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Testing the mettle of tropical timber

Tropical timber is locked in a battle for market share with substitute products such as non-tropical woods, metals such as aluminium, and plastics. Tropical timber has many fine features—such as durability, aesthetic appeal, and strength—but its competitors also have saleable qualities.

One area in which products competing with tropical timber have had an advantage in recent years is in perceptions of their environmental friendliness. For many consumers, especially in developed countries, tropical timber brings to mind images of waste and forest destruction. This edition of the *TFU* explores efforts to develop environmental product declarations (EPDs) for tropical timbers as a way of providing credible

Inside: Environmental product declaration for meranti plywood, khaya lumber, and ipe and cumaru decking; small-diameter logs; timber trade data ...

ITTO

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Regular features

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Images: A log loader moves a meranti log to be debarked before peeling for plywood veneer. *Photo: Y. Massijaya* (cover); Logs are hauled from an Amazonian forest. *Photo: W. Oliveira* (above)

... Editorial continued

data on their environmental performance and providing a fair basis for comparison between products performing similar functions.

As Chan and Yanuariadi point out (page 3), EPDs are gaining momentum in the marketplace as tools for defining environmentally responsible construction materials but, until now, no EPDs have been developed for tropical timbers. An ITTO initiative has set out to change this, commissioning life-cycle assessments to generate data for EPDs for three tropical timber products—meranti plywood, *Khaya* lumber, and ipe and cumaru decking.

Adu and Eshun (page 5) describe a life-cycle assessment for *Khaya* lumber production in three companies in Ghana, encompassing the felling of *Khaya* trees and cutting them into logs in the forest; transportation of the logs to the sawmill; the manufacture of lumber, including kiln-drying; and transportation to storage warehouses. The results of the assessment were used to create an EPD for *Khaya* lumber, which compared favourably with EPDs for 19 species of lumber produced in the United States.

An article by Gan Kee Seng and Muh Yusram Massijaya (page 9) describes the first-ever life-cycle assessment of meranti plywood, using data collected from five companies in Indonesia and Malaysia. One of the benefits of life-cycle assessment is that it can pinpoint areas where companies can improve the efficiency of their operations to reduce their environmental impact (and potentially save money). Gan and Massijaya found that the meranti plywood companies they surveyed could improve their environmental performance by improving the recovery of veneers and co-products from logs; using biomass for thermal and electricity needs; improving the control of resin use; and increasing the efficiency of material flows in manufacturing operations to reduce internal transportation.

Jankowsky, Galina and Andrade (page 13) undertook a similar exercise for the production of ipe and cumaru decking in Brazil. One of their main conclusions is that the long-distance transport of lumber has a major bearing on life-cycle assessments of decking production. Indeed, all three life-cycle assessments presented in this edition of the *TFU* make it clear that the use of fossil fuels (mainly in transportation and electricity production) has a substantial effect on the environmental impact of production, and reducing this is critical for improving environmental performance. All three life-cycle assessments (and therefore EPDs) cover "cradle to gate", omitting, for example, the ecological impacts of harvesting and the benefits and costs of forest management. Adding these components will be important in future studies, as will assessments of end-of-life and ultimate disposal of the products.

On a somewhat different topic, Zhou Yongdong (page 17) reports the findings of an ex-post evaluation he conducted of a project implemented by the Faculty of Forestry at Bogor Agricultural University in Indonesia in collaboration with agencies in Malaysia, Papua New Guinea and the Philippines. The project, which investigated the potential uses of small-diameter logs in biocomposite products, showed that plantation and community forests could provide the raw materials for biocomposite products and thereby substitute for traditional large-diameter logs from natural tropical forests. Professor Zhou found that the project was mostly conducted well, and the lessons learned from its implementation could be applied in future projects.

An article on page 19 summarizes the main findings of ITTO's *Biennial Review and Assessment of the World Timber Situation 2013–2014* (formerly conducted annually), which reports on developments in the global timber sector and wood markets in the period 2010–2014, with a focus on tropical timber. The *Biennial Review* provides data on production and trade by volume and value for primary wood products, and on trade by value for secondary processed wood products. It shows that the tropical timber trade is changing—and changing fast.

Nevertheless, in this era of rapid change, some things seem certain—tropical timber trade patterns and products will continue to evolve, and the social and environmental requirements for sustainable forest management will become more stringent over time. It is also highly likely that life-cycle assessment and EPDs will become increasingly important elements in the tropical timber trade's marketing armoury as it continually strives to prove its mettle.

Declaring for the environment

ITTO begins work on environmental product declarations for tropical wood

by Barney Chan[1] and Tetra Yanuariadi[2]

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Floaters: Meranti logs for plywood production stored in a log pond in Probolinggo, Indonesia. *Photo: MY Massijaya*

Environmental product declarations (EPDs) are gaining momentum in the marketplace as tools for defining environmentally responsible construction materials and improving the competitiveness of tropical timber vis-à-vis other materials.

Activity 23 of ITTO's Biennial Work Plan 2013–2014 stipulated the preparation of EPDs for three wood products, one in each tropical producing region. EPDs were subsequently prepared for meranti plywood (Indonesia/Malaysia), *Khaya* rough-sawn lumber (Ghana) and ipe and cumaru decking (Brazil).

This work has uncovered many fundamental issues. It also presents ITTO with an opportunity to lead the development of internationally agreed approaches to EPDs and to better focus its ongoing work to assist the tropical timber sector in meeting environmental and marketing challenges.

Environmental product declarations

ISO [International Organization for Standardization] 14025 defines an EPD as quantified environmental information on the life cycle of a product to enable comparisons between products fulfilling the same functions, typically in business-to-business communications. ISO 14025 states that such EPDs:

- are provided by one or more organizations;
- are based on independently verified life-cycle assessment (LCA) data, life-cycle inventory (LCI) data, or information modules in accordance with the ISO 14040 series of standards and, where relevant, additional environmental information;
- are developed using predetermined parameters; and
- are subject to the administration of a programme operator, such as a company or group of companies, an industrial sector or a trade association, public authorities or agencies, or an independent scientific body or other organization.

LCAs compile the inputs and outputs and potential environmental impacts of products throughout their life cycles[1], and they are an essential part of any EPD. EPDs, and hence LCAs, are becoming increasingly important in the tropical timber sector, especially given the nascent global movement towards "green building", which essentially is environmentally responsible construction. Without an EPD, it is difficult—if not impossible—for tropical timber to compete with similar products in the construction industry.

This issue has grown in importance recently as more and more countries adopt green building initiatives. The United Kingdom developed a system for assessing, rating and certifying the sustainability of buildings in 1990. The United States Green Building Council developed a system for rating the design, construction, operation and maintenance of buildings in 1993 under its Leadership in Energy and Environmental Design (LEED). The European Commission launched its GreenBuilding Programme in 2005. Japan has a rating system called the Comprehensive Assessment System for Building Environmental Efficiency, and Australia's system is called Green Star. All these systems require EPDs for building materials like sawn lumber, plywood, doors and window frames.

[1] Information is lacking in the tropical timber sector on the full life cycle of most products, and the studies reported in this edition of the *TFU* stop at the factory gate, enabling comparison with non-tropical wood products used for similar purposes.

EPDs and ITTO

Members of the ITTO Trade Advisory Group (TAG) are well aware of the growing importance of EPDs because they work closely with buyers and specifiers in ITTO consumer countries—they know which way the wind is blowing. TAG has responded to the concerns of members by bringing this important marketing tool to the attention of the International Tropical Timber Council.

In May 2003, Dr Richard Murphy made a formal presentation on LCA to the Committee on Economic Information and Market Intelligence during the 34th session of the Council in Panama under ITTO pre-project PPD 48/02 (M). In his presentation, Dr Murphy reviewed existing work on LCAs for tropical timber, gave case studies, and discussed the pros and cons of LCAs. He recommended, "coordinated efforts to simulate further LCA work of direct relevance to tropical forests and products".

At that time the TAG stressed to the Council that EPDs were gaining momentum in the marketplace as a tool for meeting social and environmental responsibilities in construction materials and that, in the absence of EPDs, tropical timber products were at a significant competitive disadvantage with respect to substitute products. The development of EPD ratings for tropical wood products would help ITTO producer countries meet environmental, social and economic goals consistent with ITTO's objective of enhancing international trade in legally harvested tropical timber from sustainably managed forests.

Nevertheless, it was not until November 2012, almost ten years later, that the Council agreed to include the development of three EPDs in ITTO's Biennial Work Programme. The selected products were to represent a range of products and specifications from the three tropical regions. The activity was to outline a process for compiling EPDs through the development of an LCI database and comparative LCA reports for three products in line with ISO standards, including carbon footprint assessments in line with PAS2030 specifications. Articles elsewhere in this edition provide overviews of the three studies, and full reports are available on the ITTO website.

Lessons learned

The work undertaken as part of the ITTO Biennial Work Programme 2013–2014 is probably the first serious attempt to develop EPDs for tropical timber products. Given its pioneering nature, it has been challenging work, and a number of methodological and fundamental issues needed to be addressed. The lessons learned include the following:

- More data are required to increase the validity of results on meranti plywood, *Khaya* rough-sawn lumber, and ipe and cumaru decking.
- All work under this activity was undertaken within mills (or was based on existing literature), and all raw materials were assumed to be inside the mill entry gate. The EPDs account for environmental performance up to the exit gates of the mills.
- The nature of the timber industry worldwide is that logging takes place far from mills. The transportation of logs contributes negatively to EPD ratings and can be substantial if the distance is very great; one of the companies in the Brazilian study illustrates this.
- Except for a study in Malaysia, no LCA-related work has been conducted on the acquisition of raw materials (i.e. logging and the transportation of logs from forest to mill).

Way forward

Each of the three studies draws important conclusions and makes recommendations. Taken as a whole, this work has clearly shown the pivotal role that ITTO can play globally. For example:

- ITTO could promote and encourage more work on EPDs among ITTO members, including on raw materials.
- ITTO is well placed to take a leading role in the definition and clarification of product category rules for tropical timber products.
- ITTO can be a neutral and credible depository of EPD information on tropical timber products internationally and should adopt this important role.

The three EPDs have pointed to several ways in which companies can improve their environmental performance. The use of wood waste to generate electricity and heat can significantly reduce global warming potential (GWP): for companies using coal-generated electricity, the environmental load, particularly GWP, may be more than double those companies employing cogeneration. Therefore, the use of wood waste for cogenerating electricity should be encouraged.

Companies might also reduce the GWP of their operations by reducing diesel use by trucks (e.g. through the greater use of rail); improving the efficiency of material flows in the manufacturing process to reduce internal transportation; and drying wood using solar panels combined with high-frequency inverters.

Aiming higher with *Khaya*

A life-cycle assessment of African mahogany lumber in Ghana recommends changes to improve the environmental performance of the timber sector

by Gustav Alexander Adu and John Frank Eshun

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Loaded: Khaya logs are transported by truck to a local sawmill in Ghana. *Photo: G. Adu*

International markets are increasingly demanding environmentally sound products, and the effective use of life-cycle assessment (LCA) and environmental product declarations (EPDs) in the timber sector is likely to be a critical factor in ensuring access to environmentally aware markets and promoting the environmental benefits of tropical timber. This article reports on an LCA conducted for lumber produced from *Khaya* species (generally known as African mahogany) by three companies in Ghana.

The study reported here assessed the environmental impacts of lumber production—comprising the felling of *Khaya* trees and cutting them into logs in the forest; transportation of the logs to the sawmill; the manufacture of lumber, including kiln-drying; and transportation to storage warehouses—with the aim of determining the carbon footprint of, and generating an EPD for, *Khaya* lumber.

Life-cycle assessment

LCA is a tool for assessing the environmental performance of products and identifying environmental "hotspots" in a product chain. It is normally conducted for a product system from "cradle to grave" by accounting for all the environmental impacts from resource extraction to end-of-life disposal based on ISO 14040 and ISO 14044, which are LCA standards created by the International Organization for Standardization (ISO). The outcomes of LCAs may be used to identify opportunities for reducing environmental impacts of a product at the various stages of its life cycle, decision-making in industry, and product marketing (e.g. in environmental claims, ecolabelling schemes and EPDs).

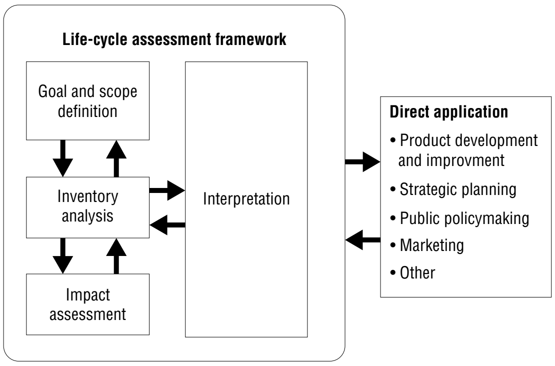
In accordance with ISO 14044, an LCA consists of four interrelated phases (Figure 1). The first phase is "goal and scope definition"; this is the planning phase of an LCA, in which the goal and scope are identified and the functional unit, system boundaries, data quality and review process are specified.

The second phase is the "inventory analysis", which involves the compilation and quantification of inputs and outputs in all involved processes. Outputs include material outputs (e.g. "1 m^3 of furniture part") and emissions (e.g. carbon dioxide—CO_2). Decisions made in this phase include how to handle processes that produce more than one product. Inventory analysis identifies and quantifies the resources extracted and consumed and the environmental releases occurring in the various processes that make up the life cycle of the product.

The third phase is "impact assessment", which is carried out using data compiled in the inventory analysis. Emissions are assigned to categories according to their impact. For example, methane is a greenhouse gas and is assigned to the impact category "global warming". Each substance is allocated to all impact categories to which it contributes and assigned a potential impact in each of those impact categories relative to a dominant factor in the category; for global warming potential (GWP), for example, this is typically 1 kg of CO_2 emissions. The impacts are multiplied by the quantity of each emission type and the resulting impact values are summed for the respective impact category. The purpose of impact assessment is to help assess a product system's inventory analysis to better understand their environmental significance.

The fourth phase involves "interpretation", in which data obtained in the inventory phase and the impact assessment phase are combined in line with the defined goal and scope of the study. Conclusions are drawn, and recommendations may be made to decision-makers.

Figure 1: Phases of a life-cycle assessment according to ISO 14044



Goal of the study

The main goal of the study reported here was to assess the cradle-to-gate environmental performance of *Khaya* lumber with a view to increasing its competitiveness in the market. Specifically, the study aimed to:

- compile all measurable inputs and outputs of the manufacturing process of *Khaya* lumber;
- compile and evaluate all potential impacts on the environment;
- assess the carbon footprint, in line with PAS 2050 methodology; and
- generate an EPD for *Khaya* lumber.

There are three main phases in a product's life:
1) manufacturing;
2) use; and
3) end-of-life disposal. Each of these is addressed below.

Manufacturing

Of the three phases, the manufacturing phase accounts for the highest levels of resource and energy consumption and inflows and outflows of waste and goods. It has three steps. Step 1 involves harvesting the trees, cross-cutting them into logs, extracting logs to a dump site in the forest, and transporting logs to the mill. Natural tropical forest is the main source of *Khaya* logs in Ghana; forest management is labour-intensive and does not involve chemical treatments or machinery use and hence incurs no environmental burden. Harvesting, on the other hand, involves the use of chainsaws, bulldozers, tractors, skidders, stackers and articulated trucks.

Step 2 is the manufacture of the product (*Khaya* lumber). A head rig or bandmill is used to cut logs to various thicknesses, with the type of cut influenced by the grade of the log. From the bandmill, boards are moved to the edger to be trimmed of slab, bark, wane and other defects and cut to width. Edgers may run on single or multiple saws, and a cross-cut saw is used to cut the boards to length. Medium-to-large mills use re-saw bandmills to recondition boards with mis-cuts or defects.

