

July 2002 USDA Forest Service Semi-Annual Report to USAID

Sustainable Forest Management Highlights

- Detailed comparisons of the effects of reduced impact logging (RIL) and conventional logging (CL) on canopy opening have been completed. RIL caused only about half as much canopy damage as Conventional Logging. A paper has been accepted by *Forest Ecology and Management* to be published in December 2002.
- Researchers are developing methods to detect logging and to estimate canopy damage. The research teams results show that a linear mixing model of Landsat bands can be used to estimate canopy damage. This paper in press in *Ecological Applications* opens new possibilities for logging detection and analysis using readily available satellite data.
- From this research, a practical tool could be developed with a limited amount of new funding to translate the research approach into a practical product. Support would be needed for a computer programmer as well as other field professionals.
- In the Biophysics studies, over 30 km of transects laid out and researched in the Tapajos National Forest show large and significant difference between the coarse woody logging debris in conventionally logged blocks compared to reduced impact logging blocks. Follow-up transect studies are used to monitor the continuing input of coarse woody debris to the forest floor. This is an important component of the carbon cycle that has been ignored in past studies.
- Field activities began in October 2001 on the Acre Mahogany Management Project with an inventory of mahogany and 10 associated timber species in 500 hectares of primary forest on steep terrain located 40 km south of Sena Madureira near the Iaco River.
- Synthesis of field results from southeast Pará plus planning for field activities in Acre led to publication by Imazon in late April 2002 of “Mogno na Amazônia Brasileira: Ecologia e Perspectivas de Manejo.

Sustainable Forest Management Activities and Progress

The Effects of Harvesting on the Tapajos National Forest

This project has 2 goals: (1) To evaluate the effect of selective timber harvest at the Tapajos National Forest on a wide range of ecosystem functions, and (2) To evaluate the economic efficiency and effects on harvest system sustainability for alternative methods of land management. Research activities can be grouped into 6 themes. Divisions among these themes are somewhat arbitrary and function primarily to illustrate the range of activities that the USFS and IBAMA will pursue as part of the Tapajos Project, with substantial leveraging from the INPE/NASA LBA project. Harvests are ongoing at the FLONA Tapajos. In 1999 only 100 ha were harvested, in 2000 nearly 1000 ha were harvested, in 2001 approximately 600 ha were harvested. An additional 600 ha is scheduled for timber harvest from June through December 2002. With current progress, the entire concession of 3200 ha. will be logged by the end of the calendar year 2003.

Harvesting Systems.

Researchers from Auburn University and the University of New Hampshire surveyed a recently harvested (Square 2, Block 1) and adjoining undisturbed control area in 2002. They took samples to measure the effects of harvesting on soil properties. This area was previously surveyed in 1996 in preparation for this study. Several students from Auburn University and the Federal University of Para participated. Data analysis continues.

Stanford University, University of New Hampshire Researchers and the Fundação Floresta Tropical have done detailed comparisons of the effects of reduced impact logging (RIL) and conventional logging (CL) on canopy opening. RIL caused only about half as much canopy damage as CL. A paper has been accepted by *Forest Ecology and Management* to be published in December 2002.



During August 2001, the researchers complemented this survey by measuring logging residues (coarse woody debris) generated by the harvest activity in two 100 ha logged blocks and two control areas. In addition, they set up studies to measure the ongoing process of branch-fall and tree mortality following logging. Logged blocks are compared to controls.

LBA researchers, Jeff Hicke, Kevin Cody, Michael Keller,

Michael Palace, collecting data in Cauaxi, Brazil.

A preliminary analysis of data from Tapajos and also the Fazenda Cauaxi in Paragominas Municipality, Pará State has been completed. This analysis shows that reduced impact logging (RIL) produced only half as much logging residue one year following single tree selection harvests as conventional logging (CL). This has important implications for carbon budgets and recovery.

