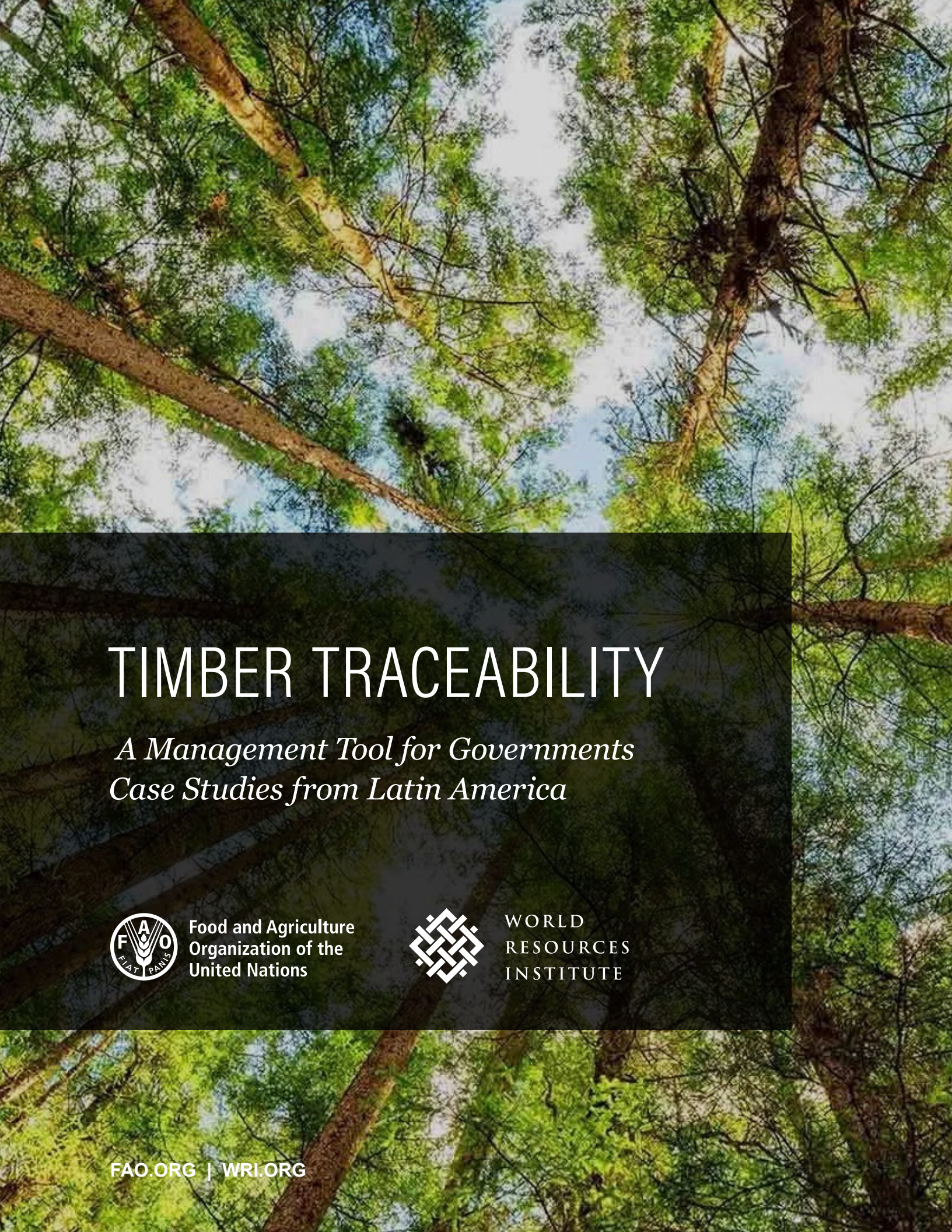

TIMBER TRACEABILITY

A Management Tool for Governments
Case Studies from Latin America

Food and Agriculture Organization of the United Nations

WORLD RESOURCES INSTITUTE

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LIST OF ABBREVIATIONS

ACA: annual cutting area

AOP: annual operating plan

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora

CSO: civil society organization

ES: executive summary

FAO: Food and Agriculture Organization of the United Nations

FMP: forest management plan

GDP: gross domestic product

ITTO: International Tropical Timber Organization

TLAS: Timber Legality Assurance System

VPA: Voluntary Partnership Agreement

WRI: World Resources Institute

BRAZIL

DOF: Document of Forest Origin

IBAMA: Brazilian Institute of Environment and Renewable Natural Resources

SCC: Chain of Custody System

SEMAS: State Secretary of Pará for the Environment and Sustainability

SEMA: State Secretary of Mato Grosso for the Environment

SFB: Brazilian Forest Service

SINAFLOR: National Control System of the Origin of Forest Products

SISFLORA: System for Marketing and Transporting Forest Products in Pará and Mato Grosso

COLOMBIA

CARs: Regional Autonomous Authorities for Sustainable Development

CARDER: Regional Autonomous Authority of Risaralda

MADR: Ministry of Agriculture and Rural Development

MADS: Ministry of the Environment and Sustainable Development

VITAL: Integrated Online Environmental Procedures Window

SUNL: national unique online pass

ECUADOR

DF: Directorate of Forests

MAAE: Ministry of the Environment and Water

MAGAP: Ministry of Agriculture, Livestock Farming, Aquaculture and Fisheries

SAF: Forest Administration System

SPF: Forest Production System

GUATEMALA

CONAP: National Council on Protected Areas

IECAI: electronic report of initial loading

INAB: National Forest Institute

ITEMAS: quarterly forest enterprises report

SEINEF: Electronic Information System for Forest Enterprises

SIFGUA: Forest Information System of Guatemala

HONDURAS

ICF: National Institute for the Conservation and Development of Forests, Protected Areas and Wildlife

SNIF: National Forestry Information System

SIRMA: Timber Traceability Information System

PANAMA

MiAmbiente: Ministry of the Environment

NFC: near-field communication

STCF: Forest Traceability and Monitoring System

PERU

MC-SNIFFS: Control Module of the National Forest and Wildlife Information System

MINAM: Ministry of the Environment

OSINFOR: Agency for the Supervision of Forest Resources and Wildlife

PTPA: United States of America–Peru Trade Promotion Agreement

SERFOR: Peruvian Forest Service

SNIFFS: National Forest and Wildlife Information System

Executive Summary

Traceability is a global trend and is becoming a new norm for conducting business and trade in international wood markets. This report outlines lessons learned and best practices in planning government-led timber traceability systems in Latin America, serving as a reference for government officials in other countries tasked with developing and implementing similar systems.

HIGHLIGHTS

- As governments across the globe have begun to develop and implement timber traceability systems, it is increasingly important to document lessons and best practices for existing processes.
- Traceability systems help achieve several objectives, including formalizing the forest sector, increasing the collection of taxes and royalties by governments, suppressing illegal timber markets, and supporting law enforcement. For private-sector actors, traceability systems can serve as an operations management tool to increase competitiveness.
- Among other things, it is important to define the purpose and expected benefits of the system for all actors involved, secure their buy-in through consultative and participatory processes, assess their capacities and training needs, and define a long-term financial sustainability strategy early in the process to ensure the system can be successfully implemented.
- Besides providing a secure supply-chain information management system, robust traceability systems should include verification activities, such as field verification and audits.
- While technological advances can seem powerful and appealing, traceability systems should be developed using appropriate technologies for the country. System designers should be realistic about what they can accomplish with technology and mindful of the capacity requirements needed to support the widespread use of these technologies.
- Forest authorities need political, legal, technical and financial support to address challenges and successfully develop and implement timber traceability systems in their countries, as well as support to conduct outreach and capacity-building activities associated with the systems.

Context

During the last decade, a wide array of timber traceability systems has been developed in timber-producing countries. As the trend towards traceability continues, it is important to document lessons and best practices as a reference for government officials in other countries who are interested in pursuing this path in the future.

This growing interest reflects, in part, an increase in demand for products of legal origin from international markets. Buyers are required to comply with regulations such as the Lacey Act of the United States of America or the European Union Timber Regulation by assessing and managing the risk of sourcing illegal timber in their supply chains. As such, governments in timber-exporting countries have become increasingly interested in exercising more control over timber supply chains and helping private-sector actors in their countries access these now regulated markets.