In the sawing process, *Khaya* logs are sawn into rough-sawn green lumber (mostly in thicknesses of 25 mm, 32 mm, 38 mm or 50 mm, with random widths and mostly 2.44–3.66 m lengths). The outputs of this process are green rough-sawn *Khaya* lumber and wood residues (i.e. bark, sawdust, slabs, edgings and chips). Wood residues are combusted as fuel for steam generation, mostly to dry lumber. *Khaya* lumber is dried in mostly steam-heated kilns before export; lumber sold locally may not be dried in this way, however.

Step 3 is the transport of the *Khaya* lumber. The modelled transportation methods were: transportation of logs from the forest to sawmill on articulated trucks; transportation of green *Khaya* lumber from sawmill to kiln; and transportation of dried lumber to the company's warehouse with forklifts.

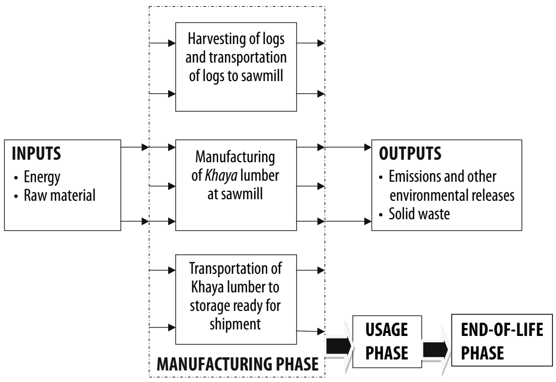
Use phase

The use phase of a product normally includes unit processes such as transfer to customers (e.g. shipping *Khaya* lumber out of a port in Ghana to buyers in Europe); the further processing of the product (e.g. in the manufacture of furniture, joinery and building products); and product duration.

End-of-life phase

For a primary product like *Khaya* lumber produced in and exported from Ghana, the use phase and final product disposal phase are not fixed. In this study, the system boundary was set for cradle-to-gate, as depicted in Figure 2.

Figure 2: Cradle-to-gate system boundary for LCA on *Khaya* lumber, showing inclusions and exclusions



Parameters and data

The functional unit (that is, the reference unit for calculating environmental inputs and outputs of a product system) used in the study was 1 m^3 of rough-sawn *Khaya* lumber with a thickness of 25–50 mm and a moisture content of 12%; these parameters are consistent with product category rules for solid wood products. The study used primary data generated from a survey of three companies in Ghana (described below), as well as values obtained from the literature.

Table 1: Summary of potential environmental impacts of the production of 1 m^3 of kiln-dried *Khaya* lumber in three companies in Ghana

Company	GWP (kg CO_2-eq)	AP (kg SO_2-eq)	EP (kg PO_4-eq)	POCP (kg ethylene-eq)	HTP (kg $C_6H_4Cl_2$-eq)
A	325.60	5.10	3.16	0.67	3.24
B	238.80	3.70	2.51	0.55	2.54
C	195.44	2.99	2.17	0.49	2.17
Average	253.11	3.93	2.61	0.57	2.65

Note: GWP = global warming potential; AP = acidification potential; EP = eutrophication potential; POCP = photochemical ozone creation potential; HT = human toxicity; CO_2 = carbon dioxide; SO_2 = sulphur dioxide; PO_4 = phosphate; $C_6H_4Cl_2$ = dichlorobenzene.

Company survey

Three randomly chosen timber companies (named A, B and C for the purposes of this article) with roundwood inputs greater than 25 000 m^3 provided data by completing a questionnaire on the inputs and outputs of their activities in 2013 with respect to resources, material uses, energy requirements and waste production. Follow-up interviews were conducted to check data quality. The companies were located 50 km (company A), 130 km (B) and 250 km (C) from their log sources. All three undertake their own logging and truck the logs to their factories for processing. In addition to lumber, A produces sliced and rotary veneer and plywood; B produces sliced veneer and mouldings; and C produces sliced veneer, mouldings and square-edged lumber. All three companies obtain their electricity from the national grid; in Ghana, electricity is generated by hydropower (50%) and thermal power (50%).

Exports of air-dried *Khaya* lumber from Ghana attract a levy, and therefore most (98.6%—5843 m^3) *Khaya* lumber exported in 2012 was kiln-dried (which does not attract the levy). The predominant *Khaya* species used is *K. ivorensis*.

Life-cycle inventory

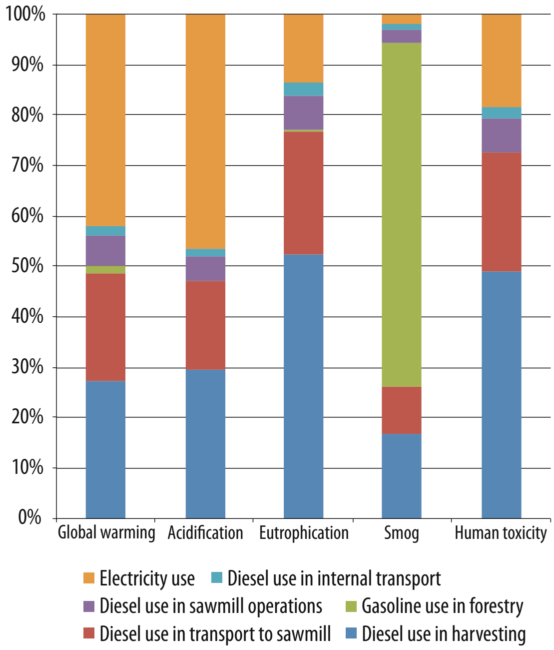
Emission inventory data were unavailable for timber companies in Ghana and the study therefore used emission factors from standard references. Inputs included the use of resources, such as timber, as well as material inputs, such as fuels. Outputs were emissions into air, water and land, as well as all products and byproducts.

The study accounted for emissions contributing to global warming[1], acidification[2], eutrophication[3] and smog.[4] The emissions considered were CO_2, methane and nitrous oxide for global warming; sulphur dioxide and nitrogen oxides for acidification; nitrogen oxides for eutrophication; and methane, nitrogen oxides, non-methane volatile organic compounds and carbon monoxide for smog.

Results and discussion

Table 1 presents the overall results of the study. The major contributor to GWP was electricity, comprising, on average, 42% of total value. The second-largest component was diesel use in harvesting (27%), followed by diesel use in transportation to the sawmill (21%).

Figure 3: Contribution of various activities to total potential environmental impact per m^3 of *Khaya* lumber production in three companies in Ghana



Of the three companies, C had the lowest GWP value because of the relatively low thermal component of its electricity per unit of lumber produced; A and B generally had higher emission levels in the other impact categories as well because of their relatively high production levels. The results of this study indicate that the environmental impact associated with *Khaya* lumber production in the three companies is due largely to the use of fossil fuels.

Carbon footprint

Carbon footprint is a relatively new term for GWP and refers to the total greenhouse-gas emissions associated with a product or service. Emissions of individual greenhouses gases are converted to GWP and expressed as CO_2-equivalent (eq) values. Table 1 shows an average GWP of 253 kg CO_2-eq; this may be taken as the carbon footprint for 1 m^3 of *Khaya* lumber produced in Ghana.

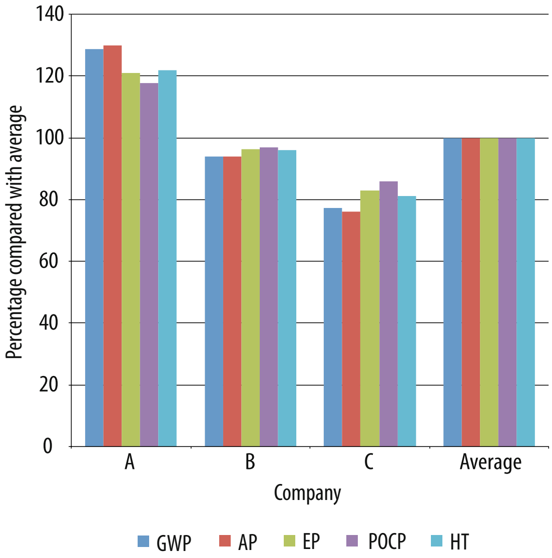
1 Greenhouse gases such as CO_2 and methane are expressed as global warming potential (GWP), which is an index of cumulative radiative forcing between the present and some chosen later time horizon caused by a unit mass of gas emitted, expressed relative to the reference gas CO_2 (1 kg of CO_2) (Houghton et al. 1994).

2 Acidification is measured as the amount of protons released into the terrestrial/aquatic system. The classification factors of acidification potential are routinely presented either as moles of H+ or as kg of sulphur dioxide equivalent (Heijungs et al. 1992).

3 The enrichment of water and soil with these pollutants (nitrogen oxides) may cause an undesirable shift in the composition of species in ecosystems, a process called eutrophication.

4 The combustion of fuel during the *Khaya* production process and transportation causes the emission of non-methane volatile organic compounds, carbon monoxide, methane and nitrous oxides, which are considered tropospheric ozone precursors that contribute to low-level smog.

Figure 4: Relative environmental impact categories for *Khaya* lumber based on average values for three companies in Ghana



Note: GWP = global warming potential; AP = acidification potential; EP = eutrophication potential; POCP = photochemical ozone creation potential; HT = human toxicity.

Environmental product declaration

EPDs are standardized documents used to communicate the environmental performance of products based on LCA. Table 1 shows the EPD for *Khaya* lumber produced in Ghana based on average environmental impacts for various parameters. The results compare favourably with those for 1 m^3 of rough-sawn, kiln-dried lumber in the United States (cradle to gate) for 19 species (AHEC 2009) as well as those for tropical plywood production in Malaysia and Indonesia (Gan and Massijaya 2014).

Conclusions and recommendations

The results of this study indicate that the environmental impact associated with *Khaya* lumber production in Ghana is caused mainly by the use of fossil fuels. A change away from fossil fuels in electricity generation, forest operations and timber transport towards renewable energy sources could therefore help reduce these impacts. Companies could reduce diesel use by trucks by, for example, increasing the use of rail and the efficiency of material flows in the manufacturing process. Kiln-drying using solar energy (with high-frequency inverters) might also help improve environmental performance. The fate of wood waste is a critical issue in environmental performance and requires urgent attention. Nevertheless, taking all the environmental indicators outlined in this LCA study into account, we conclude that *Khaya* lumber produced in Ghana, if obtained from sustainably managed natural tropical forest, is a good environmental performer.

This study has yielded unique, good-quality primary data that can enhance LCA approaches in Ghana and help in identifying areas where environmental performance can be improved in the timber industry.

We make the following recommendations.

Governments should:

- provide a policy and institutional environment conducive to industrial performance and LCA-based research in Africa;
- where road transport cannot be substituted, improve road networks to reduce the excessive use of diesel fuel in transporting industrial raw materials;
- support infrastructural development consistent with a low-carbon economy and green development; and
- invest in green energy technologies such as solar, wind and hydropower for electricity generation in countries and across the region to reduce diesel consumption.

ITTO and its members should:

- support further LCAs and build capacities within member countries to research and assemble the data necessary for LCAs; and
- promote studies on other tropical timber species and their products and widely disseminate the results.

The private sector should:

- improve the transportation of timber (e.g. by using newer, more fuel-efficient vehicles and improving maintenance) to minimize the environmental impact of their operations;
- invest in technology to minimize wood waste and improve processing efficiency; and
- improve record management systems.

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Plywood's journey from cradle to gate

The first-ever life-cycle assessment of meranti plywood in Indonesia and Malaysia finds considerable differences between companies

by Gan Kee Seng[1] and Muh Yusram Massijaya[2]

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Cradle: Plastic figure-8 nails are applied to meranti plywood logs to reduce end-splitting in a log yard in Probolinggo, Indonesia. *Photo: MY Massijaya*

Environmental certification, eco-labels and other environmental claims are common in the marketplace, and the range and differing standards can create confusion among companies and consumers. Some systems for demonstrating environmental qualifications focus on a few selected product attributes, while others may be more comprehensive but lack commonalities in scope or evaluation method to allow the direct comparison of products. Many systems refer to ISO [International Organization for Standardization] 14040 and ISO 14044 in establishing environmental impacts through life-cycle assessment (LCA). In comparing the environmental impacts of different products within the same "family" of products, it is essential to examine the same attributes consistently. Comparing the results of LCAs using differing approaches could lead to inaccurate results.

Environmental product declarations (EPDs) are based on product category rules (PCRs) that specify the parameters to be considered for a given group of products. An EPD is a comprehensive, internationally recognized report that compiles and standardizes technical sustainability information with the aim of providing complete, credible data and providing a fair basis of comparison between products. EDPs also aim to reduce the potential for product manufacturers to publish undifferentiated, selective, unverified, misleading, incomparable or incomprehensible environmental data derived from non-standard methodologies. EPDs are gaining momentum in the marketplace as a tool for communicating the environmental performance of a product.

Given recent developments in EPDs and LCAs, as well as increasing requirements in international timber markets for green products (e.g. green building rating systems such as BREEAM in the UK), ITTO commissioned an LCA for meranti plywood that would enable the development of an EPD. Meranti plywood is well known internationally for its usefulness in a wide range of applications, and it is exported worldwide, mainly from Southeast Asian countries. The LCA was designed to fill critical gaps in the environmental performance of tropical wood products and to increase the market acceptance and specification of meranti wood products as green building materials.

LCA tools and applications are being developed in Europe, Japan and North America, but few LCAs have been conducted in Southeast Asia on tropical timber products (Murphy 2004). An LCA of timber products not only involves "foreground" data on timber and the manufacturing processes, but also other local inputs and outputs ("background" data) to holistically represent the whole product system or life cycle. Good-quality local background datasets—such as on local electricity and fuel supply, and transportation—may be unavailable for assessing the entire product system satisfactorily.

Meranti plywood

Meranti plywood is made using mixed light-to-medium hardwoods consisting mainly of the meranti group of timbers in Indonesia and Malaysia. Its strength, durability and relatively low cost make it a preferred building material; it is used widely in the building construction sector, and a small volume is also used for furniture manufacture. Plywood is made using sheets of veneers glued together (with mainly formaldehyde-based resin), with the wood grain of the sheets arranged perpendicularly. Plywood normally comprises an odd number of veneers (e.g. 3, 5, 7, 9 or 15 sheets). The thickness

Flaw repair: A worker repairs a meranti plywood veneer sheet on the factory floor. *Photo: MY Massijaya*

of a sheet of plywood ranges from 3 mm to 28 mm, and the sizes are usually 3 feet x 6 feet and 4 feet x 8 feet. In addition to the manufacture of plywood, plywood plants may sell dried veneer and other products such as laminated veneer lumber (LVL) and blockboard using timber recovered from peeler cores. The box sets out the main stages of plywood production.

The environmental impacts of meranti plywood production from "cradle to gate" (that is, from harvesting in the forest to the manufactured product, not including transport beyond the factory) were quantified in the study reported here using LCA methodology. The environmental impacts of meranti plywood manufactured were assessed at five mills in Indonesia and Malaysia. In conducting the assessment, the processing steps were mapped and the inputs and outputs measured—materials (logs and resins), transport fuel, energy consumption (including that generated from biomass), and water.

Plywood companies in Indonesia and Malaysia are privately owned manufacturing entities that purchase raw materials from forest concession-holders. Some companies may also own concession areas, but these mostly operate independently. Plywood companies are usually large, producing more than 5000 m³ per month of various types of plywood. Plywood plants generally use all wood wastes to produce process heat and to cogenerate electricity for their own consumption (and additional electricity is obtained from the national electricity grid). In some places, coal is used to generate electricity and meet thermal requirements.

The stages of meranti plywood production

Log yard. Logs are sorted in a log pond or log yard, especially to determine species and log quality. Log ponds are used for "floater" species, and log yards are used for "sinker" species.

