Major Floods Loss Assessment Based on Integration of multiple technologies

Co-organized by
◆ WFP Centre of Excellence for Rural Transformation (WFP China COE)
◆ National Disaster Reduction Center of China (NDRCC)

Supported by
Ministry of Agriculture and Rural Affairs of the People's Republic of China
Ministry of Emergency Management of the People's Republic of China

Workshop on Flood Response and Recovery – Henan Case

CONTENTS

Supported by

Ministry of Agriculture and Rural Affairs of the People's Republic of China

Ministry of Emergency Management of the People's Republic of China

1

PRINCIPLES OF ASSESSMENT

Principles of Assessment

- Specify the objects and contents for assessment, especially the key contents. Priorities should be given to the consideration of disaster types, features of the disaster-stricken areas and the scales of disasters.
- Specify the basic units for assessment, according to disaster types and the scales of disasters.

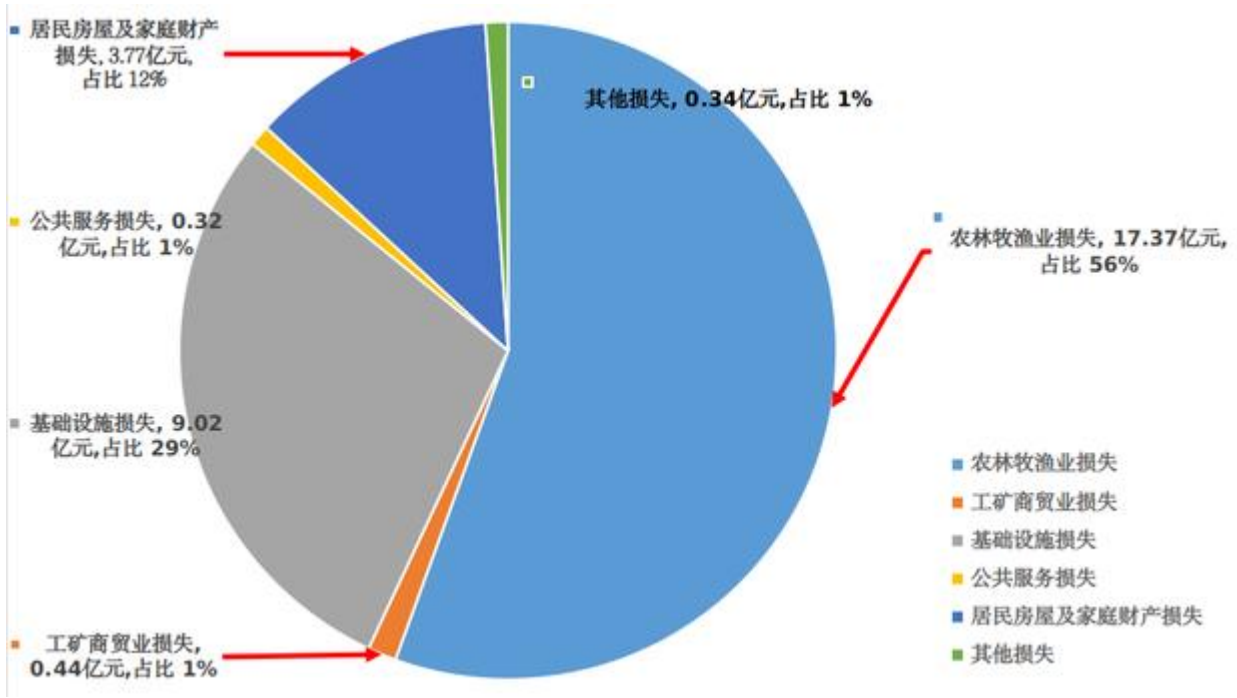
CONTENTS OF ASSESSMENT

1. Physical Quantity Assessment

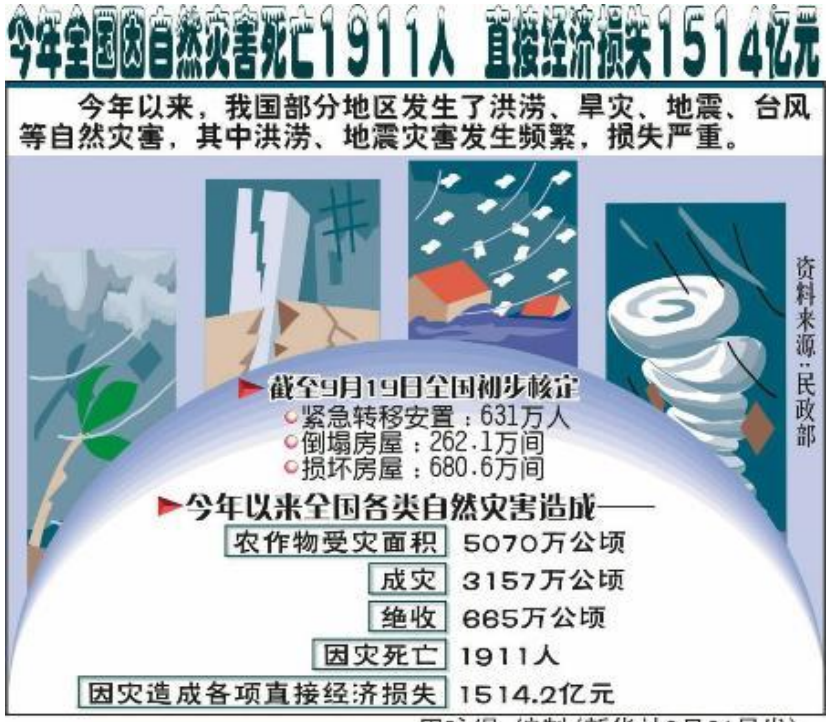
Incorporate various methods such as on-the-spot investigations, empirical models, local statistics reports and remote sensing interpretation, etc. in the assessment of the physical quantities of damages and losses such as casualties, house damages and ruins, agricultural losses, industrial losses, losses in the service sector, losses in infrastructures, losses in social undertakings, residents' property losses and losses of land resources.

2. Direct Economic Loss Assessment

On the basis of the physical quantity assessment, utilize multiple methods such as economic loss accounting to assess the direct economic losses caused to houses, agriculture, industry, the service sector, infrastructures, social undertakings, residents' properties and land resources.

