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New pathways for reducing global illegal logging

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Abstract

The negative impacts of illegal logging and associated trade (ILAT) on forest carbon and species biodiversity have been widely recognized for decades. Despite several decades of attempts to halt illegal logging through policies such as those advocated by the European Union (The Forest Law Enforcement, Governance and Trade, FLEGT), there has been limited success to date. Now, with newly changing perspectives about ILAT, advances in methods for detecting ILAT and its environmental impacts, and an ostensibly improved policy environment for controlling it, we have a unique opportunity to stop it. This policy brief brings attention to this timely and important issue and provides some direction for enhancing monitoring, assessing impacts, and implementing urgent actions.

The global scale and negative environmental impacts of ILAT have been widely recognized for decades. However, progress in reducing it has been limited and uneven among countries and regions. While timber extracted from illegally deforested and degraded forest lands declined in the 2000s compared to the 1990s, it increased again since 2010 (Pan et al., 2024). Meanwhile, the flow of illegal wood products through global supply chains and markets has steadily increased (Hoare and Uehara, 2022). And, while most illegal logging still occurs in tropical countries, it has worsened sharply in boreal forests of the Russian Far East.

Why has there been so little progress in reducing ILAT for three decades?

By definition, ILAT includes all practices related to harvesting, processing, and trading of timber in conflict with national and sub-national laws, so the term links different, complex issues that involve different sectors, actors, governance, forest laws, and more (Kleinschmit et al., 2016). ILAT components are closely interwoven: illegal logging feeds illegal wood trade and the profits from illegal trade drive illegal logging. Why has ILAT proven such a difficult issue to tackle? Several major factors likely help to sustain it: (1) variation and often ambiguity in the definitions of "illegal logging" in different countries concerning the legality of tree harvest practices; (2) poor monitoring of illegal logging, particularly in countries with poor forest governance, so there are few reliable data for assessing extent and environmental damage; (3) poor monitoring and tracking of illegal wood products that enter supply chains and markets; and (4) limited multilateral mechanisms or practices capable of preventing illegal trade between nations.

Newly evolved illegal logging definition and concept

Because of poor monitoring data there have long been few hard, quantitative measures of ILAT's environmental and social impacts, whether on carbon and biodiversity, tax revenues, or the livelihoods of indigenous people, which increases the obstacles to taking action to combat ILAT. However, as illegal wood has increasingly come from sources of illegally deforested tropical forestland and become a major contributor to timber trade, the definition of illegal logging has also evolved to directly link to illegal land conversion for agriculture that causes large-scaled deforestation and the illegal status of the timber harvested in the tropics (Kleinschmit et al., 2016). Meanwhile, small-scale illegal logging can be identified using new very high-resolution tree imagery and directly connected to tropical forest degradation (Qin et al., 2022; Lapola et al. 2023). Together, these new approaches suggest that ILAT's environmental impacts can now be assessed in real time by combining remote-sensing data with ground-monitoring data for detecting deforested and degraded forest areas, and identifying those that are illegal. Rapid detection of illegal logging activities facilitates intervention by governments to enforce policies, as well as providing the means to track impacts more closely than ever before.

Impacts of ILAT on forest carbon losses

Following the new definitions of illegal logging, we developed quantitative estimates of carbon losses related to illegal logging in the tropics, which to our knowledge is the first such evaluation. Our estimates are partially based on a new paper (Pan et al. 2024) that compiles updated global data for estimating carbon losses due to tropical deforestation and forest degradation. The new study comprehensively estimated carbon content and density in tropical intact forests, instantaneous carbon emissions to the atmosphere from deforested lands, leftover carbon transferred to other land-uses, carbon content in harvested timber from the deforested lands, and postponed carbon losses from wood product processing or short-lived wood products. The study also provided deforested tropical intact forest areas resulting from remote sensing-based detection of deforestation (Pan et al., 2024). The data from the new study provide long-term baselines on the carbon fluxes and status of tropical forests. Thus, coupled with estimated illegal ratios of tropical land conversions (~55%) (Hoare and Uehara, 2022), we were able to estimate that illegally deforested tropical intact forests totaled 257 million hectares over the decades from 1990 to 2019 (Table 1). The committed carbon emissions

