Chapter 3
Quantifying Illegal Logging and Related Timber Trade

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CONTENTS

3.1. Introduction

Understanding the magnitude of illegal logging and related timber trade as well as illegal trade flows is critical to addressing the problem. This chapter provides an overview of the estimates of illegal logging and related international timber trade, as well as providing a summary and comparison of estimation methods. Major legal and illegal international timber trade flows are portrayed along with domestic, regional and global wood products markets, and supply chains representing key agents in producer, processing and consumer countries. The chapter also presents financial flows associated with illegal logging and timber trade. Finally, data gaps are identified, and new developments in illegal logging and timber trade are discussed along with possible solutions.

3.2 Species, Markets and Trade Patterns of Wood Products

3.2.1 Species Rarity, Value and Illegality

Illegal logging and related timber trade affects many timber species, but highly valuable - often rare and endangered - species that are protected under harvest and/or trade regulations are a key target.

Economic theory indicates that the marginal cost of a natural resource will increase as its stock decreases. Thus, if the price (marginal benefit) of the good remains relatively stable or increases at a lower rate than its marginal cost, at some point (as the stock declines) the marginal cost will be higher than the price, preserving the resource from depletion (Clark, 1990). While this is still true for some species, for some rare species, their rarity will drive their prices up more than their marginal costs, potentially leading to their depletion, which is called the "anthropogenic Allee effect" (Courchamp et al., 2006).

This phenomenon coupled with illegal activities can create a vicious cycle among value, rarity (scarcity) and illegality (see Figure 3.1). Many rare and endangered tree species have higher economic values than others because of their unique physical and chemical properties (e.g. colour, texture, odour and hardness of the wood) and cultural values, and these values are positively related to rarity/scarcity. The higher value generates higher incentives for illegal commercial harvesting and trade. Increased logging and trade in turn enhances the rarity/scarcity of the species, intensifying their threatened status and even driving them to extinction.

Among the rare and endangered species targeted by illegal logging and timber trade are mahogany (genus Swietenia), rosewood (genus Dalbergia) and ebony wood (genus Diospyros) (Huang and Sun, 2013; TRAFFIC, 2012; Youatt and Cmar, 2009). For each of these genera, there are many species. These wood species are generally used in niche markets of high-value products such as parquets, boats, furniture, musical instruments and other items, and actively traded in domestic and global markets (TRAFFIC, 2012). Because of their threatened status, some species have been put under the protection of international conventions, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2016), and on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2016).

3.2.2 Domestic, Regional and Global Wood Products Markets and Supply Chains
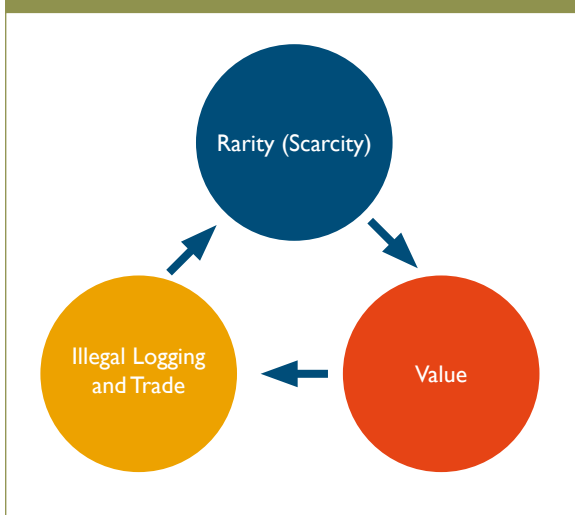
There are multiple market layers for wood products. In terms of geographic scope, there are domestic (local and national), regional and global markets. Additionally, there are legal and illegal markets as well as formal and informal markets (see Chapter 2 for more details on these definitions). These different layers and types of markets are interlinked, constituting a complex web of timber production, trade and markets.

Figure 3.2 illustrates the interlinkages between the domestic, regional and global markets of legal and illegal wood products. This simplified web consists of two producer countries (one producing legal timber and the other producing both legal and illegal timber), one processing country and one consumer country. Each country in the web has its own domestic market that is further connected to the regional and global markets. The entire web represents the global network of wood products markets. A more complex global web of wood products markets comprises multiple producer, processing and consumer countries.

Timber supply to domestic markets in many tropical forest countries is largely provided by informal logging/milling, namely chainsaw milling (Box 3.1). Although chainsaw milling in some countries is allowed under certain conditions, it is illegal in most tropical countries (Wit et al., 2010). Chainsaw milling does not require sophisticated and expensive equipment. As a result, its cost is relatively low, thus meeting the needs for providing cheap timber to the domestic markets. Its barriers to entry are also low. Hence, although individual chainsaw milling
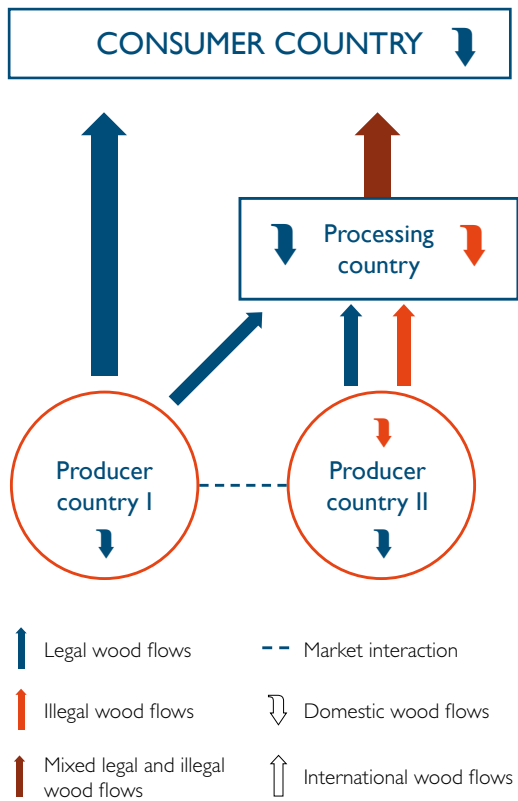

Figure 3.1

Vicious cycle among value, rarity and illegality

Figure 3.2

Interlinkages between domestic, regional and global wood products markets

operations are small scale their aggregate production level can be substantial (Bayol et al., 2013), creating difficulty for monitoring and controlling.

Regional and global markets involve producer, pass-through, processing and consumer countries. Large and well-connected operators are often the key players in these markets although small operators of informal logging/milling are also involved (Kishor and Lescuyer, 2012). Regional markets particularly involve neighbouring or adjacent countries. A neighbouring country could be a "pass-through", processing or consumer country. A "pass-through" country can play various roles in timber trade and laundering. Some pass-through countries may not engage in timber processing while some others may. They transit timber from the original producer country to the next country in the regional or global supply chain, and in some cases they re-export the timber back to the original producer country (Nellemann and INTERPOL Environmental Crime Programme, 2012).

The supply chains of wood products differ across different market types and layers. From domestic to global markets, the complexity of supply chains increases. In general, the key players of domestic, regional and global supply chains all include loggers, transporters, traders, financers and buyers. However, the characteristics of these players may differ across these supply chains.

The supply chains for domestic markets are relatively simple with key players generally being locally- or domestically-orientated. Timber transport to domestic markets is of shorter distance with fewer barriers to market access compared to regional or global markets. Thus, there are few

Box 3.1

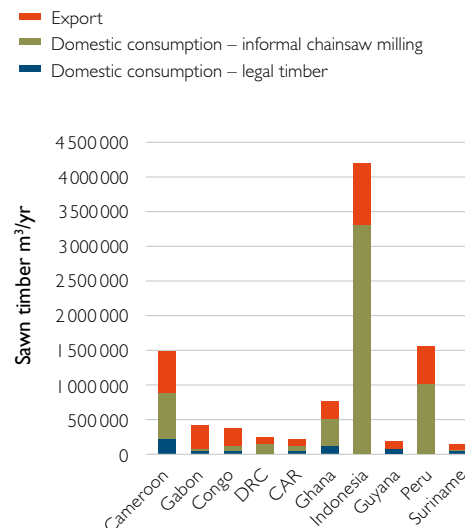**Timber supplies to domestic and export markets by informal logging in selected tropical countries**

Informal or chainsaw logging is widely used in tropical forest countries while it is often not in full compliance with regulations. It constitutes 30-40 percent of total timber production in Guyana, Republic of Congo, Democratic Republic of the Congo (DRC) and Uganda; over 50 percent in Ghana, Cameroon and Peru; and almost 100 percent in Liberia (Wit et al., 2010).

