MODIS VCF and Change: Global Disturbance Monitoring

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1. INTRODUCTION

Forest disturbance mapping with remotely sensed data at regional, biome or global scales is a challenge. Two approaches to quantifying change in forest cover are commonly pursued – mapping and sampling. Mapping is required for any application that mandates a spatially explicit product, while sampling enables estimation of change within a region while greatly reducing processing overhead. Global scale assessments using remotely sensed data sets involve either of these two exhaustive mapping or sample-based approaches. This paper presents results of both approaches at global and regional scales as examples of monitoring using multi-resolution, -spectral and -temporal remotely sensed data.

2. METHODS AND RESULTS

While global mapping at the high spatial resolutions (<50m) required to quantify forest extent and change may soon be undertaken, efforts to date have employed coarse spatial resolution data sets (1,2,3,4) (>250m), with only one attempting to quantify forest cover change (5). However, coarse resolution data lack the spatial detail required to adequately quantify area of forest extent and change. Probability-based sampling approaches that use high spatial resolution data have proven to be an effective alternative for quantifying forest extent and change over large areas, and biome-scale studies designed to overcome the varying quality and inconsistencies of national data sets have been implemented (8,9,10). The current UNFAO Forest Resource Assessment for 2010 employs a systematic sampling scheme to quantify biome-scale forest change dynamics from 1990 to 2005. This effort includes the analysis of over 10,000 Landsat samples. To reduce this processing overhead, multi-sensor approaches that enable targeted sampling have been prototyped. Stratified sampling guided by coarse resolution global-scale change indicator layers allow for efficient global and national-scale assessments of forest cover change and the quantification of trends over time.

One example of such an approach is the use of MODIS time-series of forest change indicators (based on the Vegetation Continuous Field mapping methodology) to stratify nations, regions and/or biomes for

analysis with higher spatial resolution Landsat data. Results from a series of biome-scale studies are being used to produce a global-scale synthesis (11,12,13). Such a method has also been used to quantify changes in rates for Indonesia. Results there highlighted a dramatic decline in mean annual forest cover loss when comparing the 1990 to 2000 and 2000 to 2005 epochs. Results demonstrate the viability of using multi-temporal, multi-sensor fusion approaches to disturbance monitoring.

Exhaustive mapping of forest disturbance using satellite data have evolved from the initial work highlighting the dramatic deforestation dynamic of the Brazilian Amazon (14) to the first annual large area deforestation monitoring system, Brazil's National Institute for Space Research PRODES project (15). Other countries have incorporated earth observation data into national monitoring schemes. India, for example, has a similar periodic forest extent and change product to that of Brazil (16). However, synthesizing global forest cover and change from national-scale mapping efforts is not currently feasible because national capabilities for forest monitoring vary greatly, and the methods and definitions concerning forest cover and extent differ among countries. Disturbance mapping at a continental scale has been prototyped for North America using Landsat data (17), pointing the way forward for regionally, and possibly globally consistent application of disturbance monitoring methods.

As a contribution to NASA's Mid-Decadal Global Land Survey study, a consistent method for mapping global forest cover change using Landsat data has been undertaken. Based on a method prototyped in the Congo Basin, where MODIS-scale forest cover Vegetation Continuous Field characterizations are used to pre-process Landsat time-series data, wall-to-wall quantification of forest disturbance is performed in an automated fashion (18). The method has been updated since the opening of the EROS archive to exhaustively mine the available imagery in producing maps of forest disturbance. Initial results for 2000 to 2010 for Indonesia, the Democratic Republic of Congo and European Russia point the way forward for consistent, global-scale quantification of forest change.

In summary, methods for global monitoring of forest cover change using multi-sensor inputs are maturing. While sampling methods afford an efficient and accurate approach to global-scale assessments, many applications require spatially explicit data. Automated methods for high-spatial resolution mapping of forest cover disturbance are under development and will soon be implemented at the global scale.

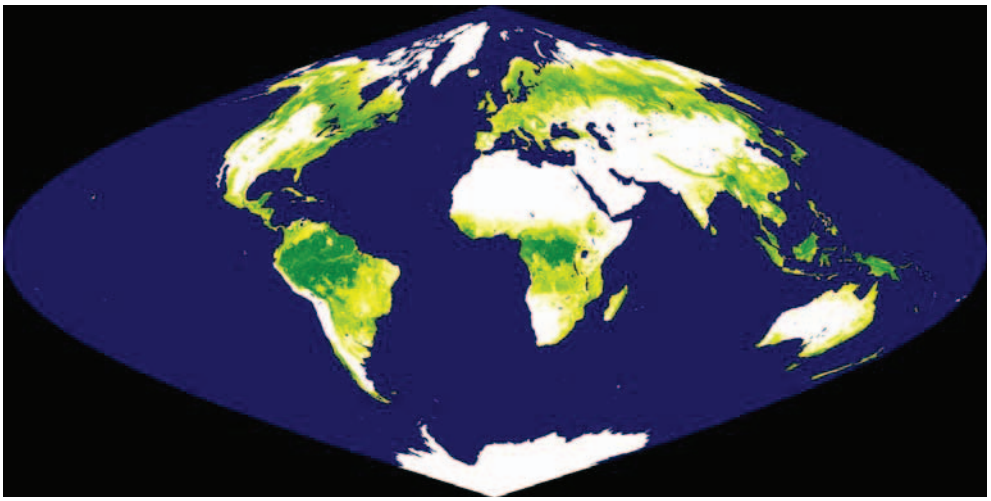

Figure 1. Forest area estimation from MODIS calibrated by Landsat.

