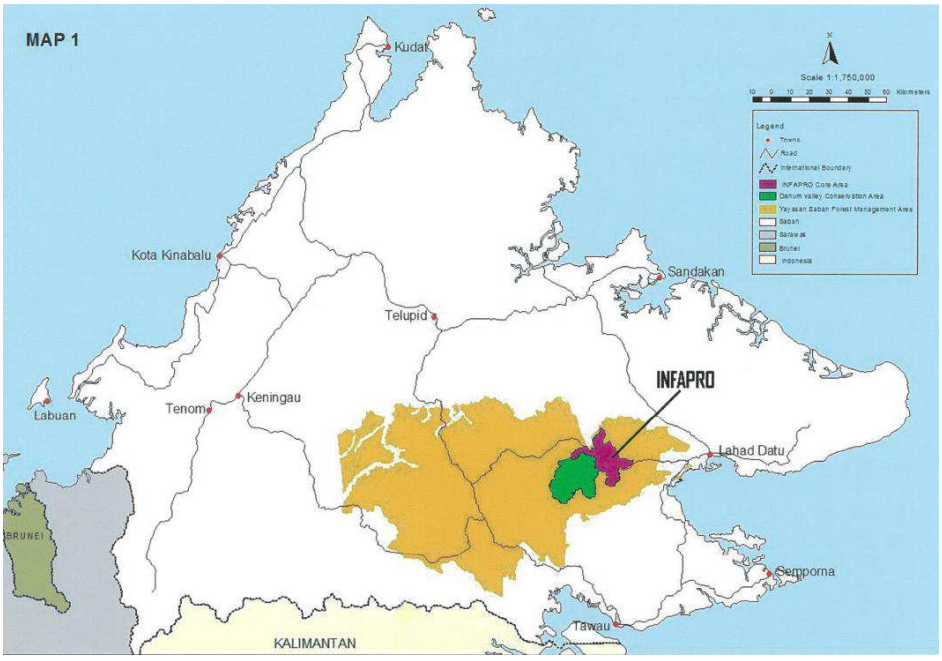
Infapro – 20 years of forest rehabilitation in North Borneo for carbon sequestration

Introduction

The Malaysian state of Sabah, on the island of Borneo, is home to the impressive lowland Dipterocarp forests, named after the trees of the Dipterocarp family that dominate the jungle. The trees are among the tallest in tropical forests worldwide, reaching heights not less than 70 meters. This is where Orang-utans, Borneo pygmy elephants, gibbons, Malayan sunbears, clouded leopards and the Sumatran rhinoceros feel at home. It is also important as a water catchment area and it is a valuable provider of ecosystem services and forest products, like the precious meranti hardwoods. However, because of the high commercial value of timber, these forests have come under threat by overexploitation through intensive logging. Recently the conversion of forest to oil palm plantation has become another threat. Infapro is a project that aims to rehabilitate a large area of degraded forest that was severely damaged by different logging systems since the 1980s. Infapro, or Innoprise-Face Foundation Rainforest Rehabilitation Project, is an initiative by *Face the Future* (formerly Face Foundation) and Innoprise Corporation Sdn Bhd (investment arm of the Yayasan Sabah Group). The aim is to stimulate the regrowth of the forest by removing the suppressive cover of vines and climbers and by enriching the forest with planted seedlings. A major objective is to mitigate climate change by increasing the sequestration of atmospheric carbon in trees. This paper gives an overview of the 20 years of history and experiences of the project.

Location

Infapro is within the Lahad Datu district, on the eastern coast of Sabah, Malaysia (Map 1). It is located within the Yayasan Sabah Concession Area of around 1 million hectares and borders the well-known pristine forests of the Danum Valley Conservation Area. The project area is almost entirely surrounded by forest, except for the oil palm plantations to the North of its boundary. The total size of the project area is 25,000 hectares and up to date about 12,000 hectares have been treated. The vegetation is known as lowland and upland mixed Dipterocarp forest. The climate is tropical with an average annual rainfall of 2,700 mm and a mean daily temperature of 26.7 °C, as recorded in Danum Valley Field Centre (DVFC), which is located 11 km away from Infapro base camp.



