REDUCED IMPACT LOGGING IN SABAH, MALAYSIA[1]

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ABSTRACT

A commercial project introducing reduced impact logging techniques for selective harvesting of tropical rainforest was conducted over 1,400 ha in a concession in Sabah, Malaysia. The project was a joint venture between Innoprise Corporation, a Malaysian forestry company, and New England Power, an American electricity company. Guidelines were developed for logging dipterocarp forests, training activities were carried out, and the system was put into operational practice. A system for verification of compliance with the guidelines was developed and implemented. Results have shown that the use of reduced impact logging techniques can lead to an overall reduction of approximately 50% in the impact of logging, compared to the traditional methods currently in practice. The project also demonstrates an innovative financial mechanism for funding of sustainable forestry, based on carbon sequestration in forest biomass.

1. INTRODUCTION

Of the major environmental issues today, loss and degradation of tropical forests remain among the most pressing. While deforestation can occur for a series of reasons pertaining to land use change, forest degradation is usually the result of poor management and lack of planning. Among all the activities related to forest management, the one which has the strongest impacts is harvesting. In order to remove 8-10 trees per hectare in Malaysia, as much as 50% of the remnant stock is damaged (Pinard 1995) and up to 40% of the soil is traversed by heavy machinery (Nussbaum 1995). It is therefore essential that efforts to promote good forestry concentrate on promoting better logging practices.

Apart from its direct effect on the remnant forest, the future crop, and the environment, uncontrolled logging often results in sub-optimal utilisation of resources and higher operating costs. A study in the Amazon has shown that approximately one third of the trees felled in a particular operation were left lost in the forest, due to lack of communication between tree fellers and tractor operators (Imazon, in preparation). Due to the high capital and running costs of harvesting machinery, inefficient utilisation of this equipment results in higher operational, fuel, and maintenance costs (Jonkers and Mattsson-Marn 1980). It has been shown that large reductions in damage can be achieved through the use of relatively simple measures. Among the most important, are the use of directional felling, planning of logging roads, and climber cutting (*e.g.,* Froehlich *et al.* 1981; Hendrison 1990; Johns *et al*., in preparation).

While improvements in the efficiency and planning of harvesting operations can provide financial benefits, low impact logging may also result in extra costs compared to uncontrolled logging.

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Controlled logging demands more management time, and planning, higher supervision of field activities, and training of field staff. It requires more pre-felling activities such as mapping, road marking, tree flagging, and climber cutting. Furthermore, in some cases it may result in the reduction of timber output due to creation of no-harvesting zones, such as buffer zones, steep slopes, or conservation areas, as well as maintenance of seed trees. It is important, therefore, to understand the economics of low impact logging in order to minimise extra costs and maximise benefits.

This paper describes a project which used reduced impact logging techniques in Sabah, Malaysia. This project also illustrates an innovative mechanism for funding of the extra costs of introducing low impact logging, based on carbon sequestration through forestry. The background of the project is given, as well as an overview of its technical and economic aspects.

2. THE PROJECT

2.1. Background and funding mechanism

The ICSB-NEP Reduced Impact Logging (RIL) Project is a cooperative venture between Innoprise Corporation Sdn. Bhd. (ICSB), a semi-government organisation which has the largest forest concession in the state of Sabah, Malaysia, and the New England Power (NEP) Company, an American electricity company wishing to address the challenge of reducing its net CO_2 emissions through the preservation of plant biomass in tropical forests. The objective of the project was to introduce the use of reduced impact logging (RIL) techniques in order to lower the level of damage caused by selective harvesting operations, reducing the release of CO_2 from decomposing vegetation and soil loss (Marsh 1992).

In an initial phase, 1,400 ha of forests were logged according to the RIL techniques from 1992 to 1995. The project aimed at reducing logging damage by 50%. All the incremental costs of training and implementation of the project were paid by NEP, who has full rights to the carbon savings. On the other hand, ICSB benefited from improved management of its forests, and a better residual stand after logging.

The project was located in two compartments within ICSB's logging concession: one near Lahad Datu, and one near Tawau, in Eastern Sabah. Most of the research was conducted at the compartment near Lahad Datu, which is close to the Danum Valley Field Centre (DVFC), a well established ecological research station (Marsh and Greer 1992), which provided logistic and scientific support for the foresters and researchers involved in the project.

The project consisted of three main components. Firstly, development of appropriate logging guidelines for the forest conditions in Sabah. Secondly, training of staff in the various aspects and techniques required for the successful implementation of the guidelines. Thirdly, establishment of a system for independent verification of compliance and quantification of logging damage. This paper describes these components, as well as some of the results, problems and outcomes derived from the initial phase of the project.