from those illegally converted lands via deforestation was 1.23 Pg C year^{-1}, and accumulated up to ~37 Pg C over 30 years. Carbon contained in harvested timber from these illegally deforested intact forests averaged ~0.52 Pg C year^{-1} and accumulated up to ~16 Pg C over three decades (Table 1). In addition, other relevant and subsequent carbon losses from illegal tropical timber, including postponed losses during wood processing and use in short-lived wood products such as pulpwood and fuelwood, were at ~0.47 Pg C year^{-1} and accumulated up to 14 Pg C in 30 years (Table 1) (Pan et al., 2024).

A remote-sensing based forest degradation study in Amazonia suggested that among various disturbances that cause degradation, about 30% was due to logging (Qin et al., 2021). Small-scaled selective logging often opened forest canopy and was typically illegal. However, carbon emissions from selective logging were small, averaging about 0.09 Pg C year^{-1}. Thus, we estimate that total simultaneous carbon emissions from illegal deforestation and illegal selective logging, which are linked to illegal timber sources, could total at least 1.32 Pg C year^{-1} (Table 1). This represents about three fifths of estimated tropical deforestation and degradation emissions (2.24 Pg C yr^{-1}) (Pan et al., 2024). Note that the estimate of carbon losses from selective logging was only derived from the study of Amazonia, while relevant data are lacking from other tropical regions. This is to say actual carbon emissions from illegal logging in all tropical forests are likely to exceed 1.32 Pg C year^{-1}. After also accounting for subsequent carbon losses from illegal wood products, the total carbon loss annually would be 1.84 Pg C year^{-1}, and resulted in large carbon losses of ~55 Pg C during 30 years' period (Table 1).

Impacts of ILAT on biodiversity and conservation

Negative impacts of ILAT on biodiversity and conservation are linked to the targeting of particular tree species that are in high demand and which bring high profits. For instance, increasing demand for rosewood species for traditional Asian furniture stimulated an increase in the rate of illegal logging by 5-9 times in tropical countries of Southeast Asia, driving rosewood trees (*Dalbergia cochinchinensis*, *D. cultrata*, *D. oliveri*) to near extinction. In the aftermath, demand was redirected to tropical African forests with increased illicit poaching of tree species (*Pterocarpus erinaceu*) used to replace rosewood (Dumenu, 2019). Illegal selective logging for other precious tropical tree species includes mahogany (*Swietenia*), ebony (*Diospyros*), teak (*Tectona*), and Ipê (*Handroanthus*), greatly endangering their existence. In the boreal forests of the Eastern Asia, illegal

logging also targets valuable timber species such as Korean pine (*Pinus koraiensis*), Mongolian oak (*Quercus mongolica*) and Manchurian ash (*Fraxinus mandschurica*), leaving degraded forests with altered species composition.

Tropical deforestation linked to ILAT destroys forest habitats for fauna and flora including in many of Earth's biodiversity hotspots. Sensitive species are vulnerable to extirpation in fragmented forest lands that have lost integrity. Community integrity and diversity are also impacted by edge effects and drying from land conversion practices. Often driven by access along logging roads, encroachment and hunting pressures cause further population declines and local extinctions. Illegal and selective logging leads directly to forest degradation, with impoverished habitats for old-growth specialists by opening the canopy, encouraging fire, and interfering with natural successional dynamics. Finally, tropical deforestation and degradation create barriers to native seed dispersal while facilitating invasive species, leading to the creation of novel ecosystems with altered species composition and functioning.

