



**Application of GIS in Rapid Mapping  
-the Vulnerability and Risk Mapping  
in China**

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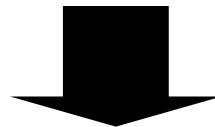
**Discussions**

# Concepts

- Macro mapping—national or regional
- Micro mapping---large scale mapping
- Direct mapping---Image interpretation and field mapping
- In-direct mapping---based on certain models and other approaches

# concepts

**Inventory mapping**



**Susceptibility mapping**



**Hazard Mapping**

# concepts

- Rapid mapping:

Mapping environment, data availability, data accuracy, user demands, map type, data transfer, direct mapping, in-direct mapping, methodology, etc.

- Urgent mapping:

- Emergency mapping:

# Methods for disaster inventory

- Image interpretation
- (Semi) automatic classification
- Based on spectral information
- Based on historical information
- Field investigation
- Archive studies
- Dating methods
- Monitoring networks

| Group   | Technique                                    | Description   | Scale    |        |       |          |
|---|--|---|----------|--------|-------|----------|
|   |  |   | Regional | Medium | Large | Detailed |
| Image interpretation  | Stereo aerial photographs                    | Analog format or digital image interpretation with single or multi-temporal data set                            | M        | H      | H     | H        |
|   | High Resolution satellite images             | With monoscopic or stereoscopic images, and single or multi-temporal data set                                   | M        | H      | H     | H        |
|   | LiDAR shaded relief maps                     | Single or multi-temporal data set from bare earth model   | L        | M      | H     | H        |
|   | Radar images                                 | Single data set<br>Image ratioing, thresholding   | L        | M      | M     | M        |
| (Semi) automated classification based on spectral characteristics | Aerial photographs                           | Single data images, with pixel based image classification or image segmentation                                 | M        | H      | H     | H        |
|   | Medium resolution multi spectral images      | Multiple date images, with pixel based image classification or image segmentation                               | H        | H      | H     | M        |
|   | Using combinations of optical and radar data | Either use image fusion techniques or multi-sensor image classification, either pixel based or object based     | M        | M      | M     | M        |
| (Semi) automated classification based on altitude characteristics | InSAR  | Radar Interferometry for information over larger areas<br>Permanent scatterers for pointwise displacement data  | M        | M      | M     | M        |
|   | LiDAR  | Overlaying of LiDAR DEMs from different periods   | L        | L      | M     | H        |
|   | Photogrammetry                               | Overlaying of DEMs from airphotos or high resolution satellite images for different periods                     | L        | M      | H     | H        |
| Field Investigation methods                                       | Field mapping                                | Conventional method   | M        | H      | H     | H        |
|   |  | Using Mobile GIS and GPS for attribute data collection  | L        | H      | H     | H        |
|   | Interviews                                   | Using questionnaires, workshops etc.  | L        | M      | H     | H        |
| Archive studies   | Newspaper archives                           | Historic study of newspaper, books and other archives   | H        | H      | H     | H        |
|   | Road maintenance organizations               | Relate maintenance information along linear features with possible cause by landslides                          | L        | M      | H     | H        |
|   | Fire brigade/police                          | Extracting landslide occurrence from logbooks on accidents  | L        | M      | H     | H        |
| Dating methods for landslides                                     | Direct dating method                         | Dendrochronology, radiocarbon dating etc.   | L        | L      | L     | M        |
|   | Indirect dating methods                      | Pollen analysis, lichenometry and other indirect methods  | L        | L      | L     | L        |
| Monitoring networks   | Extensometer etc                             | Continuous information on movement velocity using extensometers, surface tiltmeters, inclinometers, piezometers | -        | -      | L     | H        |
|   | EDM  | Network of Electronic Distance Measurements, repeated regularly   | -        | -      | L     | H        |
|   | GPS  | Network of Differential GPS measurements, repeated regularly  | -        | -      | L     | H        |
|   | Total stations                               | Network of Theodolite measurements, repeated regularly  | -        | -      | L     | H        |
|   | Ground-based InSAR                           | Using ground-based radar with slide rail, repeated regularly  | -        | -      | L     | H        |
|   | Terrestrial LiDAR                            | Using terrestrial laser scanning, repeated regularly  | -        | -      | L     | H        |

# The applications of different resolution images for disaster mapping---image selection and assessment

Urban disaster



QuickBird  
0.5米

Sub-urban and town



P5  
2.5米

Rural disaster



ETM  
15-30米

urban (hi-density )

town (medium density )

rural (loose density)

Sharp in lane, road, building, green land, garden, cross, drainage, etc.

Sharp in main road, main building、main square, lake, landuse, etc.

Sharp in land, hill, mountain、main river, lake, field, main road、etc.

# The applications of different resolution images for disaster mapping---image selection and assessment

Landslide--large scale



Aerial photograph

landslide –medium scale



Spot

landslide –small scale



Landsat TM

Large scale

Medium scale

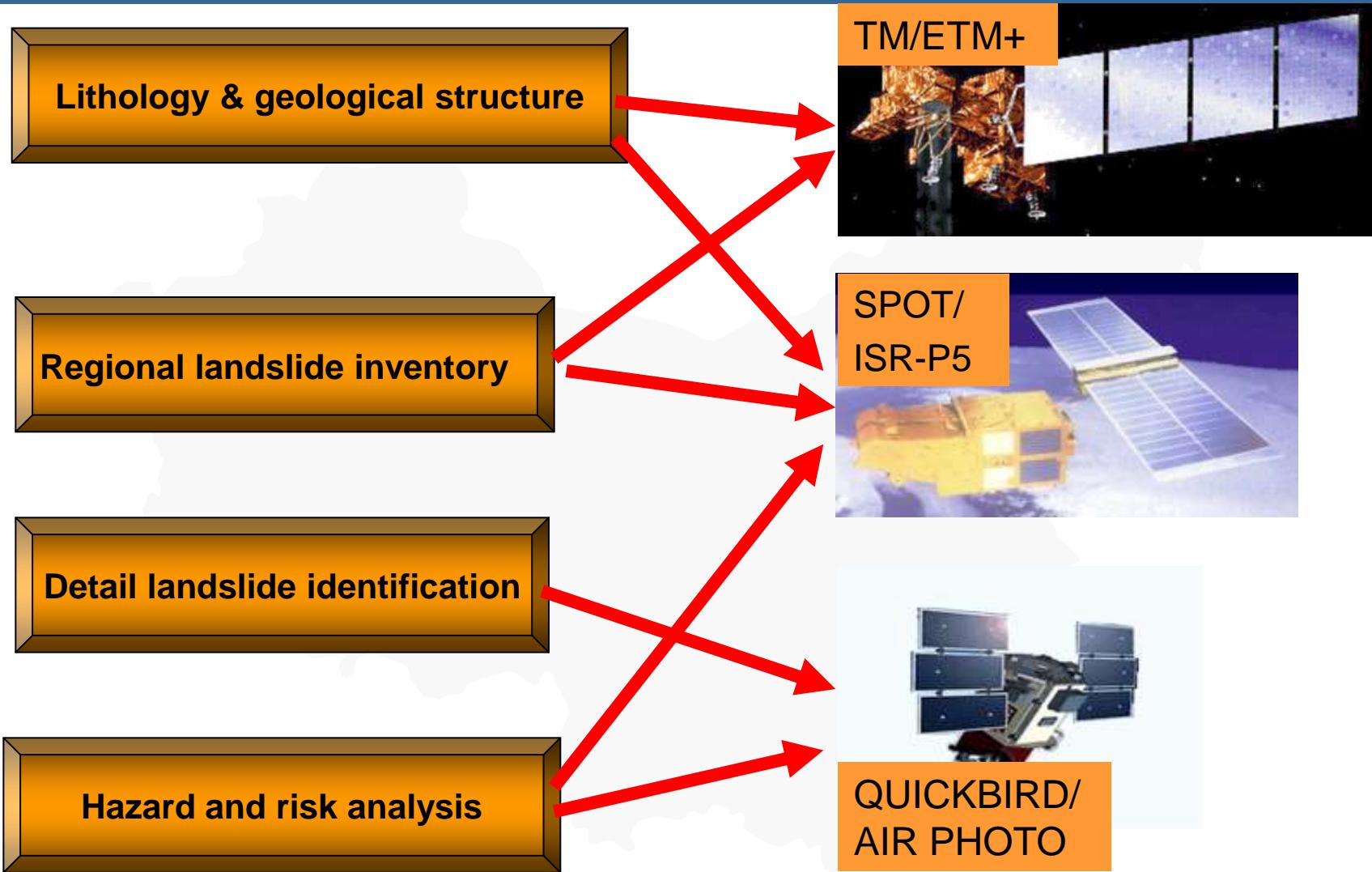
Small scale

Detail landslide distribution,  
sharp landuse and its  
surrounding environment

Sharp landslide distribution  
and landuse type

Dot distribution and its  
topographical background

# Different remote sensing data for landslide



# The approaches and steps for: image + basic geographic information

Input image & geo-data



Delineation disaster boundary



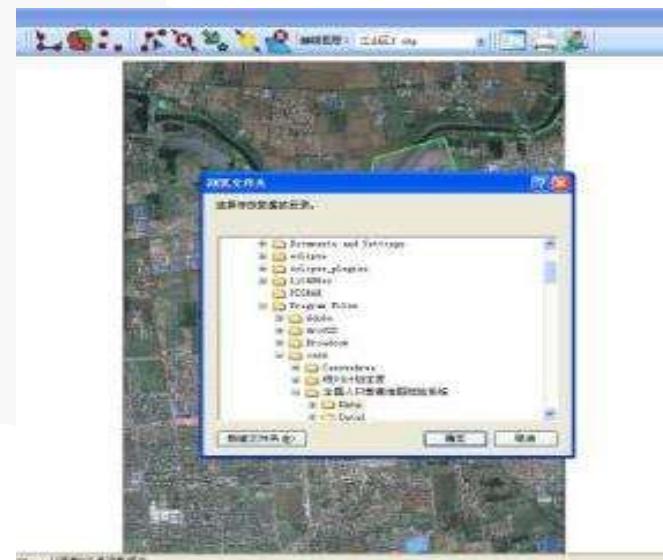
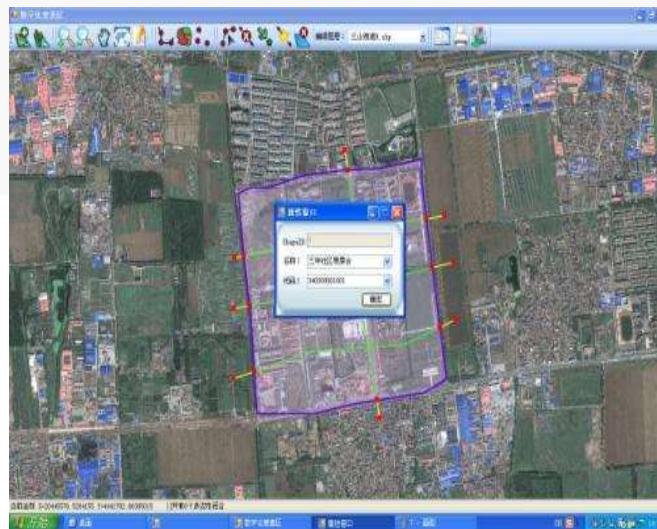
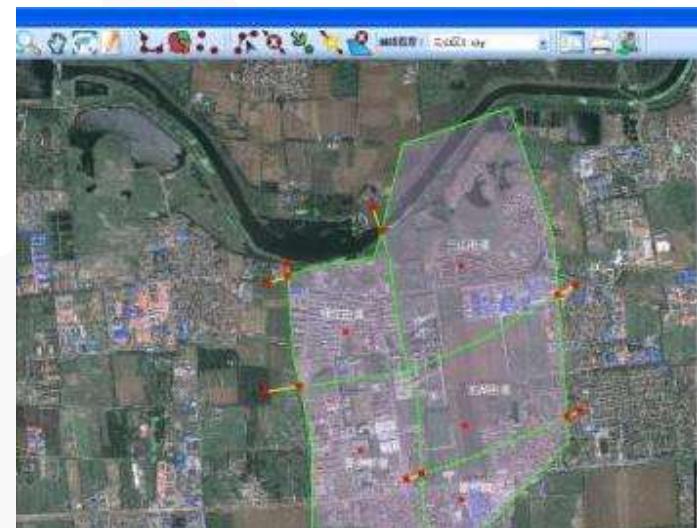
Specific delineation



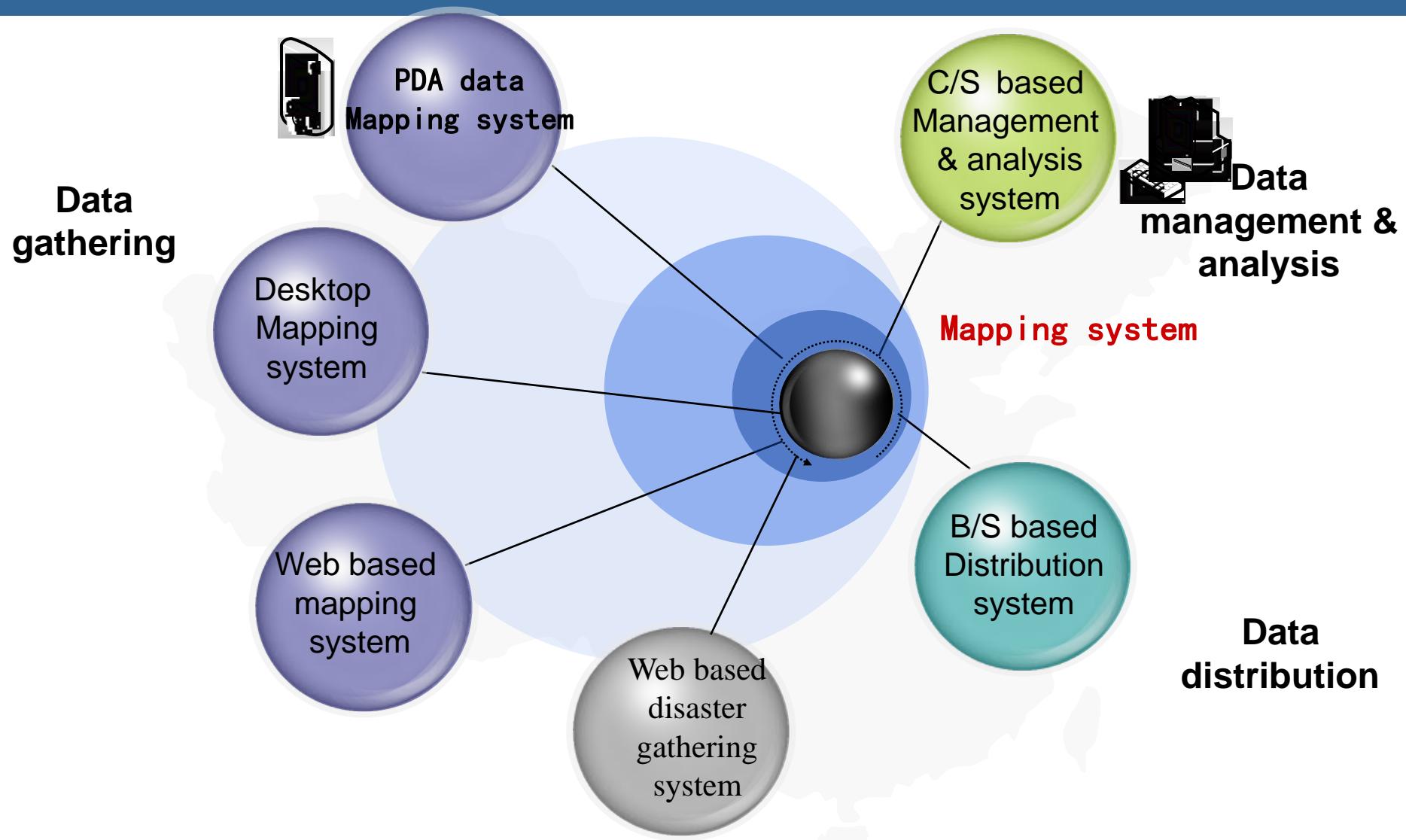
Coding and attribute built



Landuse & infrastructure



# Mapping platform design



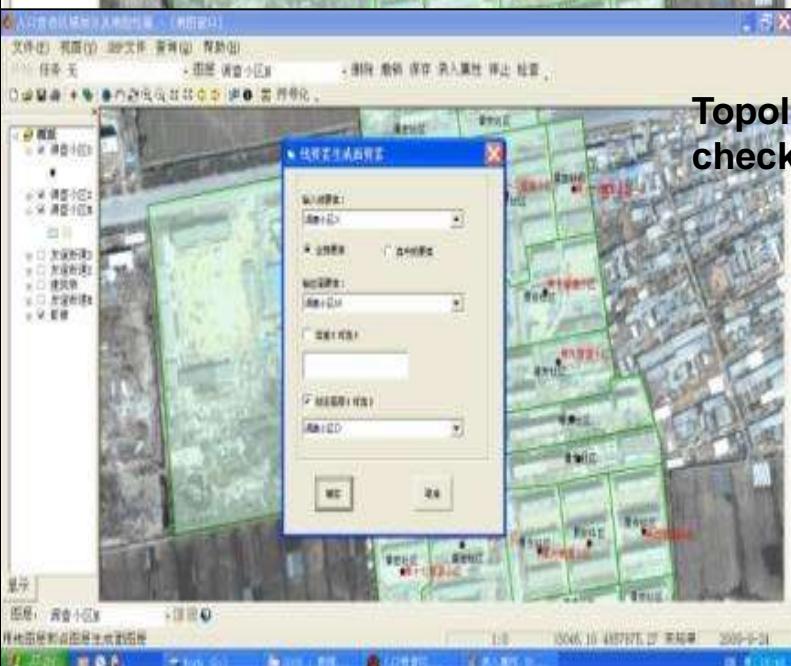
# Desktop mapping system



# Interface of Mapping system as a case for census block mapping



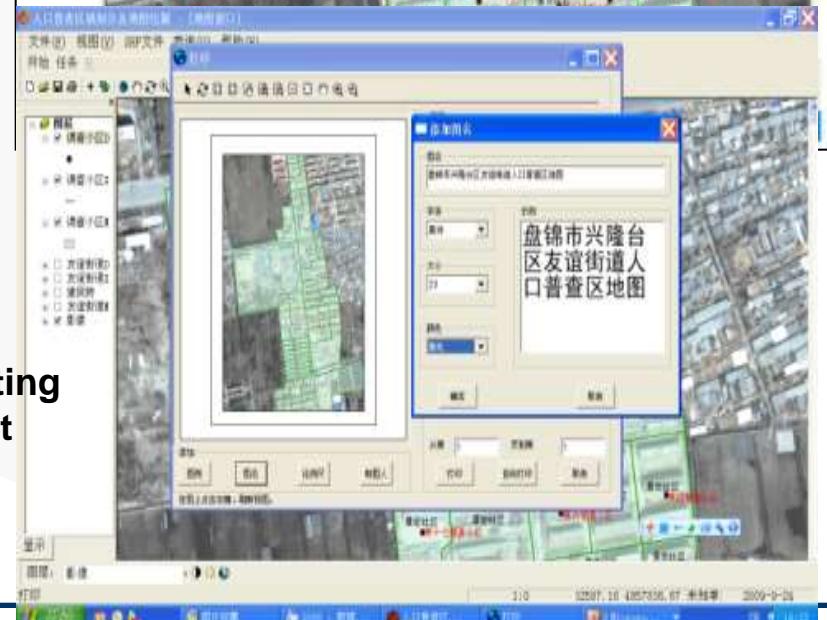
Boundary  
delineation



Topologic  
checking

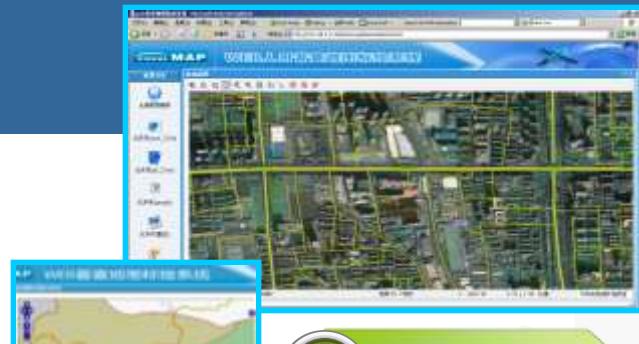


Attribute  
construction



Map editing  
and print

# Web based mapping system



data input

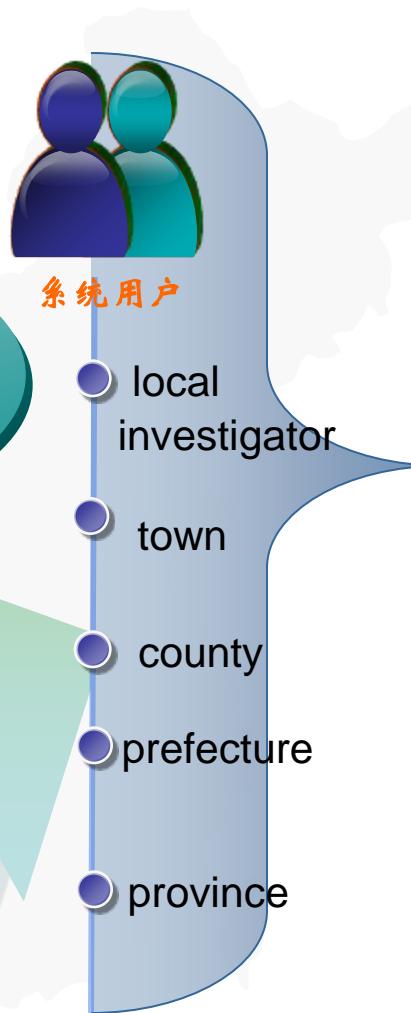
topology

Boundary

infrastructure

Data up/down load

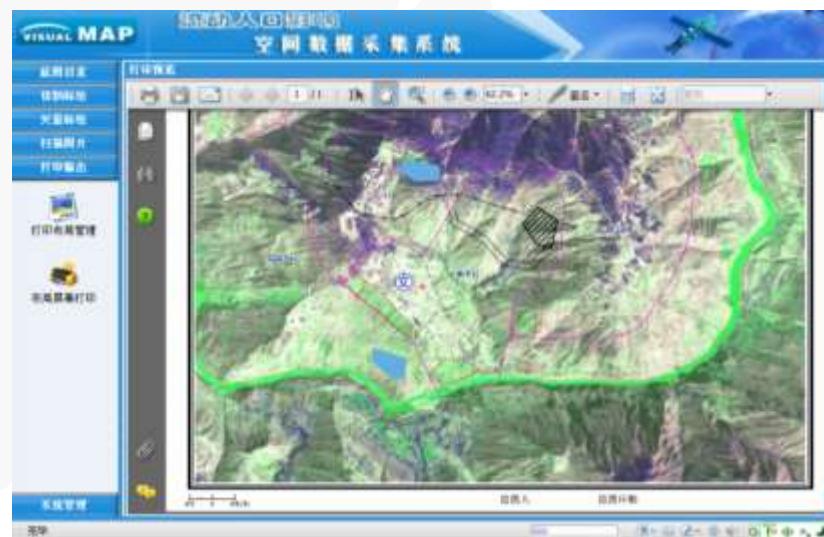
Web based  
Mapping  
system



Online  
mapping  
only for  
those  
areas  
having  
internet  
connecti  
on



# Web-based mapping system interface





New town

New beichuan middle school landslide: The volume was about 5 million m<sup>3</sup>

