

## REMOTE SENSING AND GIS APPLICATION TO SUPPORT EFFECTIVE MONITORING AND CERTIFICATION PROCESS OF PRODUCTION FOREST IN INDONESIA

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### ABSTRACT

To promote sustainable forest management of production forest and improve sustainability assessment of its management, a research project has been designed and being implemented jointly by the International Institute for Geo-Information Science and Earth Observation "ITC, TROPENBOS International foundation, and a number of local institutions in Indonesia. The project is aiming at " Design and development of an effective monitoring and certification system to support sustainable management of production forest. This article presents some of the findings of the research program. In this context special attention is given to the potential role of GIS, Remote Sensing and Decision Science.

### 1. INTRODUCTION

Rapid decline of forest cover and forest degradation especially in the tropical rain forest is now acknowledged as a "global problem" with social, economical and environmental implications. To assist in coping with the problem and to promote sustainable forest management, one of the policy instrument which is formulated by the international communities is "Forest Certification" that would allow export of forestry products only from so-called "sustainable managed forests". In this line, the Indonesian Ministry of Forestry has decided to extend the concession rights of only those that are practicing Sustainable Forest Management "mandatory certification". What is Sustainable Forest Management? How can it be achieved and assessed, especially considering the decentralization process that has taken place in Indonesia? What should be the criteria and indicators of achievement? How should they be measured, estimated and generalized; how should they be aggregated to a decision reflecting sustainability? how can it be handled in large areas ranging from a few hundreds to hundred thousands of hectares of forest, many of which not easily accessible.

Currently, many scientists are involved in the development of models, procedures, standards to conceptualise, operationalize and evaluate Sustainable Forestry Management "SFM" at the international, national or forest management unit (FMU) level. As a result, many management models for SFM and guidelines with large sets of sustainability Criteria, Indicators and Verifiers have been developed and recommended. However the developed management models and their related indicator system so far experiences problem in terms of feasibility, efficiency and effectiveness. This is especially true in Indonesia where new policies for decentralization and partnership with local communities have been adopted. The certification model for the Indonesian production forest had been developed based on a forest management model, which assumes the full authorities for the concessionaire and the central government. Such assumption is not valid and the situation has completely changed. The current criteria and indicators have little connection with the actual forest management practices, and are yet intended to assess the quality of management (LEI, 2000). The current attempts to measure and verify so many

criteria, indicators, and verifiers (over 200) require excessively large sets of information from the concessions. Proper acquisition, management and processing of such information are a massive and complex process. In some cases, non-existence, in others non-availability, accessibility and questionable reliability of the data and information, data capture, collection and processing, the time and cost that involved, has made the proper implementation of 'certification' in accordance with these excessive numbers of hierarchically structured indicators very difficult, especially when sufficient reliability is expected.

To improve the situation a research project has been developed and implemented with support from a number of international and national institutions in Holland as well as in Indonesia. From Holland the International Institute for Geo-Information Science and Earth Observation and Tropenbos International Foundation, while from Indonesia the Indonesian Ministry of Forestry, Watershed Management Technology Center (WMTC), Indonesian Ecolabelling Institute (LEI), PT. Hutan Sanggam Labanan Lestari in Berau and Bogor Agriculture University are contributing to the project. This paper briefly elaborate on the existing problems of certification process in Indonesia, and further describes the objectives, concept, components and some of the achievements of the project.

## 2. PROJECT DESCRIPTION AND CONCEPT

To promote sustainable forest management through improving the monitoring and certification process, this research is aiming at selecting/adapting a collaborative management model, and its required information systems for monitoring and evaluation at concession level. It further supports certification of the concession management. In the latter effort is made to simplify the current certification process while ensuring its social and political acceptance, and retaining its necessary scientific rigor, and proposes a practical, effective and efficient forest certification and monitoring system. To this end, the research is aimed at the following:

- Bench-marking of the state of the art issues in SFM and certification for production forest at local level, mainly in Indonesia,
- Selection/adaptation of a joint forest management model which includes the role of local community, community values and knowledge, local government and concessionaires to support sustainable forest management at concession level for production forest concessions in Indonesian,
- Improve the existing forest certification model that is suitable for the Indonesian production forest, which is scientifically acceptable by the international communities, and technically and economically feasible to be implemented in Indonesia,
- Explore the role of geo-information technology (GIS, Remote Sensing, and Decision Support Systems) in the process of reaching the above disciplinary objectives;
- Institutional and Civil Society strengthening/building through knowledge generation, transfer and application in close collaboration with the local institutions.

The project has started on 2001 and shall continue by 2007-2008.

Conceptually, the research includes three main components as presented in Figure 1. In the following each elements are briefly explained.

