Monitoring Land Use/Land Cover Change in Southeast Asia

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ABSTRACT

Land use/land cover change, particularly that of tropical deforestation, and forest degradation have been occurring at an unprecedented rate and scale in Southeast Asia. The rapid rate of economic development, demographics and poverty are believed to be the underlying forces responsible for the change. Accurate and up-to-date information to support the above statement, is however, not available. The available data, if any, are outdated and are not comparable for various technical reasons. Time series analysis of land cover changes and identification of driving forces responsible for such changes are needed for the sustainable management of natural resources and also for projecting future land cover trajectories. We analyzed the multi-temporal and multi-seasonal NOAA AVHRR satellite data of 1985/86, and 1992/93, and SPOT VEGETATION data of 1999/2000 to (1) prepare historical land cover maps and (2) to identify areas undergoing major land cover transformations (called "hot spots"). The identified "hot spot" areas were investigated using high-resolution satellite data such as Landsat and SPOT supplemented by intensive field survey. Shifting cultivation, intensification of agricultural activities and change of cropping patterns, and conversion of forest to agricultural land were found to be the principal reasons for land use land cover change in Oudomxay province of Lao P.D.R, Mekong Delta of Vietnam and Loei province of Thailand respectively. Moreover, land use/land cover dynamics of the region and typical land use/land cover change patterns of the 'hot spot' areas were also examined. We also developed a field-based methodology for land use/land cover change analysis at the national level with the help of national remote sensing institutions.

STUDY AREA
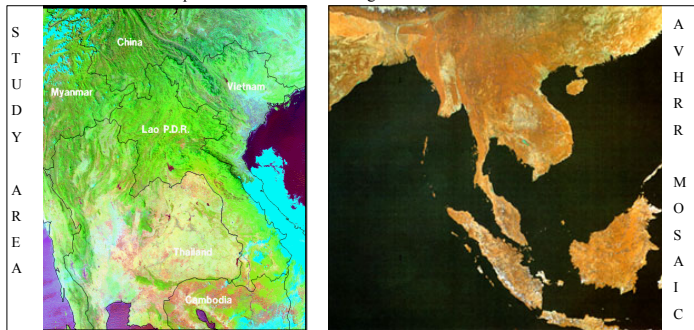
AVHRR MOSAIC

OBJECTIVES

1. Prepare cloud free and georeferenced mosaics of South and Southeast Asia using NOAA AVHRR satellite data;
2. Prepare time-series land cover maps of selected countries in South and Southeast Asia;
3. Identify 'hot spot' areas and investigate in detail using high resolution satellite data and ground survey;
4. Develop methodological guidelines and land cover classification system suitable for the project;
5. Training and hardware/software support to national institutions; and
6. Regional aggregation and analysis and serve as a regional data gateway to transfer data from
7. global to regional, national and sub-national level and vice-versa.
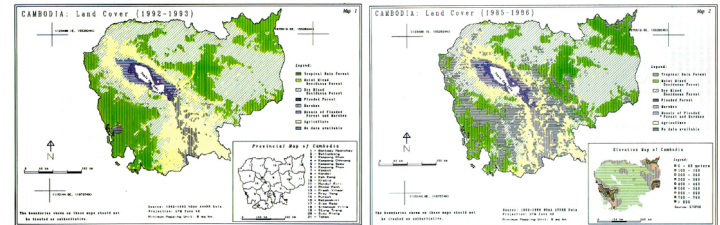
METHODOLOGY

NOAA AVHRR HRPT and LAC data were collected from NRCT(Thailand), SMA/SMC (China), EROS Data Center (USA), and NOAA/NESDIS (USA). Both harvest season and summer season data were used for the analysis. Pre-processing was performed for data extraction, noise removal, radiometric calibration, geometric correction, cloud masking and country masking. Radiometric calibration was performed using the procedures described by European Space Agency (ESA, 1991) Handbook on 'SHARP LEVEL-2: Development Procedures and Format Specifications' and by NOAA Technical Memorandum NESS 107 (NOAA/NESDIS, 1988) on 'Data Extraction and Calibration of TIROS-N NOAA Radiometers'.

Due to the lack of atmospheric data, atmospheric correction was not performed.To reduce the bidirectional reflectance effect caused by the viewing geometry and surface angular anisotropy affects of AVHRR channels 1 and 2 (Gutman 1991), images taken at large view angles (off-nadir views) which fall at the extreme of the scan line was excluded for the analysis. A two-step procedure was used for the geometric correction of AVHRR images. The images were first resampled to a reference map projection based on locational data generated by orbital model navigation. They were then further corrected by a linear first order rectification based on ground control points. Unsupervised classification was performed followed by iterative labeling.

