# Theory and Practice of Annual Natural Disaster Risk Assessment

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**14/09/2015**

NDRCC

# Outline

1. Basic Theory of  Risk Assessment

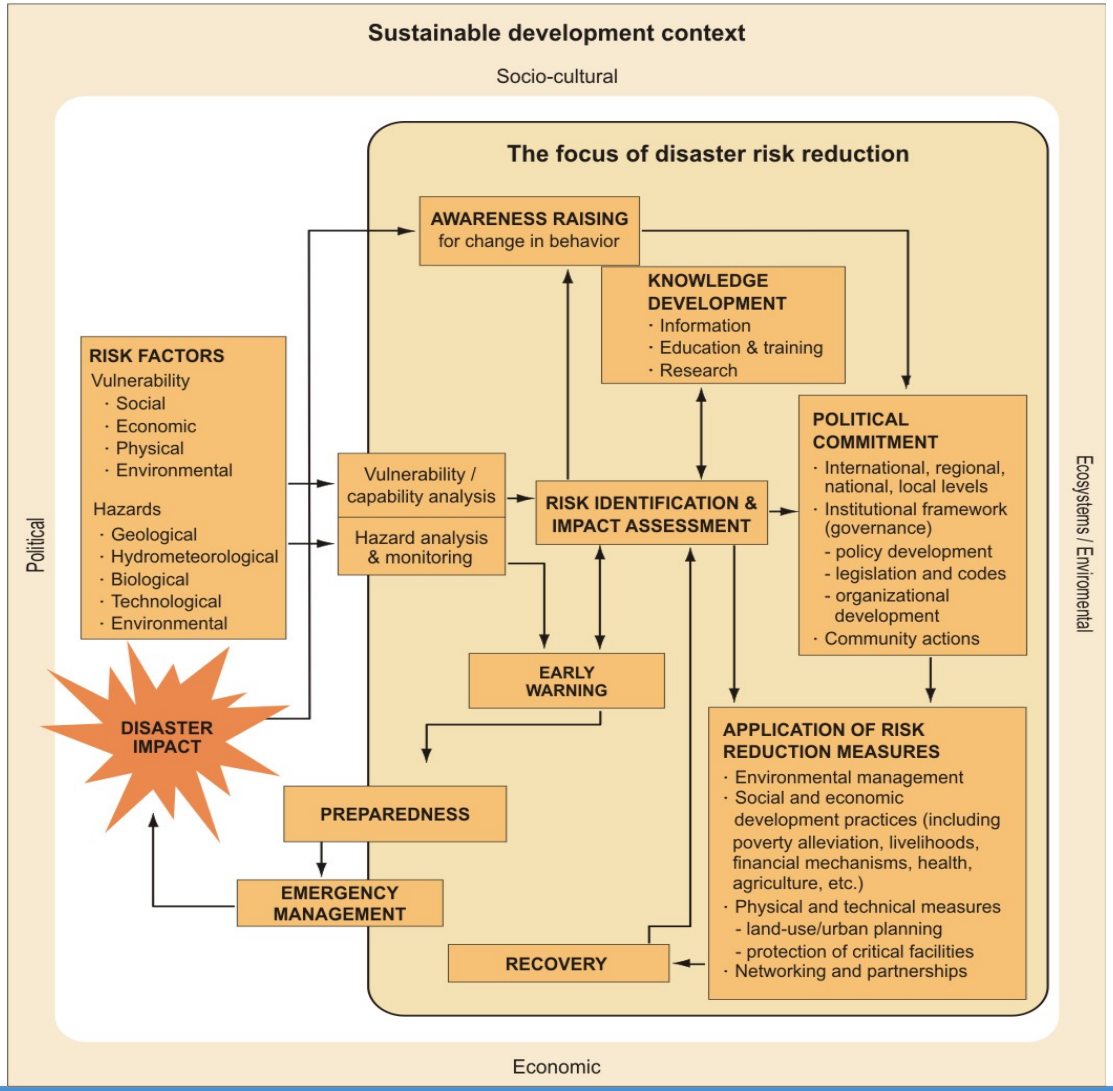
2.  Annual Disaster Risk Assessment of China