Illegal wood product trade and new legislation

Trade in illegal timber and related wood products represents another aspect of ILAT that must be addressed. Most illegal timber is consumed locally, and less than half of illegal wood products enter trading supply chains, some of which ends up in international trade flows (Kleinschmit et al., 2016). Because ILAT is poorly monitored, assessments of timber sources are considered to be the best indicators for identifying illegitimacy. The quantity of illegal wood products is usually estimated as fractions of timber supplies from timber producing countries characterized by high risks of ILAT. Over the last three decades, the percentage of illegal wood products appeared to decline as a proportion of the world's total exported wood products (from 48% to 29%) (Hoare and Uehara, 2022). Yet the total volume of exported illegal wood products (roundwood equivalent) was in fact steadily increasing by ~38 million m^3 along with significantly greater total exported wood products (Hoare and Uehara, 2022).

Since the 1990s, several countries and regions, both wood producers and importers, have strengthened forest governance and regulations aimed at banning ILAT. And there are developing legislations and agreements between major wood exporting and importing countries, for instance, the EU's FLEGT and VPAs (Voluntary Partnership Agreements) – a bilateral trade agreement negotiated between the EU and a timber-exporting country outside the EU. Following the suit, a few countries

have developed or strengthened their legislations forbidding illegal wood trade, such as the US's Lacey Act, Australia's ILP Act, Japan's Clean Wood Law, and New Zealand's amended Forest Act.

Recently, the EU has revised and begun updating the FLEGT regulation (https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en), promoting deforestation-free wood products on the European market. However, as long as there are considerable profits and gaps in regulations and law enforcement, illegal wood products are likely to find paths for entering markets. Tackling the challenge of reducing ILAT depends on enhanced forest governance and legislation domestically and internationally, and sincere cooperation with effective legal enforcement of laws among countries harboring wood producers, importers, and consumers.

China's international role is critical to reducing ILAT

For decades China has been the world's largest importer and consumer of wood-based products, sourced from both legal and illegal origins. Its domestic market is the main driver of increasing imports, as domestic wood supplies are estimated to meet just half of China's wood consumption (National Bureau of Statistics of China, 2023). But China has also become the world's most important timber-processing hub and wood furniture exporter, which makes identification of illegal wood origins very difficult when manufactured products are re-imported by major consumer countries in North America and Europe. In all, any change in China's import, export, and consumption of wood products and its forest governance and laws would have considerable global impacts on ILAT.

In 2020, China revised its forest law to ban ILAT with implications for both domestic and international timber sources– and for the first time provided a clear legal basis to exclude illegal timber from the market and establishes legal guidance for China's wood processing industry, although questions remain about concrete implementation of a timber tracking system and enforcement. As China now has mechanisms to intensify efforts to ban wood products with illegal origins, inevitably there is great anticipation by the international community that China will exert significant downward pressure on global ILAT, aligning with the efforts by EU, the US, Australia, Japan, and New Zealand, as well as a few tropical timber producer countries. An effective ban of global illegal wood trade by these key players would send strong feedback to large and small-scale

illegal logging, cascading towards the final resolution of reducing global deforestation and forest degradation, as well as other illegal agricultural commodities.

Reducing ILAT with multi-tasking approaches

The world's forests remain under threat from ILAT, with serious implications for mitigating climate change and achieving the UN's sustainable development goals. However, advances in methods for detecting ILAT and its environmental impacts, and the ostensibly improved policy environment for controlling it, suggest we are at a unique moment of maximum potential for making a difference in stopping it. For instance, placing the global ILAT issue under the framework of the UN's REDD+ (Reducing Emissions from Deforestation and forest Degradation in developing countries, plus the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries) and other relevant international agreements, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Global Biodiversity Framework, can potentially foster synergetic and effective mechanisms for reducing global ILAT altogether.

Reducing global ILAT and establishing legal and sustainable international wood supply chains can only be achieved with serious international compliance and cooperation. This involves cooperation between wood supplier and consumer countries, among governance, forestry, wood industry, and legal sectors, amid operations of enforcement agencies, monitoring and tracking, and data sharing– tasks impossible if undertaken by individual or a few countries and sectors. Action to stop ILAT aligns closely with the UNFCCC and IPBES ambitions (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, https://www.ipbes.net/) to confront the global climate and biodiversity crises, and mitigate climate change by eliminating greenhouse gas emissions and preventing further loss of nature.

