Integrated Risk Governance Under Global Change
– Case: Experiences and Lessons from the Freezing Rain and Snowstorm Disaster in China during the Early 2008

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Flood Disaster Risk

Flood in Yangtze River Basin of China in Summer & Autumn, 1998
Flood Risk
Drought Disaster Risk

Severe Drought in ChongQing, China, August, 2006
Dust Risk
Increasing trend of high intensity rains in the USA

Rains more than 30 mm in Germany

Source: Wetterstation Hohenpeißenberg
Frequency: higher intensity rainfalls all over Japan

Hourly rainfall > 60 mm
- Average: 6.7 times/year
- 1976-1985
- 1986-1995
- 1996-

Hourly rainfall > 100 mm
- Average: 2.3 times/year
- 1976-1985
- 1986-1995
- 1996-
Surface Temperature Change and Main Disaster Numbers

- CRUTEM3
- NCDC
- GISS
- Lugina et al. 2005

- Earthquake, tsunami, volcano eruption
- Windstorm
- Flood
- Temperature extremes (e.g. heatwave, drought, wildfire)
Surface Temperature Change and Disaster Losses

The graph shows the difference in temperature from 1881-1980, with various datasets represented by different lines. The vertical axis measures the difference in temperature, while the horizontal axis represents years from 1950 to 2009. The datasets include CRUTEM3, NCDC, GISS, and Lugina et al. 2005.

The lower part of the graph tracks disaster losses from 1950 to 2009, measured in US$ billion. It includes overall losses (in 2000 values), insured losses (in 2006 values), and trends for both overall and insured losses.
Contents

- Introduction
- Integrated Large-scale Disaster Risk Governance
- Case: the freezing rain and snow disaster in China during the early 2008
I Introduction
The System School - Disaster chains

Typhoon-storm disaster chain
The System School - Disaster chains

Cold wave – wind disaster chain
The System School - Disaster chains

Drought disaster chain
II Integrated Large-scale Disaster Risk Governance
IRG - What should be integrated?

Introducing the notion of independent dimensions of Multi-stakeholder, Multi-action, and Multi-phase activities

Three Dimensional Paradigm of IRG
IRG – How to integrate?

Conferences, forums and workshops—“Brainstorming”
- IDRC
- WCDR
- IRGC
- IIASA-DPRI

Information sharing network
- Global Platform for Disaster Risk Reduction (GP/DRR, UN/ISDR)
- DRH-Asian (Japan)
- Integrated Risk Governance Network (iRiskNet|IRG-China)

Integrated Risk Maps
- Hotspots of Global Disaster Risk (UNDP&WB)
- The national first generation integrated risk map in China

Modeling and Simulation
- Alliance for Global Open Risk Analysis (Japan)
- System for System (Old Dominion Univ., US)
- Integrated Risk Governance Simulation and Dynamics (BNU, China)
Disaster Risk Science

- **Disaster Science:**
  - Formation Mechanism of DS
  - Change Process of DS
  - Disaster Reduction Countermeasure

- **Emergency Technology:**
  - Contingency Plan
  - Contingency Action
  - Contingency Command

- **Risk Management:**
  - Risk Identification
  - Risk Classification
  - Risk Assessment
  - Modeling
  - Response
  - Adaptation
In view of research to practice, integrate the regional disaster risk management and sustainable development. Improve global and regional society response strategy and policy to catastrophe risk, provide operational assessment tools.
In view of the inter-disciplinary (natural sciences, social sciences and human sciences, technology and engineering, management), go deep in exploring approaches for transfer of catastrophe risks.
Integrated Disaster Reduction

Safety Construction  
Disaster Relief

Integrated Disaster Reduction

Emergency Management  
Risk Governance
III Case: the freezing rain and snow disaster in China during the early 2008
3.1 Hazards
3.2 Disaster Loss
3.3 Response
3.4 Lessons and Experiences
3.1 Hazards \( \rightarrow \) Precipitation (Jan. 10 ~ Feb.2)

The precipitation in heavy rain/snow areas amounts to: 50-250mm/event

Freezing rain area (in red)
Hazards → Snowing-Day Anomaly

10-12 days longer than mean annual snowing days
Hazards → Temperature Anomaly (Jan.10~ Feb.2)

Temperature Anomaly (Jan.10~ Feb.2):

- Anomaly in Northwestern & Central China: minus 2-4°C
- Anomaly in parts of Hubei, Hunan, Guizhou, Guangxi, Gansu & Ningxia: greater than minus -4°C
- Anomaly in Tibet: 1-4°C
Annual continuous freezing days along the middle stream and downstream of Yangtze River (including Hunan, Hubei, Jiangxi Anhui, Shanghai, Jiangsu and Guizhou)

Note: data for year 2007-2008 is from Dec.1 2007 to Feb.2, 2008
The mean and maximum daily temperature of the middle and downstream of Yangtze River (including Hunan, Hubei, Jiangxi, Anhui, Shanghai, Jiangsu provinces) and Guizhou.