Logging

The necessity of forest rehabilitation is due to intensive logging that took place in the 1980s. Selective logging was applied in annual coupes of 2,000 to 3,000 hectares, meaning that only

commercially interesting species were harvested. However, since there is a high volume of commercial timber in these primary forests and because non-commercial trees were damaged through sawing and extraction of wood, the forest was severely degraded. Extraction volumes of up to 120 m^3 per hectare have been reported. Two yarding systems were applied then: tractor yarding and high-lead yarding, where logs are transported uphill or downhill along a cable in the air. As a result there was a continued high tree mortality in the years after harvesting – many trees were damaged and weak and collapsed after some time, affecting other standing trees in their fall and thereby extending the high mortality rates and the recovery of the forest. In addition, there is an abundant growth of vines, climbers and weeds due to the increased light availability, suppressing the remaining potential crop trees and hampering the growth of new seedlings and thereby preventing the regeneration of the forest. Following the harvesting the forest does not recover and there is no net uptake of Carbondioxide. The removal of many Dipterocarp seed trees by logging has resulted in less seed availability of important species afterwards, which is a main reason for enrichment planting.

The effect of logging in the reference area Malua Forest Reserve, where Reduced Impact Logging was applied.

Forestry techniques

The Infapro project intervention has developed over time. Several challenges had to be solved before successfully running the project. One of them is to provide a steady supply of high quality tree seedlings for planting within the degraded forest. Dipterocarp trees fruit irregularly with an abundance of seed in so called mast years and limited or no seeds in the period between those mast years. The seeds cannot be kept for a long time. Project staff, in conjunction with researchers, have worked on techniques to keep a stock of healthy seedlings for several years in the nursery. There is now knowledge on how to treat the seeds for germination, how to raise the seedlings and how to keep them at a specific size for several years until planting. If the seedlings grow too big, they are difficult to be transported to the planting site. Growth in the nursery is suppressed by adjusting light and water conditions. In addition to using seeds, staff also collects wildlings (seeds that germinated into seedlings under the mother trees) from the forest, which are brought out and maintained in the nursery as seedlings. Another development related to the availability of seedlings: at the start only a few tree species were used for enrichment planting, since it was not known how to produce seedlings of other species at the scale required for the project. Since then, the variety of species used for enrichment planting has strongly increased, and up to date more than 75 different indigenous species have been used. A third development is going from replanting with timber species and forest fruit trees that are beneficial for animals like orang-utans, gibbons, other mammals and birds. This

also helps restoring the natural composition of the forest quality and structure. A fourth development has to do with making more use of natural processes for rehabilitation. Instead of planting every 3 or 5 meters a seedling, the staff first looks at the availability of natural regeneration of desired tree species. If these are available, no seedlings will be planted, but instead the natural seedling will be tended to by the staff. Fifthly, initially liberation thinning of large trees was applied around desired tree species in order to encourage the growth. This practice was however abandoned and replaced with shade adjustment: the technique is refined with liberating the desired tree species by removal of the small, dense understorey species. In addition, the width of the strip cleared from competing weeds has been reduced to 1 meter. This is referred to as Reduced Impact Site Preparation (RISP). What is still applied successfully is the cutting of climbers and vines and weeds that compete with the trees. The sixth development relates to the rehabilitation of heavily impacted sites like log landings and also skid trails. The establishment of trees in such severely degraded areas is a challenge, since the soil is often heavily compacted. A successful strategy has been to select pioneer trees and fast-growing and light-demanding Dipterocarps for these sites and to plant bigger seedlings than usual.

Climbers are very dominant in some parts of the forest, especially in canopy gaps.

