GOFC Data and Information for Tropical Forest Assessment and Management

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ABSTRACT

This project started in May 1,2000. The objectives of this project are 1) to support the GOFC project by providing new data and data products for the world's tropical forests, 2) to evaluate the application of data and products to tropical forest management needs through collaboration with several forestry management agencies in tropical countries, coordinated through a network of collaborating scientists, and 3) to promote and strength linkages with national resource and forest management services collaborators for better dissemination of GOFC products. The primary data used are Landsat 7 ETM+ images. In the past year (5/2001 – 4/2002), we organized meetings with our users and collect field data in Thailand, Vietnam, Laos, and Cambodia. The purposes were two folds: 1) to deliver and verify our remote sensing products for forest management uses, and 2) to continue collecting detailed ground truth data for validation of fractional cover at varying spatial and temporal scales. The remote sensing products are now being now analyzed for various management purposes at different countries ranging from fire detection, forest degradation, to selective logging detection and monitoring.

Keywords:

1) Research Fields: Agriculture, Land Degradation, Rangeland Management
2) Geographic Area/Biome: Global, Grassland, Southeast Asia
3) Remote Sensing: Landsat, MODIS, SAR
4) Methods/scales: Data Fusion, GIS, Mixture Modeling; Spatial scales 1m, 4m, 30m, 250m, 500m, and 1km.

QUESTIONS, GOALS, AND APPROACHES

Scientific Questions to Be Addressed

The major science questions that this project aims to answer are: what are the changes in land cover and/or land use in the tropical southeast Asian region? Can we use Landsat images to quantify LCLUC of the region and provide improved Landsat products to assess the social and environmental impacts. By collaborating with the scientists from the region, this project will also address what the human and environmental causes of LCLUC are.

Social science constitutes a major component of this research, although we coordinate with another LCLUC project with Skole as the PI to enable its full implementation. The primary objective of this study is to develop new remote sensing products, which many can be directly used for understanding the dynamics of LCLUC in the region and the social drivers. Thus in combination with the project of Skole et al, this GOFC project probably comprises about 25% social science content.

The proportion of the project related to other aspects of ESE science priorities will roughly have the following themes:

Carbon (25%)
Water (0%)
Nutrients (0%)
GOFC (75%)
Other (0%)

Overall Goals

The overall goal of this project is to support the GOFC project by providing new data and data products for the world's tropical forests. Specifically, we aim at developing improved remote sensing products to characterize tropical forest in the Southeast Asian region, and evaluating the applications these products to tropical forest management needs by a series of demonstration meetings and site visits, through collaboration with several forestry management agencies in tropical countries. The ***goals of this past second year*** of this project were to 1) validate the forest density products developed within this project with intensive ground field data to quantify uncertainty or product confidence, 2) test the usefulness of these products in forest management practices, and 3) continue examining scale dependency of these products with an aim to expanding from Landsat scale to 1km VEGETATION scale.

Timeline of past year

Our proposed products include both raw satellite images and enhanced data products. We are making progresses on the development of both data and products as scheduled. Many Landsat TM and ETM+ have been acquired over the study region and some products have been developed and being validated (see our first report for details). In the second year, our focus was on the product improvement and validation. The table below indicates the overall progress. We are on schedule on all but one proposed products.

Timeline of the project: The green areas are completed while the red areas are to be completed.

Table 1. Project time line

	2000				2001				2002			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Data Acquisition												
ETM+												
VGT												
IKONOS												
Data Products Development												
Georeferencing												
Atm. Correction												
BRDF Normalization												
Forest Fractional Cover												
GLAI and fPAR												
Product Cal/Validation												
Calibration												
Validation												
Outreach												

Completed To be completed

Issues Encountered in the Second Year

We had planned to use MODIS and MISR data to produce forest density products but so far limited images from these two sensors are available. We will continue to request images from these sensors. It is more challenging than we expected to acquire ground fractional cover data of forests. Although several field trips were made to the study sites, more ground data are needed to represent the diverse forest type. The sites are quite heterogeneous and scaling of forest density from ground observation to satellite estimate appears challenging.

Original Approach

The approach we take for the development of remote sensing products include the 1) development of an operational atmospheric correction techniques, 2) development of sensor viewing and sun angle normalization procedures, 3)development of forest cover products such as forest densities and leaf area index. Because of the availability of georeferenced images from ETM+, MODIS, and SPOT sensors, we did not implement georeferencing techniques of our own.