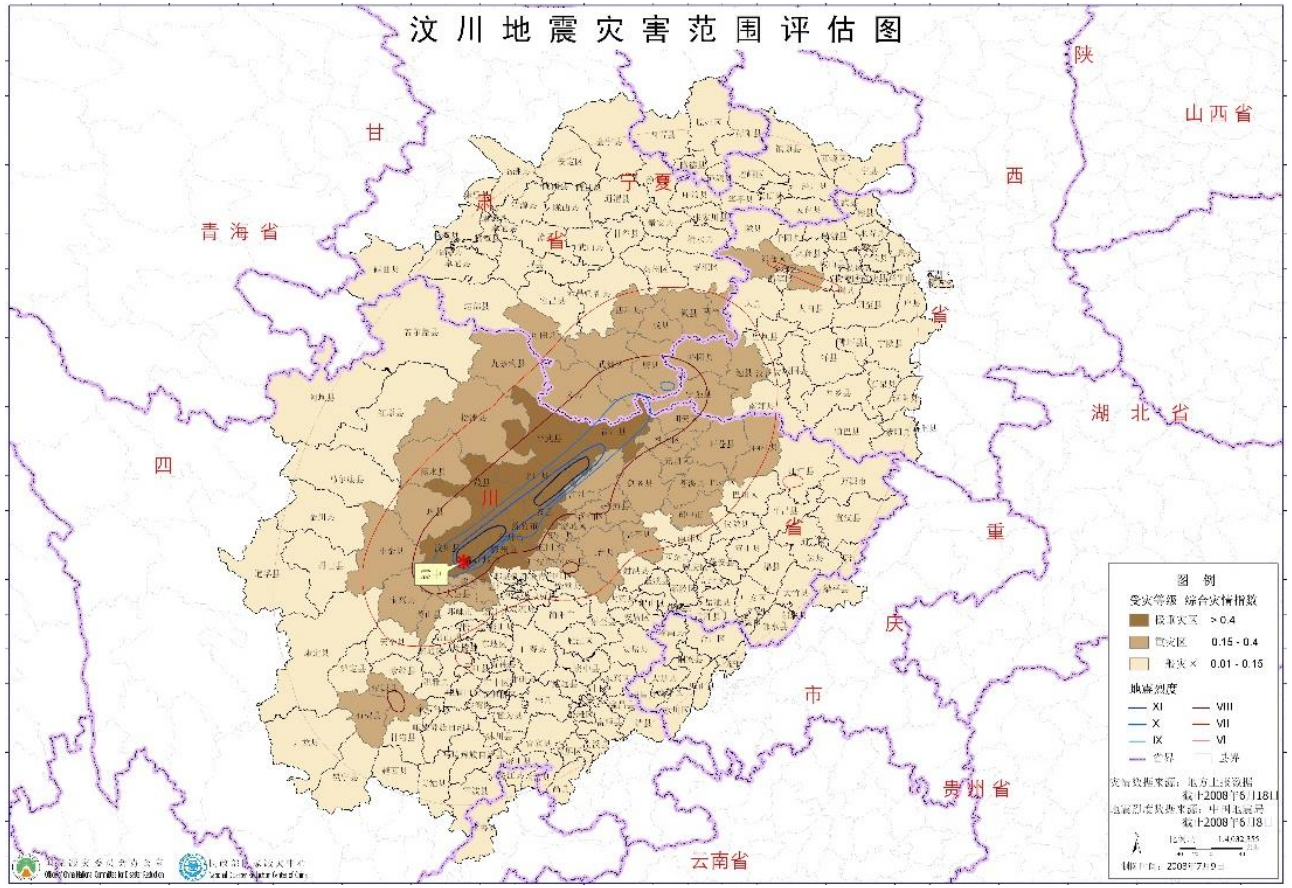


source：https://baijiahao.baidu.com/s?id=1723071815406862088



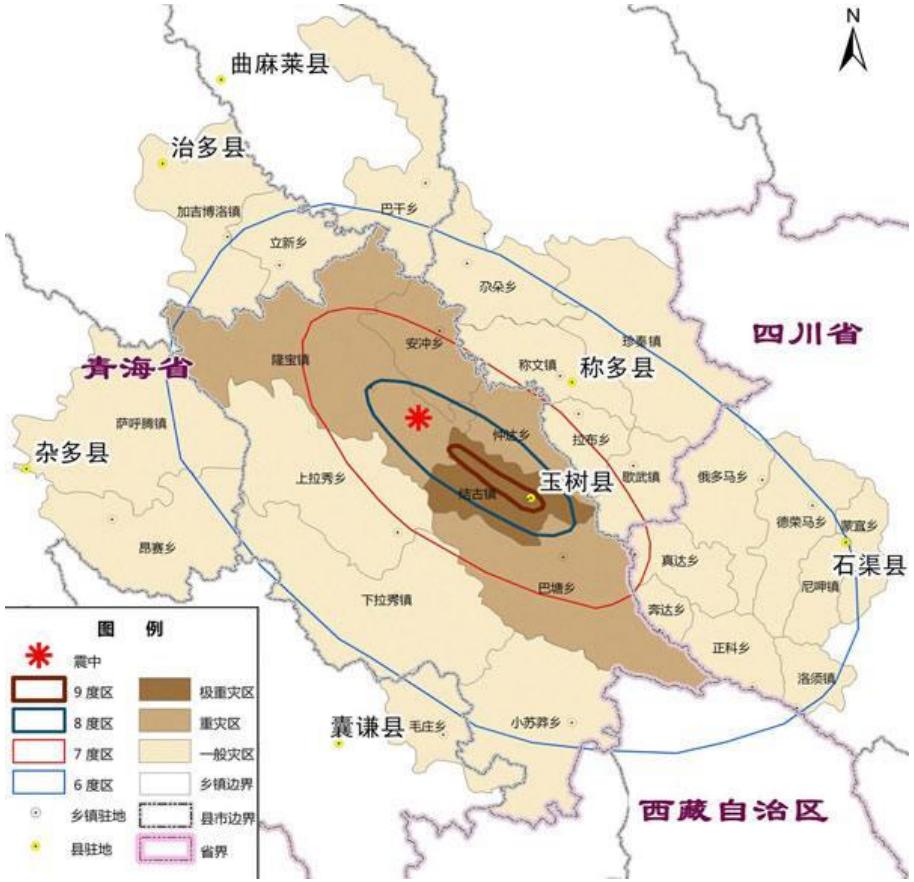
3. Disaster Scope Assessment

Take each assessment unit as the basic unit and assess a disaster's intensity distribution across a certain area.



Wenchuan Earthquake Map of Disaster scope Assessment

source：《Atlas of Disaster Monitoring and Assessments on Wenchuan Earthquake》



Yushu Earthquake Map of Disaster scope Assessment

source：《玉树地震灾后恢复重建总体规划》

///

ASSESSMENT METHODS

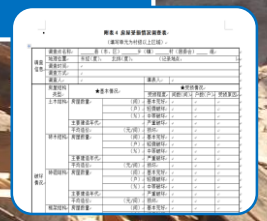
1. On-the-spot investigation and Assessment

After a disaster, on-the-spot investigation and assessment groups should be established with membership from the relevant professional departments and experts to carry out investigations.

The investigations are mainly conducted in the following aspects: 1) house damages and ruins, 2) agricultural losses, 3) losses in industry and the service sector, 4) infrastructural losses (in fields such as transport facilities, municipal facilities, water conservation facilities, power facilities, telecommunications facilities, radio and communication facilities and governmental facilities, etc.).

Data and devices required in the investigations mainly include 1) on-the-spot questionnaires; 2) PDA terminals; 3) high-definition remote-sensing images of key areas, working layers of different regions gained from on-the-spot collection, and relevant thematic data.

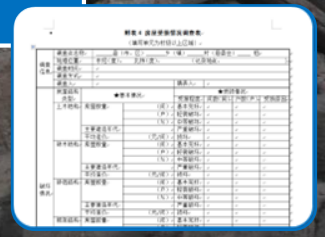
制定现场调查统计表**designing forms of investigation**

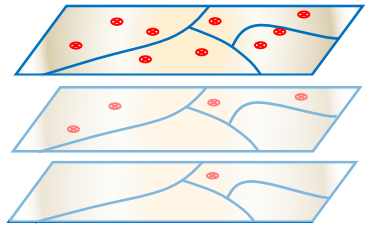


规划现场调查样区
sampling plan

现场调查
On-the-spot investigation

现场-后方数据协处理Data Proccesing with the command center and On-the-spot





Spatial Statistics Sampling Methord

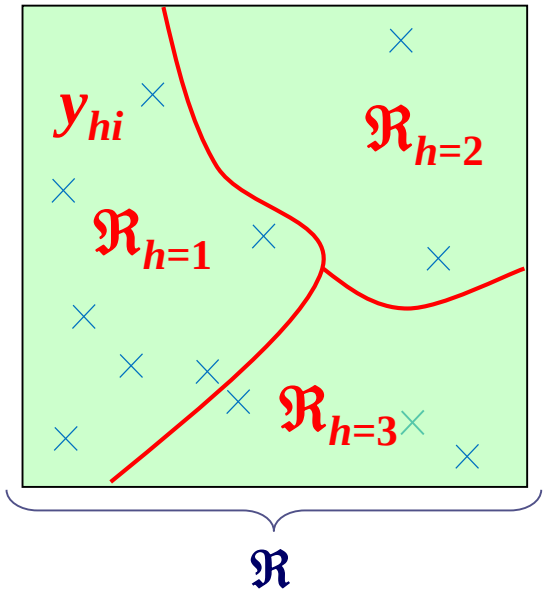
(MSN：Mean of Surface with Nonhomogeneity_)

