Typhoon Risk Assessment of China

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1. Background
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3. Exposure and Vulnerability
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1. Background

- Northwest Pacific generates about 34 typhoons every year, 36% of the globe.
- Approximately seven landfalls in China per year
- Huge casualties and losses to China. 34.7 billion RMB per year from 1985-2007.
1. Background

Typhoon Risk = Hazard × Vulnerability × Exposure

Rainstorm
- Max_Rain_in_24h
- Accum_Rain

Wind
- Max_Wind_Speed

Structure-based
- Hazards Intensity

Loss-based
- Loss Ratio

Exposure
- GDP, rural buildings, farmland, ...
- Historical Loss

EP Curve of Hazards

Vulnerability Curve

Loss Expectation and Loss Probability of Exceedance
2. Typhoon Hazards

- Indicators of Typhoon Hazards:
  - Accumulated rainfall,
  - Maximum rainfall in 24h,
  - and maximum wind speed, etc.

- Probability Distribution Function of the hazards
  - Daily observed meteorological data from China Meteorology Administration (1951-2009, 752 stations of whole China)
  - Generalized Extreme Value (GEV) theory to get the station-level return period of hazard intensity of the indicators
  - Spatial interpolation in GIS in 1km*1km grid.
2. Typhoon Hazards -- Mapping

(Accumulated Rainfall)

5 years return period

10 years return period

20 years return period

50 years return period
2. Typhoon Hazards -- Mapping

(Maximum rainfall in 24h)

5 years return period

20 years return period

10 years return period

50 years return period
2. Typhoon Hazards -- Mapping

(Maximum 10min Wind Speed )

- 5 years return period
- 20 years return period
- 10 years return period
- 50 years return period
3. Exposure and Vulnerability

- Exposure Selection
  - Macro-scale typhoon risk assessment of China
  - Towards land use planning and policy making in future

  - GDP, rural residential building and crop area are selected, considering their data availability and loss statistical indicators.
3. Exposure and Vulnerability

• Development of Vulnerability Curve
  - A loss-based method to develop vulnerability function

  - Historical loss data at county level from National Disaster Reduction Center of China (NDRCC) in 2009
    • Typhoon cases: Morakot, Molave and Crater

  - Hazard intensity
    • Observed data from meteorology departments

  - Fitting to derive vulnerability curves
    • Exponential Fitting
    • Loss ratio VS. Hazard intensity
Vulnerability Curve

Loss Ratio VS Hazard intensity

Accumulated Rainfall

GDP

Rural building

Max rainfall in 24h

Rural building

Crop area

Accumulated Rainfall
Uncertainty of vulnerability curve

- **Limitation of loss data**
  - only loss data of coastal areas
  - Difficult to quantify vulnerability of exposure of the inland that are rarely hit by typhoons.

- **Overall vulnerability**
  - different exposure types, different vulnerability

- **Changing Exposures**
  - Rapid developing China
4. Typhoon Risk Assessment

- Typhoon Risk is quantified as
  - loss expectation or
  - loss of different return periods

- Risk is calculated by
  - Risk = Hazard * Exposure * Vulnerability
  - Loss Ratio VS. Accumulated Rainfall

- 1km-grid typhoon risk maps in GIS
  - loss expectation of GDP, GDP loss of different RP;
  - loss expectation of rural residential building;
  - and loss expectation of crop area.
4. Typhoon Risk Assessment

Loss Expectation of GDP by Typhoon

中国台风灾害直接经济损失期望分布

Unit: 10,000 RMB
(1,140 EURO)
4. Typhoon Risk Assessment

Direct Economic Loss by Typhoon (5 years return period)

Unit: 10,000 RMB (1,140 EURO)
4. Typhoon Risk Assessment

Direct Economic Loss by Typhoon (10 years return period)
4. Typhoon Risk Assessment

Direct Economic Loss by Typhoon (50 years return period)

Unit: 10,000 RMB (1,140 EURO)
4. Typhoon Risk Assessment

Direct Economic Loss by Typhoon (100 years return period)

Unit: 10,000 RMB (1,140 EURO)
Loss Expectation of Rural Residential Building

Unit: m²

Guangdong

中国台风灾害农村住房损失期望分布
Loss Expectation of Farmland of Zhejiang Province

Unit: m²

- 2000-4000
- 1000-2000
- 750-1000
- 500-750
- 250-500
- 100-250
- 50-100
- 0-50

East China Sea
Hangzhou
Shanghai
Validation

Annual Economic Loss by Typhoon (1985-2002) (Southeast Province of China)

- Guangdong > Zhejiang > Fujian > Guangxi > …
- Consistent with the result of risk assessment
5. Discussions

• **Finding:** Structures and crops in China are more vulnerable to rainstorm and induced floods. It is significant that the historical loss ratio has the best exponential fitting with accumulated rainfall, instead of wind speed.

• Exposure
  – More types besides GDP, rural residential building and crop.
  – Detailed exposure category

• Vulnerability Assessment
  – Different types: exposure category
  – Different regions: exposure characteristics

• Data
  – Rationality: easy to be quantified; etc.
  – Availability: ‘Exist in China or not?’; ‘Available’; etc.
Thanks!