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. Last year, we organized meetings and started collaborative work in the Southeast Asia. New remote sensing products are now being developed and validated by our collaborators in Thailand, Philippines, Indonesia, Vietnam, Laos, and Malaysia.

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

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 products, which many can be directly used for understanding the dynamics of LCLUC in the region, including 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 new remote sensing products to characterize tropical forest in the Southeast Asian region, and evaluating the applications these new products to tropical forest management needs by a series of demonstration projects through a collaboration with several forestry management agencies in tropical countries. In the first year of project life, we aim at developing operational algorithms to 1)correct atmospheric effect of Landsat images and to 2)map forest densities at 30m spatial resolution.

Timeline

Our proposed products include both raw satellite images and enhanced data products (Table 1 in original proposal). We are progressing the development of both data and products faster than we had expected. Many Landsat TM and ETM+ have been acquired over the study region and some products have been developed and being validated. More specifically, in the first year, we have accomplished the followings:

1. Level 1a products – We have acquired more than 245Landsat TM in 1992 and 160 ETM+ scenes from 1999-2000 in the SEA region and they are placed on our web site for dissemination to out collaborators.
2. Level 1b products – We have already been granted of SPOT VEGETATION images over the Southeast Asia and Asia regions.

3. Level 2 products – We have developed an operational algorithm that relies on the image itself and requires no additional atmosphere measurements. (See details below)
4. Level 3a products – An algorithm for computing fractional forest cover has been developed and is under rigorous validation with IKONOS data. (See details below)

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

			2000				2001				2002			
Activity	Products	Research Activities	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1		**Data Acquisition**												
1	1a	Acquisition of TM, ETM+ images												
1	1b	Acquisition of VGT and MODIS images												
2		**Data and Products Development**												
2	2a	Georeferencing												
2	2b	Atmospheric correction												
2	2c	Sun and view angle normalization												
2	3a	Forest fractional cover												
2	3b	Total green leaf area index and fPAR												
3		**Product calibration/validatio/outreach**												
3	4a	Product calibration												
3	4b	Product validation												
3	4c	Outreach												

Completed To be completed

Issues Encountered in the First Year

We anticipated the availability of image data products from MODIS and MISR sensors of Terra satellite early this year, but we have not been able to effectively download these images for the region yet. We plan to do this as soon as they become available.

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 team meeting in Manila with our collaborators to validate our products. Detailed products developed are provided previously.

New Findings: We have developed a first order product for fractional forest cover. This product has been initially calibrated and validated with IKONOS. It appears at this time that we should be able to successfully integrate this new product within the framework of products described by the GOFC Design Strategy. These products are important for understanding the dynamics of LCLUC, particularly human effects on forest degradation from logging and other forms. These are not well documented and understood in the region, and we are discovering large areas of forest degradation, which needs better measurement and mapping. Thus the products, which we describe in detail below, will be invaluable for understanding the spatial and temporal variability in LCLUC in SE Asia.

New Potential: We have put substantial effort in developing an operational technique to correct atmospheric effect on Landsat images. In the past, atmospheric correction of Landsat images requires some information about the atmospheric conditions be measured. However, atmospheric condition data are often difficult to obtain over large areas operationally. We have developed an approach that is independent of atmospheric measurements. In this approach we used the relationship between band 3 and bands 5/7 of Landsat images. Previous studies indicated that band 3 and band 5 (or 7) are linearly corrected with a slope of approximately of 0.5 when the data are free of atmospheric effect by aerosols. Due to atmospheric perturbation, the slope of the observed data would change. By using an atmospheric radiative transfer model such as 6S and MODTRAN, simulated data can be used to compute the atmospheric conditions under which the observed slope is. Then the atmospheric condition is thus determined and used subsequently for atmospheric corrections.

New Products: We have been developing and calibrating forest density products using a linear unmixing approach in spectral vegetation index domain:

$$fc = \frac{VI - VI_s}{VI_f - VI_s} \times 100$$

This approach has been tested in tropical Amazon region, but validation has not been performed in the Southeast Asia. A major challenge we encountered during the first year investigation is the validation. More specifically, the challenge is the spatial scales. At 30m resolution, we cannot "see" individual trees with Landsat images. However, when finer resolution data are used, the pixel Without good ground truthing such as aircraft-based images or airphotos, validation of the fractional forest density is difficult. However, we have acquired limited IKONOS images and the validation is underway. The preliminary results indicate that the scaling from IKONOS 1m to ETM+ 30m resolution presents a major challenge. Figure 2 is an example of forest fractional cover derived from Landsat and IKONOS images. The fractional forest cover was binned into 10 densities

and the comparison of the Landsat-derived fractional density with that derived from an IKONOS image at compared at 30m and 90m spatial resolutions is presented in Figure 2.

