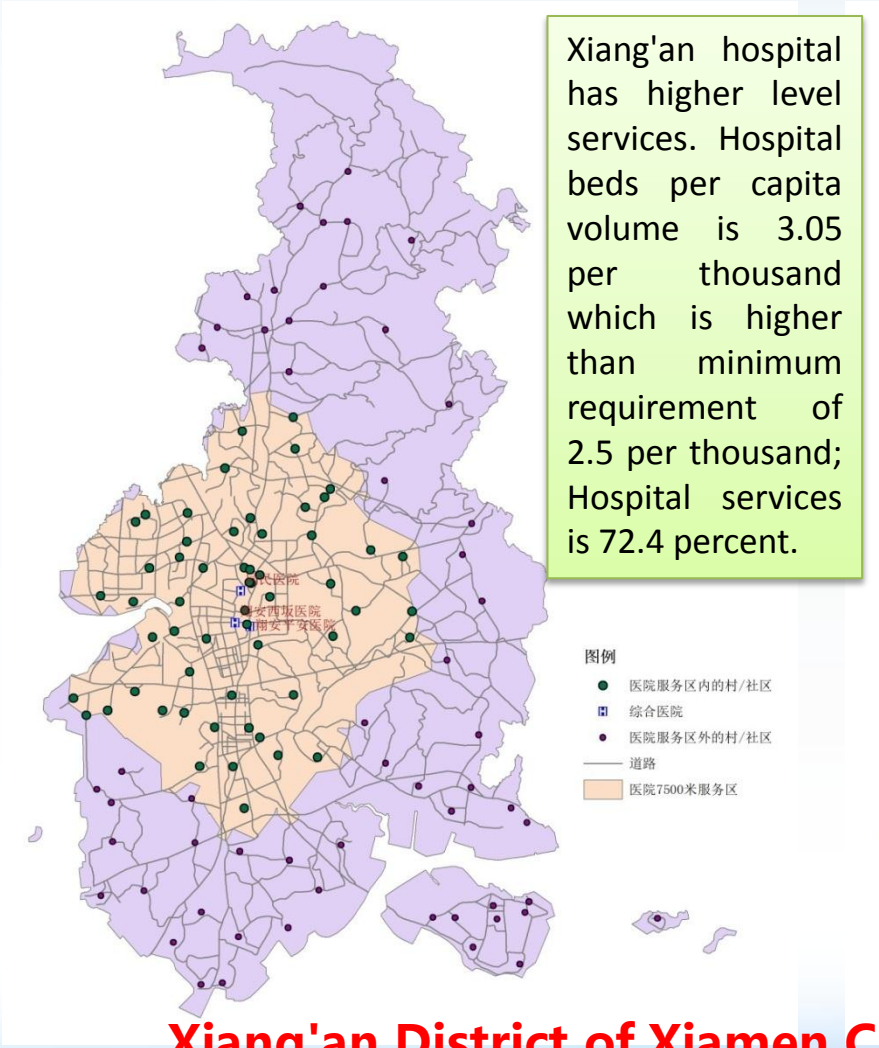
Ecological harmoniousness -- ecological environment condition index



- Land ecological index of 60% of the area is above good above in Xiamen.
- excellent land is 646.9 km^2 accounting for 40.0 % which is mainly in the northern and the southern island of Xiamen.
- The mountains distribute more widely. Ecological environment quality is better due to a large proportion of forest.