3. Discussion

# Basic Theory of Risk Assessment

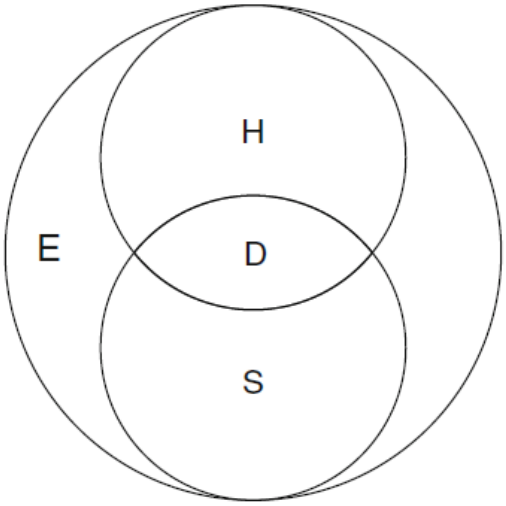
***Framework***

Conceptual framework for disaster reduction



# Basic Theory of Risk Assessment

## *Disaster System*



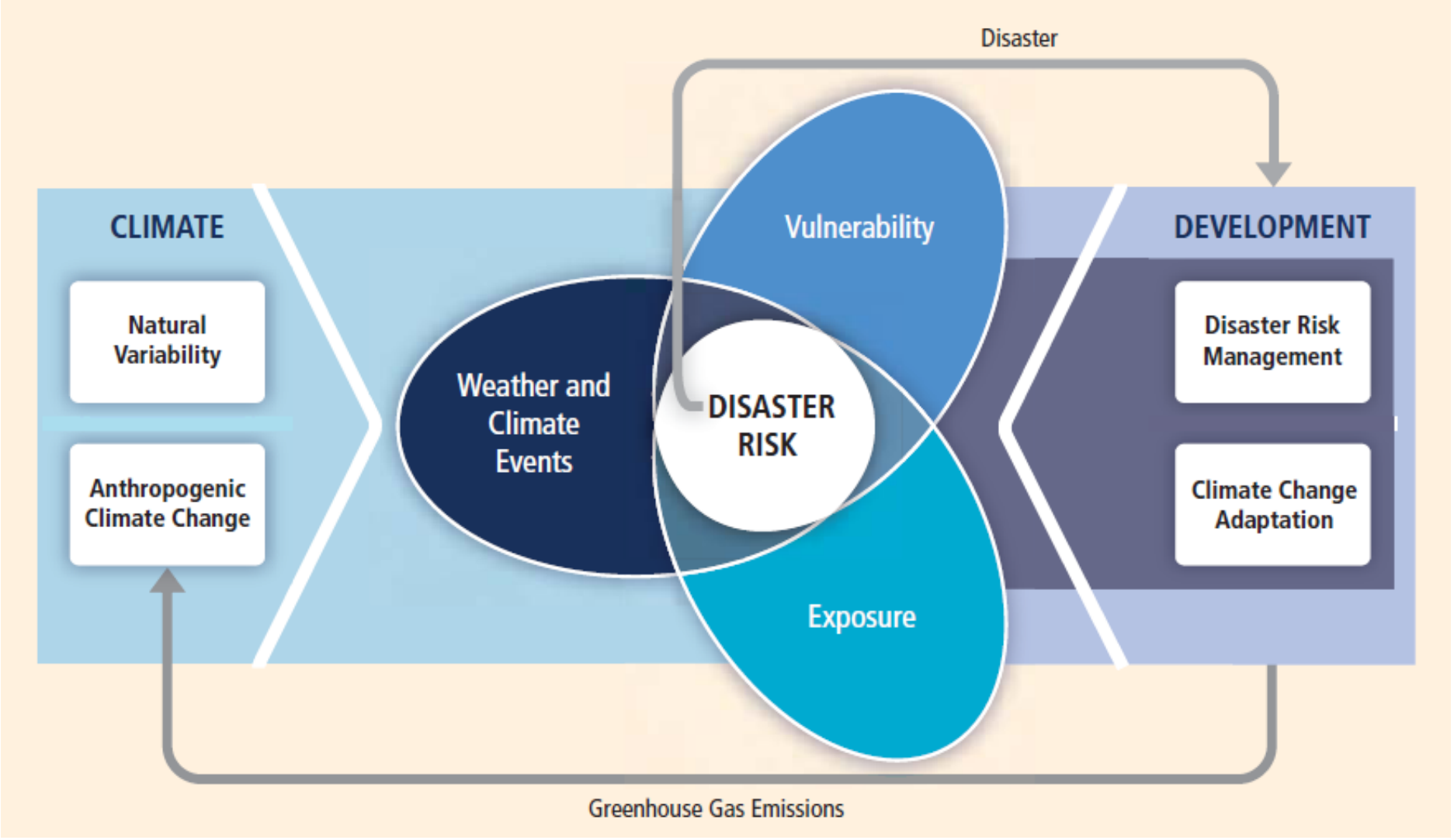

E: Environment
H: Hazard
S: Exposure
D: Disaster

Disaster system, a dynamic system on the earth surface with complex characteristics, is composed of natural ***hazards (H), exposures (S), environments (E), and disaster losses (D)*** .

Disaster system is a type of social–ecological system and also an important part of the earth surface system. Since hazards can be classified into three types by origin—natural, natural–human (environmental or ecological), and human, a disaster system can also be classified into three subsystems—natural disaster system, environmental (ecological) disaster system, and human ecological system. Disaster losses and damages are consequences of the interactions of hazards (H), exposures (S), and the environmental system (E) in which disasters occur (Shi 1991, 1996, 2002, 2005, 2009).