Most of the timber produced by the informal sector is consumed in domestic markets (Figure 3.3). Yet, informal logging also contributes to timber supply in regional and global markets, though to a lesser extent (Kishor and Lescuyer, 2012; Wit et al., 2010). The export share of timber produced from informal logging may vary across countries and over time and be affected by domestic, regional and global market conditions and policy. In Cameroon, 92 percent of timber produced from informal logging was consumed domestically in 2009 (Cerutti and Lescuyer, 2011). In the DRC, timber from informal logging was 13 times more than that produced in the formal sector, and only 15 percent of timber produced in the informal sector was exported in 2012 (Lescuyer et al., 2014).

Figure 3.3

Timber supplies to domestic and export markets in selected tropical countries

Source: Kishor and Lescuyer, 2012

39

middlemen along domestic timber supply chains. However, given the large size of some domestic markets, many operators can be involved, as well as state officials collecting bribes all along the supply chain (Cerutti et al., 2013).

The complexity of regional supply chains varies depending upon the nature, scope and structure of the regional markets (Forest Trends, 2010; Schloenhardt, 2008). The existence of a regional market is often due to the differences in forest resource endowments and wood processing capacity across the countries in the region as well as their historical, economic, cultural and political ties (Schloenhardt, 2008). Geographic proximity also facilitates the forming of a regional market as it reduces transport costs and the risk associated with illegal activities (e.g. border crossing) (Forest Trends, 2010).

The global supply chains of illegal wood products are the most complex. Unlike the players of domestic (and some regional) supply chains, the players of the global supply chains are often large and more sophisticated operators, who have more resources and means to facilitate illegal production and cross-border trade (Kishor and Lescuyer, 2012). Timber laundering can take place in multiple stages along a complex global supply chain, making it difficult and costly to monitor illegality (Nellemann and INTERPOL Environmental Crime Programme, 2012).

3.2.3 Global Trade Patterns of Wood Products

The annual average value of international trade of overall wood products (primary and secondary wood products including roundwood, sawnwood/lumber, and pulp and paper pr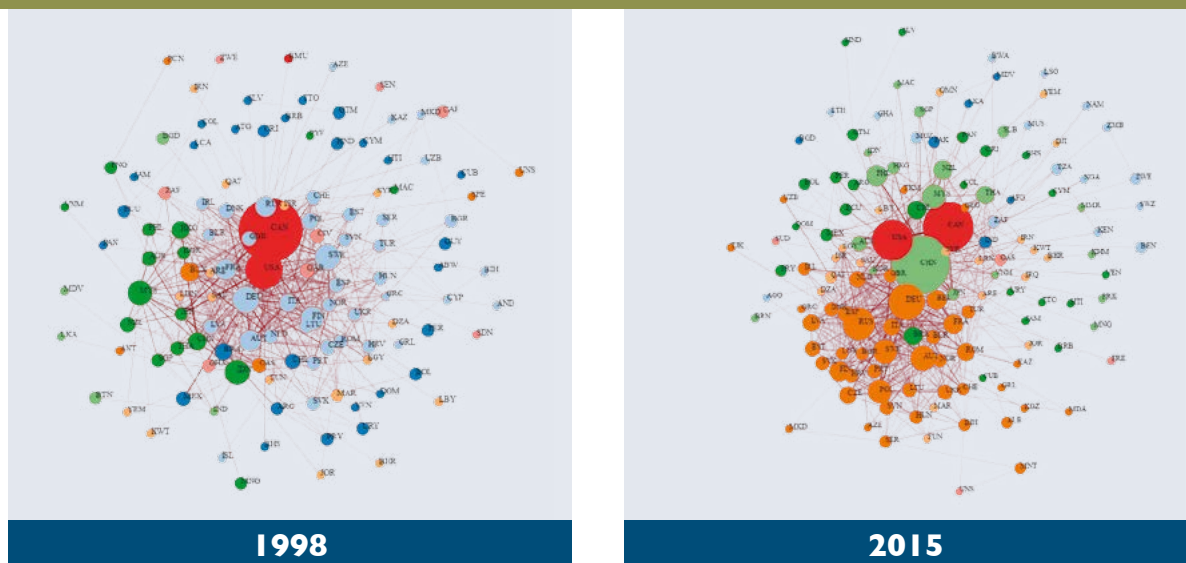oducts but excluding furniture) amounted to USD 360 billion during 2012-2014, of which approximately USD 20 billion was roundwood and USD 36 billion sawnwood (DESA/UNSD United Nations Comtrade Database, 2016). Historically, bilateral trade of wood products took place primarily between producer and consumer countries in the developed world and between consumer countries in the developed world and tropical timber producer countries. As China has become the global processing hub of wood products and the demand for wood products in emerging economies has increased, this trade pattern has changed dramatically (Figure 3.4). China now is the world's largest importer and exporter of wood products (DESA/UNSD, United Nations Comtrade database, 2016). Although wood products trade among developed countries remains an essential part of total global wood products trade, trade with China and other emerging economies has become increasingly important in overall wood products trade in general and illegal timber trade in particular.

The magnitude of global wood products trade has risen over time (DESA/UNSD, United Nations Comtrade database, 2016) due to income growth, population expansion and globalization, among other factors. For example, from 2000 to 2014, total global trade of primary wood products (roundwood, sawnwood, plywood and veneers) increased by 41 percent in quantity and doubled in value. The growth trend, however, was not monotonic: all four commodity groups showed a decrease in 2008-2009 as a result of the global financial crisis (see Figure 3.5).

Global illegal timber trade patterns differ from global overall timber trade patterns. Illegal timber trade has been primarily associated with tropical hardwood; only in recent years has Russia, especially its Far East region, become a

Figure 3.4

Global trade network of overall wood products from the supplier's point of view *(with node size proportional to export market share and node colour representing geographic regions; the country codes are presented in Appendix 3.2)*

1998

2015

Source: WITS, 2016

significant source of illegal non-tropical timber. Most of the tropical hardwood trade at high risk of illegality has taken place in route from countries where the rapid growth in overall hardwood trade has occurred (Hoare, 2015a; Nellemann and INTERPOL Environmental Crime Programme, 2012).

3.2.4 Major Producers and Importers of Tropical Timber

Illegal logging is widespread across all tropical forest regions. Yet, Brazil, Indonesia and Malaysia remain the three dominant suppliers of legal and illegal tropical timber (see

Trends in international trade of primary wood products

Figure **3.5**

i) Value (million USD)   ii) Quantity (1,000 tonnes)

a. Roundwood

b. Sawnwood

c. Veneer

d. Plywood

hardwood — softwood — - - total

Source: own elaboration with data from DESA/UNSD, United Nations Comtrade database

Estimated production of legal and illegal timber by selected tropical countries, 2013 — Figure 3.6

Source: Adapted from Hoare, 2015a with modification

Tropical roundwood imports by selected countries — Figure 3.7

i) Value (million USD)

ii) Quantity (1,000 tonnes)

■USA ■China ■EU-28 ■India ■Australia □total

Source: own elaboration with data from DESA/UNSD, United Nations Comtrade database