When fully implemented, these traceability systems should be able to trace individual logs, or batches of timber, from a legal place of harvest through the supply chain to domestic or international retail.

While traceability systems bring additional requirements, private-sector actors can leverage traceability systems to enhance their competitiveness by optimizing management operations and enhancing quality control. Businesses can also use traceability systems to comply and demonstrate compliance with legality requirements, reducing their risk of legal exposure.

Knowing the origin of the products and details about the supply chain allows traceability system users to assess the legal, social and environmental claims associated with the product. However, traceability systems by themselves do not guarantee the legality of the products. A product can be traceable but not necessarily legal.

Greater control over timber supply chains, especially if it includes pre-forest management operations, can also support sustainable forest management and help document best practices.

However, developing and rolling out timber traceability systems can be challenging. Timber supply chains are complex, and traceability systems often involve changes in approaches, operations management and logistics that require significant financial and labour investments. System implementers often face resistance from the sector and capacity gaps.

About this report

With support from the Norwegian International Climate and Forests Initiative, the Tillia Fund, the European Union, the Swedish Government and UK Aid, the World Resources Institute (WRI) and the Food and Agriculture Organization of the United Nations (FAO) and European Union (EU) Forest Law Enforcement, Governance and Trade (FLEGT) Programme (FAO-EU FLEGT Programme) aim to document lessons and best practices in the planning of government-led timber traceability systems from seven countries in Latin America as of the end of 2020. This will provide a reference for government officials in other countries who are tasked with developing and implementing timber traceability systems.

This report also seeks to help other audiences recognize that traceability is a global trend and is becoming a new norm for conducting business and trade in international wood markets. It acts as a follow-up to the FAO publication *Traceability: A Management Tool for Business and Governments* (November 2016), which presented experiences from African countries and complements an upcoming WRI publication on traceability (Stäuble et al., 2022) focusing on providing practical guidance on building traceability systems.

The focus on Latin America (Figure ES-1) is partly because many governments in the region have proactively implemented traceability systems and demonstrated a relatively high capacity to implement them, leveraging technologies and equipment to respond to the unique needs of their countries. The report focuses on government systems because they are mandatory and meant to be adopted by a wide variety of private-sector stakeholders on a large geographic scale (at national and subnational levels). The selection of countries is based on previous and current FAO and WRI work on timber traceability matters in these nations.

The traceability systems described in this report are at varying stages of development, offering an opportunity to present a snapshot of the different processes and timelines involved in the development and implementation of such systems. The report focuses on traceability systems for solid wood products from natural and planted forests.

Figure ES-1 | Countries highlighted in this report

Brazil, Colombia, Ecuador, Guatemala, Honduras, Panama and Peru were selected based on previous and current FAO and WRI work on timber traceability matters in these countries.
Source: United Nations Geospatial. 2020. Map geodata [shapefiles]. New York, USA, United Nations.

The traceability systems described in this report include the following elements:

- A defined **scope** in terms of:
  — forest production system (e.g. natural forests or forest plantations); and
  — phases in the supply chain and products covered (e.g. from forest management to sawmill or forest management to finished product).
- Requirements for **collecting and reporting supply-chain information through documentation**. The data-collection events are generally structured along steps in which trees are measured in the forest, harvested, transported, converted or altered, sorted, distributed and traded.
- A **database** for storing and processing traceability information.
- Defined procedures for **validation and verification of traceability information** throughout the scope of the traceability system.
- Mechanisms for **quality control, transparency** and monitoring of the overall performance and integrity of the system.

METHODOLOGY

The research team collected information on the following traceability systems:

Table ES-1 | Traceability systems featured

SYSTEM	AUTHORITY	LEGAL JURISDICTION
BRAZIL		
National Control System of the Origin of Forest Products (Sistema Nacional de Controle da Origem dos Produtos Florestais [SINAFLOR])	**Brazilian Institute of Environment and Renewable Natural Resources** (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis [IBAMA])	Mandatory use in all states after January 2018 (Embassy of Brazil in London, 2017).
Document of forest origin (Documento de Origem Florestal [DOF])		The DOF is operational at the national level in titles on federal lands and in states that do not operate their own system.
System for Marketing and Transporting Forest Products 1.0 (Sistema de Comercialização e Transporte de Produtos Florestais 1.0 [SISFLORA 1.0])	**State Secretary for Environment in the State of Mato Grosso** (Secretaria de Estado de Meio Ambiente do Mato Grosso [SEMA-MT])	State of Mato Grosso
System for Marketing and Transporting Forest Products 2.0 (SISFLORA 2.0)	**State Secretary for Environment and Sustainability in the State of Pará** (Secretaria de Estado de Meio Ambiente e Sustentabilidade do Pará [SEMAS-PA])	State of Pará
Chain of Custody System (Sistema de Cadeia de Custódia [SCC])	**Brazilian Forest Service** (Serviço Florestal Brasileiro [SFB])	Federal forest concessions
COLOMBIA		
National Timber Traceability System (Sistema Nacional de Trazabilidad para la Madera [SNTM]) **Research focus:** **Integrated Online Environmental Procedures Window** (Ventanilla Integral de Trámites Ambientales en Línea [VITAL])	**Ministry of Environment and Sustainable Development** (Ministerio de Ambiente y Desarrollo Sostenible [MADS])	National
ECUADOR		
National Forestry Traceability System (Sistema Nacional de Trazabilidad Forestal [SNTF]) **Research focus:** **Forest Administration System** (Sistema de Administración Forestal [SAF])	Timber from natural forests ▪ **Forest Administration System** (Sistema de Administración Forestal [SAF)), managed by the Ministry of the Environment and Water (Ministerio del Ambiente y Agua de Ecuador [MAAE]) Timber from forest plantations ▪ **System for Production Forests** (Sistema de Producción Forestal [SPF)), managed by the Ministry of Agriculture, Livestock Farming, Aquaculture and Fisheries (Ministerio de Agricultura, Ganadería, Acuacultura y Pesca [MAGAP])	National

Table ES-1 | Traceability systems featured (Cont'd)

SYSTEM	AUTHORITY	LEGAL JURISDICTION
GUATEMALA		
Electronic Information System for Forest Enterprises (Sistema Electrónico de Información de Empresas Forestales [SEINEF])	**National Forest Institute** (Instituto Nacional de Bosques [INAB])	National
HONDURAS		
National Forestry Information System (Sistema Nacional de Información Forestal [SNIF]) **With focus on the:** **Timber Traceability IT System** (Sistema Informático de Rastreabilidad de la Madera [SIRMA])	**National Institute for the Conservation and Development of Forests, Protected Areas and Wildlife** (Instituto Nacional de Conservación y Desarrollo del Bosque, Áreas Protegidas y Fauna Silvestre [ICF])	National
PANAMA		
Forest Traceability and Monitoring System (Sistema de Trazabilidad y Control Forestal [STCF])	**Ministry of the Environment** (Ministerio de Medio Ambiente [MMA])	Darién province, to be implemented nationally
PERU		
Control Module of the National Forest and Wildlife Information System (Sistema Nacional de Información Forestal y de Fauna Silvestre [MC-SNIFFS])	**Peruvian Forest Service** (Servicio Nacional Forestal y de Fauna Silvestre [SERFOR])	National

Information was compiled through a literature review, stakeholder interviews and field-based observations. The field assessment focused on the following: how the systems provided traceability and legality verification data to users; how the country context was reflected in the planning, development, implementation and uptake of the system by the users; identifying obstacles and opportunities; the robustness of the system structure in preventing fraud and unintentional errors; and, the role of technological innovation, if any, in the development of the systems.

Overall, the data collected helped understand the governments' reasons for developing traceability systems as well as the differences in structure and functions across countries, among other things. To the extent possible, data was collected on the legal traceability framework in the country, the expected system functions, the development process and how the systems are meant to work, financial and technical resources and capacity needs, and implementation strategies together with successes, challenges and opportunities.

