

The failure of eco-forestry as a small-scale native forest management model in Papua New Guinea



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ABSTRACT

Deforestation and forest degradation are problems common to many tropical countries, including Papua New Guinea (PNG). These problems are often a result of the environmentally unsustainable logging practices of industrial logging companies. Beginning in the 1990s, six organizations attempted to mitigate the deforestation and forest degradation occurring in PNG by facilitating small-scale native forest management by Indigenous forest landowners. All six organizations utilized an ‘eco-forestry’ approach, involving selective harvesting of timber combined with the milling of timber by Indigenous forest landowners using portable sawmills. The lumber produced was sold into local and international markets as sustainable certified under Forest Stewardship Council (FSC) principles. The use of portable sawmills was also intended to provide the landowners with a greater financial return compared to the timber royalty payments they could receive from logging companies. This study used a literature review and interviews with key informants from the eco-forestry organizations and the PNG Forest Authority to assess the effectiveness of variants of the portable sawmilling model. We found that each of the six organizations were unsuccessful in developing a financially viable model for small-scale native forest management by Indigenous forest landowners in PNG. All the Indigenous landowners were unable to continue their portable sawmill operations once the donor funding of the eco-forestry organizations ceased. In addition, the operators of portable sawmills struggled to produce lumber that met the quality and quantity demands of buyers, who ultimately ceased purchasing the lumber. Furthermore, the Indigenous landowners struggled to adhere to the FSC principles, resulting in a loss of FSC certification. The study identifies a need for a new small-scale native forest management model in PNG. We recommend that future research involve collaboration with private sector businesses and professionally trained operators to inform the development of a small-scale forest management model which is financially profitable while also adhering to the principles of eco-forestry.

1. Introduction

Papua New Guinea (PNG) has one of the largest remaining continuous areas of tropical forest in the world. There are approximately 29 million hectares of forest with 97 percent of the forest held under customary land ownership by Indigenous clan groups (PNGFA, 2009). Large-scale industrial logging companies operating in PNG export approximately 90 percent of the logs harvested in the country (PNGFA, 2009). Just over 3.4 million m³ of non-coniferous logs were exported from PNG in 2016 (SGS, 2017). This amount represents 8.5 percent of total non-coniferous log exports from all tropical countries in the world in 2016 (ITTO, 2017). The PNG Government imposes export duties on exported logs, which totalled approximately \$95.5 million USD in 2016 (SGS, 2017). The customary landowners receive royalty payments as compensation for the harvested timber, which varies between \$3.30

and \$11.55 per m³ in 2016 USD, depending on the tree species (NFS, 2011).

The harvest methods of the large-scale logging companies operating in PNG have been widely criticised, especially in respect to the widespread environmental damage resulting from noncompliance with the PNG Logging Code of Practice (PNGFA, 1996), (e.g. Bun and Scheyvens, 2007; Fox et al., 2011; Bun, 2012). In addition, the timber harvests have resulted in social inequalities due to the royalty payments received by the landowners being disproportionately small relative to the value of the timber being removed. Furthermore, the system for distributing royalty payments to landowners lacks financial transparency, causing landowners to question if they have been paid the amounts they were owed (Bird et al., 2007). These issues provided the impetus for PNG’s customary landowners and supporting non-governmental organizations (NGOs) to explore alternative forest management methods such as ‘eco-forestry.’

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'Eco-forestry, as a form of forest management is poorly defined with limited performance metrics established. It has been described by the Food and Agricultural Organization (FAO) of the United Nations as an ecologically sustainable and economically viable alternative to conventional logging. The key principles of eco-forestry were derived from the 'Sustainable Forest Management' (SFM) and the 'Ecosystem Approach' (EA) to forest management (Scialabba and Williamson, 2004). The 15 principles of SFM were originally promulgated by outputs of the United Nations Conference on Environment and Development (UNCED, 1992). The objectives of the 15 SFM principles was to provide guidance for the management, conservation and sustainable development of all forest types to meet the ecological, economic, social, cultural and spiritual needs of society (Wilkie et al., 2003). The 12 principles of the EA approach to forest management also originated as an outcome of the UNCED, and were developed by the Convention on Biological Diversity to provide a holistic approach to forest management aimed at conserving ecosystem services (CBD, 2000). While SFM and the EA had different starting points - forest management versus conservation ecology - they are sufficiently similar to be combined for planning purposes (Wilkie et al., 2003; Sayer and Maginnis, 2005). Thus, eco-forestry became a forest management model based on the principles of these two forms of forest management. The Commission on Sustainable Development (CSD) was established by the United Nations General Assembly to ensure effective follow-up of the outputs of UNCED. It was recognized by the CSD that the development of criteria and indicators (C&I) would be a crucial step for evaluating the performance of sustainable forest management (Szaro et al., 2005). Third party sustainability certification emerged as a tool for establishing C&I and verifying the occurrence of the required indicators (Sayer and Maginnis, 2005). In PNG, the primary organization for third party certification is the Forest Stewardship Council (FSC). The current FSC principles, criteria, indicators and verifiers for PNG were established in 2010 (FSC, 2010).'