Population (ℜ)：autocorrelaton自相关 + stratified heterogeneity分层

实际均值

$$\bar{Y}_{\Re} = \Re^{-1}\int_{\Re} y(s)ds$$

$$= \Re^{-1}\sum_{h=1}^{H}\Re_h\left[\Re_h^{-1}\int_{\Re_h} y(s)ds\right]$$



样本估计

$$\bar{y}_{\Re} = \sum_{i=1}^{n} w_i y_i$$

$$= \sum_{h=1}^{H}\sum_{i=1}^{n_h} a_h w_{hi} y_{hi}$$

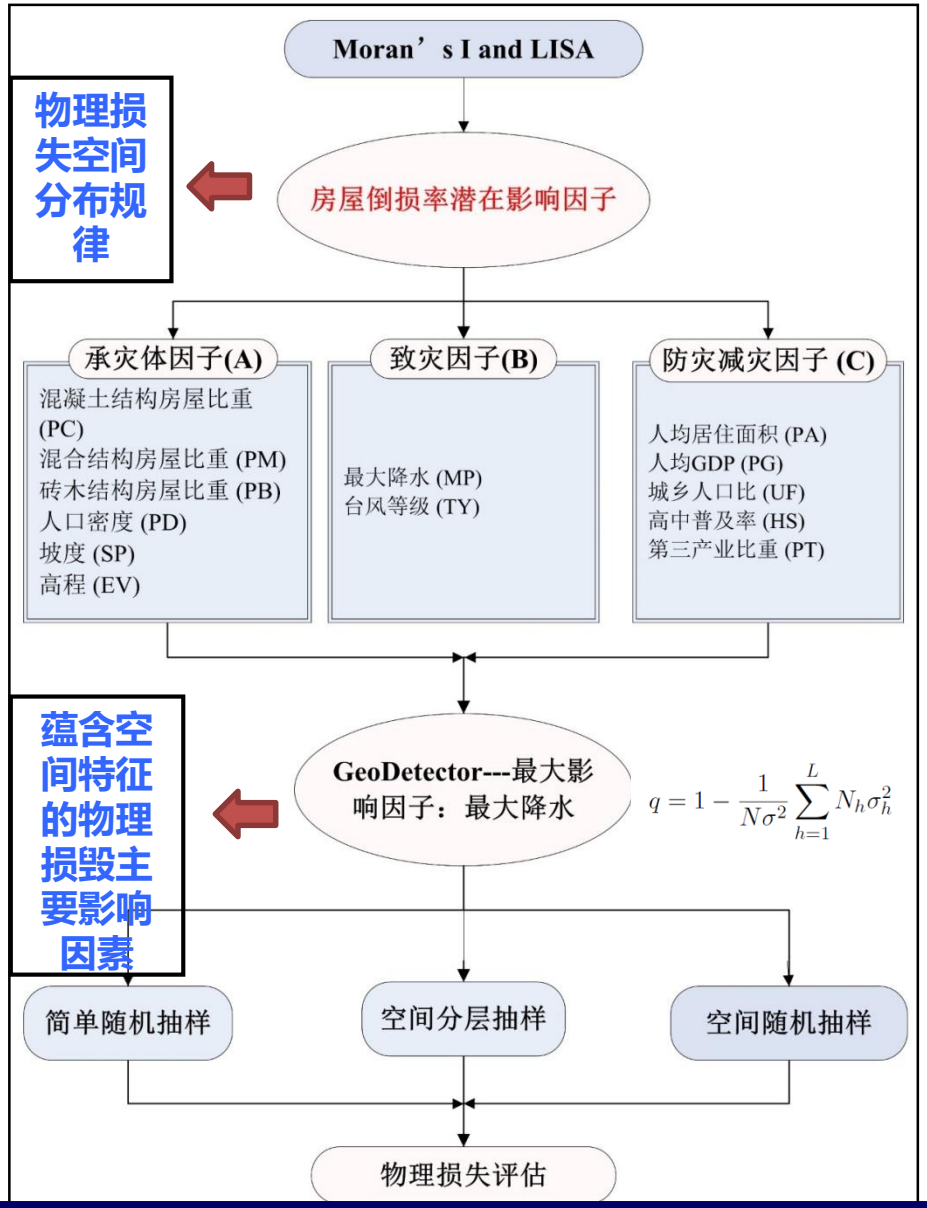
目标

$$\min\ v(\bar{y}_{\Re}) = E[\bar{y}_{\Re} - \bar{Y}_{\Re}]^2 \quad \text{st. } E(\bar{y}_{\Re}) = E(\bar{Y}_{\Re})$$

Wang JF, Christakos G, Hu MG. 2009. Modeling spatial means of surfaces with stratified non-homogeneity. **IEEE Transactions on Geoscience and Remote Sensing** 47(12): 4167-4174

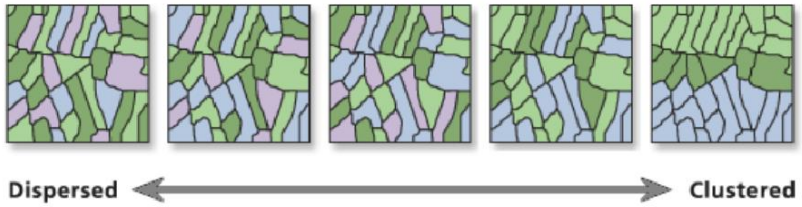
http://www.sssampling.cn/MSN/

MSN: technical proposal



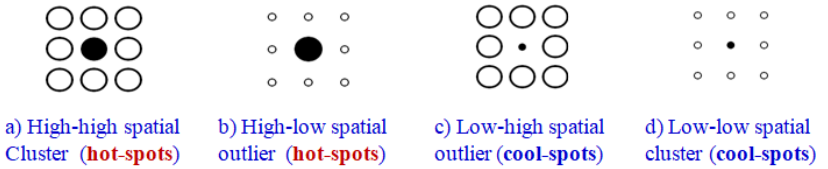
全域空间自相关指数：全局Moran’s I

$$I = \frac{N}{W}\frac{\sum_i\sum_j w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_i(x_i-\bar{x})^2}$$

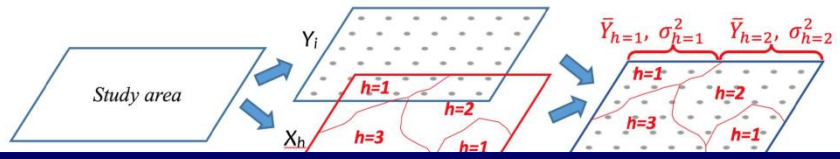


局域空间自相关指数：LISA

$$I_i = \frac{z_i-\bar{z}}{\sigma^2}\sum_{j=1,j\neq i}^{n}[w_{ij}(z_j-\bar{z})]$$



地理探测器（**Geodetector**：q）是探测空间分异性，并揭示其背后驱动因子的一种新的统计学方法。**思想**：研究区分为若干子区域，如果子区域的方差之和小于区域总方差，则存在空间分异性；如果两变量的空间分布趋于一致，则两者存在统计关联性。

