The Vulnerability Assessment for Local Adaptation to Climate Change in Korea

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※ This study was supported by NIER
Contents

I. Introduction
II. Methods
III. Results
IV. Discussions & Conclusions
- **Climate change** brought about various changes. Such as …
  - a rise in **temperature and sea level**
  - an increase in **precipitation**

- IPCC advised **the importance of adaptation measures** to minimize negative effects by climate change.

- The Republic of Korea established **the national adaptation measures** to respond to climate change.

- Then the government demanded that **local governments establish detailed adaptation plans**.
However, local governments have limitations

- a lack of funds
- a lack of human resources.

Therefore, the governments should supply local governments with funds and human resources.

Also, government should assess vulnerability of important sectors and provide the result to local governments.

Vulnerability assessment is very important for local governments. Because, local governments can use the results to demand financial assistance and distribute funds.
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### Organization

<table>
<thead>
<tr>
<th>Supporter</th>
<th>Adviser</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Institute Environmental Research</td>
<td>Korea Environment Institute</td>
</tr>
</tbody>
</table>

#### 7 Sectors

<table>
<thead>
<tr>
<th>Sector</th>
<th>Research team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>Graduate school of Public Health / SNU</td>
</tr>
<tr>
<td>Forests</td>
<td><strong>College of Agriculture and Life science / SNU</strong></td>
</tr>
<tr>
<td>Water</td>
<td>Seoul National University of Science &amp; Technology</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Kyung Hee University</td>
</tr>
<tr>
<td>Agriculture</td>
<td>National Academy of Agricultural Science</td>
</tr>
<tr>
<td>Marine</td>
<td>National Fisheries Research &amp; Development Institute</td>
</tr>
<tr>
<td>Disaster</td>
<td>Korea Research Institute For Human Settlement</td>
</tr>
<tr>
<td>Delphi research</td>
<td>Konkuk University</td>
</tr>
</tbody>
</table>

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**Ⅰ. Introduction**

**Ⅱ. Methods**

**Ⅲ. Results**

**Ⅳ. Discussions & Conclusions**
Scope of study

Spatial & Temporal scope
- 232 local governments (city).
- Future: 2020, 2050, 2100
- Scenario: A1B scenario (SRES)

Period of study
- April to November, 2011

Sector: Study consist of 7 sectors and 32 items.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Number of items</th>
<th>Name of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>9</td>
<td>Floods, hurricanes, heat waves, infectious diseases…</td>
</tr>
<tr>
<td>Forests</td>
<td>7</td>
<td>Landslide caused by heavy rain, forest fires, forest vegetation due to drought…</td>
</tr>
<tr>
<td>Water</td>
<td>3</td>
<td>Water management (treatment, utilization)…</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>5</td>
<td>Tree growth and distribution, insects…</td>
</tr>
<tr>
<td>Agriculture</td>
<td>3</td>
<td>Soil erosion of cropland, vulnerability of rice and apples…</td>
</tr>
<tr>
<td>Marine</td>
<td>1</td>
<td>Vulnerability of fisheries…</td>
</tr>
<tr>
<td>Disaster</td>
<td>4</td>
<td>Vulnerability of infrastructure to sea level rise</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>
✓ **Process** of vulnerability assessment

![Diagram showing the process of vulnerability assessment]

- **Selection of sector**
- **Process of assessment**
  - **Establishment of Data**
  - **Selection of Variables**
  - **Setting weights of variables**
  - **Interviews with experts & Literature reviews**
  - **Delphi research**
- **Vulnerability Map**

✓ **Vulnerability formula** (UNDP, 2005)

\[
\text{Vulnerability} = \alpha \times \text{climate exposure} + \beta \times \text{sensitivity} - \gamma \times \text{adaptation ability}
\]

\[(\alpha, \beta, \gamma \text{ is weight})\]
✓ **Workshops & Meetings**

- We had several *workshops* with local government officials and experts.
- Through the workshop, we got *various comments* and applied it to our research.
- Also, we had *internal meetings with researchers* to communicate each other.
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Example of results: variables and weight

- “Delphi research with 56 experts”  
- An example of landslide by heavy rains.

<table>
<thead>
<tr>
<th>Item</th>
<th>Variables</th>
<th>Weight</th>
<th>Lists of variables</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landslide by heavy rains</td>
<td>Climate exposure</td>
<td>0.40</td>
<td>number of dates with over 80mm of precipitation</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>daily maximum precipitation(mm)</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>summer daily precipitation(mm)</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 days of maximum precipitation(mm)</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>Sensitivity</td>
<td>0.37</td>
<td>average slope of regional forest(degrees)</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>area of coniferous forest(ha)</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>average height of regional forest(m)</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>area of planned forest(ha)</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>Adaptation ability</td>
<td>0.23</td>
<td>government officials per population</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>rate of managed land(ha)</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GRDP(trillion won)</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>financial independence(%)</td>
<td>0.38</td>
</tr>
</tbody>
</table>
Assessment of vulnerability (example): vulnerability of landslide by heavy rain

- Vulnerability is calculated by Climate exposure, Sensitivity and Adaptation ability.

\[
\text{Vulnerability} = \alpha \times \text{climate exposure} + \beta \times \text{sensitivity} - \gamma \times \text{adaptation ability}
\]