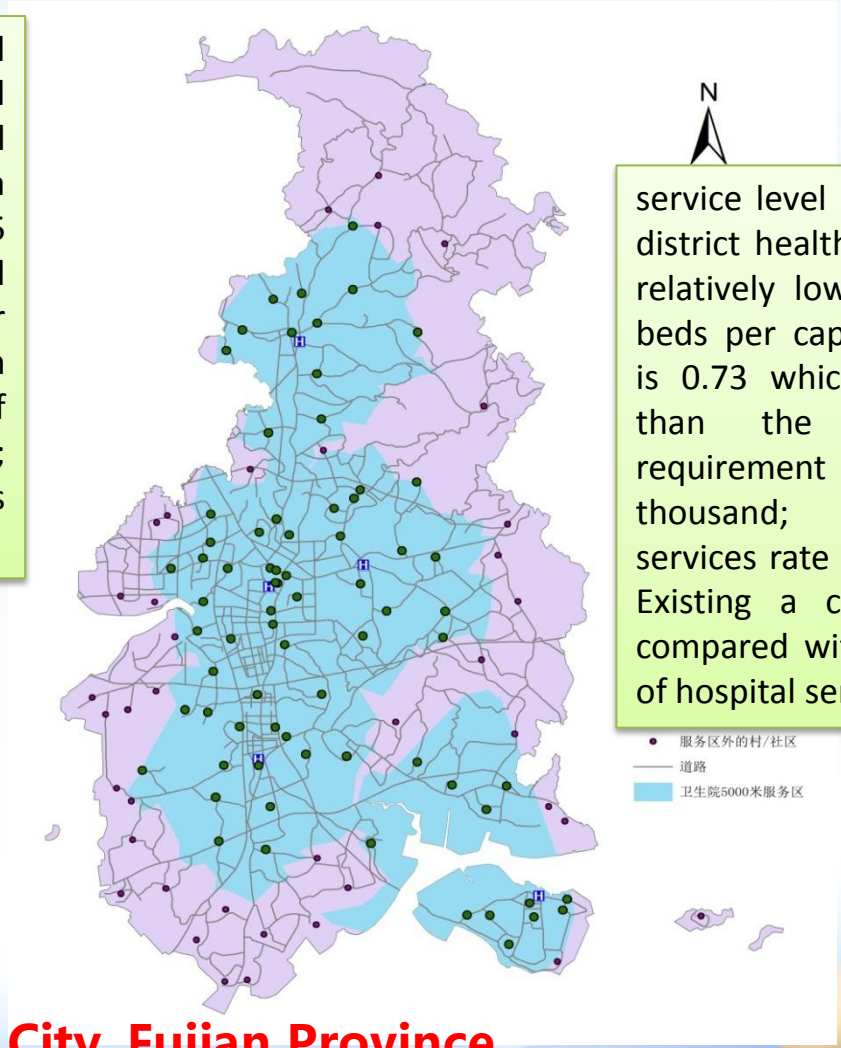
Spatial layout of the hospital organization

Fig.a hospital service area of 7500 meters



Xiang'an hospital has higher level services. Hospital beds per capita volume is 3.05 per thousand which is higher than minimum requirement of 2.5 per thousand; Hospital services is 72.4 percent.

Fig.b health centers area of 5000 meters



service level of Xiang'an district health centers is relatively low. Hospitals beds per capita volume is 0.73 which is lower than the minimum requirement of 1.0 per thousand; hospitals services rate was 51.0%, Existing a certain gap compared with the rate of hospital services.