Old town

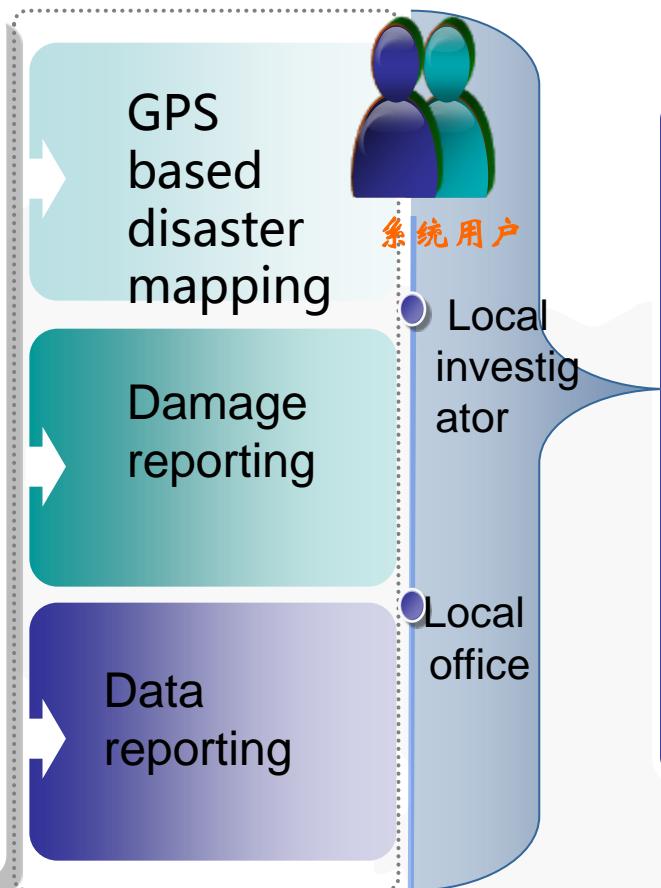
Wangjiayan landslide: The sliding mass consisted of about 7 million m<sup>3</sup> of metamorphic rocks

By Tang Chuan

# PDA (mobile phone) data gathering system



PDA (手机) mapping system



Using highly complicated area for data checking & reporting

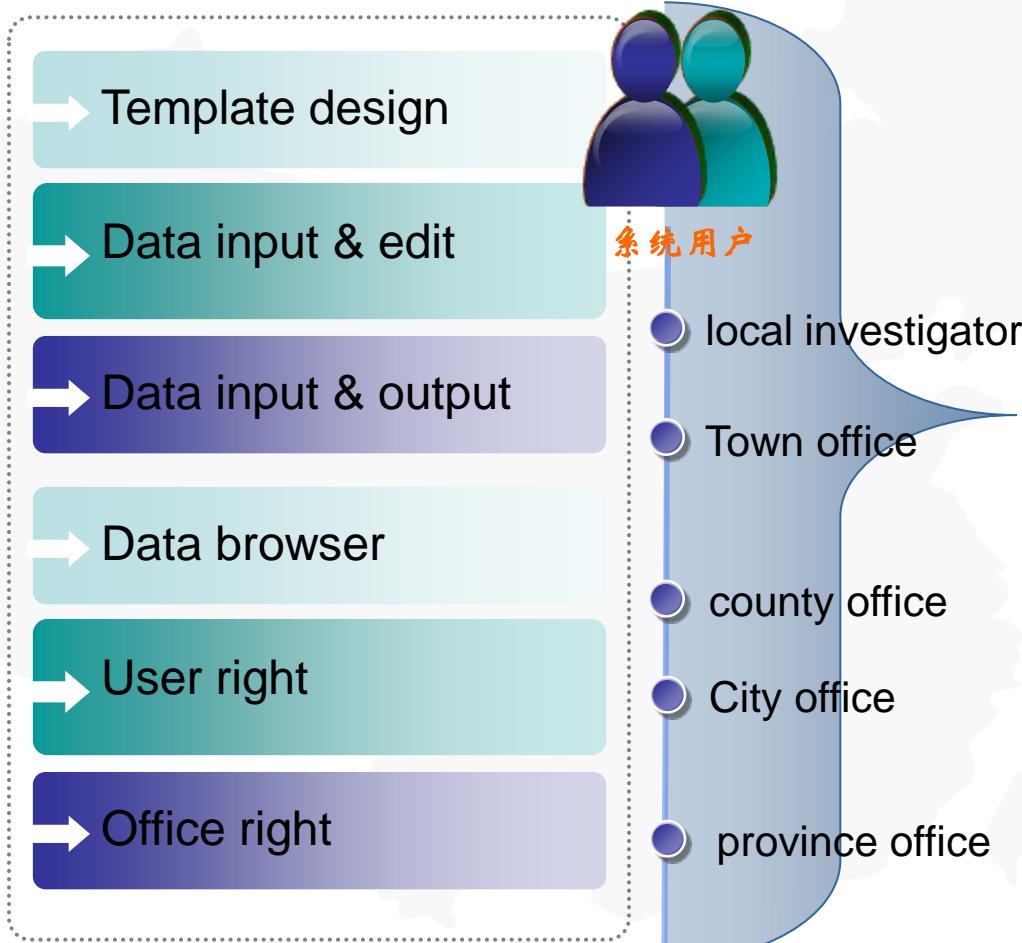


mobile phones used by the system



Field device used by Ministry of Land Resources

# Online disaster investigation system design



Mainly for disaster Investigation based the designed table or template

# Main interface and template design

**Log in**

**Investigation template design**

**Data statistics**

1. 耕地信息

1.2 耕地总面积  
总和: 1913.0 平均数: 382.6 总记录数: 5

1.3 收入最多的耕地

|        |       |
|--------|-------|
| 水田 : 3 | 60.0% |
| 旱地 : 1 | 20.0% |
| 草地 : 1 | 20.0% |

总记录数: 5

2. 基本信息

2.2 性别

|       |       |
|-------|-------|
| 女 : 1 | 20.0% |
| 男 : 4 | 80.0% |

总记录数: 5

2.4 是否五户户

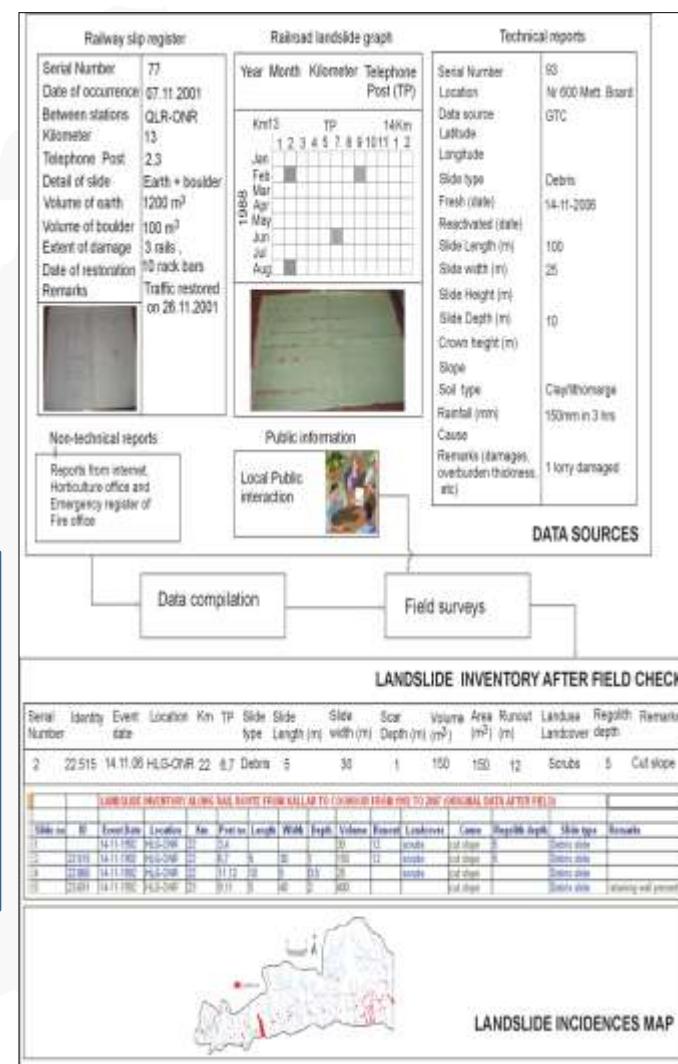
|       |       |
|-------|-------|
| 否 : 3 | 60.0% |
| 是 : 2 | 40.0% |

总记录数: 5

**table**

**Data input**

| 序号  | 调查对象 | 单位  | 代码    |
|-----|------|-----|-------|
| 1.1 | 名称   | 万公顷 | Q0001 |
| 1.2 | 面积   | 万公顷 |       |
| 1.3 | 特征   | 万公顷 | Q0001 |
| 1.4 | 类型   | 万公顷 | Q0001 |
| 1.5 | 坡度   | 万公顷 | Q0001 |
| 1.6 | 利用方式 | 万公顷 | Q0001 |
| 2.1 | 主要作物 | 万公顷 | Q0001 |
| 2.2 | 耕种制度 | 万公顷 | Q0001 |



# Geohazards inventory sheets

## (by ministry of Land Resources)

|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|--|------|--|---------|---------|-----------------------------|--|------------------------------|--|--|--|--------------------------------|--|-------------------------------|--|-------------------------------|-----------------------------|-------------------------------|--|----------------------------|--|
| 崩塌（潜在崩塌）调查表  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 崩塌情况   |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| <input checked="" type="checkbox"/> 崩塌 <input type="checkbox"/> 潜在崩塌 |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 统一编号:  |      | 50023202001                            |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 名称:  |      | 武隆县铁矿乡浅层山崩者                            |         |         |                             | 武隆县铁矿乡红崖庄长兴组                           |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 野外编号:  |      | 392                                    |         | 经度:     |                             | 3234780<br>36443540                    |                              | 标高(米):                                 |  | 坡顶 1340<br>坡脚 1310                       |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 室内编号:  |      | 401540-01                              |         | 纬度:     |                             | 107°25'09"<br>29°13'42"                |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 崩塌类型:  |      | 滑移式                                    |         | 崩塌发生时间: |                             | 年 月 日                                  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 崩塌环境   |      | 地质岩性                                   |         |         | 地质构造                        |  |                              | 断块类型                                   |  | 地下水类型                                    |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 地质年龄:                                  | 时代:     | 岩性:     | 产状:                         | 构造部位:                                  | 地质构造:                        | <input checked="" type="checkbox"/> 陡崖 | <input type="checkbox"/> 陡坎            | <input type="checkbox"/> 孔隙水             | <input type="checkbox"/> 裂隙水   |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 地层系上部:                                 | 灰岩      | 页       | 315°/32°                    | 白垩向斜                                   | YI                           | <input type="checkbox"/> 缓坡            | <input type="checkbox"/> 平台            | <input type="checkbox"/> 岩溶水             | <input type="checkbox"/> 溶隙水   |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 降雨量(毫米):                               |         |         |                             | 水文:                                    |                              |  | 土地利用:                                  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 年均:                                    | 最大降水量   |         | 丰水位(m):                     | 枯水位(m):                                | 植被与河流位置:                     | 黑                                      | <input checked="" type="checkbox"/> 耕地 | <input type="checkbox"/> 草地              |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 暴雨:                                    | 日       | 时       |                             |  | 左岸                           | 右岸                                     | <input type="checkbox"/> 灌木            | <input type="checkbox"/> 森林              |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  | 1082.2  | 250     | 45                          |  | 凹岸                           | 凸岸                                     | <input type="checkbox"/> 灌木            | <input type="checkbox"/> 建筑              |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  | 坡高(m):  | 坡长(m):  | 坡宽(m):                      | 规模等级:                                  | 坡度(°):                       | 坡向(°):                                 |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  | 25      | 1000    | 10                          | 250000                                 | 大型                           | 85                                     | 95                                     |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  | 岩样结构    |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 结构特征   |      | 结构类型                                   |         |         | 厚度                          |  |                              | 洞隙结构类型                                 |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 节理裂隙:                                  | 5       | 2       | 5                           | ×                                      | 3                            | ×                                      | 10                                     | <input checked="" type="checkbox"/> 疏散裂隙 |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 类型:                                    | 产状:     |         | 长度(m):                      | 间距(m):                                 | 平缓层裂隙                        |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 节理裂隙:                                  | 79      | 24      | 5                           | 2                                      | 风化带                          |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 片理或层:                                  | 176     | 29      |                             |  | 卸荷裂隙                         |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  | 2       |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  | 土的名称及特征 |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      | 土壤特征                                   |         | 名称:     |                             |  | 下伏基岩特征                       |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         | 名称:     | 密度:                         | 硬度:                                    | 时代:                          | 岩性:                                    | 产状:                                    | 埋深(m):                                   |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         | 粘性土:    | 稍                           | 干燥                                     | 地层系上统:                       | 页岩                                     | 315°/32°                               | 5  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 埋深(m):   | 上升泉  |  |         | 下降泉     | 涌水                          | <input checked="" type="checkbox"/> 降漏 | <input type="checkbox"/> 地表水 | <input type="checkbox"/> 雪水            | <input type="checkbox"/> 人工            |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  | 名称:  |  |         | 形态:     | 特征:                         | 发现时间:                                  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  | 拉张裂隙 |  |         | 后壁      | 宽4-6cm                      | 2002年07月01日                            |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 现今变形破坏迹象   |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 可能失稳因素   |      | <input checked="" type="checkbox"/> 降雨 |         |         | <input type="checkbox"/> 地震 |  |                              | <input type="checkbox"/> 人工加载          |  |  | <input type="checkbox"/> 开挖坡脚  |  | <input type="checkbox"/> 坡脚冲刷 |  | <input type="checkbox"/> 坡脚侵润 |                             | <input type="checkbox"/> 块体切割 |  |                            |  |
|  |      | <input checked="" type="checkbox"/> 风化 |         |         | <input type="checkbox"/> 部剪 |  |                              | <input type="checkbox"/> 塌破震动          |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |
| 目前稳定性程度  |      | <input type="checkbox"/> 稳定性好          |         |         | <input type="checkbox"/> 较差 |  |                              | <input type="checkbox"/> 差             |  |  | <input type="checkbox"/> 今活化趋势 |  | <input type="checkbox"/> 稳定性好 |  |                               | <input type="checkbox"/> 较差 |                               |  | <input type="checkbox"/> 差 |  |
|  |      |  |         |         |                             |  |                              |  |  |  |                                |  |                               |  |                               |                             |                               |  |                            |  |

| 长度(a): | 宽度(a): | 厚度(a): | 体积(a³): | 坡度(°): | 坡向(°): | 坡面形态: | 稳定性: |
|--------|--------|--------|---------|--------|--------|-------|------|
| 1000   | 10     | 25     | 200000  | 85     | 85     | 凸     | 稳定性差 |

| 可能失稳因素:                             | 降雨                       | 地震                       | 人工加载                     | 开挖坡脚                     | 坡脚冲刷                     | 坡脚侵润                     | 块体切割                     | 风化                       | 部剪                       | 塌破震动                     |
|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> |

| 目前稳定性程度:                 | 好                                   | 较差                       | 差                        | 今后变化趋势:                  | 好                        | 较差                       | 差                        |
|--------------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |

| 造成灾害:                    | 死亡人口(人): | 损坏房屋: | 道路(a): | 桥梁(a): | 其它危害: | 直接损失(万元): | 灾害等级: |
|--------------------------|----------|-------|--------|--------|-------|-----------|-------|
| <input type="checkbox"/> | 0        | 间     | 0      | 0      | 0     | 0         | 小型    |

| 潜在危害:                               | 威胁人口(人): | 威胁财产(万元): | 险情等级: |
|-------------------------------------|----------|-----------|-------|
| <input checked="" type="checkbox"/> | 5        | 5         | 小型    |

| 监测建议:                               | 定期目视检查                   | 安装简易监测设施                 | 地面位移监测                   |
|-------------------------------------|--------------------------|--------------------------|--------------------------|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| 防治建议:                               | 群测群防                     | 专业监测                     | 搬迁避让                     | 工程治理                     | 多媒体                      | 隐患点:                     | 是                                   |
|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------------------|
| <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

| 群测人员: | 赵明生 | 村长: | 赵明生 | 电话: | 77902991 | 防灾预案: | <input checked="" type="checkbox"/> |
|-------|-----|-----|-----|-----|----------|-------|-------------------------------------|
|-------|-----|-----|-----|-----|----------|-------|-------------------------------------|

示意图

清空平面图

输出平面图

剖面图

输出剖面图

调查负责人:

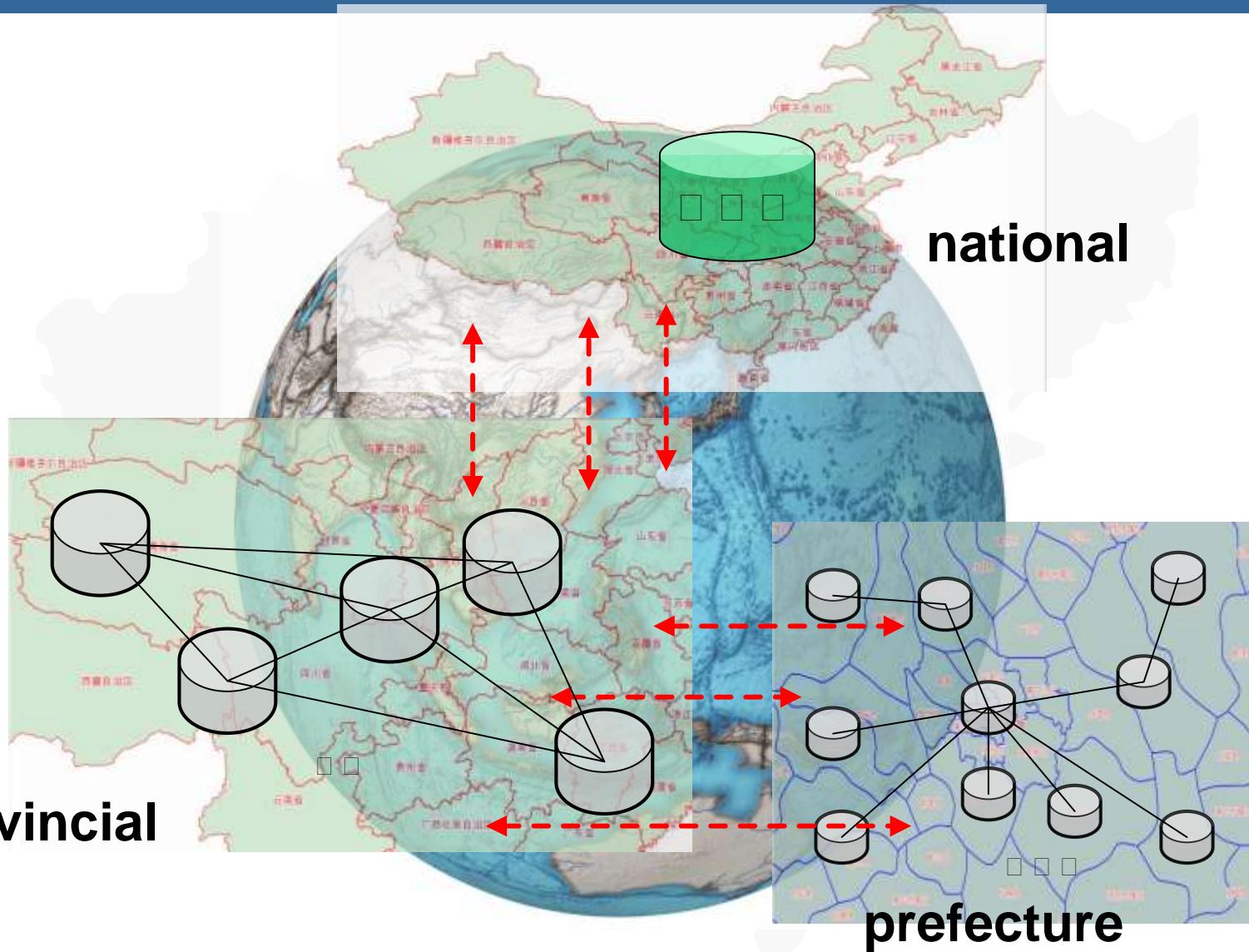
绘表人:

填表日期:

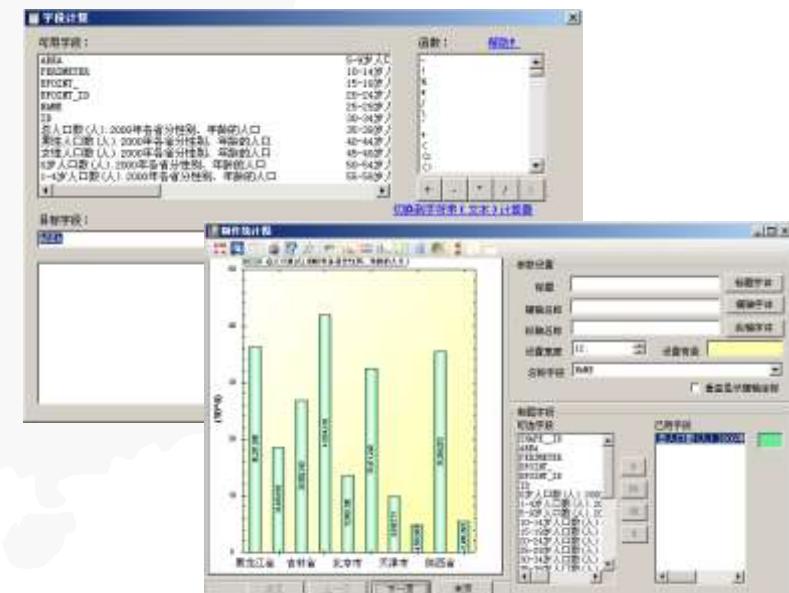
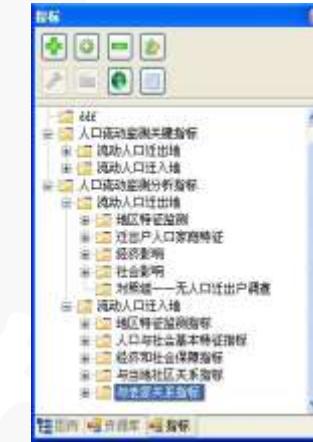
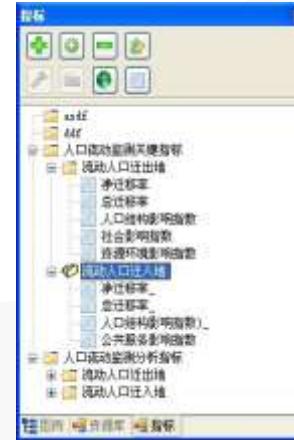
审核人:

调查单位:

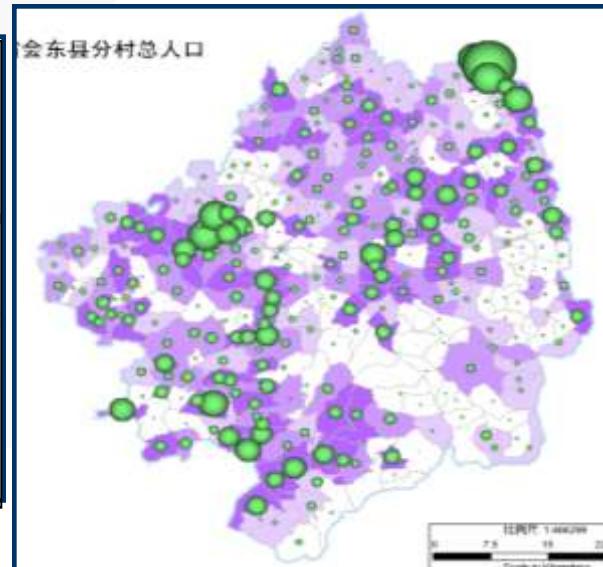
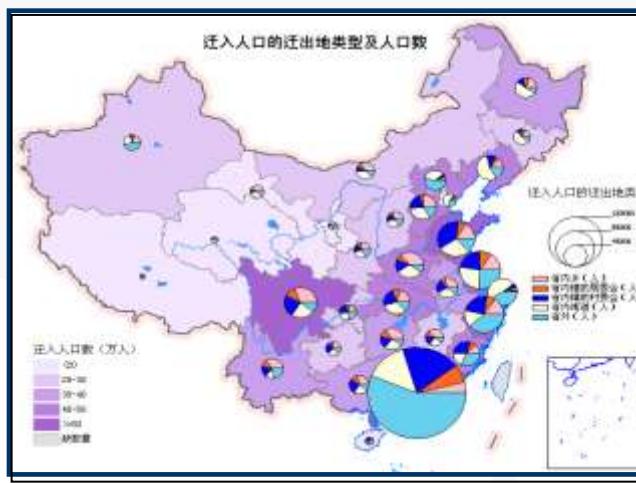
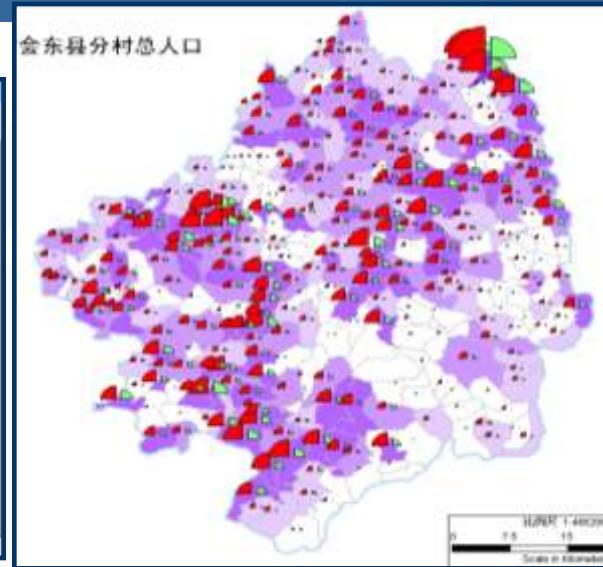
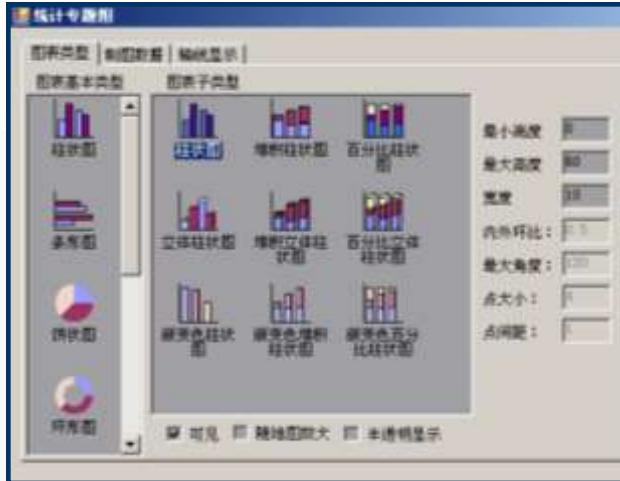
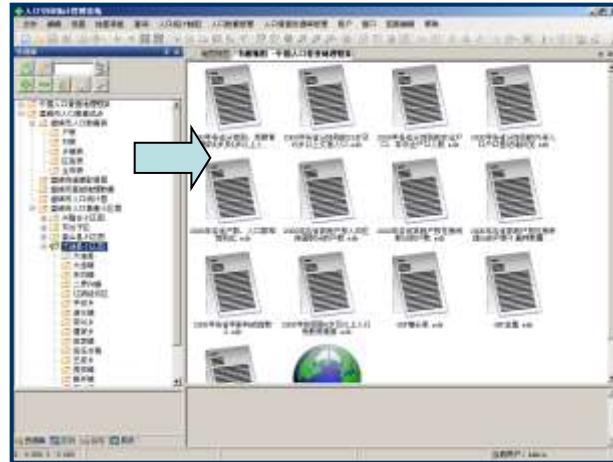
# C/S based data management system



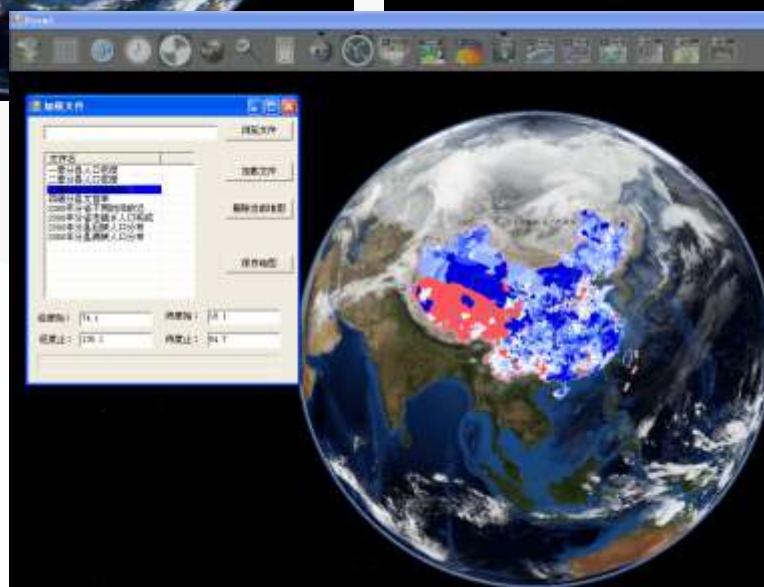
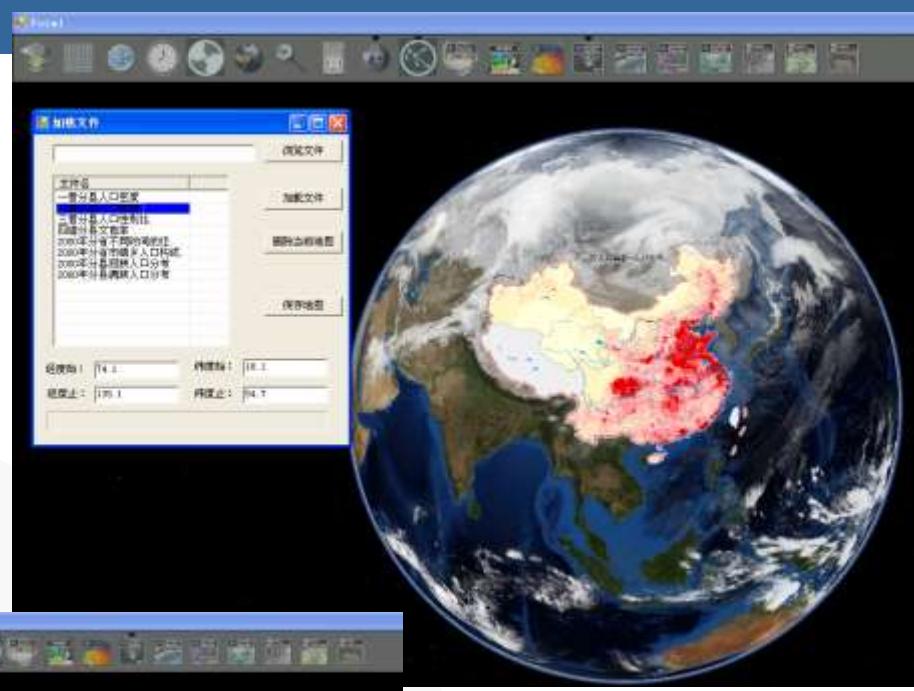
# C/S based data management system



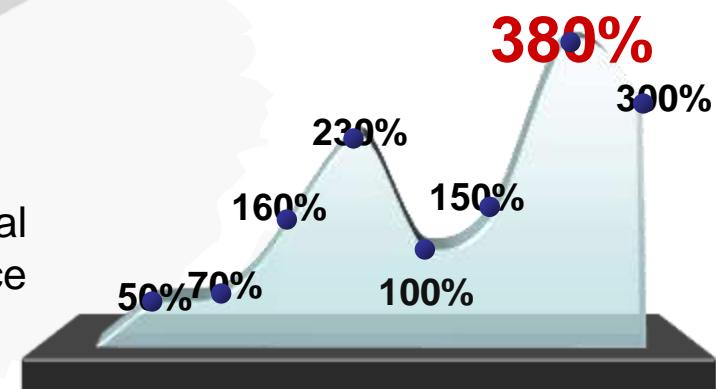
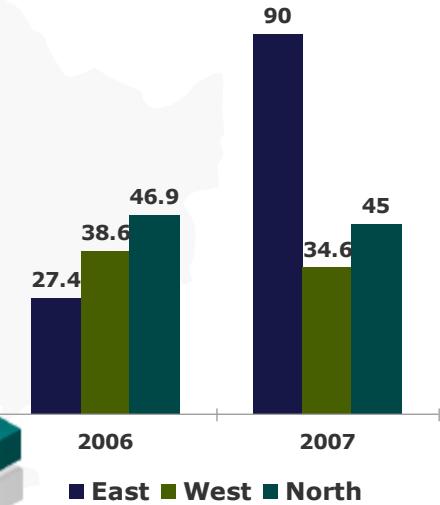
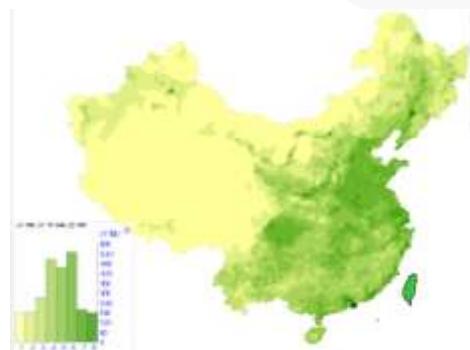
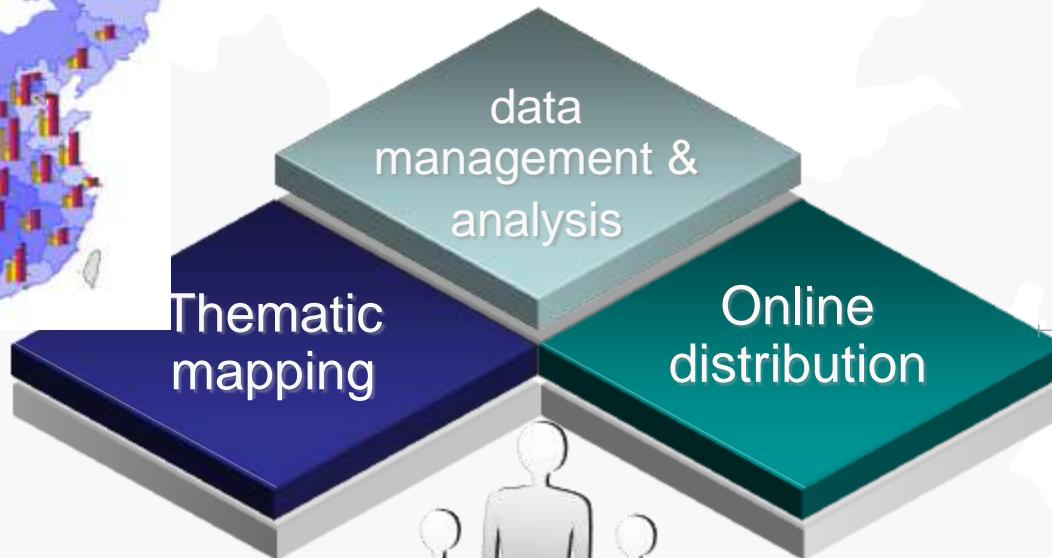
# C/S based statistical mapping software

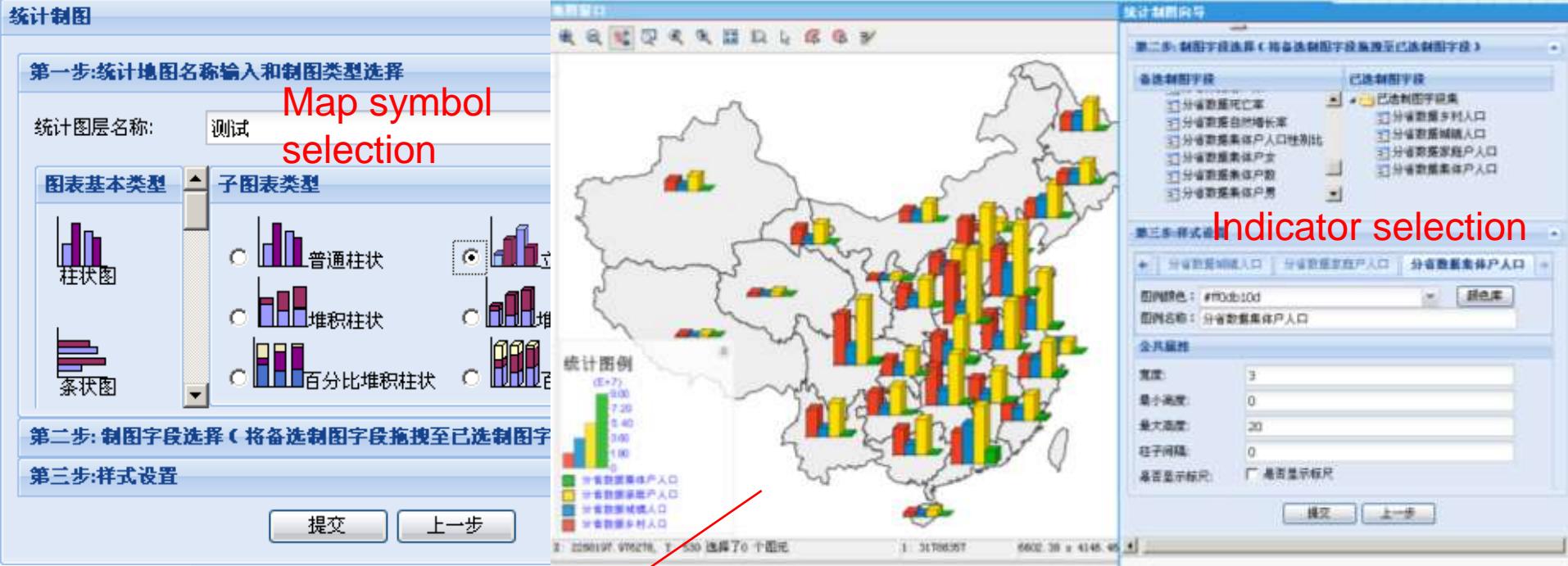


# Map visualization



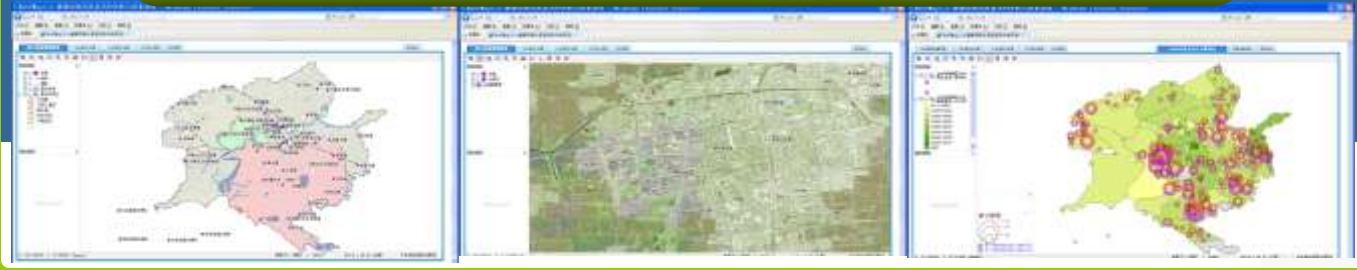
# Online map distribution system





# Web-based system

## Map distribution system

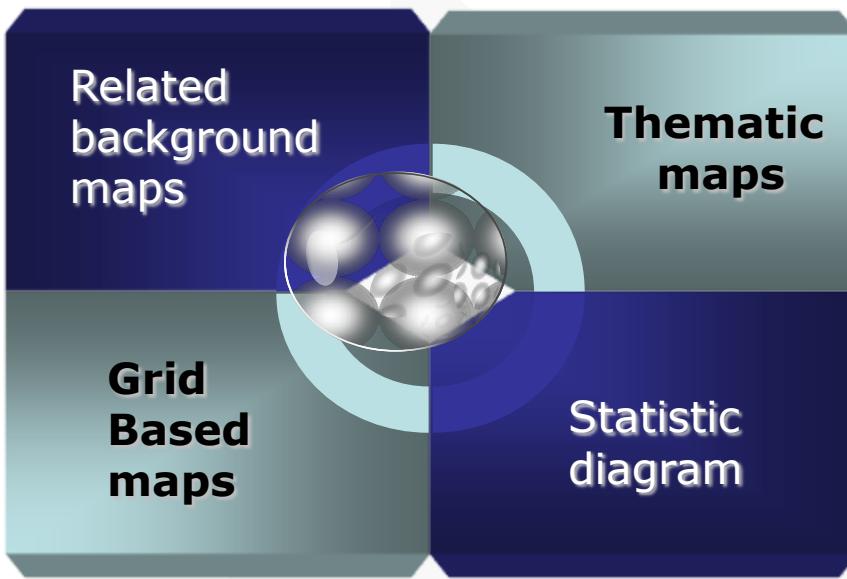


## Grid data distribution

点缓冲区分析  
以天安门为中心, 10公里为半径建立缓冲区

将缓冲区和北京市1公里网格人口数据进行叠置分析, 得到:  
天安门10公里缓冲区内人口总数为890万左右

线缓冲区分析  
以北京市北五环为中心, 5公里半径缓冲区内的人口为: 2353308



WMS/WFS service

KML service

3-D GUI

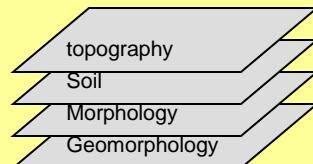
Atlas integration

Map navigation GUI

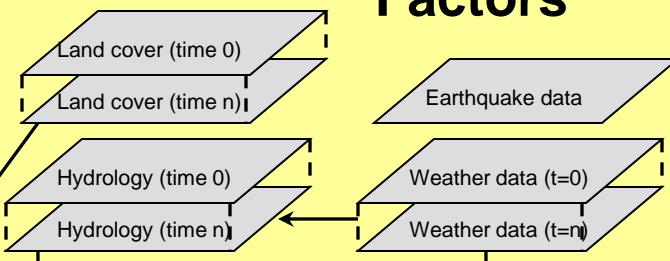
Statistic diagram

Data atlas publisher

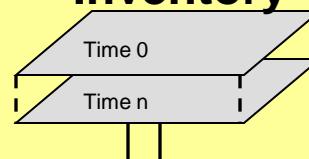
# Environmental Factors



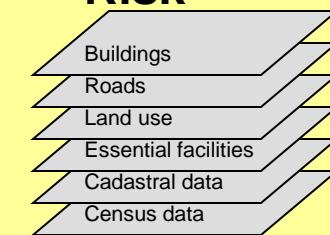
# Triggering Factors



# Disaster Inventory



# Elements at Risk

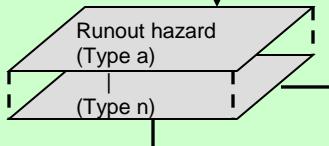
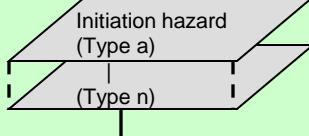


A

## Spatial modeling of disaster initiation

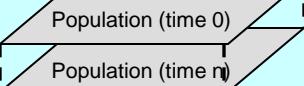
## Magnitude - Frequency analysis

## susceptibility assessment



## Magnitude – loss relationships

## Scenario development



## Hazard X Vulnerability X Amount

## Specific Risk

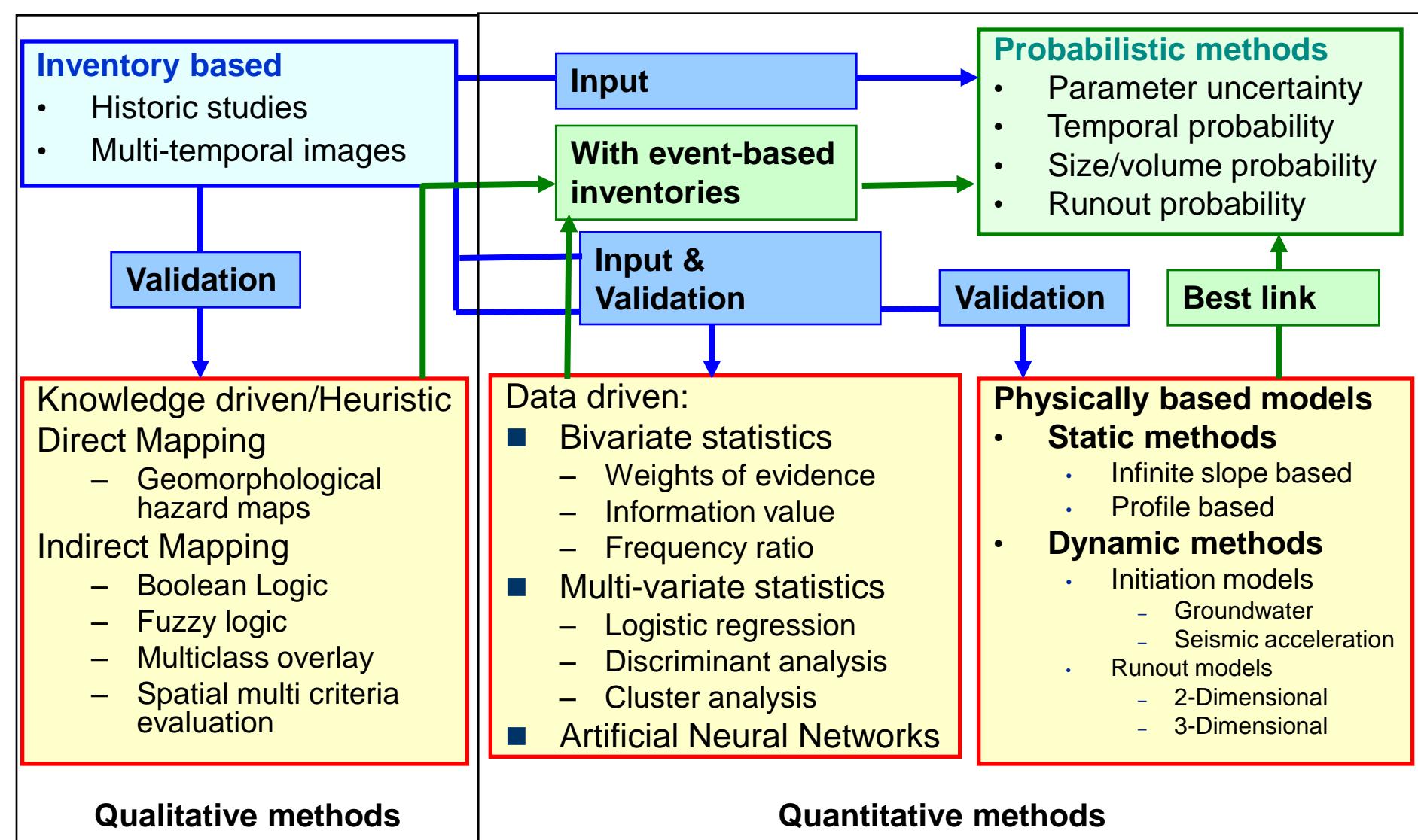
- Σ All disaster types
- Σ All disaster volumes
- Σ All triggering events
- Σ All elements at risk