Bucking. Logs emerge from the debarker, having been stripped of their bark.[1] The debarked meranti logs are transported using a hoist to the bucking/cross-cutting section, where they are cut to length (bucked) into billets for peeling.

Log grading and cleaning. Billets are graded and transported to the log washer on a conveyor. The logs are cleaned using water spray.

Peeling. Usually, logs are centred using laser projection and peeled with a rotary lathe. Rotary veneer is the most popular technique in veneer production for ordinary plywood production. The veneer thicknesses for core veneer are: 1.3 mm, 1.6 mm, 2.2 mm, 3.6 mm and 4.0 mm. Thicknesses for face and back veneers are 0.60 mm, 0.65 mm, 0.70 mm, 0.80 mm, 0.85 mm and 1.70 mm.

Veneer drying. Green veneer is dried in steam-heated ovens. The veneer is dried in continuous or batch dryers to a maximum of 12% moisture content for face and back and a maximum of 10% for core and centre core layers. The drying time ranges from 10 to 25 minutes depending on veneer thickness (with thicker veneers requiring longer drying times).

Veneer selection and repairing. Dried veneer sheets are selected based on their quality, and repaired if necessary.

Glue spreading and lay-up. Dried veneer sheets are passed through the glue spreader and then laid up, with the fibre arranged perpendicularly to adjacent veneers.

Cold pressing. Cold pressing facilitates glue bonding by achieving better glue transfer and increasing wetting and penetration.

Hot pressing. Heat and pressure are used to cure the resin, thereby bonding the veneers together permanently.

Sizing/cutting. After hot pressing, the plywood panels are cut to standard sizes (or order sizes).

Sanding. The outer layers of plywood (face and back) are sanded using sander machines. The standard sanding speed depends on plywood thickness.

Packing. The plywood sheets are packed and marked based on the standard.

[1] Some plywood companies debark meranti logs in the forest, in which case debarking in the mill is unnecessary.

The plywood production process is similar in Indonesia and Malaysia, although there is variability in specific conditions, such as the raw material supply, machinery, the thickness of veneer and plywood sheets, the kind of plywood, and the target quality of the plywood produced.

Field briefings and surveys were conducted in five plywood companies in Indonesia and Malaysia; Table 1 shows the

Table 1: Profiles of plywood companies engaged in the LCA

		Company				
	Unit	**A**	**B**	**C**	**D**	**E**
Monthly log input	m³	11 322	15 314	21 164	40 000	24 849
Monthly plywood production	m³	6 702	10 495	11 249	22 272	15 042
Co-products		Blockboard, veneer	Blockboard, lamineboard	Blockboard, veneer	Laminated veneer lumber	Veneer

Table 2: Environmental impact potential for the production of 1 m^3 of meranti plywood

Impact category	Unit	Company					Average industry value
		A	B	C	D	E	
AP	kg SO_2-eq.	1.70	1.35	2.08	2.11	2.30	1.91
EP	kg phosphate-eq.	0.253	0.197	0.333	0.383	0.391	0.311
GWP (100 years)	kg CO_2-eq.	592	485	411	329	411	446
ODP	kg CFC11-eq.	8.95×10^{-9}	6.74×10^{-9}	1.84×10^{-8}	1.66×10^{-8}	1.90×10^{-8}	1.40×10^{-8}
POCP	kg ethylene-eq.	0.188	0.147	0.247	0.250	0.285	0.223

Note: AP = acidification potential; CFC11 = trichlorofluoromethane; CO_2 = carbon dioxide; EP = eutrophication potential; eq. = equivalent; GWP = global warming potential; POCP = photochemical ozone creation potential; ODP = ozone depletion potential; SO_2 = sulphur dioxide.

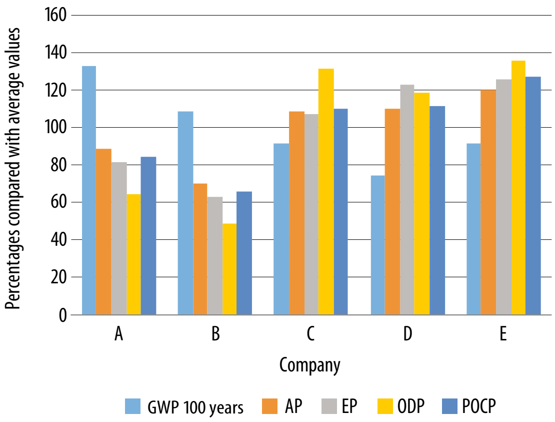
general profiles of the companies assessed in the study. Twelve-monthly datasets were developed to provide data on the input and output of materials and energy for the production of 1 m³ of plywood.

Findings

A production model was created using GaBi 6 (an LCA software), and the impacts of each mill were assessed for their acidification potential, eutrophication potential, global warming potential (GWP), ozone depletion potential and photochemical ozone creation potential. Values were determined for each company for the production of 1 m³ of meranti plywood, and an industry average was calculated (Table 2).

The environmental impact potentials varied by company. The performance of an individual plywood company may be compared with the average, as shown in Figure 1. Bars significantly higher than 100% indicate a high environmental impact compared with the mean. For example, the GWP of company A was 33% higher than the average of the five companies.

Figure 1: Relative environmental impact of five meranti plywood companies, compared with average values

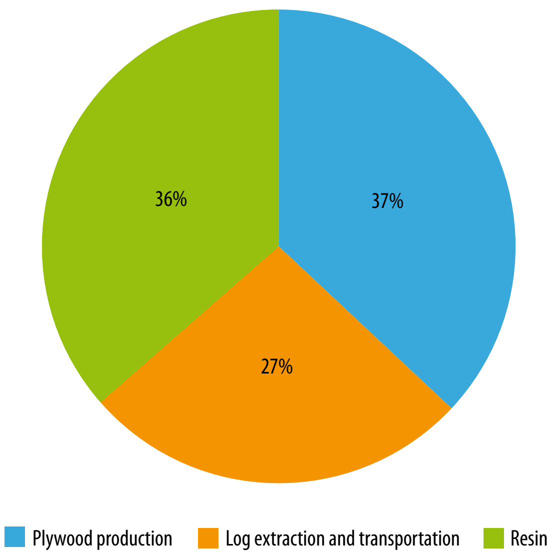


Notes: GWP = global warming potential; AP = acidification potential; EP = eutrophication potential; POCP = photochemical ozone creation potential; and ODP = ozone depletion potential.

Plywood production and resin were responsible for the emission of similar proportions of carbon dioxide (CO_2); log extraction and transportation was responsible for a significant (but somewhat lower) proportion (Figure 2).

The study found that the company using biomass to meet the bulk of its energy needs (i.e. company D) had the lowest GWP; biomass is considered a biogenic fuel, and the CO_2 released is not considered an emission. The study also found that average GWP (for the five companies combined) was 446 kg CO_2-equivalent per m³; this figure, therefore, could be considered the carbon footprint for the production of 1 m³ of tropical plywood, with plywood production and resin contributing significant proportions of this. The study did not take into account the carbon sequestered in the trees used as raw material for making plywood, which, to some extent, would offset the CO_2 emitted from the consumption of fossil fuels at various stages of manufacturing.

Figure 2: Contributions of the three main components to mean greenhouse warming potential



Conclusion

Several areas in the manufacture of plywood contribute substantially to overall greenhouse-gas emissions. Meranti plywood companies could improve their environmental performance by addressing these areas, such as by improving the recovery of veneers and co-products from logs; using biomass for thermal and electricity needs; improving the control of resin use; and improving material flow in manufacturing operations to reduce internal transportation.

This study is the first attempt to measure and quantify the emissions associated with the production of meranti plywood in the tropics. The primary data were obtained from the manufacturers, and care was taken to ensure accuracy. The study also used secondary data from various sources, particularly emission factors for inputs such as fuels and resin. The results constitute baseline information for companies seriously looking to improve the environmental profiles of their production. For the users of meranti plywood, the emissions reported here may be used to justify the use of meranti plywood compared with other materials.

A full technical report of the study is available at: www.itto.int/technical_report.

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Coming soon!

ITTO will soon launch a website dedicated to expanding the use of lesser-used species. The new website, which will be targeted at timber businesses and consumers, will facilitate access to existing technical information about species availability, wood properties, uses and processing into value-added wood products.

The website will enable smart searches of:

Tropical timber species by:
- uses
- properties
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Timber availability and sourcing:
- identification of trees and woods
- species distribution and abundance
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It will also contain information and contacts for producers and consumers, including:
- a virtual technical library and classic publications
- a multilingual search facility of ITTO projects and links to ITTO statistics and publications
- consumer tips and education.

For more information go to www.itto.int or www.tropicaltimber.info

Checking the decking

A life-cycle assessment finds that the environmental qualities of ipe and cumaru decking produced in northern Brazil compare favourably with those of other wood flooring products

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Consumers are increasingly interested in the social, economic and environmental impacts of the products they buy, but they need reliable, objective information if they are to make informed choices. Buildings play an important role worldwide in the consumption of energy and natural resources and the emission of greenhouse gases (GHGs). Life-cycle assessment (LCA) has been used in the building sector since 1990 (Ortiz et al. 2009) to analyze the energy involved in the production, use and disposal of the various products used in buildings (Cabeza et al. 2014). It is an important tool for assessing the impacts of the building industry and the materials used in it.

Environmental product declarations

LCAs are conducted following the standards of the International Organization for Standardization (ISO 14040 and ISO 14044), but the best way to compare products is to use environmental product declarations (EPDs), which are based on product category rules (PCRs). The use of EPDs is a strategy for communicating the environmental performance of a product externally and for reducing the environmental impact of a product (Askhan 2006; see also the article by Gan Kee Seng and Muh Yusram Massijaya in this edition).

Trees have the capacity to fix carbon and thereby play a positive role in mitigating climate change. The most important factor in obtaining a high environmental rating for wood and wood products is reducing the emission of GHGs in the production process. Little literature is available on the GHG emissions involved in tropical timber production, however, with the most important contributions provided by LCA and EPD studies supported by ITTO (Gan and Massajaya 2014; Adu and Eshun 2014).

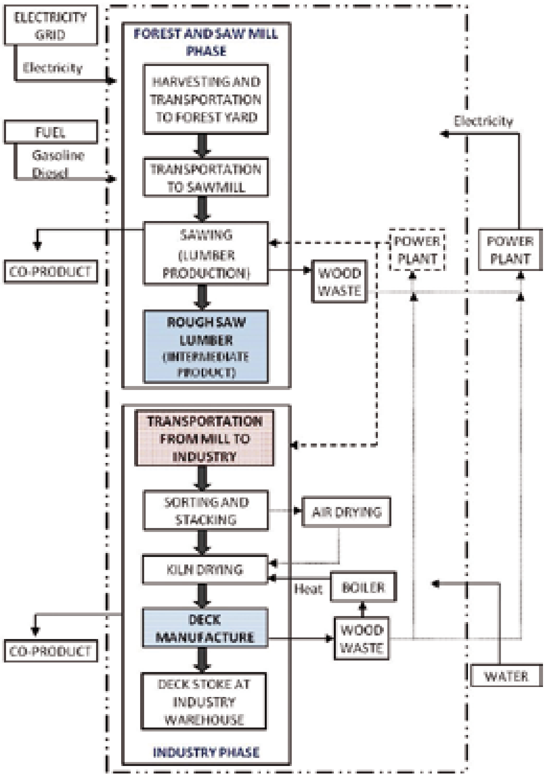
Considering the growing importance of tropical timber LCAs and EPDs for building purposes, ITTO funded an LCA study for decking manufactured with ipe (*Handroanthus* spp., syn. *Tabebuia* spp.) and cumaru (*Dipteryx odorata*) lumber to assist in the development of an EPD for those products.

Deck manufacturing and system boundaries

Decking manufacture in Brazil involves a high diversity of sources, company sizes, and technologies. There are two main industrial flows: 1) primary and secondary processing industries in the North Region; and 2) the primary processing industry in the North Region and the secondary processing industry in the Southeast and South regions, involving the transportation of primary products from diverse places in the north of the country to the south. In line with ISO 14040, the boundaries of this study were set for "cradle to gate"; that is, from the tree in the forest to the product stock in the factory (Figure 1). Cradle-to-gate assessment has two basic phases:

1) the forest and sawmilling phase, which involves tree harvesting, log extraction, log transportation to the sawmill and sawing into lumber, and internal transportation; and

Figure 1: System summary and boundary, cradle-to-gate assessment



Note: dashed and dotted line = system boundary; solid line boxes = foreground processes; dashed line boxes = processes not common to all industries; dotted line = alternate flow.

2) the "industry" or manufacturing phase, which involves transportation to the manufacturing factory, kiln drying, primary lumber processing (dimensions adjustment), secondary lumber processing (deck manufacture), and internal transportation.

In the forest and sawmilling phase, the inputs are gasoline and diesel and the outputs are lumber (intermediate product), useful residues, and waste (co-products). In the manufacturing phase, the inputs are diesel, electrical energy and water (for the kiln-drying boiler), and the outputs are wood residues and the final product (decking boards). In both phases, short pieces not used in the manufacture of decking, called "useful residues" here, are directed to other types of flooring. "Waste", comprising sawdust, bark and very small pieces, is burned to produce energy.

Survey of eight companies

Eight companies involved in the manufacture of ipe and cumaru decking were asked to complete a questionnaire; seven of the eight were selected for data collection (Figure 2). All data collected in the selected companies were for the entire production in 2014.

Three companies (labelled A, B and C) own the forest in which logs are harvested, or have a concession in public forest; their involvement in the process ends with the production of rough-sawn lumber. Two companies (D and E) own the forest in which logs are harvested and produce both rough-sawn lumber and the final product (i.e. ipe and cumaru decking). Two companies (F and G) purchase rough-sawn lumber from suppliers and manufacture the final product.

To apply the LCA to the complete industrial flow (from cradle to gate), data from the forest harvesting and sawmill phase were integrated with data from the manufacturing phase. Table 1 shows the life-cycle inventory inputs for the four assessed companies that manufacture the final decking product (i.e. D, E, F and G).

A generic model of the decking manufacture process was created using GaBi6 software, and this model was used to analyze the integrated data of all companies.

Impact assessment results

The potential environmental impacts of the production process were analyzed with respect to global warming potential (GWP), acidification potential, eutrophication potential, ozone depletion potential and photochemical ozone creation potential in three scenarios:

1) five companies with forest harvesting and sawmilling operations (Table 2);
2) four manufacturing companies, integrating forest and mill activities (Table 3); and
3) the impact of long-distance lumber transportation (Figure 3).

Table 3 shows that company F has a very high value for GWP (relative to the other companies), which can be attributed to a high electricity input and low decking recovery. A specific characteristic of company F is the wide range of flooring products it produces, which makes it more difficult to buy lumber with dimensions adequate for decking. The lumber is kiln-dried and then planed to deck profile. The first planer, which transforms the rough-sawn lumber to squared-four-sides (S4S) lumber, must be a powerful machine because it needs to remove large amounts of dry wood and adjust the S4S lumber dimension to facilitate the multiple head planer cut; combined, these factors mean a high electricity input.

Figure 2: Approximate location and kind of company assessed in the study

Company F is also the only one located in southeast Brazil, with the distance to lumber suppliers ranging from 2000 to 2900 km, meaning high inputs of diesel for lumber transport (Figure 3 and Figure 4), with a consequent impact on GWP.[1]

Of the seven companies assessed, six are in northern Brazil. A better approach would be to exclude data from company F because the large transport distances skew the results. An assessment of data from companies A, B, C, D, E and G, where transport distances are much smaller, gives a better picture of decking manufacturing practices in northern Brazil.

1 As reported by Gan and Massijaya (2014) in their LCA study for tropical plywood manufacturing in Malaysia and Indonesia (and see also their article in this edition of the *TFU*), GWP in the manufacture of wood products is directly related to the consumption of fossil fuels, including for electricity production.