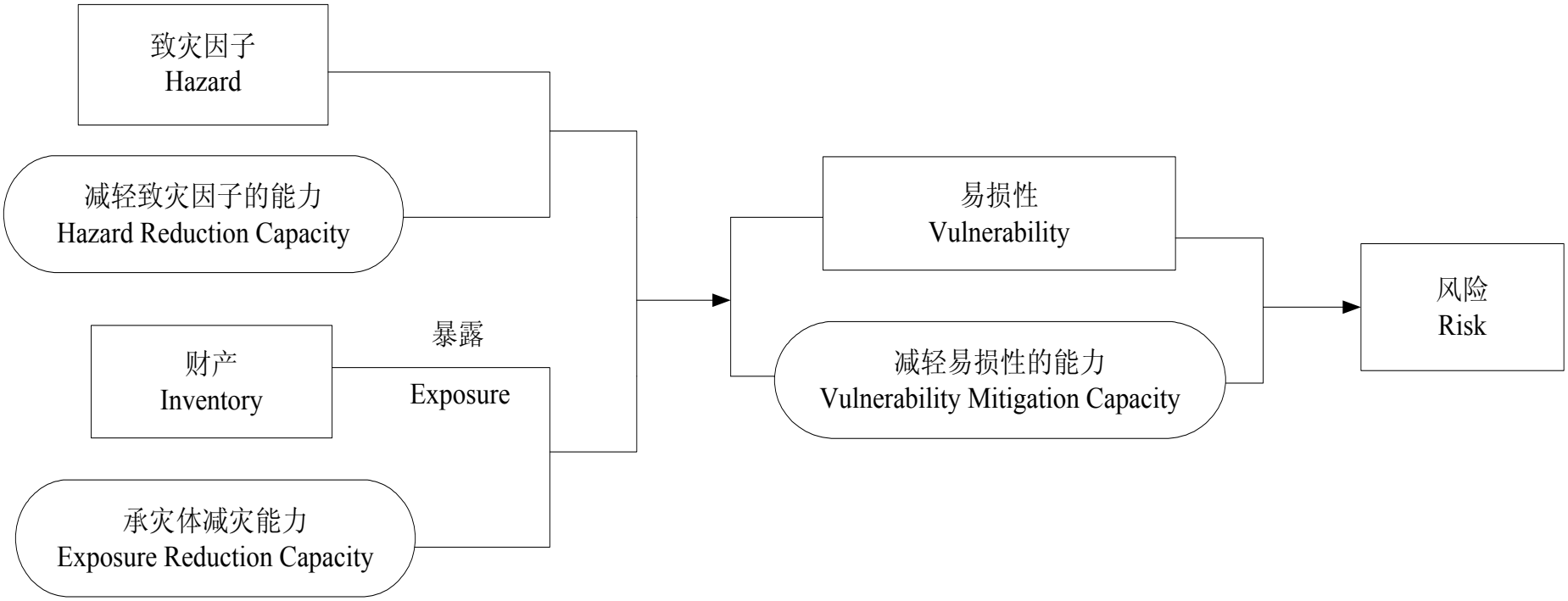
# Basic Theory of Risk Assessment

## *Disaster Risk*



# Basic Theory of Risk Assessment

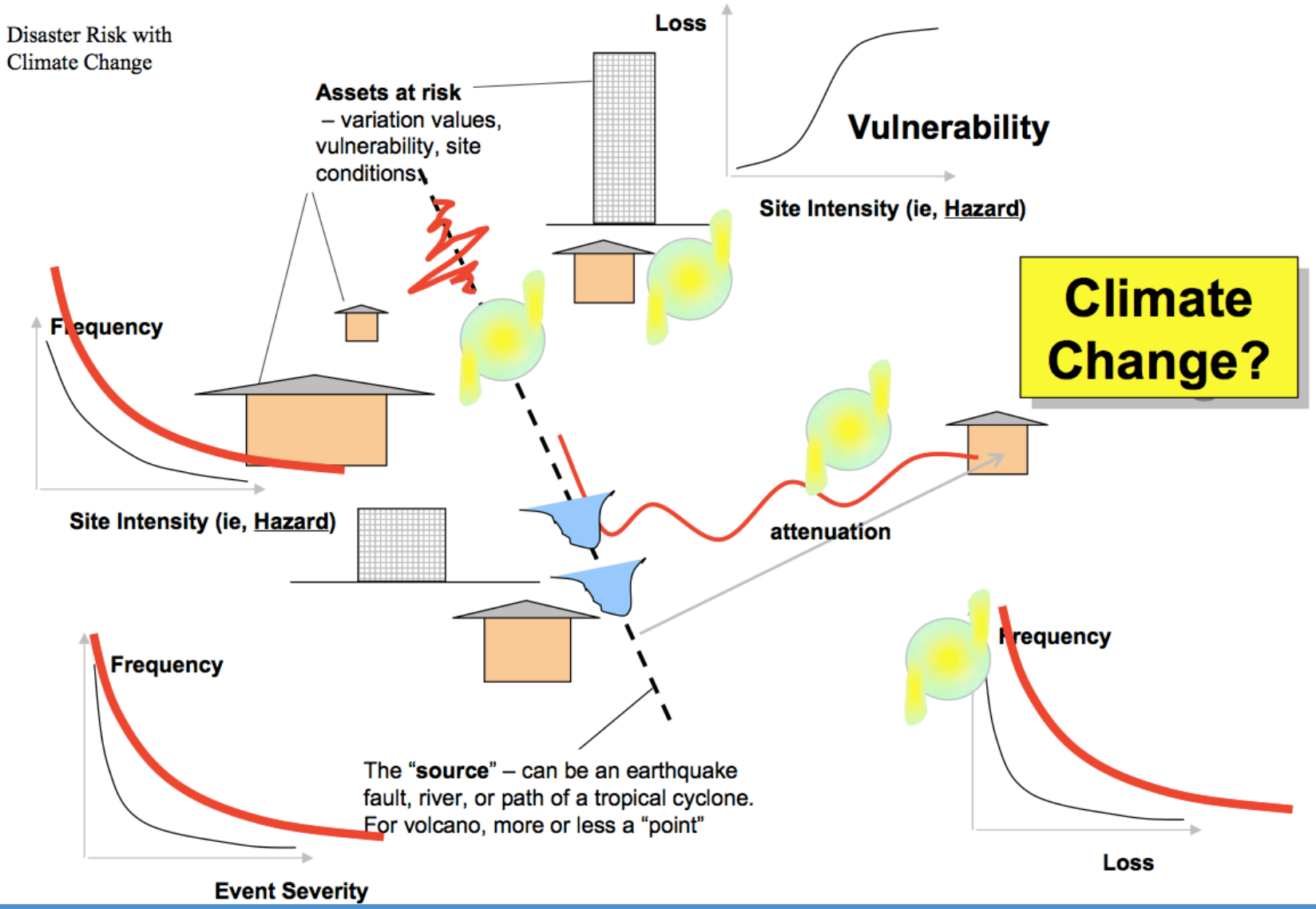
## *Disaster Risk Assessment*




- Currently, more researchers agree on the risk expression of the United Nations ISDR (International Strategy of Disaster Reduction):

  **Risk (R) = hazard factors (H) ×vulnerability (V)**

# Basic Theory of Risk Assessment



# Outline

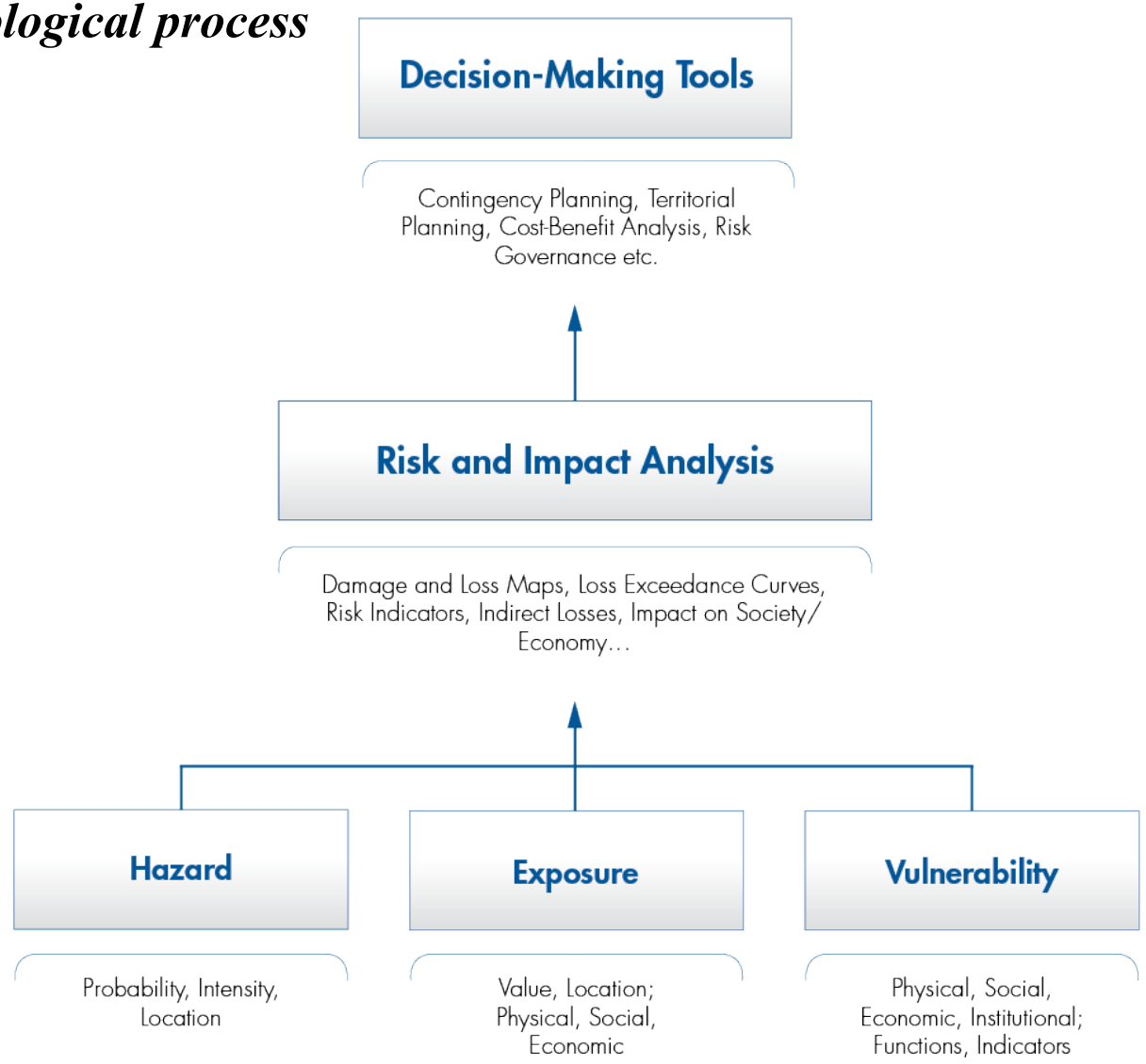
1. Basic Theory of  Risk Assessment

2.  Annual Disaster Risk Assessment of China

3. Discussion

# Annual Disaster Risk Assessment of China

## *Technological process*



# Annual Disaster Risk Assessment of China

## *Important factors*

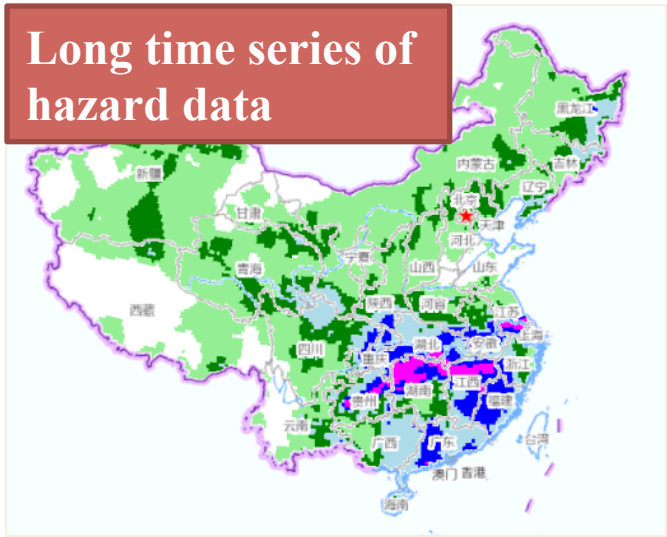

| Stochastic Event Set Module | Hazard Module | Exposure Input | Vulnerability Module | Financial Module |
|---|---|---|---|---|
| Location,<br>Intensity,<br>Rate | Quantification of hazard (hazard parameter footprint) | Exposure geographical distribution,<br>Type, Value | Damage to buildings,<br>Content | Financial implication to the insurer and reinsurer |