## Total Risk

Loss (type) / time

D

# Main methods for hazard assessment



# Practice and case studies

**Project:** National Scale of Vulnerability and Risk Zonation and Mapping of Natural Hazards in China

**Budget:** 90 millions RMB

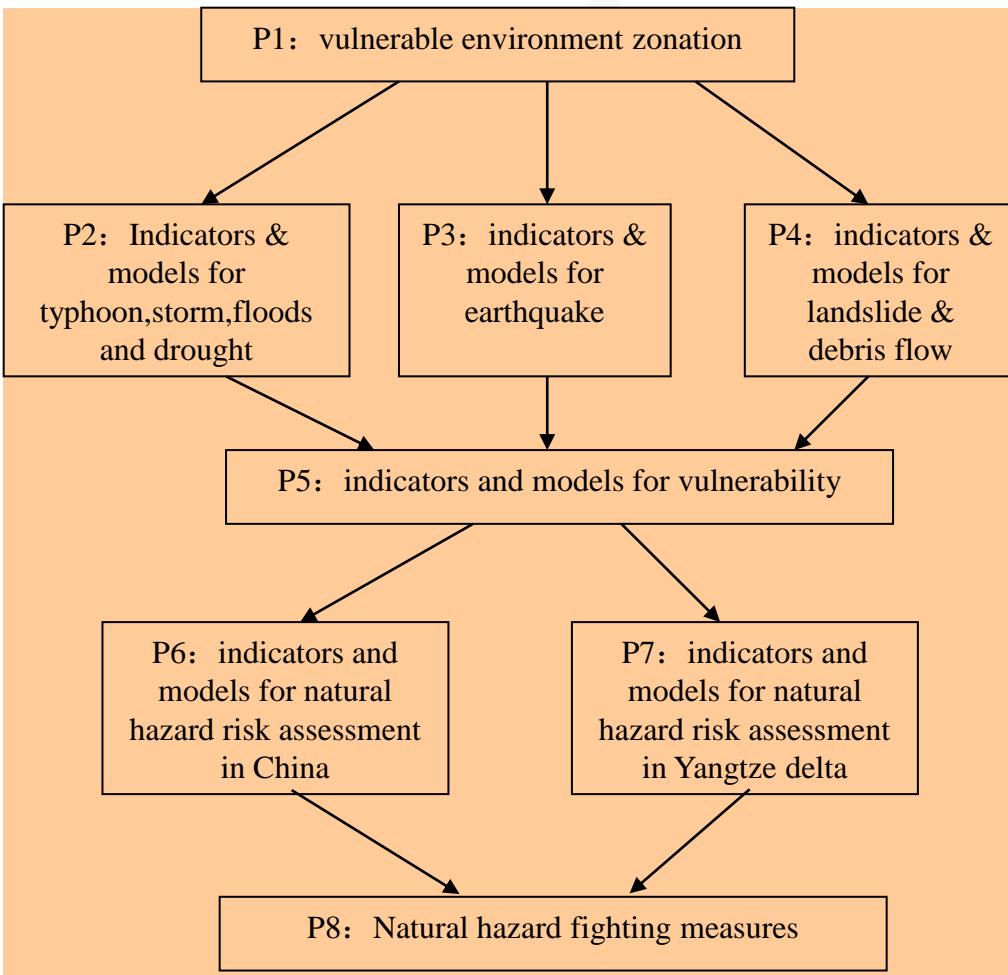
**Duration:** 2009-2011

**Support:** Ministry of Science and Technology of China & Chinese Academy of Sciences

**Implementation:** Institute of Geographical Sciences & Natural resources Research with others

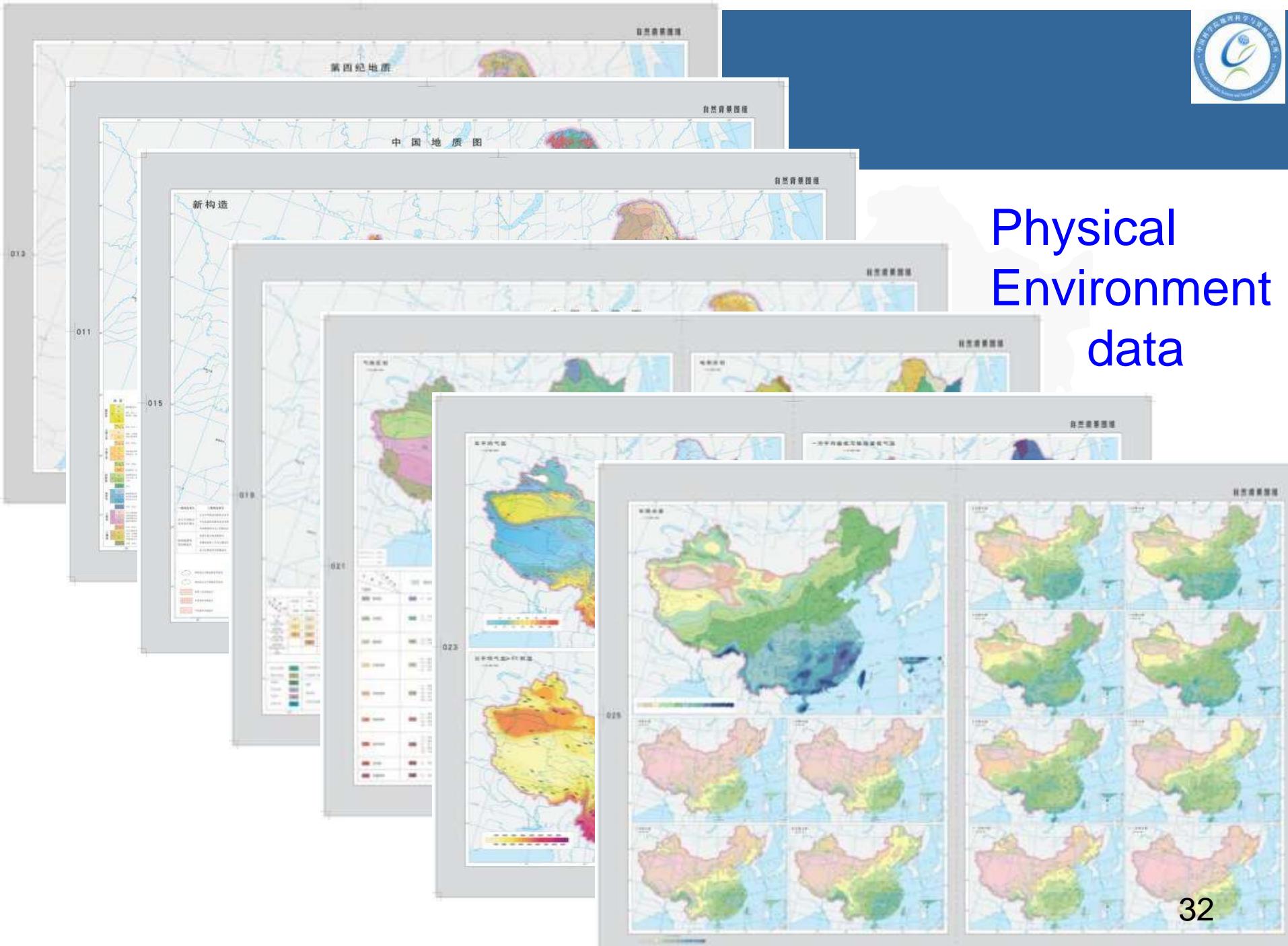
# Main structure of the project

Indicators, models and 1:1 millions vulnerability and risk map database in China



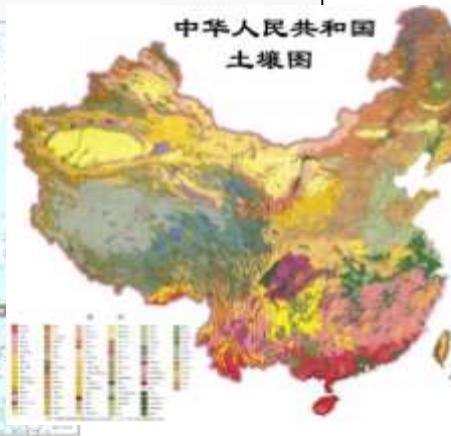
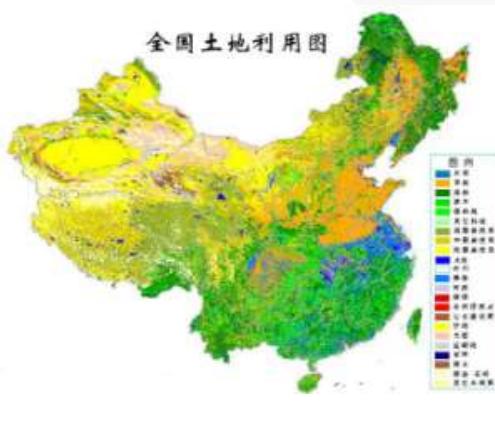
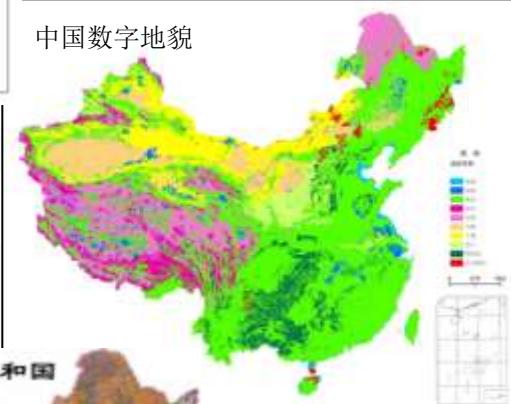
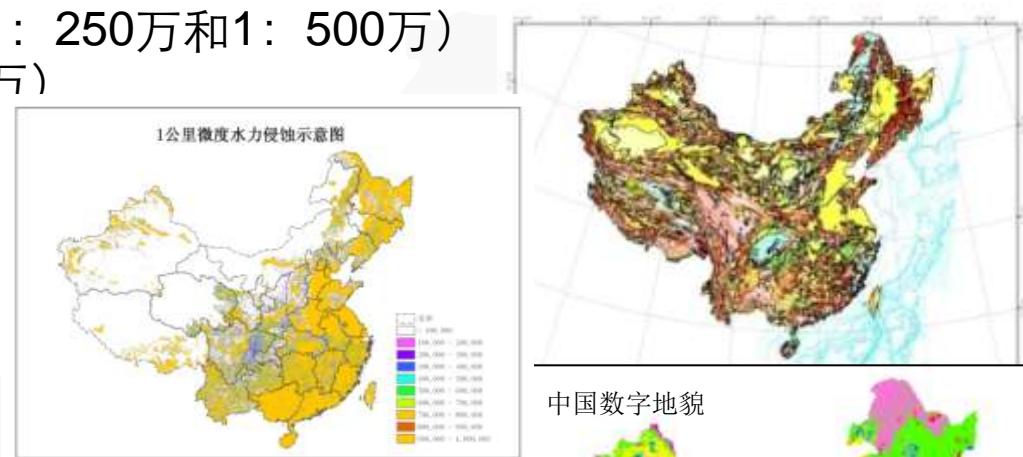
| 课题  | 内容                          | 主要产出   |
|-----|-----------------------------|--|
| 课题1 | 中国重大自然灾害孕险区划                | 自然环境与社会经济数据库, 背景灾害风险数据库                      |
| 课题2 | 气象水文灾害（台风、暴雨、洪涝）风险评价指标体系与模型 | 1:100万重大气象水文致险因子危险性综合评估图                     |
| 课题3 | 重大地震灾害风险评价指标体系与模型           | 1:100万强震致险因子危险性等级分布图、强震灾害危险等级分布图、强震灾害风险等级分布图 |
| 课题4 | 重大滑坡、泥石流风险评价指标体系与模型         | 1:100万综合重大滑坡、泥石流致险因子危险性综合评估图                 |
| 课题5 | 承险脆弱性综合评估指标体系与模型            | 1:100万综合灾害风险脆弱性等级评估图                         |
| 课题6 | 重大自然灾害风险损失等级评估指标体系与模型       | 1:100万综合灾害风险损失等级评估图                          |
| 课题7 | 长三角地区自然灾害风险等级评估指标体系与模型      | 1:10万综合灾害风险损失等级评估图                           |
| 课题8 | 自然灾害风险防范评价体系                | 指标体系模型                                       |

# Physical Environment data



# Database construction

- Geological database (1: 50万、1: 250万和1: 500万)
- Hydro-geologic database (1: 600万)
- Soil database (1: 100万)
- Landuse (1: 100万, 1: 25 万)
- DEM (GTOPO30, SRTM3)
- Social –economic database
- Geomorphology database (1:100万)
- Climate database(grid based)
- MODIS database
- Population database (polygon and grid based)
- Vegetation database(1: 100万)
- .....

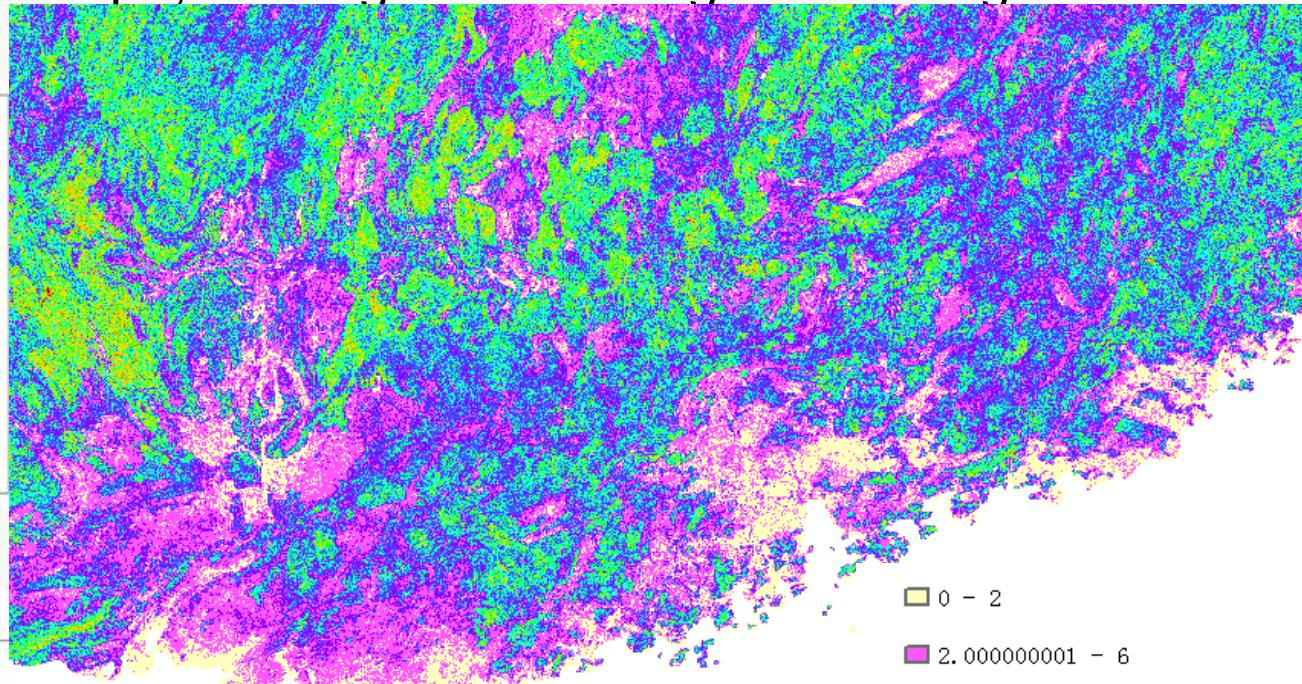
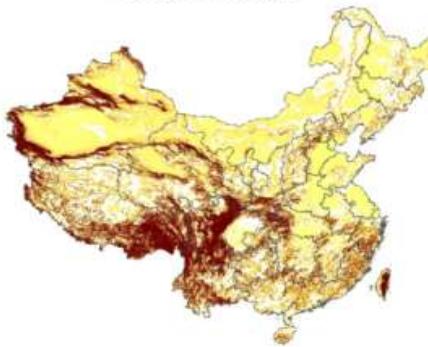


# Database construction

## Data gathering and database construction:

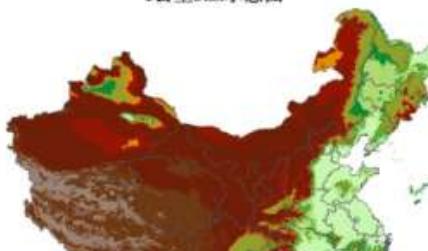
- 1:4000000,1:1000000,1:250000 basic geographical data preparation
- 1: 50000 DEM based slope, drainage and other geo-fissure generations

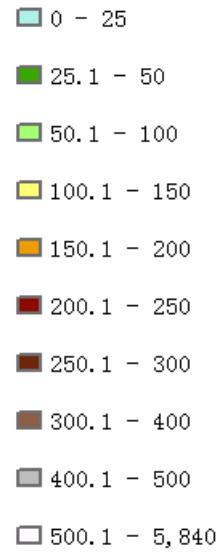
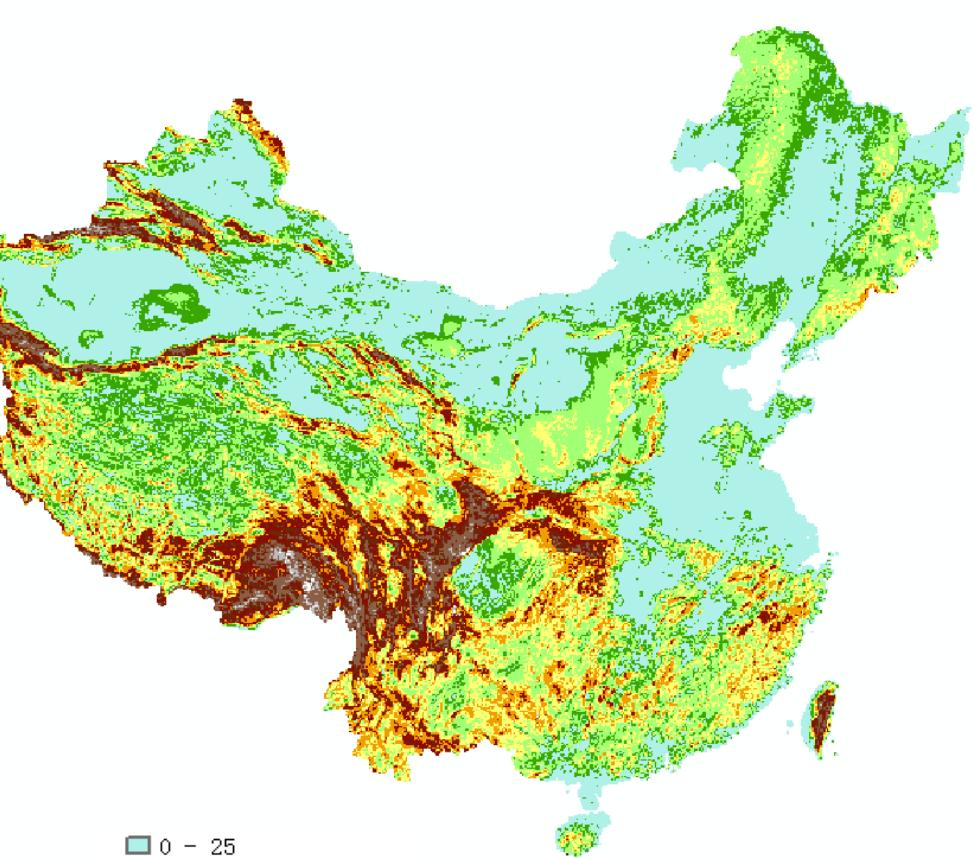
1公里坡度分布示意图



