



A Value Chain Approach to Sustainable Forest Management? Timber Supply Chain Practices for Sustainability in Myanmar's Forest Sector

Hudu Banikoi^{1,2}, Bhaskar Singh Karky², Anu Joshi Shrestha², Zaw Min Aye³

¹University of Freiburg, Germany, ²International Centre for Integrated Mountain Development, Nepal and ³Forest Research Institute, Myanmar
Corresponding author: hbanikoi@rocketmail.com

Abstract

Myanmar's forest management system, timber production and trade have been criticised as being exclusionary and responsible for forest loss in the country. These criticisms have overshadowed some good practices in timber production and trade in the country. This study used a value chain approach to assess timber production and trade in the country to provide important lessons that can be learned from the sector. We contend that, in spite of its weaknesses, there are good policy measures and practices in timber production and trade, which are not only necessary for sustainable timber supply, but also important for sustainable forest management and climate change mitigation mechanisms. These exemplary measures and practices include the method of scientific forest management (the Myanmar Selection System), the use of Reduced Impact Logging technique in harvesting timber, the use of elephants skidding and river transportation, timber legality monitoring and the introduction of the log export ban on timber trade. However, more needs to be done to improve the social sustainability aspect of the timber value chain.

Key words: Forest management, Myanmar, REDD+, timber production, value chain

INTRODUCTION

Myanmar has operated a centralised system of forestry since colonial rule (Bryant 1997; Springate-Baginski *et al.* 2016) and as such, reserved forests management is still based on command-and-control where the focus is on establishing and patrolling borders and punishing illegal harvesters forest products (Prescott *et al.* 2017). This system of forest management and forest products trade, has been criticised as being exclusionary, inappropriate, and responsible for deforestation and forest degradation in the country (Woods 2013; Springate-Baginski *et al.* 2016). Issues of illegal timber logging, deforestation and forest degradation have still continued to dominate reports and discussions over forest management and forest products trade (Woods 2013; Springate-Baginski

et al. 2014; EIA 2015;). It has been noted that legal logging of teak and other hardwoods for export has also contributed to the degradation of forest in Myanmar (Kollert and Walotek 2015). Emphasising this point, Springate-Baginski *et al.* (2016: 15) noted that “a major reason for forest degradation in Myanmar is systematic over-exploitation of reserved as well and protected public forests at the political orders of former governments”; most of which happens to be excessive timber extraction, primarily teak but also other high value hardwoods. Most notably and perhaps a much more damning assessment of the country's forest management system, Myanmar reportedly has the third-highest rate of annual forest loss, only behind Brazil and Indonesia (FAO 2015), which

has exposed and exacerbated the country's vulnerability to the deleterious impacts of climate change such as extreme disasters in the form of flood, droughts and diseases (Kollert and Walotek 2015; Ko 2016).

The criticisms and calls for liberalisation and reforms in the system of forest management and timber trade in Myanmar (NEPCon 2013; Woods 2013; EIA 2015 Treue *et al.* 2016; Springate-Baginski *et al.* 2016) have been louder than, and overshadowed any attempts and efforts towards examining the positive socio-ecological aspects of forest management and forest products production and trade in the country. This study aims to fill this gap by using a value chain approach to assess the various policy measures and practices in the forest management and timber trade system of Myanmar, which are exemplary and relevant for sustainable forest management and results based-based payment of carbon conservation mechanisms such as the Reducing Emissions from Deforestation and Forest Degradation (REDD+). The study specifically focuses on teak timber production and trade by assessing the policy measures, practices and activities in the various stages of timber production, harvesting, transportation and trade, with aim of identifying good practices that are important for sustainable forest management and sustainability outcomes.

FOREST PRODUCTS VALUE CHAINS, SUSTAINABLE FOREST MANAGEMENT AND REDD+

The value chain of a product simply “describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving

a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use” (Kaplinsky and Morris 2001:4). Forest products value chains can be much more complex, entailing several links in the chain (Kaplinsky and Morris 2001). Timber is the main high value forest product in tropical and subtropical forest countries, and a timber value chain generally comprises various activities, processes and actors involved in the production (tree growing/forest management), harvesting (felling, delimiting, and bucking), transportation (skidding, hauling, processing and the consumption of timber and its products (von Geibler *et al.* 2010; Schure *et al.* 2014). The value chain of timber thus starts from the growing of trees through to the consumption of the timber and its products and generally encompasses various inputs such as seeds, chemicals, equipment, land and water for the forestry sector (for timber production), inputs from the machinery sector (for harvesting and sawing) and also draws on design and branding skills from the service sector (Kaplinsky and Morris 2001:4).