Figure 3.6) despite a decrease in the extent of illegal logging in recent years. Indonesia, Brazil and Malaysia respectively supplied 50, 25 and 10 percent of total estimated illegal tropical timber in 2013 in the nine countries reported by Hoare (2015a) although other producer countries may have higher percentages of illegality.
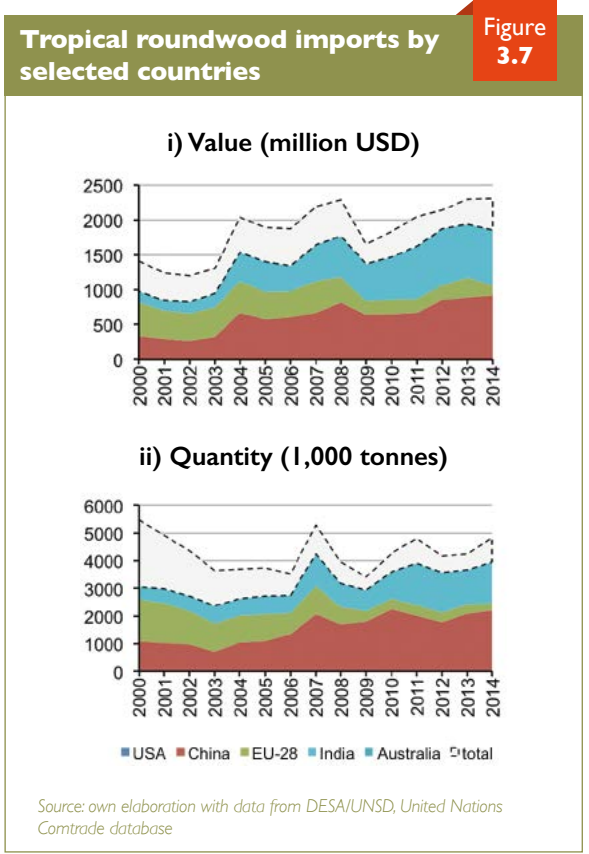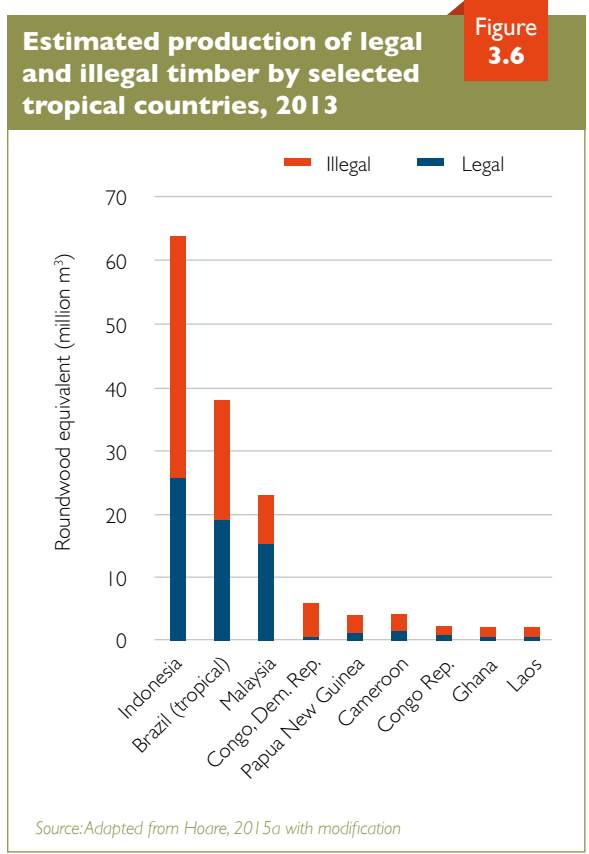
Traditionally, the EU, the US and Japan were the major importers of tropical wood products. In recent years, China and India have surpassed them to become the two main global importers of tropical roundwood, together covering 72 percent of global tropical log imports in 2014 compared to 28 percent in 2000 (see Figure 3.7), while Japan remains the largest importer of tropical hardwood plywood (DESA/UNSD, United Nations Comtrade database, 2016).

Approximately 70 and 67 percent of the tropical roundwood exported, respectively, from Africa and Southeast Asia were destined to China and India in 2014 (see Figure 3.8). In 2000 these figures were 25 percent from Africa and 34 percent from Southeast Asia. The increased imports of tropical roundwood by China and India are attributable to at least three reasons. First, rapid economic growth in China and India increased their domestic demand for wood products in general, and tropical wood products in particular, partly because of the cultural values associated with some tropical timber species (Huang and Sun, 2013). Second, as an export-orientated economy, China converts primary wood products into secondary wood products (including furniture) for exports. Given its limited available domestic forest resources (timber in particular) and logging ban in place on natural forests, China has to depend upon imported wood materials to produce secondary products for
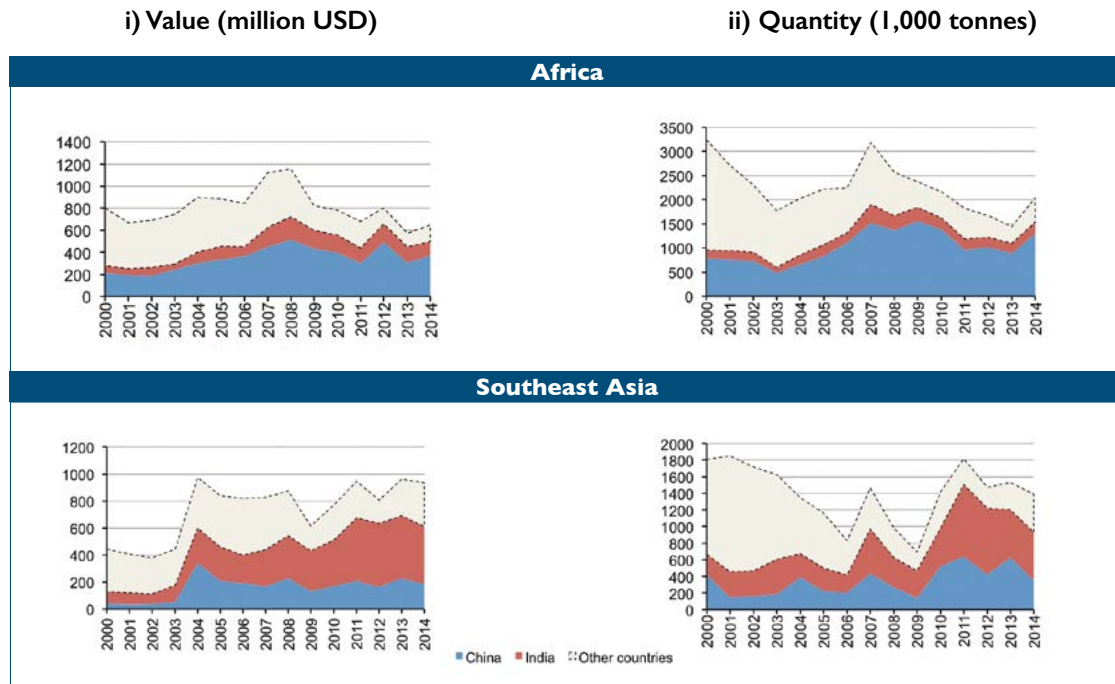
exports (Zhang and Gan, 2007). Third, traders may prefer exporting timber to markets characterized by less stringent regulatory frameworks (e.g. China and India) since legality requirements set by other market destinations (e.g. the EU and the US) are often associated with extra costs necessary to provide certification and/or required documentation (Giurca et al., 2013).

3.2.5 Financial Flows Associated with Illegal Logging and Related Timber Trade

Financial flows follow the opposite direction of timber or wood product flows. International transactions associated with illegal timber trade are often in large volume and involve banks in consumer, pass-through, processing and producer countries. Because of large volumes and the well-developed banking systems in consumer and processing countries, it is relatively easy to trace money flows associated with illegal trade. On the other hand, the money flows in producer countries are more informal and in small volume, and the banking systems in most tropical timber producer countries are poorly developed. Although the volume of transactions is small, the number of transactions is large, making it difficult to trace the money flows in tropical timber producer countries (Kishor and Lescuyer, 2012).

The distribution of benefits from illegal logging and related timber trade is highly skewed (see Box 3.2). Most benefits associated with international illegal timber trade accrue to middlemen -processors, traders and financers - in the producer, pass-through, processing and consumer countries, (particularly those in the pass-through and processing

Figure 3.8

Tropical roundwood imports by China and India from Africa and Southeast Asia

i) Value (million USD)   ii) Quantity (1,000 tonnes)

Source: own elaboration with data from DESA/UNSD, United Nations Comtrade database

countries). As to the portion of timber revenues left in the local communities of producer countries, most of it goes to a few local "elites." Local loggers receive only minimal compensation although it is usually higher than the income that they would otherwise obtain (Kishor and Lescuyer, 2012). Hence, local loggers also have incentives to engage in illegal logging.

While the actors associated with illegal logging and timber trade gain from their illegal activities, such activities are also reported to cause annual losses in the order of billions of US dollars in assets, revenues, taxes and royalties (World Bank, 2006; Nellemann and INTERPOL Environmental Crime Programme, 2012). Moreover, revenues from illegal timber trade have been used to finance corruption and other illegal activities. In some African and Southeast Asian countries (e.g. Liberia, DRC, Sierra Leone, Cambodia and Myanmar), revenues from illegal timber trade were a major financial source for wars and conflicts (Seneca Creek Associates and Wood Resources International, 2004).

3.3 Existing Estimates on Illegal Logging and Related Timber Trade

3.3.1 Estimation Methods

By their very nature, statistics on illegal forest activities are difficult to find, therefore, indirect methods are used to estimate illegal logging and related timber trade. The estimation methods commonly used include

trade data discrepancies, wood balance analyses, import source analyses, expert surveys and hybrid methods. More detailed descriptions of these methods are presented in Appendix 3.1. Due to data limitations and/ or for the purposes of comparisons and mutual confirmation, several estimation methods are often employed in a single study.

3.3.2 Existing Estimates and their Comparisons

There have been several attempts to estimate illegal logging and related timber trade. Most of these estimates have focused on illegal production and international trade of timber for commercial use (Hoare, 2015a; Seneca Creek Associates and Wood Resources International, 2004). Recently, some effort has been made to estimate the extent of illegal forest conversion for agricultural production (crop and livestock) and their associated timber production and trade (Lawson, 2014a).