Table 1: Life-cycle inventory inputs to produce 1 m^3 of ipe and cumaru decking for four manufacturers

Input	Unit	Company				Weighted average
		D	E	F	G	
Input—ipe decking						
Log	m^3	6.825	4.057	5.436	3.505	4.924
Diesel	kg	69.6	41.5	55.6	34.1	49.6
Gasoline	kg	1.2	0.7	0.9	0.6	0.8
Electricity—grid	GJ	0.1	0.0	1.5	0.6	0.9
Electricity—power plant	GJ	1.3	1.9	0.4	0.3	0.5
Water—river	litres	0.0	120.3	0.0	0.0	0.6
Water—municipal	litres	0.0	0.0	151.9	87.2	97.3
Input—cumaru decking						
Log	m^3	7.870	4.717	5.804	4.259	5.363
Diesel	kg	71.0	42.8	52.6	36.7	48.2
Gasoline	kg	1.4	0.8	1.0	0.8	1.0
Electricity—grid	GJ	0.1	0.1	1.4	0.6	0.9
Electricity—power plant	GJ	1.4	1.9	0.4	0.3	0.7
Water—river	litres	0.0	120.4	0.0	0.0	19.7
Water—municipal	litres	0.0	0.0	155.2	85.3	108.8

Note: Data are for integrated flow without diesel consumption in the transport of lumber from sawmill to manufacturer.
Weighted average = sum of inputs demanded by the companies divided by the sum of the produced decking from those companies.

Table 2: Environmental impact potential for the production of 1 m^3 of ipe and cumaru decking, five companies directly involved in the forest and sawmill phase of production

Impact category	Unit	Company					Weighted average
		A	B	C	D	E	
Ipe decking							
AP	kg SO_2-eq	1.40	0.24	0.21	0.71	1.52	0.65
EP	kg phosphate-eq	0.23	0.03	0.03	0.12	0.26	0.11
GWP (100 years)	kg CO_2-eq	46.5	33.9	27.3	29.0	56.5	31.0
ODP	mg CFC11-eq	0.989	0.777	0.702	0.653	1.150	0.628
POCP	kg ethylene-eq	0.28	0.03	0.03	0.14	0.30	0.13
Cumaru decking							
AP	kg SO_2-eq	0.86	0.22	0.18	0.64	1.48	0.68
EP	kg phosphate-eq	0.14	0.03	0.03	0.11	0.25	0.11
GWP (100 years)	kg CO_2-eq	28.3	30.7	23.3	26.1	54.8	31.1
ODP	mg CFC11-eq	0.607	0.706	0.598	0.502	1.110	0.706
POCP	kg ethylene-eq	0.17	0.03	0.02	0.13	0.30	0.13

Note: AP = acidification potential; CFC11 = trichlorofluoromethane; CO_2 = carbon dioxide; EP = eutrophication potential; eq. = equivalent; GWP = global warming potential; POCP = photochemical ozone creation potential; ODP = ozone depletion potential; SO_2 = sulphur dioxide. Weighted average = sum of inputs demanded by the companies divided by the sum of the produced decking from those companies.

Table 3: Environmental impact potential for the production of 1 m^3 of ipe and cumaru decking, four companies with manufacturing operations

Impact category	Unit	Company				Weighted average
		D	E	F	G	
Ipe decking						
AP	kg SO_2-eq	1.98	2.67	1.35	0.76	1.20
EP	kg phosphate-eq	0.326	0.443	0.159	0.101	0.162
GWP (100 years)	kg CO_2-eq	71.1	72.4	147.0	67.0	101.0
ODP	mg CFC11-eq	0.893	0.526	0.679	0.449	0.601
POCP	kg ethylene-eq	0.397	0.551	0.193	0.122	0.196
Cumaru decking						
AP	kg SO_2-eq	2.13	2.71	1.30	0.77	1.47
EP	kg phosphate-eq	0.351	0.446	0.156	0.103	0.206
GWP (100 years)	kg CO_2-eq	74.3	80.6	138.0	67.7	107.0
ODP	mg CFC11-eq	1.040	0.601	0.752	0.597	0.749
POCP	kg ethylene-eq	0.428	0.556	0.190	0.124	0.252

Note: Integrated flow from forest to company, excluding diesel consumption for lumber transportation. AP = acidification potential; CFC11 = trichlorofluoromethane; CO_2 = carbon dioxide; EP = eutrophication potential; eq. = equivalent; GWP = global warming potential; POCP = photochemical ozone creation potential; ODP = ozone depletion potential; SO_2 = sulphur dioxide. Weighted average = sum of inputs demanded by the companies divided by the sum of the produced decking from those companies.

Figure 3: Global warming potential related to the transport of lumber from sawmill to manufacturing company for the production of 1 m^3 of ipe decking

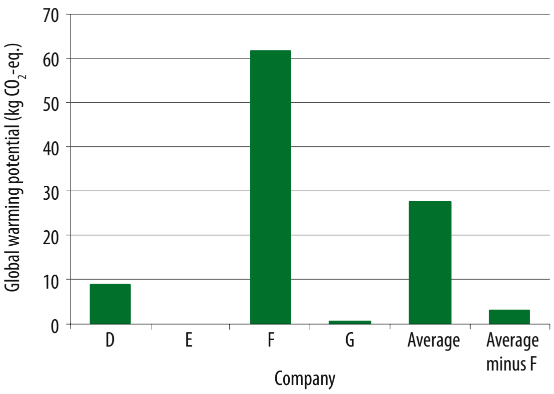


Figure 4: Global warming potential related to the transport of lumber from sawmill to manufacturing company for the production of 1 m^3 of cumaru decking

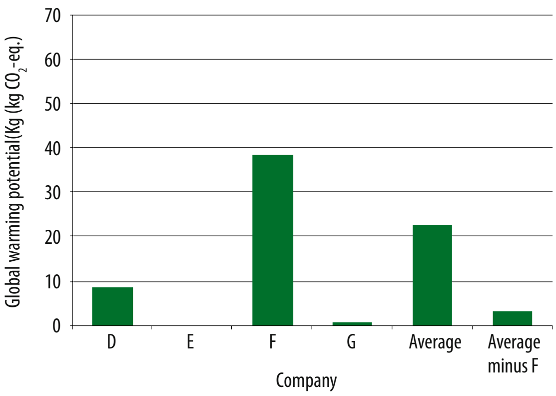


Figure 5: Global warming potential for the production of 1 m^3 of ipe decking (integrated flow from forest to company)

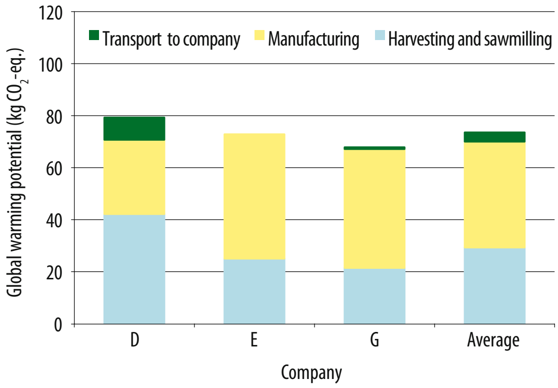


Figure 6: Global warming potential for the production of 1 m^3 of cumaru decking (integrated flow from forest to company)

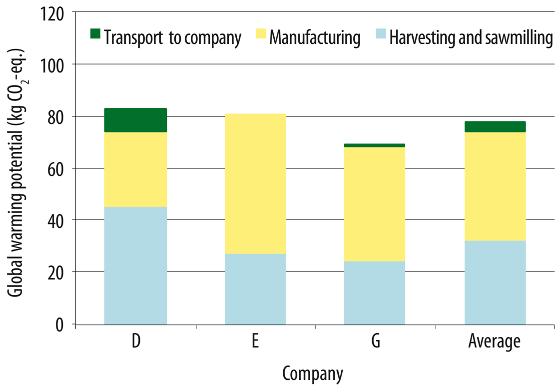


Table 4: Environmental impact potential for the production of 1 m^3 of ipe and cumaru decking, northern Brazil

Impact category	Unit	Species	
		Ipe	Cumaru
AP	kg SO_2-eq.	1.83	1.90
EP	kg PO_4-eq.	0.30	0.31
GWP (100 years)	kg CO_2-eq.	73.2	77.3
ODP	mg CFC11-eq.	0.623	0.746
POCP	kg ethylene-eq.	0.361	0.373

Note: AP = acidification potential; CFC11 = trichlorofluoromethane; CO_2 = carbon dioxide; EP = eutrophication potential; eq. = equivalent; GWP = global warming potential; POCP = photochemical ozone creation potential; ODP = ozone depletion potential; SO_2 = sulphur dioxide.

Greenhouse-gas emissions and carbon footprint

Figure 5 and Figure 6 depict GWP values for companies D, E and G (integrated industrial flow); these values are representative of companies manufacturing ipe (Figure 5) and cumaru (Figure 6) decking in northern Brazil (i.e. the Amazon). Table 4 gives average values for the five impact categories considered in this study, combining harvesting and sawmilling, transport to company, and manufacturing. These values should form the basis of EPDs for ipe and cumaru decking manufactured in northern Brazil.

A GWP of 73.2 kg CO_2-eq can be considered the carbon footprint for 1 m3 of ipe decking produced in northern Brazil, and 77.3 kg CO_2-eq can be considered the carbon footprint for cumaru decking. These values compares favourably with the GWPs reported for other wood-based products (Gan and Massijaya 2014; Adu and Eshum 2014) and other types of wood flooring (Nebel et al. 2006).

Conclusion

This study gathered valuable data and experience in LCA research in Brazil. Based on this acquired experience, we make the following general comments:

- Currently there are no LCAs on tropical forest harvesting, and these are needed for full assessments. Further research on this aspect is required.
- Brazil is a large country, and long-distance lumber transport has considerable environmental impacts. It is important, therefore, to complement the present research by including more companies, especially those in the south and southeast of the country.
- The interpretation of results from LCA studies can vary depending on the PCRs adopted. It is important, therefore, to create PCRs specific to tropical timber and its manufactured products.

ITTO has an important strategic role to play in continuing to promote research to support LCAs and EDPs for tropical timber products.

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Will small logs become a big deal?

The supply of large-diameter logs is declining in Asia, but biocomposite products can make use of a new generation of smaller logs

by Zhou Yongdong

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Labour-intensive: Repairing and joining veneer made from small-diameter logs in a mill in West Java, Indonesia. *Photo: Zhou, Y.*

As the global economy grows, so too does the requirement for wood products. But the availability of traditional large-diameter tropical logs is decreasing, and logging bans have been instituted in many tropical countries, resulting in wood-supply deficits.

The use of small-diameter logs (SDLs)[1] from natural forests and plantations in the production of biocomposite products may be a solution to this supply deficit, but information on markets and technologies is needed. Biocomposite projects involving wood include (among others) plywood, laminated veneer lumber (LVL), glued laminated timber (glulam), particleboard and medium-density fibreboard (MDF). Project CFC/ITTO/62 PD 40/00 Rev. 4 (I): "Utilization of small diameter logs from sustainable sources for biocomposite products", a joint project by the Common Fund for Commodities and ITTO, aimed to investigate markets and technologies for biocomposites produced using SDL resources.

This article reports the findings of an ex-post evaluation of the project, which was carried out in August 2014, 32 months after project completion, and included field visits in three involved countries. The project, which cost US$600 000, was implemented from late 2007 to the end of 2011. It was implemented by the Faculty of Forestry at Bogor Agricultural University in Indonesia, with the collaboration of the following agencies: University Putra Malaysia, the Forest Product Research and Development Institute in the Philippines, and the Forest Research Institute in Papua New Guinea.

Project overview

The development objective of the project was to contribute to the continuity of timber production; forest resource security; socioeconomic benefits from sustainable sources; knowledge of the wood properties of SDLs; and the transfer of technology on the use of SDLs for value-added biocomposite products. The research focused on the present and future markets of biocomposite products, the physical and mechanical properties of SDLs as raw materials for biocomposite products, and the basic properties of biocomposite products.

The project collected and made available comprehensive information on SDLs and their potential use in value-added biocomposite products. Seven outputs were delivered through the execution of 18 activities. The main research findings are as follows:

- *Markets*: the review of markets and trends provided an analysis of the production, export, import, consumption, trade and prices of five biocomposite products: plywood, LVL, glulam, particleboard and MDF. It found that plywood and MDF made from SDLs could plausibly be developed for international markets, and that veneer sheets and particleboard made from SDLs would plausibly find domestic markets.
- *Properties*: the physical-mechanical properties of timber species were analyzed for biocomposite products made from SDLs from 24 species from natural forests and 14 species from plantation forests in Indonesia; nine species in Malaysia; three species in the Philippines; and six species in Papua New Guinea.

1 SDLs are defined as logs with a maximum diameter of less than 50 cm.

Core value: SDL veneer is the major (central) part of the plywood. *Photo: Zhou, Y.*

Small is beautiful: Plantation-grown small-diameter logs used for core-layer veneer for plywood in a mill in West Java, Indonesia. *Photo: Zhou, Y.*

- *Difficulties*: issues with milling and quality control were identified for LVL and plywood produced from SDLs, including low-quality veneer and problems with hot press veneer drying, veneer repairing and composing, gluing, and pressing. No milling problems were identified in the manufacture of particleboard and MDF from SDLs.
- *International standards*: an evaluation of various properties of plywood, LVL, glulam, particleboard and MDF made from SDLs found that products could meet international standards.
- *Equipment*: an investigation of equipment needs for production and manufacturing, including a review of equipment availability and the identification of sources and estimation of costs, recommended the replacement of rotary machines (traditionally used for large-diameter logs) with spindleless lathes for peeling SDLs.
- *Barriers*: the Japan Standard (JPIC/JAS), the British Standard (BS), the United States Standard (IHPA) and the German Standard (DIN) were identified as potential trade barriers for biocomposites made with SDLs.
- *Quality control*: quality-control procedures were conducted to ensure that products could meet certain standards. Efforts should be made to ensure that products exceed minimum thresholds for certain critical indicators of quality.

A regional workshop was convened to assist with technology transfer on the management and use of SDLs in the production of biocomposite products. Academics, timber industry representatives, and government officials from Indonesia, Malaysia, Papua New Guinea and the Philippines attended the workshop.

Findings

The project showed that plantation and community forests could provide the raw materials for biocomposite products and thereby substitute for traditional large-diameter logs from natural tropical forests. Traditional plywood enterprises can survive only if they can shift from large-diameter logs to SDLs, but more work is needed on repairing and joining veneers from SDL resources. Project activities raised awareness in the wood products sector about the potential economic benefits of using SDLs in biocomposite products and, overall, the project will have a positive impact on the sustainable development of wood-product industries. The increased use of plantation-grown wood in value-added products such as biocomposites is essential for creating employment and income for local people and economies.

Lessons learned

Despite the project's many achievements, there were weaknesses in project identification, design and implementation, and lessons can be learned.

Project identification and design

- The participation of project beneficiaries in project identification and problem analysis is indispensable for minimizing the need for later changes to planned project activities.
- The "key problem" should be addressed explicitly through detailed analysis of the logical framework. Outputs should be identified for all project content.

Project implementation

- Four countries were involved in the project—contingency plans should be prepared for any complexities that might arise, such as in coordination, research execution and administration.
- Differences in the capacities of institutions involved in regional projects can lead to extended delays, and participating government and research institutions should therefore be prepared to pursue various project components at differing rates to avoid delays in project execution.

The changing timber trade

***ITTO has just published the Biennial Review and Assessment of the World Timber Situation 2013–2014*[1]**

Cut and dried: Kiln-dried wood flooring is put on a truck for transport to market in Brazil. *Photo: I. Jankowsky*

ITTO's *Biennial Review and Assessment of the World Timber Situation 2013–2014*[2] reports on developments in the global timber sector and wood markets in the period 2010–2014, with a focus on tropical timber. It provides data on production and trade by volume and value for primary wood products, and on trade by value for secondary processed wood products. The base year for global comparisons is 2013, the latest year for which reasonably reliable data were available for most countries. Data were derived from the analysis and synthesis of responses of ITTO member countries to the Joint Forest Sector Questionnaire 2013 and 2014 and from consultations with members and other agencies; other sources were used to supplement data where they were incomplete or obviously incorrect.

