Forest Degradation Assessment in the Brazilian Amazon

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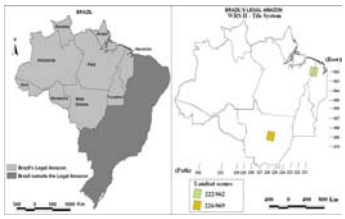
INTRODUCTION

Overview:

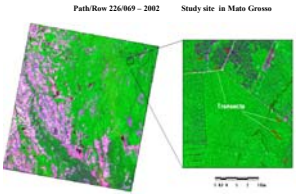
Fire in tropical forests is a severe and growing problem that is exacerbated by both forest fragmentation (Cochrane, 2001) and selective logging (Cochrane et al. in press). Anthropogenic fire-use is now the dominant disturbance in many regions of the Amazon basin. The resultant changes in the fire regime of these forests create a positive feedback in which successive fires are more likely and more severe (Cochrane et al., 1999). The consequences of this altered disturbance regime may be the irreversible eradication of many currently forested areas, with extreme repercussions upon regional climate, biodiversity and socioeconomic opportunities (Cochrane 2003). Despite the importance of uncontrolled forest fire in the tropics there is no basin-wide knowledge of how much forest has burned in the Amazon.

The work, funded by this project, includes calibration of an established method for detecting and classifying burned forests (Cochrane and Souza Jr., 1998) for various forest types and damage levels at several sites across the Basin. Through use of multitemporal imagery analyses, the spatially articulated fire regimes of several regions across the landscape will be estimated with specific attention to any spatio-temporal relationships between selective logging activity and fire. Given that fire regimes are a function of both climate and landscape configuration (Cochrane, 2001), this knowledge will allow for the modeling of landscape level impacts (Cochrane and Laurance, 2002). These information will be critical for understanding and predicting future land cover changes in the Amazon.



Field visits to two study sites in the Amazon states of Para and Mato Grosso, the municipalities of Paragominas and Nova Ubiratan, respectively (figure 1), were completed during August 2003.

Fieldwork included land cover validation, empirical observation, ground measurements (biomass quantification and plant diversity), and hemispherical canopy photos for canopy openness quantification and fractional cover validation. These tasks were performed at different forest sites in each region, including undisturbed, logged, and burned forests.

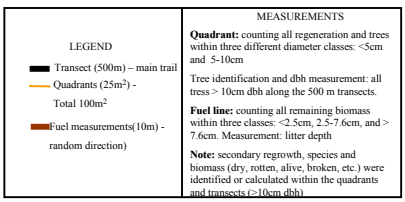


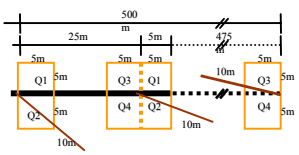
- State of Para: total of 2110 meters, 6 transects, and 211 hemispherical photos

- State of Mato Grosso: total of 3250 meters, 7 transects, and 325 photos

- Hemispherical photos were acquired beneath the canopy of undisturbed, logged, and burned forests

Field Procedures:





Using the transect trails, run a cord (50 meters) to mark 10 meter intervals

Using a two axis level, snap vertical hemispherical photos from beneath the canopy.

CANOPY DEGRADATION

Undisturbed forest canopy

Forest disturbed by logging and fire

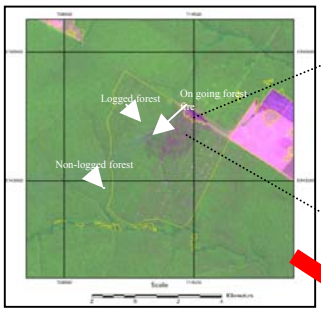
Fish eye lens photo of undisturbed forest canopy

Fish eye lens photo of disturbed forest canopy

Imagery Analyses

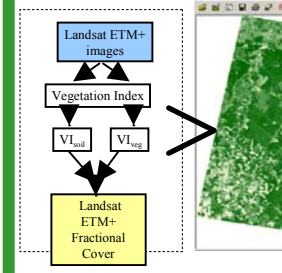
In this analysis ETM+ MSAVI (Qi et al. 1994, Wang et al. 2003) derived fractional coverage was used. The index results show the fractional percentage of green vegetation. There is considerable variation in the fractional cover within disturbed forests while those within undisturbed forests have lower variances. The technique shows promise for monitoring vegetation change due to disturbance and subsequent regeneration. (Data provided by Eraldo Matricardi)