Value chains are important causal links between socio-economic and ecological dynamics in the current production and consumption patterns, but their development in many cases does not consider their negative ecological impacts (von Geibler *et al.* 2010: 1). The forest products market structure and value chain practices are key determinants of timber extraction and as such, sustainable timber value chains are essential for positive ecological impacts (Sierra 2001). Inefficient and inequitable timber logging and trade practices can lead high rates

of deforestation and forest degradation (Schaafsma *et al.* 2014). Unsustainable timber extraction and trade is believed to contribute to over two-thirds of tropical and sub-tropical deforestation in Asia and Latin America (Kissinger *et al.* 2012), a phenomenon that poses a threat not only to climate change mitigation efforts such as the REDD+ mechanism, but also the sustainable livelihoods of local people. Sustainable forest management is integral to REDD+ because it could ensure sustainable forest products supply while providing employment and revenue to forest owners and governments of tropical developing countries; but this requires incorporating sound logging systems because prevailing logging practices have been responsible for rapid forest degradation in tropical developing countries (Sasaki *et al.* 2012).

In defining sustainable timber value chains in the context of sustainable forest management and REDD+, the key issues centre on renewability of extraction and the impacts on poor local people (Schure *et al.* 2014: 9). Achieving sustainable forest management for climate change mitigation is not possible if maintaining sustainable wood supply is not a core goal of forest management (Sasaki *et al.* 2012), but in most tropical countries illegal logging and, in some cases, unsustainable legal logging have caused deforestation and forest degradation with attendant adverse consequences for carbon sequestration (FAO 2015). Thus, forest products value chains development is important for sustainable forest management, especially in tropical and sub-tropical developing countries where the livelihoods of several people directly depend on timber and non-timber forest products (von

Geibler *et al.* 2010; Schure *et al.* 2014). More importantly, supply chain-related policy interventions and value chain approaches can address the externalities and deficiencies within forest products value chains for rural development and ecological sustainability (von Geibler *et al.* 2010; Hoermann *et al.* 2010). These interventions and environmentally-friendly practices within forest products value chains, especially timber production and trade, are particularly important for transnational market-based climate governance approaches such as the REDD+, and objectives of climate change mitigation, biodiversity conservation and sustainable rural livelihoods (Springate-Baginski *et al.* 2014). Therefore, assessing the policy measures and practices in the timber production and trade could provide learning opportunities on exemplary value chain approaches that are relevant for achieving REDD+ and sustainable forest management and development objectives.

MATERIALS AND METHODS

The study used value chain approach, drawing an analytical framework from existing literature and guidelines on value chain analysis (Kaplinsky and Morris 2001; Humphrey and Schmitz 2001; Gereffi *et al.* 2005). By adopting a classic approach to value chain analysis, the study interviewed key value chain stakeholders and reviewed literature and statistical data on timber trade in Myanmar to help provide a strong analytical background to value chain issues (Lusby and Panlibuton 2007). Interviews were held with Forest Department (FD) officials and officials of the Myanmar Timber Enterprise (MTE) in two teak extraction regions of the country – Sagaing region and Shan State – as well as in the capital, Nay Pyi Taw and Yangon, the

country's commercial centre and formal timber export point. This primary data was then enhanced by secondary data from an extensive literature review and analysis of policy and statistical documents. Data analysis was largely done qualitatively and was preceded by a transcription of the interviews and organisation of the data manually in the contexts of the various themes and objectives of the study.

RESULTS

Forest Policy and Regulations on Timber Production and Trade

Forest policy in Myanmar has been greatly influenced by export-oriented timber trade since the colonial era (Springate-Baginski *et al.* 2014). All natural forest areas in Myanmar, be it reserved forests, protected public forests or unclassified forests, legally belong to the State and are managed by the Forest Department. However, about 4100 ha of the approximately 32 million ha of forests have been designated as community forests managed by local communities under long term lease agreements with the government (Sunderlin *et al.* 2008; Htun 2009; FAO 2015). The timber administration system in Myanmar as exists today was established under the British colonial era (Springate-Baginski *et al.* 2016). Under the forest policy and legal framework, the forest department is responsible for timber production while the MTE is vested with the legal right and responsibility for extraction and marketing of timber, with the FD only regulating timber extraction using the AAC (Annual Allowable Cut) (*ibid.*). Also, teak and other hardwood timber from private plantations can only be harvested by the owners with permission from the forest department. The forest

policy recommends a market oriented approach to log allocation, removal of state ownership in processing, and increasing allocation of logs to Small and Medium Enterprises Small and Medium Enterprises (SME) sawmills (Castrén 1999: 12).