Developing and implementing a traceability system can be overwhelming and challenging, and it can be useful to break the process into chunks to make it more manageable. The lessons and best practices identified in the case studies can help address some of these challenges in practical ways. The data collected was analysed, and the results were structured to highlight the following aspects:

- Initial considerations:
  - Defining system objectives and benefits
  - Financing
  - Stakeholder and capacity mapping
  - Legal requirements
- Design and development:
  - New versus existing systems
  - Traceability approach
  - Data collection and reporting
  - Data analysis, monitoring and verification

Conclusions

There is a global trend towards traceability, and it is fast becoming a new norm for business and trade in international timber markets. Governments in many tropical timber-producing countries are developing and implementing timber traceability systems for a range of reasons, such as exercising more control over the forest sector and helping private-sector actors in their countries access regulated legality-oriented markets.

There is no "one-size fits all" process for developing and implementing a traceability system. Nonetheless, an examination of the systems identified in this report, all at various stages of development, offers an opportunity to present a snapshot of the different processes and timelines involved in system development and implementation, allowing us to analyse lessons and best practices.

Successfully building a traceability system relies on considering and addressing key aspects during the early stages of system development. These include defining the purpose and expected benefits of the system for all actors involved; securing their buy-in through consultative and participatory processes; assessing their capacities and training needs; defining a long-term financial sustainability strategy; deciding whether to build a system from scratch or based on existing infrastructure; and, establishing interagency coordination processes.

Taking a phase-based approach to rolling out a traceability system allows the implementing agencies to build stakeholder capacity and awareness. It also helps navigate private-sector concerns and improves their understanding and ability to meet the system requirements. All the national-level traceability systems highlighted in this report are being rolled out in phases, with implementing agencies using test runs and pilots to raise awareness, train users, test applicability and feasibility, and navigate user concerns.

A strong information management system can help identify inconsistencies and raise flags about any inaccurate information. These systems can further increase the efficiency of forest agencies and

reduce costs by reducing the need to manually verify information. **However, databases alone cannot guarantee robust traceability if the traceability system does not include data verification activities, including field verification and audits.** These activities are critical in authenticating data self-declared by companies.

Civil society organizations (CSOs) are central to ensuring supply-chain transparency, particularly given the increasing requirements for timber buyers to assess and manage their risks of sourcing illegal timber in their supply chains. These organizations play a critical role in monitoring the information that government agencies have made accessible from their traceability systems and in making non-proprietary information more usable to the public and international stakeholders.

Recommendations

Implementing agencies should ensure that the key aspects highlighted in this report are addressed in the early development stages of the traceability system to facilitate long-term sustainability and industry buy-in.

Forest authorities need the back up of high-level political will, a solid legal and regulatory framework as well as financial and technical support to successfully develop and implement traceability systems.

System developers and implementing agencies should develop traceability systems using a phased-in approach including an initial penalty-free period. This approach helps identify challenges, foster greater understanding of user capacities and thus provide comprehensive training to ensure that all users can meet the requirements when they become mandatory.

Ensuring that private-sector actors have the capacity to comply with the system requirements is key. Engaging these users through targeted outreach and communications early in the planning and design phases is vital to secure their buy-in, identify their capacity needs and build those capacities.

Risks related to self-reporting and verification can be mitigated by establishing reporting requirements that are attainable with current user capacities, avoiding hard to verify requirements, establishing clear and publicly available procedures on reporting requirements, integrating safeguards to prevent fraud or data manipulation, and increasing transparency by making self-reported data publicly available for third-party monitoring.

While modern technologies (remote sensing, mobile technologies, physical markers, information management systems) present key advantages, they should be used at the level appropriate in each country, given user capacities and the countries' legal frameworks.

Initiatives by CSOs can play a role in ensuring supply-chain information reaches timber markets and helping buyers assess and manage the risks of sourcing illegal timber in their supply chains. Providing access to this information from government timber traceability systems is important for CSOs to play this role.

INTRODUCTION

Traceability has been defined as the ability to trace the history, application and location of a product, including the origin of its materials and parts, its processing history, and its distribution and location after delivery (ISO, 2015). Traceability systems centralize and document information about the product, the transformations it may have undergone and the transactions that have taken place between actors, which allows the product to be traced back through any transformations to its origin (Mundy and Sant, 2015). As such, traceability systems provide a mechanism to help verify the sources of raw materials, as well as the legal, environmental and social claims associated with a product.

An increasing number of governments in tropical timber-producing countries around the world have developed and implemented national timber traceability systems for different reasons, including:

- to exercise more control over the timber sector, including for maximizing government revenue based on timber-related fees, taxes and sales;
- to increase monitoring and control over the management of forest resources;
- to combat illegal logging and associated trade practices;
- to support private-sector response in addressing global market demands for evidence of legal timber (e.g. the Lacey Act of the United States of America and the European Union Timber Regulation [EUTR]); and
- to help document the legality of timber products to show they fulfil international commitments that require proof of legal origin, such as the European Union FLEGT Voluntary Partnership Agreements (FLEGT VPAs) with select countries and the United States of America–Peru Free Trade Agreement.

For the private sector, the benefits of traceability are improved quality control, streamlined processes and business optimization, which can increase business competitiveness. Traceability systems also enable operations to comply with legality requirements and demonstrate compliance and proof of legal origin for raw materials. This can increase access to regulated markets, which are sensitive to sourcing illegal or controversial timber. Timber traceability is a major trend on a global scale: companies are implementing traceability systems in their operations, convinced as they are of their value as an operations management tool. However, not all enterprises embrace traceability as an operation management tool, and implementation of and compliance with traceability systems are often considered to be a significant administrative and financial burden.

For governments in timber-producing countries, traders and importers in timber-consuming countries, traceability systems are important tools to verify that raw materials used in wood products were sourced from legal, responsible and non-controversial sources. Traceability systems also improve efficiency and reduce bureaucracy, as well as providing more ways of controlling product quality. When traceability systems are connected to pre-harvesting field activities and inspections, they can be used to support more sustainable forest management.

Developing and rolling out a timber traceability system can be challenging. Timber supply chains are complex in nature, but traceability systems often also involve changes in approaches, operations management and logistics that require significant financial and labour investments. For this reason, system implementers often face resistance from the sector and capacity gaps.

Objective

This report explores traceability systems in seven Latin American countries and seeks to identify lessons and best practices to help address the challenges in establishing such systems (Box 1). The intended target audience is primarily government officials tasked with developing and implementing traceability systems in timber-producing countries.

This report should also help audiences recognize that traceability is a global trend and becoming a new norm for conducting business and trade in international wood markets. It builds on the FAO publication *Traceability: A Management Tool for Business and Governments* (November 2016), which presented experiences from African countries at both the national and operator levels.[1] However, rather than looking at both public and private traceability systems, the focus is only on government timber traceability systems functioning at national and subnational levels. This is because these are mandatory and meant to be adopted by a wide variety of private-sector stakeholders at large geographic scales. Further, governments use these systems as a way of monitoring the forest sector, supporting decision-making in forest management on a wide scale, and to help document and demonstrate the legality of forest products at subnational and national levels.

Figure 1 | Countries with traceability systems highlighted in this report

Brazil, Colombia, Ecuador, Guatemala, Honduras, Panama and Peru were selected based on previous and current FAO and WRI work on timber traceability matters in these countries.

Source: United Nations Geospatial. 2020. Map geodata [shapefiles]. New York, USA, United Nations.

Scope of the report

The focus on Latin America (Figure 1) is for two main reasons. First, the region is home to the largest tropical rainforest on Earth, the Amazon basin and other important forests with high historic deforestation rates and which are under significant pressure of land conversion. Second, over the past few years, many governments in this region have proactively begun planning and developing traceability systems with relatively high capacity.

Through the methodologies and approaches applied, the designers of traceability systems in Latin America have leveraged technologies and equipment to respond to the unique needs of their countries, offering unique insights. The focus on Brazil, Colombia, Ecuador, Guatemala, Honduras, Panama and Peru stemmed from the fact that these are countries where WRI and the FAO-EU FLEGT Programme have worked on timber traceability issues.