(\(\alpha, \beta, \gamma\) is weight)
Vulnerability map (example) : vulnerability of landslide by heavy rain

- The result of vulnerability of landslide. Areas of darker red are vulnerable to landslide.
- Vulnerability in northeast area of Korea is expected to increase in 2100.
- Through the result, local governments can find importance of adaptation plans.
Verifying the result (example): vulnerability of landslide due to heavy rain

- **Both maps** are the result of assessment for **vulnerability of landslide**.
- The right map is the result that was published on the Journal. The result is reliable.
- They show **similar trends** of vulnerability. Therefore, our result is also reliable.
Climate exposure map (example): vulnerability of landslide by heavy rain

- Variables of **climate exposure** consist of:
  
  “Number of dates with over 80mm of precipitation, Daily maximum precipitation(mm), Summer daily precipitation(mm), 5 days of maximum precipitation(mm)”.

- Climate exposure is expected to increase in **northeast area**. It shows similar trend with vulnerability map.
Construction of report

- The results were divided into 4 items (variables, map, statistical analysis and verification).
- Report includes various maps about present & future vulnerability.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Table of surrogate variables</td>
<td>Variables lists and Weights</td>
</tr>
<tr>
<td>2. Map</td>
<td>Present</td>
</tr>
<tr>
<td></td>
<td>Future</td>
</tr>
<tr>
<td>3. Statistical analysis</td>
<td>Rank of local governments vulnerability</td>
</tr>
<tr>
<td></td>
<td>Contribution analysis</td>
</tr>
<tr>
<td>4. Verification of result</td>
<td>Comparing results with other study</td>
</tr>
</tbody>
</table>

- Climate exposure
- Sensitivity
- Adaptation ability
- Vulnerability
- Climate exposure + Sensitivity
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✓ Final report
- The report consists of 5 volumes.
- NIER distributed reports to local governments.

✓ CCGIS program
- CCGIS (Climate Change adaptation toolkit based on GIS) program was distributed.
- This program used to mapping vulnerability.
✓ Website for distribution

- **Objective**: Distribution of program and data.
- **Additional effects**: Sharing problems, Register of comments by local governments.
- **Website**: [www.snu.ac.kr/ccgis/](http://www.snu.ac.kr/ccgis/)
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Results of quantitative methods: Prediction of distribution of forest types (KEI)

- Examples of quantitative methods.
  - Prediction of distribution of forest types with MaxEnt model in other study.
  - More specific spatial data and absolute value of vulnerability can be achieved.

Therefore,

- Consideration about quantitative methods.
- Establishment of database related to climate change.

※ MaxEnt Model: One of the most commonly used methods for inferring species distributions from occurrence data.
Significance of study

- First attempt
  ✓ Assess vulnerability with the entire land of Korea.
  ✓ Assess 7 sectors which is important to respond to climate change.

- Supporting local governments
  ✓ Local governments can utilize the results to decide the priority of vulnerable sector and distribute financial assistance.

- Reflection of local features
  ✓ This study used descriptive methods which is utilizing surrogate variables. Thus, local governments can modify the data which is used to vulnerability assessment.

Future study

- Higher resolution: the unit of assessment is city and county. For that reason we achieved the result of a low-resolution. Thus, we need to assess more specific area.

- Establishment of data: we don’t have enough data about entire land of republic of Korea. Therefore government of Korea should establish database related to climate change.
Thanks for your listening

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Appendix
Definition of surrogate variables

- To assess vulnerability, we used the surrogate variables which is classified as “climate exposure, sensitivity and adaptation ability”.

- These variables are defined like below.

<table>
<thead>
<tr>
<th>Surrogate Variables</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>climate exposure</td>
<td>climate change impact, such as, temperature and precipitation</td>
</tr>
<tr>
<td>sensitivity</td>
<td>climate change impact range or vulnerability impact, such as, slope, soil condition</td>
</tr>
<tr>
<td>adaptation ability</td>
<td>climate change impact reduction, such as, financial support and supporters</td>
</tr>
</tbody>
</table>

- We used this formula to calculate vulnerability.

- The formula refers to UNDP(2005).

\[
\text{Vulnerability} = \alpha \times \text{climate exposure} + \beta \times \text{sensitivity} - \gamma \times \text{adaptation ability}
\]

\[(\alpha, \beta, \gamma \text{ is weight})\]
A ranking graph was created to compare vulnerability among local governments.

Local governments can get an information about the priority of vulnerable sector or item by getting relative vulnerability.

Local governments can utilize this data to request and distribute budget.

Statistical analysis (example): vulnerability of landslide by heavy rain
A radial graph was created to identify the contribution of variables.

Through the radial graph, we can get an information about contribution of certain variables.

This graph shows average vulnerability of 232 local governments. We can also search an information about certain local government by using CCGIS.

Local governments can find out vulnerable variables, therefore they can utilize this graph to establish adaptation plans.
✓ Comparison with other study: Assessment of vulnerability in Gyeonggi province

- Research institute in Gyeonggi province (GRI) performed vulnerability assessment in 2009.
- They didn’t select specific sector and assessed overall vulnerability to climate change.
- GRI want to assess specific sector and we are supporting assessment of forest sector from last year.