The Myanmar Forest Policy (1995) identified six imperatives for ensuring the sustainable development of forestry sector for environmental and economic purposes. The six imperatives include: protection of soil, water, wildlife, biodiversity and environment; sustainability of the forest resource for continuous supply of its tangible and intangible benefits; supply of basic needs of the people such as fuel wood, shelter and food; efficiency in harnessing the full economic potential of forest through increased productivity while controlling the socio-economically and environmentally unacceptable side effects; participation of people in conservation and utilisation of the forests; and public awareness about vital role of forests in well-being and socio-economic development of the country (Ministry of Forestry 1995: 3–5). These six imperatives constitute the nucleus of the forest policy and establish a firm foundation for defining its objectives and strategies to achieve these objectives (Ministry of Forestry 1995: 5).

In addition to the forest policy, there are several legislations governing production, management, harvesting and trade of timber in Myanmar. For the purpose of this teak value chain study, few relevant legislations and regulations are considered. The Forest Law (1992) which highlights forest protection and environmental and biodiversity conservation, also defines teak tree tenure in the country. According to this law, “a standing teak tree wherever situated in the state is owned by the state”

(Status of Tropical Forest Management 2011, cited in (Linn and Liang 2015: 25), which includes natural teak on farmlands (Castrén 1999). This law however provides opportunity for the promotion of private sector involvement in reforestation and timber trade, as well as the encouragement of decentralized (community) forest management, demonstrating a shift from the revenue generation focus to shared forest management with local people (Linn and Liang 2015).

The Forest Rules (1995), which deals with the declaration of areas of the permanent forest estate; the management of forest lands; the establishment of forest plantations; and the procedures for obtaining permission to extract forest produce, was also promulgated to implement the provisions of the Forest Law (1992) (Linn and Liang 2015: 20). The Forest Rules (1995) also has provisions on timber harvesting and trade, including procedures for: harvesting forest produce; establishing and operating timber depots; establishing wood-based industries; investigating violations; administrative actions to penalize violations, such as imposing fines and confiscating the timber; and offenses and penalties (ibid). In addition to these, the MTE carries out timber extraction according to the guidelines in the MTE Extraction Manual (1936) and the National Code of Forest Harvesting Practices (2000). This code of forest harvesting has the objectives of maximising economic returns and sustainable forest management; thus it is a comprehensive document that gives a step-by-step prescription of what needs to be done at each stage of timber extraction,

ranging from the pre-harvest planning to the harvesting operation process itself (Zaw 2003). The code also contains a requirement for the involvement of all stakeholders including: the FD, subcontractors, elephant owners, NGOs (Non-Governmental Organizations), local communities and the forest dependent (ibid).

Trade in teak and hardwoods attract different forms and rates of taxes depending on the market of trade (domestic and export markets). The taxes on teak timber trade and export such as Commercial Tax (CT) and Special Goods Tax (SGT) have continually been adjusted in the last few years. Under the Union Tax Law (2016), teak and hardwood logs as well as teak and hardwood cuttings of 10square inches and above imported and/or produced in the country were subject to 25 per cent SGT, while export of same attracted a 50 per cent SGT. Under the new Union Tax Law (2017) the SGT for the import and trade of wood logs and wood cuttings in the country has now been reduced to 5 per cent, while the SGT for export of the same has also been reduced to 10 per cent. This is to encourage the import of other hardwoods so as to reduce extraction from natural forests but according to the MTE, the future plan is to allow the import of other hardwoods at zero per cent tax. Also, the sale of teak and hardwood products in Myanmar is subject to a standard 5 per cent commercial tax. Private transporters also have to pay a nominal fee to the FD for a removal pass to be able to transport timber and timber products from one township to another.