Biophysics

Eddy covariance studies of carbon dioxide and water vapor flux are continuing at the tower sites. Logging took place around the tower at km 83 from August 2001 through January 2002. A control site is has been operational at km 67 since April 2001. Researchers from Harvard University, University of California and University of Sao Paulo have acquired more than 1.5 years of continuous data at the logged site. In addition, they have also acquired more than 1 year's worth of data at the control site at km 67. The data is publicly available (<http://beija-flor.ornl.gov/lba/>). University of New Hampshire and EMBRAPA scientists have operated automated instrumentation to measure soil moisture and the emission of carbon dioxide from the soils at logged and control sites since April 2001. Researchers are also taking similar measurements at the logged site.

To complement the carbon budget effort, researchers are studying the cycling and decomposition of coarse woody debris in harvested and undisturbed blocks at the FLONA Tapajos and Cauaxi site. Over 30 km of transects show large and significant difference between the coarse woody logging debris in conventionally logged blocks compared to reduced impact logging blocks. Follow-up transect studies are used to monitor the continuing input of coarse woody debris to the forest floor. This is an important component of the carbon cycle that has been ignored in past studies.

Permanent plots at the FLONA Tapajos are being monitored by Harvard University Researchers at sites that were logged in 2001 and undisturbed sites. Over 2000 trees have been measured with dendrometer bands for precise measurements of diameter increment over the short term. The data is publicly available (<http://beija-flor.ornl.gov/lba/>).

Biogeochemistry

Researchers continue to monitor nutrient and trace gas effects of harvesting. A second survey was completed on sandy-clay soil. Preliminary indications are that timber harvesting increases nitrous oxide and methane emissions measurably. However, when these emissions are extrapolated to a wider area, the effects of harvesting on trace gases (expressed as a Global Warming Potential) are far smaller than the effects from the carbon loss. These results were will be presented by a Forest Service Researcher in a keynote address at the Second LBA Scientific Conference.

Remote Sensing of Logging

Stanford University, Forest Service, EMBRAPA, Fundação Floresta Tropical researchers are developing methods to detect logging and to estimate canopy damage using remote sensing analysis. Work to date has focused on readily available Landsat multispectral imagery. Analysis

of Landsat images compared detailed field observations at the Fazenda Cauaxi shows that simple band comparisons and textural analysis are insufficient for estimation of logging damage although textural analysis may be useful for location of logging activity.



A Michael Palace using laser range finder to measure tree Geometry - canopy height, depth and crown width.

More recent work by the same team shows that a linear mixing model of Landsat bands can be used to estimate canopy damage. This paper in press in *Ecological Applications* opens new possibilities for logging detection and analysis using readily available satellite data.

Conversion of the algorithms developed by this research team into applications usable by government agencies, business enterprises, and non-governmental organizations would represent a major new practical tool for monitoring of logging in tropical forests. A practical tool could be developed with a limited amount of new funding needed to support a programmer as well as professionals who could help translate the research approach into a practical product.

Big-leaf mahogany in the Brazilian Amazon: its life history and management in natural and artificial systems

The Mahogany Project in Brazil has shifted geographical focus from southeast Pará, where studies of mahogany's growth and regeneration ecology have been on-going since 1995, to the western Amazonian state of Acre. There, management recommendations derived from field research in Pará for mahogany's sustained-yield production from natural forests are being tested as part of a pilot management project implemented within a private land-holding of approximately 8000 hectares.

Field activities began in October 2001 with an inventory of mahogany and 10 associated timber species in 500 hectares of primary forest on steep terrain located 40 km south of Sena Madureira near the Iaco River. Inventory and preparation for logging activities during the 2002 dry season continued through the 2001-2002 rainy season.

Field studies on mahogany in southeast Pará could have a direct and substantial impact on forest policy in the Brazilian Amazon through application of management recommendations in the state of Acre. With mahogany's felling, transport, and commercialization banned in Brazil since October 2001 due to widespread irregularities in industry logging practices, viable harvesting regulations for mahogany that are both profitable and enforceable are urgently needed to restore credibility to Brazilian supplies of mahogany. Synthesis of field results from southeast Pará plus planning for field activities in Acre led to publication by Imazon in late April 2002 of "Mogno na Amazônia Brasileira: Ecologia e Perspectivas de Manejo.