<u>Avoidance of relogging</u>

Infapro has prevented short-term relogging in its area. Most of the areas within the same Forest Management Unit, which has a total size of 241,000 hectares, have been logged selectively again within around 20 years after the first round of logging. The Infapro area was not part of these harvesting operations, since it is fully in the rehabilitation process. The carbon benefits associated with the avoidance of relogging has been quantified and is credited under the Voluntary Carbon Standard. A specific VCS methodology (VM0005), developed by Silvestrum and *Face the Future*, provides carbon accounting rules to determine how much carbon would have been released if the area was relogged. Since the logging only happens in the baseline and is thus counterfactual, a reference area was used to find out what harvesting volumes are removed and which harvesting

techniques would be used. The project conservatively assumed that baseline relogging would be based with Reduced Impact Logging (RIL) techniques, which reduces the damage to the forest and therefore diminishes the carbon emissions that can be claimed by the project. In fact, RIL was applied in a neighboring reference area (Malua Forest Reserve) of around 34,000 hectares. In the rest of the FMU conventional logging techniques were applied. Apart from the direct emissions from the harvested wood, there are also emissions related to clearing of forest for roads and log landings, damage to other trees when felling, and fossil fuel consumption by heavy machinery. This has been quantified based on default values from literature for tropical forest, as provided by the methodology.

Research, training and knowledge sharing

The experiences from Infapro have been useful for other forest rehabilitation initiatives. More than 80 publications have been issued since the start of the project activity. Knowledge was also shared in a workshop hosted by Infapro in 2000, held in conjunction with the 21st IUFRO World Congress in Kuala Lumpur, Malaysia. Infapro is also open to interested visitors that want to see the results of the project and want to learn from the experiences with the rehabilitation of Dipterocarp forest. Annually several groups and many individual visitors come to the project, including VIP dignitaries, government officials, academic researchers, NGO representatives, journalists, students and tourists. The application of rehabilitation techniques in Sabah has increased since the start of the project in 1992. In the period 1997 – 2009 about 143,000 hectares of degraded forest have been silviculturally treated or rehabilitated (this figure includes activities in Infapro). However, most of the interventions in the forest are related to climber cutting rather than enrichment planting, due to the relatively high costs of full forest rehabilitation.

Infapro's success to date has been based on its research-led approach. In addition to the multiple-faceted research efforts carried out as part of the project, an intensive training programme for all project staff is maintained and implemented. Such trainings and applied research has allowed Infapro to implement research findings directly and efficiently and leads to successful rehabilitation of logged-over tropical forest. Rather than being rigid, project activities have evolved to ensure the maximum success as well as the transfer of technologies both locally and internationally and adaptive management based on results and findings.

Long-term research involves more specialised investigations such as the carbon offset monitoring, production of planting material by vegetative propagation techniques, manipulation of the canopy for light, plant nutrition, association of dipterocarps with mycorrhizae, soil dynamics, and natural recovery of logged-over forest, the ecophysiology of dipterocarps, pests and diseases. These subjects are either directly pursued by the research team or in collaboration with other scientists at DVFC or other institutions such as Forest Research Institute Malaysia (FRIM), Kuala Lumpur and Forest Research Centre (FRC), Sepilok, Sabah.

SFM in Sabah

There is much progress with Sustainable Forest Management in Sabah over the last decades. The Sabah Forestry Department started in 1995 to introduce SFM as a model in the Deramakot Forest Reserve. That means the harvesting volumes are strictly regulated and the forest is being rehabilitated. In 1997 Deramakot was awarded an FSC certificate for good forest management. Based on these experiences SFM is applied more widely over Sabah. The Ulu Segama – Malua Forest Reserve, of which Infapro is part, has now also been certified under the FSC principles and criteria – the certificate is valid from June 2011. A moratorium on logging in Ulu Segama – Malua was announced by the Sabah State Government on 15 March 2006. As per 1 January 2008 no logging activities are allowed in this Forest Management Unit. Recently, the Ulu Segama Forest Reserve including Infapro is re-gazetted to be a Class I Protected Forest Reserve.