In PNG, eco-forestry as a forest management model has been linked to the use of portable sawmills. Beginning in the 1970s, church groups and NGOs imported portable sawmills so that Indigenous communities could mill lumber for their own needs. Advances in the mill designs in the 1980s improved portability, resulting in widespread adoption throughout the country (Bun and Scheyvens, 2007; Holzknrecht et al., 2012). Beginning in the 1990s, multiple NGOs facilitated small-scale native forest management which followed the principles of eco-forestry. The NGOs incorporated portable sawmills into this forest management model, with the mills being operated by the Indigenous forest landowners. While the use of portable sawmills as an alternative to conventional logging and log processing for rural development has been practiced in Vanuatu, the Solomon Islands, the Philippines and Brazil (World Bank, 1996), PNG is the only tropical country that has specifically linked eco-forestry and portable sawmills as a forest management model. For the remainder of this paper the entities involved in eco-forestry projects in PNG will be referred to collectively as the 'eco-forestry organizations.'

There have been few rigorous attempts to critically assess the success of eco-forestry projects in PNG, and whether portable sawmills are an appropriate technology for use in such projects. In addition, there is a lack of information about whether there are opportunities to scale-up the existing small-scale forest management activities utilizing the eco-forestry management model with portable sawmills. The aim of this study was to assess the effectiveness of eco-forestry using portable sawmills as a model for small-scale native forest management by PNG's Indigenous landowners and determine if it is a viable model that can be further developed and scaled-out to additional communities in the country. The criteria by which we assess the of the eco-forestry organizations in this study were; (1) the financial viability of their operations; (2) their ability to accomplish their management objectives; and (3) their ability to adhere to the principles that the eco-forestry management model was based on.

2. Methods

2.1. The eco-forestry organizations

Six eco-forestry organizations have been involved in facilitating small-scale forest management activities with Indigenous forest landowners in PNG using portable sawmills since the early 1990s. Most of these organizations were structured as NGOs. Only two of these organizations are currently operational. They are the Foundation for People and Community Development (FPCD) and FORCERT. The eco-forestry organizations discussed in this paper were headquartered in the cities of Kimbe, Lae, Madang and Rabaul in PNG (Fig. 1). Key features of these organizations are presented in Table 1.

2.2. Data collection

Data was collected from a literature review and interviews with key informants. A literature search was first conducted using Google Scholar, JSTOR and ProQuest search engines to locate relevant journal articles, conference papers and reports discussing eco-forestry organizations in PNG. The keywords used in the literature search were; Papua New Guinea; eco-forestry; and portable sawmills. The initial literature search yielded 101 documents. Of these documents, only 10 provided information specific to the operations of the eco-forestry organizations. Three trips were made to PNG in 2016 to the cities of Lae, Madang and Port Moresby to conduct interviews with key informants from the eco-forestry organizations and the PNG Forest Authority. During these visits, additional documents relating to the eco-forestry organizations were collected, comprising four external evaluations of the eco-forestry organizations, a strategic plan for one of the eco-forestry organizations and eight operational reports produced by the eco-forestry organizations. The eight operational reports were only available as paper-copies and were in the PNG Forest Research Institute library in Lae and from current or former employees of the eco-forestry organizations.

An interview protocol was designed based on the preliminary results of the literature review. The interview questions were designed to identify the management activities implemented by the eco-forestry organizations, their accomplishments, the destinations of the milled lumber, and the funding received to implement the eco-forestry activities.¹ The interview format was similar for all interviewees. The initial question asked during the interview was; 'What are the specific activities that were implemented by (the NGO being interviewed) to facilitate eco-forestry with the Indigenous landowners?' Follow up questions focused on; training provided to the landowners; if forest management plans had been completed; lumber volumes produced; transporting the lumber to market; lumber sales; accomplishments; challenges experienced; and sources of funding for NGO activities. All the interviews were conducted by the first author, with hand-written notes taken during the interviews. The length of the interviews varied between 30 min and two hours. The initial interviews were with four current and former employees of one of the eco-forestry organizations, the Foundation for People and Community Development (FPCD). Only one current employee of FORCERT was willing to participate in an interview. This person was also a former employee of IRECDP. It was not possible to conduct interviews with three of the eco-forestry organizations discussed in this paper because these organizations had ceased their operations and no former employees could be contacted. Additional interviews were conducted with 10 employees of the PNGFA that had knowledge of the past operations of the eco-forestry organizations. Details of the key informants interviewed for the study are presented in Table 2.

¹ Total funding estimates were collected from four of the eco-forestry organizations. Partial estimates for two of the organizations were collected from reports and news articles. All the data estimates were inflated to 2016 USD values. To address privacy concerns, data related to specific organizations and the sources utilized has been kept confidential.