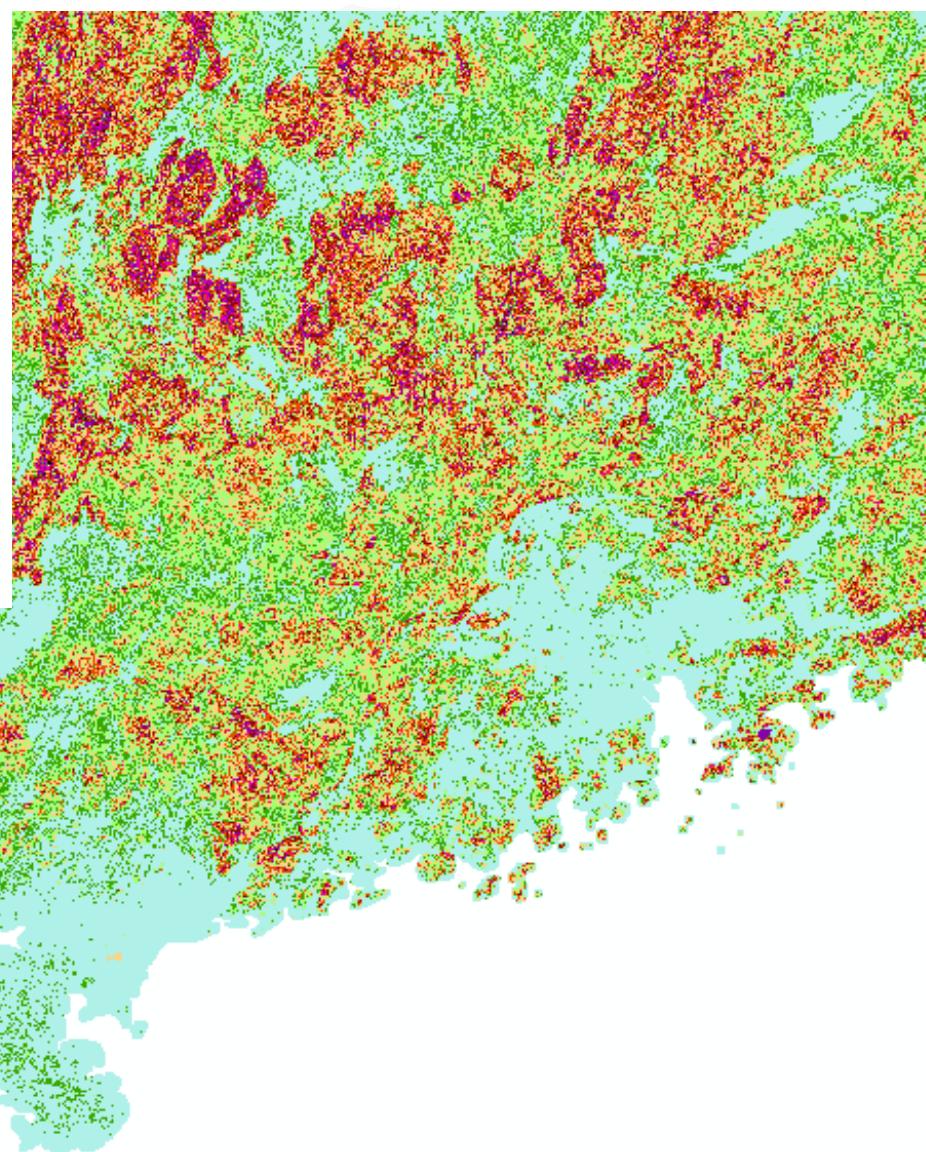
Grid based  
Slope steepness

1公里DEM示意图

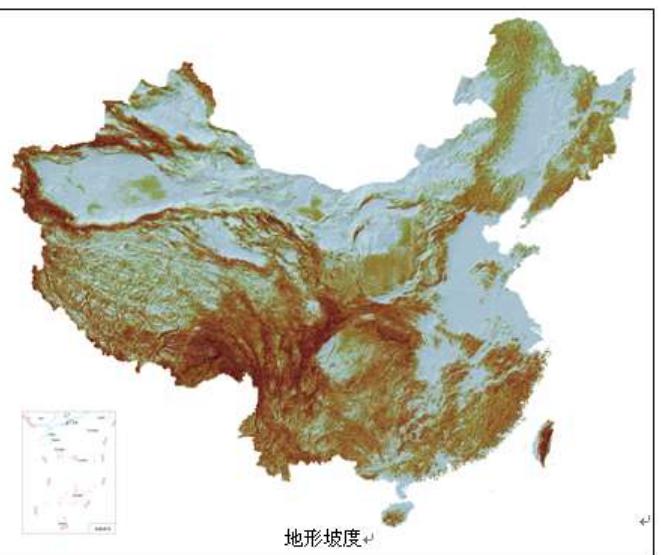




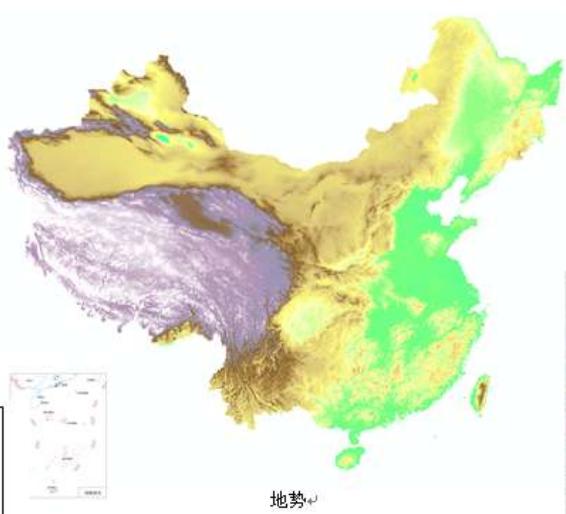
## Terrain roughness grid based



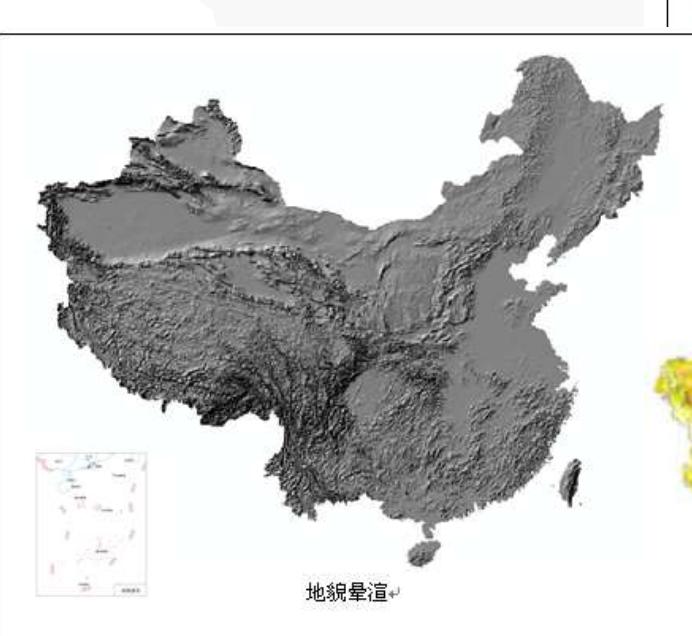
# Input geo-factors for hazard mapping



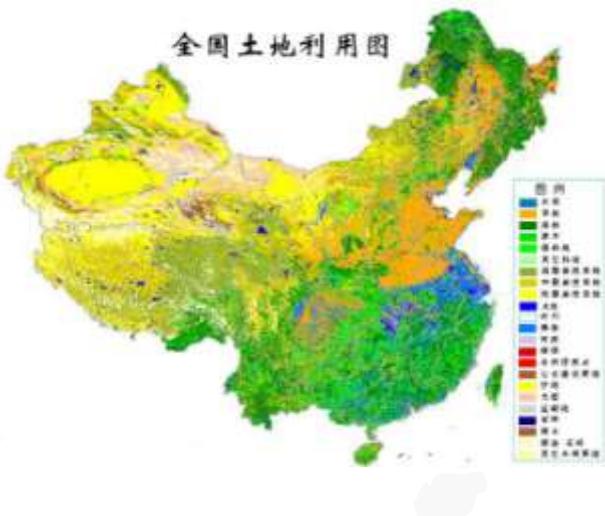
地形坡度



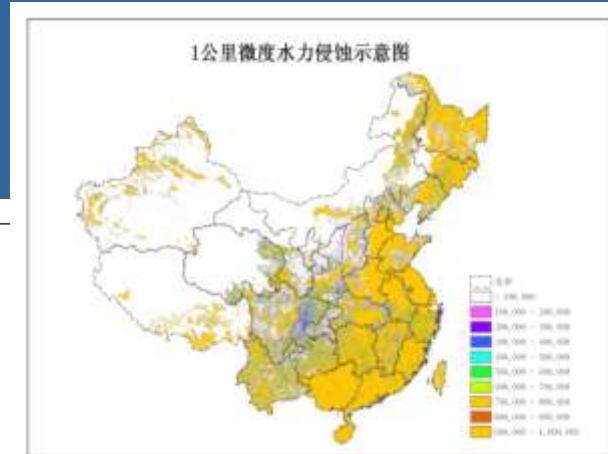
地势



地貌晕渲



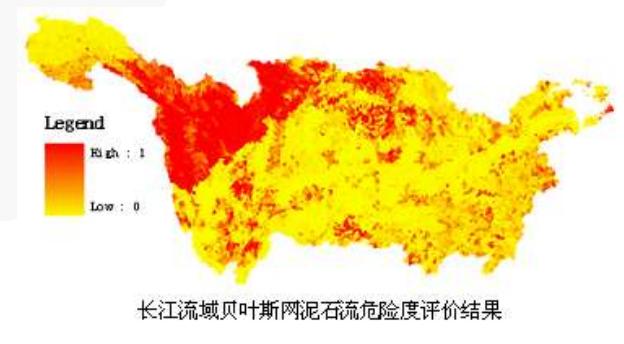
全国土地利用图



1公里微度水力侵蚀示意图

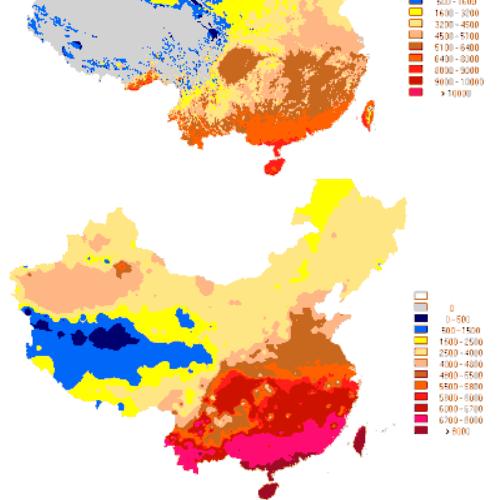
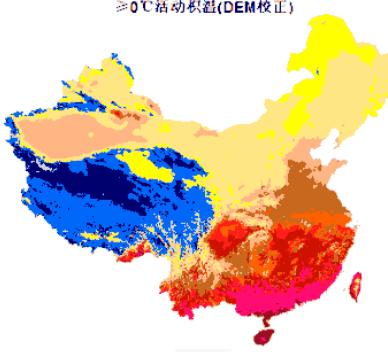
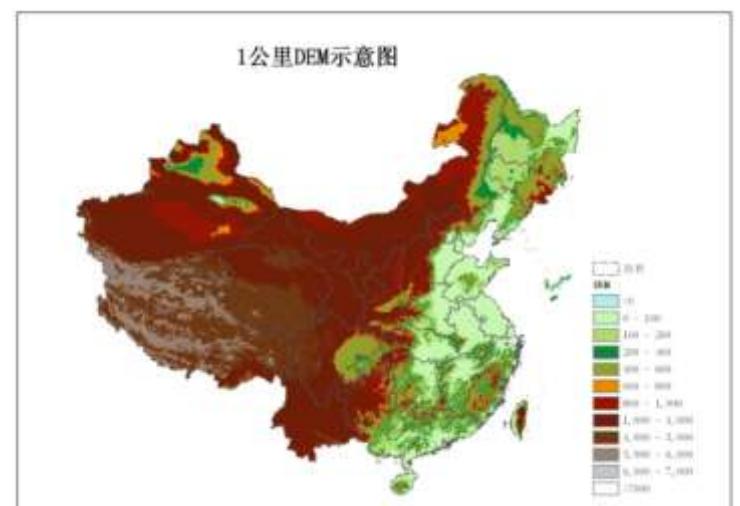
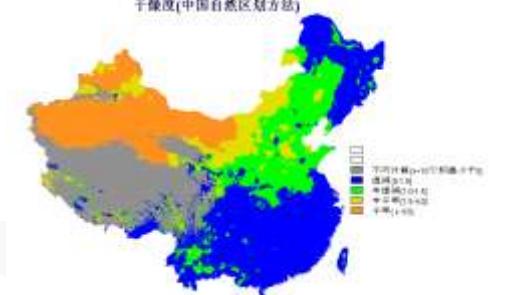
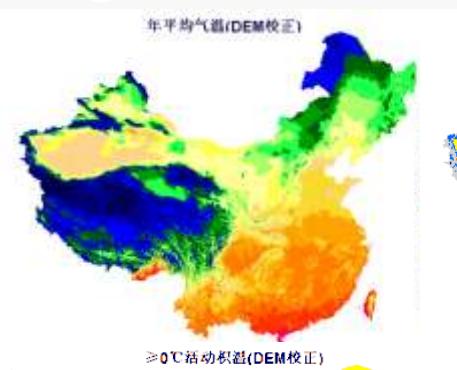
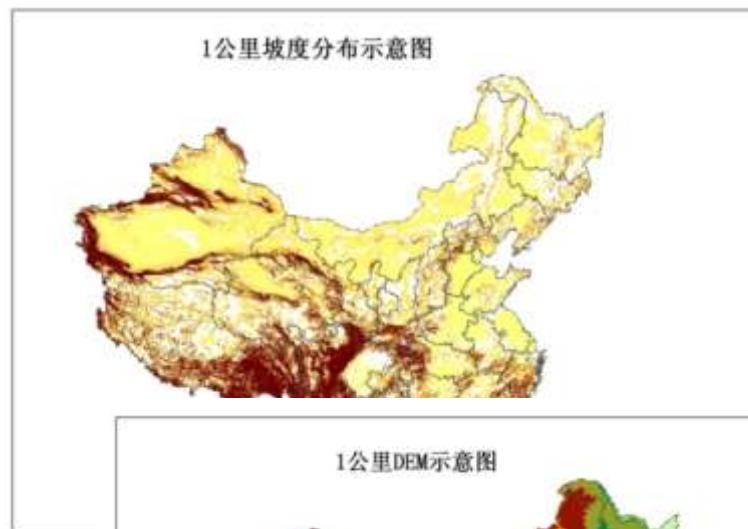
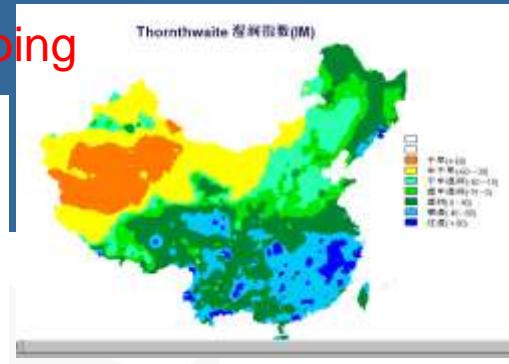
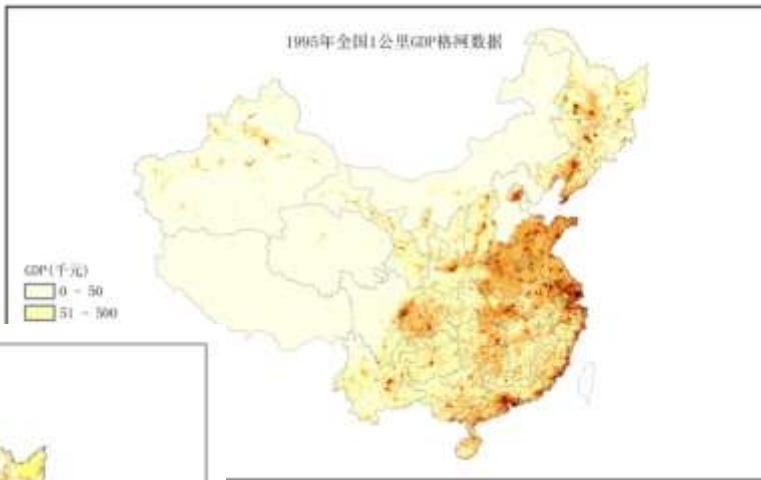
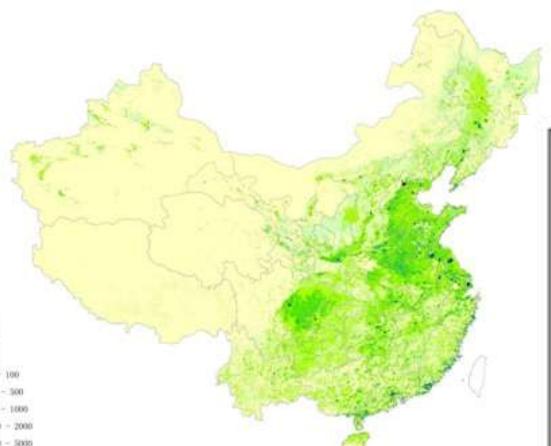


中国水文地质图

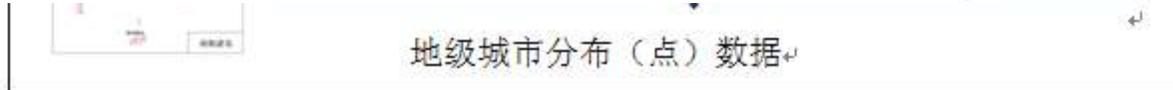
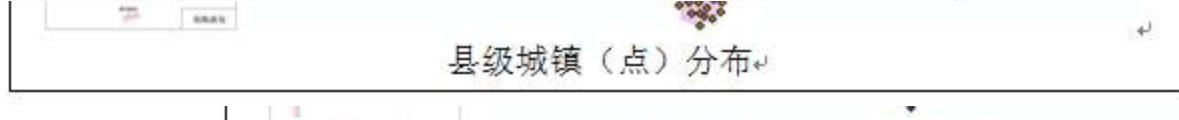
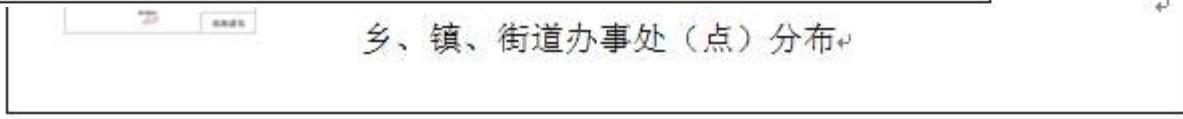
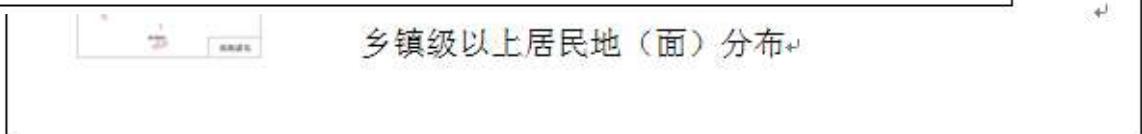
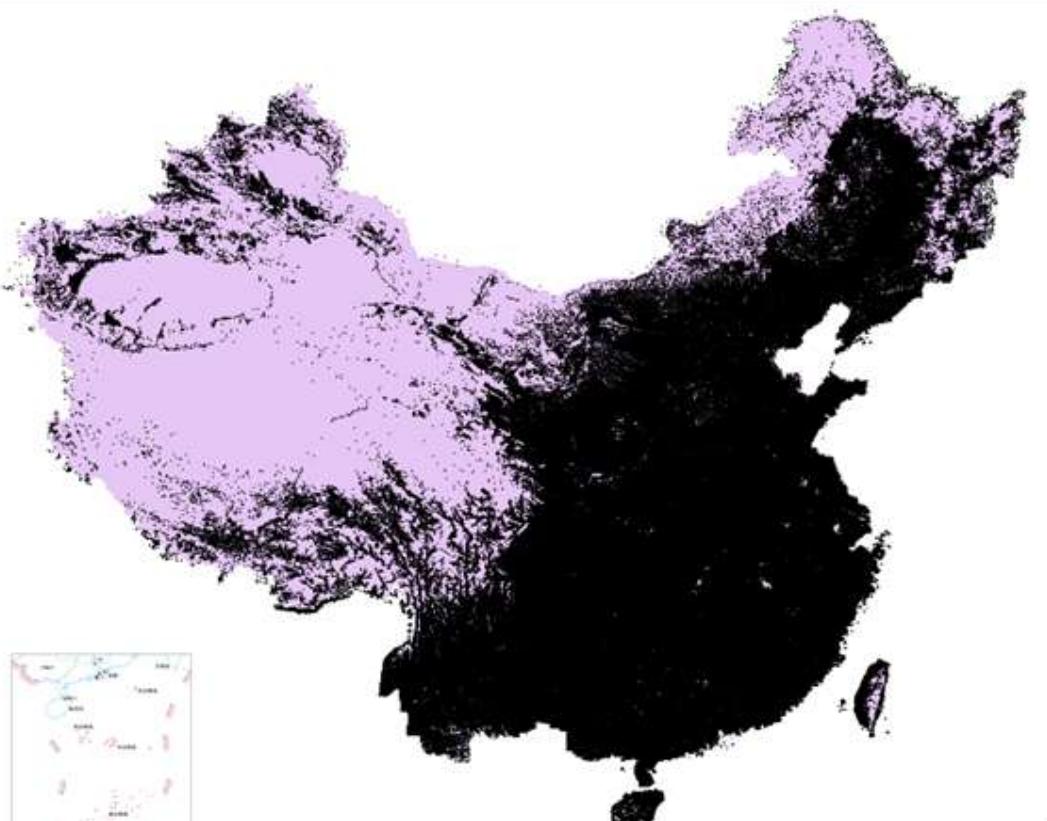