Biodiversity

Dipterocarp forests contain an amazing variety of flora and fauna species. This forest is especially interesting in Sabah – according to Yamakura (1986) Borneo is regarded as the center of the world distribution of Dipterocarpaceae, while forest studies in mainly Sabah have shown a high species diversity, tall architecture and big local variation in these Dipterocarp forests. The number of different tree species that can be encountered on 1 hectare of forest amounts to 240[1]. Common tree genera are *Hopea*, *Shorea*, *Parashorea, Dipterocarpus* and *Dryobalanops*. Among these many are listed on the IUCN Red List of Threatened Species. But also the wildlife that the forest supports is impressive. The area is part of the Yayasan Sabah Concession Area, which constitutes the largest habitat of orang-utans in North-eastern Borneo. The population accounts for about half of the total orang-utan population of Sabah. The area is also an important refuge for key wildlife species such as the Sumatran rhinoceros, Borneo pygmy elephant, tembadau/banteng, sun bear and the clouded leopard (SFD, 2008). The most common large omnivore is the Malayan sun bear. Primal diversity is relatively rich, comprising of orang-utans, borneo gibbons, red langurs, long-tailed and pig-tailed macaques. Carnivore diversity includes the rare clouded leopard, bay cat and flat-headed cat, leopard cat, marbled cat, Malay badger, yellow throated marten, banded linsang and several species of civet, small clawed and smooth otters. Eight of the nine species of hornbill found in Borneo occur within the area, the most common being the rhinoceros hornbill (Infapro, 2001).
Edwards et al. (2009) did research on biodiversity of birds in logged and unlogged forest, including the Infapro area. He found that species richness and diversity of birds were at prelogging levels Infapro. This is especially the case for insectivores, while there was a reduction in the abundance of frugivores and the total abundance of birds. According to Edwards "Our results indicate that rehabilitation of selectively logged forest has the potential to improve landscape scale biodiversity in addition to providing benefits in terms of carbon sequestration." Researchers from the Bornean Clouded Leopard Programme have also been monitoring the presence of cat species, especially the clouded leopard, within the project area with camera traps. The results are expected to be published soon.

Borneo pygmy elephants find an important home in the Infapro area.

<u>Carbon monitoring</u>
From the beginning, the main aim of the project is to mitigate climate change by enhancing the carbon sequestration capacity of the forest. This is achieved by releasing the existing degraded forest from climbers and vines and by carrying out enrichment planting. Whereas in the baseline (i.e. in the absence of the project activity) the forest would remain in a degraded state with limited carbon sequestration, in the project scenario there is an increase in growth as the forest recovers. This effect has been quantified by measuring carbon stocks in the project area. Up to date the additional

[1]http://wwf.panda.org/what_we_do/where_we_work/borneo_forests/about_borneo_forests/ecosystems/lowland_dipterocarp/

measured sequestration of carbon per hectare has amounted to around 50 ton, which is equivalent to about 183 ton of CO_2. Monitoring was carried out with Field-Map technology, a computer aided field data collection system. The precise location of all the trees within the permanent sample plots are stored in the database. This allows for example to analyse growth of individual trees. The data collection is very accurate. When independent verifiers remeasured some monitoring plots, the mean difference in measured DBH was only 0.49 cm, which is partly explained by the growth of the trees since the last measurement by the monitoring staff.

Carbon monitoring is done with Field-Map© software and equipment.