Tables 1 and 2 provide an overview of statistics comparing tropical wood production and trade with all wood production and trade (i.e. including temperate and boreal wood) for all ITTO member countries and the world (ITTO and non-ITTO member countries) in 2013 (Table 1) and 2014 (Table 2).

Primary wood-product production

ITTO member countries produced 240 million m^3 of tropical industrial roundwood (logs) in 2013 and 243 million m^3 in 2014. Indonesia, India, Brazil and Malaysia (in descending order, by volume) accounted for almost two-thirds of tropical log production in ITTO producer countries in 2013, and the bulk (69%) of production was in the Asia-Pacific region. Indonesia's production totalled 62.4 million m^3 in 2013, although natural forests there are facing pressure from conversion to agriculture (particularly oil-palm plantations) and forest plantations (for pulp and paper) and from rising domestic demand for wood products in the growing housing construction sector.

Brazil's tropical log production amounted to 30.8 million m^3 in 2013, mainly in the northern states of Amazonas, Matto Grosso and Pará. Estimates of production in both Brazil and Indonesia would likely be considerably higher if unofficial/illegal harvests were taken into account. Malaysia's production declined from 2008 to 2013, due largely to lower export market demand, while resource availability also declined due to government policies on implementing sustainable forest management. Other significant producers in 2013 were (in descending order, by volume) Thailand, Viet Nam, Nigeria, Myanmar, the Democratic Republic of the Congo, the Philippines, Papua New Guinea, Cameroon, the Congo, Côte d'Ivoire and Colombia. The lack of reporting on the production of tropical logs and other primary wood products by most major ITTO producer countries continues to limit the quality of production data available for these products.

ITTO producer member countries produced 49.6 million m^3 of tropical sawnwood in 2013 and 50.0 million m^3 in 2014, which was more than 90% of world tropical sawnwood production. Brazil remains the largest producer (16.1 million m^3 in 2013), with all other major producers—Viet Nam, India, Indonesia and Malaysia (in descending order by volume)—located in the Asia-Pacific region; these five countries produced 67% of ITTO's tropical sawnwood production in 2013. China was the only significant tropical sawnwood producer among ITTO consumer countries, with production at 2.4 million m^3 in 2013. About two-thirds of tropical veneer production in producer countries takes place in the Asia-Pacific region, with total production

1 This article is based on ITTO's 2013–2014 Biennial Review of the World Timber Situation, available at www.itto.int. Contact the ITTO Secretariat for more information or with queries.

2 Previously, ITTO's periodic review and assessment of the world timber situation was published annually. The periodicity of the review was changed to biennial in 2013.

Table 1: ITTO summary statistics, 2013 (million)

	Logs			Sawnwood			Veneer			Plywood		
	All	Tropical	%	All	Tropical	%	All	Tropical	%	All	Tropical	%
ITTO production (m^3)	1 464.3	240.1	*16.4*	362.5	52.1	*14.4*	11.6	5.2	*44.8*	129.4	18.4	*14.2*
World production (m^3)	2 010.8	270.0	*13.4*	429.4	54.8	*12.8*	13.1	5.4	*41.2*	135.5	19.1	*14.1*
ITTO imports (m^3)	121.6	16.7	*13.7*	99.7	8.6	*8.6*	2.7	1.2	*44.4*	20.8	6.0	*28.8*
World imports (m^3)	126.1	16.9	*13.4*	120.5	11.2	*9.3*	3.0	1.3	*43.3*	26.5	7.0	*26.4*
ITTO imports (US$)	19 100.0	6 397.1	*33.5*	29 867.1	4 515.7	*15.1*	2 625.3	659.5	*25.1*	11 660.2	3 736.0	*32.0*
World imports (US$)	19 605.2	6 463.5	*33.0*	35 311.7	5 601.1	*15.9*	2 969.1	784.6	*26.4*	14 190.7	4 291.9	*30.2*
ITTO exports (m^3)	96.5	13.2	*13.7*	100.7	9.7	*9.6*	2.5	1.2	*48.0*	23.8	7.4	*31.1*
World exports (m^3)	126.5	16.8	*13.3*	130.2	10.3	*7.9*	3.0	1.2	*40.0*	27.2	7.5	*27.6*
ITTO exports (US$)	14 135.6	4 748.7	*33.6*	29 768.7	4 499.9	*15.1*	2 437.8	675.4	*27.7*	13 280.0	4 626.7	*34.8*
World exports (US$)	17 478.5	5 894.7	*33.7*	35 612.8	4 978.0	*14.0*	2 755.6	706.8	*25.6*	14 958.1	4 685.6	*31.3*

Note: "All" = coniferous, temperate and tropical hardwood production; "ITTO" = all ITTO member countries; "World" = all ITTO member and non-member countries.

Table 2: ITTO summary statistics, 2014 (million)

	Logs			Sawnwood			Veneer			Plywood		
	All	Tropical	%	All	Tropical	%	All	Tropical	%	All	Tropical	%
ITTO production (m^3)	1 505.8	243.2	*16.2*	368.9	52.5	*14.2*	11.8	5.5	*46.6*	130.4	19.0	*14.6*
World production (m^3)	2 052.2	273.1	*13.3*	435.9	55.2	*12.7*	13.3	5.8	*43.6*	136.5	19.7	*14.4*
ITTO imports (m^3)	132.5	19.6	*14.8*	105.9	8.8	*8.3*	3.2	1.5	*46.9*	19.5	6.0	*30.8*
World imports (m^3)	136.9	19.8	*14.5*	126.8	11.4	*9.0*	3.6	1.6	*44.4*	25.2	7.1	*28.2*
ITTO imports (US$)	21 373.1	8 276.2	*38.7*	33 017.0	4 850.0	*14.7*	2 807.3	652.8	*23.3*	11 891.3	4 013.6	*33.8*
World imports (US$)	21 878.3	8 342.6	*38.1*	38 461.5	5 935.4	*15.4*	3 151.2	777.9	*24.7*	14 421.9	4 569.5	*31.7*
ITTO exports (m^3)	105.4	15.8	*15.0*	103.7	9.8	*9.5*	2.8	1.5	*53.6*	23.1	7.8	*33.8*
World exports (m^3)	135.4	19.4	*14.3*	133.3	10.4	*7.8*	3.6	1.5	*41.7*	26.5	7.9	*29.8*
ITTO exports (US$)	15 232.0	5 927.1	*38.9*	30 926.3	4 586.0	*14.8*	2 498.7	633.0	*25.3*	14 403.9	4 636.7	*32.2*
World Exports (US$)	18 574.9	7 073.1	*38.1*	36 770.4	5 064.1	*13.8*	2 816.6	664.4	*23.6*	16 082.0	4 695.5	*29.2*

Note: "All" = coniferous, temperate and tropical hardwood production; "ITTO" = all ITTO member countries; "World" = all ITTO member and non-member countries.

amounting to 4.378 million m^3 in 2013, about 8% higher than in 2012. The production of tropical plywood in producer and consumer countries totalled 18.4 million m^3 in 2013, with China, Malaysia, Indonesia and India (in descending order, by volume) accounting for 85% of world production. The only other producers of significant volumes of tropical plywood were Brazil, Ecuador, France, Ghana, the Philippines and Viet Nam.

Primary wood-product imports

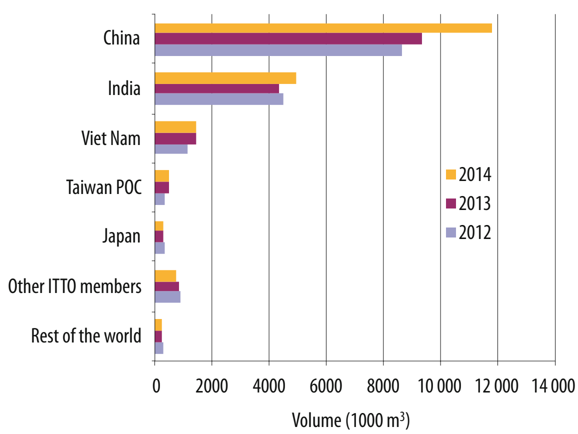
Total imports of tropical hardwood logs by ITTO members picked up strongly in 2013, recovering from the effects of the global economic downturn, which had resulted in very low demand since 2009. Total ITTO imports increased by 5% in 2013, to 16.7 million m^3; moreover, preliminary data indicate that import volumes leapt a further 17% in 2014, to 19.6 million m^3.

The Asia-Pacific region dominates the tropical sawlog and veneer log trade, accounting for about 98% of global imports and 70% of global exports; the major log trade flows in 2013 were from Malaysia, Myanmar, Papua New Guinea and the Solomon Islands (not an ITTO member) to China, India and Viet Nam. Many of the other significant Asian producer countries have some form of log export ban in place, notably Cambodia, Indonesia, the Lao People's Democratic Republic (not an ITTO member), the Philippines and Thailand, while Myanmar implemented log export restrictions in April 2014.

Most of the remaining exports were from Africa to China, India and Viet Nam. China, India and Viet Nam accounted for over 90% of total ITTO tropical roundwood imports in 2013, compared with 22% in 1995 (when Japan dominated the trade) and 46% in 2000.

China remains the dominant importer of tropical logs (Figure 1): it absorbed 56% of total ITTO tropical log imports in 2013, and its tropical log imports surged a further 26% in 2014, to 11.8 million m^3. The value of China's imports also leapt in 2014: total (softwood and hardwood) log import value grew by 22%, and tropical hardwood log import value

Figure 1: Major tropical log importers, 2012–2014



Note: Taiwan POC = Taiwan Province of China.

Figure 2: Major tropical sawnwood importers, 2012–2014

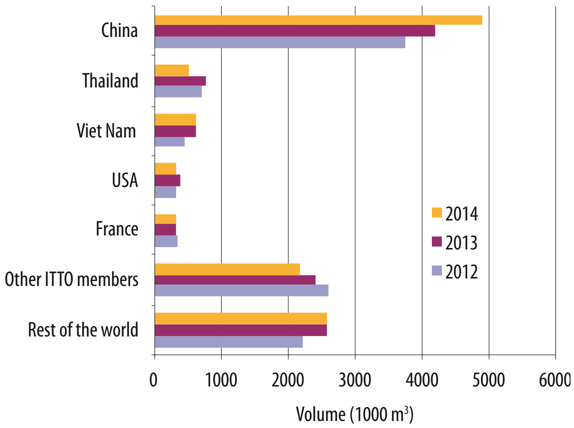
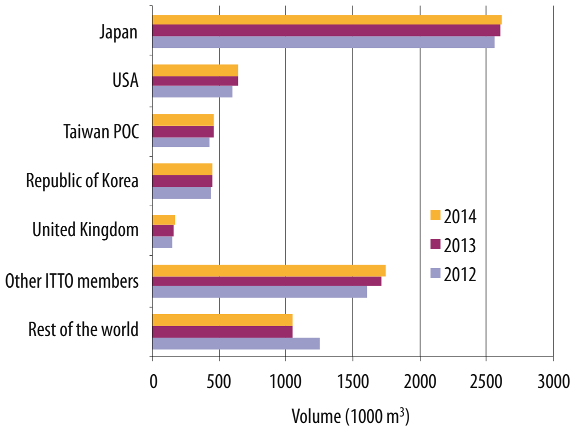


Figure 3: Major tropical plywood importers



Note: Taiwan POC = Taiwan Province of China.

grew by 53%. Imports soared in late 2013 and the first half of 2014, but demand began to slow towards the end of 2014, resulting in high inventories at ports and declining import prices. A notable trend in the last four years has been surging growth in China's imports of "rosewood" (also referred to as redwood or hong mu) logs, comprising a number of species in the genera *Dalbergia, Pterocarpus, Millettia, Cassius and Diospyros*. The proportion (by value) of rosewood imports in the tropical log trade grew from 4% in 2010 to 22% in 2014.

The Asia-Pacific region continues to dominate the tropical sawnwood trade, with China and, to a lesser extent, Thailand and Viet Nam the major importers (Figure 2) and Indonesia, Malaysia and Thailand the major exporters. Total ITTO imports of tropical sawnwood recovered from a low of 8.1 million m³ in 2012 to 8.7 million m³ in 2013 and 8.8 million m³ in 2014. China's major suppliers of tropical sawnwood in 2013 were Thailand (45% by volume), the Philippines (17%), Indonesia (8%) and Malaysia (5%). Significant volumes were also imported from Gabon, the Lao People's Democratic Republic, Mozambique, Myanmar and Viet Nam. There are notable discrepancies, however, in the reported volumes of trade between China and Indonesia and between China and the Philippines; both Indonesia and the Philippines reported significantly lower volumes of exports to China than China reported as imports from those two countries. China's tropical sawnwood imports from African countries continued to rise in volume and the share of total imports, accounting for 12% of China's tropical sawnwood imports in 2013 compared with less than 3% in 2010.

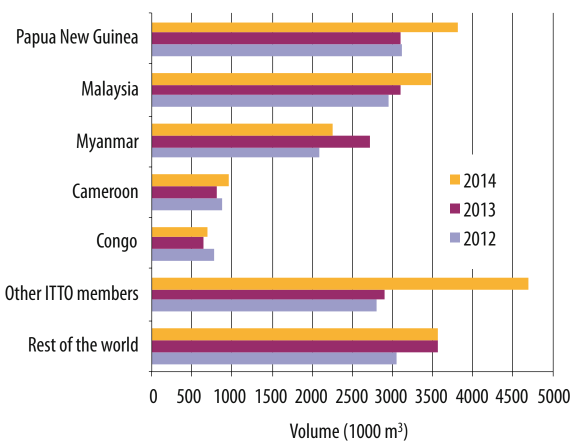
Although the volume of global trade in tropical plywood has trended downward in the last decade, it has fluctuated since 2008, with imports dropping to 5.8 million m³ in 2012 but rising to 6.0 million m³ in 2013. The trade continues to be dominated by a few major players (Figure 3). Japan is the largest importer, accounting for 43% of all ITTO member country plywood imports in 2013. The bulk of tropical plywood imports were sourced from Indonesia and Malaysia, and most of the remainder came from China.

Primary wood-product exports

ITTO producer members combined exported 13.2 million m³ of tropical logs in 2013. Log export bans and other impediments imposed by major log exporters outside the Asia-Pacific region (e.g. Gabon and the Russian Federation) and, more recently, within the region (e.g. Myanmar) have led to increases in log exports from Papua New Guinea and the Solomon Islands to China. Papua New Guinea overtook Malaysia as the largest tropical log exporter in 2013 (Figure 4), and 90% of its 3.1 million m³ of exports in that year went to China. The Solomon Islands exported 2.0 million m³ of tropical logs to China in 2013; the rate of harvesting in the Solomons has far exceeded the sustainable capacity of the country's merchantable forests, and most projections estimate that the forests will be exhausted within the next decade.

At 3.1 million m³, the volume of Malaysia's log exports in 2013 was low compared with the high volumes of the early 1990s. About 59% of Malaysia's tropical log exports in 2013 went to India, and the other major markets were also in Asia. Log exports by Myanmar (ITTO's third-largest exporter, at 2.7 million m³) increased by 30% in 2013 as import demand swelled before the log export ban came into effect in April 2014. Myanmar's log exports continued to surge in early

Figure 4: Major tropical log exporters, 2012–2014



2014 but then declined, with total exports in that year of 2.3 million m^3. Exports are expected to decline significantly in 2015 with the log export ban in place.