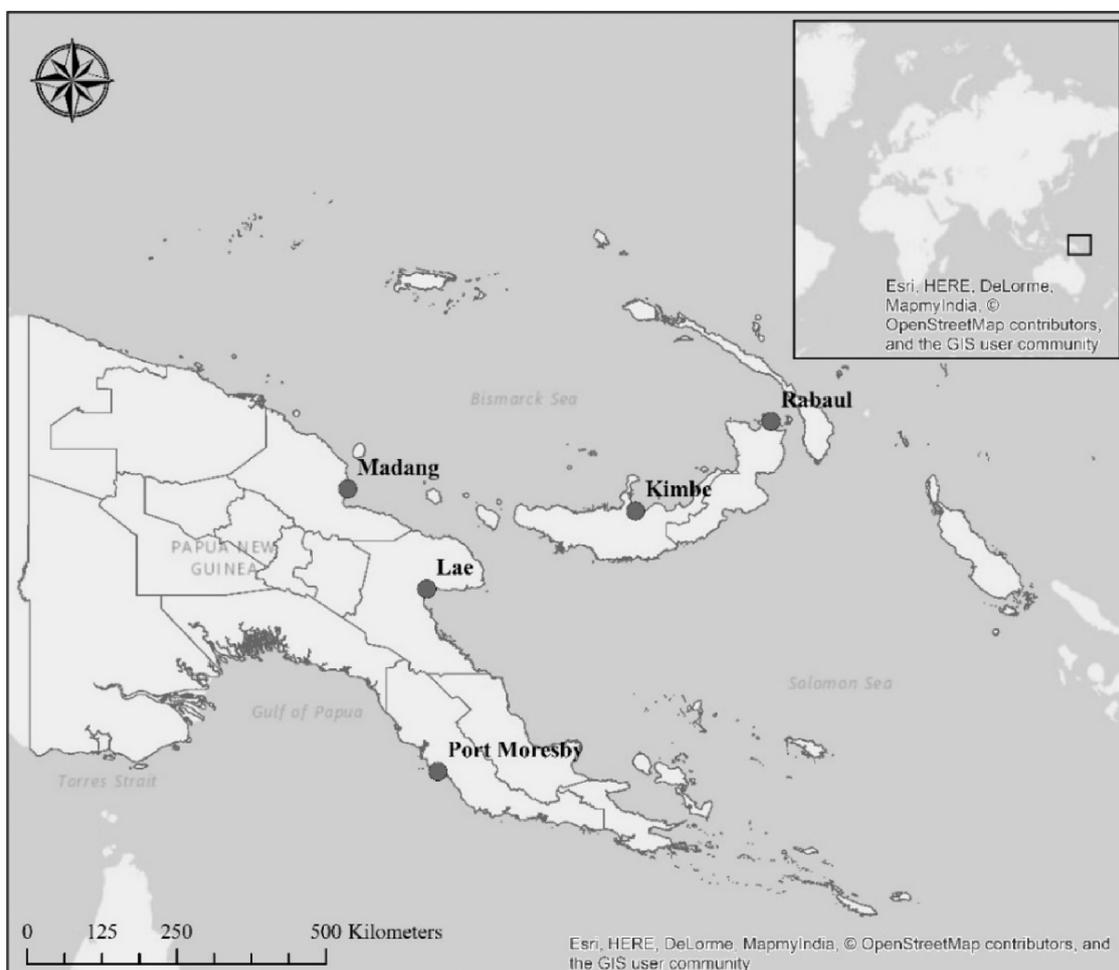


Fig. 1. Data collection sites and headquarter sites for the eco-forestry organizations and the PNGFA.

2.3. Data analysis

We completed our data analysis in two steps. The first step was a summary of each of the six eco-forestry organizations is provided in the following sections. The summaries outline each organization’s: a) year of commencement, location in PNG and objectives, b) management activities, c) accomplishments, and d) year of ceasing operations and why.

The second step was a thematic analysis to identify patterns in the data using methods outlined by Boyatzis (1998). The materials used in the thematic analysis were the ten documents identified in the literature search, the four external evaluations of the eco-forestry organizations, the strategic plan of one of the eco-forestry organizations and the eight operational reports produced by the eco-forestry organizations and the notes written by the first author during interviews. A thematic code was developed by the first author from a sub-sample of these materials. The sub-sample was the four external evaluations of the eco-

Table 2
Description of the key informants interviewed.

Organization	Number of people	Interviewee expertise
PNG Forest Authority		
National headquarters	4	Forest management
Madang Provincial office	3	Forest management
Lae Forest Research Institute	3	Forest management
Eco-forestry organizations		
FORCERT	1	NGO management
Foundation for People and Community Development	4	NGO & forest management
Islands Region Environmental & Community Development Programme	1	NGO management

Table 1
Key features of the eco-forestry organizations.

Name	Start year	End year	Institutional framework	Number of mills
Village Development Trust	1990	2010	NGO	4
Pacific Heritage Foundation	1992	2003	NGO	12
Islands Region Environmental & Community Development Programme	1995	2001	NGO/Government	40
PNG Eco-forestry Programme	2002	2005	Government	15+
Foundation for People and Community Development	1996	–	NGO	6
FORCERT	2004	–	NGO	40

Table 3
Thematic code labels and descriptions.