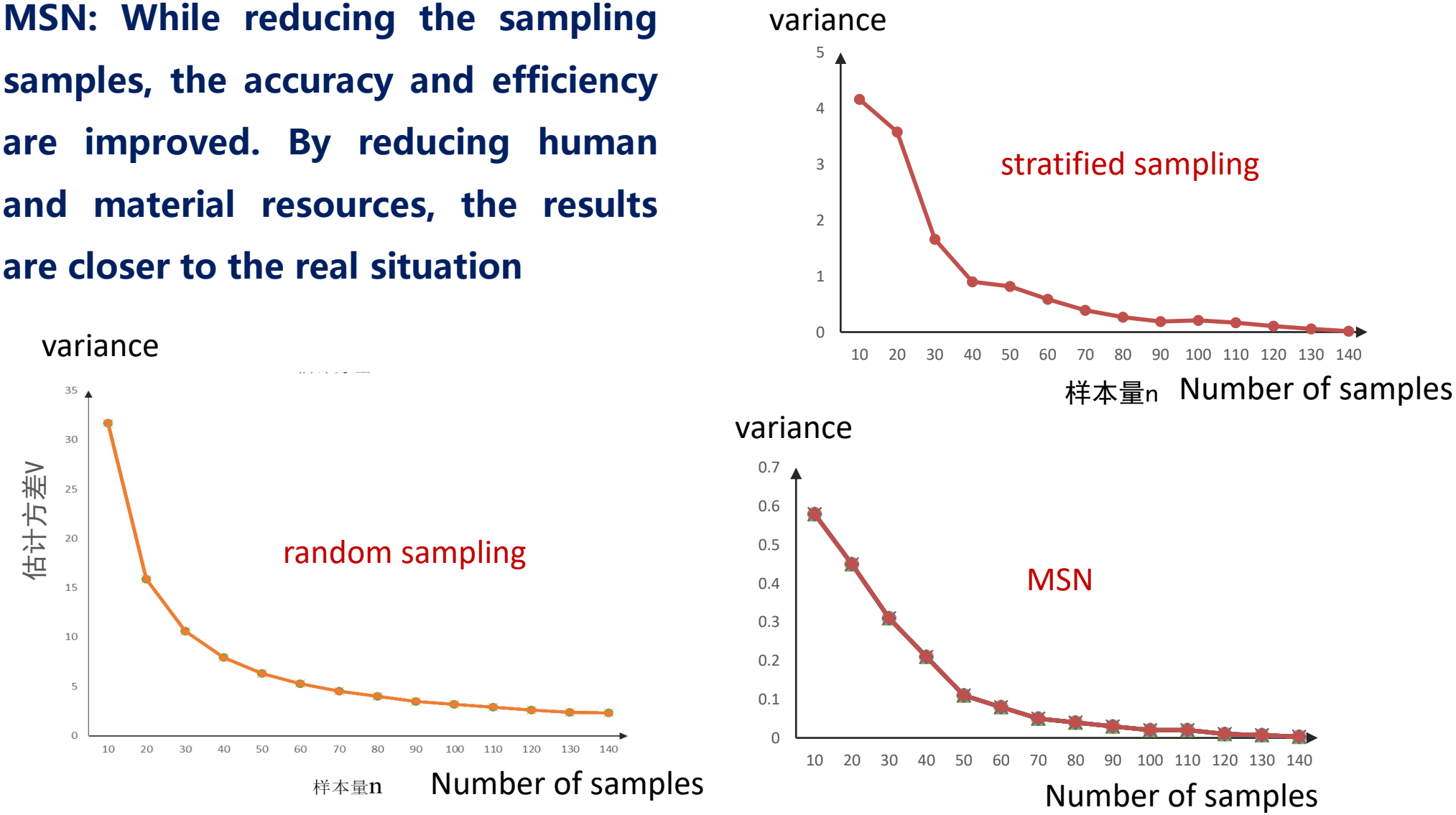


Nie, J., Zhang, X.X., et al., 2021. The impact of super typhoon lekima on the house collapse rate and quantification of the interactive impacts of natural and socioeconomic factors. GEOMATICS NATURAL HAZARDS & RISK.12 (1):1385-1400.

Zhang, X.X., Nie J., et al., 2021. Spatial pattern of the population casualty rate caused by super typhoon Lekima and quantification of the interactive effects of potential impact factors. BMC PUBLIC HEALTH. 21 (1): 1260.

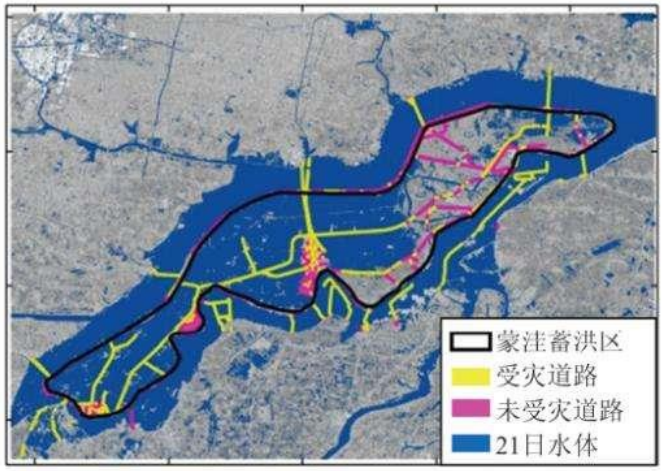
Error Analysis

MSN: While reducing the sampling samples, the accuracy and efficiency are improved. By reducing human and material resources, the results are closer to the real situation

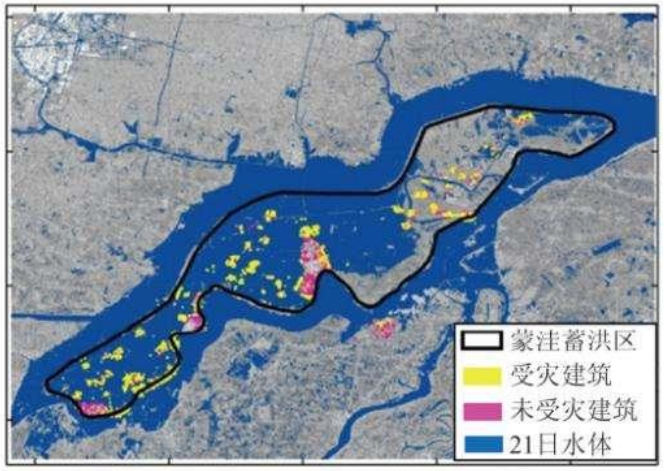


2. Remote sensing and monitoring of disasters

Take high-resolution data of key areas collected by aviation and unmanned aircrafts as the main source for investigation and incorporate ground investigation data in the monitoring and assessment of damages and losses caused to houses, infrastructures (especially transportation lines) and agricultural land such as crop land and woodland in the disaster-stricken areas.



(a) 道路受灾情况



(b) 建筑受灾情况

3. Local statistics reporting

According to the features of catastrophic disasters, design statistical indicators and formulate relevant files such as "Statistics Table of Disaster Losses" and the corresponding instructions on how to fill these statistics tables. Governments in disaster-stricken areas should organize and carry out an overall on-the-spot investigation, conduct statistical calculations and submit the results to the higher governments.

1.Loss of rural housing
2.Loss of urban residents housing and non-residential buildings
2.1 Loss of urban residents housing
2.2 Loss of urban non-residential buildings
3. Agricultural loss
4. Industry (including the defense industry) loss
5. Service industry loss
6. Infrastructure loss
6.1 Infrastructure (Transport facilities) loss
6.2 Infrastructure (Municipal utilities) loss
6.3 Infrastructure (Water conservancy and power facilities) loss
6.4 Infrastructure (Radio communication facilities) loss
6.5 Infrastructure (Railway facilities) loss
6.6 Infrastructure (Power facilitie) loss
6.7 Infrastructure (Communication facilitie) loss
7. Social institution loss
7.1 Social institution loss (Education)
7.2 Social institution loss (Public Health)
7.3 Social institution loss (Culture)
7.4 Social institution loss (Science)
7.5 Social institution loss (Social welfare)
7.6 Social institution loss (Environmental protection)
8. Residents' property loss
9. Land resource loss
10. Nature reserve loss
11. Cultural heritage loss
12. Biological diversity loss
13. Mine resources loss