The reduced availability of export logs in the Asia-Pacific region has put pressure on alternative supply sources, particularly in Africa; tropical log exports from that region increased significantly in 2014, to 4.8 million m^3. China and, to a lesser extent, India and Viet Nam have become the major destinations for Africa's tropical log exporters, while exports to EU countries have declined.

ITTO producers exported 9.3 million m^3 of tropical sawnwood in 2013, up by 6% from 2012. ITTO members accounted for most of the global exports of this product, with the Lao People's Democratic Republic the only significant non-member exporter in 2013, shipping 435 000 m^3. Malaysia, the top-ranked exporter of tropical sawnwood in 2013, exported 2.0 million m^3 (Figure 5). Thailand was the major destination for Malaysia's tropical sawnwood exports, and other markets included (in descending order, by volume) China, the Philippines, Taiwan Province of China and the Netherlands. Thailand's exports of tropical sawnwood (mostly rubberwood) recovered from 1.6 million m^3 in 2012 to 1.9 million m^3 in 2013 and 2.0 million m^3 in 2014 in response to increased activity in China's furniture industry, which is the major destination for Thailand's exports.

Tropical plywood exports from ITTO producer countries have recovered from a low of 6.1 million m^3 in 2012, increasing to 6.4 million m^3 in 2013 and 6.8 million m^3 in 2014, with Indonesia and Malaysia the dominant suppliers (Figure 6). Malaysia exported most in 2012, at 3.0 million m^3, up from a low of 2.9 million m^3 in 2012 in response to depressed global markets. Malaysian tropical plywood production is increasingly restricted by the availability of raw materials (peeler logs)—log demand and prices for log exports (particularly from Sarawak to India) increased in response to the log export ban in Myanmar in 2014. Indonesia's tropical plywood exports

Stacked and packed: Plywood packaged and ready to go in the Philippines. *Photo: D. Eusebio*

plunged from highs of around 10 million m^3 in the early 1990s (when they constituted about 85% of total ITTO producer exports) to 1.9 million m^3 in 2009, but they have risen slowly in the last five years, to 2.8 million m^3 in 2013 and 3.3 million m^3 in 2014.

Secondary processed wood products trade

Secondary processed wood products (SPWPs) are products composed of roundwood that have already undergone primary conversion to sawnwood, veneer, plywood and other intermediate products. The primary categories of tropical SPWPs in trade are wooden furniture and parts (the major category, accounting for almost two-thirds of total trade value); builders' woodwork (joinery and carpentry); other SPWPs; mouldings; and cane and bamboo furniture and parts.

The total value of ITTO imports of SPWPs—nearly two-thirds of which was wooden furniture and parts—was US$78.8 billion in 2013, which was 87% of global imports of SPWPs. ITTO consumer countries imported the bulk of the shipments (Figure 7), accounting for more than 96%

Figure 5: Major tropical sawnwood exporters, 2012–2014

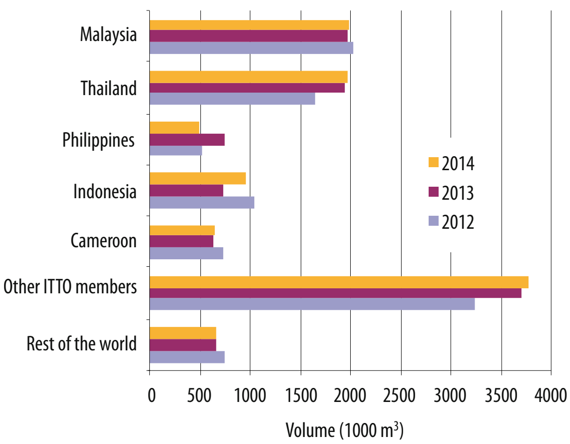


Figure 6: Major tropical plywood exporters, 2012–2014

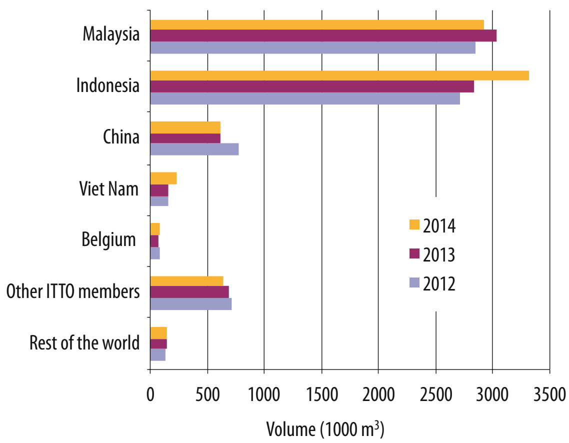
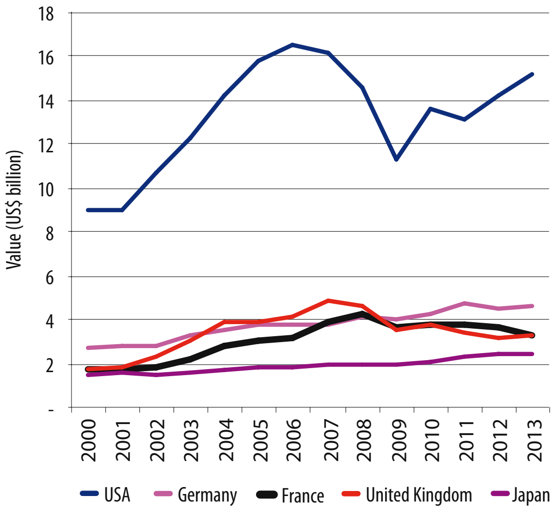


Figure 7: Major importers of wooden furniture and parts, 2000–2013



of ITTO imports of SPWPs in 2013; most of the trade was between consumer countries. The bulk of import demand has been in the advanced economies—predominantly EU countries, Japan and the US— although consumption is increasing in developing countries, notably Brazil, China and India. Trends in import growth in the last decade reflect economic growth trends in ITTO consumer countries, with imports dropping in 2009 at the height of the global financial crisis and remaining at low levels until 2013, when the US economy began to pick up and exporters looked to develop non-traditional markets.

Exports of SPWPs have undergone considerable change by supply source in recent years, with substantial growth in exports from China, the Philippines and Viet Nam, which has more than compensated for relatively subdued export growth in developed economies. Export trends reflect changes in the relative export competitiveness of supplying countries. ITTO consumers exported US$74.5 billion of SPWPs in 2013, 6% more than in 2012 and accounting for 83% of ITTO producer and consumer exports. China has been the world's largest exporter of SPWPs since 2003; it exported SPWPs valued at US$23.8 billion in 2013, which was 37% of all exports of SPWPs by ITTO consumer countries in that year. The EU's aggregate value of SPWP exports was US$42.4 billion in 2013, up by 8% compared with 2012. Germany, Italy and Poland were the major exporters in the EU, accounting for 15%, 15% and 14%, respectively, of EU exports in 2013. Figures 8 and 9 show trends in exports of wooden furniture and parts from China and other major tropical exporting countries in 2000–2013.

The ITTO Statistics Database is available at www.itto.int/annual_review_output. The Biennial Review *is available in English, French and Spanish at www.itto.int/annual_review.*

For more information on the ITTO Statistics Database and the Joint Forest Sector Questionnaire contact Mr Jean-Christophe Claudon, ITTO Statistical Assistant, at itto-stats@itto.int.

Figure 8: China exports of wooden furniture and parts, by major importing country and selected regions, 2000–2013

2000–2013

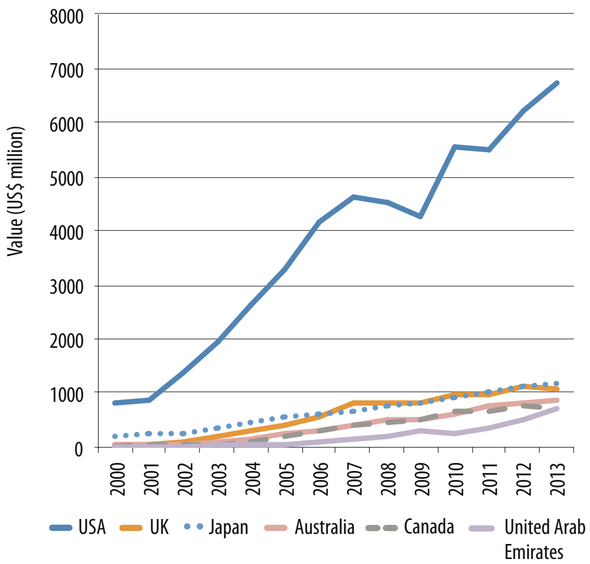
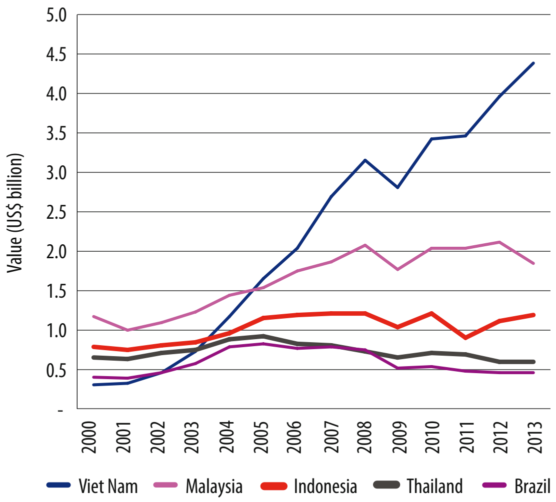


Figure 9: Major tropical exporters of wooden furniture and parts, 2000–2013



Fellowship report

An interdisciplinary team worked with a local community in Mexico to develop industrial designs and marketing strategies for high-value wood products

by Rebeca Midence Cerdas
(midence.24@gmail.com)

Design concepts: Prototypes of timber products made from tzalam (*Lysiloma* spp.). *Photo: R. Midence Cerdas*

Reforestation efforts should correlate the rational use of natural resources with social and economic benefits for forest producers. According to Dourojeanni (2000), the failure of many forest production projects is due to the following recurrent factors: a lack of economic profitability; social and political pressures from landless farmers for agricultural lands or from loggers for uncontrolled access to forests; poor administrative management practices, especially in state-owned forests; and a lack of financing and national and international support.

From the promulgation of the 1986 Forestry Law through to the current law, efforts have been made in Mexico to legitimize the right of forest communities to harvest and market their forest resources. To this end, forest producers have been supported through community forest enterprises and forest production chains. This organizational framework seeks to provide and develop capacities among all stakeholders involved in forest management so as to ensure the rational and efficient use of their resources.

One of the major challenges in a forest production chain is to identify the forest products that will generate income. Often, the lack of a clear definition of these products is the main cause of low profitability in commercial activities. When participating forest communities receive insufficient income from their activities to maintain an acceptably high quality of life, they may resort to aggressive and unsustainable forest exploitation.

In January 2014, the National Forest Commission (*Comisión Nacional Forestal*—CONAFOR), the Monterrey Institute of Technology (*Instituto Tecnológico de Monterrey*—ITESM) and the University of Guadalajara's University Centre for Biological and Agricultural Sciences (*Centro Universitario de Ciencias Biológicas y Agropecuarias*—CUCBA) established an interdisciplinary team comprising 60 industrial design undergraduate students, three professors, five master´s degree students and personnel from the CUCBA wood laboratory to implement a pilot plan for developing new products.

This article presents a three-step methodology developed through research based on an exploratory industrial design approach aimed at identifying markets for products derived from Mexico's production chains.

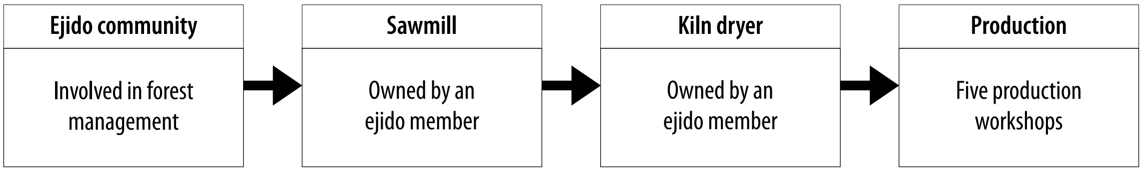
Step 1: Competitive diagnosis of the target forest community

A case study was undertaken with ITTO support in a forest community located in Othón Pompeyo Blanco, in the south of Quintana Roo state, which has had legal land rights over its territories since 1941. The territories cover 18 654 hectares, 46% of which has been set aside as forest lands.

One of the tree species in the production chain is tzalam (*Lysiloma* spp.), which produces timber of exceptional quality and is highly marketable. The species is found in Mexico, Central America and the Caribbean and is closely associated with the pre-Hispanic Mayan culture. Some important facts about this timber species, according to Silva (2006), are as follows:

- **Characteristics:** yellowish cream-coloured sapwood, clearly distinct from the colour of the heartwood, which is light-to-dark brown (with a "copper" or purple tinge); slightly distinct or lacking growth rings; a subtle to marked grain pattern, and occasionally no visible grain; and medium texture and moderate lustre; no distinctive odour or taste (dry wood).

Figure 1: Involvement of ejido community members in the production of tzalam



- **Natural durability:** highly durable wood that is resistant to fungal and insect attack (but probably not resistant to marine borers).
- **Current uses:** exterior and interior construction; carpentry and fine furniture; mouldings; flooring; crafts; and wood-turned products.

One of the key qualitative findings of the case study was that community representatives have little or no knowledge of marketing and sales and very limited access to information that would allow them to identify market studies and strategies. Figure 1 shows the involvement of stakeholders in the tzalam production chain.

At the completion of the case study in the community, it was concluded that it was necessary to identify strategies for the development of their products. The most important of these are:

- **Combining strengths and opportunities:** the community should take advantage of the current world trend favouring the consumption of sustainable or "green" products certified as originating from sustainably managed forests. Product information should stress that the wood comes from a Mayan area and has "exotic charm" because of this.
- **Strengths to minimize threats:** the community should counteract the threat posed by cheaper imported timber by targeting markets that will value both the design of their products and the sustainability of the resource.
- **Addressing weaknesses through opportunities:** the community should maximize the opportunities provided by CONAFOR and by sources of finance such as the Agricultural Trust Funds (*Fideicomisos Instituidos en Relación con la Agricultura*—FIRA) to obtain financial resources for the marketing of its products, particularly the development and promotion of a recognized brand name associated with sustainability principles and the Mayan culture and heritage.

Step 2: Product design

The starting point for product design was an exercise carried out by undergraduate industrial design students, which involved the following steps: study of wood properties in cooperation with CUCBA; analysis of existing products in the market; awareness-raising among the communities through CONAFOR; the production of design drafts; feedback on proposed designs; and proposed design prototypes. Figure 2 presents this process diagrammatically.

Figure 2: The process of product design

Product designs were based on the physical properties of the wood, including strength, attractiveness (e.g. colour) and durability, as well as emotional perception characteristics. The aim was to make the products fun, original and of perceived high quality.

One of the key findings of the design process was that although the actual hardness of the wood is an attribute that facilitates the production of high-strength products that can even be used outdoors, it also poses one of the main challenges in generating products that can be replicated by the community because of the difficulty in working the wood without highly specialized tools. As a result, several designs had straight-lined patterns and rectangular shapes.

The project team attended the 2014 Forest Expo in Guadalajara, where the excellent finish and attractiveness of the wood products were highlighted. Many Expo participants were interested in purchasing products and were given information about the community.

The following ten products were selected for a pilot market appreciation trial:

- Product 1, "auditum"—a loudspeaker that amplifies sounds generated by cellular phones through the excellent acoustics of timber.
- Product 2, "lucem"—a straight-lined pendant lamp made of a combination of wood and colorful threads.