Xiang'an District of Xiamen City, Fujian Province

Administrative division and management unit：

Convenience of medical residents

Fig. Village / community distance to the nearest hospital

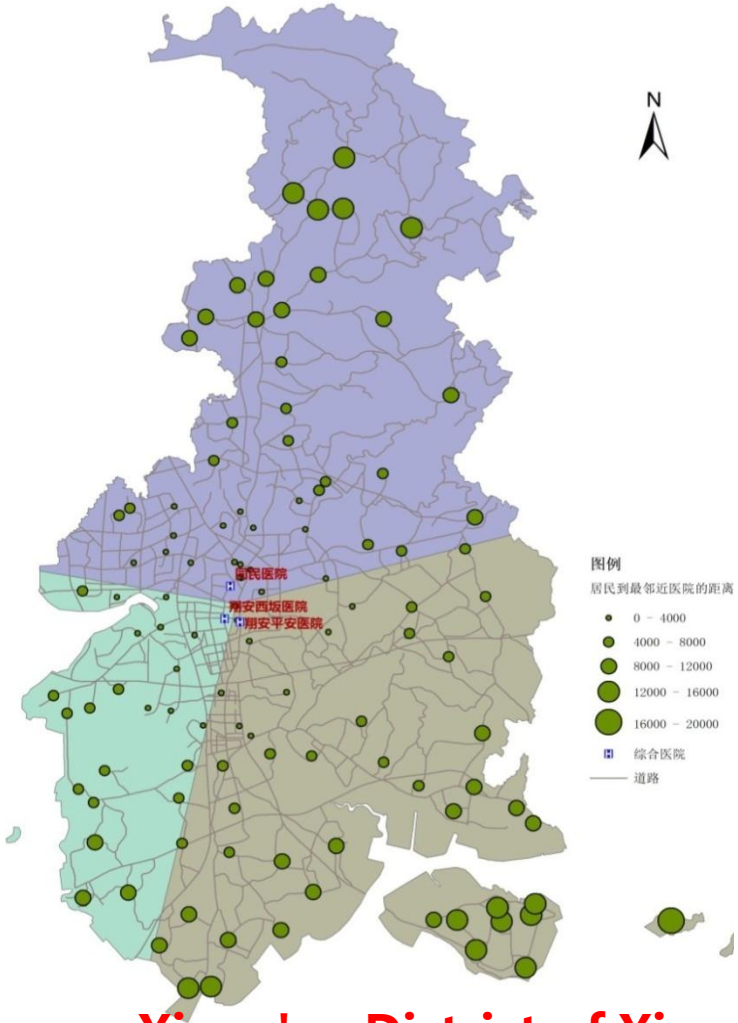
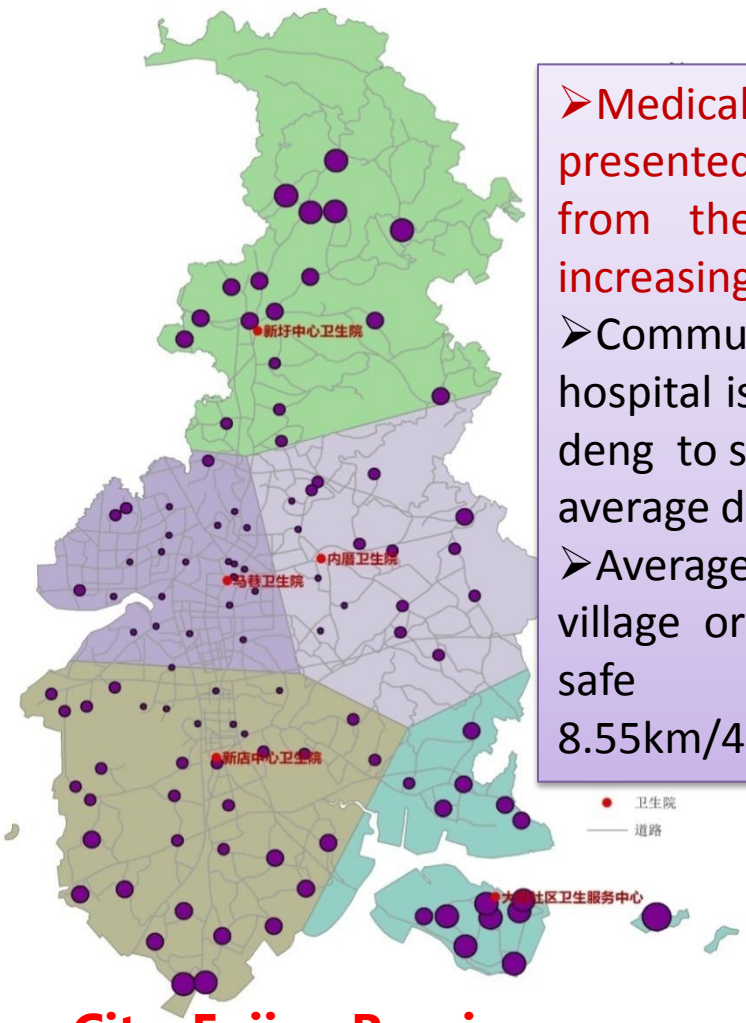


Fig. Village / community health centers distance to the nearest



- Medical residents recently presented to the hospital from the center, gradually increasing to around trend.
- Community to the nearest hospital is 17 km from small - deng to safe hospital, and average distance is 6.6 km.
- Average distance from village or community to the safe hospitals are 8.55km/4.88km/5.85km.