Table 3.1 shows some recent estimates of the magnitude of illegal logging in high risk producer countries. Seneca Creek Associates and Wood Resources International (2004) employed wood flow (import source) analysis coupled with interviews conducted in the producer countries; Hoare (2015a) was based on the work of Chatham House, which used a variety of methods including wood balance analysis, expert surveys and other methods. The World Bank (2006) primarily drew on Seneca Creek Associates and Wood Resources International (2004). Nellemann and INTERPOL

Box 3.2

Revenue distribution among the key players in the Ramin value chain

Ramin (listed on CITES Appendix II) was produced in Indonesia and illegally exported to the US and European markets. Most of the revenue from this trade accrued to the middlemen, particularly those in the pass-through and processing countries where illegal timber was legalized via timber laundering and processing (Kishor and Lescuyer, 2012).

For one cubic metre of timber, the local logger received only USD 2.20 while it was sold at USD 1,000 in the final market (Figure 3.9). The price multiplier from the local logger to the local broker, measured by the ratio of the price received by the logger to the price received by the broker, was about nine. But it jumped to 73, 323 and 455 from the logger to the middleman in the pass-through country, to the foreign processor, and to the US trader, respectively. This suggests high profit margins for the middlemen engaged in the illegal trade.

Figure 3.9

Ramin value chain and benefit distribution

Source: Kishor and Lescuyer, 2012

Table 3.1

Estimated percentages of illegal logging

Country	Source of estimate			
	Seneca Creek Associates and Wood Res. Intl. (2004)	World Bank (2006)	Hoare (2015a)	Nellemann & INTERPOL (2012)
Bolivia	80	80		
Brazil (Amazon)	20-47	20-47	> 50	
Cambodia	90	90		
Cameroon	50	50	65	
Colombia	42	42		
Democratic Republic of the Congo			> 90	
Ecuador	70	70		
Gabon	50-70	70		
Ghana	34-60		70	
Indonesia	70-80	70-80	60	
Laos	45	45	80	
Liberia	80			
Malaysia	35	35	35	
Myanmar	50	50		
Papua New Guinea	70	70	70	
Peru	80-90	80		
Republic of Congo			70	
Russia	20-50	10-50		
Thailand	40	40		
Vietnam	20-40	20-40		
World				15-30

Notes: All these estimates were derived from syntheses of different sources of information and using a combination of different estimation methods. Seneca Creek Associates and Wood Resources International (WRI) (2004) used wood flow analysis and interviews; World Bank (2006) was primarily based on Seneca Creek Associates and WRI (2004) with additional information from other sources. Hoare (2015a) was mainly based on the information gathered by Chatham House using a variety of methods. Nellemann and INTERPOL Environmental Crime Programme (2012) was based on synthesis and reviews of existing reports.

Table 3.2

Product	Illegal production in total production	Illegal trade in total trade	Illegal trade in total production	Illegal trade in illegal production	Legal trade in legal production
Roundwood (logs)	8	14	1	14	7
Softwood		12	1		
Hardwood		17	1		
Lumber	6	6	2	27	30
Softwood		2	1		
Hardwood		23	5		
Plywood	17	23	9	53	35
Softwood		4	1		
Hardwood		30	17		

Estimated percentages (in terms of volume) of illegal production and trade of primary wood products at the global level

Source: synthesized from Seneca Creek Associates and Wood Res. Intl., 2004

Environmental Crime Programme (2012) did not provide estimates of illegal logging in individual countries, instead gave a range of the estimated illegal logging at the global aggregate level based on the synthesis of existing reports including Seneca Creek Associates and Wood Resources International (2004) and the World Bank (2006).

These four different reports all focused on commercial timber. Yet, the years of their estimates were different as were their methods. Additionally, some estimates were drawn from others. As such, caution should be taken when using and comparing these estimates.

In general, the majority of illegally-produced timber (except for plywood) is consumed in domestic markets of producer countries (Seneca Creek Associates and Wood Resources International, 2004). Domestic consumption (in volume) accounts for 86 percent of illegally-produced roundwood, 73 percent of illegally-sourced lumber and 47

percent of illegally-produced plywood. Of the three types of primary wood products (roundwood, lumber and plywood), plywood has the highest percentage of illegal production and international trade. Hardwood is more likely to be illegally harvested and traded than softwood for all three types of products. Illegally-produced wood products (except for lumber) are also more likely to be internationally traded than legally-produced wood products (Table 3.2).

Only a handful of attempts have been made to estimate the volumes and values of illegal international trade of wood products at the multiple-country or global level (Table 3.3). These estimates were derived in different years using different methods and covered different scopes of products and geographic areas and may therefore, not be readily comparable.

Seneca Creek Associates and Wood Resources International (2004) estimated that the annual value of suspicious (likely illegal) primary wood products produced worldwide

Table 3.3

Estimates of illegal timber trade

Source of estimate	Volume (million m³)	Value (USD billion)	Products covered	Countries covered
Seneca Creek Associates and Wood Resources International (2004)	18 (roundwood) 6.9 (lumber) 5.2 (plywood)	5	Primary wood products (roundwood, lumber, and plywood)	Worldwide
Hoare (2015a)	60 (roundwood equivalent)	17	Primary and secondary wood products (including furniture)	Imports into 10 countries (China, France, India, Japan, Netherlands, South Korea, Thailand, UK, USA and Vietnam) from nine tropical countries (Brazil, Cameroon, DRC, Ghana, Indonesia, Laos, Malaysia, Papua New Guinea and Rep. of Congo)

		Table 3.4
Estimated exports of timber from forest conversion in tropical countries, 2012		

Country	Total RWE[a] primary tropical product exports (million m³)	% of exports from forest conversion (main estimate[b])	Implied conversion exports RWE (million m³)
Malaysia	15.6	65	10.1
Indonesia	10.4	75	7.8
Papua New Guinea	3.2	30	1.0
Burma	2.6	50	1.3
Solomon Islands	2.1	15	0.3
Cameroon	1.8	5	0.1
Laos	1.6	55	0.9
Brazil	0.5	20	0.1
Gabon	1.1	10	0.1
Congo	0.9	2	0.0
Ivory Coast	0.7	4	0.0
Ghana	0.5	1	0.0
Others	3.4	14	0.5
Total	44.4		22.2

[a] RWE (roundwood equivalent) measures the volume of wood-based products as equivalent to the volume of roundwood (logs) used in the manufacture of the same products, by considering appropriate conversion factors.

[b] In Lawson (2014a), both the main estimate and the low-end sensitivity analysis results are presented with the latter using the most conservative assumption (i.e. zero percent of exports from forest conversion) for countries with little or no information.

Source: Lawson, 2014a

was USD 22.5 billion. Of this total value, about USD 5 billion was internationally-traded, accounting for approximately 10 percent of global trade value of primary wood products in 2002.

Hoare (2015a) reported that the share of illegal wood products trade had remained relatively stable (about 10 percent of total trade volume of wood products) since 2000. From 2006 to 2013, the import volume of illegal wood products by China, India and Vietnam increased by more than 50 percent whereas the illegal import volume slashed by one-third for the US and one half for the EU, respectively (Hoare, 2015a).

A significant portion of illegal logging and related timber trade stems from illegal forest clearance (Table 3.4). Thirty-one percent of tropical timber internationally-traded originates from illegal forest conversion (Lawson, 2014a). A large part of illegal forest conversion is for commercial agricultural production, particularly export-orientated agricultural production. For the period 2000-2012 total and illegal conversion of forestlands for commercial agriculture contributed to 71 percent and 49 percent respectively of total tropical deforestation. In the same period, 24 percent of total tropical deforestation was directly caused by illegal conversion for agricultural exports. Brazil and Indonesia have witnessed the largest area of forest conversion for commercial agriculture. They together accounted for 75 percent of total tropical forest area that was illegally converted for commercial agriculture between 2000 and 2012 (Lawson, 2014a).