PROGRESS AND NEXT STEPS

According to the original plan of our proposal, we have been progressing well in advance. We have developed some of the proposed products and organized a second user meeting in Chiang Mai, Thailand and field trips to collect ground truthing data. The timed events include the following:

User's meeting: We organized two user's training meetings in Thailand in the past year. The first one was held in Chiang Mai, Thailand from 9th – 14th, August 2001, and second meeting was held from 1/13/2002 – 1/17/2002. During the meeting, we updated the products improvement and validation activities while the users presented their uses of these products provided to them for various forest applications.

Field Activities: Several trips were made to further collect the seasonal forest characteristics in the past year sponsored by this project and an APN project. The sites and dates sampled included five countries:

- Mae Chaem Watershed and sub-watersheds, Chiang Mai, Thailand (August 2001)
- Mae Chaem Watershed and sub-watersheds, Chiang Mai, Thailand (January 2002)
- Tamdao National Park, Vietnam (August 2001)
- Luang Prabang – Sayaburi, Lao PDR (November 2001)
- Ratanakiri, Cambodia (November 2001)
- Berau, East Kalimantan, Indonesia (January 2002)

Two separate reports were written for these field activities. A detailed report on training of forest density estimation and application is placed at:
http://www.bsrsi.msu.edu/trfic/APN2001-09/pdf_files/2001-09%20Final%20Report.pdf

Detailed documentations of field activity of ground data collection and analysis from last year's results are attached in Appendix A. These documents are also available at:

http://foliage.geo.msu.edu/research/projects/gofc/fieldwork_report_01.pdf

http://foliage.geo.msu.edu/research/projects/gofc/fieldwork_report_02.pdf

Continued Product Development:

1) We continued fine-tuning of the atmospheric correction by using the relationship between band 3 and band 7. The focus in the past year has been on the sensitivity of the slopes of TM3 and TM7 of tropical regions. Although it was reported that the relationship was stable for quite number of surface types, we found that the slope is very variable in the tropics. It is expected however, that a unique set of slopes will be established for operational atmospheric corrections in the tropical Southeast Asia region.

2) We used AIRSAR derived DEM data and corrected bidirectional effect due to topography (slope and aspect) on the Landsat ETM+ images. We demonstrated that

topographic effect might be substantially reduced using DEM data and a simple bidirectional reflectance distribution function model. The effect of the BRDF correction on improvement of forest density products is being evaluated with ground data collected in January field trip.

Validation: Validation effort has been in two fronts: one is the forest density product validation and another is product usefulness validation by our collaborators in the Southeast Asia

1) Forest density product validation has been primarily relied on the field data and fine spatial resolution of IKONOS image. The field data analysis is reported in Appendix A at the end of this report.

2) Product usefulness validation has been an on-going activity. Forest density product (fractional cover) is being evaluated in two aspects: a) fire damage assessment and b) forest management.

New Findings: -

New Potential: It seems that the fractional cover products have a great potential to quantitatively assess the fire damage and selective logging.

New Products: Although nothing new, we attempted to use AIRSAR derived DEM and conducted a topographic correction of Landsat images over hilly regions in Thailand. Although the results need to be further analyzed, the approach of using a simple BRDF model to correct topographic effects seen on ETM+ images appears to be promising.