New Publications this Period:

Asner, G.P., M. Keller, R. Pereira Jr. and J.C. Zweede. 2002. Remote sensing of selective logging in amazonia: Assessing limitations based on detailed field observations, Landsat ETM+, and textural analysis. *Remote Sensing of the Environment* 80:483-496.

Barreto, P., Grogan J., and A. Veríssimo. 2002. Mogno na Amazônia Brasileira: Ecologia e Perspectivas de Manejo. available at www.imazon.org.br.

In Press

Pereira, R., J.C. Zweede, G.P. Asner, and M. Keller. In Press. Forest Canopy Damage and Recovery in Reduced Impact and Conventional Selective Logging in Eastern Para, Brazil. *Forest Ecology and Management*. (Publication expected in December 2002).

Asner, G.P., Keller, M. Pereira Jr., R., Zweede, J.C. and Silva, J.N. In Press. Canopy Damage and Recovery Following Selective Logging in an Amazon Forest: Integrating Field and Satellite Studies. *Ecological Applications*

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Other Collaborators

Jason Neff - provides expertise to describe behavior of organic matter at the FLONA Tapajo
Alan Townsend and Greg Asner (University of Colorado) and Mercedes Bustamante (University of Brasilia) provide expertise in the analysis of satellite imagery and soil and vegetation samples from the vicinity of the FLONA Tapajos.

Fire and Environmental Change Highlights

- The Fires and Environmental Research Applications Team, USDA Forest Service and Brazilian collaborators continued the distribution of the first volume of the Cerrado photo series in Brazil and the United States. The photo series is a bilingual publication. A bilingual brochure that describes the photo series is being distributed to a large mailing list that includes personnel from all Brazil's Federal and State protected areas, and agencies and institutions involved in management and conservation in the Cerrado region.
- The Cerrado photo series publication was presented on a poster and display at the 5th Brazilian Congress of Ecology in November 2001 in Porto Alegre. Also, a significant number of copies have been distributed on request to world scientists concerned with global emissions, management, and conservation of Cerrado or savannas.
- Collaborative research projects continue with the IBAMA, INPE's combustion laboratory, the University of the State of Sao Paulo, and the University of Washington, in Alta Floresta, Mato Grosso, Brazil. Data from a 2001 experimental burn was completed and preliminary data was presented at the 2nd International LBA Conference in Manaus in July, the 5th Brazilian Congress of Ecology in November 2001 in Porto Alegre, and ENCIT 2002.
- Laboratory tests continue in the combustion furnace at INPE's laboratory facilities in Cachoeira Paulista. Testing will continue in 2002 and 2003. Full analysis of combustion gases is also being conducted with a field campaign on smoke analysis in flaming and smoldering combustion scheduled for 2003 and 2004. Laboratory tests will provide improved combustion rates and better smoke emission factors from Amazon forest burning.
- The FERA team and Brazilian cooperators continue to participate in Brazilian conferences and workshops to disseminate results generated by this cooperation. Two posters were presented at the 5th Brazilian Congress of Ecology in November 2001 in Porto Alegre, Rio Grande do Sul.
- FERA and the Universidade de Brasilia began planning field work for the second volume of the Cerrado photo series. Pre-selection of field sites has been completed by collaborators from the University.
- In March 2002, Dave Sandberg, Roger Ottmar, and Ernesto Alvarado presented a seminar on their work in Brazil at the International Programs office in Washington, DC. They presented an overview of accomplishments since the cooperation with Brazil began, and future direction of the collaborative program.

Fire and Environmental Change Activities and Progress

Combustion and Carbon Emissions from Tropical Biomass

The Fire and Environmental Research Applications Team, USDA Forest Service, Pacific Northwest Research Station, continue a successful and active cooperative program with Brazilian counterparts. On March 28 of 2002, USFS and University of Washington researchers delivered a seminar on the work in Brazil at the International Programs office in Washington, DC. Attending the seminar were personnel from International Programs and from other governmental and non-governmental agencies involved in international work in natural resources, e.g. USAID, the Brazilian Embassy in Washington D.C., the World Bank, Conservation International, and others. They presented an overview of accomplishments since the cooperation with Brazil started and future direction of the collaborative program.