3.4 Following the Trade Data

3.4.1 Recent Trends in International Trade Flows of Illegal Wood Products
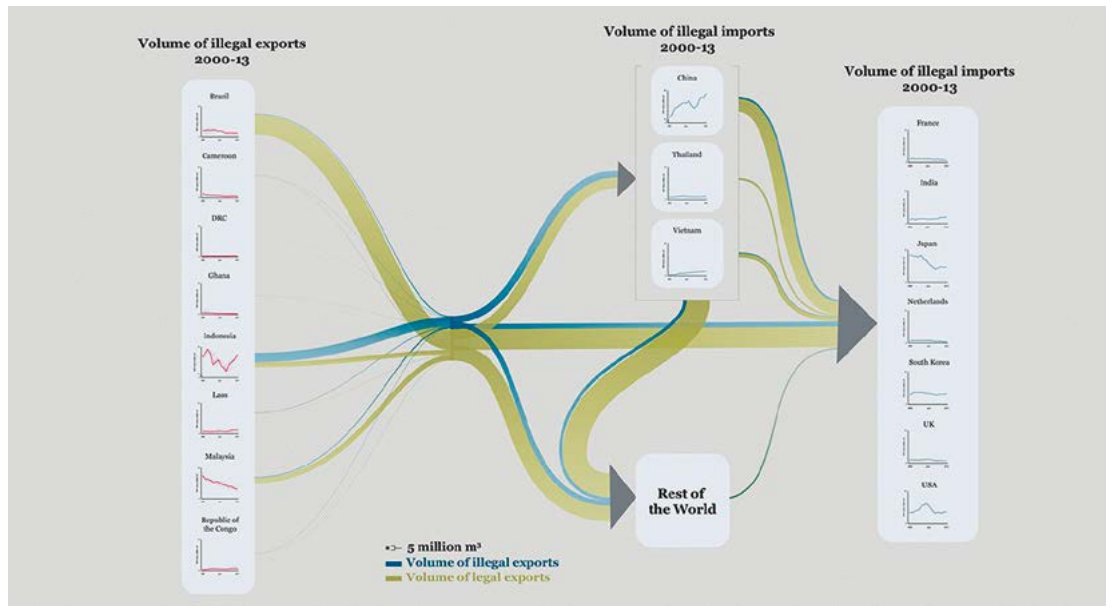
Since 2000, although the import share (in volume) of primary and secondary wood products at high risk of illegality has decreased for most of the 10 major processing and consumer countries studied by Hoare (2015a), no persistent declining trend in total volume of illegal imports by these countries has been observed. China has emerged as the largest importer of overall wood products (DESA/UNSD, United Nations Comtrade database, 2016) and those at high risk of illegality (Hoare, 2015a), while a significant portion of China's imports is processed for exports to other countries including the US, the EU, Japan and the rest of the world (Zhang and Gan, 2007).

As discussed above (Section 3.3.2), some estimates have been made on international trade flows of illegal wood products using different methods with different scopes. One recent study reported by Hoare (2015a) focuses on trade flows of wood products at high risk of illegality originating from selected tropical producer countries to 10 processing and consumer countries (see Figure 3.10). These studies together provide useful information about illegal timber trade.

Given the limited availability of estimates of global illegal timber trade flows, here we aim to expand existing work by focusing on the values and flows of international

The scale and flows of illegal timber trade among selected producer, processing and consumer countries in 2013

Figure **3.10**

Source: Chatham House, 2016

trade of roundwood and sawnwood at high risk of illegality for two reasons. First, the information on trade flows of primary wood products is critical to understanding illegal logging and related timber trade as they are the material for secondary products. Second, it is difficult to accurately estimate the illegality associated with the trade of secondary wood products given limited data on the share of illegal wood in various secondary products of different origins.

We use import source analysis, i.e. by multiplying estimated illegal logging rates in producer (source) countries by trade volumes reported in the United Nations Commodity Trade Statistics Database (DESA/UNSD, United Nations Comtrade database, 2016). The illegal logging rates used in our assessment are based on the synthesis of existing estimates reported in Section 3.3.2 and from other sources. Our assessment covers five key producer regions, i.e. the Russian Federation, South America (Brazil, Colombia and Peru), the Congo Basin (Cameroon, DRC and the Republic of Congo), Southeast Asia (Cambodia, Indonesia, Laos, Malaysia and Myanmar) and Oceania (Papua New Guinea (PNG)). For each source country/region, its total export and top three trade partners (export designation countries) are identified and analyzed. With few exceptions (Brazil and Malaysia) trade flows are quite concentrated and the top three trade partners account for on average 88-89 percent of total exports and in some cases (e.g. Cambodia, Laos and PNG) almost the entire export from the producer country.

Import source analysis is preferred over other methods because it allows for using officially-recorded international trade statistics and making reference to widely-used illegal logging rates. Although it requires considerable efforts to organize trade data, it represents straightforward calculations that can easily be replicated at different scales and by others. The estimates also can easily be updated when new trade figures and illegal logging rates become available. This methodology, however, is not free of limitations. First, the illegal logging rates, despite huge efforts to improve and update them, remain just 'best estimates' produced to give an idea of the scale of the problem. Second, our focus on roundwood and sawnwood, as well as the selection of key source countries, results in some underestimation of total global trade of all wood products, for example by excluding trade flows of finished and semi-finished products (e.g. veneers, wood panels, pulp and paper, furniture, etc.). Finally, this approach does not take into account illegal trade that occurs domestically.

The trade value of roundwood and sawnwood at high risk of illegality is estimated to have totalled about USD 6.3 billion in 2014 (42 percent of total roundwood and sawnwood exports from producer countries). China is by far the leader among the top importers of illegal roundwood and sawnwood, importing more than 50 percent of the total illegal export value from the five producer regions. China together with Vietnam, India, the EU, Thailand and the US cover 84 percent of the total value of imports. As for the exporters, Southeast Asia accounts for some 55 percent of

Main global trade flows of roundwood and sawnwood at high risk of illegality, 2014 (million USD)

Figure 3.11

1. Russian Federation West; 2. Russian Federation Far East; 3. South America (Brazil, Colombia, and Peru); 4. Congo Basin (Cameroon, Democratic Republic of the Congo and Republic of Congo); 5. Myanmar; 6. Laos; 7. Malaysia; 8. Indonesia; 9. Papua New Guinea.

See Figure 3.12 for details on intra-regional trade flows within Southeast Asia.

CHN = China; EU = European Union; IND = India; USA = United States of America.

illegal roundwood and sawnwood exports (with Myanmar and Laos playing a major role), followed by the Russian Federation (20 percent) and PNG (11 percent). Figure 3.11 and Table 3.5 provide an overview of the main global trade flows of illegal roundwood and sawnwood in 2014. A more detailed analysis for each region follows.

Russian Federation

We assume a 20 percent nationwide average illegal logging rate in the Russian Federation, balancing the higher rates reported for the Russian Far East and the lower ones for the western part of the country (FAO, 2012; Nellemann and INTERPOL Environmental Crime Programme, 2012). Illegal forest activities in the Russian Far East are much more widespread (Smirnov et al., 2013), with some estimates indicating that at least 80 percent of all forest activities are illegal (EIA, 2015). Valuable temperate hardwood species such as Mongolian oak (*Quercus mongolica*), Manchurian ash (*Fraxinus mandshurica*), Japanese elm (*Ulmus propinqua*), Amur linden (*Tilia amurensis*) and Manchurian linden (*Tilia mandshurica*) are often the target of illegal logging and trade. By taking advantage of gaps/weaknesses in existing forest laws and law enforcement mechanisms, illegal operators perpetrate illegal activities, including overharvesting by exceeding legally-permitted harvesting levels, abuse of sanitary harvesting permits for cutting old-growth timber in protected areas, and timber smuggling and laundering of illegally-sourced timber through official permits (EIA, 2014).

China is the main importer of Russian hardwood timber: 96 percent of hardwood roundwood is exported to China to be processed into furniture and flooring for China's domestic consumption and for exports to the European, Japanese and

US markets. From 2004-2011 Mongolian oak harvested in the Russian Far East and exported to China exceeded the authorized logging volume by 2-4 times (Smirnov et al., 2013).

Data from UN Comtrade Database (DESA/UNSD, United Nations Comtrade database, 2016) do not allow for differentiating timber exports from different regions of the Russian Federation. Based on the nationwide data we assume that exports towards China (about USD 620 million, equally distributed between roundwood and sawnwood) as well as other East Asian countries (e.g. Japan and South Korea) are likely to originate from the Russian Far East, whereas those towards the EU (USD 240 million, two-thirds of which are sawnwood) originate mostly from the western part of the country.

South America

The total value of illegal roundwood and sawnwood exported from South America was estimated at USD 387 million in 2014. Brazil remains the main illegal wood producer and exporter in the region (74.5 percent of total regional trade value). The country's main export markets are the US, the EU, and China; however, between 2010 and 2014 Brazilian sawnwood exports to the EU decreased by more than 30 percent, whereas its exports to the US increased by 13 percent.