4. Economic methods

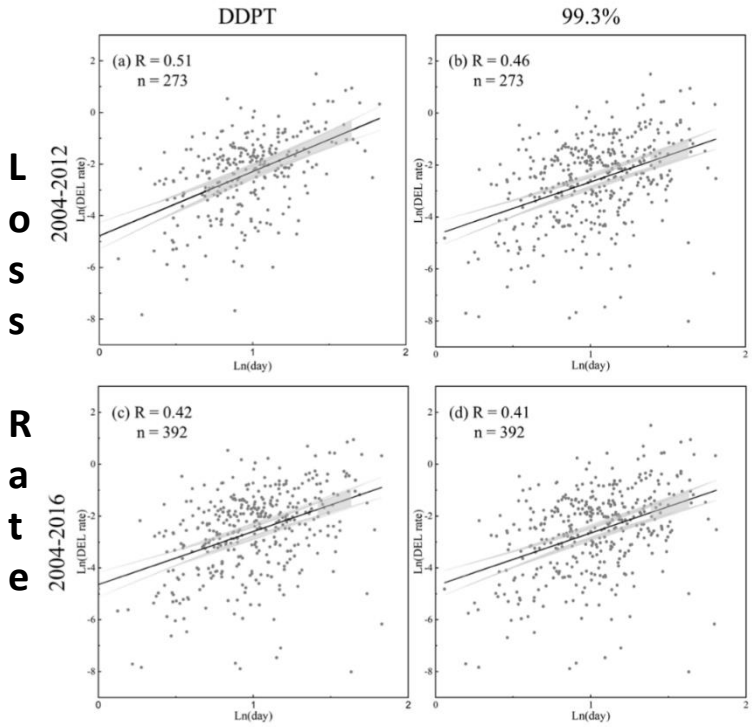
On the basis of physical quantity loss assessment, integrate the disaster loss data reported by local governments with those from investigations and inspections of relevant departments and organizations; make calculations through the unit replacement cost for individual disaster-affected entities such as those entities in the form of houses, entities in industry, agriculture and the service sector, entities in infrastructures, entities in social undertakings, entities in the form of residents' properties and land resources.

- **Replacement cost approach**
- **Market comparison approach**
- **Income approach**

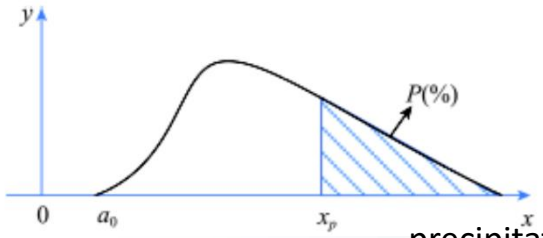
Loss Assessment Model of Rainstorm Flood Disaster

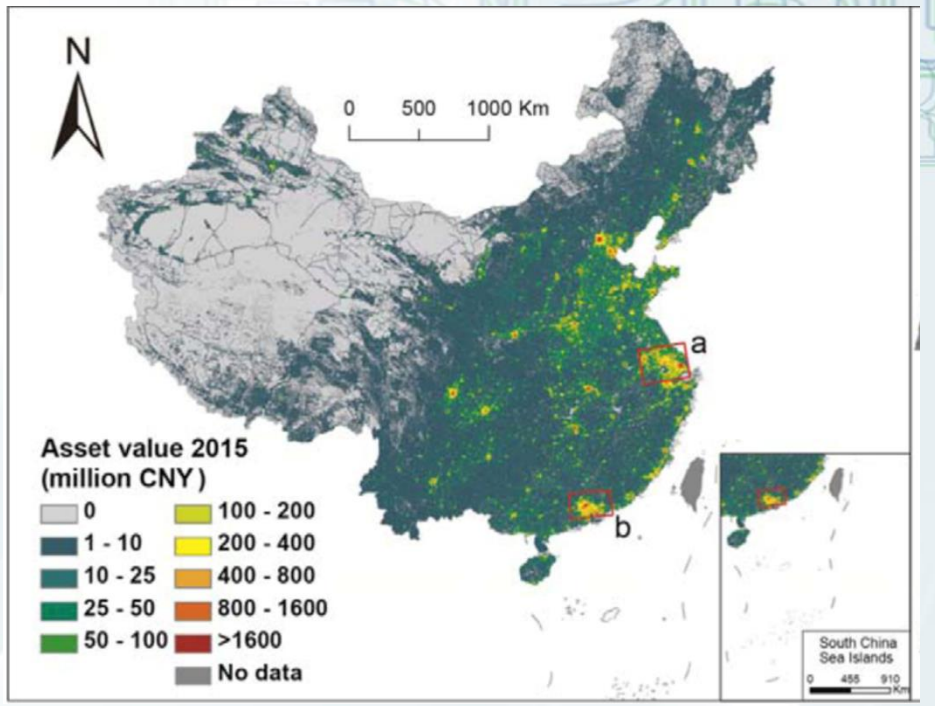
$$\ln(L) = a_1 + \mathrm{b}_1 \ln(D) + c_1 \ln(W) - d_1 \ln(I)$$

DDPT　　WCSE　　Per capita GDP



DDPT Rule：
Exceed Quantile 99.3%

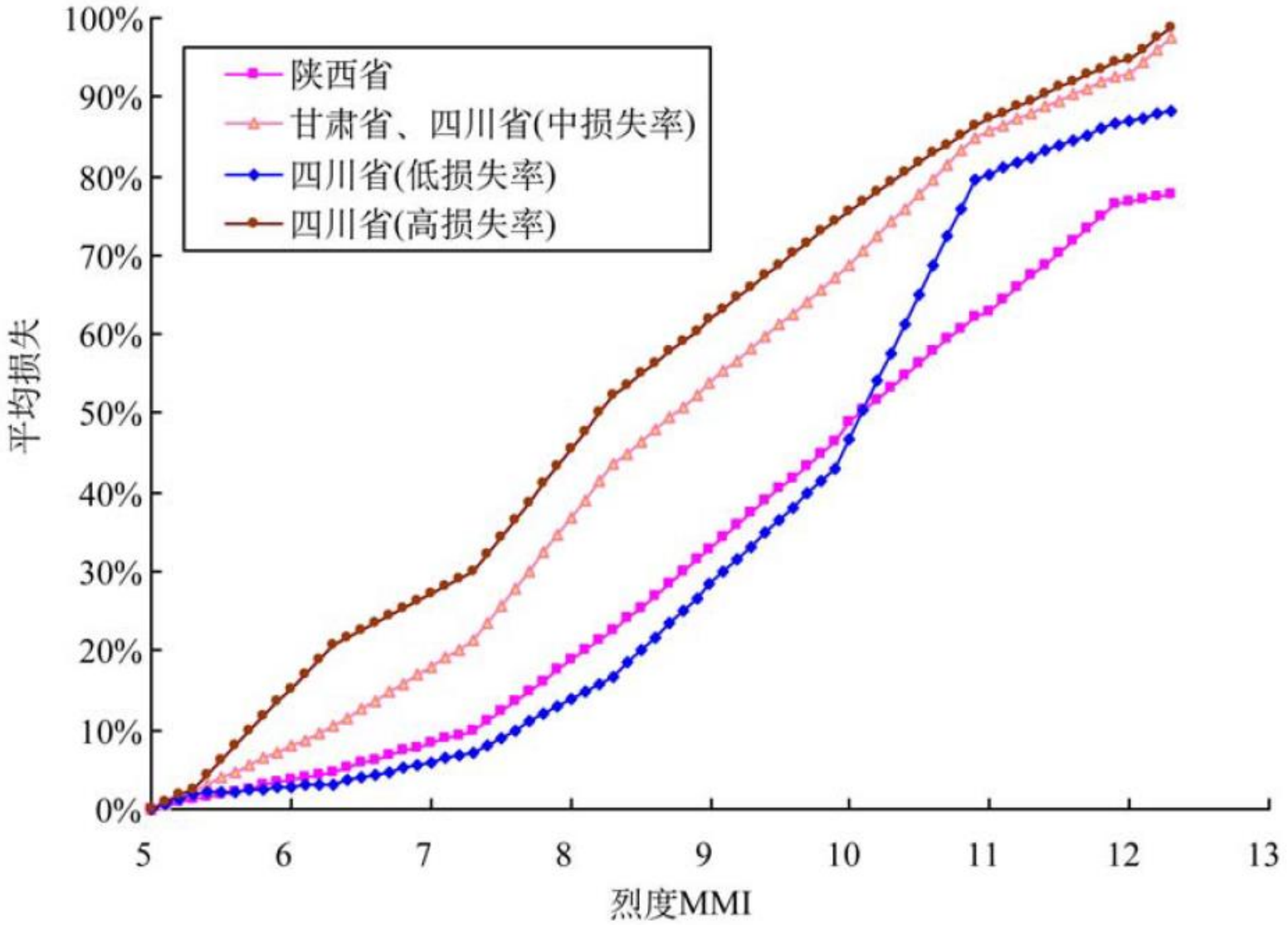




WCSE（2015）

DDPT : disaster-triggering daily precipitation threshold极端降雨日数
WCSE: wealth capital stock exposure资产暴露度