Color Composite ETM+ RGB 5/4/3

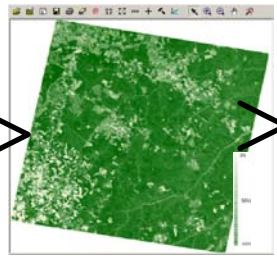


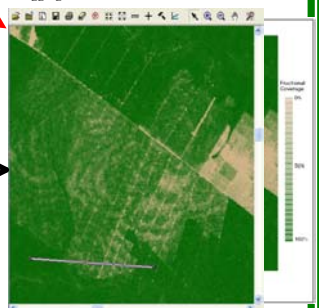
Detail of fractional cover image of the logging area after much of it has burned

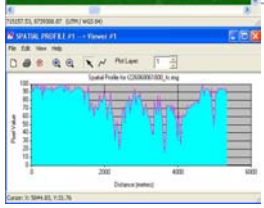
Fractional Coverage:



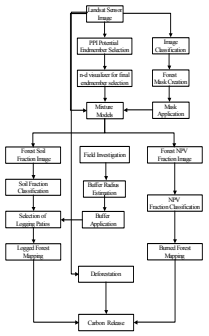
Example of Fractional Coverage for an entire Landsat scene





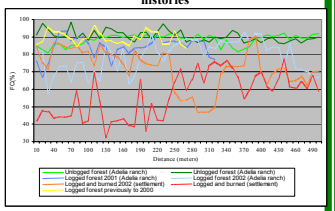


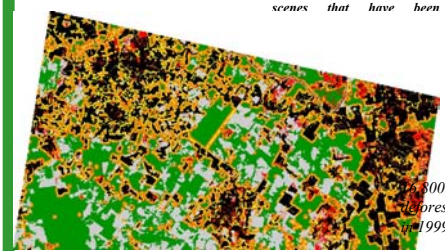
Linear cross section of forest fractional cover covering both disturbed and undisturbed forest



Schematic diagram of the procedures proposed for measuring the areas of Amazônia affected by selective logging and fire, and subsequently estimating potential carbon release. Although the logging analyses have been completed for years 1992, 1995 and 1999 under other grants (PI Skole), the land cover analysis has been more complicated than anticipated due to the similarities between severely burned or logged forests and forest regeneration. To rectify this, Kodandapani and Matricardi have systematically edited the scenes that have been

Fractional coverage field measurements for forest transects with a variety of different disturbance histories





A 800 km² sample landscape showing combined effects of deforestation (black), fragmentation (yellow/orange), fire of 1999(red) and selective logging 1992-1999 (gray).

Publications resulting from research funded by this grant (NASA NIP 2002):

Cochrane, M.A. 2003. Fire Science for Rainforests. *Nature* **421: 913-919.**

Cochrane, M.A., D.L. Skole, E.A.T. Matricardi, C. Barber and W. Chomentowski. Selective Logging, Forest Fragmentation and Fire Disturbance: Implications of Interaction and Synergy for Conservation. In *Working Forests in the Tropics: Conservation through Sustainable Management?* **Edited by D.J. Zarin, et al. Columbia University Press. (in press).**

Johnson, E.A. and M.A. Cochrane. 2003. Disturbance Regime Interactions. Pp. 39-44 in *Climate Change and Biodiversity: Synergistic Impacts***. Edited by T. Lovejoy and L. Hannah. Advances in Applied Biodiversity Science, Number 4. Conservation International. Washington, DC.**

Skole D.L. and M.A. Cochrane. Observations of LCLUCC in Regional Case Studies. In *Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface* **(Gutman et al. eds). Kluwer Academic Publishers (in press).**

Skole D.L., M.A. Cochrane, E.A.T. Matricardi, W. Chomentowski, M. Pedlowski and D. Kimble. Pattern to Process in the Amazon Region: measuring forest conversion, regeneration and degradation. In *Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface* **(Gutman et al. eds). Kluwer Academic Publishers (in press).**

Csiszar, I., C.O. Justice, A.D. Mcguire, M.A. Cochrane, D.P. Roy, F. Brown, S.G. Conard, P.G.H. Frost, L. Giglio, C. Elvidge, M.D. Flannigan, E. Kasischke, D.J. McCrae, T.S. Rupp, B.J. Stocks, and D.L. Verbyla. Land Use And Fires. In *Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface* **(Gutman et al. eds). Kluwer Academic Publishers (in press).**