Flood damage analysis and development of flood damage models for the Mekong delta

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Vietnam is severely affected by floods, which cause damage to people and assets.

Current flood risk management does not include private precaution.

Governmental damage assessment does not include indirect damage.

The flood damage models did not apply for Vietnam yet.
Objectives

- Results about the phases of the flood risk management cycle including the preparedness, response, damage and recovery from interviews with households and small businesses in Can Tho will be presented.

- Multi-variate flood damage models base on regression trees and bagging decision trees are developed to select the more important damage influencing parameters and promising alternative flood damages models for Can Tho city of the Mekong delta.
Can Tho city is considered the economic, educational and cultural centre of the Mekong delta.

- Area: 1,390 km²
- Population: 1.2 mil. inhabitants
- Influence by riverine and tidal flooding

Study area and spatial location of the sampled households and businesses.
Methods

Development of questionnaire for households and businesses

Pre-test

Face-to-face interviews with households and businesses about flood season 2011

Flood damage analysis

Development of flood damage models
Survey was conducted in Can Tho city about flood season 2011

Start in January

480 flood-prone households and 378 businesses in 4 districts of Can Tho city.

70 questions for households and 88 questions for businesses about the following topics:
Flood characteristic, preparedness, early warning and emergency measures, damage to household and business, recovery, risk perception

End in February
Flood damage analysis: preparedness, response, damage and recovery
Flood preparedness

- **Sand bags**
- **Concrete**
- **Concrete tile**
- **Sand bags**
Only 7% of households and 6% of businesses did not undertake measures.
Early warning and emergency measure

<table>
<thead>
<tr>
<th></th>
<th>Household (%)</th>
<th>Business (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood experience</td>
<td>74</td>
<td>65</td>
</tr>
<tr>
<td>Received warning</td>
<td>71</td>
<td>70</td>
</tr>
<tr>
<td>Applied emergency mesure</td>
<td>86</td>
<td>84</td>
</tr>
</tbody>
</table>

**Emergency measures**

- Move furniture
- Save valuables
- Move vehicle
- Pump water out
- Seal doors
- Move goods/products
### Flood impact and damage

<table>
<thead>
<tr>
<th>Median values</th>
<th>Household</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water depth in house (cm)</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Duration (days/month)</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Distance to river (m)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total damage (USD)</strong></td>
<td>333</td>
<td>152</td>
</tr>
</tbody>
</table>
## Flood damages

<table>
<thead>
<tr>
<th>Data</th>
<th>Direct damage (median)</th>
<th>Indirect damage (median)</th>
<th>Ratio (indirect damage/direct damage)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Damage to structure</td>
<td>Damage to content</td>
<td>Total</td>
</tr>
<tr>
<td>Groceries</td>
<td>48</td>
<td>19</td>
<td>157</td>
</tr>
<tr>
<td>Eat and drink</td>
<td>71</td>
<td>0</td>
<td>143</td>
</tr>
<tr>
<td>Home appliances</td>
<td>19</td>
<td>48</td>
<td>238</td>
</tr>
<tr>
<td>Service</td>
<td>24</td>
<td>0</td>
<td>143</td>
</tr>
<tr>
<td>Production facilities</td>
<td>119</td>
<td>14</td>
<td>285</td>
</tr>
<tr>
<td>Total for business</td>
<td>48</td>
<td>10</td>
<td>152</td>
</tr>
</tbody>
</table>
Recovery

- Groceries
- Eat and drink
- Home appliances
- Service
- Production facilities
- Total for business
- Household

- Houses repaired
- Not enough money
- In planning project area
- Hardly damaged
Flood damage models: stage-damage function, regression trees, bagging trees
### Flood characteristic
- Water depth (wst)
- Duration (d)
- Flood velocity (v)
- Contamination (con)

### Preparation, Response and Emergency
- Precaution (pre), Early warning (wt, wi, wte), Emergency measures (em), recovery, risk perception, flood experience

### Building characteristic
- Building value (bv), content value, building quality (bq), floor space of building (fsb), damage to households and businesses, loss ratio, house size

### Socioeconomic status
- Socioeconomic status Plapp (socp)
- Age (age), income (inc), elderly person (eld), children (chi), education,
No. of decision nodes:
  bv: 3
  d: 3
  wt: 2
  eld: 2
  bq, inc, fsb, wi, age, socp, v: 1

**Minimum number of case in terminal node is 20**
Regression tree

The diagram represents a regression tree with the following features:

- The root node is `bv < 3.201e+007`.
- If `bv < 3.201e+007`, the tree splits further based on other conditions.
- The tree structure includes conditions for `wt`, `inc`, `bq`, `v`, and `fsb`.

The branches of the tree are divided by these conditions, leading to different outcomes or predictions.
Feature importance variables: bv, bq, fsb, v, d, socp, inc
Comparison

- RMSE
- MBE
- Correlation coefficient
Many people in Can Tho city have flood experience and were well prepare for the flood in 2011.

However, households are more vulnerable than businesses since they live in lower quality buildings and are exposed to higher flood intensities.

Indirect damage of business is 1.4 times higher than their direct damage.

Only 25% of businesses and 35% of households had repaired their houses 3 months after the flood.

Important damage-influencing parameter are building value, flood duration, building quality, income, floor space of building.
Thank you very much for your attention!