Note: data range Jan.10 ~ Feb.1
Hazards → Dramatic Temperature Decrease from Jan.10 to Feb.2

- Mean temperature decreased 10-20°C in the middle and downstream of the Yangtze River.
- Temperature dropped to -6~0°C in the middle and downstream of the Yangtze River.
- Diurnal temperature range (DTN) was very small or near to zero.
<table>
<thead>
<tr>
<th>Hazards</th>
<th>Four weather events: Jan.10<del>Jan16; Jan. 18</del>Jan.22; Jan.25<del>Jan.29; Jan.31</del>Feb.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Features</td>
<td>● <strong>Large Impacted Area</strong>: around 1.3 million km² were affected;</td>
</tr>
<tr>
<td></td>
<td>● <strong>High Intensity</strong>: return period ranging from 50 yrs in most areas and</td>
</tr>
<tr>
<td></td>
<td>100 yrs in some areas;</td>
</tr>
<tr>
<td></td>
<td>● <strong>Long Duration Time</strong>: 4 continuous weather events lasted over 20 days.</td>
</tr>
</tbody>
</table>
## Disaster loss

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casualty</td>
<td>129 people</td>
</tr>
<tr>
<td>Missing</td>
<td>4 people</td>
</tr>
<tr>
<td>Relocated Population</td>
<td>1.66 million</td>
</tr>
<tr>
<td>Impacted Crop area</td>
<td>11,874.2 kha</td>
</tr>
<tr>
<td>Collapsed house</td>
<td>0.485 million rooms</td>
</tr>
<tr>
<td>Damaged house</td>
<td>1.686 million rooms</td>
</tr>
<tr>
<td>Direct Economic Loss</td>
<td>151.65 billion RMB</td>
</tr>
</tbody>
</table>
## Disaster Losses

