Monitoring of tropical forest changes using remote sensing techniques toward REDD and sustainable forest management

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REDD

Reducing Emissions from Deforestation in Developing countries

- New challenge toward next framework -
Outline

- Introduction of our feasible study on REDD in Southeast Asian countries
- Monitoring of deforestation and degradation using Remote Sensing
- Monitoring of illegal logging
- Monitoring of shifting cultivation
- Capability of remote sensing for monitoring and SFM
Research on the feasibility to estimate the GHG emissions reduction through Avoiding Deforestation

Estimating deforestation and emissions using a remote sensing technique

Creating the baselines of deforestation

In Cambodia, Laos and Thailand

Feasibility analysis of the AD mechanism

Proposal of improvement or alternative mechanisms

Contribution to Japanese government and International discussion through COP/MOP SBSTA IPCC

Creating the baselines of deforestation

Year

Baseline

Credit

Emission from Deforestation

Social and economic analysis

Examining the feasibility and issues of AD
Study Fields

- Thailand
  - Deforestation happened already

- Cambodia
  - On-going deforestation

- Laos
  - Deforestation in the near future

Harvested Forests Map using SPOT vegetation 1999-2004
Key Points of the Project

- **Mekong basin countries**
  - Different scale and process of deforestation from Indonesia and Brazil
  - Each country has different stages of deforestation

- **Remote sensing techniques**
  - Integration of several sensors including ALOS, MODIS, TM, IKONOS

- **Reference scenarios**
  - Trial of socio-economics models

- **Degradation**
  - Combination of remote sensing and ground survey

- **Socio-economics approaches**
  - Process of deforestation and degradation
  - Design and Governance
Scheme of Detecting Deforestation and Degradation

Deforestation

Logging / Forestation

Hot spot mapping

Deforestation / Degradation

Comparison

1. Change detection using mid-resolution images
   * Phenology phase
2. Hot spot detection
3. Sampling design
4. Interpretation design
   * Interpretation keys
5. Designing degradation index

Classification

Smoothing < 1ha

Year X (beginning)

eg. TM, ASTER, AVNIR-2

November

Year Y (End)

Modelling

Volume estimation for trees and stands

Comparison

Degradation index

Interpretation
1. land-use change
2. No of canopy
3. Canopy diameter

Sampling

Degradation / Deforestation

eg. QB, PRISM

Logging / Forestation

Comparison

1. Change detection using mid-resolution images
   * Phenology phase
2. Hot spot detection
3. Sampling design
4. Interpretation design
   * Interpretation keys
5. Designing degradation index

Classification

Smoothing < 1ha

November

February

Phenology phase correction

February

Degradation index

Modeling

Volume estimation for trees and stands

Comparison

Deforestation / Degradation

Classification

November

February
Detection of “Deforestation” using Remote Sensing

Clarifying the deforestation that can be stably detected using the mid-resolution imagery. Deforestation could be caused by a variety of background and with a variety of scale.
Selective logging is common in the commercial operations. Logging roads and the traces of harvesting along the roads are visible in the high resolution imagery.

Making Degradation Index using visual interpretation of the high resolution imagery.

- Fig. Degradation by Selective Cutting
- Year 1993 (Aerial photo)
- Year 2001 (Aerial photo)
- Extracted trees (Ex. Crown diameter=8.9m)
- Aboveground tree biomass (Mg)
- Tree crown diameter (m)
- Fig. relationship between Crown size and tree biomass
Site of illegal logging in Cambodia
Patterns of deforestation in Cambodia

- Conversion to farmland development by small-scale farmers (1-5 ha)

- Large-scale development by concession (rubber plantation, acasia plantation?) (10-1000 ha)
Shifting cultivation in northern Laos

Remote area (whole mountain or overall slope (30-100 ha)

Urban forest area (ownership is clear and patch distribution, 0.5-1.5 ha)

Shortening of rotation and enlargement of cultivation area

Conversion to rubber plantation after shifting cultivation
Monitoring of sifting cultivation by ASTER images

2002/2/9  2005/2/1
2003/3/16  2006/3/8

- Image pre-processing
- Object-oriented classification

6 years - shifting cultivation distribution map

Monitoring of sifting cultivation for six years
Field survey for validation of remote sensing results in Cambodia
Capability of remote sensing for monitoring and SFM

- Different definitions and difference between land use and land cover
- Limit of data acquisition of optical sensor
- Possibility and limit of SAR data
- Selection of method for change detection
Definitions of forest, non forest, conservation, degradation and deforestation
Cloud cover in optical sensor

Rate of Acquisition

\[
\frac{\text{Frequency of certain cloud cover}}{\text{Frequency of data acquisition}}
\]
Locality and seasonality of data acquisition

Landsat TM data acquisition in Laos and Cambodia

Data source:
GISTDAWeb
1997.7-2001.8
2003.11-2007.10
Change detection in Amazon using SAR images

Amazon mosaic (Rondonia area)

JERS (Sep/Dec, 1995, pixel spacing=100m)
Mode : FBS41.5[deg]
Polarization : HH
Map projection : Mercator

PALSAR (2006, pixel spacing=50m)
## Comparison of methods for change detection

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantage</th>
<th>Fault</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference</td>
<td>Simple and good result</td>
<td>Change of land cover types is not identified</td>
<td>High</td>
</tr>
<tr>
<td>PCA using two scenes</td>
<td>Cutting are and plantations appear in certain PC</td>
<td>Results are influenced by seasonal changes of vegetation and land cover</td>
<td>Medium</td>
</tr>
<tr>
<td>Change Vector Analysis</td>
<td>Properties of changes are clarified</td>
<td>Analysis of change vectors is complicated</td>
<td>Medium</td>
</tr>
<tr>
<td>Comparison between classification results</td>
<td>Land cover types are clarified</td>
<td>Accuracy of classification is different between two scenes</td>
<td>Low</td>
</tr>
</tbody>
</table>
Remarks

- Monitoring with remote sensing has advantages and limits for various types of deforestation.
  - Forest fire, sifting cultivation,… ?

- The difficulty of creating baseline from complicated factors of deforestation
  - How to simplify it or other ideas?

- It is very important how to act after monitoring of deforestation.
  - Strategy, requirements…..
Any questions?

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