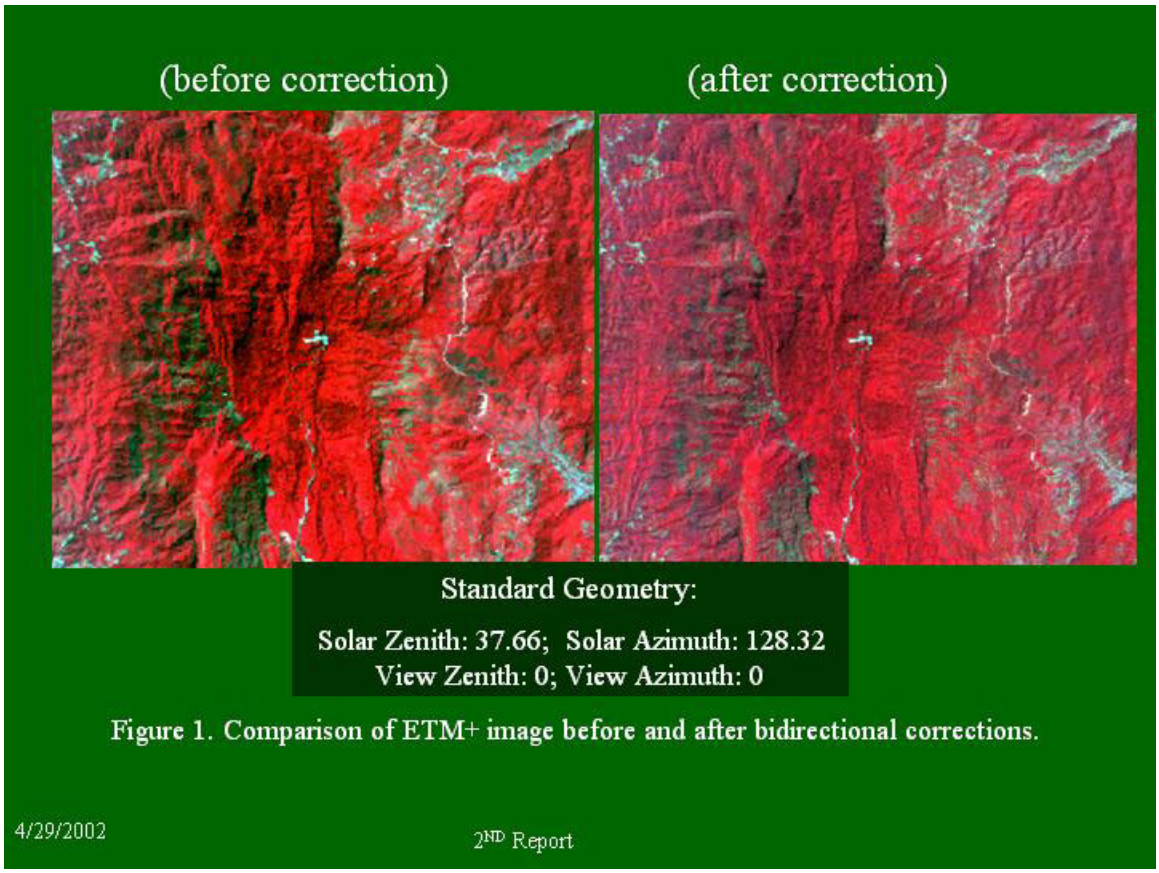

Figure 1. Comparison of ETM+ image before and after bidirectional corrections.

When scaled up to the scale of SPOT VEGETATION image, the fractional cover shows regional variations of forest density.