# Annual Disaster Risk Assessment of China

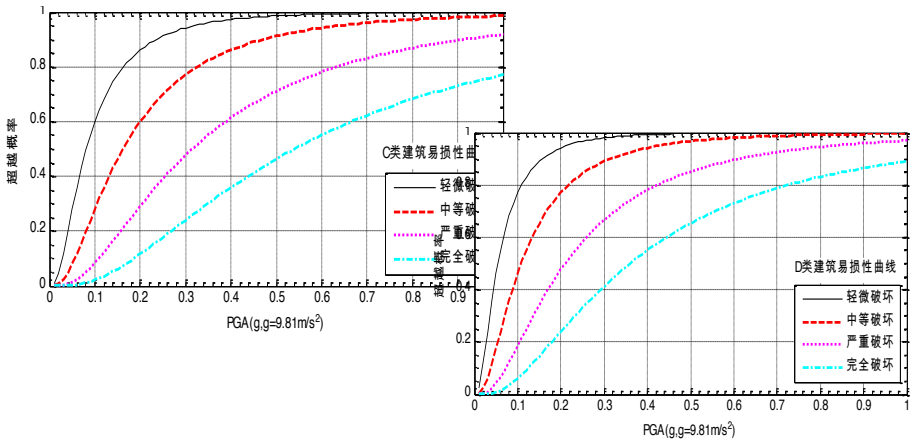
**Long time series of historical disaster loss data**

| | | | | | | 死亡失踪人口 | 紧急转移安置人口 | 饮水困难人口 | 农作物受灾面积 | 农作物绝收面积 | 倒塌房屋间数 | 损坏房屋数量 | 直接经济损失 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 125.0 | 1297.5 | 252.0 | | | 42.0 |
| | | | | | | | | 142.0 | 1013.8 | 83.0 | | | 43.0 |
| | | | | | | | | 112.0 | 3183.6 | 798.0 | | | 127.0 |
| | | | | | | 26 | 9.0 | | 86.7 | | 2.3 | 3.9 | 24.7 |
| | | | | | | 3 | 6.4 | | 660.3 | 252.9 | 2.7 | 25.3 | 14.6 |
| 山西省 | 140000 | 2009-8-16 | 旱灾 | 四级提升二级 | 395.5 | | | 51.9 | 578.8 | 115.7 | | | 19.5 |
| 河北省 | 130000 | 2009-11-1 | 低温冷冻和雪灾 | 三级 | 328.4 | 8 | | | 162.7 | | 0.2 | 0.5 | 15.3 |
| 山西省 | 140000 | 2009-11-1 | 低温冷冻和雪灾 | 三级 | 268.7 | 5 | 0.6 | | 73.6 | 18.6 | 2.0 | 2.6 | 32.8 |
| 北京市 | 110000 | 2010-1-13 | 低温冷冻和雪灾 | 四级 | 4.3 | | 0.0 | | 0.7 | 0.1 | 0.0 | 0.0 | 1.4 |
| 天津市 | 120000 | 2010-1-13 | 低温冷冻和雪灾 | 四级 | 0.6 | | 0.0 | | 0.6 | 0.0 | 0.0 | 0.0 | 0.5 |
| 河北省 | 130000 | 2010-1-13 | 低温冷冻和雪灾 | 四级 | 93.3 | | 0.0 | | 86.6 | 2.3 | 0.0 | 0.1 | 4.3 |
| 山西省 | 140000 | 2010-1-13 | 低温冷冻和雪灾 | 四级 | 9.8 | | 0.0 | | 6.7 | 0.0 | 0.0 | 0.0 | 1.5 |
| 内蒙古自治区 | 150000 | 2010-1-13 | 低温冷冻和雪灾 | 四级 | 41.7 | 2 | 0.0 | | 6.2 | 3.1 | 0.0 | 0.0 | 5.4 |

**Long time series of hazard data**

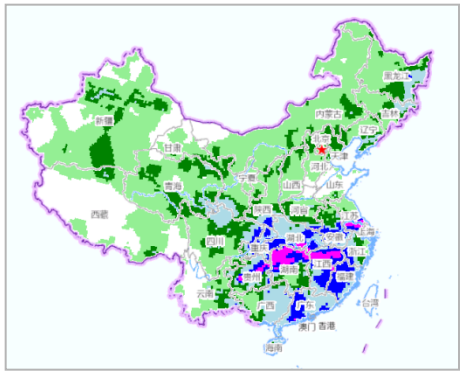


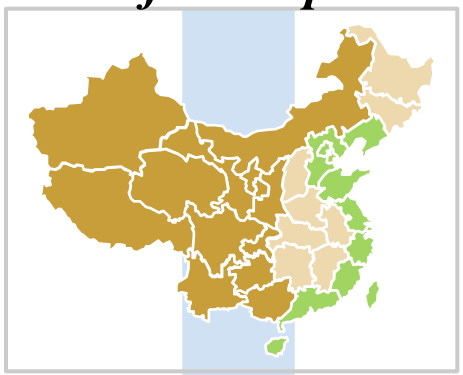

**Vulnerability curve**

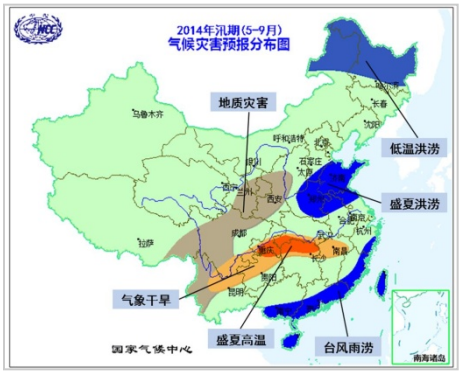


# Annual Disaster Risk Assessment of China

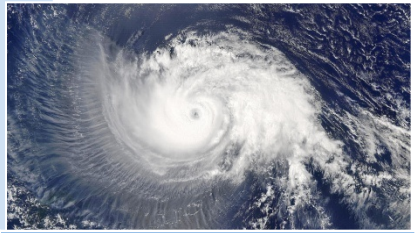
***Disasters risk assessment and final report***








| historical hazard data | historical disaster loss data | early warning information |
|---|---|---|