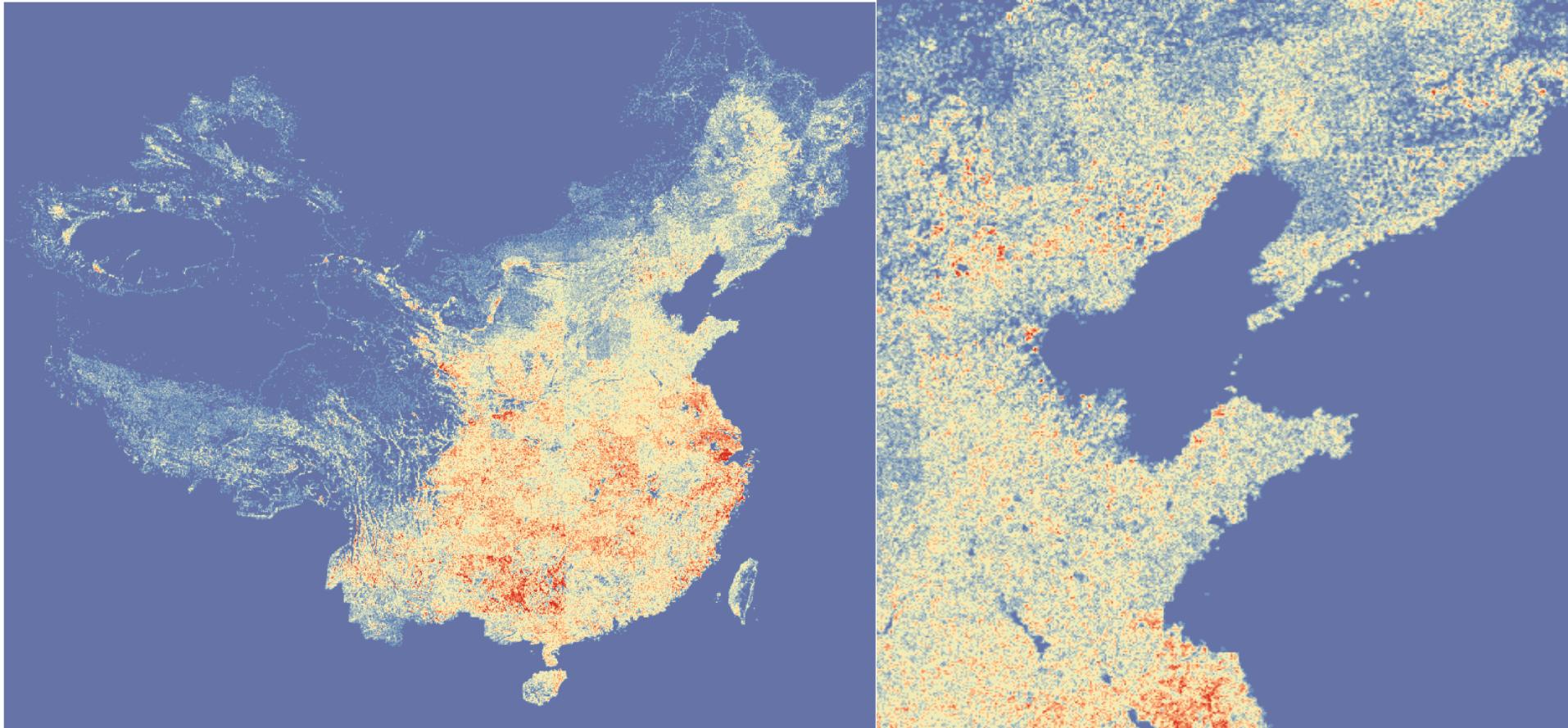
长江流域贝叶斯网泥石流危险度评价结果

# 1km\*1km datasets for hazard mapping

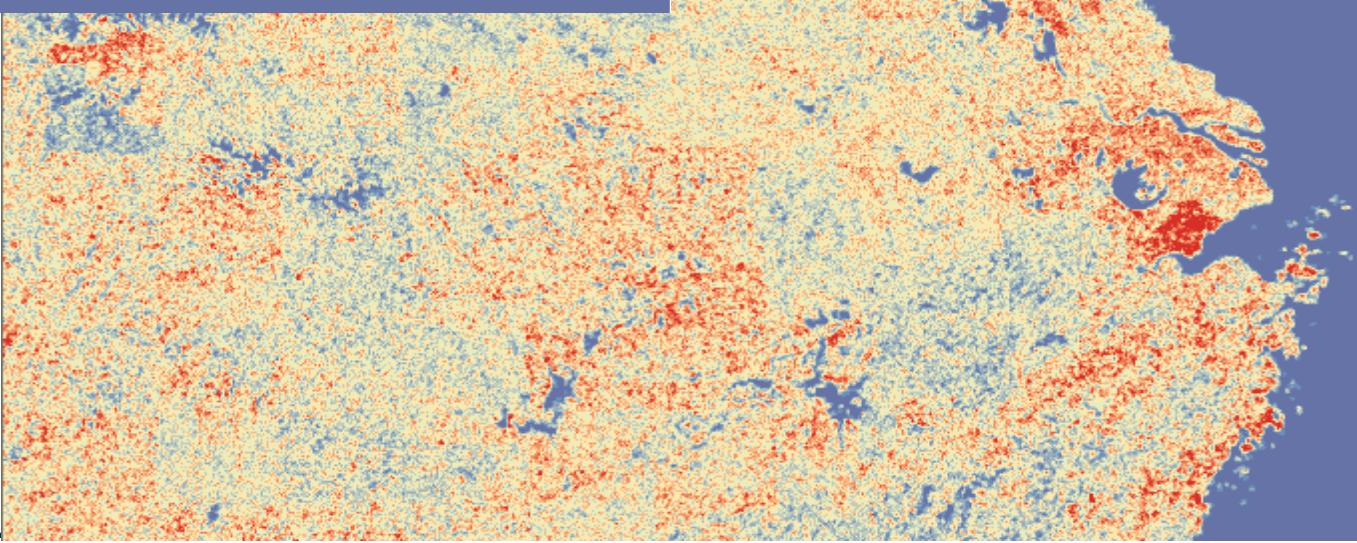


# Settlement Prefecture-village



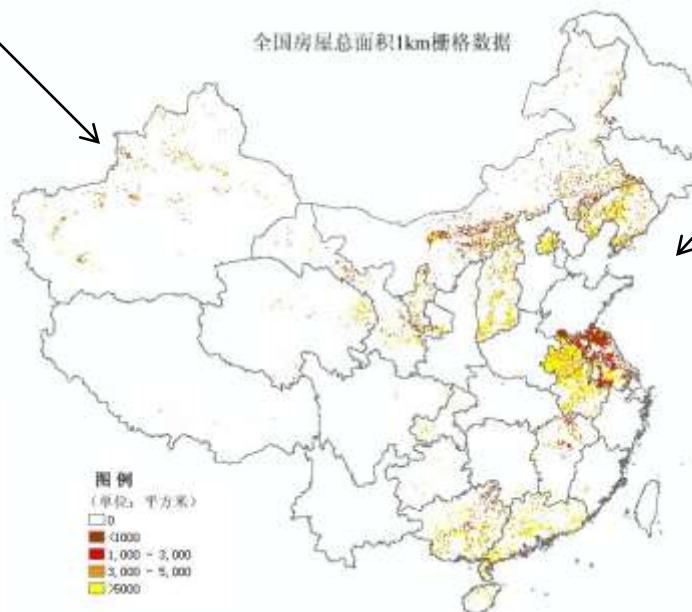
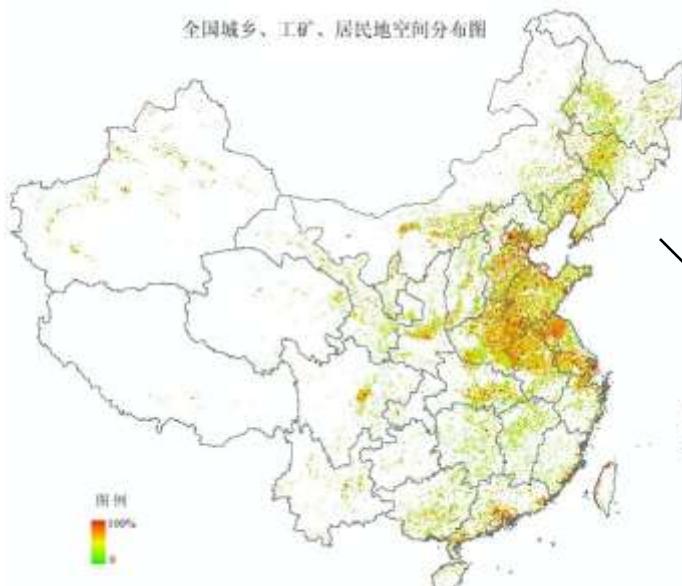


50000 townships  
1200000 villages



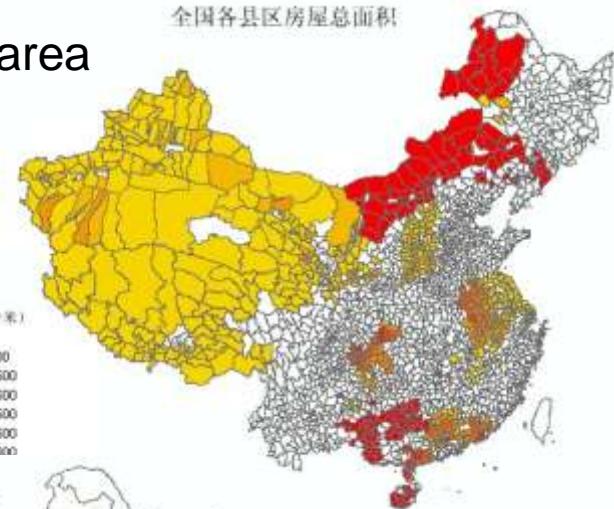
# 1km\*1km settlement data generation

*1km\*1km landuse for  
stettlement*

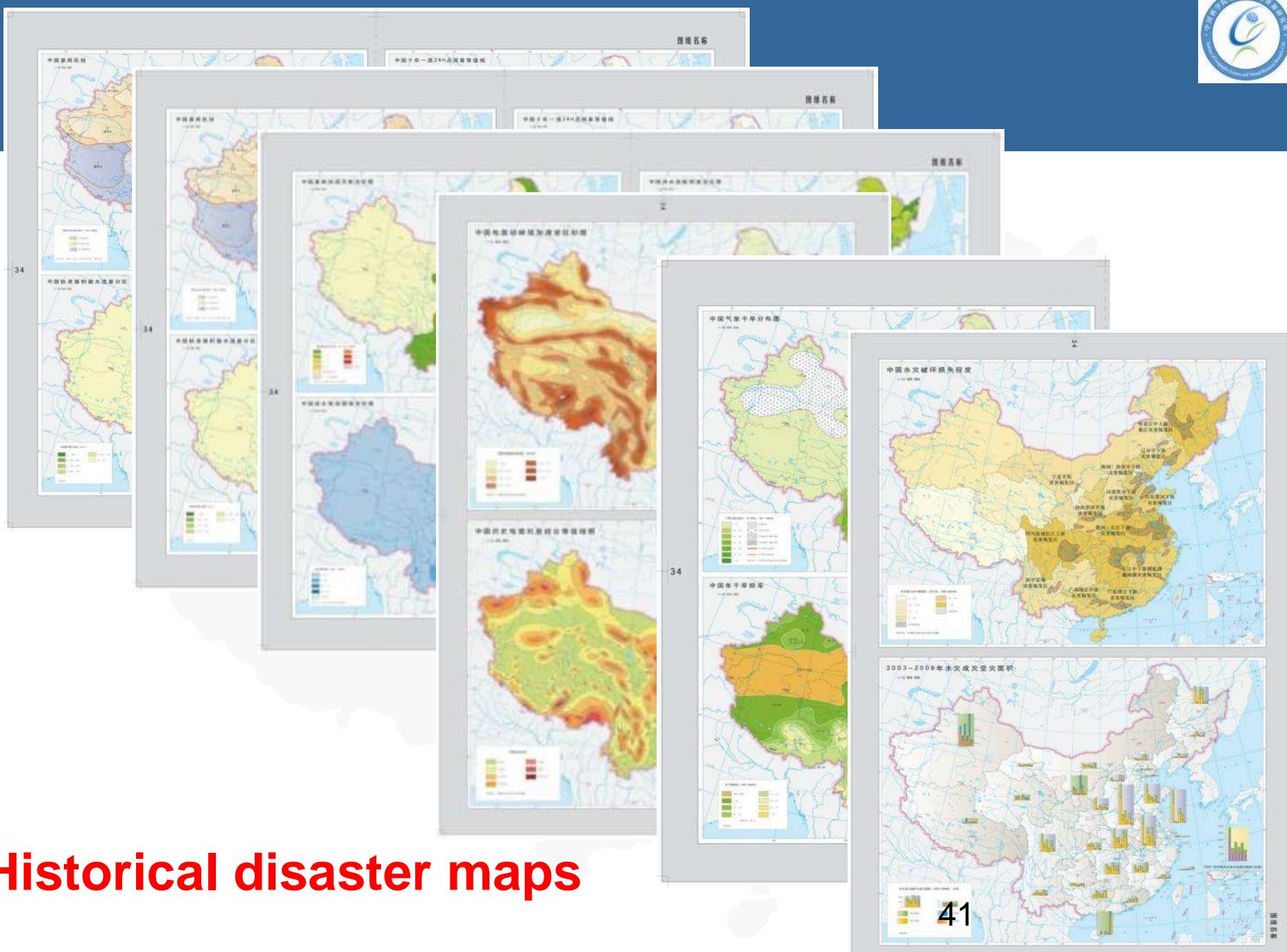


County house area

全国各县区房屋总面积



House area  
per 1km\*1km



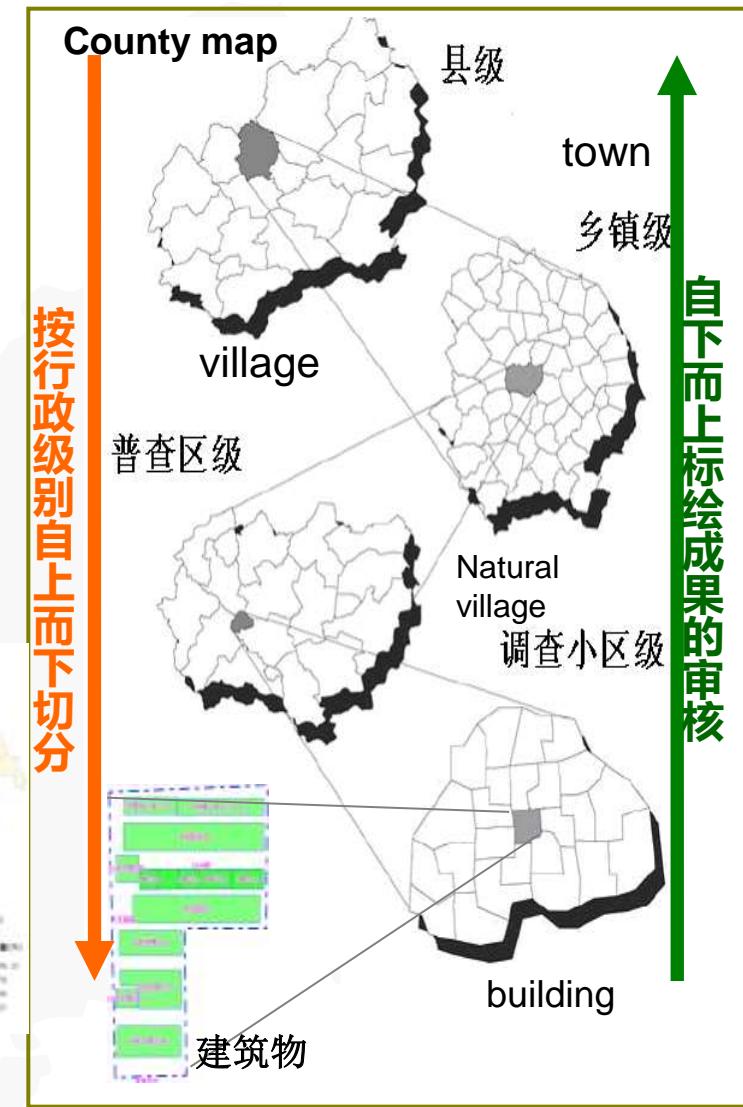
# Historical disaster maps

41

# Social –economic data

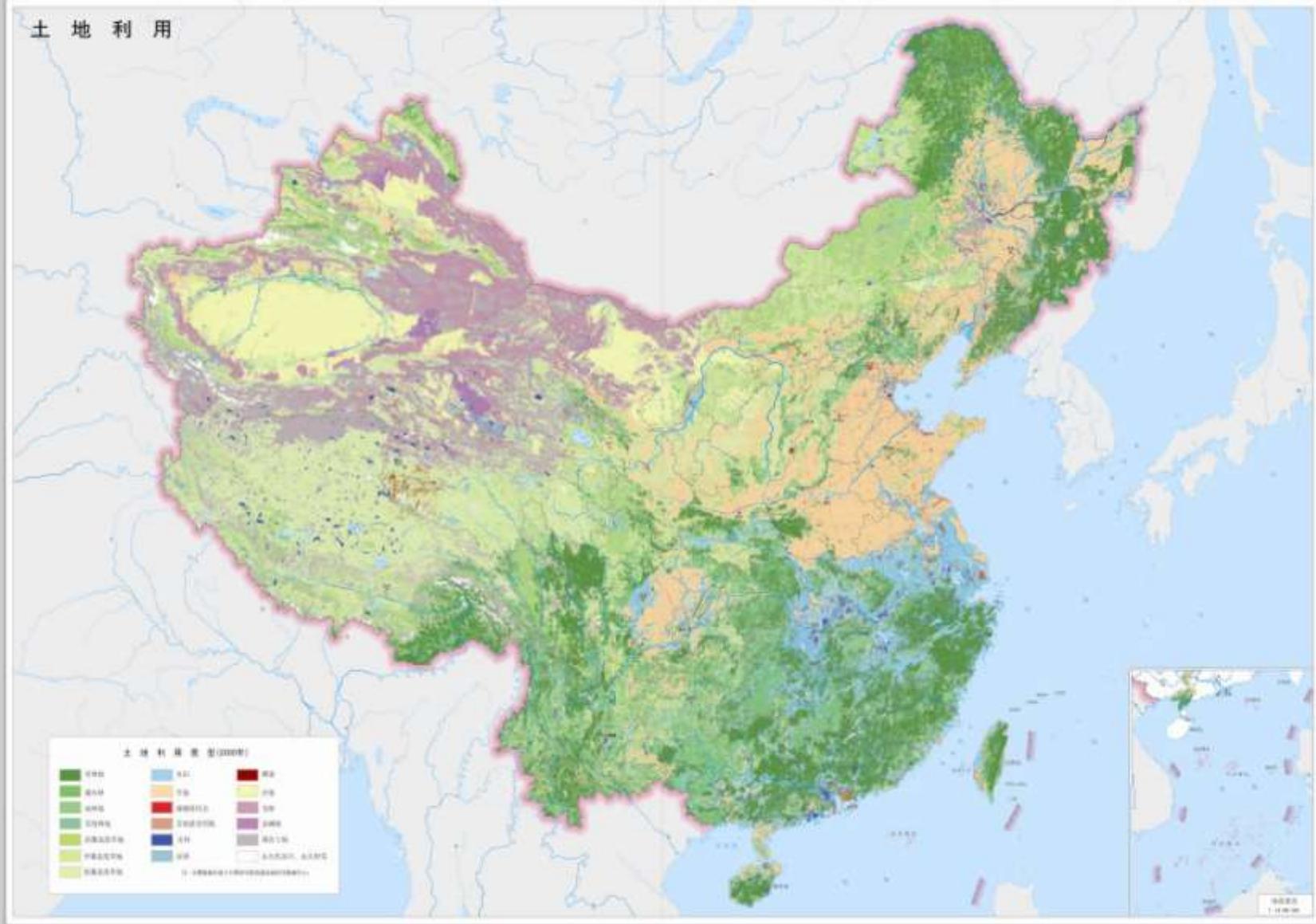
- Different scales of administration database
- Provincial,prefecture, county,town social economic database for more than 100 indexes

| Spatial scales | indicator |
|----------------|-----------|
| By county      | 地区生产总值    |
|                | 人均地区生产能总值 |
|                | 全社会固定资产投资 |
|                | 地方财政收入    |
|                | 地方财政支出    |
|                | 社会消费品零售总额 |
|                | 农林牧渔业总产值  |
|                | 常用耕地面积    |
|                | 农作物总播种面积  |
|                | 粮食作物播种面积  |
|                | 粮食总产量     |
|                | 规模以上工业总产值 |
|                | 农村居民人均纯收入 |
|                | 城镇职工平均工资  |
| By prefecture  | 农村人均住房面积  |
| By province    | 油气田数量与油产量 |
|                | 原煤、焦炭生产量  |
|                | 矿山企业数量    |