Box 1 | The basics of timber traceability systems

When a traceability system is fully implemented it should be able to trace either individual logs or batches of timber, from a legal harvest origin through the supply chain to domestic or international retail. The traceability systems described in this report include the following elements:

- A defined scope in terms of:
  - forest production system (e.g. natural forests or forest plantations); and
  - phases in the supply chain and products covered (e.g. from forest management to sawmill, or from forest management to finished product).
- Requirements for collecting and reporting supply-chain information through documentation. The data-collection events are generally structured along steps in which trees are measured in the forest, harvested, transported, converted or altered, sorted, distributed and traded.
- A database for storing and processing traceability information.
- Defined procedures for validation and verification of traceability information throughout the scope of the traceability system.
- Mechanisms for quality control, transparency and monitoring of the overall performance and integrity of the system.

Knowing the origin of products and details about the supply chain allows users to assess the legal, social and environmental claims associated with them. However, traceability systems by themselves do not guarantee product legality. A product can be traceable without necessarily being legal.

The design of a system to include the elements above will be discussed in detail in the analysis section of this report.

CHAPTER 1

METHODOLOGY

This report aims to glean lessons and best practices in the development and implementation of timber traceability systems based on the experiences in seven Latin American countries.

The research team collected information on 11 traceability systems across these countries using a three-pronged approach:

1. **Literature review** – including material on the forest sector and forest-sector governance in the country, documents concerning the systems under review, internal documents on the systems made available by officials, publications and other documents.

2. **Field-based observations** – involving site visits at various stages of the supply chain and observations by technical experts on how the systems are used. Observations were documented with digital photographs, GPS tracking, and paper- and digital-based notes. The field assessment focused on the following questions:

    - How does the system provide its different users with requested data on product traceability and legality verification?
    - How is the country context reflected in the development, implementation and uptake of the traceability system by its users? What are the obstacles and opportunities?
    - How robust are the structure and implementation of the system against fraud and unintentional errors (e.g. undetected mixing or substitution of legal and illegal materials in the supply chain)? What is the role of technological innovation, if any, in the development and implementation of the traceability system?

3. **Interviews** – including face-to-face and virtual meetings and structured interviews as well as email exchanges with more than 70 stakeholders. Interviewees included system developers, system owners and managers, service providers and technical support organizations, including CSOs. Interviewees also included traceability system users from government authorities, business owners and employees. Interviewees were selected based on their expertise and to represent the widest possible scope of stakeholders to cover different user roles and business types and scales. See Annex 1 for a list of people interviewed, and Annex 2 for a sample questionnaire.

The data collection sought to understand why governments choose to implement traceability systems, how the structure and functions of these systems differ across countries, and how choices about function and scope are made. To the extent possible, data was collected on:

- the legal framework governing traceability in the country;
- expected system functions;
- overview of system development and how the system is meant to work;
- financial and technical resources and capacity;
- implementation strategy, including system rollout and safeguard strategy; and
- successes, challenges and opportunities.

All data collected was compiled and assessed to identify commonalities and differences in the development and implementation of the systems, including their performance in terms of reducing the risk of the different types of fraud typical in the sector.

The insights gained from analysing experiences in the seven countries were structured using the traceability diagnostic framework proposed by Stäuble *et al.* (2022), as shown in Table 2.[2] However, because the traceability systems highlighted in this report are at different stages of implementation, the analysis focused on the planning stage, from initial considerations to design and development.

Table 1 | Structure for the analysis of traceability systems

PLANNING PHASE	ASPECTS COVERED
Brazil	**Aspects covered**
Initial considerations	Defining system objectives and benefits Financing Stakeholder and capacity mapping Legal requirements
Design and development	New versus existing systems Traceability approach Data collection and reporting Data analysis, monitoring and verification

CHAPTER 2

ANALYSIS

Developing and implementing a national timber traceability system can be overwhelming, especially if the system planned is complex. This depends on whether the system will need to be built from scratch and how much stakeholder consultation is needed, as well as on the existing financial, human and technical capacities of the government agencies involved. Table 2 presents an overview of the traceability systems highlighted in this report.

Table 2 | Traceability systems highlighted in this report

SYSTEM	BRIEF DESCRIPTION	AUTHORITY	LEGAL JURISDICTION
BRAZIL			
National Control System of the Origin of Forest Products (Sistema Nacional de Controle da Origem dos Produtos Florestais [SINAFLOR])	Launched in March 2017, SINAFLOR aims to "regulate and track the entire logging process and enhance the transparency and security of the forest sector, in accordance with Articles 35 and 36 of the Brazilian Forest Code. By increasing the transparency and traceability of the entire timber production process, SINAFLOR aims to prevent the entry of illegally sourced wood into the legal market" (Lujan).	**Brazilian Institute of Environment and Renewable Natural Resources** (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis [IBAMA])	Mandatory use in all states after January 2018 (Embassy of Brazil in London, 2017).
Document of forest origin (Documento de Origem Florestal [DOF])	Launched in 2006, the DOF was considered a first step in transforming the Brazilian forest sector-control system from a paper-based process to a more sophisticated semi-electronic system managed at the federal level.		The DOF is operational at the national level, in titles on federal lands and in states that do not operate their own system.
System for Marketing and Transporting Forest Products 1.0 (Sistema de Comercialização e Transporte de Produtos Florestais 1.0 [SISFLORA 1.0])	SISFLORA was implemented in Mato Grosso and Pará by the governments of those states soon after the DOF was introduced. In 2017, the State Secretary for Environment and Sustainability in the State of Pará (Secretaria de Estado de Meio Ambiente e Sustentabilidade do Pará [SEMAS-PA]) upgraded to SISFLORA 2.0. The State Secretary for Environment in the State of Mato Grosso (Secretaria de Estado de Meio Ambiente do Mato Grosso [SEMA-MT]) continues to operate SISFLORA (thus SISFLORA 1.0) as the private sector deemed the requirements of version 2.0 to be too onerous to comply with (ITTO, 2017b). Both systems were originally developed to reduce IBAMA's regulatory burden as 70 percent of timber products come from these two states (BVRio, 2016).	**SEMAS-PA and SEMA-MT**	States of Mato Grosso and Pará
Chain of Custody System (Sistema de Cadeia de Custódia [SCC])	The SCC was developed by the Brazilian Forest Service to monitor the material flow from concessions in federal forest areas to harvesting through to primary processing.	**Brazilian Forest Service** (Serviço Florestal Brasileiro [SFB])	Federal forest concessions
COLOMBIA			
National Timber Traceability System (Sistema Nacional de Trazabilidad para la Madera [SNTM]) **Research focus: Integrated Online Environmental Procedures Window** (Ventanilla Integral de Trámites Ambientales en Línea [VITAL])	The Colombian system consists of four modules currently at different stages of implementation (FAO, 2019): forest management planning, forest operations, transport and operational books. Once all four modules are developed, they will be connected through the VITAL, a central infrastructure which will connect all the modules in the system.	**Ministry of Environment and Sustainable Development** (Ministerio de Ambiente y Desarrollo Sostenible [MADS])	National

Table 2 | Traceability systems highlighted in this report (Cont'd)