Thematic code label	Description of thematic code
Group one themes	Did the eco-forestry organizations provide these services?
Community development	Construction of buildings and training to improve health of community.
Forest management plan	Completed forest management plan with inventory, objectives and activities.
Sawmill operator training	Trained portable mill producers in the use and maintenance of portable sawmills.
Business training	Trained portable mill producers in business fundamentals.
FSC certification	Assisted portable mill producers in getting FSC certification.
Harvest set-up	Marked harvest trees and appropriate sites to set-up the sawmills.
Oversee harvest and milling	Were present during harvest and milling operations to assist portable mill producers.
Marketing and sales of lumber	Identified foreign buyers for the milled lumber and completed sales contracts.
Operated CMU	Aggregated the lumber milled by multiple portable mill producers at a lumber yard.
Group two themes	Did the eco-forestry organizations experience these challenges?
Business management	Maintaining the business functions of the organization.
Financial sustainability	Loss of donor funding or inability to generate revenues required for operations.
Sales requirements (quality)	Lumber quality did not meet the requirements of the buyers.
Sales requirements (quantity)	The volume of lumber produced did not meet the production demands of the buyers.
Maintaining FSC certification	Failure to consistently meet the FSC certification requirements.
Overextension of resources	Not enough employees/resources to meet the needs of the portable mill producers.
Group three themes	Did the portable mill producers experience these challenges?
Financing	Landowners could not obtain financing for a portable sawmill.
Lumber quality targets	Lumber quality did not meet the requirements of the buyers.
Production targets	Failure to meet lumber production targets set by the eco-forestry organizations.
Sawmill maintenance	Inability to get proper mechanical maintenance or spare parts for sawmills.
Transporting lumber	Transportation being prohibitively expensive due to poor road infrastructure.
Business concepts	Business concepts were difficult for portable mill producers to comprehend.

forestry organizations. Twenty-one recurring themes were identified during the review of the sub-sample. The twenty-one themes were classified into three groups; (1) eco-forestry organization management model activities, (2) challenges experienced by the eco-forestry organizations, and (3) challenges experienced by portable mill producers. From these themes, twenty-one thematic codes were developed (Table 3). All the materials used in the thematic analysis were reviewed by the first author to determine the presence or absence of the thematic codes for each eco-forestry organization. Patterns were identified from thematic codes that had the highest occurrences among the six eco-forestry organizations.

3. Results

3.1. Village development trust

The Village Development Trust (VDT) is an NGO established in 1990 in Lae in Morobe Province. VDT's primary objective was to encourage small-scale forestry with management performed by the landowners (Fox et al., 2011). A long-term objective of VDT was to establish a lumber yard and re-sawing facility in Lae dedicated to the production eco-forestry wood products (Bun and Scheyvens, 2007). VDT's management model facilitated eco-forestry by providing support to portable sawmill owners, but no forest management standard was ever applied (Bun and Scheyvens, 2007). VDT facilitated sales of the milled lumber to private merchants in Lae for a 10 percent commission fee (Chatterton et al., 2000). VDT was one of the first organizations to accomplish the export of eco-forestry lumber, which occurred in 1992/1993 (Chatterton et al., 2000). VDT, with the assistance of Habitat for Humanity², also facilitated the milling and construction of 30 homes in the Waria Valley, which lies in the south-eastern corner of the Morobe Province (Chatterton et al., 2000). A report by Fox et al. (2011) indicates that VDT was in the process of assessing a new eco-forestry project for approximately 20,000 ha of forest in the adjacent province of Madang just before it ceased all its operations in 2010. The exact

² Habitat for humanity is a global non-profit organization that helps people build affordable homes. See www.habitat.org.

reason for the VDT's cessation of operations is unknown, but it is assumed to have occurred due to a loss of donor funding support (Subendranathan, 2008; Fox et al., 2011; Nerius et al., 2011).

3.2. The Pacific Heritage Foundation

The Pacific Heritage Foundation (PHF) is an NGO that started in 1992 and was based in Rabul in East New Britain Province (Henderson, 1997; Chatterton et al., 2000). A British DIY chain store called B&Q subsidized PHF's operations (Henderson, 1997; Bun and Scheyvens, 2007; Scheyvens et al., 2007; Subendranathan, 2008). The objective of PHF was to provide B&Q with a line of certified sustainably-sourced lumber. In 1994, the PHF became the first eco-forestry organization in PNG to receive Forest Stewardship Council (FSC) certification, with 12,500 ha certified (Chatterton et al., 2000). PHF began marketing the lumber in 1995, but the certification lapsed in 1996 (Bun and Scheyvens, 2007). At its peak, the organization had 12 portable mill producers in PNG. The PHF ended its operations in 2003, due to a loss of funding and other management problems (Bun and Scheyvens, 2007; Scheyvens et al., 2007). Salafsky et al. (1998) and Subendranathan (2008) indicated that the struggles that PHF experienced were a combination of challenges, including the managerial and financial requirements needed for its operations. The organization struggled to meet the requirements for export sales including timely delivery and maintenance of the quality and quantity of the eco-forestry lumber required by the buyers. The second challenge was adhering to the FSC standards and corrective action requests, which ultimately led to the cancellation of the annual FSC monitoring visit and withdrawal of FSC certification.