Xiang'an District of Xiamen City, Fujian Province

Administrative division and management unit：

equal basic public services: education resources

-Deqing county in Zhejiang province

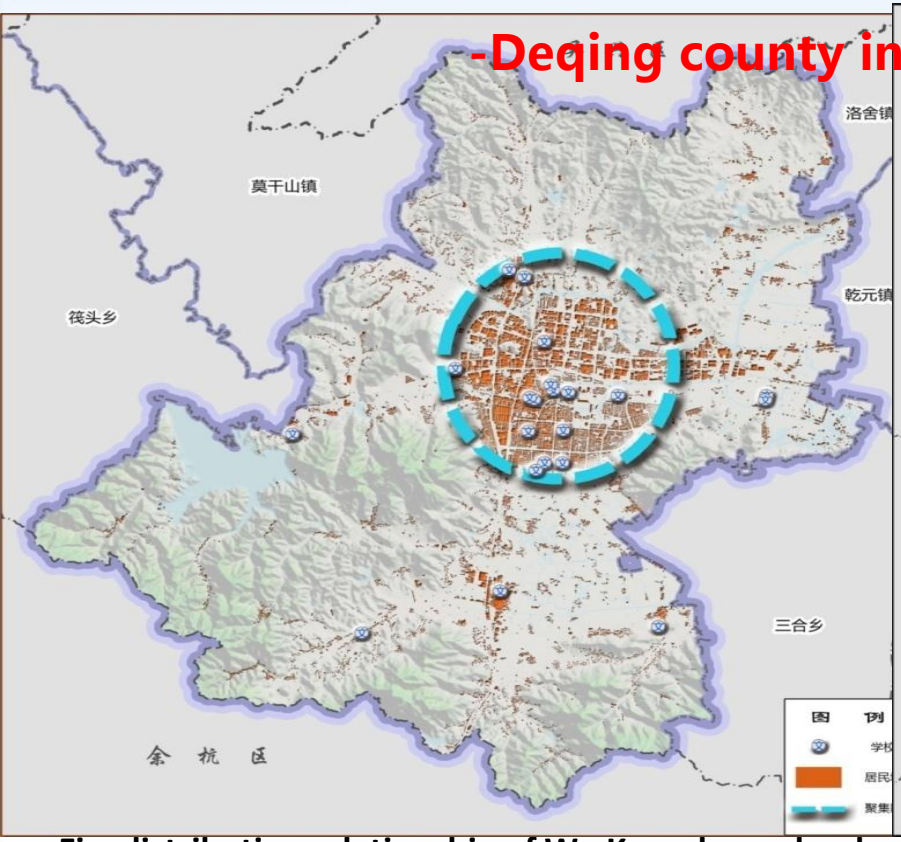


Fig. distribution relationship of Wu Kangzhen schools and residents

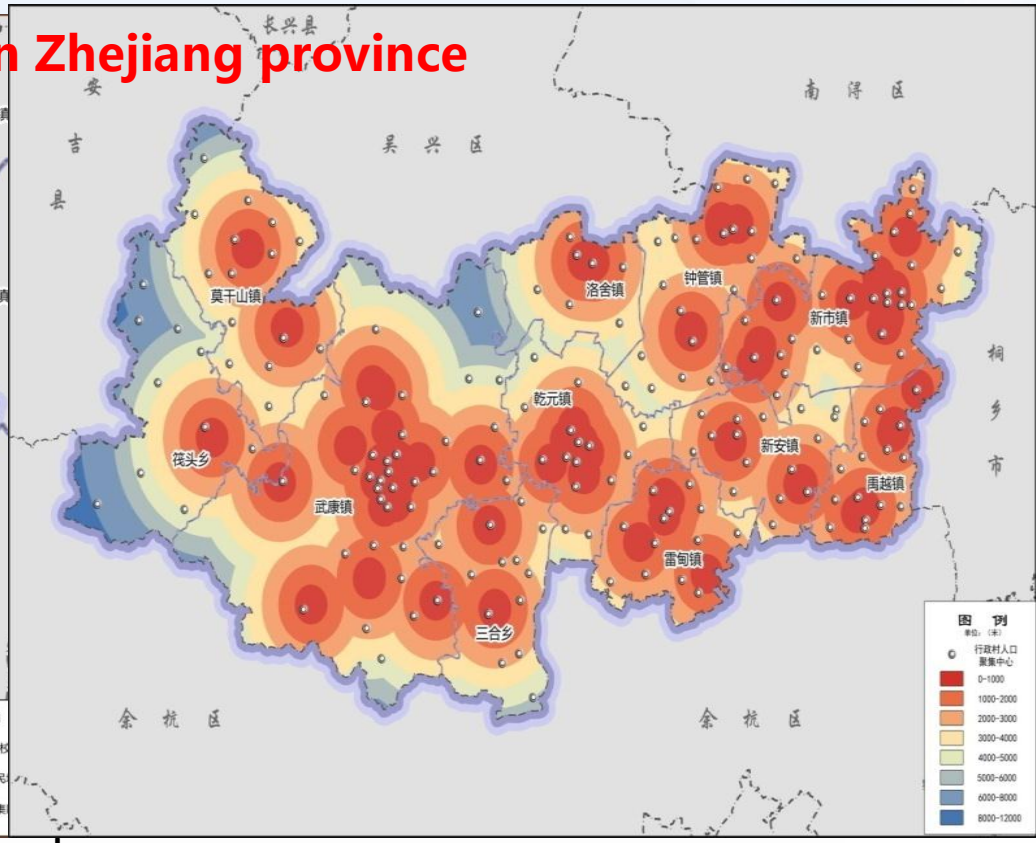


Fig. 1-12 kilometers buffer of each primary and secondary schools in Deqing County

- About 69.2% of the schools distribute more concentrated areas in the town of WuKang ,which indicaties the distribution of the school is relatively concentration.
- 80.53% of administrative villages located in Deqing County, within the service radius of 3 km.It indicates that it is ideal in Deqing.