SYSTEM	BRIEF DESCRIPTION	AUTHORITY	LEGAL JURISDICTION
ECUADOR			
National Forestry Traceability System (Sistema Nacional de Trazabilidad Forestal [SNTF]) **Research focus: Forest Administration System** (Sistema de Administración Forestal [SAF])	The SNTF is populated with information from two systems which control the flow of timber products from two sources, both at the national level: one for timber from forest plantations and one for timber from natural forests. For our research we focused on the SAF, which monitors the timber flows of products originating in national forests. The SAF uses more sophisticated technology for managing the risks associated with natural forests. These features include the use of web-based databases by the verification agency for validation at road checkpoints.	Timber from natural forests (national level) ▪ **Forest Administration System** (Sistema de Administración Forestal [SAF]), managed by the Ministry of the Environment (Ministerio del Ambiente y Agua de Ecuador [MAAE]) Timber from forest plantations (national level) ▪ **System for Production Forests** (Sistema de Producción Forestal [SPF]), managed by the Ministry of Agriculture, Livestock Farming, Aquaculture and Fisheries (Ministerio de Agricultura, Ganadería, Acuacultura y Pesca [MAGAP])	
GUATEMALA			
Electronic Information System for Forest Enterprises (Sistema Electrónico de Información de Empresas Forestales [SEINEF])	Launched in 2014 and based on the Regulation of Forest Enterprises Control, SEINEF is a semi-electronic timber sector monitoring system, with volume-tracking and transaction-verification functionalities. This helps the private sector operate more effectively by having increased access to market information, while also helping guide verification activities or road checks.	**National Forest Institute** (Instituto Nacional de Bosques [INAB])	National
HONDURAS			
National Forestry Information System (Sistema Nacional de Información Forestal [SNIF]) **With focus on the: Timber Traceability IT System** (Sistema Informático de Rastreabilidad de la Madera [SIRMA])	Launched in 2008, this centralized data platform allows the national forest authority to maintain records across various steps of the supply chain. Through the SNIF, the national authority can carry out checks on supply-chain actors, and it makes the document approval process more agile and transparent. SIRMA is a centralized online tool for monitoring timber flows. SIRMA uses SNIF data as the basis for issuing transport permits, and managing and analysing data submitted by timber processing industries through monthly reports. Through SIRMA, the national forest authority can compare and reconcile inputs and outputs at every step of the supply chain, allowing control of inventories, production and trade.	**National Institute for the Conservation and Development of Forests, Protected Areas and Wildlife** (Instituto Nacional de Conservación y Desarrollo del Bosque, Áreas Protegidas y Fauna Silvestre [ICF])	National
PANAMA			
Forest Traceability and Monitoring System (Sistema de Trazabilidad y Control Forestal [STCF])	The timber monitoring system in Panama is currently being implemented under Resolution DM-0068-2018 dated 2018, which is based on the use of the STCF. The STCF is the only system in the region which will allow wood to be traced from the point of origin to export. As of October 2019, the system had been launched in East Panama and Darién province (Rodriguez, 2019), and in the next few years, it will be rolled out across the entire country.	**Ministry of the Environment** (Ministerio de Medio Ambiente [MMA])	Darien province, to be implemented nationally

Table 2 | Traceability systems highlighted in this report (Cont'd)

SYSTEM	BRIEF DESCRIPTION	AUTHORITY	LEGAL JURISDICTION
PERU			
Control Module of the National Forest and Wildlife Information System (Sistema Nacional de Información Forestal y de Fauna Silvestre [MC-SNIFFS])	MC-SNIFFS includes a series of electronic record-keeping applications for forest management operations, primary processing facilities and transport authorizations. These tools are designed to generate the information needed to document the flow of timber products, establish traceability and demonstrate legality. However, while the use of these applications is required by law (Forest Management Regulation of the Legislative Decrees 1220 and 1319, as well as SERFOR's Executive Direction Resolutions 104-2017 and 044-2020), these tools are still being rolled out, so their use is voluntary.	**Peruvian Forest Service** (Servicio Nacional Forestal y de Fauna Silvestre [SERFOR])	National

By breaking down the process, it may be easier for system designers to identify potential risks and gaps within the development strategy, or to understand why the development of the system has stalled or failed. Below is an analysis of the experiences, approaches and best practices from the country case studies. They are organized by two main aspects within the planning phase:

- initial considerations
- design and development

The findings from individual case studies are highlighted where appropriate in bold, and the details on the systems by country can be found in Annex 4.

Initial considerations

To begin, designers need to define the purpose and benefits of the system and the resources at hand, including how the system will be financed, and any changes in the regulatory framework that are needed to enable and support the implementation of the system.

Defining objectives and benefits

It is critical to identify and clearly define the purpose and benefits of the system for all relevant actors early on, to ensure that the system is developed in a manner that meets the expectations of various groups. For example, in Honduras, one of the benefits in developing the system was to obtain statistics on the sector. Thus, SIRMA was designed to harmonize different records in order to generate reports with up-to-date information, which allow the government to access near real-time information on wood product flows, and identify red flags and possible incidents of illegality before the products are traded. In Guatemala, two objectives of the forest authority for the system were to regulate informality in the forest sector and reduce tax evasion. Thus, once forest sector operators are registered in the national forest registry and SEINEF, the system tracks and documents business transactions throughout the supply chain, making it harder for informal or unregistered businesses to sell and transport their products.

Defining the benefits of the system early on can also help secure buy-in from the private sector because businesses are able to see how the system will benefit them. For instance, an important incentive for businesses to participate in SEINEF is to have assurance of operations legality. The system also facilitates the payment of royalties and taxes, which, if unpaid, can result in very expensive fees and possible legal action.

Appropriately tailored communications and consultations can help identify the needs and expectations of all key stakeholders and define the purpose of the system. Further, this early engagement with stakeholders is key for securing their buy-in and helps identify insights and expectations, which can influence the design of the system. In Guatemala, small businesses operating informally identified by INAB officials are encouraged to register rather than threatened with sanctions that could destroy livelihoods. The growing number of registered users in the national

forest registry since the start of SEINEF in 2014 as well as interviews with system users (see Annexes 1 and 3) suggest that INAB's approach is appropriate.

Financing

Bilateral aid agencies and international organizations have supported the development of government-led timber traceability systems in most of the countries highlighted in this report. These investments highlight the importance of information management systems, chain of custody and record-keeping for international markets to validate claims of legal origin associated with timber products. However, while international donors may support the initial development and implementation costs of some systems, overall management and implementation of all systems must be financed by in-country government agencies to ensure their long-term sustainability.

Developing a traceability system is only a wise investment if the long-term financing of the system's implementation and maintenance is defined during the planning phase, based on specific needs and the country context, regardless of the price tag. Governments must account for how the cost of designing, implementing, maintaining and improving a system will be covered, either through public or international investment. Ideally, the budget should also include funds needed for consultation, training and the deployment strategy as well. One way to ensure that systems are maintained is to earmark funds for their maintenance in government legislation. This should ensure that governments keep funds for things such as software updates, equipment purchases and training.

Expensive systems do not necessarily translate into well-designed, functional or user-friendly systems. Comparing systems based on cost is not always effective because systems vary in their geographic scope as well as in the parts of the supply chain they cover, and thus vary in cost. Most of the systems highlighted in this report were developed domestically, with limited budgets, and in a modular approach. While progress has been slow, these processes have yielded valuable lessons.

In **Panama**, the government worked with a smaller budget – around USD 50 000 – to develop their system. While the system's design was ambitious and used a comprehensive approach to traceability, the system only covered one region of the country, which helps explain the lower budget.

In Guatemala, the initial investment for **SEINEF** came from the International Tropical Timber Organization (ITTO) and the United States Agency for International Development (USAID). ITTO supported the development of the **Guatemalan Forest Information System** (Sistema de Información Forestal de Guatemala), which became the backbone for SEINEF (INAB, 2013; ITTO, 2014). The forest authority

INAB invested approximately USD 200 000 from ITTO funds to set up SEINEF. Funding from USAID was then used for outreach activities (TV and radio advertisements) and training, targeting the private sector and communities. Currently, INAB charges users for printing the transport permits to partly fund the upkeep of **SEINEF**.

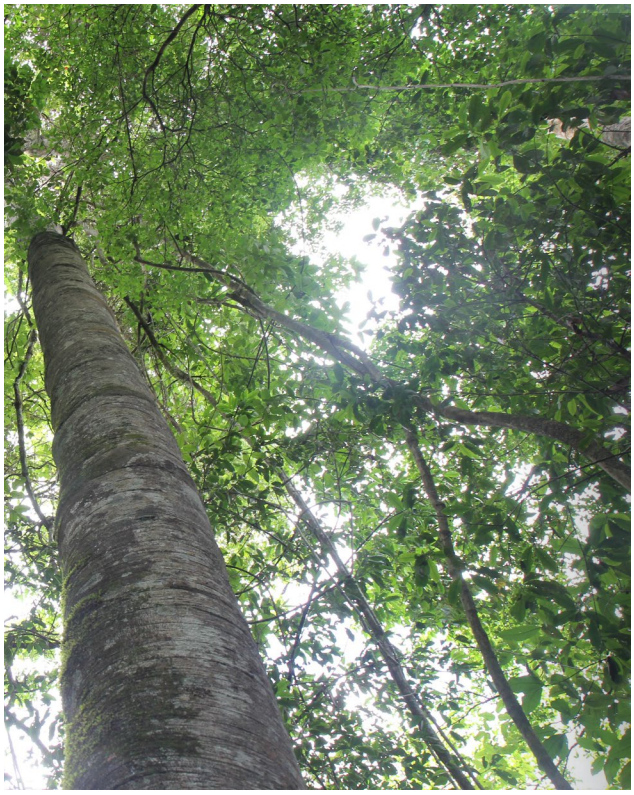
Management fees, transport documents and providing traceability materials (tags, labels, etc.) to operators can be a source of revenue for the upkeep and maintenance of systems. Since most traceability systems are established to support the collection of fees and royalties, they can contribute to their justification and acceptance if they are directly financed from these inputs, as is the case in Guatemala.

