Understanding disaster risk
~ Lessons from 2009 Typhoon Morakot, Southern Taiwan

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08/03 Typhoon Morakot formed

08/05 Typhoon warning for territorial sea

08/06 Typhoon Warning for Inland

08/07 Rainfall started & typhoon speed decrease rapidly

08/08 00:00 Heavy rainfall started

08/08 12:00 ~24:00 Rainfall center moved to south Taiwan, which triggered serious geo-hazards and floodings

08/09 Rainfall started & typhoon speed decrease rapidly

08/10 Rainfall stopped gradually

Data from “http://weather.unisys.com/”

1. Introduction
1. Introduction

- There **4 days** before the typhoon landing and forecasting as **weakly one** for norther Taiwan.

- Emergency headquarters **all located in Taipei** and **few raining around the landing area**.

- The induced strong rainfalls after typhoon leaving around southern Taiwan until **Aug. 10**.

- The damages **out of experiences** crush the operation system, made **serious impacts**.

Path of the center of Typhoon Morakot
1. **Introduction**

Largest precipitation was **2,884 mm**

- **Long duration** (91 hours)
- **Hard to collect the information**
- **High intensity** (123 mm/hour)
- **Large depth** (3,000 mm-91 hour)
- **Broad extent** (1/4 of Taiwan)
The scale and type of the disaster increasing with the frequent appearance of extreme weather.
Large-scale landslide and compound disaster become a new challenge

Before Typhoon Morakot (2008/11)

After Typhoon Morakot (2009/08)
2.1 Root Cause and disaster risk drivers

- Landslide (Shallow, Soil)
- Landslide (Deep, Bedrock)
- Landslide dam break
- Flood
- Debris flow
- Landslide dam form

Rainfall depth (mm) vs. Time (hour)

- Typhoon Morakot (2009)
- Typhoon Kalmaegi (2008)
- Typhoon Toraji (2001)
- Typhoon Winnie (1997)
- Typhoon Herb (1996)
- Typhoon Isewan (1959)
2.1 Root Cause and disaster risk drivers
Time Series of Compound Disaster in Xiaolin Village
## 2.2 Disaster Data

<table>
<thead>
<tr>
<th>Area</th>
<th>2009/9 Landslide Area (ha)</th>
<th>Ratio (%)</th>
<th>2010/9 Landslide Area (ha)</th>
<th>Ratio (%)</th>
<th>2011/9 Landslide Area (ha)</th>
<th>Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>濁水溪</td>
<td>6823</td>
<td>2.15</td>
<td>6312</td>
<td>1.99</td>
<td>6377</td>
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<tr>
<td>曾文溪</td>
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<td>1744</td>
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<td>1.45</td>
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<td>高屏溪</td>
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<td>4.57</td>
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<tr>
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<td>3.45</td>
<td>4663</td>
<td>4.81</td>
<td>4583</td>
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<tr>
<td>林邊溪</td>
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<td>4.84</td>
<td>1558</td>
<td>5.23</td>
<td>1516</td>
<td>4.81</td>
</tr>
</tbody>
</table>
2.2 Disaster Data

Spatial Distribution of Hazard locations 1*

1. Flood locations generated by WRA & DPRC
2. Geo-hazards pointed by DPRC

1. Geo-hazards in the mountains located follow the range of precipitation > **1,400mm**
2. Where precipitation > **2,000mm** is the most serious area
3. Most floods located at the downstream of rainfall center (Chiayi, Tainan, Kaohsiung & Pingtung Counties)
4. Some floods were caused by possible natural dam break
5. In central Taiwan, the floods occurred due to insufficient local drainage system
2.3 Disaster risk mapping

- Based on 88 hazardous villages in Typhoon Morakot
  - Class 1: seriously damaged
  - Class 2: lifeline breakage
  - Class 3: safety villages

- Upper Bound
  - Landslide Ratio > 8%
  - Riverbed Variation > 5 m

- Lower Bound
  - Landslide Ratio < 2%
  - Riverbed Variation < 2 m
## 2.3 Disaster risk mapping

<table>
<thead>
<tr>
<th>Factors</th>
<th>Protection Targets</th>
<th>Risk: Low — Moderate — High</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image_url" alt="Image of table" /></td>
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<td></td>
</tr>
</tbody>
</table>

### Protection Targets

- **Ⅲ No village**
- **Ⅱ Village safety/Lifeline breakage**
- **Ⅰ Village damaged**

### Landslide Ratio

- **3** < 2%
- **2** 2% ≤ , ≤ 8%
- **1** > 8%

### Riverbed Variation

- **C** < 2 m
- **B** 2 m ≤ , ≤ 5 m
- **A** > 5 m
2.3 Disaster risk mapping

Importance
- High
- Mid
- Low

Time Scale
- Short
- Mid
- Long
2.4 Disaster risk assessment
• IDEA FOR MITIGATION STRATEGIES (6W1SH)

- Where ➔ Potential Area
- What ➔ Risk analysis (Influence Area)
- Why ➔ On-site monitoring
- When ➔ Forecast and Warning System
- Who ➔ Evacuation Plan
- How ➔ Training, Drills, Education
Strategy for Compound Sediment Disasters

- Before large-scale landslides were triggered, other kinds of disasters had already occurred.

- The purpose of the neck point analysis is to decide the optimal evacuation time.
3. Suggestion Models, Datum Exchange

- Linked with research centers in Taiwan, Japan, Indonesia, Malaysia etc.
- A simulation platform with multiple interface: hydrology, water management, sediment disaster models etc.

Asian Cloud Project 2010 ~
4. Summary

Lessons from Compound-disasters in Hsiaolin village

- Compound Disaster, included shallow landslide, debris flow, flooding, large-scale landslide, landslide dam break, occurred in Hsiaolin village

- The main disaster is large-scale landslide
  - 3/4 of the village was buried.
  - Whole village was flashed by the dam break discharge.

- What can we do for the disaster?
  - Only 12 hours for the response after the debris flow early warning launched.

Solution:

Mitigation Strategies of Large-scale Landslide Disaster