| earthquake | flood | typhoon | drought |
|---|---|---|---|

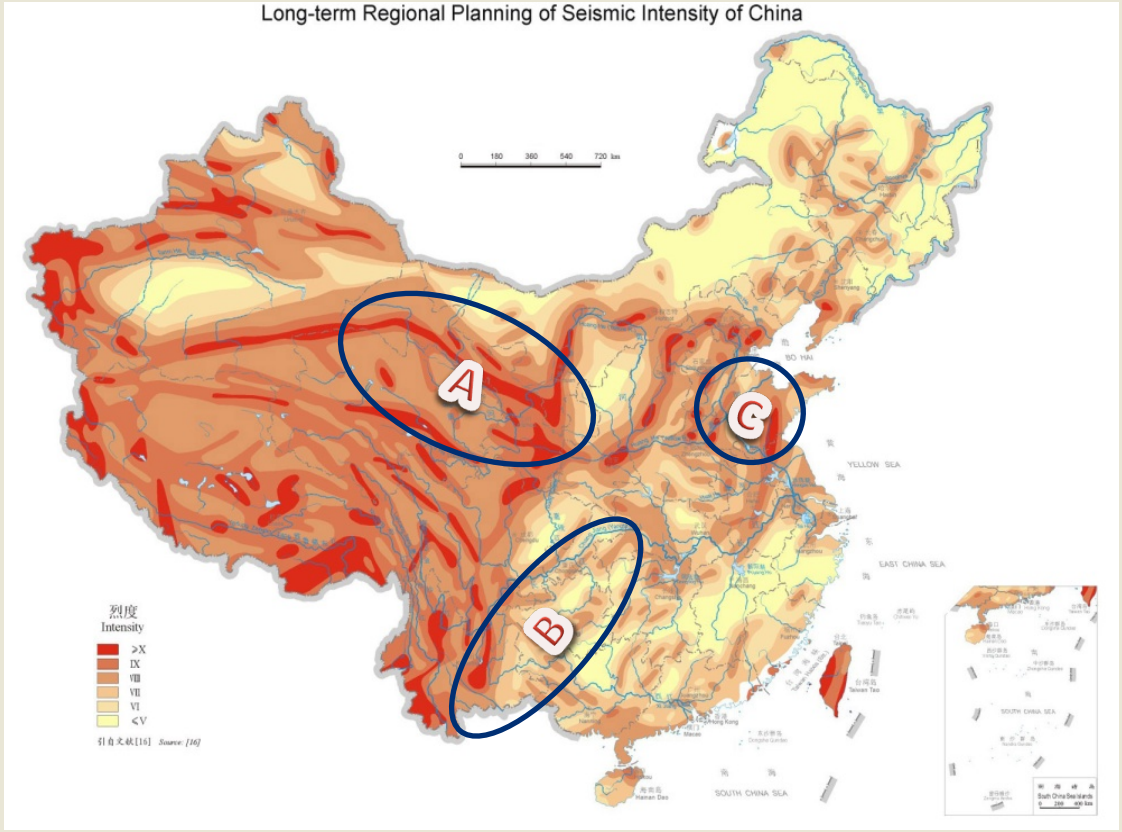
**Assessment of high risk region** → **Loss assessment of different scene**

**National Report** → **Provincial Report**

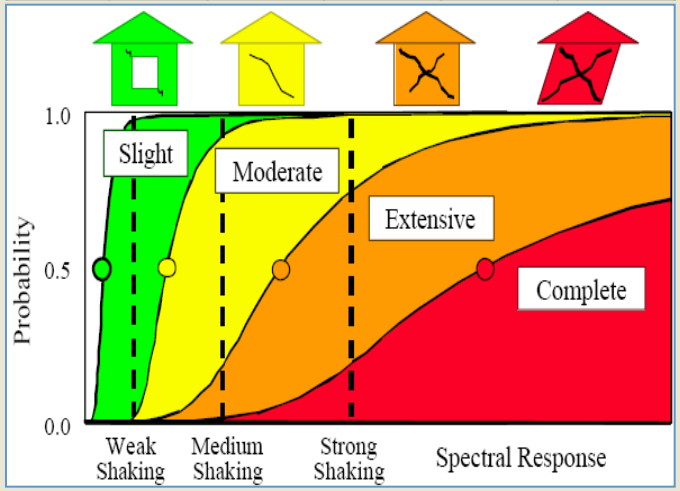
# Annual Disaster Risk Assessment of China

## *Technological process—Earthquake*

**Hazardous region forecast** → **Building damage rate matrix** → **High risk region assessment** → **Possible loss assessment**



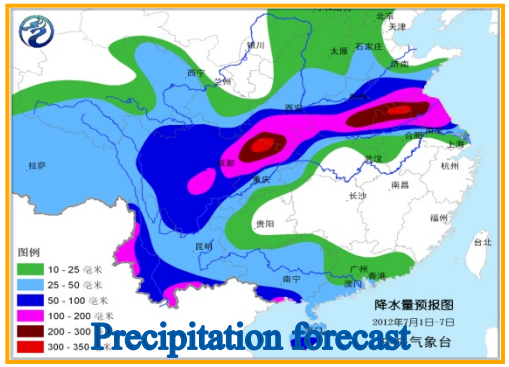

| 烈度 | 基本完好 | 轻微破坏 | 中等破坏 | 严重破坏 | 完全破坏 |
|---|---|---|---|---|---|
| VI | 99.5 | 0.5 | 0.0 | 0.0 | 0.0 |
| VII | 95.0 | 4.4 | 0.5 | 0.1 | 0.0 |
| VIII | 80.0 | 15.0 | 4.3 | 0.65 | 0.05 |
| IX | 52.0 | 28 .5 | 14.5 | 4.4 | 0.6 |
| X | 25.0 | 31.0 | 27.5 | 13.0 | 3.5 |



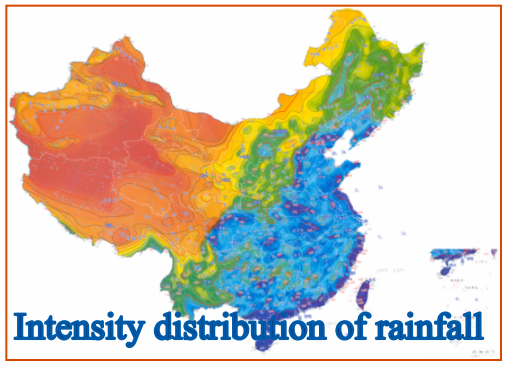
# Annual Disaster Risk Assessment of China

*Technological process—Flood*

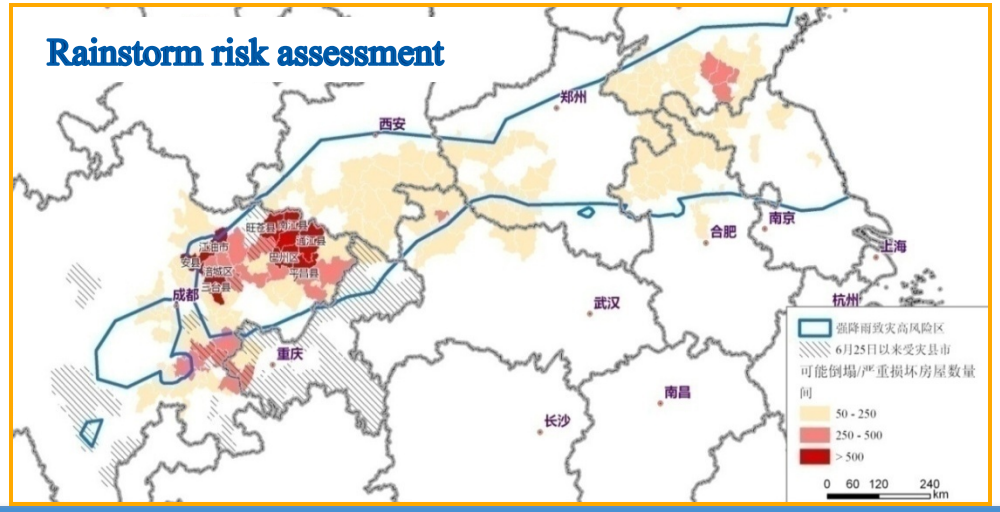
**Precipitation forecast information** → **Rivers distribution** → **High risk region assessment** → **Possible loss assessment**



Precipitation forecast


Intensity distribution of rainfall


Basin and rivers




**Results of risk assessment**

| 省/市 | 可能倒塌和严重损坏房屋/间 |
|---|---|
| 江苏 | 990 |
| 安徽 | 1895 |
| 山东 | 4601 |
| 河南 | 1399 |
| 湖北 | 2202 |
| | …… |