2.2. Guidelines for reduced impact logging

Given the inevitable impact of heavy machinery on the forest environment, the key to the success of reduced impact logging techniques is the use of clear guidelines and good planning for timber extraction.

The logging guidelines adopted by Innoprise were based on those developed by the Queensland Forest Service, for logging tropical rain forests in Australia (Queensland Forest

Service 1991). It also incorporated components of the guidelines of the SUAS (Swedish University of Agricultural Sciences) Project (a logging research project jointly conducted with ICSB; Cedergren *et al.* 1994), the Rainforest Alliance's timber certification program (Smartwood), the CELOS management system developed in Suriname (de Graaf 1986), and the Food and Agriculture Organisation (FAO) Model Code of Forest Harvesting Practice (Dykstra and Heinrich 1995).

The RIL guidelines were customised to address the characteristics of the site: heavily stocked forests (up to 170 $m^3 ha^{-1}$ extractable timber) with very large trees (up to 65 m tall), steep terrain and heavy rainfall (*ca.* 2,700 mm yr^{-1}).

The guidelines were developed in an interactive and dynamic way, based on a process of discussion, trials, evaluations and continuous improvement. It included ICSB foresters and forest rangers, logging contractors, specialists in logging from the Queensland Forestry Service, SUAS, and University of Florida, representatives of the Sabah Forestry Department, and researchers from DVFC. Given the difficulty of the terrain and logging conditions, the development of these guidelines was a learning process for all concerned.

The guidelines concentrated on reducing the impacts of tree felling and heavy machinery on the remaining timber stock and forest soil. None of these elements is original (*e.g.,* Jonkers 1987, Hendrison 1990, Dykstra 1994), but they have rarely been implemented in tropical forest conditions on a commercial scale. The main elements of the guidelines are as follows:

- inventory and mapping (1:5000 scale) of trees to be harvested and potential future crop trees (PCT's) > 20 cm dbh;
- Designation and mapping of streamside buffer zones, steep slopes, and sites known to be of importance to wildlife (*e.g.,* large fig trees);
- Cutting all vines (dbh > 2 cm) at least 9 months prior to logging;
- Marking trees to indicate direction for felling, which should aim at facilitating skidding and avoiding damage to potential crop trees;
- Planning and marking roads and skid trails, aiming at reducing skidding distances, down-hill skidding, and stream-crossing. Roads and skids were preferentially located on ridge-tops;
- Reduction in the size and number of log-landings, using road-sides whenever possible;
- Protection of surface soils and water courses, by reducing use of bulldozers blades, introduction of cross-drainages on skid trails, adoption of a maximum slope limit for tree felling (35°) and skidding (25°), establishment of stream buffer zones, and halting forest operations during wet weather.

The guidelines include detailed specifications for road construction, stream crossing, wet weather shut-down, skid trail width, log-landing size and location, and post-logging closure of roads and skid trails (ICSB records, unpublished document; Putz and Pinard 1993, Pinard and Putz, in press, Pinard *et al.* 1995). Detailed discussions on the importance of each of these elements is found in the FAO Model Code of Forest Harvesting Practice (Dykstra and Heinrich 1995).

2.3. Training and implementation

The initial phase of the project included a substantial training component. Training was aimed at all levels in the ICSB hierarchy, including the senior management, foresters, forest rangers, tree fellers and tractor operators. Foresters had to get acquainted with technical and planning tools for improved management of harvesting operations. This included a visit to the Queensland Forestry Service, and associated consultancy support to assist in the development and implementation of RIL methods, as well as attendance at specialised courses. Some of ICSB staff are now pursuing further academic qualifications in this subject. Training of forest rangers aimed at a confident understanding of the RIL guidelines, in order to ensure its proper implementation on the ground. Rangers were in charge of supervising the logging operations, a task which requires a considerable degree of decision making. Chainsaw operators were trained in tree marking and directional felling techniques, including a short field course provided by Nordfor, a Swedish training consultancy working with the SUAS project. Bulldozer drivers were instructed on less damaging ways to skid, avoiding use of the blade and maximising use of the winch. On-going continuous training of the logging crews was provided by ICSB foresters and rangers. The major challenge in implementation, however, was one of management, because RIL challenges traditional attitudes and requires a fresh look at operations, procedures, payment scales, and so on.