Timber Production

Timber production here involves the growing and management of trees and forest from which the teak timber is sourced. All teak timber is sourced from Reserved Forests and Protected Public Forests of the Permanent Forest Estate (natural forest) which is managed by the Forest Department using a scientific forest management system known as the Myanmar Selection System (MSS). This method of forest management is based on selective logging of matured trees in a 30-year cycle as opposed to the clearing of whole forest stand (Castrén 1999; Springate-Baginski *et al.* 2016). Under the MSS, specific territories are reserved for timber production (reserved forests), and these are harvested according to the 10-year forest management plans, based on tree inventory and annual allowable cut

calculations so that only the increment volume is extracted (Springate-Baginski *et al.* 2016). The MSS was adopted in the moist and dry mixed deciduous forests of Myanmar and consists of division of 30 blocks of equal yield capacity, of which selective logging is carried out in each of the blocks every year; with the minimum exploitable girth limit for moist deciduous forests being 229cm (7.5ft) while that of the dry mixed deciduous forests is set at 198cm (6.5ft) (Kollert and Kleine 2017: 43). Under the MSS system, seed bearers are maintained to ensure natural regeneration of teak forests (*ibid*). The same MSS is used for other hardwood species but is modified to meet the specific requirements of various species; thus, the AAC is established both for teak and other hardwoods based on the number of juvenile trees surveyed during the logging operations under the MSS (Castrén 1999: 6; Myint 2012) (Figure 1).

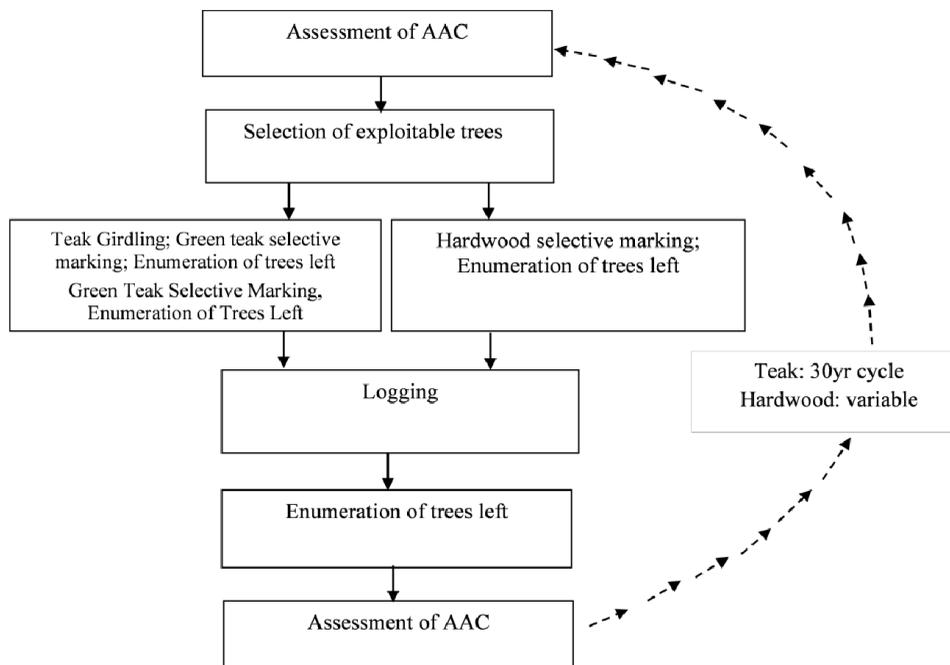


Figure 1: The Myanmar Selection System (MSS)

Source: Myint 2012; Castrén 1999

The AAC for teak and other hardwood species is calculated by the FD using data from the inventory of trees and their growing stock conducted by the District Forest Offices in the various forest management units/districts. This AAC helps to regulate amount of timber harvested from forests to ensure that there is sustainable timber supply and sustainable forest management. The FD is also responsible for pre-harvest mapping of trees, the girdling and marking of selected teak trees for felling as prescribed in the management plan of the Forest Management Unit (FMU). Information on the selection of trees marked for felling and a map showing location of the marked trees is handed over to the MTE for logging. The MTE also plays a role in timber production by doing enrichment planting after harvesting and taking care of these trees for a year before handing it over to the FD.