# landuse

承 诺 第



# Forest

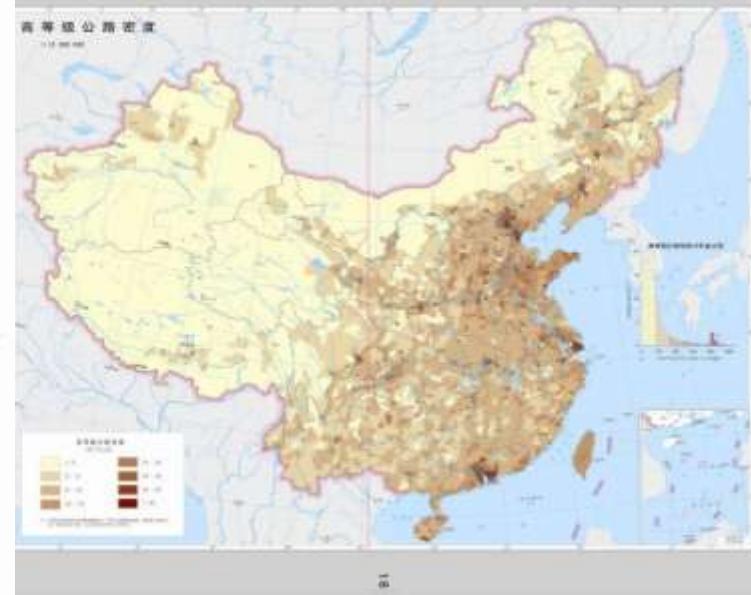


# Cultivated land

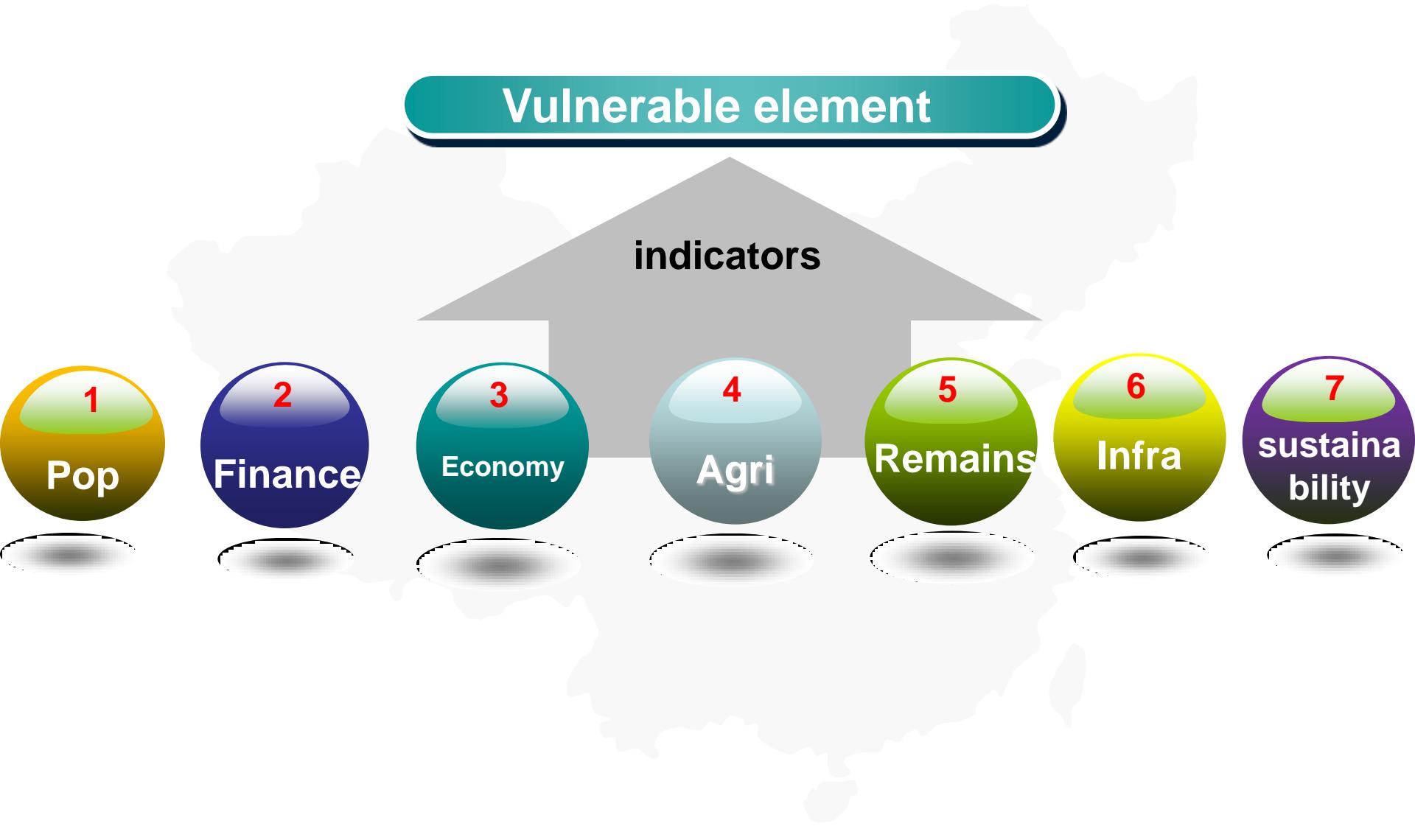


承 谢 感

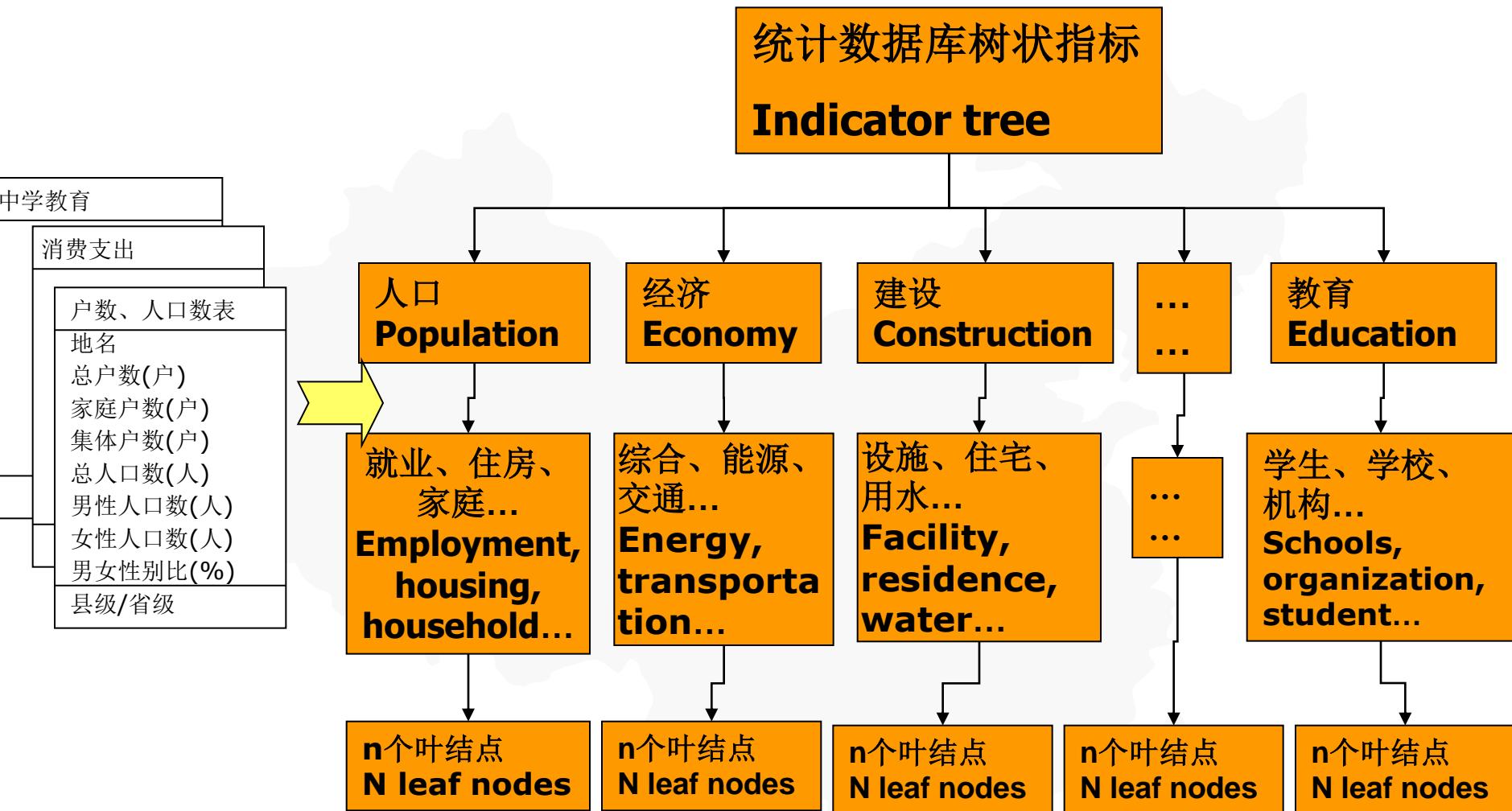
Road



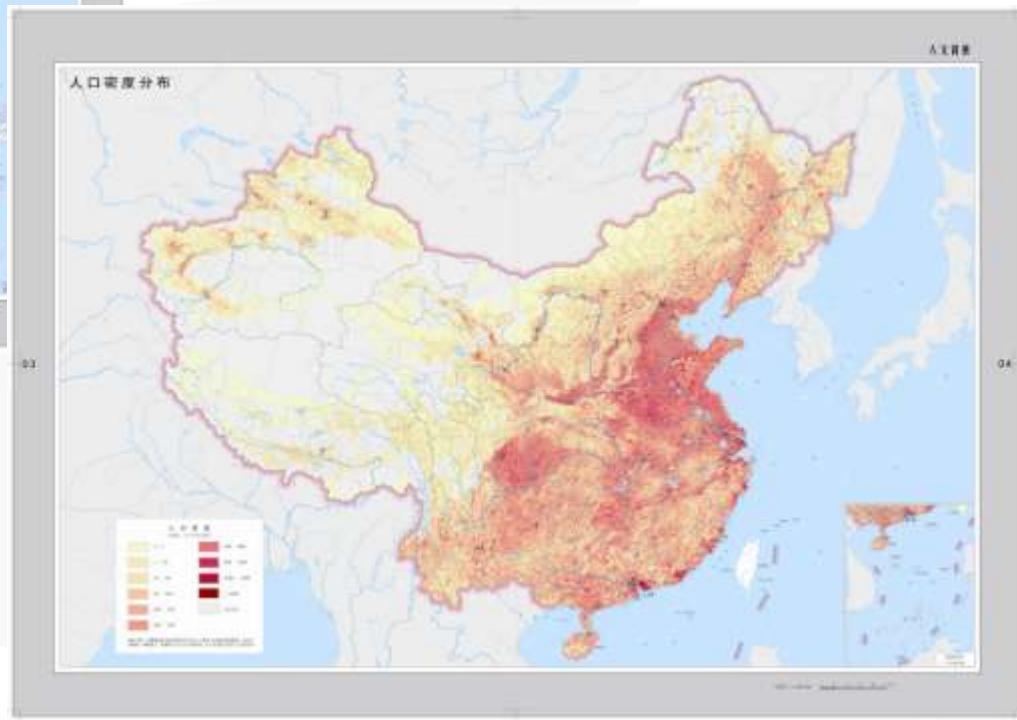
# Vulnerable element database



# Population indicators



# Population and population density



# Population data

人口密度



第五次人口普查各县市人口分布

第五次人口普查各县市  
15-64岁人口比重

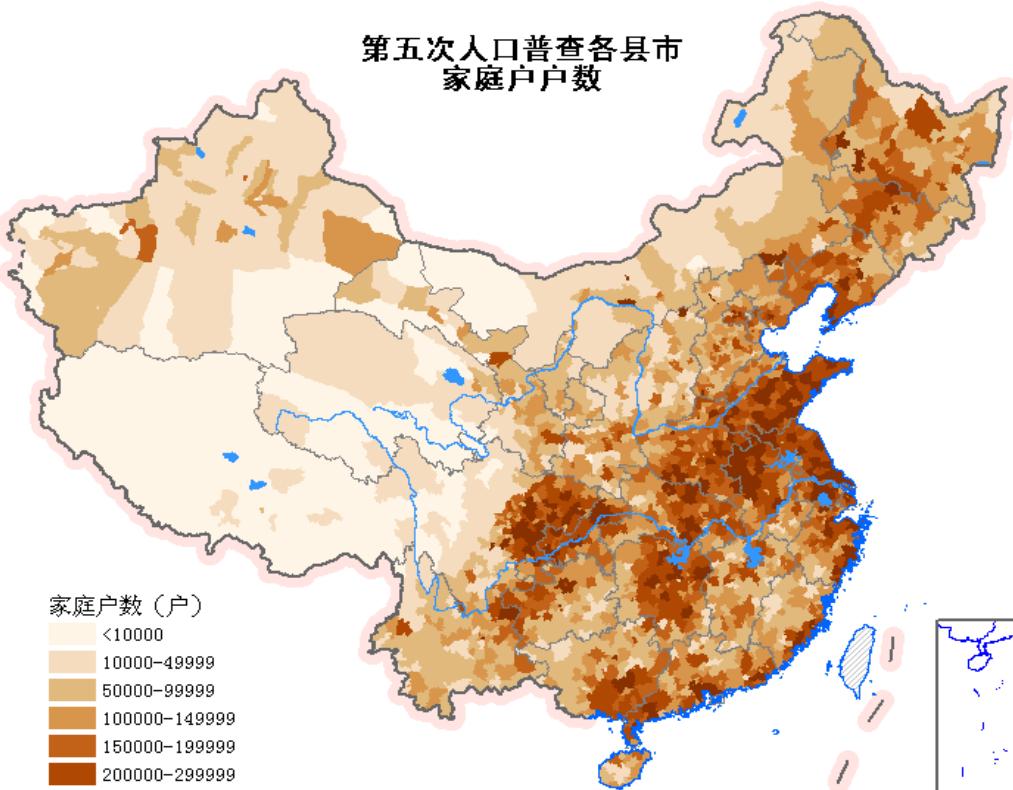
第五次人口普查各县市  
0-14岁人口比重

第五次人口普查各县市  
65岁及以上人口比重

第五次人口普查各县市在业人口

第五次人口普查各县市  
家庭户户数

人口密度 (户)  
<1.0  
1.0-4  
5.0-9  
10.0-  
50.0-  
100.0

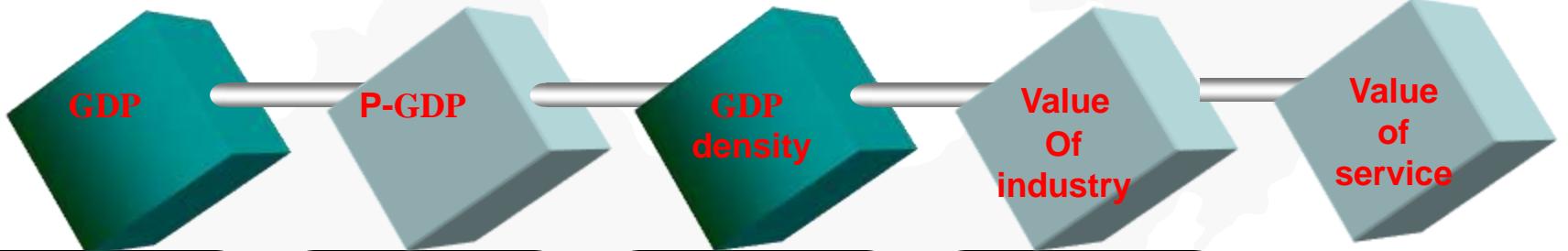


家庭户数 (户)

|               |
|---------------|
| <10000        |
| 10000-49999   |
| 50000-99999   |
| 100000-149999 |
| 150000-199999 |
| 200000-299999 |
| >=300000      |

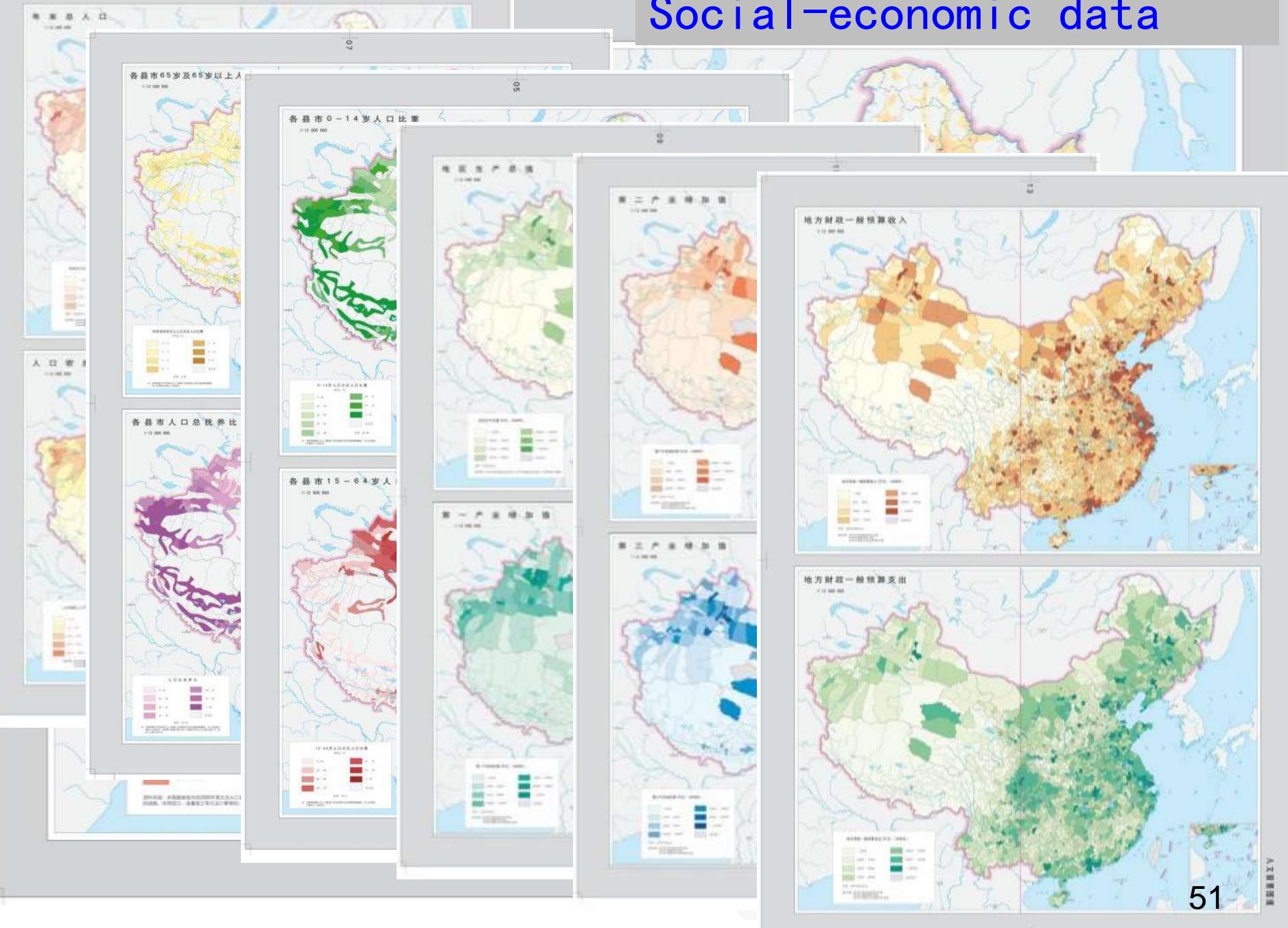
# Economic indicators

We consider: GDP, Per capital GDP,GDP density, total income of industry, total income of tertiary industry, etc



|       |       |       |       |       |
|-------|-------|-------|-------|-------|
| ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... |

# Social-economic data



# Assessment model construction

**Concepural model:**  $R=H \times Ve \times Vs \times P$

include: H—Hazard; Ve—Exposure; Vs—Susceptibility;  
P—Probability

## Multi risk model

Single hazard intensity

Multi hazard intensity

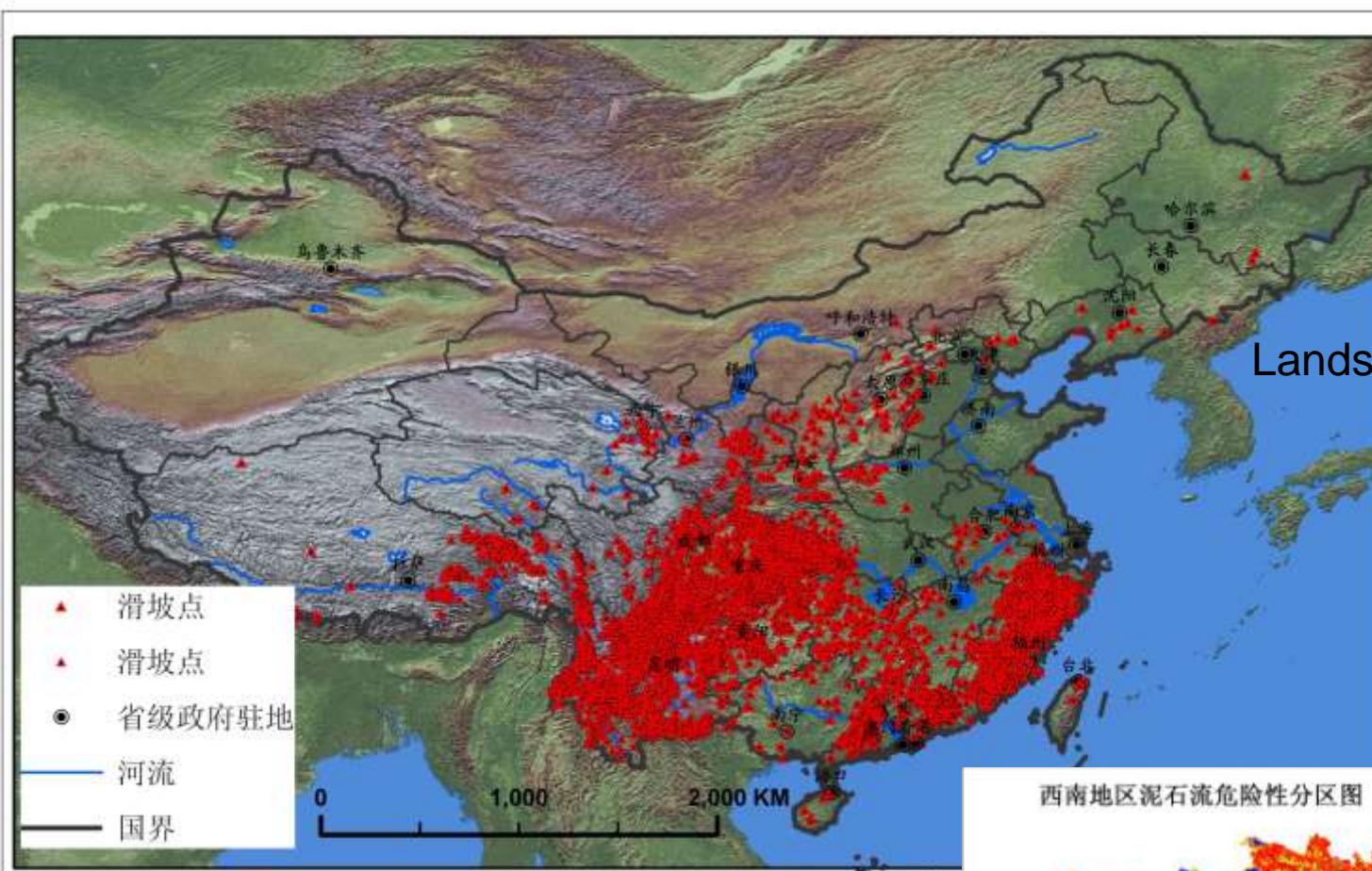
Regional vulnerability

Multi risk map

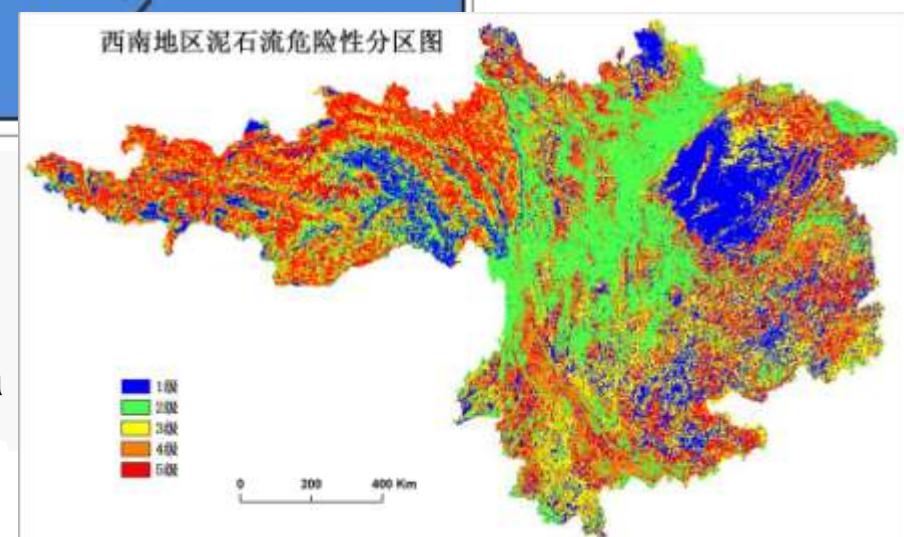
$$R = f \left( \sum_{i=1}^n H_i \cdot \sum_{i=1}^n V_i \cdot \sum_{i=1}^n E_i \right)$$

## Multi risk matrix

|                     |   | Degree of vulnerability |   |   |    |    |
|---------------------|---|-------------------------|---|---|----|----|
|                     |   | 1                       | 2 | 3 | 4  | 5  |
| Intensity of hazard | 1 | 2                       | 3 | 4 | 5  | 6  |
|                     | 2 | 3                       | 4 | 5 | 6  | 7  |
| 3                   | 4 | 5                       | 6 | 7 | 8  | 9  |
| 4                   | 5 | 6                       | 7 | 8 | 9  | 10 |
| 5                   | 6 | 7                       | 8 | 9 | 10 | 11 |