2.4. Verification

Essential elements of the RIL Project were the verification of compliance to guidelines and quantification of logging damage. In order to make the project more transparent and credible, an Environmental Audit Committee was created including representatives of three recognised institutions in the fields of forestry and environment. These were: the Rainforest Alliance, an internationally recognised non-government organisation based in the US, which runs the Smart Wood timber certification programme; the Forest Research Institute Malaysia; and a representative from the Botany Department of the University of Florida. This committee met at regular intervals during the initial phase of the project, in order to evaluate its progress and assist in the refinement of the field practices. Eventually, its final aim was to verify whether ICSB had correctly followed the RIL techniques and if this had led to significant reductions in forest damage. With the development of Forest Stewardship Council (FSC) criteria and guidelines (Upton and Bass 1995), the work done by this EAC can now be done by specialised forest certification companies.

3. TECHNICAL RESULTS

3.1. Logging damage

The overall conclusion of the Environmental Audit Committee was that the implementation of the guidelines was adequate, and that it resulted in substantial reductions in the logging impacts compared to the conventionally (CNV) logged areas. Detailed comparisons of logging damage derived from the two systems were carried out by researchers attached to the project (*i.e.*, Pinard 1995; Nussbaum 1995; Tay, in preparation), and are briefly discussed below.

Table 1 shows a comparison of the impact of harvesting of 120 $m^3 ha^{-1}$ of timber in hilly terrain using either RIL or conventional logging techniques (CNV). It can be seen that both the length and the width of roads and skid trails were much reduced in RIL areas. Log landings in RIL were about 50% smaller than in CNV logged areas. These figures are even more impressive if compared to other estimates from the region, which found up to 30-40% of logged areas traversed by bulldozers (Sabah Forestry Department 1989, Jusoff 1991, Nussbaum *et al.* 1995). In RIL areas, roads and skids were better drained and the soil was less disturbed. There was substantially less removal of fertile topsoil, since there was much less use of the bulldozer blade. Apart from a smaller number of damaged trees in the RIL areas, the severity of damage was also lower (details given in Pinard and Putz, in press).

The combined effects of RIL resulted in a forest with less disturbed soil, canopy, water courses and residual stand. It is expected that natural recovery in these areas will be much faster than in conventionally logged areas. Some of the skid trails in the RIL area were already covered in vegetation one year after logging, while, in some cases, bare skid trails can still be found 20 years after conventional logging in the same region (Pinard 1995).

Table 1. Figures of logging impacts after harvesting 120 $m^3 ha^{-1}$ in hilly terrain in Sabah, following different logging techniques. RIL = reduced impact logging; CNV = conventional logging techniques. Summary of results from *ca.* 800 ha.

	RIL	**CNV**
Roads	20 m ha^{-1} 1.6% of logged area	24 m ha^{-1} 3.3% logged area
Skid trails	71 m ha^{-1} 4% of logged area	205 m ha^{-1} 13% of logged area
Log landings	57 $m^2 ha^{-1}$	103 $m^2 ha^{-1}$
Trees damaged	29%	56%

One of the main problems of the project was that the limitations imposed by the guidelines caused a reduction in the overall productivity of the area. The main limiting factor was the slope limit for felling and skidding. Apart from the large number of trees found in steep areas, the slope limitations for skidding in some cases prevented access to areas with lower slopes. This could be circumvented if aerial logging techniques (*e.g.,* Blakeney 1992, Dykstra 1994) were introduced.

3.2. Logging efficiency and operational costs

In an initial analysis, the operational costs of RIL are higher than those of conventional logging, due to the extra activities required, *i.e.* detailed inventories, training, climber cutting, intensive supervision. On average, these additional costs amounted to approximately US$ 5 m^{-3} of timber harvested (including training). Similar additional costs were also found in a similar RIL study in the Amazon (Imazon, in preparation), although a rise in efficiency compensated the extra costs in that operation.

A time and motion study was conducted to compare the efficiency of the two types of harvesting systems. Although many parts of the operation run more smoothly (*e.g.,* skidding, empty travelling time of tractor, clearing logs of debris), some activities still required more time (*e.g.,* directional felling, winching). Furthermore, there was substantially longer idle time in RIL operations, reflecting a certain degree of uncertainty of the logging crews of how to perform these new tasks. This has reflected in the operational costs of RIL. It is expected, however, that after the initial phase of learning and intensive training, RIL operations will run more smoothly and efficiently than in conventional logging. This may lead to savings through, for instance, reduced use of bulldozers, with lower fuel and maintenance costs.