A traceability system is never "finished," even when it is up and running at its full intended scope. Continuous improvement will be driven by learning from the data collected and by adapting to changing conditions. Further, in addition to the costs of system design, deployment and maintenance, costs for inspection activities (in forests, on roads or in processing facilities), marking materials (if used) and data management also need to be counted as core costs of the system.

Stakeholder and capacity mapping

Assessing the current capacities and capacity-building needs of stakeholders early on is crucial. The stakeholders who will interact with the system are specifically government-and private-sector actors. In **Guatemala**, the forest authority found that businesses that had been operating without an electronic data management system were not overburdened by the requirements, and that they were able to use Basic MS Office applications and a PC with internet access to get started. Interviews found that companies already using electronic record-keeping tools generally viewed redundancies with maintaining their **SEINEF** accounts and internal systems justified by the benefits.

Although a system will never meet the needs of every user group, private-sector actors must understand what is required of them under the system. They should have capacity to access the system to enter information, as well as to generate information from their operations



to report into the system. In some cases, where the traceability system has been developed in response to external market requests (e.g. VPA process), developing a traceability system can be part of a strategy to understand the needs of private-sector actors and help them build their business and operations management capacities by encouraging them to adopt better documented and compliant operations.

It is also important for the forest authority to assess their own capacity for designing the system or overseeing its development; deploying the system; training users; maintaining the system; and verifying and interpreting the data collected through the system.

The use of technology is an important consideration when assessing capacities and capacity gaps. In developing **SEINEF**, the national forest authority sought to incorporate lessons from other countries, but determined that some of the options could be too technologically ambitious for Guatemala. A fully electronic traceability system would have faced financial, technological and cultural barriers. Thus, **SEINEF** was designed as a semi-electronic system with a central database, populated with information collected from online forms, spreadsheets and physical paperwork. In experiences like Guatemala, there are

more opportunities to build a fully electronic system as capacities develop.

Legal requirements

The impacts that reporting requirements will have on companies and authorities should be considered before making those requirements legally binding. For example, the authorities might not have the capacity to do weekly or monthly audits, and only quarterly audits might be feasible. Governments must find a balance between what is feasible for all parties, or they risk overburdening those interacting with the system, which could lead to its misuse.

In **Ecuador**, the Ministry of the Environment's Law for Forestry and Conservation of Natural Areas and Wildlife of 1981 and other regulations provide the regulatory framework that encourages sustainable forest management through forest management plans, transport of timber products and the supervision of "final destinations" (industries and warehouses). The overall objective was to reduce illegal timber harvesting while creating the right conditions for promoting national timber certification processes for the legal origin of timber. The **SAF** tracks these various legal requirements electronically, which assists the authorities in better identifying possible incidents of illegality.

The main requirements regarding timber traceability included under the **SAF** are linked to the use of an integrated management plan and a forest management plan, which are developed by forest operators. The validation of these documents triggers a **timber harvesting licence** (*licencia de aprovechamiento*). The timber has then to be transported along with a **transport permit** (*guía de movilización*). All procedures and approvals are conducted online, from approval of the forest management plan to the issuance of transport licences, with little contact between government officials and forest operations personnel. Finally, primary processing establishments and forest industries may only acquire and use raw materials from an authorized source.[3]

In **Brazil**, although various authorities operate different systems at the national and subnational level, they all share similar basic requirements. For title holders to prove that their products originate from a legal source, they must have a **forest management plan** and **annual operations plan** (*plano operational annual*), which is approved by the competent authority.

Once the timber is ready to be transported, a transport permit is required. Under the **DOF** system which operates at the national level, operators use the **Document of Forest Origin** system (Documento de Origem Florestal), while those operating under the SISFLORA system in Pará and Mato Grosso use a document called the **forest guide** (*guia florestal*).

To legally operate a sawmill, the producer must have a **licence**, which varies depending on where they are operating. An e**nvironmental licence** (*licença ambiental*) for businesses operating in Mato Grosso under SISFLORA 1.0; a **unique environmental licence** (*licença ambiental única*) under SISFLORA 2.0 for businesses operating in Pará; and, an **operating licence** (*licença operacional*) for businesses operating elsewhere under the DOF.

While each authority has its own documents for their system, they all serve the same purpose, which is to require sawmill operators to report their activities daily, including "all log and timber products received and delivered" as well as "all the inputs and outputs of their processing activities, by product and species" (Moura Costa *et al.*, 2017).

In **Panama**, as per the Forest Law of 1994 and the Management Norms of Panama (Resolution AG-0613-2009), to be allowed to harvest timber, forestry companies must submit a forest management plan and annual operating plan (AOP), designed by a forest manager accredited by the Ministry of the Environment.
This manager oversees the harvesting process and, alongside the recipient of the permit, concession or authorization, is responsible for ensuring that all applicable regulations are complied with. The management plan ensures selective logging based on:

- respecting cutting cycles based on the size and level of intervention by establishing annual cutting areas (ACAs);
- determining separate cutting diameters for each species harvested;
- protecting seeding trees; and

- respecting areas requiring protection (steep slopes, river banks, fragile soils, etc.).

As far as traceability is concerned, and as per Resolution DM-0068-2018 dated 2018, the main requirements are the following:

- a detailed forest inventory of the ACAs for the purposes of designing an AOP; during this inventory, trees are identified using ID tags
- the use of transport permits (*guías de transporte*) generated through the STCF for transporting wood between the forest and the storage yard and/or primary processing facility
- the use of a timber registration record for inputs and outputs of timber in processing plants

Design and implementation

In developing a system, developers should first identify and define what type of information needs to be collected. Then, they should develop a strategy for both the software design and how information will be collected, shared, analysed and verified. These workflows are essential in explaining how the system should work to both internal and external audiences. Workflows should also include clearly defined roles and responsibilities and should be understood by all actors involved and system designers, who may not have a background in forestry or traceability. The workflows should also establish control mechanisms to verify that people are fulfilling their roles, and outline how the development and implementation of the system will be monitored. Procedures for information sharing, reporting requirements and data verification are especially important.

Designing a new system versus building on existing infrastructure

There are advantages and disadvantages in building a traceability system based on existing infrastructure (including systems used in private companies) or starting one from scratch (Table 3). While most of the systems featured in this report are being custom developed, some governments have explored the possibility of adapting existing systems. Some of the advantages and disadvantages of both the approaches discussed during the interviews are shown in Table 3.

In deciding on whether to adapt or develop a system, it is important to assess whether the scope and functionalities of the existing system are compatible with the context of the geographic area of interest. Operationally, the system should also be compatible with the type of documentation and information it relies on (e.g. harvesting logbook, waybill and sawmill registration book) and the processes for collecting data (e.g. paper, spreadsheets, tablets and smartphones).

Adapting a system, especially in the case of commercial systems, can be costly because of licencing and maintenance fees, the costs of software updates, customization and data storage. Other issues to consider include where the data will be stored and who will own it, and aspects such as data accessibility,

Table 3 | Advantages and disadvantages of adapting existing systems versus developing a new system

	ADVANTAGES	DISADVANTAGES
Adapting	▪ Ideally, an existing system has shown that it can be maintained in the long term. ▪ The system has already been tested in the field. ▪ The software cost is known. ▪ The learning curve may be low for all actors involved as system development is informed by previous experiences and challenges.	▪ Depending on the context of where the system is being adapted, it may be overly burdensome and expensive to adapt rather than develop a new system. ▪ The adapted system may not feel fit for purpose and may reduce the ability to create buy-in among the key stakeholders.
Developing	▪ The system will be specifically designed to meet the needs of the local context. ▪ No revisions to the legal and regulatory framework will be needed before development begins.	▪ A new system will not have been field tested, meaning that an in-depth testing period will be needed. This might cause delays. ▪ The development costs are harder to predict.

security and integrity.