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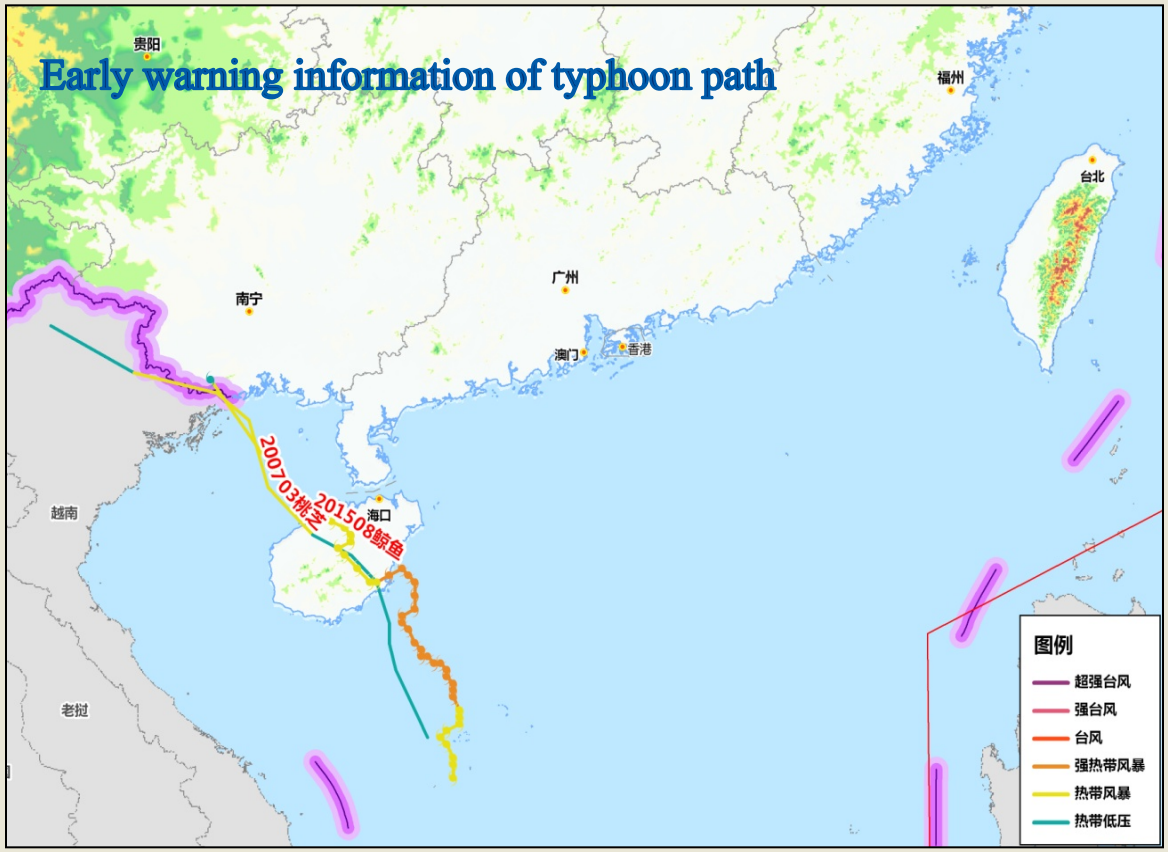
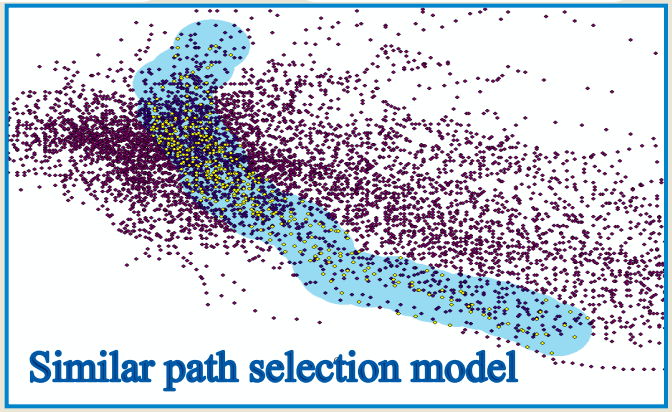
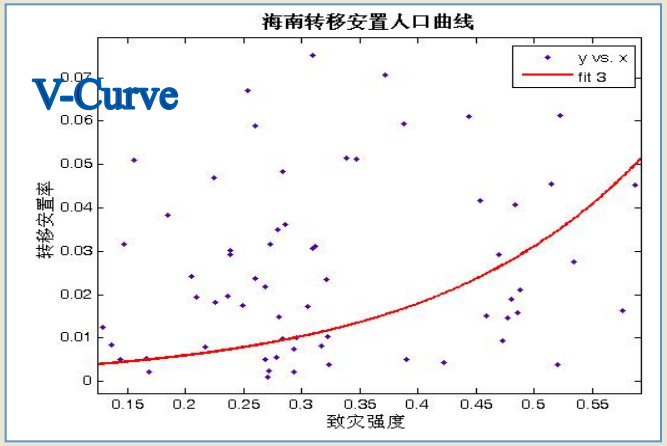
# Annual Disaster Risk Assessment of China

*Technological process—Typhoon*

Early warning information of typhoon → Select similar path in database → High risk region assessment → Possible loss assessment