This analysis of the time taken to perform different activities has led to the change of payment scales for field staff. This was done because some activities took longer to be accomplished following the new guidelines (*e.g.,* directional felling), therefore resulting in reduced earnings of staff paid on a productivity basis. This aspect is extremely important, since the success of the whole operation ultimately depends on the commitment of field staff.

4. OTHER IMPACTS

Apart from the direct benefits to the forest derived from RIL techniques, the project has had a broader impact. One of the most pleasing consequences of the project has been the development of a sense of pride among the logging crews and field staff. Furthermore, the training of a few logging crews has triggered a positive catalytic effect on the logging attitude around the region. Professional pride and competition has led to an unexpected improvement of the performance of other logging crews operating in the ICSB's concession. A simplified version of the RIL guidelines (adopting all the measures which do not require extra funding) was devised by the Regional Forest Manager of the Lahad Datu region (G. Mosigil, pers. comm.), and has been implemented throughout this part of the ICSB's concession.

Another positive effect of the project regards raising of awareness. The project has received substantial attention by local and international media (*e.g.,* Bangkuai 1992, Parrish 1992, Anon. 1993, Soutif 1993, Wong 1993, Miller 1994, Vatikiotis 1994, Spaeth 1995), bringing to the attention of the general public that there are hopeful ways to conduct logging. For the specialised public, the project has served as a demonstration area of good logging practices, and attracted hundreds of local and international visitors since its inception. It has also been the target of research projects conducted by foreign and local scientists, both by individual projects (*e.g.,* Nussbaum 1995; Pinard 1995; Tay, in preparation) or field courses (*e.g.,* Putz 1993).

At the international level, the project attracted the attention of institutions such as CIFOR, ITTO (Arentz 1994), the IPCC (Brown *et al.* 1995), and the GEF, which became interested in using the project as a basis for spreading the use of RIL techniques throughout the region.

5. ECONOMIC ASPECTS AND POLICY IMPLICATIONS

Considering the relatively low costs required to promote better logging, it is unacceptable that their adoption have often been refuted on economic grounds. The marginal costs of using low impact harvesting techniques have been calculated to range around US\$ 5 m^{-3} more than uncontrolled logging (Tay, in preparation). This amount corresponds to approximately 5% of the average value of logs in the log yards (assuming an average price of US\$ 100 m^{-3}). This fraction is even smaller if compared to the final cost of wood in a retailer's shelf in Europe (.04 %, assuming an average price of US\$ 50 per 1"x10"x3' planned plank, and a conversion rate of 50% in the saw mill).

Who should (or could) pay for the extra costs of logging ? While there is great pressure and interest in the adoption of better harvesting practices, there is little financial incentive for the producer to invest in improvement of management and training of personnel. Certification schemes have been created by consumer groups, but it is unlikely to be a price premium for certified wood (Upton and Bass 1995). Perhaps it has not been made obvious to the consumer that a very small contribution would be enough to finance the necessary changes towards sustainability. A study by the ITTO has shown that approximately 90 % of the revenue derived from timber is realised by consumer countries (Oxford Forestry Institute 1991). Out of that, 24% is in the form of profits and 25% is in the form of taxes collected by governments in consumer countries. The same study suggests that a small change in taxation in consumer countries could be used to generate the funds required to cover the extra costs of good harvesting practices.

Changes in forest revenue systems, by manipulation of royalties, forest fees and taxation systems could also be used to promote the adoption of good forestry (*e.g.,* Grut *et al*. 1991, Gray 1983). For instance, a reduction in royalties could be waived to forestry companies which adopt low impact harvesting. This reduction should be equivalent to the average marginal cost of introducing low impact logging, *ca.* US\$ 5. At the same time, fines could be imposed on those that cause unnecessary damage during logging. Interest rates could also be manipulated to promote investment in improvement of logging practices.

The project described in this case study was funded through an innovative mechanism. Carbon offsets in tropical forests are splendid examples of global sharing of the financial burden of conservation. It promotes the transfer of funds from industrialised countries to tropical countries as a commercial transaction, as opposed to charity (Marsh 1992, 1993). There are already more than 20 carbon offset projects world wide (Moura Costa 1996a, b), and this number could greatly increase once the concept of joint implementation is accepted internationally. Similar mechanisms could be created to try to remunerate other functions of the forest eco-system, such as, for instance, a “biodiversity offset program” directed to biotechnology companies prospecting for new forestry products.

6. CONCLUSIONS AND RECOMMENDATIONS

The first phase of the ICSB-NEP RIL project has created a positive momentum in the direction of achieving better logging practices. It has demonstrated that the technical impediments can be overcome without major difficulty. The contract was renewed and a second phase was initiated early 1996.

