Predicting distributions of coniferous forest and Japanese pine sawyer beetle (*Monochamus alternatus* Hope) to support climate change adaptation policy

Jaeuk Kim*, Yong Ha Park, Huicheul Jung
Chapter 1. Introduction of project

Chapter 2. Case studies (Ecosystem sector)
- Coniferous forest
- Japanese pine sawyer beetle
- Pine wood disease (PWD)
Chapter 1

Introduction of project
CH 1. Introduction of project

Overview

Objectives
1. Development estimation methods considering uncertainty for supporting to adaptation policy
2. Impact, adaptation, and economic assessment by sectors

Period
2014. 05. 01. ~ 2017. 04. 30.
(650 million won/yr)

Target
- Regions: National, provincial and county-level scale
- Periods: 2040(2036~2045), 2090(2086~2095)
- Sectors: Forest, Health, Disaster, Agriculture, Ecosystem, Water Resources
Overview

1. **Scientific approach** to assess sector’s impacts
2. **Probabilistic approach** to assess uncertainty of future projection
3. **Economic approach** to assess the feasibility of adaptation options
4. **Integrated approach** to support local adaptation decision-making
CH 1. Introduction of project

Overview

Contents (SNU)
1. Impact, adaptation option and economic assessment by sectors (forest, disaster, health, and agriculture)
2. Evaluation of adaptation strategy by sectors (forest, disaster, health, and agriculture)

Contents (KEI)
1. Construction of common scenarios
2. Impact, adaptation option and economic assessment by sector (water management and ecosystem)
3. Model development using impact response function for supporting of the adaptation policy
4. Visualization tool development for decision-making
Chapter 2

Case studies (Ecosystem sector)
1. **1st National Climate Change Adaptation plan (‘10.12)**

2. **Sectoral plan**
   - Forest: Measures to prevent from forest disaster, diseases and pests
   - Ecosystem: Damage prevention and management plan for alien species and unexpected outbreaks

3. **Limitation**
   - Difficulty in making a tangible outcome
   - Insufficient strategic framework for promoting adaptation
Introduction

1. 5 Visions
   - Cooperative adaptation
   - Science-based climate change risk management
   - Sound and Competitive economy
   - Sustainable conservation of natural resources
   - Establishing climate-safe society

2. Focused initiatives
   - Enhance climate change impact monitoring
   - Ecosystem climate risk management
1. 2,581,000ha (41.9% of forest)
2. A host of pine wood disease (PWD)
   • Red pine (*Pinus densiflora*), Korean pine (*Pinus koraiensis*), Black pine (*Pinus thunbergii*)

5th Forest type map
(Korea Forest Service, 2010)
Coniferous forest

1. MaxEnt model (Maximum Entropy Modeling)
   • Input data: 5th Forest type map, Bioclim 1~19, Forest site map, DEM
   • Training points: 250
   • Random test points: 50
   • Replicates: 10 times
   • Threshold: Maximum training sensitivity plus specificity
1. Selected variables

- **Bioclim(5):** Annual Mean Temperature (BIO1), Max Temperature of Warmest Month (BIO5), Annual Precipitation (BIO12), Precipitation of Driest Month (BIO14), Precipitation of Coldest Quarter (Bio19)
- **Topography(1):** Altitude
- **Forest site(7):** Soil drainage, Wind exposure, Soil texture, Soil depth, Soil type, Topography type, Soil erosion
Coniferous forest

MaxEnt model

1. AUC values
   - Training data: 0.667
   - Test data: 0.526

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<thead>
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<tr>
<td></td>
<td>2,667,600</td>
<td>1,823,100</td>
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Coniferous forest

MaxEnt model

1. AUC values
   - Training data: 0.667
   - Test data: 0.526

<table>
<thead>
<tr>
<th>Simulated coniferous (1971~2000)</th>
<th>Area (ha)</th>
<th>Simulated coniferous (2021~2050)</th>
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<td>1,823,100</td>
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<td>1,138,600</td>
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CH 2. Case studies (Ecosystem sector)

Japanese pine sawyer beetle

Introduction

1. Major vector of pinewood nematode (PWN)
2. In the southern region of South Korea
3. Expanding rapidly to the northern area of S. Korea since 2000
1. MB index (Taketani et al., 1975)
   - Annual summation of temperature values subtracted 15°C from the mean monthly temperature exceeding 15°C

2. CLIMEX model (Sutherst and Maywald, 1985)
   - Environment of species life cycle (e.g. temperature, moisture, degree day etc.)
1. T-test: p < 0.05
   - Presence area (MB): 21.9±13.2
   - Absence area (MB): 16.1±14.2

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<tr>
<th></th>
<th>1971~2000</th>
<th>Area (ha)</th>
<th>2021~2050</th>
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<tr>
<td>Presence area</td>
<td>625,000</td>
<td>19 &lt; MB &lt; 22</td>
<td>500,000</td>
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<tr>
<td>Presence area</td>
<td>6,140,625</td>
<td>22 &lt; MB</td>
<td>7,984,375</td>
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CH 2. Case studies (Ecosystem sector)

Japanese pine sawyer beetle

1. Parameter values
   • Moisture index
   • Temperature index
   • Stress index: cold, heat, dry, wet

CLIMEX model

(source: https://openi.nlm.nih.gov/imgs/512/353/3164644/3164644_ppat.1002219.g002.png)
Japanese pine sawyer beetle

1. T-test: $p < 0.05$
   - Presence area (EI): $23.7 \pm 12.1$
   - Absence area (EI): $17.4 \pm 7.8$

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (ha)</th>
<th>EI Range</th>
<th>Prediction (ha)</th>
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<td>2006~2014</td>
<td>937,500</td>
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<td>2,296,875</td>
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<td>2046~2055</td>
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CH 2. Case studies (Ecosystem sector)

Pine wood diseases (PWD)

Introduction

1. First infection in Busan (1988)
2. Area: 9,644 ha (2014)
Pine wood diseases (PWD)

Introduction
1. Host: Coniferous forest
2. Invasive species: Pine wood nematode
3. Vector: Japanese pine sawyer beetle
**Pine wood diseases (PWD)**

**MB index**

1. Quite similar to reality
2. Moving towards inland area

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<th>Area (ha)</th>
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<td>93,750</td>
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<td>750,000</td>
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Pine wood diseases (PWD)

CLIMEX model

1. Under estimation than MB index
2. Moving towards high ground and coast area

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<th>Area (ha)</th>
<th>2046~2055</th>
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<td>218,750 25 &lt; EI</td>
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Thank you for attention

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