Recommendations

Given that newly developed concepts directly link illegal logging with deforestation and forest degradation lead to potential approaches for quantitatively assessing impacts of illegal logging, it is sensible to take advantage of newer high-resolution remote sensing for monitoring illegal activities and improving assessment of illegal logging impacts as the technology is capable of detecting deforested lands and harvest of individual trees. It is necessary to have solid and

quantitative measures for appraising severity of destructive illegal logging to lend urgency for stopping it. Rapid detection of illegal logging activities in real time enable quick actions by government agencies, and effective investigating and prosecuting illegal operations. In addition, new wood identification methods using high-resolution genetic and other bio-technologies, such as DART-TOFMS (Price et al., 2022), are also highly applicable, and have potential to be deployed as reliable tools for detecting wood origins.

Detecting illegal selective logging and forest degradation is harder than monitoring large-scaled deforestation. We only have a few studies for Amazon rainforests, while lacking reliable data for Africa, Southeast Asia and other forest regions worldwide. We need more methodically scientific studies to gain essential data and evaluations to inform the public and policymakers. We also need strong advocacy for action and international cooperation and to raise global awareness among both actors and consumers. With existing regulations and measures, plus increased international and national policy responses to challenge ILAT, we can stop ILAT and realize the local and global benefits of using only deforestation- and degradation-free wood products.

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Table 1. Impacts of illegal logging on tropical forest carbon losses

Deforestation[1]	1990-1999	2000-2009	2010-2019	Mean	Total (1990-2019)
Tropical intact forest areas (10^6 ha)[2]	1,701	1,536	1,399	–	–
Tropical deforested intact forests (10^6 ha)[3]	192	137	139	156	467
Illegally converted lands (10^6 ha)[4]	106	75	76	86	257
Illegal conversion land C emission (Pg C yr^{-1})[5]	1.46	1.05	1.17	1.23	36.8 Pg C
Carbon content in harvested illegal timber (Pg C yr^{-1})[6]	0.50	0.50	0.56	0.52	15.6 Pg C
Carbon losses from harvested illegal timber (Pg C yr^{-1})[7]	0.45	0.45	0.51	0.47	14.0 Pg C
Degradation[8]					
Aboveground biomass loss(Pg C yr^{-1})[9]	–	0.30	0.33	0.32	9.5 Pg C
Carbon emission due to selective logging (Pg C yr^{-1})[10]	0.08	0.09	0.10	0.09	2.7 Pg C
Total C emissions related to illegal logging (Pg C yr^{-1})[11]	**1.54**	**1.14**	**1.27**	**1.32**	**39.5 Pg C**
Total carbon losses related to illegal logging (Pg C yr^{-1})[12]	**2.04**	**1.64**	**1.83**	**1.84**	**55.1 Pg C**

Note:
[1]All tropical forests
[2]Tropical average intact forest areas for the decade (Pan et al., 2024).
[3]Tropical deforested intact forest areas (Pan et al., 2024).
[4]The ratio of illegal land conversion to be estimated at ~55% (Hoare and Uehara, 2022).
[5]Assuming that emissions are instantaneous (~45%) upon deforestation (Pan et al., 2024).
[6]Carbon contained in harvested illegal timber (55% of total harvested timber) (Pan et al., 2024).
[7]Carbon losses from illegal timber during wood processing or used for short-lived wood products (Pan et al., 2024).
[8]Here, degradation estimates only include Amazon forests, carbon losses due to degradation from all tropical forests would be greater.
[9]Total degradation caused aboveground carbon losses (Qin et al., 2021).
[10]Using a ratio of illegal selective logging (~30%) of total carbon emissions (referring to Table S1 of Qin et al., 2021).
[11]Total instantaneous carbon emissions from tropical deforested and degraded intact forests.
[12]Total carbon losses related to illegal logging including instantaneous carbon emissions from deforestation and degradation, and later losses due to wood processing and uses.