3.3. Islands Region Environmental and Community Development Programme

Information on the Islands Region Environmental and Community Development Programme (IRECDP) was collected from the "End of Programme Report" (EU-IRECDP, 2001), Hunt (2002) and Scheyvens et al. (2007). The IRECDP was founded in Kimbe in West New Britain Province and operated from 1995 to 2001. The IRECDP received

funding from the European Union's (EU) Economic Development Fund and was nominally under the administration of PNG's Department of Environment and Conservation, making it an NGO/Government hybrid. The objective of the programme was to develop income earning opportunities for landowners through sustainable forest management using portable sawmills. The management model of IRECDP utilized an 11-step process for facilitating small-scale community forestry based on management guidelines (see Annex 4 of EU-IRECDP, 2001) and lessons learned from the programme (see Salafsky, 1997). Each eco-forestry project was managed by the landowners as a village business. The "End of Programme Report for Marketing Unit" by Maniho (2001) indicated that the IRECDP utilized two central marketing units (CMUs) in East and West New Britain. These CMUs acted as timber yards and purchased 80 to 90 percent of all lumber produced by the eco-forestry projects. These CMUs were intermediaries between the eco-forestry producers and the major local buyers and overseas markets.

The accomplishments of IRECDP include the facilitation of approximately 40 eco-forestry projects throughout seven provinces in PNG. In 1998, the programme received FSC Group Certification, allowing IRECDP to determine which eco-forestry projects qualified for certified status. By the year 2000, approximately 10,000 ha of forests had received certification. In 2001, IRECDP ended their role as eco-forestry facilitators, which was determined to be phase one of the programme. It was determined that phase one was successful at initiating income earning opportunities through sustainable forest management for landowners, with the assistance of donor funds. The challenges experienced by the IRECDP were primarily related to maintaining the quality, consistency of supply and timely delivery of the eco-timber to markets. Maniho (2001) recommended that phase two of the project implement cost of production studies to identify the break-even production volumes and set monthly production targets.

3.4. PNG Eco-forestry Programme

Information on the PNG Eco-forestry Programme (EFP) was collected from the EFP annual reports for the years 2002, 2003 and 2004 (EFP, 2003, 2004, 2005). The EFP was the second phase of the EU-funded IRECDP, and received additional funding from the EU. In addition to continuing the objectives of phase one, a new objective of the second phase of the programme was to improve business intelligence and the profitability of operations. EFP managers believed that in the past, IRECDP had kept the operations competitive with subsidization, which resulted in community groups' excessive financial dependency on the programme. The EFP continued to manage the eco-forestry projects and CMUs developed by IRECDP, but also introduced new activities. A second, medium-scale project was initiated in the Western Highlands Province. This project was designed to increase economies of scale and increase value-added processing. The harvest plan for this project was based on Reduced Impact Logging (RIL) techniques estimated to produce approximately 12,000 m³ of lumber annually, using a D7 dozer, tractor and two semi-portable mills.

Annual reports indicate that the EFP undertook a forest inventory, prepared a forest management plan and conducted operational training for the medium-scale project in the Western Highlands, but there is no information available if any harvest operations ever took place. Minimal data was found on the accomplishments related to the carry-over projects from IRECDP, but it is known that the FSC certification was withdrawn. Additional accomplishments of the EFP were the establishment of 25 nurseries, a reforestation support scheme and the drafting of a national eco-forestry policy. This policy draft was submitted to the National Forest Board in 2004 for approval, but it never resulted in changes to national legislation and remains in 'draft' form. The EFP shut down in 2005 when funding from the EU ceased. A review undertaken at the end of the programme by Ducenne and Rollinson (2005) determined that the EFP structure was not sustainable from a financial perspective because there was no organization capable of

administering the programme after the EU funding was exhausted. The report indicated that the involvement of the private sector in future eco-forestry activities would be a key aspect for mitigating this funding challenge. Ducenne and Rollinson (2005, p.10) stated that "The biggest misunderstanding about eco-forestry and EFP has been to associate eco-forestry with portable mills! This has been a simplistic and incomplete assimilation of the eco-forestry concept." This view is due to the low productivity levels common with portable sawmills, and the challenges of conducting a commercial portable sawmill enterprise within the socio-cultural context of clans, tribes and wantoks.³

3.5. Foundation for People and Community Development

The Foundation for People and Community Development (FPCD) is an NGO that began in 1996, and was established to take over the PNG-based projects of the NGO known as the Foundation for the Peoples of the South Pacific (FSP) (Nerius et al., 2011). FSP had numerous projects in PNG related to community development. These included health, sanitation, nutrition, business, carpentry, food security, disaster preparedness and small-scale sustainable forestry projects. When the FPCD took over from FSP, the FPCD Director, Mr Yati Bun, made eco-forestry projects in Madang Province the primary objective of their activities, but continued to facilitate FSP's previous projects out of a sense of obligation (Nerius et al., 2011). The management model utilized by FPCD to facilitate the eco-forestry projects involved conducting forest inventories, preparing forest management plans, sourcing and financing portable sawmills, and marketing the milled lumber through a CMU timber yard (Nerius et al., 2011).