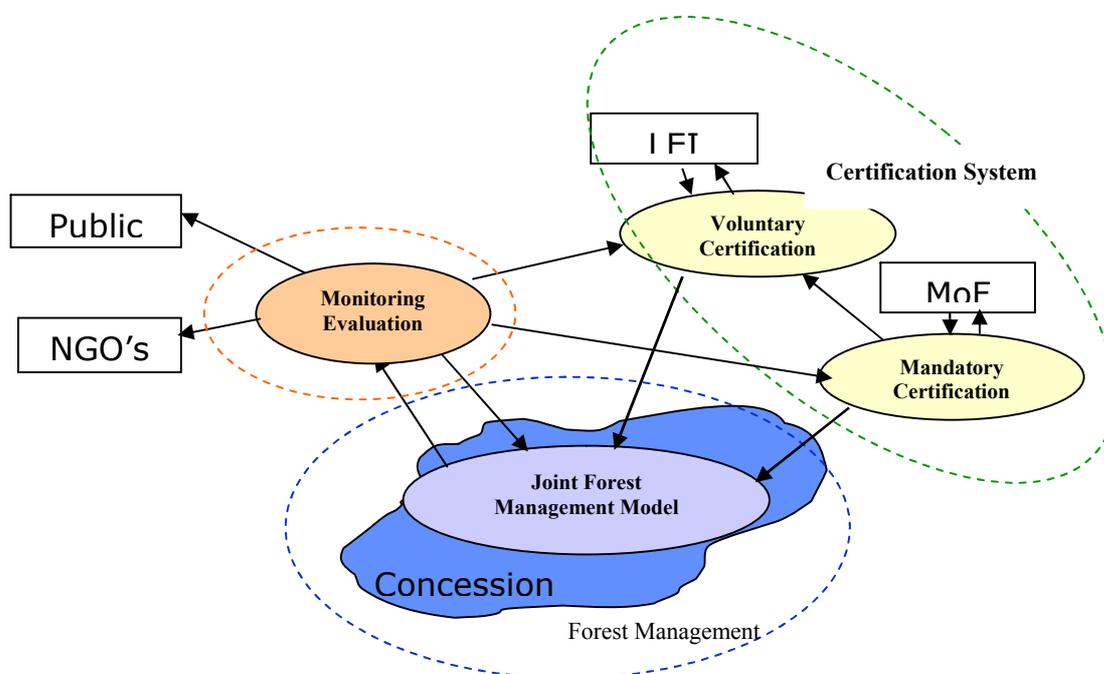


Figure 1. Conceptual presentation of different elements of the research

### 2.1 Development of sustainable forest management model:

For the last thirty years, forest administration in Indonesia had been highly centralized, with the Ministry of Forestry in Jakarta making the strategic and operational decisions about how the nation's forest estate would be managed. This top-down approach has been ineffective in securing sustainable forest management. 'Sustainability' has remained a paper exercise. With Indonesia's ongoing processes of decentralization and regional autonomy, significant degrees of authority over forest administration have been being transferred to the provincial and district governments. In some areas, this shift has intensified pressures on forests, while in other areas it has made local government decision-making more responsive to communities whose livelihoods depend on forest resources. On this basis, to be realistic before any information system designs a revisit and redesign of the management process is necessary. In this context, the concepts of Adaptive collaborative Management "ACM", Joint Forest Management "JFM", and the "Model Forest" are employed to build the collaborative sustainable forest management model. The adopted model should respond to the socio-economic and institutional issues and the demand by local communities to improve their well-being and livelihood through forest management.

### 2.2 Development of Monitoring and evaluation systems:

To support management of the concession as well as acting as a source of information for all the externals, such as the government agencies, Ngo's and mandatory and voluntary certification systems a monitoring and evaluation system is being designed and implemented. In this context, the concepts and methods of Structured System Development Methodology, participatory mapping and data collection, participatory GIS and analysis of remotely sensed data are being considered.

### 2.3 Development of forest certification system:

Based on the structure and flow of information in the developed management model and its related monitoring and evaluation system, design and development of a Decision Support System for Certification will be developed and evaluated. This system is planned to support

Mandatory and Voluntary certification process as required by the Indonesian authorities and the international communities. The system shall allow selection of appropriate sets of indicators, identify the method of assessment, and allow integration and aggregation of the subjective and objective information related to the C&I to support the overall assessment of forest management. In this process, the potential application of GIS and remote sensing techniques, especially the potential of new data collection platforms (satellite systems) together with decision support systems theories are employed in order to improve the assessment of each individual verifier and indicators.

The related, models, techniques, and methodology that is being developed are being evaluated in a typical forest production concession. For this purpose, the Labanan forest concession in East Kalimantan, Indonesia. This area is managed by Hutan Sanggam Lestari which is a joint venture between a government owned concession company, local and provincial government, as well as the local community. This forest area has been the pilot area for a large European Forest Management Project so called BFMP from 1996 –2004. Therefore possess a good amounts of historical data. The Labanan concession is located in a lowland dipterocarp, and consists of around 100,000 ha of production forest, used as production forest since 1974. This area includes 18 permanent sample plots so called “STERK plots” that have been accurately monitored since 1990.