Despite several legislative initiatives to control illegal logging and a 50-75 percent decline in the illegal logging rate in the Brazilian Amazon between 2000 and 2008 (Chatham House, 2010), the enforcement of forest legislation in Brazil is often hampered by a lack of coordination between government agencies, limited resources and inadequate penalties (Wellesley, 2014). Fabrication of official documents and the fraudulent use of genuine ones are increasingly common phenomena. Greenpeace Brazil (2014), for

Table 3.5

Global trade flows of roundwood and sawnwood at high risk of illegality by exporter and importer, 2014 (million USD)

Importers	Source regions (exporters)					Total export from all source regions	Percentage on total illegal export from all source regions
	Russian Federation	South America	Congo Basin	Southeast Asia	Oceania		
Total export	**6,328.0**	**682.0**	**1,004.9**	**6,082.8**	**978.9**	**15,076.6**	
Illegal logging rates (percent)	20[a]	Brazil: 53[b]; Colombia 75[c]; Peru: 72.5[d]	Cameroon: 33[e]; Dem. Rep. of Congo: 87[f]; Rep. of the Congo: 72.5[g]	Cambodia: 94[h]; Laos: 87[i]; Indonesia: 30; Malaysia: 18.5[k]; Myanmar: 72[l]	Papua New Guinea: 70[m]	Total illegal export towards importers	
China	619.9	78.6	302.0	1730.6	564.7	**3295.7**	52.1
Vietnam		0.8	18.3	748.2		**767.3**	12.1
India		10.2	1.4	509.3	75.5	**596.5**	9.4
EU	239.4	55.2	113.7	45.6		**453.9**	7.2
Thailand				101.4		**101.4**	1.6
USA		75.6	12.6			**88.2**	1.4
South Korea	9.4				13.0	**22.4**	0.4
Japan			0.7	14.4		**15.1**	0.2
Malaysia				12.1		**12.1**	0.2
Australia					1.1	**1.1**	0.0
Others	396.9	166.7	72.7	309.7	30.9	**976.9**	15.4
Total illegal export from source regions	**1,265.6**	**387.1**	**521.4**	**3,471.4**	**685.2**	**6,330.8**	**100.0**
Percentage on total illegal export from all source regions	20.0	6.1	8.2	54.8	10.8	100.0	

Notes: The illegal trade values are computed by multiplying the total values of roundwood and sawnwood trade flows from source countries (exporters) by their corresponding illegal logging rates. In the case of multiple exporters within the same region (i.e. the Congo Basin and Southeast Asia) the results are summed-up over all exporters for each importer. For example, the value of illegal trade flows from South America to importer C is 0.49 FB + 0.725FC + 0.75FP, where FB, F_C and F_P correspond to the total value of trade flows to country C from Brazil, Colombia, and Peru, respectively.

The sources used for estimating illegal logging rates are as follows: [a]FAO (2012); [b]Chatham House (2010); [c]van Eynde and Blomely (2015); [d]Finer et al. (2014); [e]Hoare (2015b); [f]Lawson (2014b); [g]Lawson (2014d); [h]World Bank quoted by USAID (2011); [i]Saunders (2014a); [k]Forest Trends and Anti-Forest Mafia Coalition (2015); [k]Hoare (2015c); [l]EIA (2013a); and [m]Lawson (2014c). The illegal logging rates for Malaysia, Peru and the Republic of the Congo correspond to average values computed based on the value ranges reported by the relevant sources.

Source: own elaboration based on data from DESA/UNSD, United Nations Comtrade database

example, highlights five different ways to launder illegal timber harvested in Pará and Mato Grosso States. One of them is the authorization of harvesting permits for areas already harvested, and the permits are then used to provide documentary support for illegal timber logged elsewhere. Another approach is to purposely overestimate the volume of valuable tree species in a certain area covered by a valid harvesting permit in order to use the exceeding volume to launder illegally-harvested timber from other areas. All of these fraudulent mechanisms build on gaps in the existing law enforcement system, as well as negligence or collusion by officials. However, forged documents and papers are not just limited to Brazil; they are also a common issue in Peru (EIA, 2012; Timber Committee, 2016). Peruvian exports are mostly directed to China (50 percent) and the US (10 percent). Colombia exports mainly roundwood, with India and China being the main destinations, each importing about USD 10 million per year.
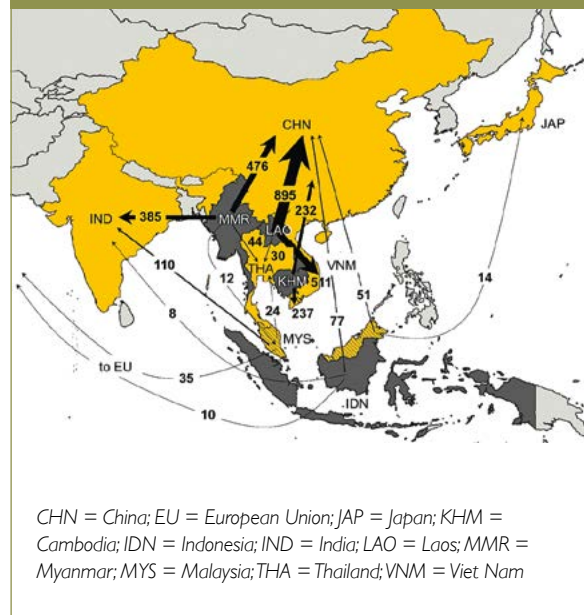
Congo Basin

The total export value of illegally-sourced roundwood and sawnwood from the Congo Basin amounted to USD 521.4 million in 2014. The Republic of Congo (41 percent) and Cameroon (36 percent) contributed to most of this value. Most (68 percent) of the Cameroon exports was sawnwood, whereas roundwood accounted for 92 percent of total export value from the Republic of Congo. Since 2012 China has surpassed the EU to become the largest roundwood and sawnwood importer from the Congo Basin. In 2007, 90 percent of the DRC's timber exports were destined to the EU, while in 2014 this value decreased to 29 percent (Lawson, 2014b). In 2014 China imported about 58 percent of total value of illegal roundwood and sawnwood from the Congo Basin, mostly (91 percent) in the form of roundwood. The EU imported 22 percent, mostly sawnwood (74 percent). Vietnam (USD 18.3 million), the US (USD 12.6 million) and, marginally, India (USD 1.4 million) altogether covered another 6 percent of the total export value from this region.

Illegal activities in the Congo Basin cover a broad range of typologies. The improper use (or abuse) of logging permits is one of the most common illegal activities, as recent cases in the DRC (with artisanal logging permits) and Cameroon (with timber recovery permits) reveal (e.g. Global Witness, 2012; Greenpeace Netherlands, 2015). Obviously, illegal logging in Africa is not restricted to the Congo Basin; rather it occurs in many other African countries; among them, Mozambique with an estimated illegal logging rate of 50 percent. China imports nearly 90 percent of Mozambican timber exports, mostly logs of valuable hardwood species such as Pau Ferro (*Swartzia madagascariensis*), Monzo (*Combretum imberbe*), Chanate (*Colophospermum mopane*), Jambire (*Millettia stuhlmanii*) and Umbila (*Pterocarpus angolensis*) (EIA, 2013b).

Southeast Asia

The estimated export value of illegally-sourced roundwood and sawnwood from Southeast Asia reached nearly USD 3.5 billion in 2014, on par with the estimate by the

Figure 3.12

Main illegal trade flows of roundwood and sawnwood within Southeast Asia, 2014 (million USD)

CHN = China; EU = European Union; JAP = Japan; KHM = Cambodia; IDN = Indonesia; IND = India; LAO = Laos; MMR = Myanmar; MYS = Malaysia; THA = Thailand; VNM = Viet Nam

United Nations Office on Drugs and Crime (UNODC, 2010). About 50 percent of this value was imported by China and another 17 percent by India. Laos (USD 1,457 million) and Myanmar (USD 1,035 million) were by far the main exporters from the region, whereas the role of traditional producers like Malaysia (USD 182.7 million) and Indonesia (USD 120.1 million) was more limited, though with some relevant trade flows towards the EU (USD 43 million). Although Indonesia is the first Asian timber exporter country to start negotiating a Voluntary Partnership Agreement with the EU and likely the first one that will issue Forest Law Enforcement, Governance and Trade (FLEGT) licences in the next few months, the value of its sawnwood exports to China between 2010 and 2014 almost doubled, while in the same period its exports towards the EU decreased by 40 percent.

Apart from exports towards its neighbouring emerging economies, this region is characterized by quite intense intra-regional trade (see Figure 3.12). In particular, Thailand's imports of illegal wood from regional producer countries reached about USD 101 million, mostly from Myanmar (44 percent) and Laos (30.5 percent) and Vietnamese imports from Laos amounted to more than USD 511 million despite a ban on exports of logs and sawnwood imposed from 1999-2002. Introduced with the aim to encourage the development of domestic timber processing, the ban was either not enforced or circumvented due to numerous permissions issued in "exceptional cases" (Smirnov, 2015). Based on UN Comtrade Database (DESA/UNSD, United Nations Comtrade database, 2016), the export value of wood products from Laos in the period 2009-2014 increased by more than eight times (almost exclusively roundwood and sawnwood). Vietnam is also by far the main destination for

Cambodian log exports. The Vietnamese government has signed a number of agreements/commitments for coordination on forest management and protection, law enforcement and trade, including with the governments of Laos in 2008 and Cambodia in 2012; however, so far they have not resulted in a significant reduction in its imports of timber at high risk of illegality (Saunders, 2014b).