<table>
<thead>
<tr>
<th>Province (City)</th>
<th>Impacted Pop (k person)</th>
<th>Death (person)</th>
<th>Missing (person)</th>
<th>Displaced Pop (k person)</th>
<th>Affected crops (kha)</th>
<th>Destroyed crops (kha)</th>
<th>Collapsed bldg (k rooms)</th>
<th>Damaged bldg (k rooms)</th>
<th>Direct Economic Loss (billion RMB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shanghai</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>10.7</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
<td>0.16</td>
</tr>
<tr>
<td>Jiang Su</td>
<td>2453.</td>
<td>7</td>
<td>-</td>
<td>21</td>
<td>232.4</td>
<td>12.0</td>
<td>9.0</td>
<td>17.0</td>
<td>2.78</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>23819.</td>
<td>9</td>
<td>-</td>
<td>136</td>
<td>832.9</td>
<td>40.8</td>
<td>4.0</td>
<td>0.0</td>
<td>17.43</td>
</tr>
<tr>
<td>Anhui</td>
<td>13423.</td>
<td>12</td>
<td>-</td>
<td>131</td>
<td>695.3</td>
<td>63.6</td>
<td>91.0</td>
<td>173.0</td>
<td>13.23</td>
</tr>
<tr>
<td>Fujian</td>
<td>1676.</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>32.8</td>
<td>1.2</td>
<td>1.0</td>
<td>213.0</td>
<td>3.09</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>22100.</td>
<td>7</td>
<td>-</td>
<td>226</td>
<td>1468.0</td>
<td>353.0</td>
<td>42.0</td>
<td>231.0</td>
<td>27.20</td>
</tr>
<tr>
<td>Henan</td>
<td>941.</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>139.4</td>
<td>2.7</td>
<td>3.0</td>
<td>6.0</td>
<td>0.68</td>
</tr>
<tr>
<td>Hubei</td>
<td>22798.</td>
<td>13</td>
<td>-</td>
<td>217</td>
<td>1417.7</td>
<td>112.0</td>
<td>98.0</td>
<td>170.0</td>
<td>11.42</td>
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<tr>
<td>Hunan</td>
<td>39277.</td>
<td>20</td>
<td>-</td>
<td>277</td>
<td>2500.1</td>
<td>458.7</td>
<td>67.0</td>
<td>300.0</td>
<td>17.20</td>
</tr>
<tr>
<td>Guangdong</td>
<td>4190.</td>
<td>-</td>
<td>-</td>
<td>290</td>
<td>414.7</td>
<td>21.2</td>
<td>2.0</td>
<td>1.0</td>
<td>3.36</td>
</tr>
<tr>
<td>Guangxi</td>
<td>13990.</td>
<td>2</td>
<td>-</td>
<td>58</td>
<td>861.1</td>
<td>49.1</td>
<td>59.0</td>
<td>72.0</td>
<td>20.00</td>
</tr>
<tr>
<td>Chongqing</td>
<td>5486.</td>
<td>2</td>
<td>-</td>
<td>6</td>
<td>246.3</td>
<td>27.7</td>
<td>3.0</td>
<td>14.0</td>
<td>0.96</td>
</tr>
<tr>
<td>Sichuan</td>
<td>10599.</td>
<td>5</td>
<td>-</td>
<td>45</td>
<td>535.6</td>
<td>54.0</td>
<td>21.0</td>
<td>88.0</td>
<td>5.83</td>
</tr>
<tr>
<td>Guizhou</td>
<td>26548.</td>
<td>27</td>
<td>-</td>
<td>112</td>
<td>1489.7</td>
<td>317.5</td>
<td>31.0</td>
<td>128.0</td>
<td>19.83</td>
</tr>
<tr>
<td>Yunnan</td>
<td>11396.</td>
<td>22</td>
<td>4</td>
<td>110</td>
<td>590.9</td>
<td>110.7</td>
<td>39.0</td>
<td>197.0</td>
<td>5.08</td>
</tr>
<tr>
<td>Shannxi</td>
<td>1850.</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>253.3</td>
<td>20.0</td>
<td>4.0</td>
<td>9.0</td>
<td>0.46</td>
</tr>
<tr>
<td>Gansu</td>
<td>4480.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>135.8</td>
<td>45.3</td>
<td>4.0</td>
<td>33.0</td>
<td>1.78</td>
</tr>
<tr>
<td>Qinghai</td>
<td>705.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0</td>
<td>0.0</td>
<td>5.0</td>
<td>14.0</td>
<td>0.42</td>
</tr>
<tr>
<td>Ningxia</td>
<td>1166.</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>10.8</td>
<td>1.1</td>
<td>3.0</td>
<td>9.0</td>
<td>0.47</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>378.</td>
<td>1</td>
<td>-</td>
<td>6.7</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>10.0</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td><strong>207275.</strong></td>
<td><strong>129</strong></td>
<td><strong>4</strong></td>
<td><strong>1660</strong></td>
<td><strong>11874.2</strong></td>
<td><strong>1690.6</strong></td>
<td><strong>485</strong></td>
<td><strong>1686</strong></td>
<td><strong>151.65</strong></td>
</tr>
</tbody>
</table>
## Disaster Loss → A closer look

### Impacted Areas
- Chongqing, Sichuan, Shanghai, Guangdong, Fujian, Yunan, Henan, Gansu, Qinghai, Shannxi, Tibet, Shanxi, Jiangsu, Xinjiang *(less impacted provinces)*

### Indirect Impacts
- **Railway**: Jingguang (Beijing~Guangdong) Railway partially stopped functioning;
- **Highway**: Jingzhu (Beijing~Zhuhai) highway partially stopped functioning; many national roads were influenced or closed temporarily;
- **Airport**: dozens of them were closed for several days or temporarily;
- **Power**: 6700 power lines failed and about 90 counties were influenced;
- **Communication**: More than 3000 wireless base station failed to work;
- **Urban Infrastructure**: Partially failed to work and some towns/cities experienced power failure longer than 10 days;
- **Induced disasters**: geo-disasters; pollution, agro-eco system damages; Sanity/health related disasters; infrastructure damages;
- **Other Life lines and production lines**: seriously influenced.
Transportation—Highway & Road
Transportation —Railway
Disaster Loss → Gallery

Transportation—Flight
Disaster Loss ➔ Gallery

Electricity—Power line
Disaster Loss → Gallery

Electricity—Power line
Communication—Wireless base station
Disaster Loss ➔ Gallery

Agriculture—Vegetable, grain, forest
Disaster Loss ➔ Why?
A. hazards beyond temperature and precipitation:
   Amplified low temperature

- Temperature decreases along with the increase of elevation
- Disaster took place in low mountainous areas and plateau area, especially in Yungui Plateau and Nanling Area
  - Altitude > 300-500m
- Chenzhou City in Hunan
  - Most area: elevation > 300m
  - 30% of area: elevation > 500m
  - Temperature: -2.0°C --8.0 °C
Disaster Loss → Why? A. hazards beyond temperature and precipitation: Extremely Low wind speed