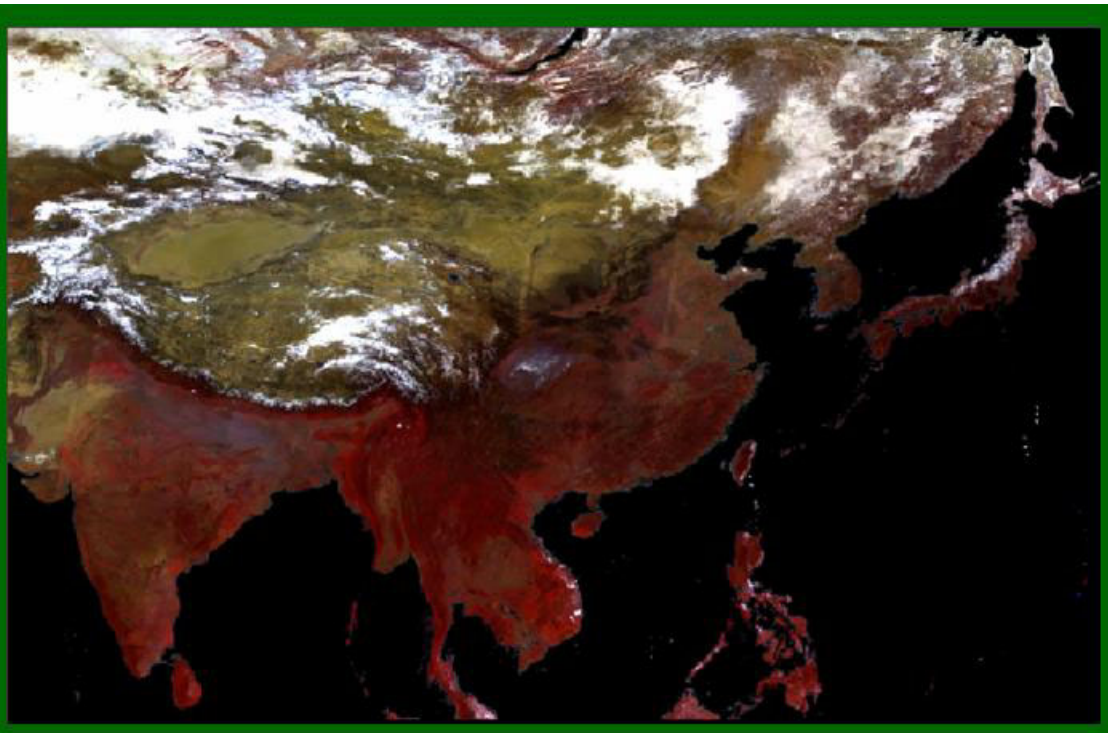

Figure 2a

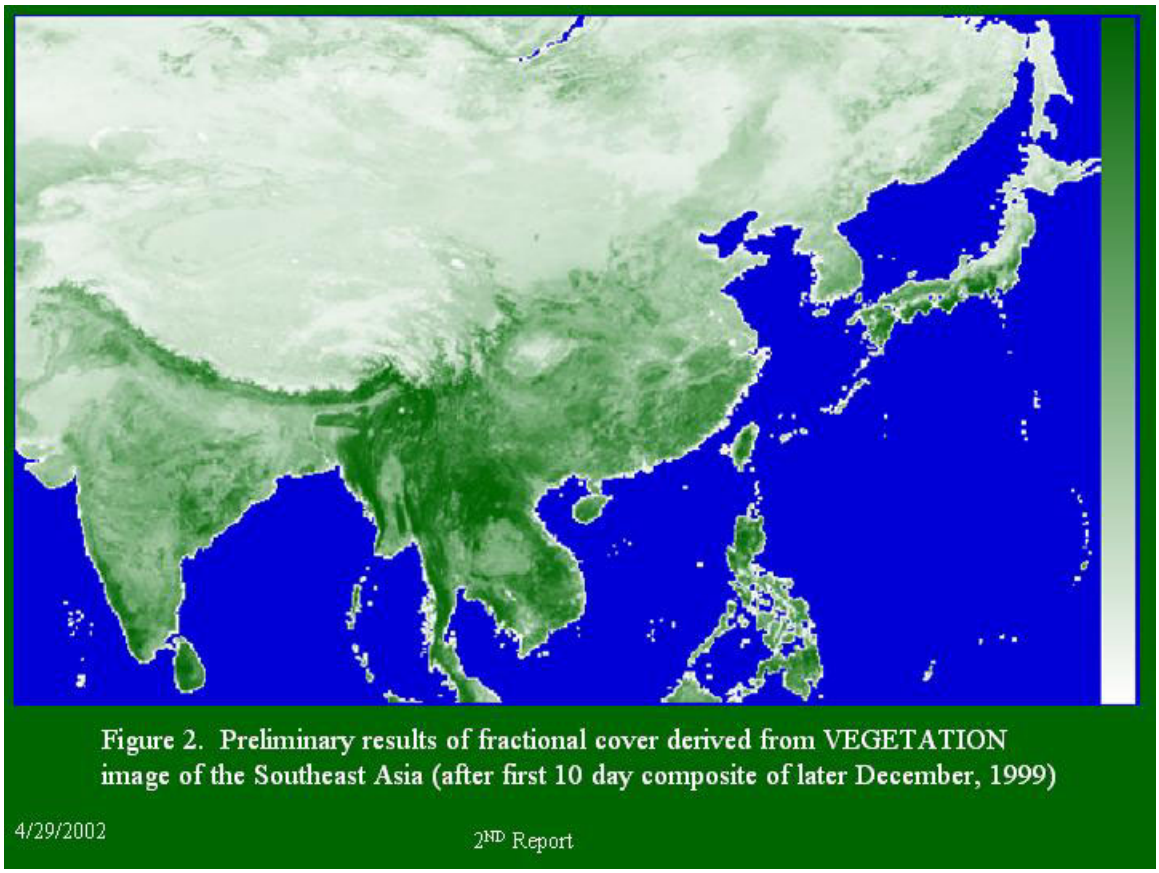

Figure 2. Preliminary results of fractional cover derived from VEGETATION image of the Southeast Asia (after first 10 day composite of later December, 1999)

Next Step:

While we will continue our product evaluation effort, new effort will be made to scale up field study to national and regional scales. For the validation effort, we have been granted IKONOS acquisition at our study sites and we plan on using these images to further validate our products together with ground truth data from fields of Laos, Vietnam, Thailand, and Philippines.