Marketing and certification

Forest carbon projects like Infapro, that result into additional carbon benefits, can create a revenue by selling the sequestered carbon by the project as credits that serve as an offset for emissions created by the buyer of the offset. Typically, buyers try to limit their carbon footprint and then want to offset the emissions that they cannot avoid. Initially Infapro was developed for the Dutch Electricity Generation Board (SEP), to offset the emissions of a new medium-sized coal power plant that was eventually never built. In 1999 Face engaged the certification company SGS, who was developing a carbon offset validation and verification standard for forests projects. The standard was created in line with the decisions taken by the Conference of the Parties of the United Nations Framework Convention on Climate Change. It contained elements that are still part of current carbon certification standards: additionality of the project, leakage, carbon monitoring and a risk assessment to determine which percentage of the credits is retained against future carbon losses from the forest. Credits for carbon sequestration were issued under the SGS standard. Since 2008 the Verified Carbon Standard released an AFOLU standard, allowing for forest carbon project to be certified. A prerequisite is that a project makes use of a generic baseline and carbon monitoring methodology to demonstrate the project eligibility and to determine the carbon benefits. Since such a standard did not exist for Infapro, *Face the Future* developed an Improved Forest Management methodology with the Dutch consultancy company Silvestrum. The development and the validation took more than a year. The validation process is very rigorous since it requires two independent validators to sequentially approve of it. The next phase was to collect data required by the methodology to demonstrate and quantify the carbon benefits related to carbon sequestration and avoided deforestation. By September 2011 the project was validated and verified under the VCS.
In addition to buying carbon credits, clients also have the option to directly fund the rehabilitation of a minimum area of forest within Infapro.

Social impacts

The social benefits of the project are mainly related to the provision of employment. Around 50 staff are employed for the variety of tasks required to run the project, including nursery management,

forest field work and research and monitoring. Accommodation is provided at the project centre 'Faceville', since the area is quite remote from any settlement. There are no local communities based within the project area or in the direct environment.

Women prepare the wildlings that have been collected from the forest.

Environmental impacts

All operations of the project are compliant with the principles and criteria of the FSC standard. There is limited or no use of chemicals and fertilizers. The project only works with indigenous trees. The environmental impacts are very limited and wherever possible these impacts are mitigated. An example of an activity that has a potential negative impact is road maintenance, since it may lead to soil erosion. This impact is mitigated by making use of existing roads for as far as possible, as well as constructing and maintaining side drains, cross drains and culverts. Where erosion risk is high surfacing with gravel may be applied. Another example is the collection of soil from the forest for the planting bags in the nursery, which leads to a reduction of top soil and may lead to loss of vegetation. This is mitigated by planting seedlings to cover the bare soil and to collect soil from landslides.

Conclusion

In conclusion, there are many lessons learnt and to be learnt from the project. The project is now a model of Tropical Rainforest Rehabilitation in the region and is pioneering many different techniques from raising high quality seedlings in the nursery to field operations and quantification of carbon and monitoring forest quality and structure. Over the years, Infapro is becoming a Centre of Learning for Tropical Rainforest Rehabilitation and proven that large scale rehabilitation of Dipterocarps can be done in an efficient manner. Such excellent milestones achieved would also not be possible without the full support from the collaborative partners, government agencies, NGOs and the dedicated staff itself.

Additional information

See the Infapro Project Design Document for more detailed and technical information on the project. This can be downloaded from the VCS Project Database, which includes Infapro.

Sources

Edwards, D.P., Ansell, F.A., Ahmad, A.H., Nilus, R., Hamer, K.C. 2009. The value of rehabilitating the logged rainforest for birds. Conservation Biology 21 – 6: 1628 – 1633.

Infapro. 2001. First 10 year Forest management plan year 2001 – 2010 of the Innoprise – Face Foundation Rainforest Rehabilitation Project (Infapro), Lahad Datu, Sabah, Malaysia.

Sabah Forestry Department. 2008. Forest management plan for Ulu Segama – Malua sustainable forest management project area 2008 – 2017.

Yamakura, T., Hagihara, A., Sukardjo, S., Ogawa, H. 1986. Aboveground biomass of tropical rain forest stands in Indonesian Borneo. Vegetation 68: 71 – 82