FERA continues with the successful campaign in collaboration with IBAMA, INPE's combustion laboratory, the University of the State of Sao Paulo, and the University of Washington, in Alta Floresta, Mato Grosso, Brazil. A new INPE scientist and new UNESP graduate students have joined the group. A faculty and student group from the Biology and



Prescribed burn in Alta Floresta, Brazil

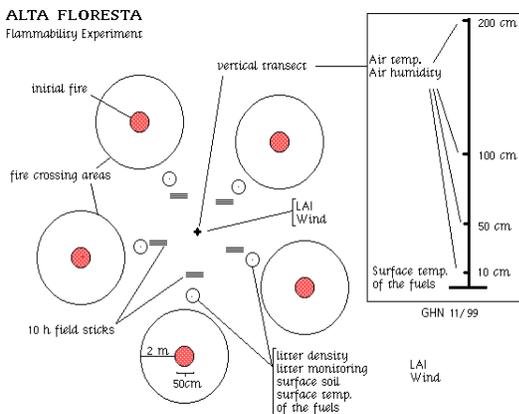
Forestry Departments at University of the State of Mato Grosso joined the group to support the field campaign in Alta Floresta. The manuscript *Biomass Fire Consumption and Carbon Release Rates of Rainforest Clearing Experiments Conducted in Northern Mato Grosso, Brazil*, (Carvalho and others 2001) published in the *Journal of Geophysical Research* has been widely distributed among scientists working in regional and global carbon emissions assessment.

Results from the FERA-INPE-UNESP cooperation have been presented in several scientific forums in the two countries. The group presented papers in ENCIT 2002 and the 5th Brazilian Congress of Ecology in November 2001 in Porto Alegre. Research continues on smoldering modeling. The model was developed by Dr. Fernando Costa during a 1-year sabbatical at the USDA Forest Service, Pacific Northwest Research Station, Corvallis, Oregon. A manuscript of the enhanced version of the model is being prepared for publication. Dr. Costa's sabbatical was sponsored by the Forest Service and Brazil's FAPESP.

Data analysis continues on the experimental burn in 2001 on the "arc of deforestation" in Alta Floresta, Mato Grosso. This burn tested and validate combustion hypothesis that have been developed from laboratory burnings. Preliminary data from a 2001 experimental burn was presented at the 5th Brazilian Congress of Ecology in November 2001 in Porto Alegre, and the 9th

Brazilian Congress of Thermal and Engineering Sciences (ENCIT 2002). Three presentations have been submitted and accepted for presentation at the 2nd International LBA Conference in Manaus in July 2002.

The work in the combustion furnace continued at INPE's Cachoeira Paulista laboratory facilities. The scheduled laboratory tests in the combustion furnace continue. Laboratory testing will continue in 2002 and 2003. Combustion tests are being conducted on logs from the Amazonian forests. Full analysis of combustion gases is also being conducted with a field campaign on smoke analysis in flaming and smoldering combustion scheduled for 2003 and 2004. A new graduate student at the UNESP will start investigating physical properties of wood from Amazonian species and their relation to smoldering combustion rates in the laboratory. Proposals to conduct this work have been prepared and will be submitted by our INPE and UNESP collaborators to FAPESP and CNPq. Laboratory tests will provide improved combustion rates calculations, and better smoke emission factors from Amazon forest burning.



Model for flammability experiments and measuring escaped fires into primary forests

The INPE-FERA continues outreach communication with Alta Floresta authorities, local IBAMA personnel, and university students and faculty to explain the scope of work and objectives of the fire research.

The biology program from UNEMAT will continue participating with work on the floristic inventory and assessing the effect of the burnings in the regeneration patterns. The group started communicating with the firefighting organization in the state of Mato Grosso to participate in on-the-field training for the local fire fighters during the experimental burns in Alta Floresta.