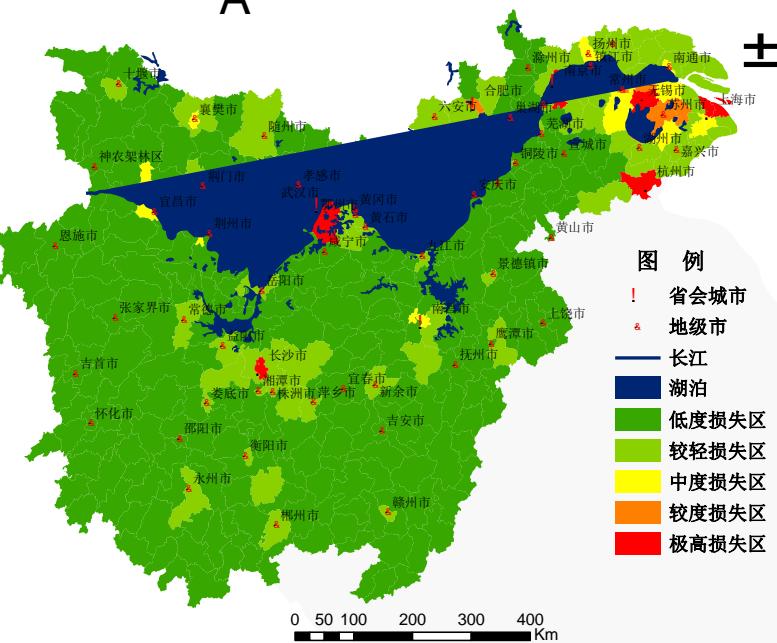
# Debris flow in Southwest China



Mapped by Inst.of Mountain Research

# Flood risk assessment in the lower reaches of Yangtze River

A

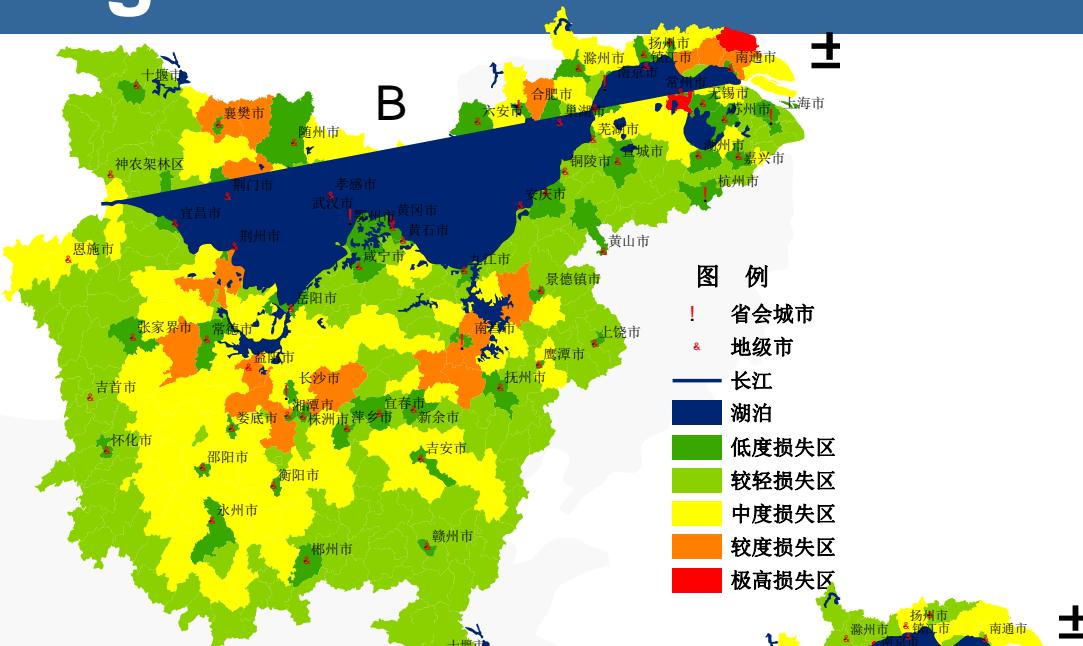


A: for GDP risk

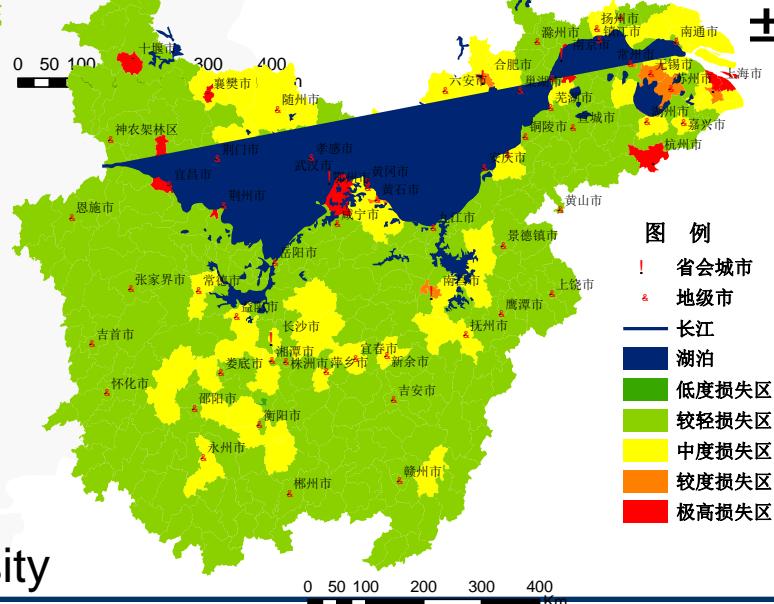
B: for agricultural risk

C: for house risk

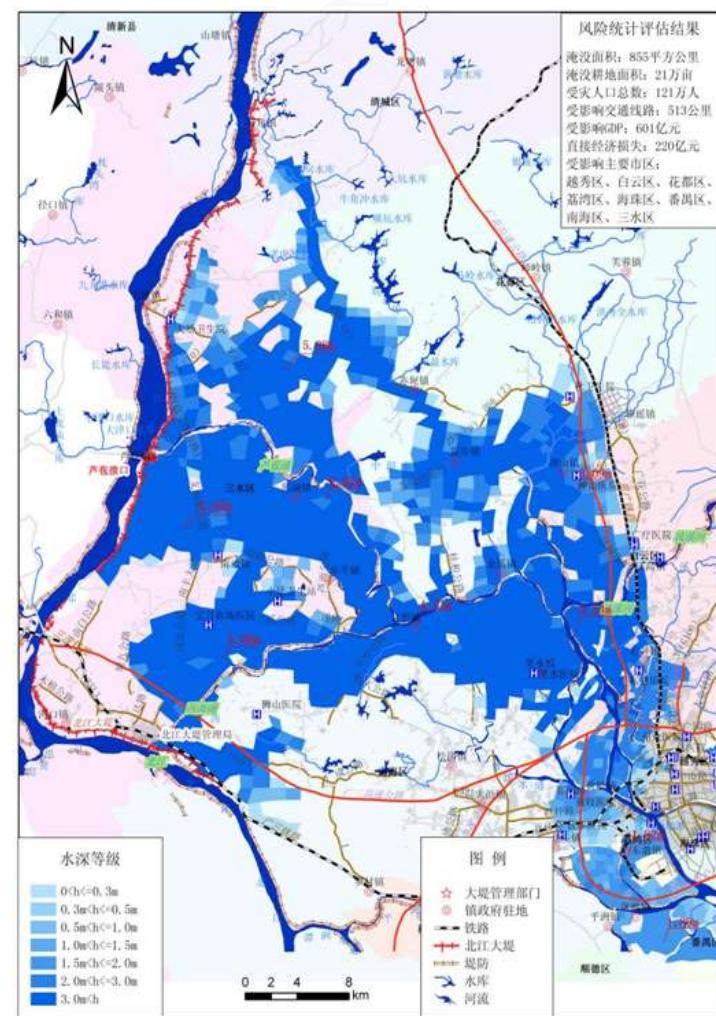
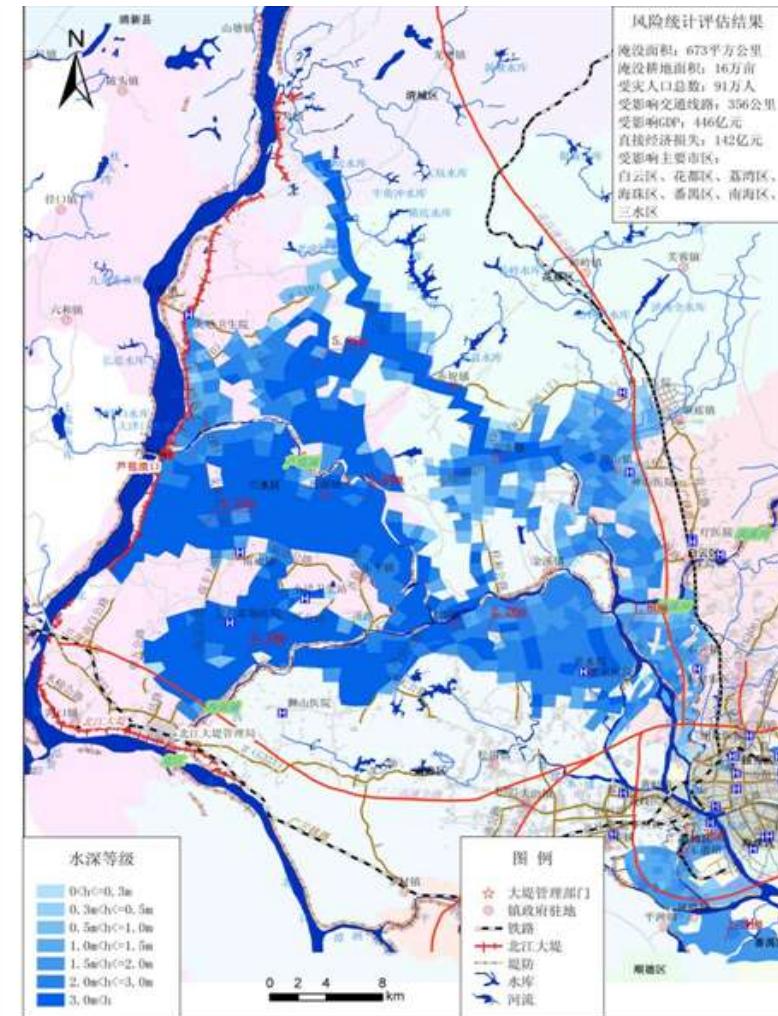
B



C



## Flood hazard maps in Beijiang (left: 300Y returns; right: 500Y retruns)

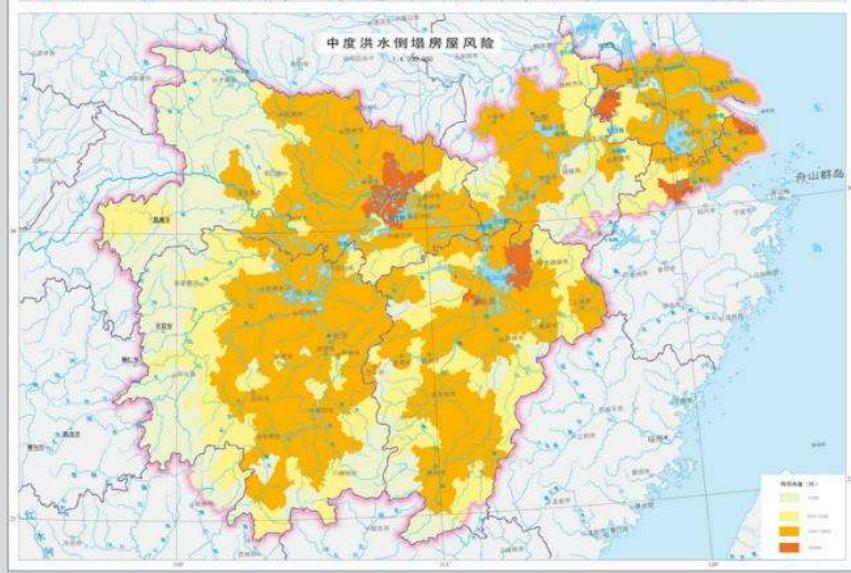
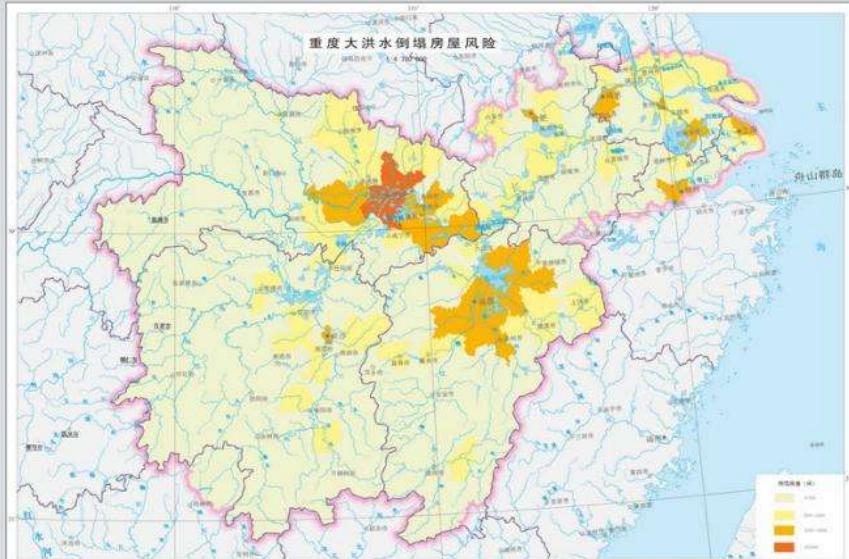
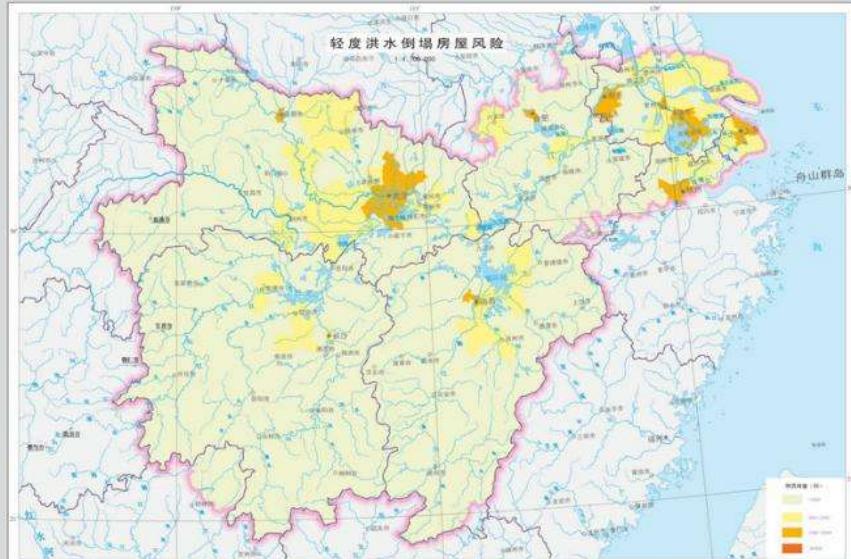


(Mapped by Chinese Academy of Meteorology)

# Susceptibility maps of floods in lower reaches of Yangze River

## 长江中下游洪涝灾害承灾体脆弱性评估

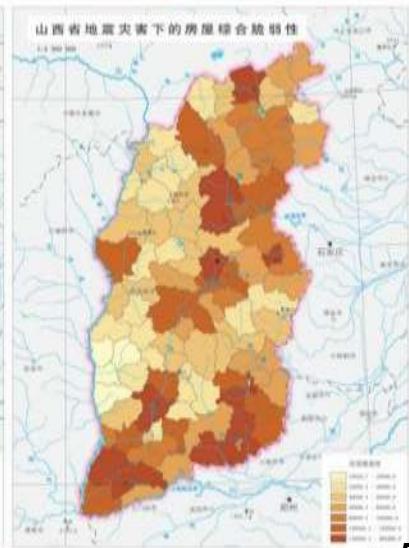
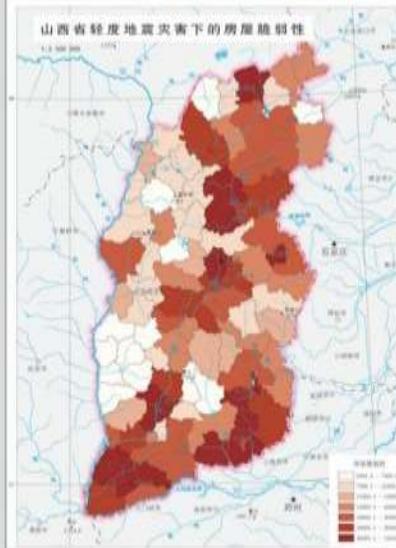
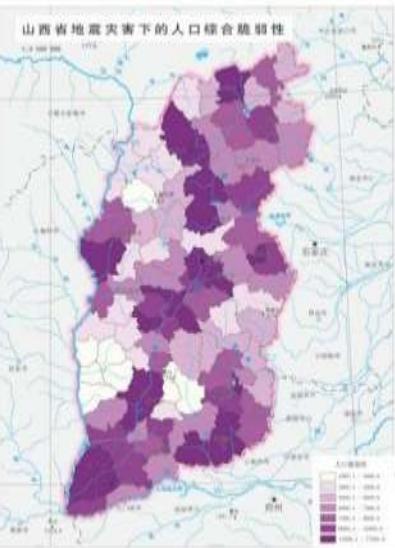
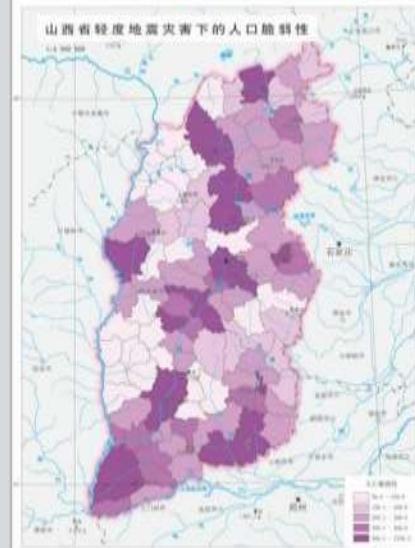
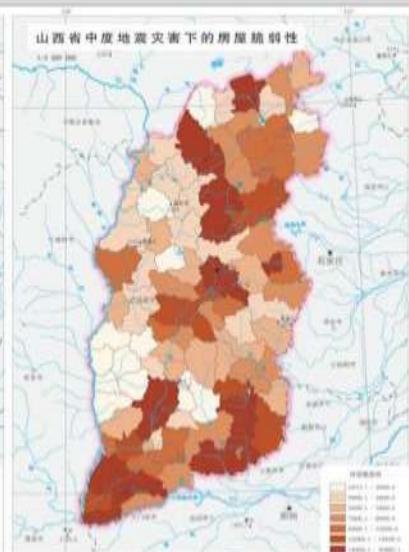
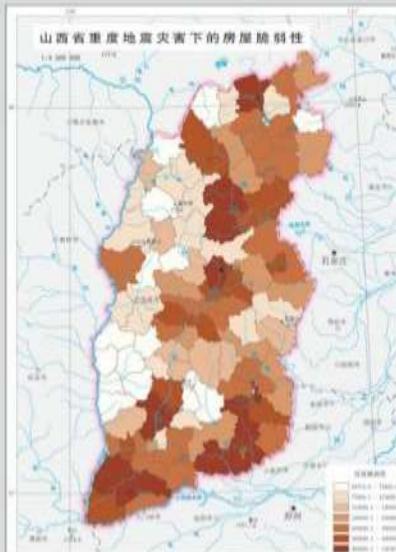
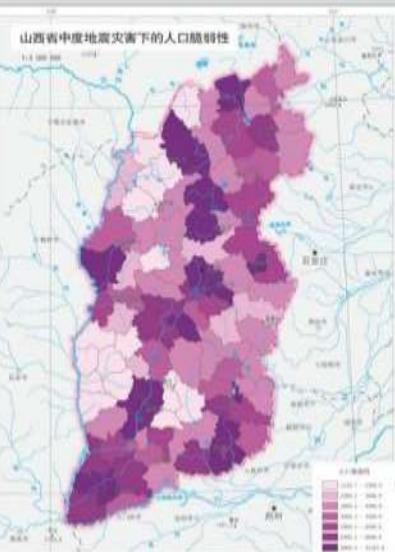
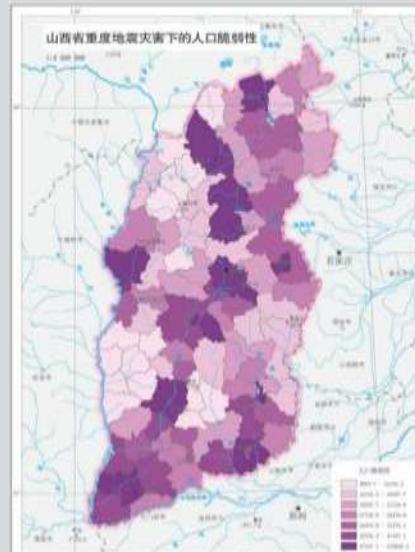
承灾体脆弱性



# Susceptibility maps of earthquake in Shanxi Province

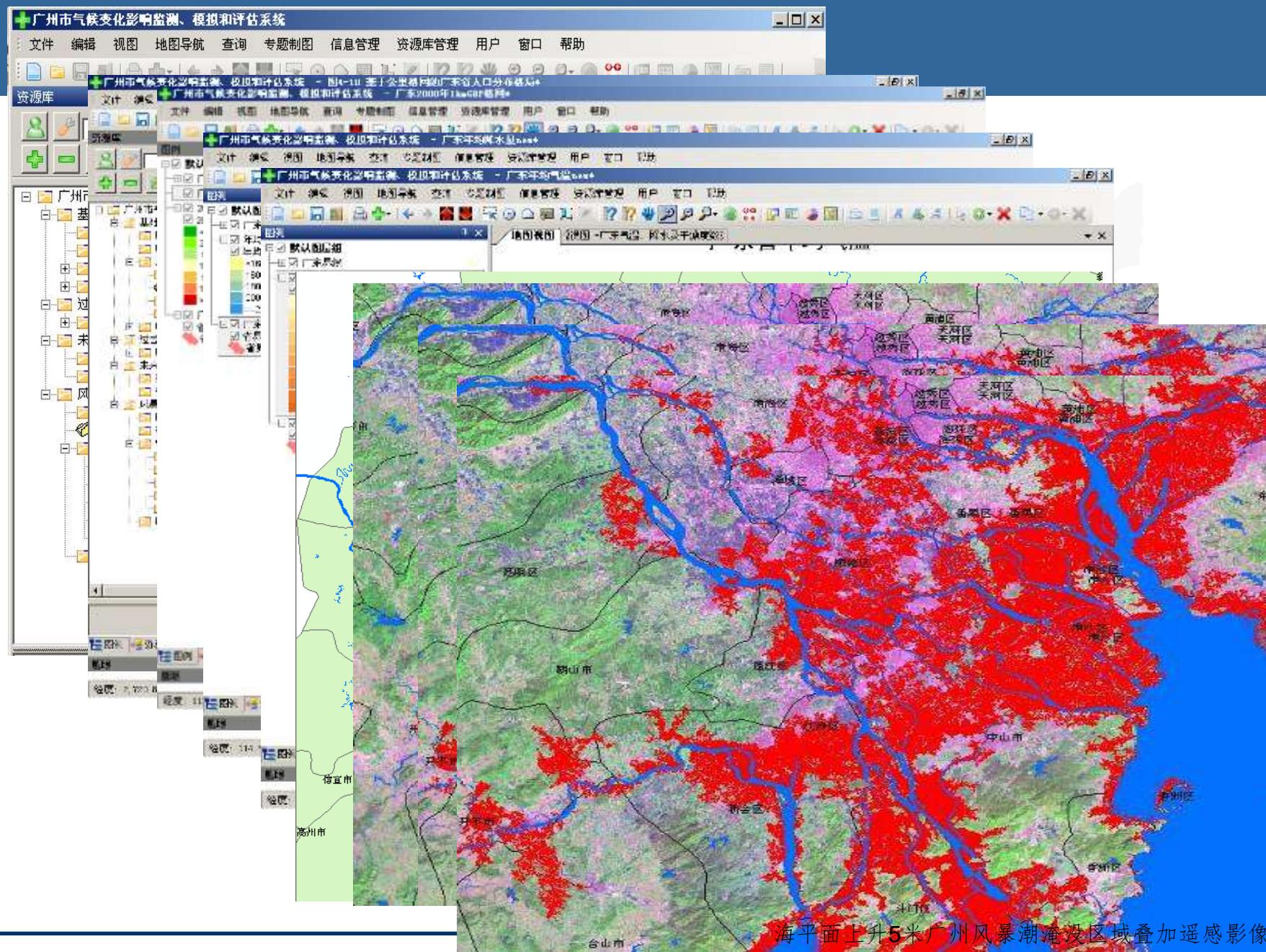
## 山西省地震灾害承灾体脆弱性评估

承灾体脆弱性



018

## **Case studies in typhoon and tsunami influence assessment**





*Thank you and questions!*