Classification Approach
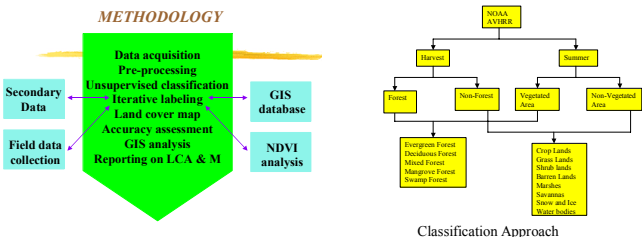
RESULTS

• AVHRR Mosaics of 1990/91 and 1998/99 were prepared and distributed in both hard-copy/digital format

• Land cover maps of 1985/86 & 1992/93 were prepared for Cambodia, Laos, Myanmar, Thailand and Vietnam. Areas undergoing major land cover transformations (hot spots) were identified.

• Major land cover change patterns were also identified.

• Regional aggregation and manipulation was performed. Hardware/software and training support was provided to national and sub-regional partners.


MAJOR FINDINGS

• NOAA AVHRR satellite data and the methodology adopted were found to be useful for the assessment and monitoring of land cover status and dynamics at a wider scale.

• Persistent cloud cover in many parts of Southeast Asia is a major problem working with AVHRR data

• NOAA AVHRR data are available in the region but systematic archive of these dataset are not available. EDC and NOAA/NESDIS were two important data sources for historical datasets.

• Pre-processing of NOAA AVHRR is time consuming and tedious.

• By combining results obtained from harvest season and summer season data, improvements in classification results were achieved. Active involvement of local expert during satellite data interpretation was found to be extremely useful.

• Mangrove forest possesses a distinct signature due to which even small patches of mangrove forests in Myanmar, Thailand, Cambodia and Vietnam were discriminated easily.

• Mosaic of forests and shifting cultivation in Northern Laos and Northern Vietnam was difficult to discern with AVHRR data resulting in overestimation of forest areas in these countries.

• Plantation forest areas less than the resolution of AVHRR sensor and beach forests occurring in a narrow strip along the coastlines were not able to discriminated.

• Regional aggregation and analysis was performed that serve as an important data source for state of the environment reporting.

HOTSPOT AREAS ANALYSIS

Three hot spot areas in Oudomxay province of Lao, P.D.R., Loei province in Thailand and Mekong Delta in Vietnam were investigated using high resolution satellite data (e.g. SPOT, Landsat) and field survey.

Shifting cultivation, conversion of forest to other lands and intensification of agriculture were found to be major causes of land cover transformations in Oudomxay province of Lao, P.D.R., Loei province of Thailand and Mekong Delta of Vietnam respectively

Shifting cultivation as seen from SPOT XS data in Laos

Land Cover Change Pattern
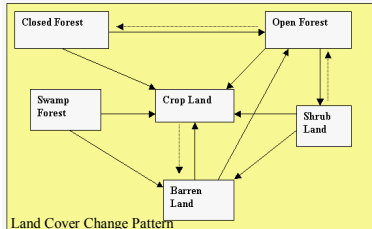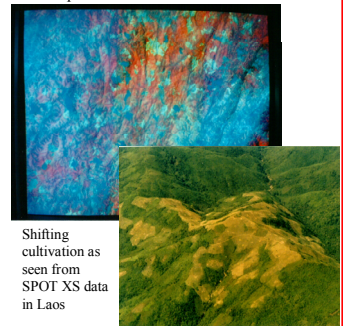
GLC 2000 partners on Asia & the Pacific

1. IRSA (China)
1. Academy of Forestry (China)
2. Chiba U/CERS (Japan)
3. IIRS (India)
4. Bogor U (Indonesia)
5. Bogor U (Indonesia)
6. Min. Agr. & For (New Zealand)
7. CIESIN (USA)
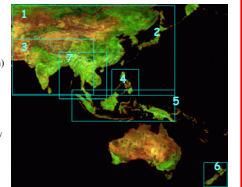
GLOBAL LAND COVER – 2000 (GLC-2000) FOR CONTINENTAL SOUTHEAST ASIA

Global Vegetation Monitoring unit of Joint Research Center (Italy) is coordinating and implementing the Global Land Cover 2000 project (GLC 2000) in collaboration with a network of partners around the world, the main purpose of which is to prepare a harmonized land cover database of the world for the year 2000 (http://www.gvm.sai.jrc.it). The Center for International Earth Science Information Network (CIESIN) of Columbia University is analyzing the data for continental Southeast Asia.

ACKNOWLEDGEMENTS

Reference:

Gutman G., 1991. Vegetation Indices from AVHRR : An Update and Future Prospects. *Remote Sensing for Environment*. Vol. 35, pp. 121-136.