- Snow was accumulated due to low wind speed
- Some ground wind speed numbers in Chenzhou Area
  - Critical wind speed: $5\text{m/s}$
  - Daily mean wind speed $<1.8\text{m/s}$
    - Daily mean maximum wind speed $<3.5\text{m/s}$ (Observed by Yizhang weather station in Hunan)
  - Mean relative humidity $>75\%$
    - Mean relative humidity $>80\%$ in the last two weather process
Disaster Loss — Why? A. hazards beyond temperature and precipitation:
Very high humidity

- Snow/Ice difficult to evaporate due to high humidity
Disaster Loss → Why? A. hazards beyond temperature and precipitation: Multiple Events

Four weather events in Chenzhou of Hunan Province (ice/snow thickness → 40cm)
Disaster Loss → Why?

B. Vulnerability and Resilience

- **Social Dimension**: lack of insurance consciousness, good in-disaster action ability
- **Economic Dimension**: Mountainous areas (economy less-developed areas) are more vulnerable; Some more developed areas like are more resilient areas
- **Organizational dimension**: Inefficient communication among central government, local governments and sectors (ministries), strong support from governments and PLA
- **Technical dimension**: Lack of disaster mitigation infrastructures & capacity (electricity, transportation, communication & materials), provincial level cooperation may help increase mitigation capacity
- **Natural dimension**: land and agricultural system recoverability, influenced by agriculture cultivation system, crop types, land use structure and intensity, etc.
C. Disaster Chain

0. Extreme weather events

1. Natural disaster: Low temperature–rainfall and snowfall–freezing

2. Production Accidents: Power off–water shortage–traffic jam–airport shutdown

3. Social security: Station overcrowded–passengers stranded


-Not just a natural extreme weather event-
Disaster Loss → Why?

D. Perspective of Disaster System
3.3 Response → Response of Central Government/State Council

Jan. 27: Tele-conference of disaster coping;
Jan. 29: Meeting of the Central Committee of the C.P.C.;
Jan. 29: Establishing emergency response working group for Hunan
Jan. 31: Establishing emergency response and command center for coal /electricity/oil supplement and transportation;
Feb. 01: State Council Meeting;
Feb. 03: Standing meeting of the Central Committee of the C.P.C.

To coordinate the collaboration among sectors and provinces

Targets: To ensure transportation, power supply & residents’ living
Response → Response of Governmental Sectors & State Companies

- **China Meteorological Administration**
  - Jan.25: Class-III emergency response;
  - Jan.27: Class-II emergency response;
  - Feb.06: Emergency response stopped;

- **Ministry of Civil Affairs**
  - Jan.26: Class IV Response;
  - Jan.29: Class-II emergency response;

- **National Development and Reform Commission**
  - Jan.27: Initiated Emergency Coordination Mechanism to ensure coal, oil, power supplement and transportation;

- **Ministry of Railways/Ministry of Transportation/Central Administration of Aviation**
  - Jan.27: Emergency meeting on transportation; flight companies started their Spring Festival Plan;

- **State Electricity Regulatory Commission/State Administration of Work Safety/State Grid Corporation**
  - Jan.27: Electricity and Coal Supplement conference;

- **PLA & Military Police**
  - Jan.30: Join to fight FRSC2000;

- **Ministry of Education**
  - Jan.30: Issued emergency notice about FRSC2008;
  - Feb.02: Issued emergency notice and counter measures about FRSC2008
Response ➔ Response of Local Governments/Social System

- Local Governments
  - Hunan Province
    Jan.26: Establishing FRSD Coping working ground and command center
  - Jiangxi Province
    Jan.26: Freezing and snowstorm plan was started;
  - Anhui Province
    Jan.26: Change Class III emergency response to Class IV
  - Guangxi Province
    Jan.26: Change Class II emergency response

- Social System
  - Donation and Volunteer (Domestic and international), ~
    Feb.07, 1.02 billion + RMB was donated
Response → Disaster Relief Materials

● Ministry of Civil Affairs
  ~ Feb.09: 0.525 billion RMB (0.331 billion for emergency response & rest for recovery and reconstruction)

● State Development and Reform Commission
  Issued 16 emergency announcement, covering coal, electricity, oil, transportation, disaster relief, agriculture, forestry, environments, geology, infrastructure, public sanity, etc.