It should not be taken as a given that if a system worked in one place it will work elsewhere. Consultation with stakeholders and outreach are critical throughout the adaptation process to ensure that the product and processes developed meet the needs of users and have taken their realities on board. It is also important to ensure that the actors who will be interacting with the system both in the forest and elsewhere are trained on system maintenance, data entry, analysis and verification. Consulting with companies who have already integrated traceability into their operations can help create buy-in, facilitate consistent data sharing and avoid duplication of efforts or the establishment of parallel systems.

When multiple systems operate within overlapping geographic boundaries or supply-chain scopes, the authorities will have to reconcile data entered from various systems to validate the legal status of the product. When designing a new system where one already exists, a mechanism to reconcile data will be paramount for confirming the legality of products harvested, processed or transported within the country.

In some cases, if existing systems are not interconnected, there are risks of loopholes and double counting. In **Brazil**, IBAMA developed **SINAFLOR** to reconcile data across state-level traceability systems to provide a clearer picture of timber flows throughout the country as the products travelled through various legal jurisdictions. Box 2 outlines how SINAFLOR is able to reconcile data across geographies and traceability systems.

In Colombia, the development of a national **Integrated Online Environmental Procedures Window** (Ventanilla Integral de Trámites Ambientales en Línea [VITAL]) was an opportunity for the Ministry of the Environment and Sustainable Development to connect and harmonize the timber traceability systems operated by environmental **Regional Autonomous Authorities for Sustainable Development** (Corporaciones Autónomas Regionales para el Desarollo Sostenible [CARs]), which were previously disconnected. VITAL also met the requirements of the private sector, which had a strong preference for submitting applications and consolidating data online rather than liaising directly with the CARs to obtain the required licences. Such processes aimed to reduce direct interactions between public servants and operators and foster improved transparency in the timber sector.

Implementing a system that inspires confidence so that timber buyers are encouraged to provide legal supplies would strengthen the national forest sector, which is currently heavily dependent on imports.

Box 2 | Compatibility of traceability systems

Operating multiple systems within one country is challenging. In Brazil, much of the wood extracted may enter different jurisdictions as it travels along the supply chain. For example, the community cooperative COOMFLONA (Cooperativa Mista da Floresta Nacional) manages a forest concession in the Tapajos National Reserve in the State of Pará. The cooperative includes a sawmill and a secondary processing facility within the concession. While these operations are all covered by the DOF system, as they are established on federal public land, the cooperative also sells a large share of its products to sawmills within the state.

The traded materials thus enter the SISFLORA 2.0 system. To avoid losing the traceability of the products as they move between different jurisdictions, IBAMA created SINAFLOR, which is an umbrella system that inputs data from the various systems and reconciles volumes to maintain integrity. If roundwood volumes used in the two systems are not reconciled, there is a risk that the same volume will be counted twice. According to IBAMA and officials from SEMAS-PA and SEMA-MT, this loophole between SISFLORA 2.0 and the DOF was closed in 2016, but it remains within SISFLORA 1.0.

Table 4 | Comprehensive traceability and volume-based traceability

TRACEABILITY APPROACH	DEFINITION	ADVANTAGES AND LIMITATIONS
Comprehensive traceability	For the purposes of this report, we define comprehensive traceability as the tracing of all wood and wood-based products individually at all stages of the supply chain. It involves physically marking stumps, trees, logs and timber. Besides external traceability (between individual supply-chain actors), comprehensive traceability requires high levels of internal traceability (i.e. traceability at processing level on each site).	Comprehensive traceability allows a more detailed tracing of the products. However, the implementation of this system is more expensive, as it requires more inputs (e.g. marking materials), personnel and controls. Comprehensive traceability for solid wood may be more achievable for niche products and when buyers are willing to pay higher prices.
Volume-based tracking	Volume-based traceability, or "mass balance system," is a record-keeping system that traces products by balancing quantities at all stages of biomass production along the supply chain. This balancing ensures that the quantity of compliant biomass that is removed is never greater than the quantity of compliant biomass that previously entered into the system (ISCC, 2010).	Logistically, volume-based traceability is easier to implement and is less costly. However, this approach is heavily dependent on conversion factors. If the conversion factors are not adequate and the yield estimations are inaccurate, they can enable timber laundering (when estimated yields are inaccurately high) or cause losses for the producer (when estimated yields are inaccurately low). Furthermore, a volume tracking system will not enable users to determine the source of finished or semi-finished products in terms of forest origin as it does not maintain such information across several links in the supply chain.

Traceability approach

For the purposes of this report, the traceability approach refers to the strategy used which can be volume based or comprehensive (item by item), as shown in Table 4.

Choosing between comprehensive and volume-based tracking depends on various factors, such as the type of illegality risk, available capacity, political and technological context, implementation costs, whether the asset is distinguishable from other assets (e.g. for hardwoods with unique length/diameter/species properties) and cost-benefit considerations. Ideally, comprehensive traceability systems that include physical marking of trees and timber products throughout the processing stages in the supply chain should be implemented in situations with a high risk of illegality, while volume tracking is sufficient in situations where the risk of fraud or introduction of illegally sourced materials is low. While a comprehensive system may seem appealing, many of the case studies in this report show that volume tracking can meet the needs of system owners with regard to monitoring the sector at a much lower cost with less effort. However, because of the significant challenges inherent in estimating accurate conversion factors (see Box 3), volume-based traceability systems must be designed in such a way that they help identify inconsistencies and raise red flags to inform inspections and field verifications. In some cases, a hybrid approach can be used: a comprehensive approach from forest to processing facility, and a volume-based approach when the product is processed, as asset tracking can be challenging if the products are not easily identifiable.

When defining the approach, critical points in the supply chain and the perceived risks of the products should be identified, as well as existing inspection mechanisms at these points and the data or data-collection methods available. In **Honduras**, the marking of mahogany (a CITES-protected species) with paint as it moves through the supply chain is an example of comprehensive traceability that includes a physical marking component (Nogueron and Middleton, 2013). Unlike with volume-based tracking, this level of traceability allows the product to be tracked from primary processing back to point of origin in the forest. Mahogany and other high-value or CITES-protected species from natural forests might require higher levels of traceability, as they

are perceived to be associated with a higher risk of illegality. While comprehensive traceability may be adequate for harvesting CITES-listed species, the same requirements might not be necessary for all species and forest types.

For example, in **Honduras**, **Guatemala**, **Ecuador** and **Colombia**, the perceived risk of illegality associated with timber from forest plantations is generally considered to be lower than for timber from natural forests. Although illegal logging and poaching of certain conifer species does occur in natural forests in **Guatemala** (Steffens, 2018), other species of pine in **Honduras** and **Guatemala** are grown in plantations and harvested through clear cuts as they have lower value and are not endangered. Making

Box 3 | Conversion factors

For volume-based traceability, the volume measuring method and conversion factors are key for monitoring timber inputs and outputs as they move through different processing stages along the supply chain. Inaccurate conversion factors can result in false information and can compromise the entire traceability system. Establishing comprehensive and accurate frameworks for measuring units and conversion factors remains an important challenge and barrier to the integrity of a volume-based traceability system. Often, different actors apply different methodologies for measuring the same unit. For example, there are at least three different basic approaches for measuring the volume of a single log, and numerous differences in converting actual volumes to commercial volumes (through bark deduction, consideration of bow, twist and other defects). Most roundwood measuring is done by hand with basic tools. Thus, there can be significant volume differences when different actors measure the same log. To reduce these discrepancies, system designers and stakeholders should agree on standardized procedures for volume measurement.