- Product 3—woman's wooden necklace.
- Product 4, "salvum"—a rack for storing wine bottles and glasses.
- Product 5, "fructus"—a fruit bowl with multiple internal compartments.
- Product 6, mosquito trap—a rectangular box with an insect-catching trap.
- Product 7, handbag—a hand-held accessory for women.
- Product 8, bed footboard—a decorative bedding accessory that can hold personal items when folded.
- Product 9, shelving—a modular shelving system for storing items by maximizing space and being adaptable to the needs of users.
- Product 10—a small pot that can be used to light an area through a narrow slot on the inside of the pot.

These products were subjected to a test to assess the market response to the concepts, the proposed pricing, and product characteristics to generate data for product trials and first sales.

One of the most important findings of the assessment was that it is very important for a product to project an image of sustainability, particularly in relation to the expression of the culture of a community.

Step 3: Developing marketing strategies

The identification of marketing strategies was part of the pilot design plan, which seeks to generate information for the development of new products with a greater level of detail.

Product definition starts with the identification of ten tzalam wood products based on a design brief. Subsequently, five features of each product that will make the customer "fall in love" with the product are identified. More than the product itself, the important feature to highlight about these designs is the experience of buying a product made of tzalam wood of Mayan origin that has been produced through a responsible process that respects both the sustainability of the forest resource and the local culture.

The first phase of the marketing strategy is the showcasing of the products created by the industrial design students in souvenir markets in the Quintana Roo tourist area. Later, these products could be introduced into first-world markets with higher cultural interest and greater purchasing power.

Once the products and their markets have been identified, a price needs to be established for each product. The suggested pricing strategy is to determine the customers' perceived value of each product; therefore the perceived quality reflected by the designs is very important.

Due to the significant investment required for a mass media promotional campaign, product promotion is expected to be based on the "slow-skimming" strategy, which involves setting high prices with low levels of promotion.

Lessons learned from the project by the university community

- It is essential to understand the experience and vision of the target communities so as to ensure that product design becomes a way of representing their culture. It is also important for the products to be distinctive and attractive to potential users—so focusing on the design of personal-use items is recommended.
- It is possible to combine elements of good design, customer satisfaction and the use of sustainable resources.
- It is important to not only explore potential markets, but also to incorporate the expertise of local craftspeople.

Lessons learned from the project by the forest community

- The project led to the realization in the forest community that markets exist that value original products (as opposed to the copies that are currently produced) that reflect the local culture and which are made using timber produced in a responsible manner.
- There are market niches that not only value physical timber products but also the experience of possessing original articles created from an "exotic" timber with the participation of a rural community.
- Community leaders have realized that there are opportunities to improve their quality of life through the innovative use of their timber resources.

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ITTO fellowship applications for the 2016 spring cycle

ITTO offers fellowships to promote human resource development and strengthen professional tropical forestry and related expertise in member countries. The next deadline for applications is 22 February 2016 for proposed activities starting after 15 July 2016. To apply online, visit www.itto.int/feature20/#FellowApp (online applications open from 1 January 2016), or contact Fellowship Coordinator Ms Kumiko Tanaka at tanaka@itto.int or at fellow-application@itto.int.

Market trends

Plywood manufacturers get respite, but will they keep beating against the current, or diversify?

Plywood manufacturers relying on exports to sustain profitability can breathe a sigh of relief as demand in traditional markets steadily improves. Growth in the United States (US) economy is on a sound footing, and although concerns linger about the European Union (EU), overall prospects are brighter. The driving force of demand for plywood in both the US and the EU is the housing and construction market, and improvements on this front are visible.

Demand in traditional markets plummeted during the global financial crisis, and plywood companies survived by cutting back on production and relying on domestic sales.

How things have changed. Domestic demand is falling in many of the tropical plywood-producing countries, mirroring overall weaknesses in their economies. Plywood exporters would be in serious trouble if it were not for the up-turn in international markets, but even that good news must be tempered, with falling exchange rates reducing the benefit. From Brazil to Indonesia, currencies have weakened against the US dollar. A strong dollar is good for exports, but the weakness of domestic currencies in plywood-exporting countries has pushed production costs up, all but wiping out the gains from the stronger dollar.

See-sawing demand is not good for profits; plywood exporters need to "look outside the envelope" to capture the economies of undisrupted production and sales. This means a change of mindset to embrace market diversification.

More of the same—prospects improving

Euroconstruct declares "break in the recession trend"

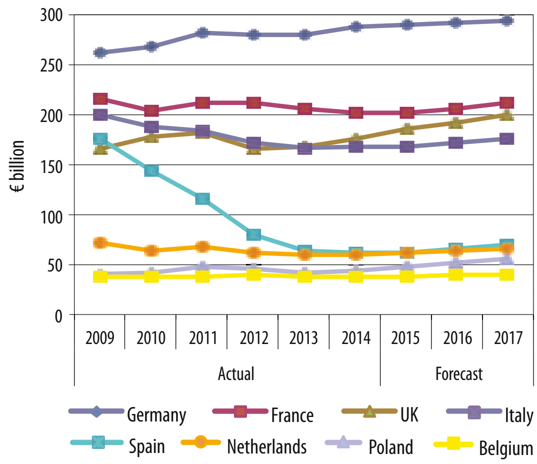
Euroconstruct has reported that the European construction industry is starting to grow after several years of decline. In its latest half-yearly report (June 2015), the agency revised up its forecasts for 2015 and 2016 and signalled positive expectations for 2017.

Construction output in the EU is now expected to grow by 1.9% in 2015, slightly faster than the 1.8% growth rate forecast in last year's report. For 2016, Euroconstruct now forecasts that construction output will rise by 2.5%, a sharp upward revision on the projections made in 2014.

Growth is forecast in all main segments of the construction market, with the highest growth expected in civil engineering, driven by infrastructure projects in central and eastern Europe. But growth in residential construction—a major market for wood products—is expected to remain slow, at only 1.7% in 2015.

Of Europe's largest construction markets, the UK is showing the strongest upward trend. Recovery in France, Italy, the Netherlands and Spain is also forecast to continue, and construction in Germany, which emerged from recession earlier than other European countries, is forecast to stabilize at a relatively high level (Figure 1).

Figure 1: Euroconstruct estimates of construction value in selected EU member states, 2009–2017



Source: ITTO Independent Market Monitoring analysis of Euroconstruct data.

US housing market recovering

The strongest sign that the US housing market is recovering is the price of plywood, which has been driven higher by firm demand from house builders and by tight domestic availability. Many mills cut back production capacity in the recession and are now scrambling to ramp up output.

US housing starts were lower than expected in February and March this year but started to gain momentum at the beginning of the second quarter. As of April 2015, annualized starts stood at 1.135 million, a 20% improvement over March. Single-family housing starts grew by 17%, while multi-family construction increased by 27%.

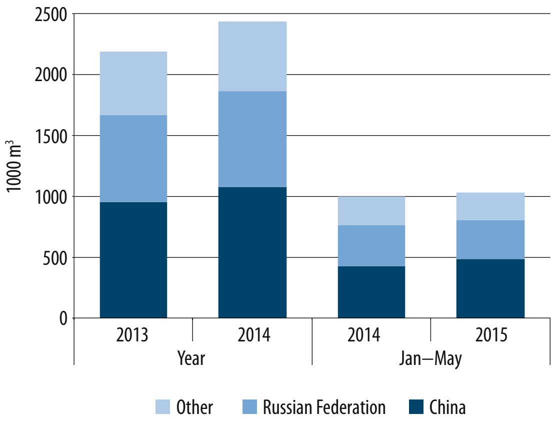
Home construction increased in 2015 to April in all regions of the US except the South. The value of building permits issued increased by 10% in April, to US$1.143 million, indicating good prospects for the second half of the year.

Growth in US non-residential construction appears to have accelerated. Investment in non-residential construction increased by 3% in April, and the US Census Bureau revised up its forecast for investment in non-residential construction.

US homeowner spending on remodelling grew by 5% towards the end of 2014, but growth in this market will slow in 2015, according to Harvard University's Joint Center for Housing Studies. Spending on remodelling has declined in recent months after a strong start to 2015, with the recent slowdown in home sales (as opposed to starts) having a negative effect on home renovation, repair and other remodelling. Second-hand homes sales are the largest driver of remodelling because new owners tend to purchase new flooring and kitchen cabinets or build extensions and outdoor features.

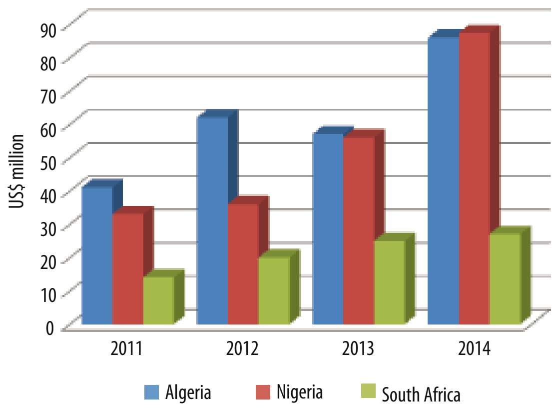
Oriented strandboard (OSB) is benefiting in both the EU and US markets from the rise in plywood prices and the shortage of plywood supply. In the EU, OSB has gained ground in both the residential and non-residential markets as a substitute for plywood from Brazil, Chile and the Russian Federation.

Figure 2: EU28 imports of hardwood plywood, by major supply country



Source: Forest Industries Intelligence analysis of Eurostat.

Figure 3: Plywood imports in Algeria, Nigeria and South Africa, 2011–2014



Source: ITTO analysis of COMTRADE.

In the US, OSB has a cost advantage over plywood; OSB is set to gain market share as plywood prices rise further, especially for lower-value end uses.

Hardwood-faced plywood is encountering competition from substitutes such as plastics, medium-density fibreboard and particleboard, but the toughest competition is between the various hardwood plywood sources.

Growth in EU hardwood plywood imports slackens

The EU imported 103.1 million m³ of hardwood plywood in the first five months of 2015, 3.3% more than in the same period in 2014 (Figure 2). Import growth has slowed to date in 2015, however—in 2014 there was an overall increase in imports of 11.1%.

The increase in EU hardwood plywood imports between January and May this year was due almost entirely to higher deliveries of mixed light hardwood (MLH) plywood from China. Hardwood plywood imports from China—now dominated by MLH products—increased by 13.6% in the first five months of 2015, to 482 400 m³.

Lower US hardwood plywood imports

US imports of hardwood plywood grew by 12%, month-on-month, in May 2015, to 242 177 m³, according to data from the US Census Bureau; year-to-May imports were 5% lower than in the same period in 2014, however. The US imported 147 813 m³ of hardwood plywood from China in May, up by 15% compared with May 2014.

The largest decline in hardwood plywood imports was from Indonesia and Malaysia; for example, shipments of Indonesian hardwood plywood to the US fell by 22%, to 22 796 m³.

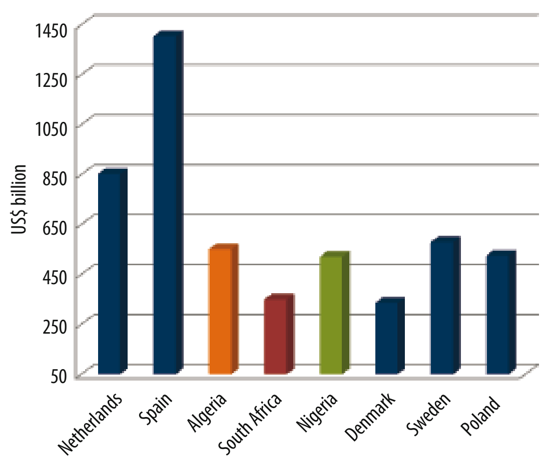
The challenge of market diversification

When markets become too crowded and alternatives and substitutes begin to gain market share, it is time to consider diversification—of either product lines or markets. If markets, what are the options? A new ITTO project (700/13 Rev. 2 (I) "Development of intra-African trade and further processing in tropical timber and timber products – Phase 1, Stage 1") will open a window on potential markets in Africa.

According to the International Monetary Fund's 2014 World Economic Outlook, six of the ten fastest-growing economies globally in the last five years are in Africa, and this number is set to rise to seven. Overall, African economies are expected to grow by almost 6% in 2015, with sub-Saharan countries expected to post growth of more than 6%.

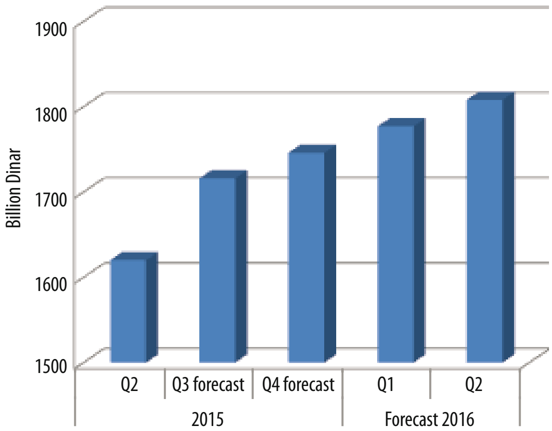
Many African economies have blossomed in recent years because of balanced demographic growth, rapid urbanization, sharp rises in gross domestic product, and the emergence of a large and expanding middle class. These changes have brought about rapid increases in domestic demand for wood products, a demand that cannot be met locally; imports, therefore, are rising. In the period 2011–2014, plywood imports grew by 165% in Nigeria, 110% in Algeria and 93% in South Africa (Figure 3). These three countries provide opportunities for market diversification, as discussed below.

Figure 4: Gross domestic product, selected countries, 2014



Source: ITTO analysis of Trading Economics data.

Figure 5: Algeria's construction output



Source: ITTO analysis of Trading Economics data.

As big or bigger than some EU economies

The pace of economic growth in Algeria, Nigeria and South Africa has lifted gross domestic product (GDP) to levels that are comparable with some EU member states (Figure 4); for example, Nigeria's GDP is now comparable with that of Sweden (albeit with a population that is 17 times larger). Growth in GDP and the construction sector underpin the strength of plywood imports.

Nigeria

In 2014, the Nigerian government re-based its GDP for the period 1990–2010; in so doing it became clear that Nigeria had the largest sub-Saharan African economy, overtaking South Africa.

Nigeria has a highly diversified economy, and continued growth in non-oil sectors will result in substantial growth in investment in construction (albeit after a forecast slowdown in 2016). Nigeria's huge housing deficit is being addressed, and the housing sector is forecast to grow at around 10% per year for many years to come. The construction industry is growing fast, and this growth will continue for the next decade, according to Oxford Economics in its report *Global construction perspectives*. The pace of growth is greater than in India; Nigeria (with its population of more than 170 million) is urbanizing quickly, and construction output is likely to contribute significantly more to GDP in the future.

Algeria

Algeria has maintained economic stability amid political upheavals in other North African countries, although the World Bank identifies several challenges for the economy, such as reducing subsidies, improving the business environment, diversifying the economy and creating more private-sector jobs.

The Algerian economy expanded by 4% in 2014, driven mainly by the recovering oil and gas sector, and GDP growth is forecast at 3.9% in 2015 and 4% in 2016. North African countries import large quantities of wood products to support the development of infrastructure, and this is particularly true of Algeria. It has been estimated that Algeria's construction market was worth around US$14 billion in 2012.

With an expanding and young population and a high rate of urbanization, the housing deficit has been a major issue for the government for many years. Analysts at Oxford Economics put the current housing gap at around 1.2 million homes. The Algerian construction output is expected to continue to increase for the foreseeable future (Figure 5).

South Africa

South Africa's economic growth slowed in 2014, with GDP increasing by 1.5%, its weakest performance since the global financial crisis. Nevertheless, improvements in the global economy, the successful completion of major government projects, and new investments have encouraged analysts to forecast a rebound in growth to 2.0% in 2015.

The construction sector in South Africa is a major contributor to the overall economy and a significant provider of employment. The sector has been unable to maintain the growth seen in the build-up to the Football World Cup in 2010. Nevertheless, the government's new National Infrastructure Plan, in which housing is a main feature, is expected to boost the construction sector.