Timber Harvesting

Timber harvesting here is used to refer to the various timber extraction activities and generally entails activities involved in construction of skidding trails, trucking roads and landings, felling of tree and delimiting and bucking of felled trees into logs. The main actor in teak timber extraction is the MTE which is a State-owned enterprise vested with exclusive legal right and responsibility to harvest teak and other hardwood species for commercial purposes, as well as, the milling, processing and marketing of timber products. The MTE however, sometimes sub-contracts private companies to extract timber, especially in areas where MTE is unable to do the logging by itself due to security concerns, topographical and logistical reasons. For instance, in the south eastern

part of Shan State, it has been revealed that teak extraction is currently being done by a private contractor due to topographical and security reasons. The method of logging used for teak and other hardwoods by MTE is the Reduced Impact Logging (RIL). Thus, the actual felling of trees is preceded by construction of skidding trails, trucking roads and landings using tractors and/or graders/bulldozers. There are also private companies contracted to carry out some of these pre-harvest construction activities due to logistical constraints.

Transportation of Timber

Transportation here involves the process entailed in moving timber from the point where tree is felled to the distribution and consumption of timber and its products. These activities include skidding and/or trucking of the logs to the landings (measuring points), and the haulage, rafting, barging, or rail transportation of logs to the terminal points of distribution (depots). The first stage of teak timber transportation in Myanmar begins with elephants skidding (dragging) of logs from stumps of the felled trees to the measuring points (landings) directly and/or to wider skidding paths where it is further hauled by skidders to the landings where logs are measured by the FD together with MTE for revenue (royalty) assessment (Zaw 2003; Kyaw 2013).

At these measuring points, revenue hammer marks and serial numbers are placed on the logs (Kyaw 2013). The log skidding activities are mainly done by using elephants owned by the MTE and also some private elephants on a contractual basis (Castrén 1999; Zaw 2003; Kyaw 2013; NEPCon 2013; Springate-Baginski *et al.* 2013; Htun 2016). For instance, in

the Sagaing region it was revealed that approximately 30 per cent of the skidding is done by using private elephants because the extraction department of the MTE does not have enough elephants to do all the skidding by itself. The second stage of transport is skidding and/or trucking of logs from measuring points to transit depots (river depots, railing sidings and/or log yards). Loading of logs into hauling trucks is done by wheel loaders (Zaw 2003). These logs are then further transported to terminal depots in Yangon by rafting, railing and trucking where the log distribution is done for processing and export. However, distribution of timber for domestic market is also done at some of the transit depots (at the divisional level).

In the Sagaing region, it was revealed that all logs are transported by rafting, whereas in the Shan State (South) and Nay Pyi Taw, all logs are transported to divisional depots and terminal depots in Yangon by trucking because there are no connecting rivers to the depots and Yangon. Most of the transportation (trucking, rafting and railing) is done by the MTE but there are also private sector actors who participate in the trucking when MTE does not have enough capacity to do the trucking. In Nay Pyi Taw, it was revealed that all transportation is done by the MTE while in the Shan State (South) and Sagaing region, part of the transportation responsibilities are carried out by private sector actors. Apart from MTE and private sector that perform most of the responsibilities in the transportation, the FD also plays a role in the chain of custody of timber by monitoring transportation and issuing trucking slips to logging trucks and removal passes to private sector trucks transporting timber across different states

and regions. Critical control and checking points are established at vantage points along the transportation route where the responsible staff of the FD check the quantity of timber brought to the station against the quantity that written on the removal pass and hammer marks to ensure that legally collected timber and not mixed with illegal ones (Kyaw 2013).

Timber Pricing, Distribution and Consumption

There are two forms and processes of distributing teak timber and other hardwoods to traders in Myanmar – auction and allocation. Teak timber is distributed to the private sector through open tender (monthly open tenders) where the various private sector companies all have equal opportunity to participate, whilst government owned wood-based industries do not participate in the auction but get direct allocation of timber from the MTE. The tender (reserved) prices for teak at auction are fixed by the MTE based on the cost of extraction and prevailing timber price dynamics in the local and international markets.

Auctions for the distribution of teak timber take place at two levels – national and divisional depots. Auctions at the national level are mostly held in Yangon but also in Mandalay and these open tenders are mostly for private sector actors who export timber. Low quality timber such as those below sawing grade seven (SG-7) (about 20-30per cent of the total teak harvested) is often allocated by MTE for the domestic market, whilst high quality timber, such as, SG-1 to SG-6 (70-80per cent of the total) is allocated for the export market. The teak allocation for the export market is shared between the Export Marketing