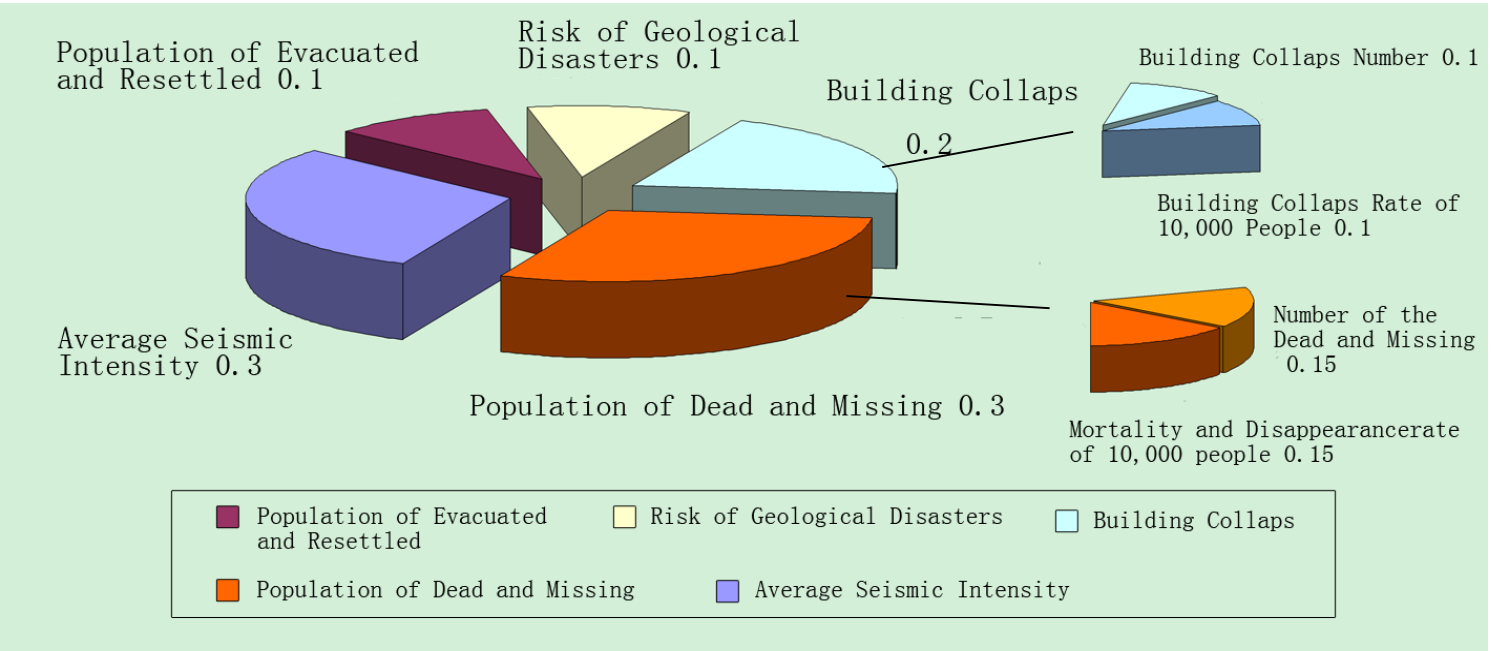
刘文辉. 气候变化背景下中国暴雨洪涝灾害风险评估研究[D]. 北京师范大学，2021.
Wu J, Li Y, Li N, Shi P (2018). Development of an Asset Value Map for Disaster Risk Assessment in China by Spatial Disaggregation Using Ancillary Remote Sensing Data. Risk Analysis, 38(1): 17-30.


陕西省
甘肃省、四川省(中损失率)
四川省(低损失率)
四川省(高损失率)
平均损失
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
5
6
7
8
9
10
11
12
13
烈度MMI

5. Disaster Scope Assessment

--- Indicator Assessment Method

Take the assessment unit as the basic unit and select key indicators to construct comprehensive disaster indices. Divide a disaster-stricken area according to the varying intensities of a disaster in the area, with the help of the comprehensive disaster indicators.