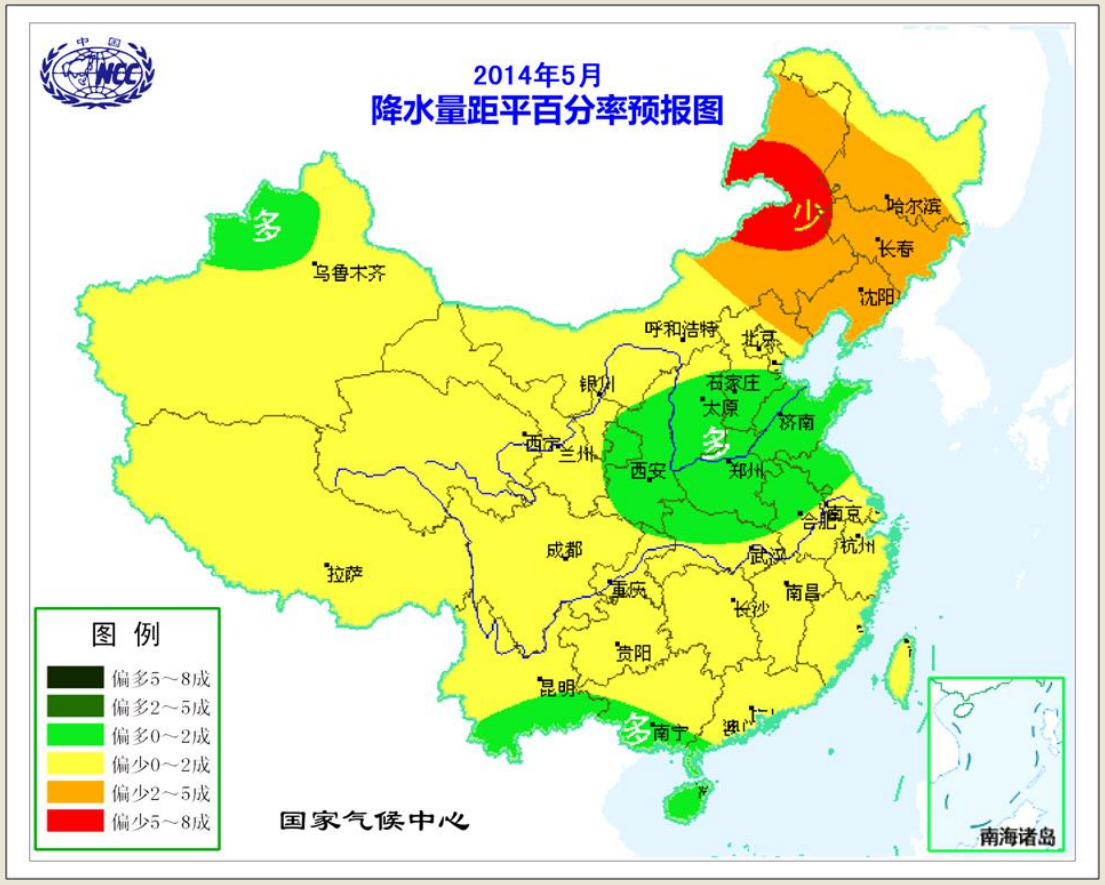



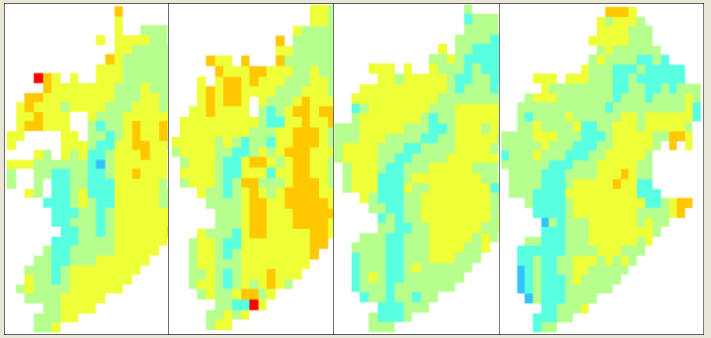



# Annual Disaster Risk Assessment of China

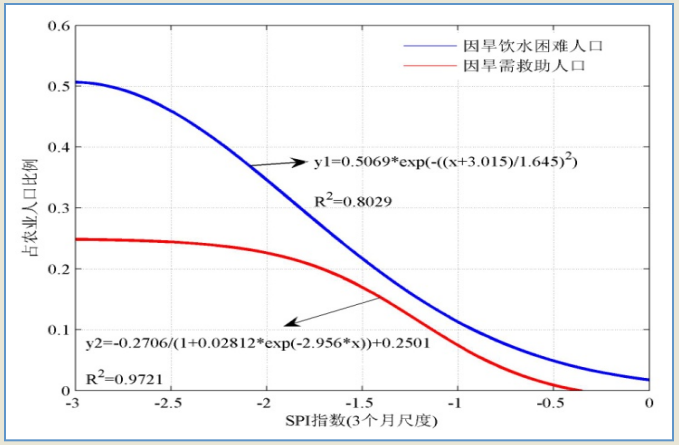
*Technological process—Drought*

**Precipitation forecast information** → **Different scenarios** → **High risk region assessment** → **Possible loss assessment**



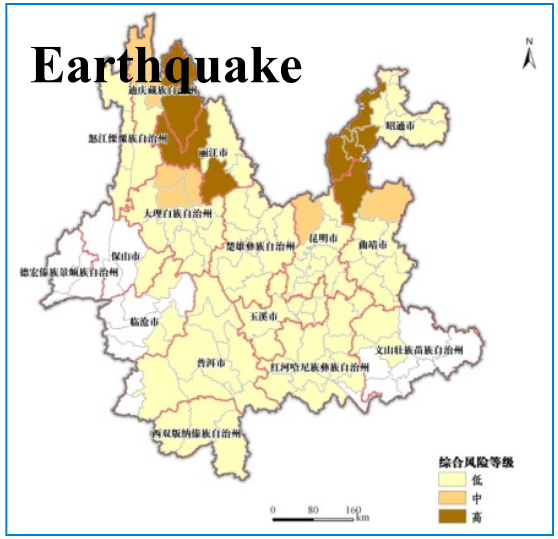



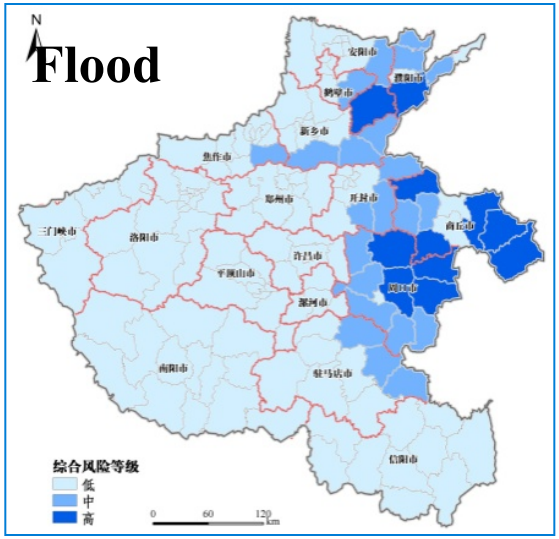
**Precipitation in different scenarios**

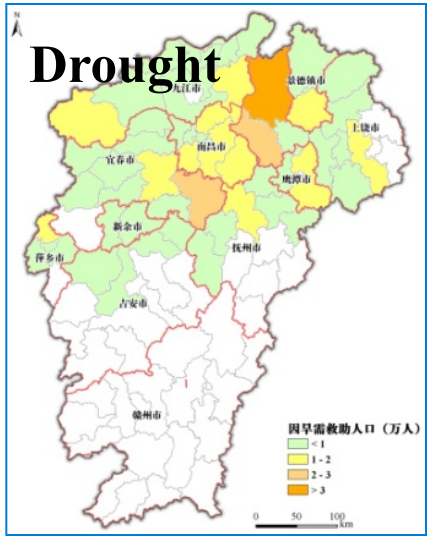


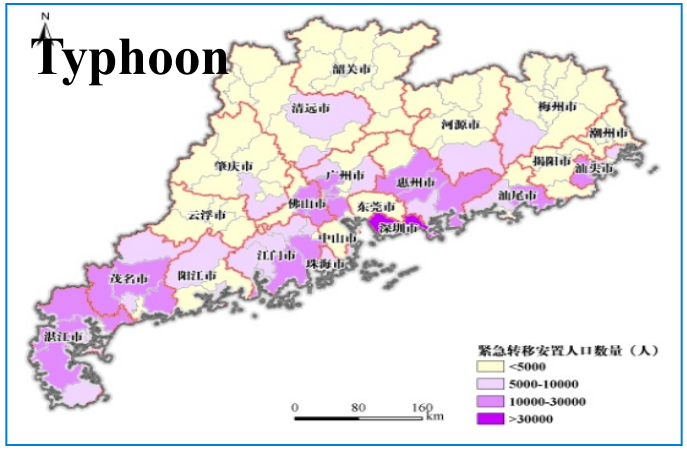
# Annual Disaster Risk Assessment of China