Although illegal logging practices are quite differentiated, "conversion timber" is the predominant source of timber in the region. For instance, in Indonesia timber from forest conversion (mainly for oil palm and timber plantations) represented nearly 95 percent of timber harvested from natural forests in 2013 (Forest Trends and the Anti-Forest Mafia Coalition, 2015) and in Malaysia at least 66 percent of timber production was derived from forest conversion in 2010 (Lawson, 2014a).

Oceania

During the last six years PNG has experienced a significant increase in timber harvest and exports, with log exports nearly doubling between 2009 and 2014. The country now ranks among the world's three largest tropical roundwood exporters. The total value of illegal wood exported from PNG in 2014 was estimated at USD 685.2 million, with China being the main destination (USD 564.7 million), followed by India (USD 75.5 million) and South Korea (USD 13 million). Sawnwood exports from PNG were limited (USD 8.6 million) and mostly directed to China, Malaysia and Australia.

A main mechanism behind the recent expansion in PNG's exports is known as Special Agriculture and Business Leases (SABLs) (Lawson, 2014c). The SABLs, originally intended for agricultural projects, are used by many logging companies to expand their operations. Some 5.5 million hectares of land leased under the SABLs are additional to 10 million hectares already allocated by the PNG government through logging concessions. As a result, more than one-third of the country's forests are now exploited by foreign (logging) companies, with detrimental effects on local communities and their rights (Mousseau and Lau, 2013).

3.4.2 New Developments in Illegal Logging and Related Timber Trade

Potential trade diversions caused by recent responses by some consumer countries

Recently, several consumer countries/regions (e.g. the US, the EU and Australia) have adopted laws to protect them from imports of illegally-sourced wood products. While helping reduce their imports of illegal wood products from tropical forest countries and other parts of the world (Gan et al., 2013; Prestemon, 2015), the implementation of these laws are likely to cause trade diversions. The diversions could include increased domestic consumption in the producer countries (though this is less evident so far) and increased imports by countries that have no or less stringent regulations on illegal trade of wood products. Such diversions can undermine the effectiveness of these initiatives by the consumer countries and

call for broader global cooperation in combatting illegal logging and related timber trade (Gan et al., 2013).

Increased imports by China and India

China and India are the two largest importing countries of tropical roundwood (see Section 3.2.4), most of which originates from producer countries at high risk of illegality. Their imports are driven by both domestic consumption and exports. Although the share of illegal imports by China between 2000 and 2013 declined from 26 to 17 percent, this did not correspond to a reduction in the total volume of illegal imports. Instead, China's imports of wood products at high risk of illegality increased from 17 million m^3 (RWE) in 2000 to 33 million m^3 in 2013 (Hoare, 2015a). China imports illegal timber from all tropical forest regions and Russia while the major source of illegal timber for India is Southeast Asia. Given their huge domestic markets and China's large capacity to process wood products for exports, it is extremely difficult to substantially reduce illegal logging and related timber trade at the global level without engaging these two countries.

Geographic shifts in illegal logging and related timber trade

As illegal logging in Brazil, Indonesia and Malaysia has declined in recent years (Hoare, 2015a), Russia, other Southeast Asian countries (e.g. Cambodia, Laos and Myanmar), PNG and some African countries, have witnessed increases in illegal forest activities. These countries have emerged as new producer countries in the global web of illegal logging and related timber trade. Among these rising producer countries, Russia has gained significantly in its share of global illegal timber production (primarily in its Far East region) and exports (mainly to China) (see Section 3.4.1 for more details).

This phenomenon suggests that illegal logging is highly geographically fugitive and persistent at the global level. Illegal logging and related timber trade is not limited to tropical forest regions; it can occur in and shift to non-tropical forest regions. This is not all due to leakage. Increased demand and changes in drivers, among other factors, can induce geographic shifts in illegal logging and related timber trade.

Timber originating from illegal forest conversion for export-orientated commercial agriculture

Traditionally, traded tropical timber originated mainly from selective logging of natural forests. During recent years, conversion timber - timber produced from forest conversion, especially from illegal forest conversion for export-orientated commercial agriculture - has constituted a significant portion of illegal timber trade. It is estimated that almost one-third of tropical timber traded globally is illegal conversion timber (Lawson, 2014a). Most of the forest conversion has occurred in the Amazon and Southeast Asia. In recent years, forest conversion in the Amazon has been curtailed to some extent, and yet forest conversion in Southeast Asia remains active (Barney and

Canby, 2011; Carlson et al., 2013; Forest Trends and the Anti-Forest Mafia Coalition, 2015).

Agro-commodities illegally produced on land converted from forests are also primarily destined for export markets. These products include beef, soy, cocoa, palm oil and timber from plantations, among other products, with a combined annual trade value of USD 61 billion (Lawson, 2014a). Increased global demand and trade for various agro-commodities have placed tremendous pressure on tropical forests and extended the scope of illegal logging and related timber trade.

In summary, global imbalances in laws and law enforcement against illegal logging and related timber trade (as well as in wealth, resources, global influence, overall governance capacity, etc.) and increased global demand for agricultural and timber products make it very difficult to eliminate or even significantly reduce illegal timber production and trade at the global aggregate level. Furthermore, illegal logging and related timber trade is highly fugitive - it can easily shift from one location to another or from one form to another. For instance, measures taken by a few consumer countries to curtail imports of illegally-sourced wood products could cause trade diversions, leading to only limited success in globally controlling illegal logging and timber trade. Similarly, log export bans or reductions in illegal logging in some producer countries may encourage log exports from some other countries or shift illegal logging elsewhere. As a driver for illegal logging fades out or is controlled, a new driver may emerge, sometimes for disguised "good" reasons (e.g. forest conversion for oil palm plantations). Hence, effectively controlling illegal logging and related timber trade at the global level calls for broader and stronger global cooperation (recognising that such cooperation is itself challenging). Additionally, illegal logging and related timber trade is not merely a forestry problem and thus cannot be resolved by the forestry sector alone. Coordination between forestry and agriculture in terms of land use, production, trade, markets and policy, and among the forestry, fisheries and wildlife sectors in terms of tracking illegal activities would be necessary and beneficial.
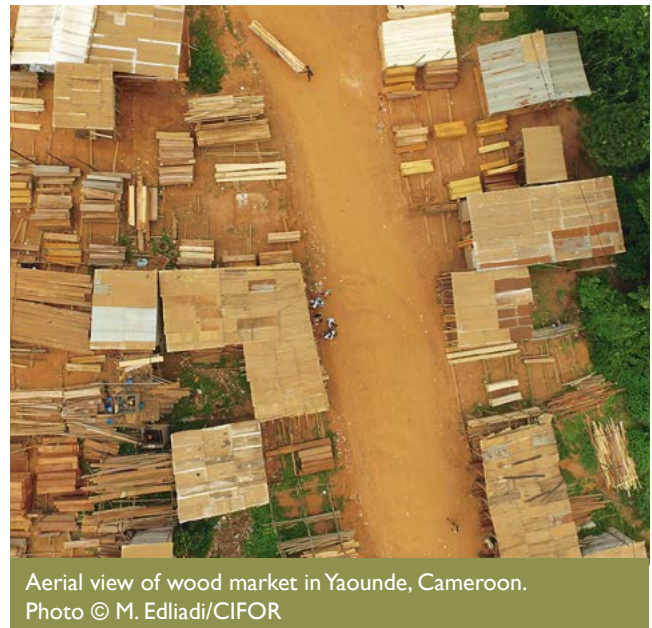
3.5 Conclusions

Existing estimates on illegal logging and related timber trade differ substantially, partly because of the estimation difficulty associated with the illegality nature and partly because of the differences in the scope of estimation (e.g. products and time period covered), definition of illegality, data sources and estimation methods used. Despite recent reductions in the production and import shares of illegal wood products in some major producer and consumer countries, illegal logging and timber trade at the global level remain persistent and highly fugitive in terms of geographic location and drivers, calling for broader and closer global cooperation across geographic regions and sectors. Most of the illegally-produced tropical hardwood timber is produced by the informal sector and consumed in domestic markets; only a small portion

of illegally-produced timber (nearly 10 percent of total global trade value of wood products) is internationally-traded, which has usually better quality and higher profit margins than domestically-marketed timber. However, timber produced from illegal forest conversion for commercial agriculture has become an increasingly important portion of global illegal logging and related timber trade, whereas the role of traditional, large scale logging has diminished in illegality. High profitability for wood products and agricultural products grown on lands converted from forests and consumer preferences for special wood species drive illegal logging and related timber trade.

The vast majority of illegal primary wood products from tropical forests are produced by Brazil, Indonesia and Malaysia, and imported by China and India. Russia has emerged as the largest single source of illegal timber from temperate and boreal forests. Because of the scale of their illegal production and imports, it is extremely important to engage these countries in global efforts to control illegal logging and related timber trade.

Domestic, regional and global markets for legal and illegal wood products are interlinked, making it difficult to monitor and resolve illegal logging and related timber trade.