Consultations continued with IBAMA and INPE personnel to develop a fine fuel flammability model that will be integrated to the PROARCO model to represent local ecological and weather variability. Ground validation of PROARCO in Alta Floresta is schedule to start during 2002 and continue in 2003 and 2004 field seasons in Alta Floresta.

Fire Risk in Reduced-Impact Harvesting Systems

Communication with the FLONA Tapajos director and Brazil's LBA representatives continues to obtain working permits for the work that will be conducted in 2002 and 2003 at the FLONA. We are preparing a plan for the fieldwork in the next two years. The research proposal of the

work that will be conducted in low impact logging areas in 2002 and 2003 was prepared and submitted to CNPq to obtain visas for participants from the United States in the project.

Photo Series to Assess Flammability in the Cerrado

During the reporting period, FERA and Brazilian collaborators continues the distribution of the first volume of the Cerrado photo series in Brazil and the United States. The photo series is a bilingual publication. A bilingual brochure that describes the photo series is being distributed to a large mailing list that includes personnel from all Brazil's Federal and State protected areas, and agencies and institutions involved in management and conservation in the Cerrado region.

A study plan and materials for a training workshop has been prepared for IBAMA park and fire managers. The training will be conducted in collaboration with IBAMA in Brasilia in June of 2002.



University of Brasilia and USFS researchers present the Photo Series to Park Managers

The Cerrado photo series publication was presented on a poster and hands-on display at the 5th Brazilian Congress of Ecology in November 2001 in Porto Alegre. Also, a significant number of copies have been distributed on request to world scientists concerned with global emissions, management, and conservation of Cerrado or savannas. FERA and the University of Brasilia collaborators, along with IBAMA park managers began planning fieldwork for the second volume of the Cerrado photo series.

Pre-selection of field sites have been conducted for additional photo series in the cerradao and mata near Brasilia and elsewhere. Volume II will include the cerradao, campo rupestre, and mata physiognomic forms. IBAMA has communicated with Unb and FERA on the need of extending the photo series work to the Caatinga ecosystem.

Aircraft Campaign, Remote Sensing and Technology Transfer

In February 2002, the anticipated remote sensing fire-mapping campaign in Roraima was cancelled. The Planned campaign was unsuccessful as aircraft clearance wasn't granted and the expectedly severe fire season did not materialize. Some flight training was completed by IBAMA personnel here in the United States last October.

Currently, the primary focus is to further IBAMA's capability for fire monitoring by augmenting their existing aerial camera system with a new FireMapper 2.0 thermal imager. It is being designed to work with their existing data recording system, cameras, and software. The FireMapper was developed by the Forest Service through a Research Joint Venture with Space Instruments, Inc. It has the capability of imaging fires and forests through heavy smoke, which

is common during the dry season in central Brazil. The instrument was first flown in Brazil in 2000. FireMapper 2.0 uses the Forest Service's experience with the original system in a more operational design. Development of FireMapper 2.0 will be accelerated with funds not used in the aircraft program. The engineering of the system is also supported by the U.S. National Fire Plan, greatly reducing the cost to our Brazilian Partners.

The Forest Service is continuing to work with Scripps Institute of Oceanography, Experimental Climate Prediction Center, which has developed a predictive climatology for South America. Regional-scale predictions are made available on the Internet. The primary purpose in continuing the agreement is to validate the models and to examine the accumulating climatology to provide advice to IBAMA on ways to manage smoke from extensive burning in Amazonia. IBAMA has available weather observations for doing the validation.

Publications

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Gielow, R.; Andrade de Carvalho Jr., J.; Alvarado, E.; Sandberg, D. V.; dos Santos, J. C. 2001. Evolução do Albedo, Saldo de Radiação e Fluxo de Calor no Solo Após Derrubada Florestal Seguida de Queimada e Rebrotas na Região de Alta Floresta, Mato Grosso. Poster presented at the 5th Brazilian Congress of Ecology in November 2001 in Porto Alegre, Brazil.

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