● PLA
  ~ Feb.05: PLA 0.594 million people * time; Reserve Army 1.832 million people * time; vehicles 34,000; Airplan 84 times;

● State Insurance Regulatory Commission
  ~ Feb.09, 1 billion + RMB was claimed (less than 5%);

● Donation
  ~ Feb.07, 1.02 billion + RMB was donated
Response ➔ Gallery

Emergency Response
3.4 Lessons/experiences → Science

Science for the understanding of hazards

Climate and weather system modeling, mid-term & short-term forecast; early warning;

- Weather forecast techs to be improved scientifically, esp. meso-scale models
- Transforming from weather event forecast/alarm to natural disaster warning

Science for integrated risk governance

- For example: land-use regulation: risk modeling → risk zone mapping → land-use regulation → restraining land-use in high-risk areas;
Lessons/experiences → Science
Integrated disaster Risk Governance

Integrated Risk Governance

- Global Environmental Change
- Globalization & Localization
- Energy & Water
- Food Provision
- Technology & Market
- Public Security

Risk

- Identification
- Assessment
- Simulation
- Response
- Adaptation
Emergency Technical Plan

Current emergency plan: the main contents of the 4-level emergency plan of China is to administratively regulate the responsibility and actions of government officials.

Scenario simulation: no technical emergency plan based on risk modeling, large-scale disaster scenario simulation, or disaster chain simulation.
Lessons/experiences → Technology

Material/resources storage/planning

- no technical plan → no disaster mitigation
- materials/resources prepared in advance

For FRSD2008: no/lack of power generator, candle, machine for removing snow/ice in highway
Infrastructure standards

Spatial planning and standard: trade-off between cost-benefit (for example: improve standard of electricity power tower and power line after FRSD2008)

Centralize V.S. Decentralize: centralized to economically decrease infrastructure cost, and decentralize to decrease vulnerability and improve resilience
Lessons/experiences → Technology

Information integration and sharing:
platform and communication infrastructure

Catastrophe Risk modeling:

Lack of catastrophe modeling system based on Chinese disaster loss (like HAZUS in the U.S.)

International commercial catastrophe models (like RMS, AIR and EQE) are black boxes and their parameters are not open
Policy making based on experts knowledge

Roles of experts and policy makers: experts to provide information, policy-makers to balance the interests of different groups of people

Risk uncertainty: listening to different experts and weighting on different opinions, to have a self-learning mechanism
Policy making based on experts knowledge

Roles of experts and policy makers: experts to provide information, policy-makers to balance the interests of different groups of people

Risk uncertainty: listening to different experts and weighting on different opinions, to have a self-learning mechanism
Lessons/experiences → Management/Institution/Legal System

Inter-sector coordination:

Lack of a powerful permanent inter-ministry level commanding and coordination sector, though state council has a office/sector to coordinate ministries

Current practice: temporary inter-ministry level working group to be established after disaster happens (usually it is already too late)

For FRSD2008: the COAL-Electricity-Oil-Transport working group was organized after the third event)
Emergency Plan Triggering

Level I Emergency plan should have been triggered during FRSD2008

Ministry-local government coordination

Ministries are fiscally supported by central government; incentives/motivations to serve local government?
Centralized government and de-centralized governments

Centralized government: once motivated, more powerful and prompt disaster mitigation and recovery actions, and usually based on a large mitigation or recovery cost

Decentralized government: better cost-benefit balance
Lessons/experiences → Risk Transfer

**System design:**

to design a system to balance the interests of property owners, insurers, re-insurers and capital market

**Coverage rate:**

only 1~1.5% of the total FRSD2008 loss was covered (for Katrina Hurricane larger than 40%)
Lessons/experiences → Risk Transfer
The large-scale catastrophe insurance mode

Disaster risk sharing mechanism according to disaster intensity
Central government and ministry/experts

Efficiency: temporal center

Misunderstanding: hazard and disaster impact → concepts of vulnerability resilience should be promoted

Lesson learned: underestimated the impact of FRSD2008, overestimated the capacity of infrastructure system (esp. transportation and electricity) → announced the recovery of infrastructure too early
Lessons/experiences \(\rightarrow\) Risk Communication

Local governments and ministry/experts:

- Responsibility, obligation

Trust between public and authority:

- Good or not? Problem of over-trusting
Communication Techs

TV: Public may not trust TV

Mobile phone: group message compulsorily, larger group of users: over 500 million users and still increasing very fast

Internet: information inaccurate, public may not trust; Failure of communication techs
Lessons/experiences ➔ Social capital

**Chinese culture**
Family-orientated, helping relatives and neighbors

**Local community**
Volunteers

**Internet Community**
Risk communication and volunteers
Thank you for your attention!