Prospects for the EU and US markets remain uncertain

While plywood importers were generally satisfied with the market situation in central and northern Europe in the first half of 2015, uncertainty remains. There is particular concern about the French market, which has disappointed again in recent months. But other markets have also been slow to gather momentum this year.

In the short term, prospects in the US hinge on the likely rise in interest rates and how this will affect the building sector in particular. The currency upheaval in August 2015, the result of the devaluation of the yuan, is still reverberating around the world, adding a new level of uncertainty to markets for wood products.

But there are new opportunities

So how enticing are the new markets? Certainly, there are risks associated with them, and new marketing approaches will be needed. Nevertheless, African countries could be appropriate targets for exporters seeking to diversify and to escape the shackles of old-world markets.

Confident exporters have an opportunity to create demand and to build partnerships in African markets—and perhaps, in the process, to find a way of smoothing out the cyclical and regular disruptions they are experiencing in traditional markets.

Topical and tropical

Compiled by Ken Sato

ITTO project to promote SFM through REDD+ in Cambodia

An ITTO project launched in July will promote research, development and training in carbon stock assessment to improve the management of tropical forests in Cambodia under REDD+ mechanisms.

REDD+ project development activities began in Cambodia in 2008, and these initiatives continue to influence the national framework for sustainable forestry. The collective experiences gained through REDD+ initiatives show the importance of standardizing procedures to meet carbon standards and to ensure that REDD+ projects are developed and implemented effectively. ITTO Executive Director, Emmanuel Ze Meka, the Minister of Agriculture, Forestry and Fisheries of the Royal Government of Cambodia, Dr Ouk Rabun, and the Head of the Cambodian Forestry Administration, Dr Chheng Kimsun, launched ITTO project "SFM management through REDD+ mechanisms in Kampong Thom province, Cambodia" [PD 740/14 Rev.2 (F)] on 23 July 2015 in Phnom Penh, Cambodia. The aim of the project is to strengthen the institutionalization of REDD+ activities to reduce deforestation and forest degradation in the Tomring forest in the country's second-largest province, Kampong Thom.

Read more about the project at: http://goo.gl/f37Mk8.

Norway and Switzerland take action to regulate timber imports

Although not a member of the European Union (EU), Norway has decided to implement the EU Timber Regulation (EUTR), with effect from 1 May 2015. Switzerland—also not an EU member—plans to introduce a regulation equivalent to the EUTR by early 2016.

Read more at: www.ihb.de/wood/news/Norway_Switzerland_EUTR_illegal_logging_43549.html.

Recently approved regulations in Peru enable indigenous participation in forest management

According to the Peruvian newspaper *El Comercio*, the Peruvian government approved regulations in late September on the enforcement of the Forestry and Wildlife Law No. 29763. This law recognizes the role of indigenous and peasant communities by enabling their participation in the board of the National Forest and Wildlife Service.

The rules were issued after four years of consensus-building with citizens and indigenous peoples. The approved regulations pertain to forest management, wildlife management, forest and wildlife management in "peasant" and native communities, and the management of forest plantations and agroforestry systems.

Read more (in Spanish) at: http://elcomercio.pe/peru/pais/promulgan-4-reglamentos-ley-forestal-y-fauna-silvestre-noticia-1844767.

Selectively logged Amazon forests recover their carbon stock in 20 years

Selectively logged Amazonian forests can recover their carbon stocks within about 20 years, according to a study published in *Current Biology* in September. The study, which involved the measurement of 79 permanent sample plots covering 376 hectares of forest at ten sites across the Amazon Basin, assessed the time taken for selectively logged forest to recapture an amount of carbon equivalent to that emitted by logging. The study estimated a recovery time of 7–21 years under current logging intensities (10–30 m^3 per hectare); it also found that the time taken to recover carbon stocks did not vary significantly across the Amazon Basin, despite the well-known northeast–southwest environmental gradient. The study is a first step towards setting a threshold for the production of timber and the maintenance of key environmental services such as carbon storage. It provides the first convincing evidence that carefully managed Amazonian tropical forests can produce timber and recover their above-ground carbon stocks within a cutting cycle of 20–30 years and thus play a key role in global carbon sequestration.

Read the full press release from CIRAD at: www.cirad.fr/en/news/all-news-items/press-releases/2015/climate-amazon-forests-recover-their-carbon-stock-in-20-years.

Yunnan/Myanmar border closed to timber

Chinese authorities have announced that timber imports from Myanmar to China's Yunnan Province have been suspended until 2016 to enable a "reorganization" of procedures for controlling timber imports passing across the border there.

Read more at: www.itto.int/mis_detail/id=4498.

Strategic alliance between Malaysian and Guangdong timber sectors

Much of the wood raw material for manufacturers in Guangdong, China, comes from Southeast Asia, especially Malaysia. Given that demand for imported timber from manufacturers in Guangdong is expected to grow, an opportunity was seen to build on the "One Belt One Road" initiative (a development strategy and framework proposed by the Government of China that focuses on connectivity and cooperation among countries in Eurasia). The Malaysian Wood Industries Association, the Timber Exporters' Association of Malaysia and the Guangdong Timber Industry Association have concluded a wide-ranging agreement expected to lead to increased cooperation and trade.

Read more at: www.itto.int/mis_detail/id=4507.

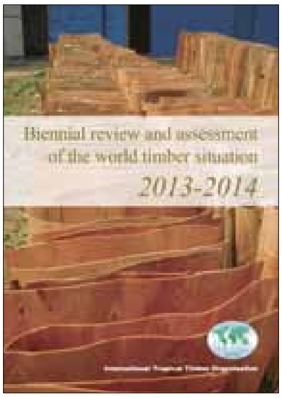
Stories on forest and farm producer organizations

Issue No. 57 (September 2015) of *ETFRN News* (the newsletter of the European Tropical Forest Research Network) features more than 200 pages of stories from local forest and farm producer organizations, associations and federations. This compilation of experiences adds significantly to a growing body of knowledge on such organizations—their challenges, opportunities, successes and failures.

Read the edition at: www.etfrn.org/publications/effective+forest+and+farm+producer+organization.

Recent editions

Compiled by Ken Sato

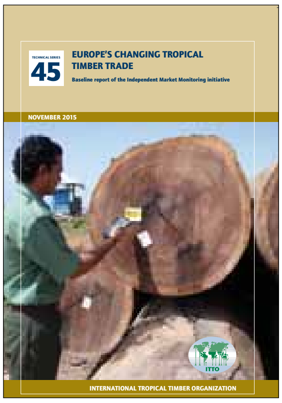


ITTO 2015. *Biennial review and assessment of the world timber situation 2013–2014.* Yokohama, Japan.

ISBN:
978-4-86507-020-0 (English)
978-4-86507-021-7 (Spanish)
978-4-86507-022-4 (French)

Available at: www.itto.int/annual_review

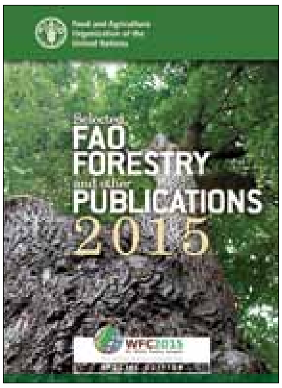
This report provides data on the production and trade of primary wood products in 82 countries in the two-year period 2013–2014. It summarizes developments in major markets for tropical timber, provides an analysis of production, consumption, trade and prices for primary tropical timber products (tropical logs, sawnwood, veneer and plywood), and describes trade in secondary processed wood products, with a focus on tropical countries.



Oliver, R. 2015. *Europe's changing tropical timber trade: baseline report of the Independent Market Monitoring initiative.* ITTO Technical Series No. 45. ITTO, Yokohama, Japan.

ISBN 978-4-86507-027-9
Available at: www.itto.int/technical_report

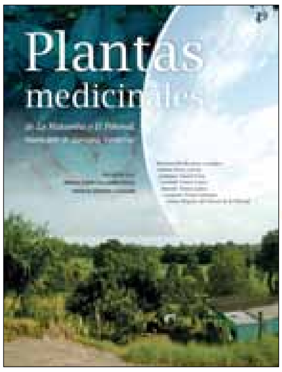
This baseline report was prepared during the inception phase of the Independent Market Monitoring (IMM) initiative on the state of European Union (EU) markets for wood products prior to the issuance of import licences under the EU's Forest Law Enforcement, Governance and Trade programme. The IMM has been established under an ITTO project to support the implementation of bilateral voluntary partnership agreements (VPAs) between the EU and participating timber-supplying countries. Recognizing that market trends in the EU and VPA partner countries are highly dependent on trade with other regions of the world, the report also puts trade flows between the EU and VPA partner countries in their global context.



FAO 2015. *Selected FAO Forestry and other publications 2015.* FAO, Rome.

Available at: www.fao.org/3/a-i4782e.pdf

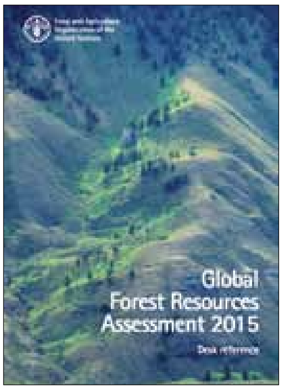
This catalogue, produced for the XIV World Forestry Congress, features over 100 titles from the Food and Agriculture Organization of the United Nations (FAO), organized under the Congress's six subthemes, to highlight FAO's work in forestry and related areas.



Pérez Utrera, E., Utrera Urea, E., Tronco López, C., Tronco López, B. & Tronco Morales, G. 2015. *Plantas medicinales de La Matamba y El Piñonal, municipio de Jamapa, Veracruz.* Compiled by B. Escamilla Pérez & P. Moreno Casasola. Instituto de Ecologia A.C. (INECOL), Veracruz, Mexico.

ISBN 978-607-7579-44-1
Available at: http://goo.gl/3IPFvM (Spanish only)

In this publication, women from the Grupo Mujeres del Vivero Piñonal in Jamapa, Veracruz, Mexico, have created a catalogue of information on 44 medicinal plants in their community, assisted by INECOL. Each plant is identified by its common and scientific name, and information is provided on medicinal uses, where the plant can be found, and additional characteristics. The manual is a significant scientific work as well as reflective of the traditions of the community. It is an output of ITTO project RED-PD 045/11: "Environmental assessment and economic valuation of ecosystem services provided by coastal forests (mangrove forests, flood forests, rainforests and scrub forests on dunes) and their agricultural replacement systems on the central coastal plain of Veracruz, Mexico".



FAO 2015. *Global forest resources assessment 2015 desk reference.* FAO, Rome.

ISBN: 978-92-5-108826-5
Available at: www.fao.org/forest-resources-assessment

This document is one of three main publications of the Global Forest Resources Assessment 2015 (FRA 2015), containing data for most of the quantitative and Boolean variables collected through FRA 2015. Presented in easy-to-consult tabular form, it is a useful companion to the synthesis report as well as to the more detailed figures available on the Forest Land Use Data Explorer website.

Meetings

26 October 2015
18th RRI Dialogue on Forests, Governance, and Climate Change
Washington DC, USA
Contact: dialogue@rightsandresources.org; www.rightsandresources.org/event/eighteenth-rri-dialogue-on-forests-governance-and-climate-change

28–31 October 2015
Eco Expo Asia
Hong Kong, China
Contact: www.ecoexpoasia.com; ecoexpo@hongkong.messefrankfurt.com

3–5 November 2015
Managing Forests to Promote Environmental Services: Climate Change Adaptation and Mitigation, Water Protection, Biodiversity Conservation, and Soil Quality Maintenance
Copenhagen, Denmark
Contact: http://ign.ku.dk/english/outreach-publications/conferences-seminars/car-es-final-conference

4–5 November 2015
Woodchem 2015
Kuala Lumpur, Malaysia
Contact: info@wiz-biz.com

5–6 November 2015
7th International Symposium of Indonesian Wood Research Society
Bandung, Indonesia
Contact: iwors2015@mapeki.org; http://mapeki.org/iwors2015/index.html

16–18 November 2015
Second INTERPOL Environmental Compliance and Enforcement Events
Singapore
Contact: environmentalcrime@interpol.int; www.interpol.int/Crime-areas/Environmental-crime/Events/Meetings/2nd-INTERPOL-Environmental-Compliance-and-Enforcement-Events

16–21 November 2015
51st Session of the International Tropical Timber Council and Associated Sessions of the Committees
Kuala Lumpur, Malaysia
Contact: Emmanuel Ze Meka, ITTO Executive Director, at itto@itto.int; www.itto.int/workshop_detail/id=4240

16–21 November 2015
3rd European Forest Week and 72nd Joint Session of the Economic Commission for Europe Committee on Forests and the Forest Industry
Engelberg, Switzerland
Contact: paolo.cravero@unece.org; http://forests-l.iisd.org/events/silva2015-and-third-european-forest-week/#more-249570

30 November–11 December 2015
21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change and 11th Session of the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol
Paris, France
Contact: www.cop21/gouv/fr/en

2–3 December 2015
Log Trade Trends: A Global Perspective
Portland, Oregon, USA
Contact: http://logtradetrends.worldforestry.org

28 January 2016
3rd Annual Western Forest Industry Conference Vancouver, Washington, USA
Contact: Richard Zabel at richard@westernforestry.org or Tim Gammell at tim@woodprices.com; http://westernforestry.org/upcoming-confereneces/mapping-the-course-2016

22–26 February 2016
Third Asia–Pacific Forestry Week
Pampanga, Philippines
Contact: Patrick.Durst@fao.org

14–18 March 2016
IUFRO Forest Genetics for Productivity
Rotorua, New Zealand
Contact: Heidi.Dungey@scionresearch.com; www.fgpc2016.nz/fgp16

11–16 April 2016
AUSTimber2016
Traralgon, Victoria
Contact: laurie@austimber.org.au; http://austimber.org.au

21–23 April 2016
PERCEPTION–PREDICTION–ACTION: Managing Risk in Uncertain Times
IUFRO 4.04.07
Istanbul, Turkey
Contact: http://riskanalysis-iufro.org//2016Meeting_Announcement.pdf

25–29 April 2016
IUFRO All-Division 7 Conference: Global Change and Forest Health—Climate Change, Biological Invasions, Air Pollution, Forest Pathology, Forest Entomology, and Their Interactions
Istanbul, Turkey
Contact: eckehard.brockerhoff@scionresearch.com

16–19 May 2016
Gene Conservation of Tree Species: Banking on the Future
Chicago, Illinois, USA
Contact: www.fs.fed.us/about-agency/gene-conservation-workshop

15–19 August 2016
15th International Peat Congress
Kuching, Sarawak, Malaysia
Contact: peat2016@gmail.com; www.ipc2016.com

30 May–3 June 2016
IUFRO Genomics and Forest Tree Genetics Conference
Arcachon, France
Contact: https://colloque.inra.fr/iufro2016

2–4 June 2016
1st International Symposium of Forest Engineering and Technologies: Forest Harvesting and Roading in Environmentally Sensitive Areas
Bursa, Turkey
Contact: http://fetec2016.btu.edu.tr/index.php

11–15 July 2016
4th International Conference on Soil Bio- and Eco-engineering: The Use of Vegetation to Improve Slope Stability
Sydney, Australia
Contact: http://sydney.edu.au/science/geosciences/soil/index.shtml

1-10 September 2016
IUCN World Conservation Congress
Hawaii, USA
http://www.iucnworldconservation-congress.org/

24 September–5 October 2016
17th Meeting of the Conference of the Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora
Johannesburg, South Africa
Contact: www.cites.org

12–14 October 2016
Mexico's Forestry Expo
Guadalajara, Mexico
Contact: expoforestal@conafor.gob.mx; www.expoforestal.gob.mx

4-17 December 2016
Thirteenth meeting of the Conference of the Parties to the Convention on Biological Diversity
Cancun, Mexico
https://www.cbd.int/meetings/