and Milling (EMM) department and the Wood-Based Industry (WBI) department of the MTE in equal proportions. The export marketing and milling department then sells the logs to the private sector wood-based industries through open tenders, while the wood-based industry department sells processed timber (teak conversions, veneer, mouldings, plywood etc.) to private wood-based industries. The logs and timber are then processed by the private wood-based industries into semi-finished and finished products and exported to the international market. The timber allocated for domestic market goes

directly to the Local Marketing and Milling (LMM) department of the MTE who then auctions part of it to domestic private wood-based industries such as the Wood-based Furniture Association (WBFA) and other wood-based SMEs who process the timber into finished products for the domestic market. The remaining timber is then processed by LMM department's sawmills into sawn wood to supply government agencies and also sell to the general public (domestic market) (Figure 2). Generally, most of the harvested teak timber in Myanmar is sold in log form to the private sector wood-based industries,

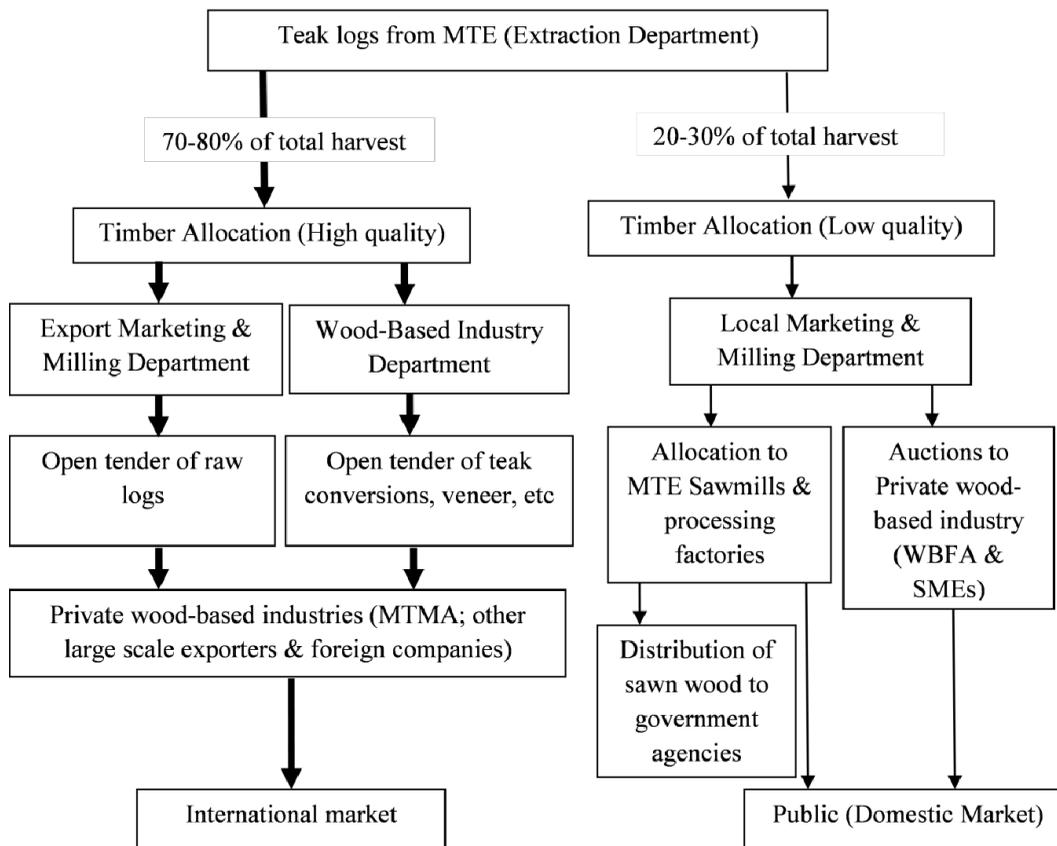


Figure 2: Teak Timber Distribution and Consumption

with only 25 per cent of the harvested teak being processed by MTE into semi-finished and finished products and sold to private sector industries. For this purpose, the MTE has wood-based industries (8 teak sawmills, 4 plywood factories, 3 veneer factories and 10 furniture factories) for processing timber into semi-finished and finished products

DISCUSSION

By mapping the value chain activities and practices in various stages of teak production and trade, various ecologically responsible practices have been identified in production, harvesting, transportation and trade stages of the value chain, which are important for sustainable forest management and broader objectives of REDD+.