The FPCD conducted forest inventories and developed forest management plans for six Indigenous community groups. With the assistance of Greenpeace, the FPCD completed eco-forestry lumber exports to New Zealand and Australia (Bun and Bazakie, 2006; Bun and Scheyvens, 2007). In 2007, FPCD achieved FSC Group Certification for 2705 ha of forest (Bun and Scheyvens, 2007; Scheyvens et al., 2007). After receiving certification, an additional 64 m³ of milled lumber was exported to Australia (Nerius et al., 2011). Due to a decline in funding, the FPCD's support for eco-forestry operations has diminished and there are currently no milling projects in operation. An external evaluation of FPCD by Nerius et al. (2011) identified several challenges. The low lumber production volume of the Indigenous communities resulted in slow or stagnant re-payments to FPCD for the previously supplied mills. The funds tied up in these repayment contracts caused a dramatic reduction in the expected number of new portable mill operations. The low level of lumber production was also a source of frustration for international buyers of the lumber, who then turned to alternative sources of FSC-certified tropical lumber. In 2012, FPCD's FSC certification lapsed. Other challenges included community disputes over the misuse of timber income, unrealistic production and profit expectations, and the lack of understanding of appropriate business practices. The external evaluation recommended that FPCD develop a stronger focus on understanding and implementing various approaches to community development and that FPCD reduce the number of projects being pursued so that the positive impacts of the remaining projects could be improved.

3.6. FORCERT

Information on FORCERT was collected from external evaluation reports completed in 2007, 2010 and 2013, as well as a strategic plan developed by FORCERT in 2015 (Titus et al., 2007; Rosenbaum et al., 2010; Ericho et al., 2013; FORCERT, 2015). FORCERT was established as an NGO in 2003 and began its operations in 2004 in Kimbe in West

³ When translated to Tok-pidgin, wantok means 'One talk.' The term refers to the social obligations of an individual to their family, clan or community.

Table 4
Thematic analysis of the eco-forestry organizations and affiliated portable mill producers.

GROUPS	THEMATIC CODES	VDT	PHF	IRECDP	EFP	FPCD	FORCERT
Eco-forestry organization management model activities	Community development	X		X		X	X
	Forest management plan			X	X	X	
	Sawmill operator training	X	X	X	X	X	
	Business training	X		X	X	X	
	FSC certification		X	X		X	X
	Harvest set-up			X		X	
	Overseeing harvest and milling operations	X	X	X		X	
	Marketing and sales of lumber	X	X	X	X	X	X
	Operated CMU		X	X	X	X	
			X				X
Challenges experienced by eco-forestry organizations	Business management		X	X		X	X
	Financial sustainability	X	X	X	X	X	X
	Sales requirements (quality)		X	X		X	X
	Sales requirements (quantity)		X	X		X	X
	Maintaining FSC certification		X		X	X	X
	Overextension of resources				X	X	X
Challenges experienced by portable mill producers	Financing					X	X
	Lumber quality targets		X	X		X	X
	Production targets		X	X		X	X
	Sawmill maintenance		X			X	X
	Transporting lumber		X			X	X
			X			X	X
	Business concepts		X			X	X

New Britain Province. FORCERT's objective was to enable eco-forestry by providing FSC Group Certification and developing a Group Certification Service Network. FORCERT's management model focused on connecting NGOs and their portable mill producers to timber yards/CMUs and then to the overseas timber markets. The CMUs were private enterprises that purchased "A Grade"⁴ milled lumber from the portable mill producers and then exported the aggregate lumber to international buyers. FORCERT's role was to assist the landowners and eco-forestry NGOs with meeting the requirements for FSC certification. FORCERT sought to be a self-sustaining entity by charging levies on the exported timber to both the CMUs and the portable mill producers.