Formula of Comprehensive Disaster Indices

$$DI=\sum(f_k \times DI_k)$$

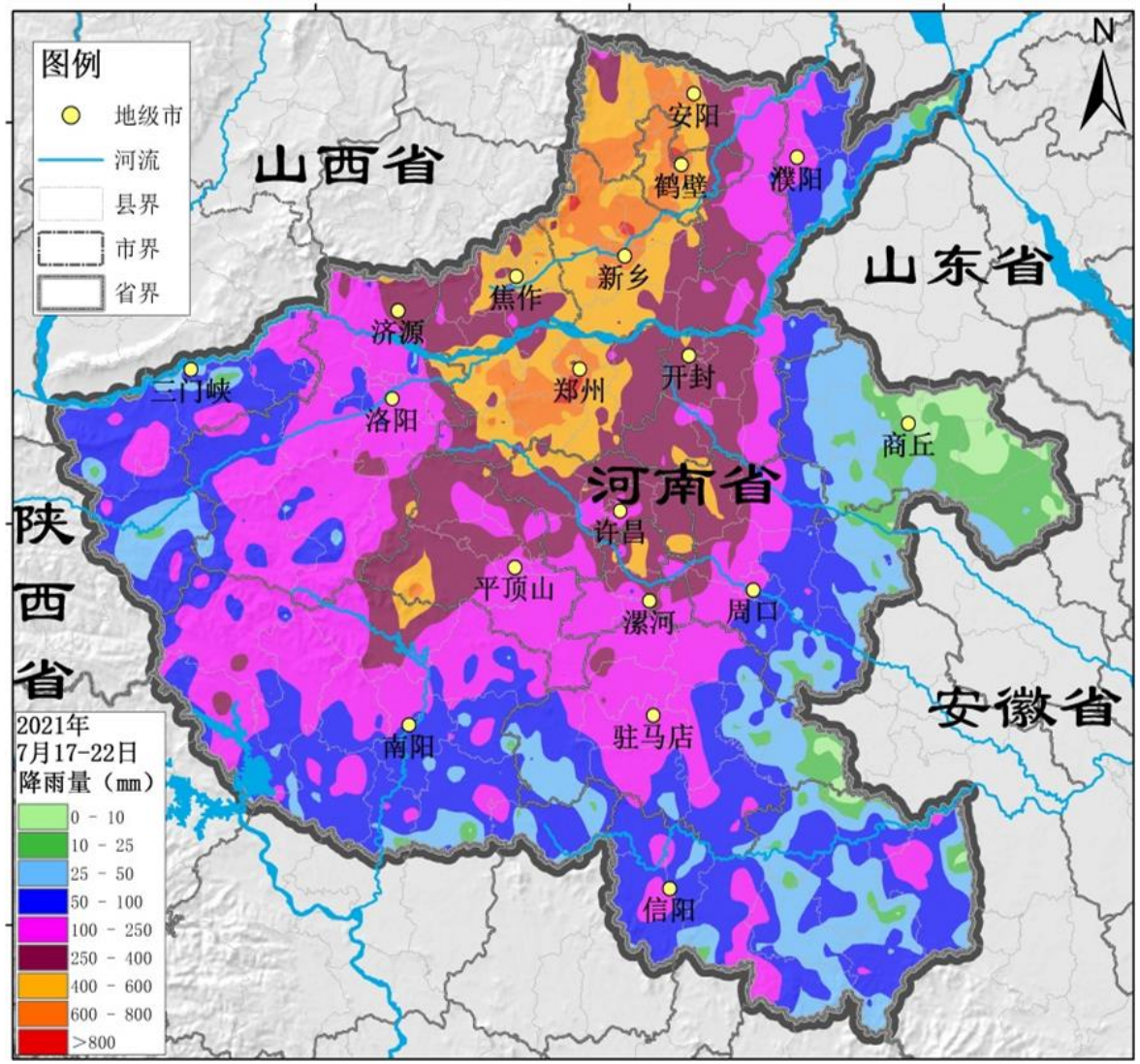
Dik: Indicator Normalization

DIk = [DIk -min (DIk)]/ [max (DIk) -min (Dik)]

Fk: Indicator Weight。

IV

TYPICAL EXAMPLE
- MAJOR FLOOD IN HENAN

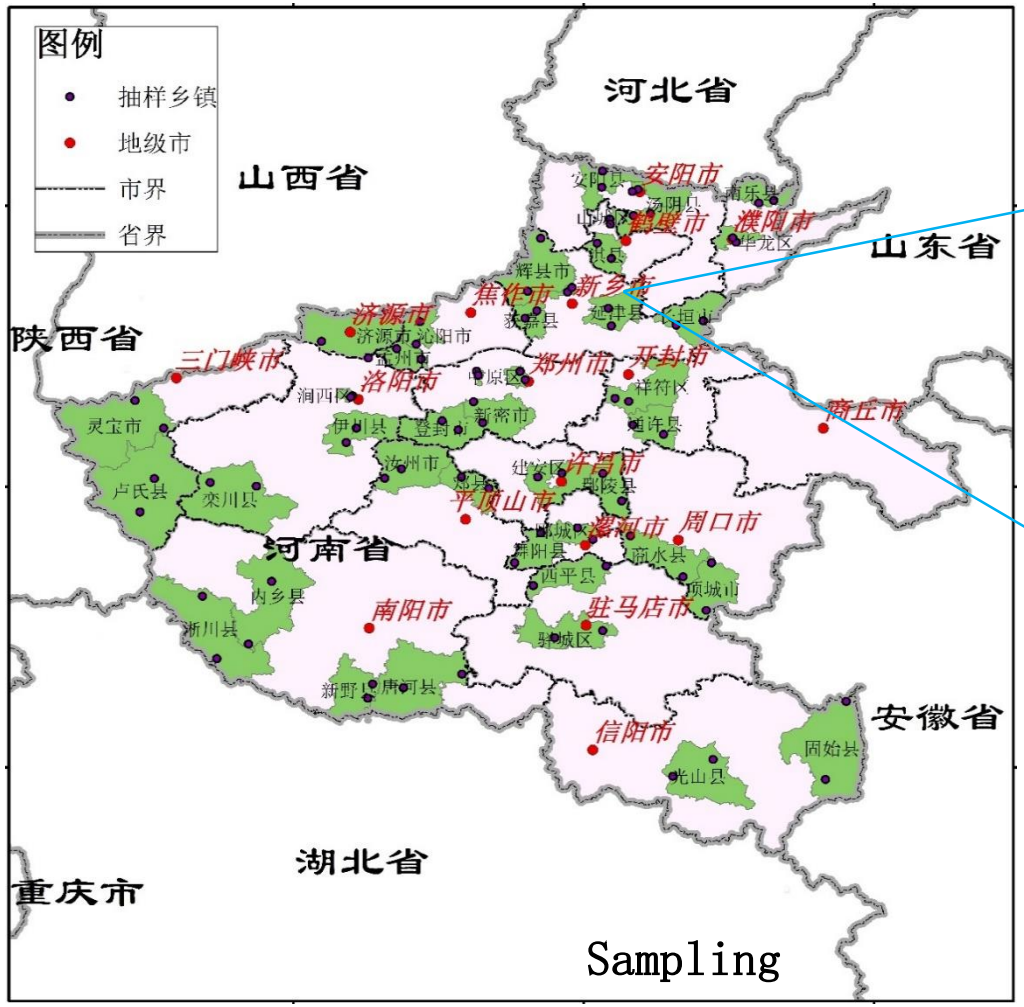


Cumulative Precipitation Map in Henan （July 17 - 23）

From July 17 to 23, 2021, Henan province suffered a rare rainstorm in history, resulting in serious floods. The disaster affected 14.786 million people in 150 counties (cities and districts) in Henan Province, with 398 deaths and missing