Firstly, on the forest policy and regulations, what can be deduced from the forest policy, which is in line with Agenda 21 goals of Myanmar, is the recognition of the need for state forest management to evolve to include local communities and the private sector as partners in forest management (Linn and Liang 2015: 21), and the role of forests in supplying socio-economic needs of the country, focusing on efficient and sustainable extraction and utilisation of forest resources such as timber. The forest policy in Myanmar has historically focused on timber production but has gradually evolved to recognise and emphasise environmental conservation issues and sustainable forest management following the Rio Earth Summit, 1992 (Linn and Liang 2015). Recent short and medium term policy measures such as the one-year logging ban for entire country in 2015/2016 and 10-year logging ban in the teak-rich Bago region are all efforts to

ensure forest regeneration and sustainable supply of timber and other benefits of forest. The government is in process of making reforms to the forest policy to ensure sustainable utilisation and supply of teak by permitting establishment of private plantations. These efforts and the reduction of taxes on import of hardwoods provide opportunities for diversifying timber supply sources and reducing pressure on the natural forest – potential for forest regeneration and sustainable forest management in the country.

Secondly, the MSS used as a scientific method of forest management and timber production entails positive sustainability outcomes. Myanmar is the country to have followed scientific forest management for the longest period in the entire Greater Mekong region for the management of teak and other hardwood species by continuing with the colonial forest management system known as the Myanmar Selection System (MSS). This is a modified name for the Brandis Selection System used by the British colonial authorities to manage forests in Burma (Castrén 1999). This obviously is positive and important for sustainable forest management, sustainable timber supply and the achievement of carbon conservation objectives if the system is strictly applied. Even though strict adherence to the scientific forest management has been disregarded under the former military government by revenue-driven over-harvesting of teak timber above the AAC (Springate-Baginski *et al.* 2016), the recent democratic transition of the country has enabled a return to strict implementation of scientific forest management system. The MSS system of forest management has high sustainability and legality measures if properly applied

(Woods 2013) and as such, it is not only important for forest regeneration and conservation in Myanmar, but is also an exemplary scientific forest management system that can be adopted for sustainably managing tropical forests.

Thirdly, the mode of transporting timber, which involves elephant skidding and river transportation is exemplary for sustainable forest management and climate change mitigation. Animal skidding is the most cost effective and environmentally friendly method skidding method (Myint 2012; Khai *et al.* 2016) because it “precludes the construction of costly and easily eroded roads into the forest or steep hilly terrains and also prevents possible destruction of valuable unfelled trees” (Zaw 2003: 2). A study by Khai *et al.* (2016) on 9-ha of logging sites in the Bago region concluded that there were no visible damages on residual trees and soil from elephant skidding three months after logging operations. This is particularly important for forest and carbon conservation as tree mortality is reduced and soil disturbances and erosional activities that could result from road construction and the use of heavy skidding machines are also reduced. The use of elephants for skidding also creates jobs for local people – as elephant riders and private elephant owners. Also, the use of river transportation offsets carbon emissions and soil disturbances that would result from the use of heavy duty trucks and/or rail transportation. This mode of timber transportation can be deemed climate friendly and thus a good timber supply chain practice that is important for climate change mitigation mechanisms such as REDD+.

Another practice in the transportation of timber that is important for forest legality and sustainability issues is the strict monitoring of timber transportation by the Forest Department. Even though the harvesting and trade of timber is done by the MTE, the transportation of timber and timber products is monitored by the forest department through checks and issuing of transportation permits at vantage points on transportation routes to ensure that the illegally collected timbers is not mixed with the legal timber. With this practice, the chain of custody of timber can easily be traced and verified. This is important for achieving good forest governance objectives as enshrined in the international forest governance initiatives such as the European Union Forest Law Enforcement, Governance and Trade (FLEGT) voluntary partnership agreement and certification scheme, as well as, the United States Lacey Act and the Australian illegal timber prohibition law. Assessing timber legality measures in Myanmar, NEPCon (2013) found that timber legality is high in government managed production forests and can be attributed to strict monitoring of timber transportation by the Forest Department.

