Fellowship report

An ITTO fellowship has assisted in developing remote sensing and canopy tree interpretation for mapping forest types in Acre, Brazil

by Ana Euler

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On the spot: the author (second from the right) poses with Amazonian villagers during ground-truthing work.

AS a young Brazilian forest engineer I believe the future of the Amazon region lies in the sustainable use of its forest resources. By reconciling conservation and sustainable use, the region's inhabitants can maintain access to natural resources without threatening the forest's supportive ecological functions. In my view, a basic task for the achievement of sustainable use is to quantify the value of the goods and services the forests provide, including those associated with environmental services.

The mapping and classification of forests could be used as a mechanism for achieving this goal. With the support of the Japanese government through the Monbusho scholarship program, and an ITTO Fellowship, I undertook a masters program to develop a new method for mapping different forest types in the Brazilian (and Amazonian) state of Acre. I focused on Acre because its economy and population depend largely on the forest resource; exploring ways of bringing about sustainable forest management is therefore of the utmost importance for the future of the state.

This article presents the methodologies I used for mapping tropical forests and discusses their usefulness and limitations. Two different approaches were taken in this case study: the remote sensing interpretation of LANDSAT TM images; and a floristic classification of forest types based on forest inventory data.

Mud map: an aerial view of alluvial forests in the Amazonian state of Acre. *Photo: A. Euler*

Remote sensing interpretation and mapping

Remote sensing is recognised worldwide as the most important tool for the mapping of land cover and land-use at the global and regional levels. I used digital (supervised and unsupervised) and visual classification methods of remote sensing interpretation to compare the ability these different classification methods for mapping forest types in Acre. LANDSAT TM (1999) images were processed with the use of ERDAS IMAGINE (bands 3,4 and 5).

Unsupervised digital classification, in which the computer performs the whole classification using data only from the satellite image, was first carried out using the ISODATA algorithm. I set the minimum number of classes to be identified by the computer at ten, with some classes merged later, for comparison with classified data. The supervised digital classification, which used a selection of samples of known identity called training sites to help classify pixels of unknown identity, was conducted using the Maximum Likelihood Algorithm.

During the visual classification, images were printed in a colour composition frame and the classes were visually distinguished and separated into groups of polygons, which were digitised and labelled. Simple accuracy assessment was performed with the use of error matrices.

The results of the interpretation processes showed visual classification to be the most efficient method for distinguishing forest types, with an overall accuracy of 89%. The supervised digital classification failed to recognise the differences between spectral classes, either overestimating or misclassifying forest types, producing a low level of accuracy (60%). The unsupervised classification successfully separated the main phyto-domains of dense forest and open forest (90% overall accuracy), but could not recognise forest types within these two domains.

Canopy tree interpretation and mapping

Inventories for forest management law enforcement have been carried out recently in Brazil, extending the quantity and quality of available forest inventory data. Forest inventories are traditionally focused on the quantification of timber resources for production purposes. My study attempted to make use of this kind of data set to propose a floristic classification of forest types based on the diagnostic of dominant canopy species. My supervisor (Professor Fujiwara of Yokohama National University) and I believe that a floristic classification using differential canopy species might provide a first step towards the identification of compositional gradients, therefore improving the level of detail of forest maps. The potential for such a method lies in its applicability to large areas where field-level tree-canopy inventory data are already available. For this purpose, forest inventory data for tree stems with diameter at breast height greater than 45 cm were submitted to phytosociological processing, involving the use of the programs TABWIN, PHYTO and TWINSPAN plus some manual table work. Tables were produced that included data on species' distribution at each site, the most frequent species, and their frequencies of distribution. Forest types and sub-types were classified according to the presence of indicator species and clusters of groups of species.

The forest types and sub-types were mapped as six types and 13 sub-types by a geographic information system (GIS; ArcView 3.2), with subsequent overlay and comparison with the satellite imagery.

Discussion and recommendations

This study found visual classification to be the most effective method of forest mapping. Nevertheless, it is important to highlight its limitations. Visual interpretation of remote sensing imagery is to some extent subjective: it can vary according to the interpreter's experience and knowledge of the mapped site and may not be repeatable. Therefore, field assessment is necessary to confirm the accuracy of mapping derived from remote sensing data. Moreover, temporal factors such as climatic conditions, seasonal variations in the vegetation, and the presence of clouds can affect the reliability of classification (both visual and digital); it is therefore important to conduct the classification using a multi-temporal set of satellite images whenever possible.

This initial trial of canopy tree interpretation has not proven the method, and doubts remain as to its reasonability and to its applicability in other forests. The next step is to verify the results of the proposed floristic classification by collecting field data from the study sites and also by applying the method to a larger area.

I intend to further develop these methodologies in a doctoral thesis. My main objective will be to work on canopy tree interpretation, combining phytosociological vegetation description and remote sensing interpretation to generate forest maps with a higher level of detail than is currently available. The combination of methods will be field-tested at several study sites (classified by canopy tree interpretation) as training sites for a digital classification.

After the completion of my masters thesis I received many emails from people working on forest mapping in South America requesting more detail on the contents of my research. I am grateful for the opportunity to increase the exposure of my results and methodological approach through this newsletter. I look forward to receiving feedback from readers, researchers and foresters who are doing related work.

Acknowledgments

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ITTO Fellowships offered

ITTO offers fellowships through the Freezailah Fellowship Fund to promote human resource development and to strengthen professional expertise in member countries in tropical forestry and related disciplines. The goal is to promote the sustainable management of tropical forests, the efficient use and processing of tropical timber, and better economic information about the international trade in tropical timber.

Eligible activities include:

- participation in short-term training courses, training internships, study tours, lecture/demonstration tours and international/regional conferences;
- technical document preparation, publication and dissemination, such as manuals and mongraphs; and
- post-graduate studies.

Priority areas: eligible activities aim to develop human resources and professional expertise in one or more of the following areas:

- improving the transparency of the tropical timber market;
- improving the marketing and distribution of tropical timber species from sustainably managed sources;
- improving market access for tropical timber exports from sustainably managed sources;
- securing the tropical timber resource base;
- improving the tropical timber resource base, including through the application of criteria and indicators for sustainable forest management;
- enhancing technical, financial and human capacities to manage the tropical timber resource base;
- promoting increased and further processing of tropical timber from sustainably managed sources;
- improving the marketing and standardisation of tropical timber exports; and
- improving the efficiency of tropical timber processing.

In any of the above, the following are relevant:

- enhancing public relations, awareness and education;
- improving statistics;
- research and development; and
- sharing information, knowledge and technology.

Selection criteria: Fellowship applications will be assessed against the following selection criteria (in no priority order):

- consistency of the proposed activity with the Program's objective and priority areas;
- qualifications of the applicant to undertake the proposed fellowship activity;
- the potential of the skills and knowledge acquired or advanced under the fellowship activity to lead to wider applications and benefits nationally and internationally; and
- reasonableness of costs in relation to the proposed fellowship activity.

The maximum amount for a fellowship grant is US$10 000. Only nationals of ITTO member countries are eligible to apply. The next deadline for applications is **3 September 2003** for activities that will begin no sooner than December 2003. Applications are appraised in May and November each year.

Further details and application forms (in English, French or Spanish) are available from Dr Chisato Aoki, Fellowship Program, ITTO; Fax 81–45–223 1111; fellowship@itto.or.jp (see page 2 for ITTO's postal address).