Physical Quantity Assessment （1）： Damaged house

— MSN Spatial Statistics Sampling Methord



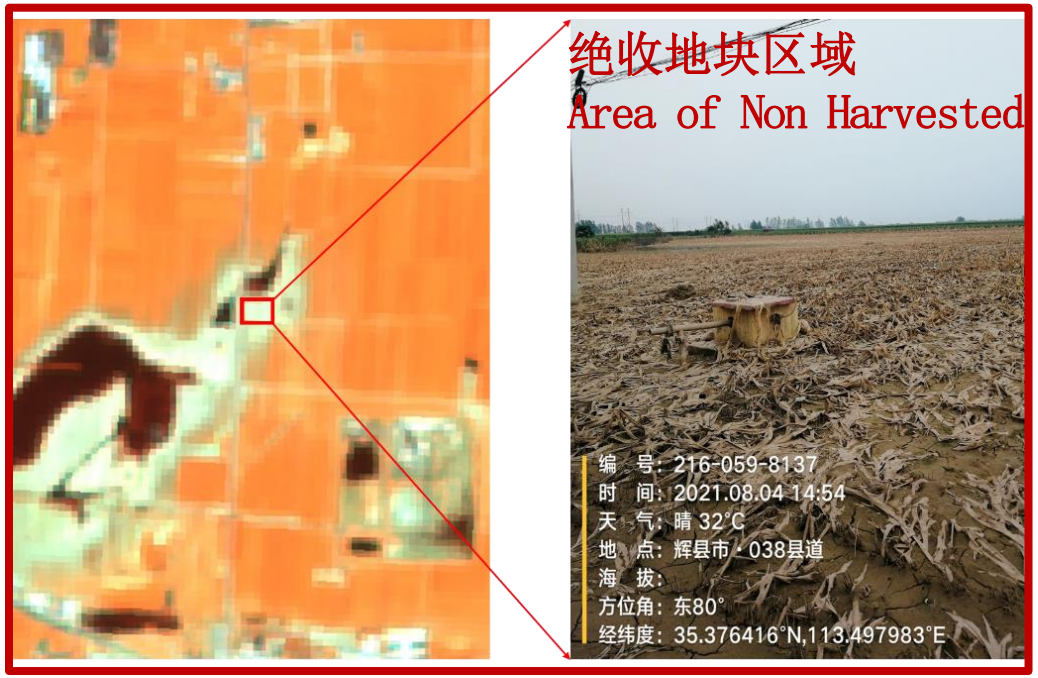
on-site inspection

Sampling Distribution: Flood in Henan, 2021.07

Physical Quantity Assessment （2）： The Disaster Area of Crops

— Remote Sensing Monitoring

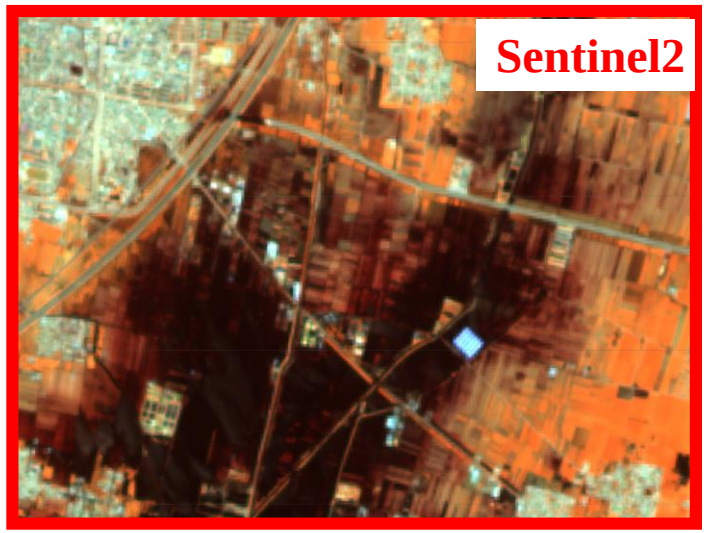
Sampling On-site



通过将野外采集的样本，与遥感的多个光谱特征进行映射，从而构建表征受灾等级的指标

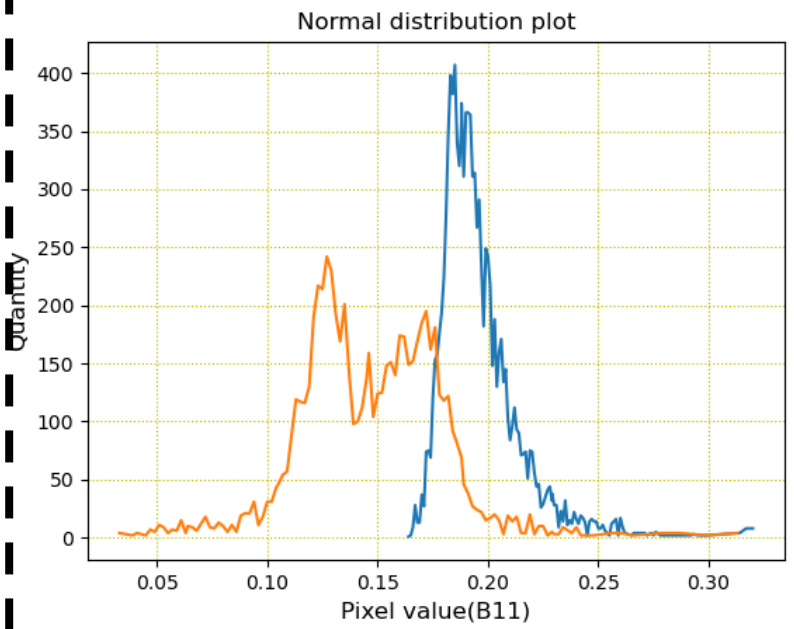
构建对应受灾等级的遥感指数
Constructing remote sensing index of crop reduction grade

Post Disater image灾后的哨兵影像



Pre Disater image灾前的Google Earth 高分影像

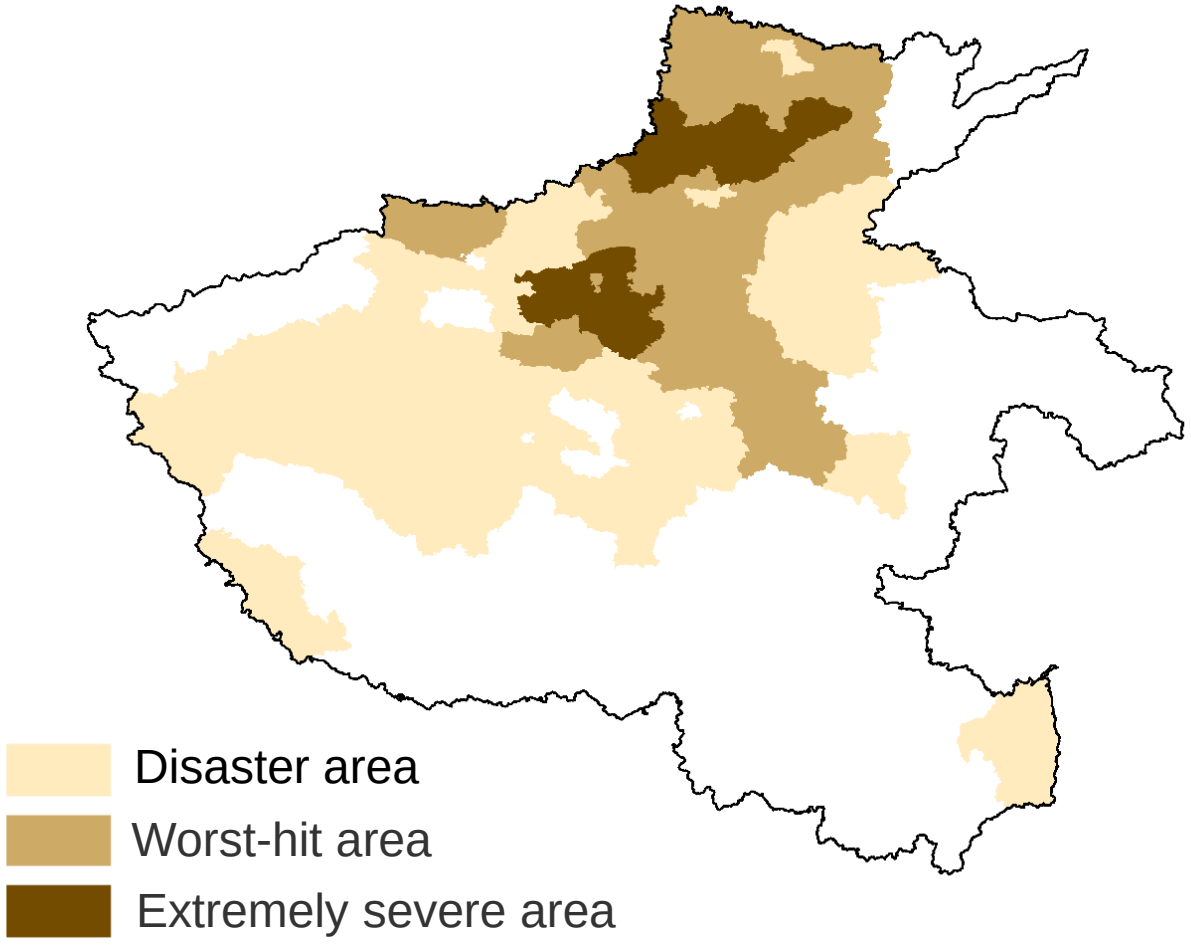
Spectral curve of remote sensing image



正常地块 Normal Area　　轻度受灾 Affected Area

不同的受灾等级可以通过遥感敏感波段来进行区分

Direct Economic Loss an Disaster Scope Assessment



Henan Flood of Map of Disaster Scope Assessment

“河南省共有150 个县（市、区）1478.6 万人受灾，直接经济损失1200.6 亿元，其中郑州409 亿元，占全省34.1%”

—《河南郑州“7·20”特大暴雨灾害调查报告》

“河南郑州等地特大暴雨洪涝灾害范围分为极重灾区、重灾区和一般灾区三类。本规划的规划范围为极重灾区和重灾区涉及的40 个县（市、区），恢复重建内容包括：居民住房、基础设施、城市内涝治理、公共服务、产业恢复振兴、生态环境修复、应急管理等。”

—《河南郑州等地特大暴雨洪涝灾害灾后恢复重建总体规划》

Thank You

Contact info: www.ndrcc.org.cn

niejuan@ndrcc.org.cn

0086-52811179

Supported by

Ministry of Agriculture and Rural Affairs of the People's Republic of China

Ministry of Emergency Management of the People's Republic of China