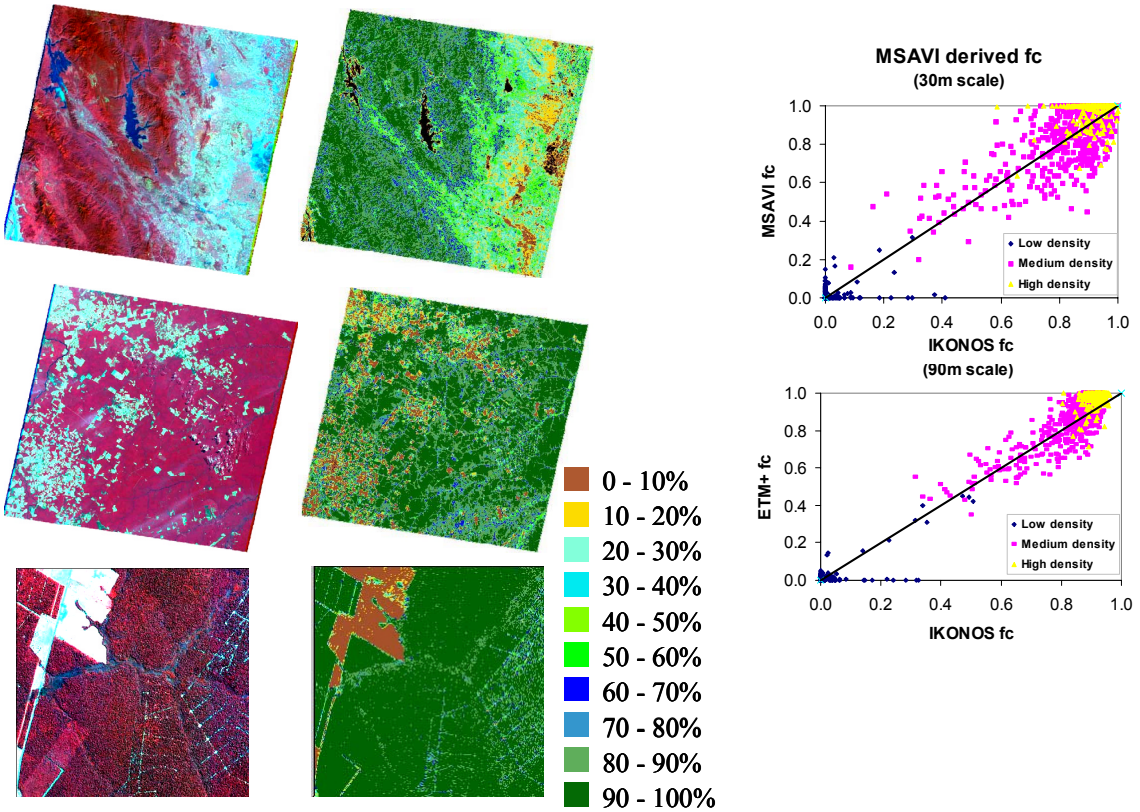

Figure 2. An example of forest product (fractional forest density) derived from Landsat ETM and IKONOS images (left), and validation at 30m (up right) and 90m (low right) spatial resolutions.

Next Step:

We have planned field trips to Thailand, Vietnam, Laos, Cambodia, and Indonesia this summer to collect ground truthing data with coincident Landsat image acquisition. The field trips will be 2 weeks each in Thailand/Vietnam and Laos/Cambodia and be joined by our collaborators in these countries.

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 believe that it is critical to have ground-truthing for validation. Field survey and measurements are needed, however, they are often limited in space and time. It is therefore critical to acquire high spatial resolution images from aircraft-based sensors such as MASTER that would provide detailed information for calibration and validation of both the improved forest products and the operational atmospheric correction algorithm.