Administrative division and management unit：

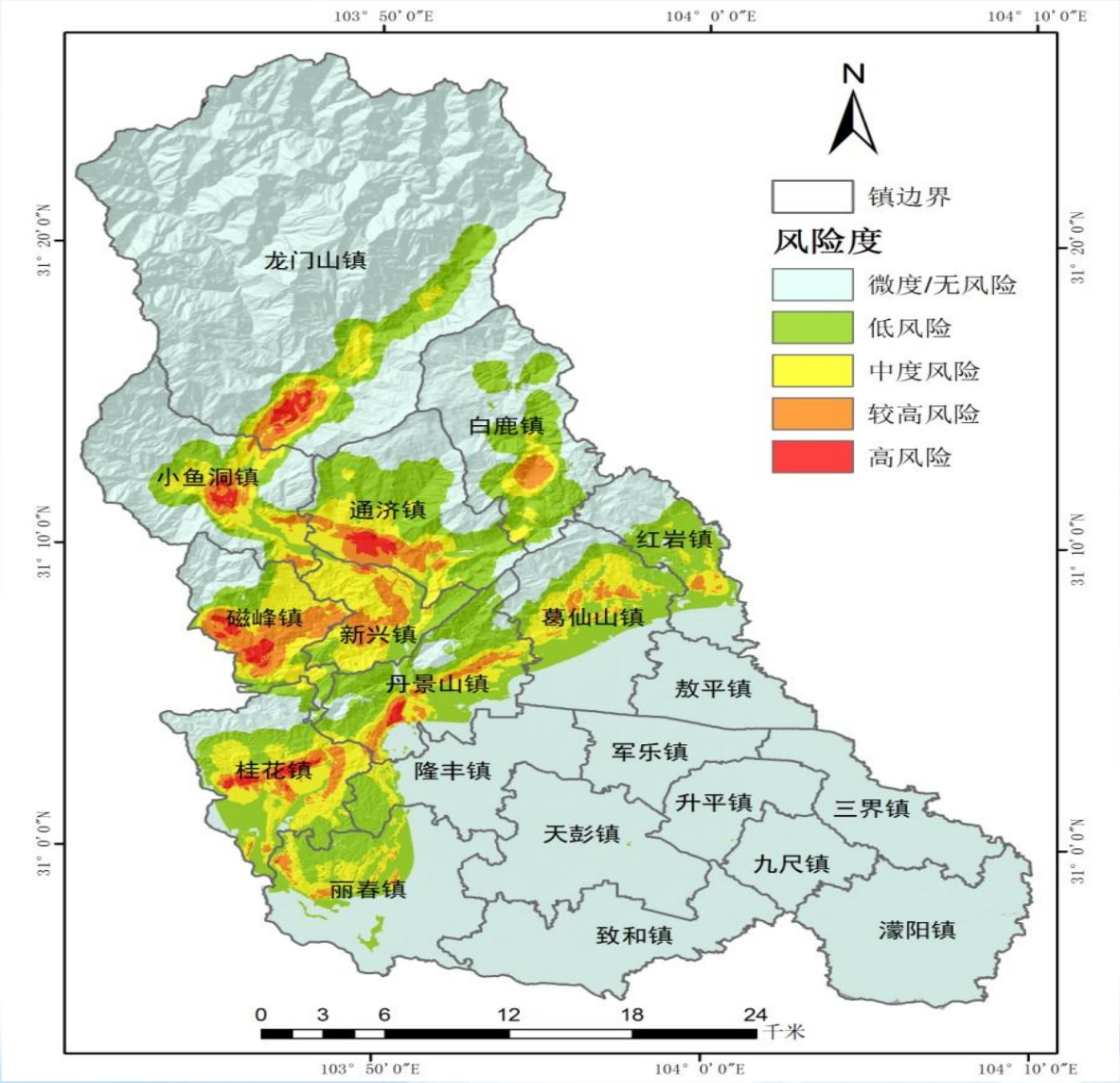
Equal basic public services—— the public service facilities configuration