Some conclusions and general recommendations can be drawn:

While a series of guidelines for low impact harvesting are available world-wide, forests differ in their characteristics and there is the need to adapt guidelines to local conditions.

Even when guidelines are available, the technical level of many companies in the tropics is very low, and they do not yet have the technical and management skills necessary to implement these systems. In many cases, these skills are not even available locally, and there is a need to provide support in the form of training and technical assistance. However, a series of successful projects indicate that the most effective way to provide such training is through a practical “hands-on” demonstration approach.

While most of the technical aspects of low impact logging have been addressed by research and development agencies, there is still the need to deal with its financial aspects. There are almost no examples of tropical forests where good technical, biological and social management have been developed simultaneously with economic sustainability. Therefore, there is an urgent need to demonstrate that forest management can be simultaneously technically and socially sound, carried out by well-trained professional local staff, within an economically sustainable framework.

It is important to differentiate the costs of introducing and conducting low impact logging. Inevitably, there are high costs of introducing a new system, due to changes in management structure and training. Investment in training is essential and it provides lasting returns which can have a leverage effect. Therefore, the initial costs of introducing reduced impact logging techniques should be amortised throughout the whole rotation period, instead of during the trial phase under which the project has been evaluated.

As described in this project, in some cases the introduction of low impact logging may lead to reductions in timber output from a given forest area. These reductions are usually related to the introduction of concepts such as maximum slopes for cutting and machine usage, riverine buffer zones, maintenance of seed trees, etc. Forestry companies should accept these costs as part of the shift required to attain sustainability. Furthermore, the forestry codes of most countries preclude logging from such areas, even though they are not always followed. On the other hand, efforts must attempt to reduce damage to the residual forest without compromising the current level of economic output derived from this economic activity. This has been the objective of another project in Sabah, run by the Swedish University of Agricultural Sciences (Cedergren *et* *al.* 1994). In some cases, alternative extraction systems could be adopted in order to permit harvesting in difficult terrain, such as animal traction, helicopters or skyline systems (Dykstra and Heinrich 1995).

The forestry sector face other commercial problems. While it is ecologically necessary to manage forests for a wide variety of species, a large number of species in African or South American forests are considered “lesser-known timbers” to the markets, and therefore are not commercially valuable (Smith *et al.* 1994). There is an urgent need to improve the marketing of these species, trying to group species with similar characteristics into timber classes, in the same way as it is currently done for Southeast Asian timbers. This work should be done in close consultation with companies involved in the commercial side of timber trading.

For vertically-integrated companies (those owning both the forests and manufacturing facilities), another aspect which would greatly increase financial returns is better wood manufacturing technology. Currently, the average conversion rate of medium-sized saw mills in the tropics is around 35 % (65% waste). However, it is possible to double this rate through the introduction of simple technical measures and training of personnel (Gerwing and Uhl 1996). Furthermore, much greater returns could be achieved if the managers had access to information and better markets, and could invest in further manufacturing its timber into finished wood products.

While much effort and study has been devoted to technical, ecological and social aspects of forestry, little has been done to address the problem of its financial feasibility. One of the main constraints for good forestry in the tropics seems to be the lack of investments in sustainable operations, which prevents improvement of forest management systems and forces companies to utilise the lowest cost options. Large investors refrain from forestry investments for a series of reasons, mainly: lack of knowledge about the sector, lack of liquidity, lack of real-time valuation of forest assets, and, more recently, aversion to environmentally-related risk. Therefore, one of the most pressing needs for forestry is to show that, while good forestry does not provide the same returns as the ‘fly-by-night’ approach of some irresponsible companies, it is still possible to achieve sustainable cash flows at competitive rates of return. It is also necessary to create mechanisms to remove the barriers that dissuade investment in the sustainable forestry sector.

Consumer countries could play a bigger role in creating incentives for sustainable forestry through, for instance, reducing the taxation imposed on tropical timbers and reverting the difference to promote the adoption of environmentally sound forestry practises. Alternatively, traders could get a tax rebate for certified timbers, which would make them more attractive to the final consumers. Non-certified timber would remain under the same taxation level, but part of the tax would revert to the producing countries.

Another aspect which needs to be addressed regards social rights and the welfare of forest-dependent communities. Many economic booms in the past have been achieved at the expense of an exploited labour force which did not benefit from the results of these activities. There is now a general consensus that any project which aims to be sustainable has to take into consideration the continuous improvement of social welfare and the needs of the people involved. Projects should, therefore, be conceived through a participatory approach in consultation with the various stakeholders.

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