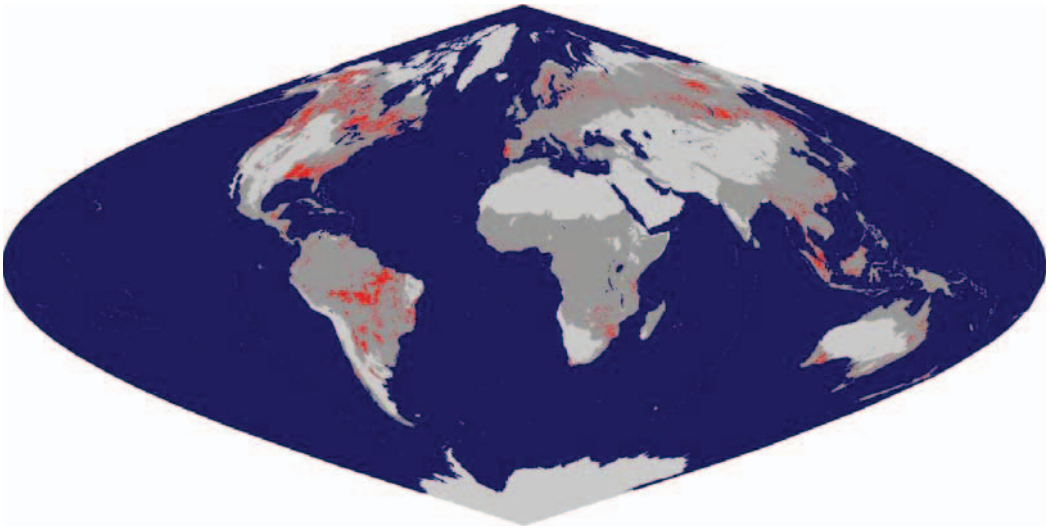

Figure 2. Forest cover loss as indicated by MODIS data.

3. REFERENCES

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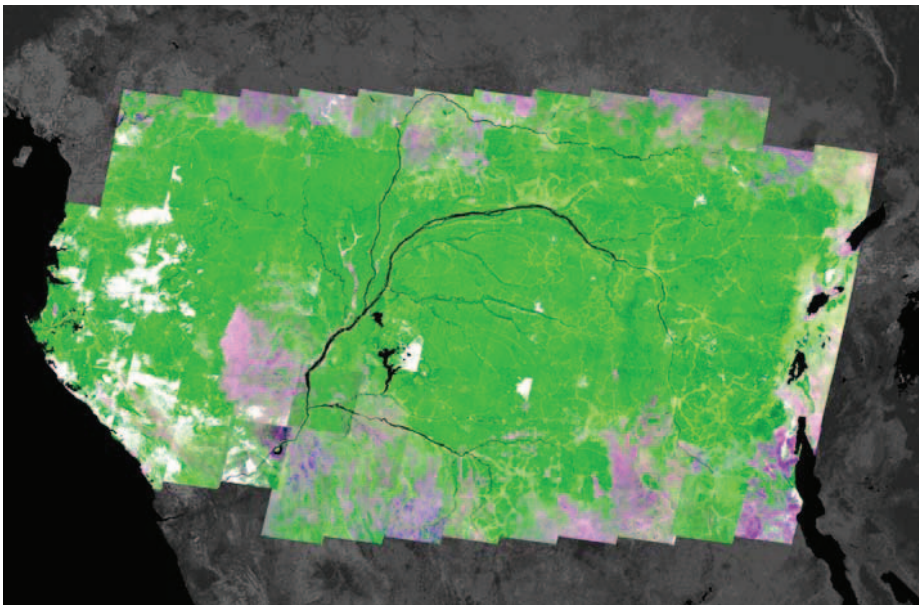

Figure 3. Landsat composite generated via MODIS-driven automated processing.

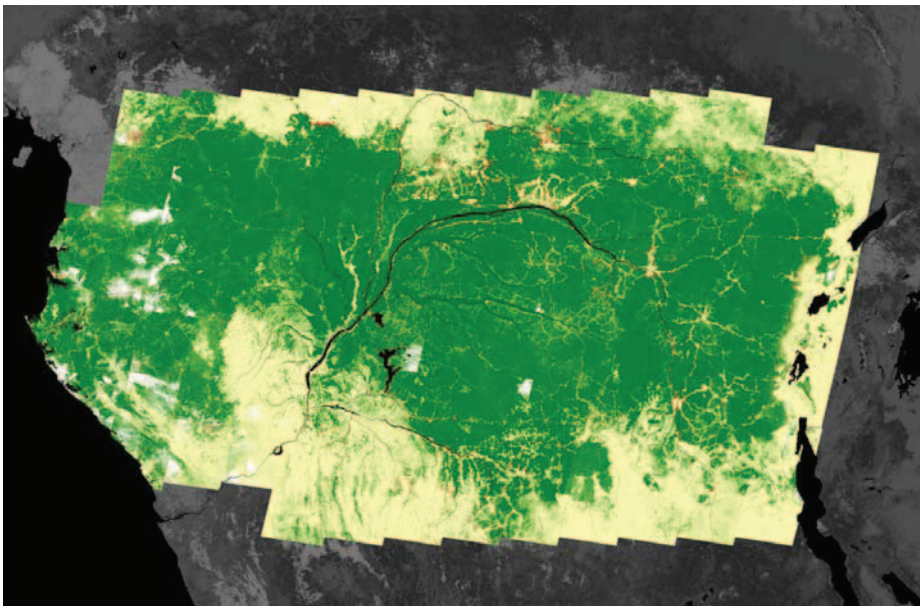

Figure 4. 1990 to 2000 forest cover extent and loss using MODIS/Landsat mass processing approach.