Fig. the distance of village to school in Dongying District

DongYing, Shandong

Geographic grid unit:

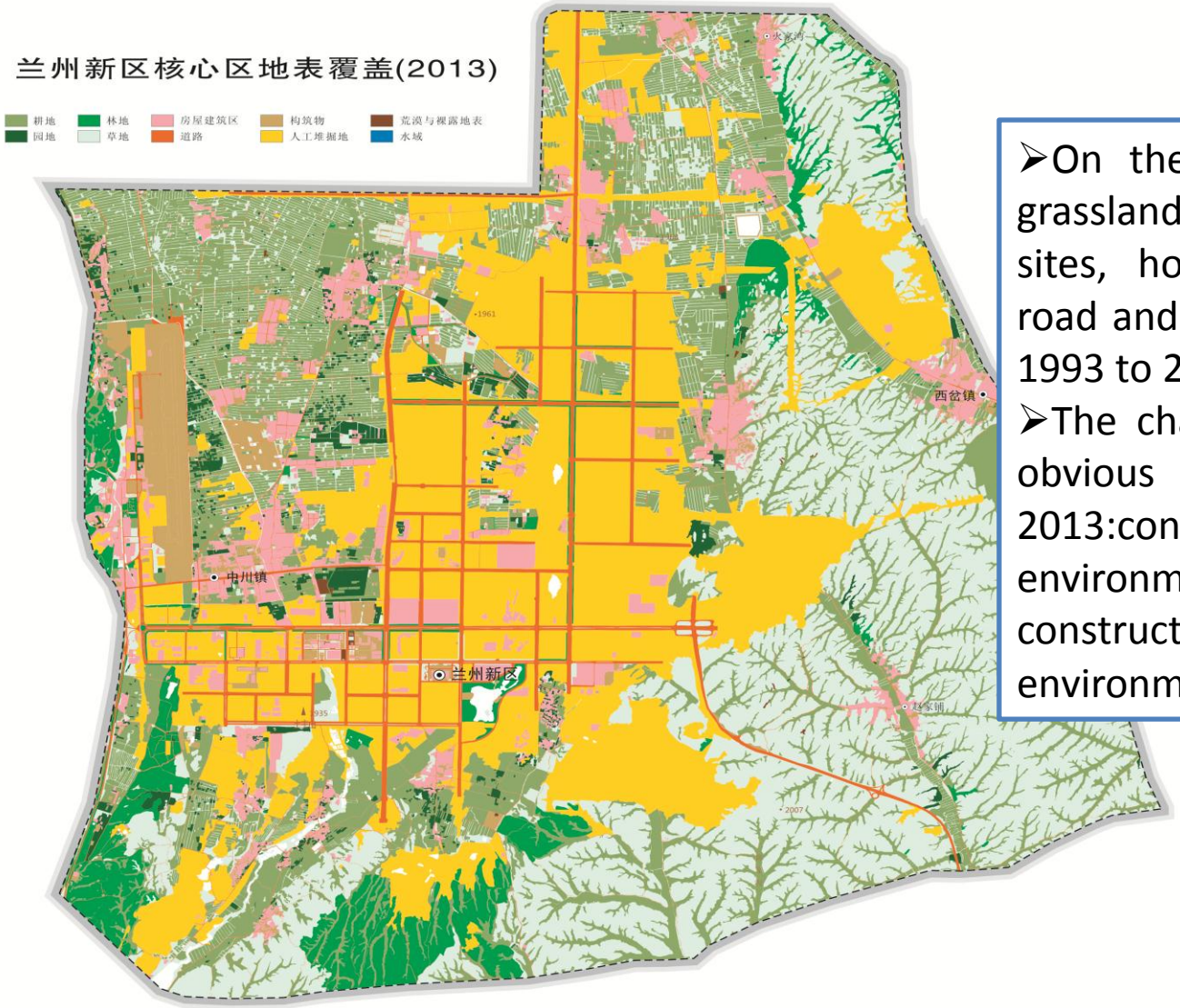
Pengzhou city of Sichuan: geological disaster risk analysis



The total number of Pengzhou settlements is 89,188 of which 80 persent are located in the piedmont plains and hilly areas. Longmen Shan , Tongji Xiaoyudong town and the town settlements which are Located in mountain town are mainly in river valleys and basically coincides with the geological disasters in high-risk areas.

