Estimation of the damage cost on compound water related disaster in Japan using 2D non-uniform flow model

Ise Bay Typhoon in 1959:
The greatest damage after WWⅡ
The coincidence of flood and storm surge

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Background

Compound

- Typhoons which brought particularly enormous damage
  - Typhoon Muroto (1934)
  - Makurazaki Typhoon (1945)
  - Ise Bay Typhoon (1959)

...The coincidence of flood and storm surge

Single

A flood (Typhoon No. 18, 2015)
Kinu River burst its banks for the first time in 29 years

A flood (Typhoon No. 10, 2016)
The typhoon hit the Tohoku district for the first time
It is necessary for Japan to evaluate quantitatively the risk of flood, storm surge, compound disaster and compare them.
Previous studies

Floods
Flood damage estimations using the distribution of rainfall causing any return period of flood (Tezuka et al., 2014 etc.)

Storm
Analysis on storm surge inundation damage using numerical models (Suzuki, 2008 etc.)

Many studies have done on impacts on each flood and storm surge
Objectives

Estimation on the damage cost of compound disaster that flood and storm surge happened at the same time (Akima et al., 2016)

! The inundation depth was estimated on the condition that highest tide level stay constant so far as the storm surge flooding calculation

! The difference between the tide level and the ground elevation was regarded as the inundation depth of storm surge

The objective of my research is to calculate the inundation depth which more similar to the actual phenomenon
Data set ~single disasters~

Floods

the distribution of rainfall causing any return period of flood (Tezuka et al., 2014)

Rainfall (mm/day)

<table>
<thead>
<tr>
<th>Rainfall (mm/day)</th>
<th>700 -</th>
<th>600 - 700</th>
<th>500 - 600</th>
<th>400 - 500</th>
<th>300 - 400</th>
<th>200 - 300</th>
<th>100 - 200</th>
<th>0 - 100</th>
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Storm surges

Any return period of the tide level deviation calculated by means of frequency analysis

Mean sea level

Tide level deviation

Elaposed time (hours)

Tide level (m)
Compound disaster: A low pressure bring flood and storm surge one after another at the same place in 4 days.

Rainfall

- The rainfall causing any return period compound disaster
- The rainfall caused by any return period low atmospheric pressure

Tide level

- Annual minimum atmospheric pressure
- Tide level deviation
- Mean sea level

Data set ~compound disasters~

\[
R^2 = 0.4612
\]

\[
R^2 = 0.3733
\]
Method

- Rainfall: 0~24h (constant)
- Tide level: 0~24h (time series)

Input to 2D non-uniform flow model

- Rainfall: 0~24h (constant)
- Tide level: 0~24h (time series)

Inundation

Damage cost

prices per unit of area calculated by each land use
Total amount of the potential damage cost in whole Japan for 50-years return period of compound disaster is 75 trillion JPY.
The time at which the highest tide level is set the highest tide level (hours).

30 hours after rain started, the damage cost of compound disaster reaches a peak.

The difference in the time of storm surge is 9.

3.7 trillion JPY
The damage cost of compound disaster in this study is smaller than that in previous study (Akima et al., 2016). This difference could be caused by the difference in infiltration of tidal waves to the land Niigata, Ishikawa, Kochi...particularly overvalued
Floods pose the greatest risk.

80% of prefectures: Storm surge < Compound disaster < Flood

Useful for efficient adaptation method against water disasters.
Conclusions

**Objective**

to evaluate quantitatively the risk of water related disaster and compare them

**Results**

1. **Improvement of Flood simulation**
   
time series variation of tide level was taken into the model

2. **Change in the arrival time of storm surge**
   
damage cost reaches a peak on the condition that time of the highest tide level is set at 30 hours after rain started

3. **Comparison of the risk of each disaster**
   
Storm surge < Compound disaster < Flood