Theory and Practice of Annual Natural Disaster Risk Assessment

Donghua PAN
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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

- Sustainable development context
  - Socio-cultural
- The focus of disaster risk reduction
  - Awareness raising for change in behavior
  - Knowledge development
    - Information
    - Education & training
    - Research
  - Risk identification & impact assessment
  - Vulnerability / capability analysis
  - Hazard analysis & monitoring
  - Early warning
  - Risk reduction measures
    - Environmental management
    - Social and economic development practices (including poverty alleviation, livelihoods, financial mechanisms, health, agriculture, etc.)
    - Physical and technical measures
      - Land-use/urban planning
      - Protection of critical facilities
      - Networking and partnerships
- Political commitment
  - International, regional, national, local levels
  - Institutional framework (governance)
    - Policy development
    - Legislation and codes
    - Organizational development
    - Community actions
- Economic
- Political
- Risk factors
  - Vulnerability
    - Social
    - Economic
    - Physical
    - Environmental
  - Hazards
    - Geological
    - Hydrometeorological
    - Biological
    - Technological
    - Environmental

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

\[
\text{Risk (R)} = \text{hazard factors (H)} \times \text{vulnerability (V)}
\]
Basic Theory of Risk Assessment

Disaster Risk with Climate Change

Assets at risk
- variation values, vulnerability, site conditions

Loss

Vulnerability

Site Intensity (ie, Hazard)

Climate Change?

Frequency

Site Intensity (ie, Hazard)

The "source" - can be an earthquake fault, river, or path of a tropical cyclone. For volcano, more or less a "point"

Event Severity

Frequency

Loss
Outline

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Annual Disaster Risk Assessment of China

Technological process

Decision-Making Tools
- Contingency Planning, Territorial Planning, Cost-Benefit Analysis, Risk Governance etc.

Risk and Impact Analysis
- Damage and Loss Maps, Loss Exceedance Curves, Risk Indicators, Indirect Losses, Impact on Society/Economy...

Hazard
- Probability, Intensity, Location

Exposure
- Value, Location; Physical, Social, Economic

Vulnerability
- Physical, Social, Economic, Institutional; Functions, Indicators
Annual Disaster Risk Assessment of China

Important factors

- **Stochastic Event Set Module**: Location, Intensity, Rate
- **Hazard Module**: Quantification of hazard (hazard parameter footprint)
- **Exposure Module**: Exposure geographical distribution, Type, Value
- **Vulnerability Module**: Damage to buildings, Content
- **Financial Module**: Financial implication to the insurer and reinsurer
Annual Disaster Risk Assessment of China

Long time series of historical disaster loss data

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Event</th>
<th>Death</th>
<th>Emergency Shelters</th>
<th>Agriculture Damage</th>
<th>Property Damage</th>
<th>Direct Economic Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>山西省</td>
<td>2007-10-19</td>
<td>村雅</td>
<td>3000</td>
<td>64.4</td>
<td>660.3</td>
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<td>2009-8-14</td>
<td>河北</td>
<td>395.5</td>
<td>51.9</td>
<td>578.8</td>
<td>19.5</td>
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</tr>
<tr>
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<td>2009-11-1</td>
<td>唐山</td>
<td>328.4</td>
<td>51.9</td>
<td>578.8</td>
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<tr>
<td>山西省</td>
<td>2009-11-1</td>
<td>抚顺</td>
<td>260.7</td>
<td>73.4</td>
<td>18.4</td>
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<tr>
<td>北京市</td>
<td>2010-1-13</td>
<td>低温冷冻和雪灾</td>
<td>4.2</td>
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<td>低温冷冻和雪灾</td>
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<td>6.2</td>
<td>3.1</td>
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</table>

Long time series of hazard data

Vulnerability curve

超越概率
C 类建筑易损性曲线
轻微破坏
中等破坏
严重破坏
完全破坏
### Annual Disaster Risk Assessment of China

**Disasters risk assessment and final report**

<table>
<thead>
<tr>
<th>historical hazard data</th>
<th>historical disaster loss data</th>
<th>early warning information</th>
</tr>
</thead>
</table>

#### Disasters

<table>
<thead>
<tr>
<th>earthquake</th>
<th>flood</th>
<th>typhoon</th>
<th>drought</th>
</tr>
</thead>
</table>

- **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

### Long-term Regional Planning of Seismic Intensity of China

<table>
<thead>
<tr>
<th>烈度</th>
<th>基本完好</th>
<th>轻微破坏</th>
<th>中等破坏</th>
<th>严重破坏</th>
<th>完全破坏</th>
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</thead>
<tbody>
<tr>
<td>VI</td>
<td>99.5</td>
<td>0.5</td>
<td>0.0</td>
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<tr>
<td>VII</td>
<td>95.0</td>
<td>4.4</td>
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<td>VIII</td>
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</table>

### Seismic Intensity Levels

- **Slight**
- **Moderate**
- **Extensive**
- **Complete**

### Earthquake烈度 Scale

- VI
- VII
- VIII
- IX
- X

### Seismic Damage Matrix

- 基本完好 (Basic完好)
- 轻微破坏 (轻微破坏)
- 中等破坏 (中等破坏)
- 严重破坏 (严重破坏)
- 完全破坏 (完全破坏)
Annual Disaster Risk Assessment of China

Technological process—Flood

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

Results of risk assessment

<table>
<thead>
<tr>
<th>省/市</th>
<th>可能倒塌和严重损坏房屋/间</th>
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</thead>
<tbody>
<tr>
<td>江苏</td>
<td>990</td>
</tr>
<tr>
<td>安徽</td>
<td>1895</td>
</tr>
<tr>
<td>山东</td>
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<td>湖北</td>
<td>2202</td>
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<td>......</td>
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</table>
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

Early warning information of typhoon path

Similar path selection model

V-Curve
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

Graph showing precipitation data with equations and coefficients.
Annual Disaster Risk Assessment of China

Visual expression

**Earthquake**

**Flood**

**Drought**

**Typhoon**

<table>
<thead>
<tr>
<th>可能受灾省</th>
<th>模拟震级</th>
<th>不同损失的可能性</th>
<th>根据倒塌及严重损坏房屋数量判断</th>
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<td></td>
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</table>
Annual Disaster Risk Assessment of China

*Drought risk assessment in different hazard level*
Outline

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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!