Lanzhou new district of Gansu

change analysis of land cover from 1993 to 2013 in the core area



- On the whole, cultivated land, grassland decline; construction sites, housing construction area, road and water area increase from 1993 to 2013 in the core area .
- The change of the core is most obvious between 2010 and 2013:construction increase, living environment condition improve, construction of ecological environment unprecedented .

Geographical grid unit

The ecological environment condition index

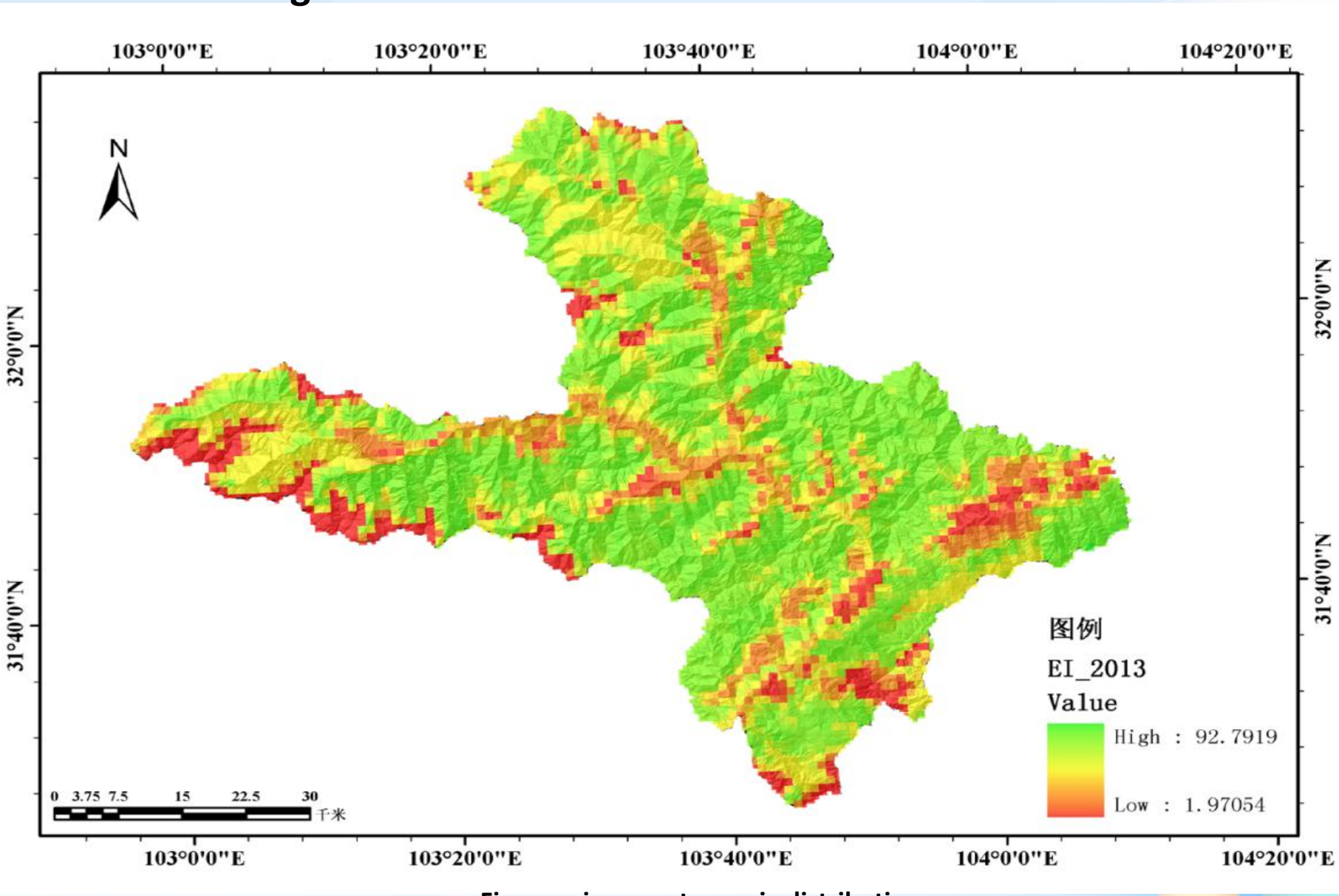
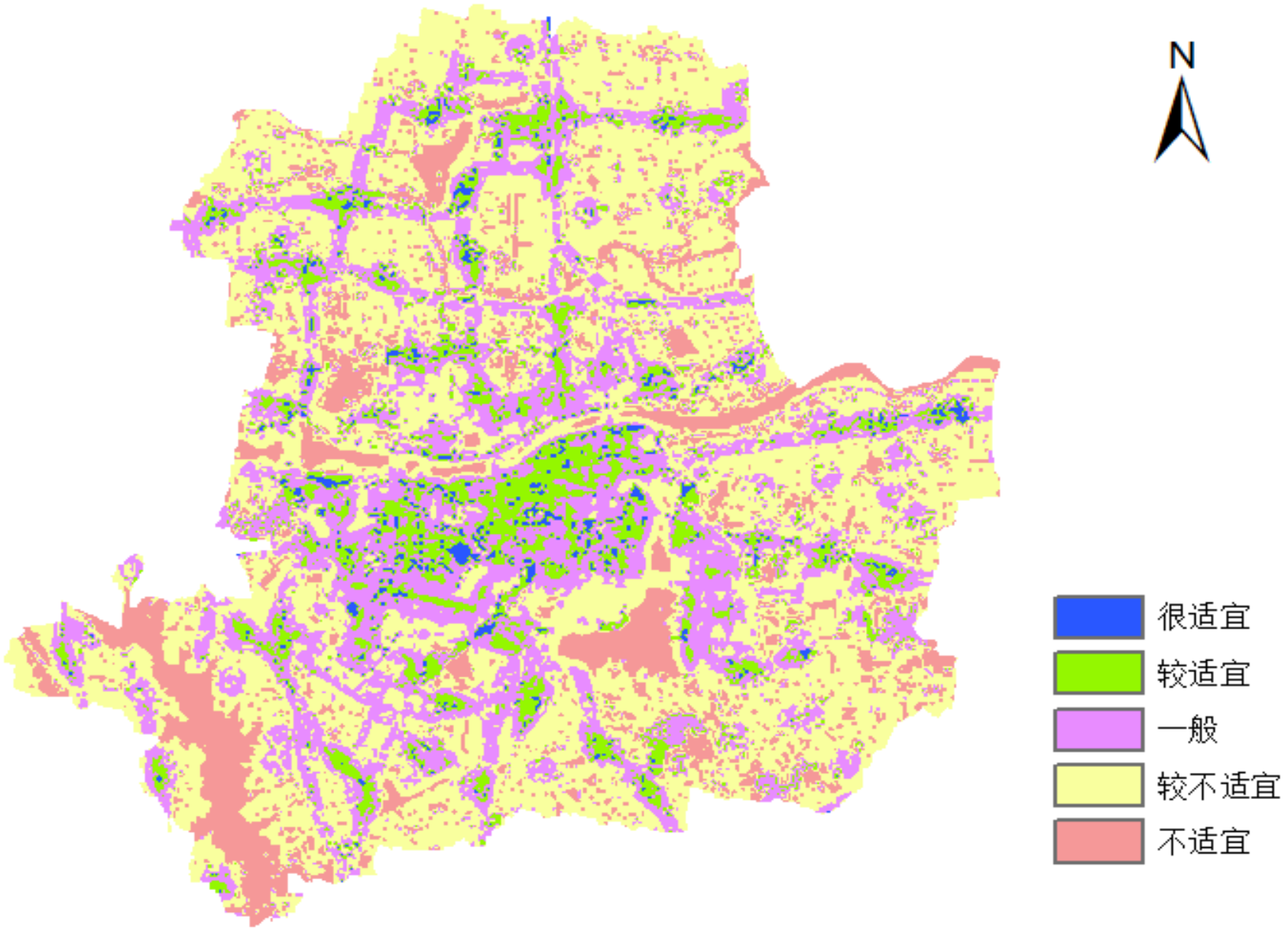


Fig.maoxian county spacia distribution
of ecological environment index of Mao county in2013

Geographical grid unit

Living environment index



3. Experiments and discussions

Discussions

- The design of grid and areal units have significant impacts over project results and both types complement each other at various application scenarios.
- From the perspective of surveying, mapping and geo-information, geographic conditions index is being formulated through integrating multiple aspects of statistics data with geographical features.
- The requirements to quality and consistency of geospatial data is higher than that of other data.
- Geographical conditions monitoring have become a common concerned topic, all experts are welcome to join us and work together on this subject.

Thanks !