Eco System Research: Assessment Research based on Remote Sensing Data

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Ooba (NIES): Ecosystem Assessments based on Remote Sensing

Recent situation of renewable energy and woody biomass in Japan

Ecological and economical modeling of wood biomass production in a small region in central Japan

Integrate impact assessment by an ecological-footprint-like index (the occupancy time rate index, ORT)


Biomass usage in Japan
Total energy consumption in Japan

Renewable energy
including solar, wind, and geothermal, and various biomass energy

Biomass use in Japan
Not increase, innovatively, despite of intensive research and development by both governmental and private sectors

Source: Japan Center for Climate Change Actions

Ecosystem Services from Forest

Abundant Wood Biomass in Japan

Forest ecosystems also provide the ecosystem services to human society

Increase of timber volume accumulation and forest area in Japan

Source: Mizuho Research Institute

Water resource
Carbon sequestration
Conservation of biodiversity
Land conservation
Control of flood
Recreation
Biomass production
Nutrient & sediment flow
Water purification

Increase of timber volume accumulation and forest area in Japan

Unmanaged forest
(No understory vegetation)

Disaster by driftwoods from unmanaged forests

Troubles with wildlife

http://www.komeri-npo.org/record/downpour/gihu/h12/14/index.html
Difficulties: Sustainable biomass use

- Energy & heat from biomass is renewable and carbon neutral
- Sustainable usage of domestic wood biomass will conduct promoting domestic forestry and enhancing conservation of forest ecosystems in Japan
- Wood biomass can be supplied continuously from the forests without serious disturbance on ecosystems?
- Relatively high costs for forest managements and biomass productions in Japan.
- Integrated assessments are needed for production & usage of domestic wood biomass.

Objectives

- Biomass production and related environmental effects are simulated for a long-term (-2200) by ecological and cost calculation models in a selected small area
- Form the simulation results, impacts under various scenarios of forest management are assessed by a ecological-footprint-like index (the occupancy time rate index)

Study Framework

- Forest map/statistical data
- Forest GIS
- Forest ecosystem model
- Forestry economic model
- Cost calculation model
- BGC-ES (Ooba et al., 2010)

Environmental Assessment

Calculation of ORT (Occupancy Rate Time)

For an object,

\[ \text{ORT} = \frac{A}{P} \times \frac{1}{C} \]

A: Amount of the object
P: Occupation period
C: The capacity of the object, i.e., the potential amount, total area, purification ability, and available labor.

Development of GIS database

- Inventory Data Sets
- Inventory Database
- Forest GIS
- BGC-ES

Inventory

Inventory Database

GIS Database

Forest Database

Forest GIS

Forest Map

Scenario:
Managed area, Rotation length, Tinning schedule (timing, strength, usage rate)
**Forest biogeochemical model: BGC-ES**


**Output:** Ecosystem services

- Carbon sequestration
- Water runoff
- Nitrogen leaching
- Timber volume
- Erosion prevention

**Quantitative Evaluation**
From the past to futures under various scenarios

**Forest Management**

**Study area**


Study area map showing Asahi and Inabu regions in Aichi prefecture, Japan

**Cost calculation model**

The model was parameterized according to their comprehensive research and data about costs and usage of various forestry machineries in Japan

\[
C = (1 + \lambda) \sum (C_m + C_l) + C_{road} + C_{st} + C_{road}
\]

- \(C_m\): cost of forestry machines
- \(C_l\): cost of labor
- \(\lambda\): rate for overhead cost
- \(C_{road}\): access-road clearing cost
- \(C_{st}\): fixed cost

**Example:**
Logging distance 250 m, Transport distance 5 km

- Felling: Chainsaw
- Burking: Chainsaw
- Logging: Swing Yarder
- Forwarding: Grapple loader
- Transport: Track

**Machinery Cost**
- Chipper: 8,590 JPY m\(^{-3}\) (66 EUR m\(^{-3}\))

**Labor Cost**

**TPS1200**

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### Forest conditions in the study area

<table>
<thead>
<tr>
<th>Tree type</th>
<th>Plantation</th>
<th>Other forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cedar</td>
<td>5,789</td>
<td></td>
</tr>
<tr>
<td>Cypress</td>
<td>5,376</td>
<td></td>
</tr>
<tr>
<td>Pine</td>
<td>75</td>
<td>239</td>
</tr>
<tr>
<td>Needle leaf</td>
<td>82</td>
<td>3</td>
</tr>
<tr>
<td>Broad leaf</td>
<td></td>
<td>3,353</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11,322</strong></td>
<td><strong>3,595</strong></td>
</tr>
</tbody>
</table>

### Simulated forest scenarios

<table>
<thead>
<tr>
<th>Management Type*</th>
<th>Forestry Activity</th>
<th>Conversion to Secondary Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BAU</strong></td>
<td>Business as usual</td>
<td>Standard</td>
</tr>
<tr>
<td><strong>FM1</strong></td>
<td>Intensive management</td>
<td>Modified</td>
</tr>
<tr>
<td><strong>FM2</strong></td>
<td>Intensive &amp; extended management</td>
<td>Modified</td>
</tr>
<tr>
<td><strong>CNV</strong></td>
<td>Forest conversion</td>
<td>Modified</td>
</tr>
</tbody>
</table>

**Legend**
- BAU
- FM1
- FM2
- CNV

### Simulation results

- **Accumulated volume (m³ ha⁻¹)**
- **Averaged forest age (year)**
- **Harvested timber (kgC ha⁻¹ y⁻¹)**
- **Water runoff (mm y⁻¹)**
- **Carbon sequestration (kgC ha⁻¹ y⁻¹)**
- **Nitrogen leaching (kgN ha⁻¹ y⁻¹)**

**Legend**
- BAU
- FM1
- FM2
- CNV
**Cost calculation**

![Graph showing cost calculation](image)

**ORT Calculation in this study**

![Diagram showing ORT calculation](image)

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**Carbon balance between absorptions and practices**

Image showing carbon balance.
Integrating ORTs

Carbon emission considering a replacement effect of coal in combustion of wood biomass such as thermal power plant

Sum of ORTs

Labor (y)

Occupancy time rate (ORT) (y)

Landuse (y)

Carbon balance (y)

Remarks

For sustainable wood biomass production

- Carbon sequestration, which is a significant ecosystem service derived from plantation forests, can be enhanced by promoting forest management practices.
- Consideration of wood biomass in the ORT calculation reveals that conversion of plantations to secondary forests, where maintenance is expensive (high amount of labor work), has a good effect on ecological and social systems, if the biomass usage is taken into account using a suitable system of carbon offsets.

For sustainable wood biomass production

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Example: Integrated Assessment of the Ise-bay basin, Japan (2006-2011)
Recent publications


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