FORCERT's accomplishments were greatest in 2008 with 40 portable mill affiliates and 5 CMU affiliates throughout PNG. In that year, a total of 1023 m³ of sawn timber was produced and 420 m³ of sawn timber was exported. There were then dramatic declines in the eco-forestry lumber export volumes, which ceased altogether by the end of 2009. A review of FORCERT's external evaluation reports revealed multiple challenges. One primary international buyer of lumber from FORCERT-affiliated CMUs ceased making purchases because the quality and quantity requirements were not consistently met, and the lumber was not always properly air-dried before shipment. The CMUs stated that the problems with meeting the quality and quantity requirements were due to the portable mill producers not meeting the agreed-upon minimum annual target of 60 m³ of "A Grade"³ lumber. In addition, the CMUs stated that portions of the lumber supplied by producers were incorrectly graded, incorrectly measured, and labelled as the wrong species. When CMUs provided payments to the portable mill producers based on the quality and grade of the lumber provided, the producers were often upset and ceased their operations. Common problems cited by portable mill producers were obtaining financing to purchase a portable sawmill, accessing spare parts for mill maintenance, the high wages demanded by labourers for mill operations, the prohibitive cost of transporting the milled lumber to the CMU, and the lack of transparency and distrust of the privately-operated CMUs. The external evaluations of FORCERT also identified challenges in FORCERT's structure and operations. FORCERT often found itself in the position of facilitating every aspect of eco-forestry operations that were supposed

to be the role of other NGOs. This cost was not anticipated and it overextended the organization's resources. The 2013 external review suggested that FORCERT direct its resources to specific member communities. FORCERT's new strategic plan is focused on forest-based community development rather than facilitating and certifying eco-forestry operations.

3.7. Thematic analysis: common factors behind the failure of the eco-forestry organizations

The thematic analysis identified the patterns in each of the three thematic code groups; (1) the management activities performed by the eco-forestry organizations; (2) the challenges experienced by the eco-forestry organizations; and (3) the challenges experienced by them and their affiliated portable mill producers (Table 4).

There were two themes present in group 1. The first theme was a focus on international marketing and sales by the eco-forestry organizations. All six of the organizations conducted marketing and sales on behalf of the portable mill producers. Four of the organizations were involved in managing the CMUs. Four of the organizations obtained FSC certification on behalf of their portable mill producers to improve the marketability of the lumber to foreign buyers. The second theme present in group 1 was a focus on training the portable sawmill producers. Five of the eco-forestry organizations provided sawmilling training and four of them oversaw the harvesting and milling operations. In addition, four of the organizations provided basic business training to the portable mill producers.

There three themes present in group 2. The first theme was financial challenges which were caused by a loss of funding and/or insufficient revenue. These financial challenges were experienced by all the eco-forestry organizations. The second theme was a struggle to fulfil export sales requirements for the quality and quantity of lumber demanded by overseas customers. This theme was present in four of the eco-forestry organizations. The third theme was the inability to maintain FSC certification, which was experienced by four of the eco-forestry organizations.

In group 3, the primary theme was the struggle of the portable mill producers to meet the quality and quantity lumber production targets. This theme was present in four of the eco-forestry organizations. Ultimately, the inability to meet these production requirements led to the cessation of eco-forestry lumber exports. The factors identified as causing the low lumber production by the portable mill producers included:

⁴ Interviews with eco-forestry organization employees revealed that "A Grade" lumber is of a higher quality than B grade lumber due to reduced imperfections such as knots, wane, checking, warping and cupping. The B grade lumber could be sold in domestic markets, but only the A grade lumber could be exported.

- Inability to acquire the necessary capital to access or purchase a portable sawmill, chainsaws and other required equipment;
- Inadequate sawmill training;
- Low availability of mechanical parts and low implementation of maintenance by operators;
- Limited available time due to physiological need requirements such as garden tending;
- Transport difficulties due to non-existent or poor road infrastructure and in some cases the long distance from the mill to the market;
- Lack of business skills, low knowledge of markets and poor fiscal management practices;
- Strong reliance by landowners on the eco-forestry organizations to facilitate all forest management and marketing activities; and
- Limited NGO experience in profit-generating activities, with most skillsets being forest management focused and not related to business management.

4. Discussion

We found that all six eco-forestry organizations ultimately failed to facilitate sustainable small-scale native forest management in PNG using the eco-forestry management model. Financial viability was the greatest challenge experienced by all organizations and the failure to establish a financially sustainable eco-forestry business ultimately resulted in all the organisations failing. All organizations received funding from donors to facilitate their operations over the period of two decades. Total funding was estimated to be in excess of \$26.8 million (2016 USD). Some of the organizations developed revenue streams through commission or levy payments to assist with meeting operational costs. However, none of these revenue streams were sufficient to enable the eco-forestry organizations to attain financial sustainability and ultimately, they all ceased to operate when the donor funding declined. The cessation of operations by the portable mill produces quickly followed, due to their strong reliance on the eco-forestry organizations for support.

The second challenge experienced by the six organizations was related to the quality and quantity of the lumber produced. The issue of lumber quality is likely related to the numerous portable mill producers involved. Invariably, each of these producers had varying degrees of training and experience, and the type and condition of portable sawmills was also likely to be highly variable throughout these operations. With these variations, a lack of consistency in the quality of the aggregate lumber is to be expected. Furthermore, the lumber produced by the eco-forestry operations was competing against lumber produced by industrial-scale sawmills utilizing modern processing technology and equipment. In the global marketplace, lumber is considered a commodity product and meeting standard moisture and grade specifications of the market is the minimum requirement for lumber producers to participate.