Aerial view of wood market in Yaounde, Cameroon.
Photo © M. Edliadi/CIFOR

Data gaps

Several data gaps exist in measuring illegal logging and related timber trade. First, there are no data that directly measure illegal logging and related timber trade. Second, there are scant data that present separate measurements of quantities and values of illegal production and trade originating from informal logging, industrial logging, forest conversion and other illegal activities. Third, there is inadequate work to understand and quantify statistical errors and inconsistencies in the conventional production and trade data from different sources and to separate them and other errors from the results of trade

data discrepancies' analysis. Fourth, there is a lack of approaches developed for mutual confirmation or, at least to some extent, validation of illegality estimates derived from different sources and methods. Finally, data on the share of illegal wood in different secondary wood products are also limited, preventing accurate estimates of illegal trade of these products.

Further efforts are needed to bridge these gaps. Additionally, it is recommended to adopt big data analytics to integrate and utilize large amounts of publicly-available timber, wildlife and fisheries data in a more effective and beneficial way.

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Appendices

Appendix 3.1
Methods for Estimating Illegal Logging and Related Timber Trade

Trade data discrepancies

Export/import discrepancies between trade-partner countries have long been used as an important indicator of illegal timber trade (Brunner et al., 1998; Johnson, 2002). The scientific literature identifies a large number of factors that can contribute to discrepancies in trade statistics between two countries (Castaño, 2007; Chen, 2010; Eastin and Perez-Garcia, 2004; Guangcui, 2003). They can be classified into "primary normal factors" (e.g. imports are recorded as "cost, insurance and freight", CIF and exports as "free on board", FOB), "secondary normal factors" (e.g. differences in product classifications), and "abnormal factors" (e.g. illegal activities) (Castaño, 2007; Goetzl, 2005). While trade data discrepancies offer a hint of problems that may exist with unreported trade, "data discrepancies by themselves are not prima facie evidence that illegal trade has occurred" (Seneca Creek Associates and Wood Resources International, 2004). However, if significant or persistent differences are detected, and if there is additional evidence available, then discrepancies can be assumed as an indicator for illegal timber trade. In particular, discrepancies can become informative about the volume of illegal trade only in cases where large volumes of primary wood products are traded (Chang and Peng, 2015; Lawson, 2007).

In general, trade data quality and consistency remain questionable. Discrepancies might be the result (among others) of poor quality data, errors in collection and compilation of trade statistics, inconsistent product classification, inaccurate measurements and conversion factors, and modified/falsified shipping documentation referring to legally-harvested timber (e.g. to avoid paying royalties or export taxes) (Castaño, 2007).

Wood balance analysis

This approach represents the basis for many estimates of illegal logging rates in producer countries. It compares timber inputs (the sum of production and imports) and outputs (the sum of exports and domestic consumption) at the country (or regional) level. Where a deficit between inputs and outputs emerges and cannot be otherwise explained, it is interpreted as an indication of illegality. The

corresponding material shortfall can then be inferred as coming from illicit domestic harvesting and/or imports (Lawson, 2007). Wood balance analysis has been implemented by several authors to analyse illegal logging rates and trade at both global (Dieter, 2009; Johnson, 2003; Seneca Creek Associates and Wood Resources International, 2004) and national levels (Lawson and MacFaul, 2010; Palmer et al., 2001; Prasetyo et al., 2012).

Although largely used to estimate the scale of illegality (in both absolute and relative terms), such analyses have some limitations. For example, official estimates of industrial roundwood production might relate to the formal sector rather than the informal (not necessarily illegal) sector, thus underestimating the extent of illegality. Moreover, production data might not be able to capture some domestic illegal harvests (e.g. roundwood from plantations established through natural forest conversion, informal small-scale logging, etc.) that have increased in recent years (Hoare, 2015a). And, trade statistics per se do not allow for identifying the proportion of illegally-sourced material embodied within imports. Finally, data capture at the national and subnational scales can vary from country to country, and within each country, thus making comparison difficult and not always consistent. Wood balance analysis is not just used for detecting illegal timber; it can also allow for generating an aggregate summary of wood resource availability and use, thus representing key information sources and forecasting tools for the forestry and wood products industry sectors (Knauf, 2015).

Import source analysis

This approach is used to assess illegal trade by multiplying estimated illegal logging rates in source countries by trade volumes reported in official statistics. It largely depends on estimates of illegality at source that are normally elaborated based on existing literature as well as expert perception surveys, field surveys and interviews with stakeholders. Such estimates might be imprecise, vary according to the source, and are rarely updated in a consistent manner over time (Lawson, 2007). Contreras-Hermosilla et al. (2007) developed one of the first sets of estimates. Additional ones were developed and (in some cases) used to

complement each other (Li et al., 2008; Miller et al., 2006; Seneca Creek Associates and Wood Resources International, 2004). Import source analysis is one of the methods used by Chatham House by "calculating roundwood equivalent volumes (RWE) and US dollar values for individual import flows (source country/product) from official import data (for timber products, wood furniture, and pulp and paper) and then multiplying these by estimates of the proportion of wood considered likely to be illegally sourced in each individual wood flow in each year" (Lawson, 2014e).

Expert survey

This method involves surveying experts on their perceptions of illegality. Although this survey method can be applied to estimating both illegal logging and illegal timber trade, most of its applications so far have been in illegal logging (production). To estimate illegal logging, researchers ask a selected group of experts in producer countries about their perceptions of extents of illegal logging in their countries. To estimate illegal trade, on the other hand, the survey respondents include experts from producer, processing and consumer countries. The surveys can be done via mail, phone, face-to-face interviews or online.

This method does not use the existing production and trade data which are not intended/designed to cover the illegal components of production and trade. Hence, it can bypass the weaknesses associated with currently available production and trade data in estimating illegal production and trade. When data on production and trade are not available, this method could be the only tool to estimate illegal production and trade. However, this method has its own limitations. The validity of its estimates depends on the selection (sampling) of experts and their knowledge of the illegal activities. Because costs will incur in the survey, this method may be more expensive than wood balance analysis and trade data discrepancies, which use the data already available.

This survey method has been used to estimate the percentage or a range of percentages of illegal logging in total timber harvest (Hoare, 2015a; Lawson and MacFaul, 2010) and the percentage of illegal conversion of forestland to agricultural production in total forestland conversion or total agricultural production (Lawson, 2014a).

Hybrid method

A hybrid method is any combination of the above estimation methods. It can be more effective and yield better estimates of illegal production and trade if its combined strengths outweigh its combined weaknesses. As described previously, each method for estimating illegal logging and related trade has its own strengths and weaknesses. Hence, a hybrid method, which combines multiple methods described above, can take advantage of strengths of each method to overcome some weaknesses intrinsic to other methods.

Appendix 3.2
Country Codes used in Figure 3.4

Country	Code
Argentina	ARG
Australia	AUS
Austria	AUT
Belgium	BEL
Brazil	BRA
Bulgaria	BGR
Cambodia	KHM
Cameroon	CMR
Canada	CAN
Central African Republic	CAF
Chile	CHL
China	CHN
Columbia	COL
Congo, Dem. Rep.	ZAR
Congo, Rep.	COG
Costa Rica	CRI
Cote d'Ivoire	CIV
Croatia	HRV
Cyprus	CYP
Czech Republic	CZE
Denmark	DNK
Ecuador	ECU
Egypt, Arab Rep.	EGY
Estonia	EST
Finland	FIN
France	FRA
Gabon	GAB
Germany	DEU
Ghana	GHA
Greece	GRC
Hong Kong, China	HKG
Hungary	HUN
India	IND
Indonesia	IDN
Ireland	IRL
Italy	ITA
Japan	JPN

Country	Code
Kenya	KEN
Korea, Rep.	KOR
Lao PDR	LAO
Latvia	LVA
Lithuania	LTU
Luxembourg	LUX
Malaysia	MYS
Mali	MLI
Malta	MLT
Mexico	MEX
Mozambique	MOZ
Myanmar	MMR
Netherlands	NLD
New Zealand	NZL
Nigeria	NGA
Norway	NOR
Papua New Guinea	PNG
Peru	PER
Philippines	PHL
Poland	POL
Portugal	PRT
Romania	ROM
Russian Federation	RUS
Singapore	SGP
Slovakia	SVA
Slovenia	SVN
South Africa	ZAF
Spain	ESP
Sweden	SWE
Switzerland	CHE
Taiwan	TWN
Thailand	THA
Turkey	TUR
Ukraine	UKR
United Kingdom	GBR
United States	USA
Vietnam	VNM

Note: Only the codes of countries most relevant to this study are shown here. More country codes can be found at http://wits.worldbank.org/wits/wits/ witshelp/Content/Codes/Country_Codes.htm. These codes may differ from the abbreviations of country names used elsewhere in this report.