## *Visual expression*



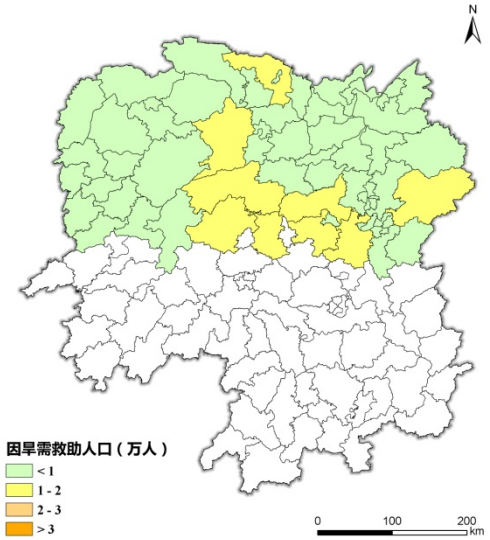



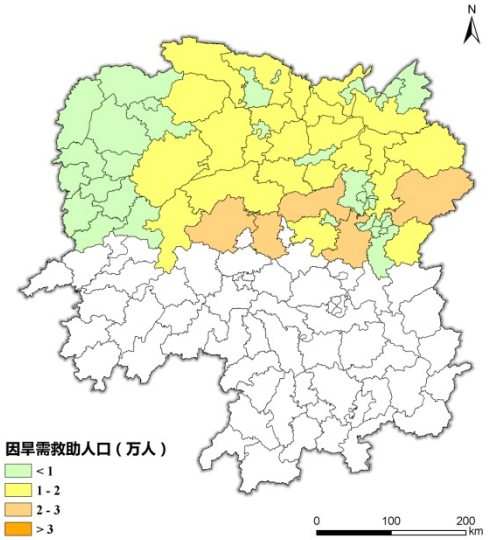



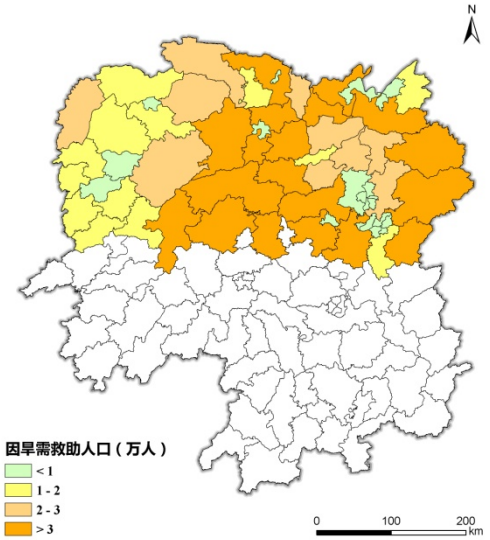

| 可能受灾省（区、市） | 模拟震级 | 不同损失的可能性（根据倒塌及严重损坏房屋数量判断） | | | | |
|---|---|---|---|---|---|---|
| | | <0.2 | 0.2-0.5 | 0.5-1.0 | 1.0-5.0 | >=5.0 |
| 列2 | 列3 | 列4 | 列5 | 列6 | 列7 | 列8 |
| 四川 | 6.0 | 100% | 0% | 0% | 0% | 0% |
| | 6.5 | 94% | 6% | 0% | 0% | 0% |
| | 7.0 | 75% | 6% | 14% | 6% | 0% |
| | 汇总 | 90% | 4% | 5% | 2% | 0% |
| 陕西 | 6.0 | 100% | 0% | 0% | 0% | 0% |
| | 6.5 | 100% | 0% | 0% | 0% | 0% |
| | 7.0 | 89% | 6% | 6% | 0% | 0% |
| | 汇总 | 96% | 2% | 2% | 0% | 0% |
| 甘肃 | 6.0 | 44% | 0% | 17% | 39% | 0% |
| | 6.5 | 28% | 8% | 8% | 19% | 36% |
| | 7.0 | 14% | 6% | 6% | 19% | 56% |

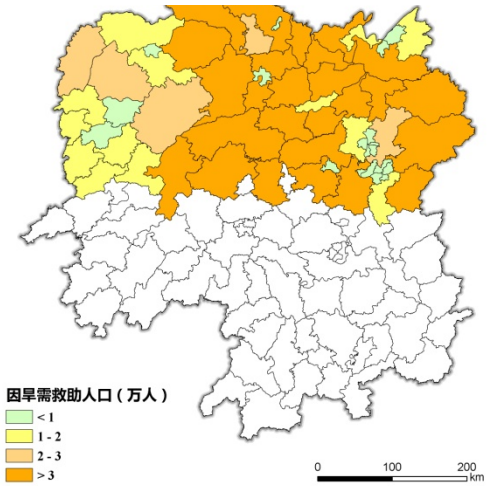
# Annual Disaster Risk Assessment of China

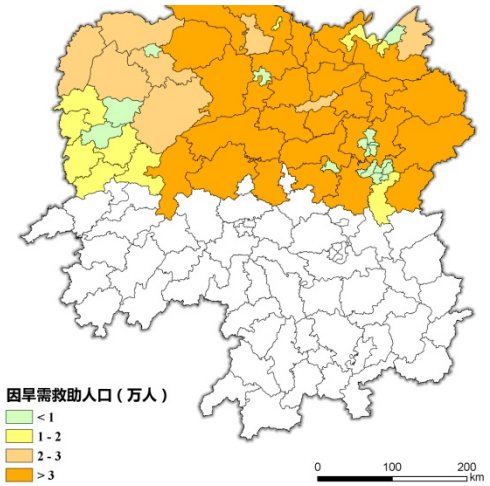
## *Drought risk assessment in different hazard level*



# Outline

1. Basic Theory of  Risk Assessment

2.  Annual Disaster Risk Assessment of China

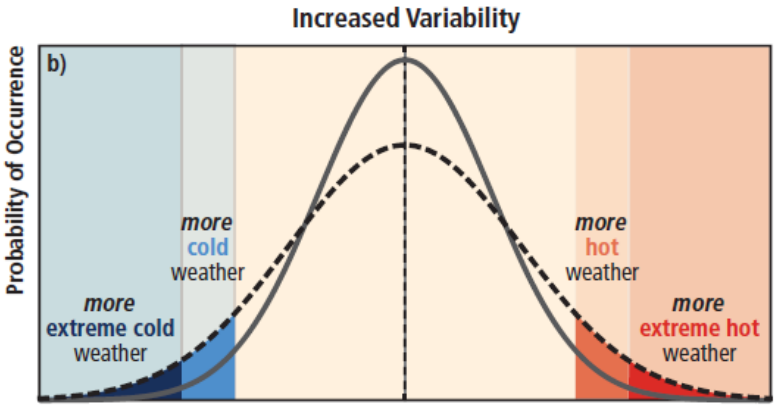
**3. Discussion**

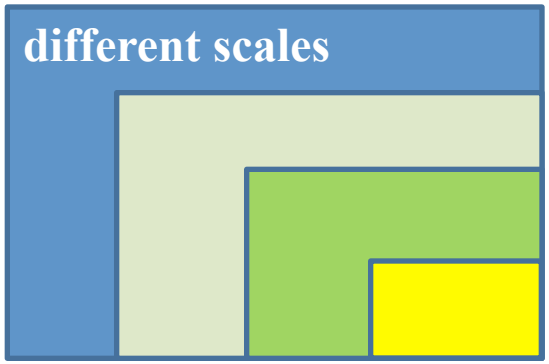
# Discussion

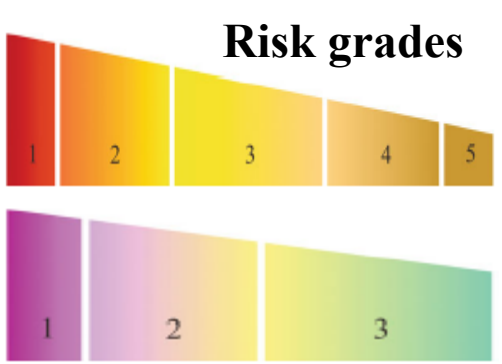
**1. Results of risk assessment is uncertainty based on the early warning information at the beginning of the year .**

**2. The results is difficult to meet the needs of different scales（Province-City-County-Town-Village）.**

**3. The division of risk grades is lack of uniform standards.**



# Thanks for your attention!

NDRCC