The low productivity of milling operations by communities can be attributed to a management model focused on portable sawmills with low production capacities in comparison to industrial-scale mills utilizing modern technology and equipment. The eco-forestry organizations pursued this approach because it was believed that increasing the number of portable mills in operation would eventually allow for economies of scale that would be competitive with other industry producers. The problem with this approach is the distance between each portable mill site and the inadequate road infrastructure in PNG severely limited the access for essential mill mechanical maintenance and facilitative support from the eco-forestry organizations. The Indigenous landowners received limited training in forest management, milling, lumber markets and business management, which created a strong reliance on the eco-forestry organizations for support. As the number of portable mill operations increased, this support became overextended and most of the portable mill producers subsequently failed to reach production targets or ceased altogether.

The final challenge identified in our analysis was the inability of the eco-forestry organizations to maintain FSC certification status. The primary factor identified as the cause for the lapses in certification was the inability or indifference of the Indigenous landowners in adhering to the FSC corrective action requests (Nerius et al., 2011). As FSC certification is the primary tool in PNG for evaluating the performance of sustainable forest management, it is implied that eco-forestry organizations failed in adhering to the principles that define eco-forestry. This begs the question; 'Is FSC certification the appropriate tool for evaluating the performance of Indigenous small-holder forestry in PNG?' Perhaps, third party certification as a sustainability evaluation tool is more appropriate for larger-scale forest management operations.

The challenges experienced by the eco-forestry organizations in achieving financial viability, lumber production quality and quantity, and an adherence to the eco-forestry principles highlight the failure of the eco-forestry approach to small-scale native forest management. The eco-forestry organizations were unable to develop the required capacities for a commercial operation. This includes the capacities of maintaining FSC certification, wood processing and business management. Even with substantial subsidization, the eco-forestry organizations were not always able to meet their management objectives. The ability to meet any of their management objectives ceased when their external funding concluded. Furthermore, they were not able to maintain adherence to the eco-forestry principles. Based on these findings, we conclude that this model for small-scale native forest management is not effective and it should not be scaled out to other communities in PNG.

5. Key themes emerging from the study, recommendations and conclusion

Our findings indicate that in PNG, the strategy of utilizing multiple portable sawmills to produce export oriented, FSC certified lumber, has failed. In contrast to earlier research findings by Hunt (2000), Fox et al. (2011) and Grigoriou (2011), our more recent evidence indicates that pursuing the international markets were not the best strategy for eco-forestry in PNG. Our analysis indicates that as a model of native forest management, eco-forestry is not financially viable in the long-term despite substantial financial subsidies. Listed below are the key themes that emerged from this analysis and our recommendations to assist in the development of future small-scale native forest management in PNG.

- 1) *The eco-forestry management model should re-focus to serve domestic markets.* This current model has been the primary approach supported by the PNG Government and NGOs operating in the country and our analysis has shown that this approach experienced significant challenges. Future operations for existing portable sawmills in PNG should focus on providing lumber for community development projects and, when appropriate, for local markets. It will be easier for future small-scale timber harvest operators to identify and meet the demands for local markets than international markets.
- 2) *Competency-based training is required for people who participate in future small-scale native timber harvests and processing should be developed prior to implementing commercial activities.* While most of the eco-forestry organizations provided sawmill and business training to the Indigenous landowners, the required capacities for commercial operations were never reached. We suggest that future small-scale commercial harvests utilize professionally trained portable sawmill operators that have already developed the necessary capacities required.
- 3) *Future small-scale native forest management timber harvests in PNG should conduct feasibility studies prior to management activities to filter out projects that are not financially viable.* Further research is needed to identify the methods and harvesting parameters for financially viable small-scale native forest management in PNG. We suggest

that this research involve collaboration with small/medium-scale private sector forest product businesses in PNG that have developed financially sustainable business models.

- 4) *FSC certification should be re-assessed in regard to its usefulness as a performance evaluation tool for small-scale native forest management in PNG.* This is not to say that small-scale forest managers should not strive to adhere to the FSC's sustainability principles as they are important guidelines for maintaining the integrity of forest ecosystems. Rather, it should be evaluated if FSC certification is an appropriate standard to apply to Indigenous landowners in PNG. Our analysis indicates that the FSC C&I may not be appropriate, given the land-use priorities and forest management capacities of Indigenous landowners in PNG.

This study found that utilizing portable sawmills to undertake small-scale native forest management (i.e. eco-forestry) in PNG has not been financially successful. All six of the eco-forestry organizations assessed in this study failed to achieve profitability and ultimately ceased all their eco-forestry operations. Even with substantial subsidies, lumber produced facilitated by these organizations did not meet the quality and quantity specifications of the buyers. Furthermore, the eco-forestry organizations struggled to maintain an adherence to principles that define eco-forestry. There is a need for a new small-scale native forest management model in PNG. Further research is required to identify a harvesting, processing and marketing model that incorporates collaboration with private sector businesses and professionally trained operators to achieve improved financial viability and adherence to forest management principles.'

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Declarations of interest

None.

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Appendix A. Supplementary data

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