For the scaling up, we have already acquired and processed our initially proposed VEGETATION images over the entire Southeast Asia region. The fractional cover produced with this data set will be rigorously calibrated and validated with ETM, which has already been calibrated and validated with Ikonos and ground data (Figure 3).

At the same time we will summarize the atmospheric correction algorithms and make a report on the progress.

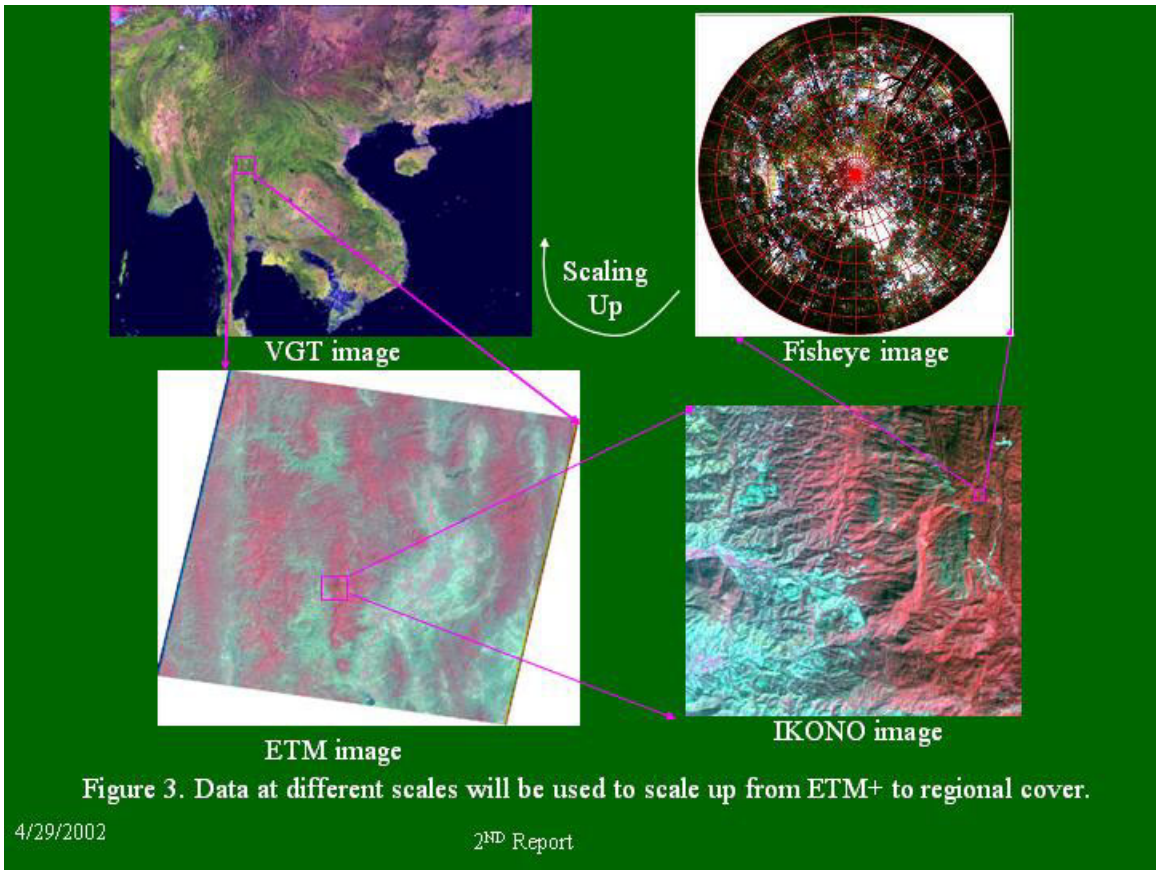

Figure 3. Data at different scales will be used to scale up from ETM+ to regional cover.

CONCLUSIONS

In conclusion, we have made substantial progress towards our goal to develop improved land use and land cover products in the Southeast Asia region. We have acquired substantial ground data for validation, with expected IKONOS data to be used in photo-interpretation for more extended validation effort. We have processed all VEGETATION images from our VEGA2000 project and will be used to produce seasonal fractional covers. We believe that we are on schedule to produce and delivery the GOFC products are proposed in the initial proposal.