Furthermore, the use of reduced impact logging as a timber harvesting technique has positive ecological benefits in terms of biodiversity conservation and protection of residual forest stands. Logging practices can negatively and/or positively affect the sustainability of forests depending on the method used. Since logging practices greatly influence end-use wood supply and carbon stocks in forests, it is important to understand if the logging system used in

the timber supply chain is environmentally and socially responsible (Sasaki *et al.* 2012: 36). The use of reduced impact logging method for timber harvesting in Myanmar is a good practice for sustainable forest management and the objectives of the REDD+. The RIL can reduce the damages on residual stand and soil (Khai *et al.* 2016) and other ecosystem functions and services (Edwards *et al.* 2014). This provides a strategy for managing tropical forests that minimises the potential risks of climate associated with large changes in carbon and water exchange (Miller *et al.* 2011), considering that RIL is capable of reducing carbon emissions by 1.5-2.1 billion tCO₂ per year in tropical timber producing countries under a 50-year projects cycle (Sasaki *et al.* 2012). Assessing the additive effects of RIL on biodiversity and carbon conservation in Deramakot forest in Malaysia, Sam *et al.* (2008:7) concluded that the RIL is “effective in maintaining a level of biodiversity equivalent to a pristine rainforest, and in stocking a greater amount of carbon than nearby conventionally logged rainforest”. That is to say, RIL is effective in sequestering greater amount of carbon in above-ground vegetation, maintaining canopy, tree species richness and composition, and effectively protecting soil fauna (Sam *et al.* 2008: 8). Khai *et al.* (2016) in their study, specifically focusing on RIL in Myanmar, found that directional felling and elephant skidding as RIL practices are very effective in reducing damage residual trees and soil in logging sites. Thus, the use of RIL method as done in Myanmar is important and appropriate for sustainable forest management projects as part of the REDD+ scheme, especially if combined with a 40-year or longer cutting cycle (Sasaki *et al.* 2012).

Lastly, there are positive interventions in the timber trading stages of the supply chain, such as the log export ban. Log export ban which was instituted in April 2014, has enabled some in-country value addition as processing before export became a requirement. It has also enabled domestic timber traders to now have access to timber than before. Before the LEB, 80 per cent of teak harvested was exported in raw logs; even though about the same amount of teak is still allocated for export, there is and must be some form of processing before export after the implementation of LEB. The positive impacts of LEB have been recognised by domestic wood-based enterprises during interviews, as well as, the officials of the MTE. It is estimated that Myanmar lost about US\$1.2billion from the export of raw logs of teak wood between FY2011-2012 and FY2015-2016, because exporters applied for legal license by understating market price (Shein 2015, cited in Ko 2016). Since logs are no longer exported, these losses are curbed and the contribution of teak to domestic timber trade has marginally improved. This log export ban has also enabled domestic forest-based SMEs to access timber for their production activities. Also, the 2014 LEB has provided opportunity for revising forest and timber trade policy to cater for domestic timber demand and equity in benefit sharing among stakeholders (Prescott *et al.* 2017). This has the potential for stimulating growth in the forest-based SME industry, which is not only important for local livelihoods, income and employment generation in the country, but also to ensure sustainable forest management. This potential of forest-based SMEs to

contribute to employment and sustainable forest management has long been espoused (Auren and Krassowska 2004; Donovan *et al.* 2006; Kozak 2007; Macqueen 2008).

CONCLUSIONS

This study used a value chain approach to assess the policy interventions and practices in production and/or management and trade of forest products towards the sustainability of forest resource of Myanmar and what positive lessons can be learned for sustainable forest management and carbon conservation measures. This study argues that, in spite of the weaknesses and challenges in tackling deforestation and forest degradation in the country, there are some policy interventions and practices in timber production, harvesting and trade which are not only important for sustainable forest management and/or climate change mitigation mechanisms such as REDD+, but are also archetypical forest management practices that can be adapted for sustainably managing tropical production forests. Even though the country has been criticised for its high rates of forest loss over the years, the major reason has been attributed to top-down political pressure from the former military governments to generate revenue which led to disregard forest management regulations (Springate-Baginski *et al.* 2016). Thus, with improved governance, especially in the forestry sector, current policies, regulations and practices in forest management, timber production, harvesting and transportation, are capable of achieving sustainable forest management and climate change mitigation in the context of REDD+ in Myanmar, and in countries that have improved forest governance systems.

It is also important to note that, these production forest management policy interventions and practices are very positive and provide a learning opportunity for other countries in South and Southeast Asia for managing production forests. Yet, there are some gaps that need policy interventions to avert derailing the effectiveness of these positive interventions and ensure sustainability of forest resource in the country. These interventions should include: policy measures to curb illegal harvesting and trade of forest products, especially timber; promoting smallholder and community forest plantations; and reducing barriers of entry for local communities and/or providing local communities with some benefits from timber trade.

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