### 3. PROGRESS

So far sixteen MSc students have completed their research in the framework of this project. They have mainly focused on various aspects of certification model that has been developed and implemented by Indonesian Ecolabelling Institute (LEI, a none government organization) for natural production forest (SNPFM). As a result of the research activities, the main issues related to certification and the ways that Geo-information and decision-science can support the process are explored. In the following some of the issues related to various elements of forest certification, mainly, decision-making process, operational aspects and potential role of remote sensing and GIS application in certification process are presented.

#### 3.1 Decision-making process

The issue related to decision-making process could be classified in three groups. The first one is related to the complex criteria structure (Figure 2) that has been determined according to a theoretical forest management model; the second is related to decision-making process which is heavily relies on the experience and judgments of assessors; and finally the compensatory method, which is used in the course of decision-making process (Jegan 2003, and Retno 2004).

The current certification system has also problems in inputs definitions, which has been thoroughly studied by A. Purbawiyatna, (2002). In the input part the major problems are: a) diverse vaguely defined verifiers with no clear procedure for their assessment, especially considering the spatial nature of verifiers, b) verifiers are assessed with linguistic variables, which are translated into crisp numbers, c) Indicators are treated as independent, however in reality many of them are strongly correlated. In the processing part a) Crisp numbers leads to under estimation or over-estimation, b) these numbers are processed using mathematical aggregation based on AHP (Saaty, 1995) and hence uncontrolled degree of compensation that leads to irrational outcome and c) final decision based on interpretation of derived crisp number. These problems are systematically studied in order to choose a proper approach and necessary procedures, which can lead to rational assessment of SFM.

Jeganathan (2003) and Retno (2004) used AHP, Fuzzy-AHP; Fuzzy Reasoning approaches, to explore the alternative method of assessing the sustainability of the forest management. They found that fuzzy reasoning based approaches gives more flexibility, transparency and full control on the processes involved in achieving the rational sustainability assessment. For a complex problem of decision making, such as assessment of the sustainable forest management, the result usually need to be obtained through reasoning by rules. This study has found that rule base assessment in fuzzy reasoning model allows better linking of the human knowledge with the existing indicators.

### 3.2 Potential role of remote sensing and GIS application

Potential role of application of RS/GIS in certification process were identified as determination of forest management typology, land-cover change determination and analysis of the status of biodiversity. Wardhana, (2002), studied the application of GIS and remote sensing in setting standard norm for certification process "Typology". He found that integration of remote sensing and GIS are very useful and effective in determining the overall condition and role of forest resources in the region and therefore very effective in determination the forest typology. Fauzi (2001) researched detection of forest structure change using image classification and found remote sensing application practical, since it deal with huge and often inaccessible area. Cui (2003) and Santosh (2003) found that Landsat-7 ETM+ can play a partial, but also crucial role for supporting forest certification process in Indonesia. They demonstrated that the following six indicators can be positively assessed with reasonable accuracy using remotely sensed data i.e. Landsat ETM+:

P1.1- "It must be guaranteed that land will remain as a forest area"

P1.3- "The level of change in land cover due to encroachment and conversion of forest, fire, and other factors"

P2.5- "Condition of remaining stands"

P2.7- "Infrastructure of the forest management unit in the harvesting of forest products"

P2.8- "Implementation of reduced impact logging"

E1.3- "The intensity of damage in protected areas which includes the danger of forest fires"

Among these 6 indicators, P1.3 and E1.3 can be assessed quantitatively, while others can only be assessed qualitatively. They also showed that object-oriented image analysis, which is implemented by eCognition software, is the suitable image processing method for the information extraction to support forest certification process, although it is not very easy to use. Many functions provided by it are not available yet in other pixel-based techniques, and some of these functions are useful for assessing forest management.

Considering the large amount of indicators and the difficulty of getting relatively cloud free images, Landsat-7 ETM+ data can only partially be used to support certification process in Indonesia. Meanwhile, considering the importance of indicators and regulations that can be assessed, this partial support is also very crucial to the whole certification process. It can help to get precious and timely information at low cost, and this information are not easy, if not impossible to get by other means.

Virigina (2004) and Anita (2004), explored the role of Landsat-7 ETM+ data in locating single tree illegal logging. They combined the classification of satellite data with the expert knowledge to successfully locate the newly illegally lodged single tree in the project area. Yohanes (2004), explored the application of remote sensing and GIS to High Conservation Valued Forest with respect to Soil erosion and water conservation.

#### 4. CONCLUDING REMARKS

Monitoring and Certification systems are important instruments to monitor and promote sustainable forest management. However, effective monitoring and credible certification systems require large set of information, which cannot be collected only for monitoring and certification purposes. The quality of the data which is collected for this purpose is acceptable/reliable and their collection make sense if they are systematically collected and used in the process of routine management activities (planning, control and evaluation) of the concession. The foundation of the sustainable management is the concession management model, supported by proper monitoring and certification system. In these processes, the concepts of Adaptive Collaborative Management, which guarantees the right and responsibility of all stakeholders, especially the local communities are an important factor. In these processes, the remote sensing technology, geographic information science, and decision science can play an important supporting role.

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