Different actors will also have different conversion factors for the same process. For example, the yield from roundwood to sawnwood will vary over time and between and within sawmills. The yield depends on parameters such as species, mill technology, the skill of the saw operator, roundwood quality and size, and product quality and size. Because of these facts, volume tracking systems will need a level of tolerance for data discrepancies. At the same time, such tolerances create opportunities for unwanted misuse of the system. Differences between the conversion factor in the system and the actual conversion factor of a process or event generally result in one of the following scenarios:

- When the system factor is higher than the actual factor, the real input volume exceeds the reported input volume. Unreported inputs can enter the supply chain.
- When the system factor is lower than the actual factor, the output volume exceeds the possible output the system foresees for the process. This sets a perverse incentive for processors to increase their efficiency, because it might be difficult for them to legitimize the additional output.

Verifying conversion factors in the field is costly and time-consuming and does not often yield complete results. Even with sophisticated systems, it will be a challenge to ensure that 100 percent of mill activities are reported daily. There continues to be much room for improvement in this field. When determining appropriate conversion factors, it is important that the authorities take stock of common products on the market. If reliable information is available, analysing data on processing inputs and outputs could help inform the setting of realistic conversion factors. These issues should be addressed prior to expanding reporting requirements and the level of detail required in processing, because only then can these measures increase the overall benefits and quality of the system.

The assumed control mechanism in this approach is that a mill has no incentive to accept illegal roundwood when it will not be able to cover the product with sawnwood credits. However, beneath the reported inputs and outputs, each mill could have a "side door" through which non-registered inputs can enter and non-registered outputs can be sold to the informal market. While the size of this side door is unknown, it undeniably exists. Without comprehensive control of mill inputs and outputs, the role of conversion factors can be compromised. The reported input–output balance could be consistent without it necessarily reflecting reality.

physical traceability mandatory for all products from these operations would be economically prohibitive and would add to the reporting burden when the level of risk for illegality is low. This does not mean that countries who are home to threatened pine species should take the same approach when reviewing their management and traceability requirements.

The perceived risk and value of the product, as well as the feasibility of the reporting requirements, are important factors to consider when determining the traceability approach or approaches for the system. Most systems in this report use a volume-based tracking approach in which industries self-report stocks, inputs and outputs and are required to establish more detailed internal traceability systems.[4] If used with a realistic conversion factor, the self-reported data demonstrates that the operator did not produce more output than is attainable from the received input. However, the data reported by operators needs to be verified with physical inspections to guarantee the integrity of the system, since there might be incentives to under-report inputs or not report all outputs sold on the informal market.

Data collection and reporting

Most countries have long used paper-based systems to capture information, but these systems can be easily manipulated, and they cannot track a product in real time since the paper documents must be centralized, digitized and/or analysed before they can be used to inform verification and enforcement actions. Digital systems still rely on documentation, such as harvesting licences, forest management plans, transport permits, production reports and export licences to trace timber. The benefit of digital systems lies in the fact that they can be used to inform verification activities, raise red flags and identify fraudulent information, which is harder to do with a paper-based system.

Data analysis, monitoring and verification

The traceability systems highlighted in this report rely on databases to compile, manage and analyse supply-chain data. Reliable and up-to-date databases are the backbone of the system and critical to their success. Thanks to internet technologies, most database functionalities can be accessed and managed from web browser or mobile applications. One advantage of internet-based data management is that users do not need to install software on their computers to enter or consult the information, as the data is stored on a server in such a way that access is allowed from anywhere in the world. Direct interaction with the system from the private sector can also help with monitoring the supply chain. For example, companies could be required to "check in" products entering or leaving their premises, allowing the government to monitor and verify the location of the products in the country (De Smedt, personal communication, 2021).

The system can be designed to obstruct illicit activities. For instance, if companies enter their declarations online, the use of the database reduces contacts between officials and enterprises. Approvals and transactions are recorded, meaning that any manipulation of the database can easily be tracked. When designing the database, system developers should consider:

- the capabilities of the staff who will work on the database and be responsible for data verification and entry;
- the way in which the database will be accessed and queried;
- the level of confidentiality for different users and the safeguards in place for protecting data integrity and addressing concerns from businesses uploading their information; and
- the connectivity and quality of the network within the structure, and the physical security of the installations.

Centralizing the data in a digital system allows the government to analyse and reconcile data across the formal sector to create a more accurate picture of the whole sector.

One success of the **SIRMA** system in **Honduras** is that it helps centralize critical data related to productive activities in the forest sector in a transparent way (CLIFOR, 2018). Under the VPA, the validation and reconciliation of data are critical to proving the legality of the products, and they rely on a fully implemented **SIRMA** system and its ability to

gather and reconcile data from other systems.

To connect the various steps along the supply chain, **SEINEF** in **Guatemala** relies on transport permits. These documents serve to collect critical information from point of harvest to primary processing.

While visiting a harvesting operation in a pine plantation in **Guatemala**, the field research team saw first hand how information was manually entered to create a **transport permit** (*nota de envio*).[5] The use of this document is mandatory and helps to ensure that the data entered in the system is both comprehensive and consistent. To keep track of **transport permits, SEINEF** assigns a unique identification code corresponding to a business registered within the system, as well as information on the cutting licence and reference to annual forest management plans. In most cases, the truck driver carrying the **transport permit** fills out information on product types, species and volumes in the shipment. They must cross out blank spaces and state the total volume of all listed units, so that subsequent manipulation of the document is difficult. While INAB personnel at road check-points can directly scan the quick-response (QR) codes and confirm shipments in the system, police who run random road checks usually do not have this option. Use of these documents is critical at road check-points where officers may not have direct access to the database and rely on the paper documents to confirm they are accurate. These documents are subsequently used at the mill gate by staff who visually cross-check the products, species and volumes stated on the document, while office staff will later transfer the data from the paperwork to the system.

If sawmills accept shipments as declared in the **transport permit**, they can easily book the materials into their input account by entering the number of the shipping note into the online platform. All relevant data will be transferred automatically. If they start to argue with the supplier about the volume – which would typically end with reduced payment and the buyer recording their measurements internally – they now face even more increased transaction costs because they must find a solution on volumes that is consistent with **SEINEF**. As a third party, INAB limited the difference between volumes stated on shipping notes and volumes entered in the user accounts to plus or minus 5 percent. Also, once issued, the transport documents are only valid for 24 hours to prevent them from being used twice or more. Because of the country topography, 24 hours is enough time for transport to be completed. Allowing more time creates opportunities for the same transport permit to be used multiple times. This creates further incentives for suppliers and buyers to streamline their transactions. However, mistakes and unforeseen events can happen in data entry and road transport, which is why periodic reporting through the **quarterly forest enterprises report** (*informe trimestral de empresas forestales*) can help create a paper trail of logs harvested and volume entering and leaving the sawmill.

Forest product supply chains often encompass activities such as forest management, manufacturing and exporting, which fall under the jurisdiction of different departments within the forest authority or, more broadly, different government agencies, who may need to contribute information to the traceability system. For example, in **Peru**, while forest management falls under the Peruvian Forest Service (SERFOR), secondary processing falls under the authority of the Ministry of Production (Andina, 2019), meaning that information from this ministry is needed to verify the legality of a timber product that has undergone secondary processing.

During the planning phase, coordination with other government agencies that have a role in forest product supply chains is critical with regard to collecting and verifying information. One way of ensuring that the system runs smoothly could be to set up a small interagency team who would be responsible for designing and managing the information collection and verification process by the various agencies. This team could also conduct periodic audits of the system to help maintain its integrity once implemented.

At the start of the implementation phase, the development team should engage with these other agencies to ensure that there are documented mechanisms in place to share and verify information. To define the needs and expectations of the system, an appropriate consultation process with all relevant government agencies early on can help identify benefits and incentives for the agencies to participate and secure their buy-in. Technological advances, such as

electronic or semi-electronic systems, can facilitate the sharing of information and interagency coordination, which ultimately will make the verification process much more streamlined.

While in **Peru** different government authorities oversee different phases of the supply chain, in **Ecuador** different authorities oversee timber from forest plantations and timber from natural forests. The Government of **Ecuador** developed two systems hosted on a common data platform, which includes geospatial information to make it easier to identify conflicting information or inaccurate analyses.

The **SAF** system is managed by the Ministry of Environment (**MAAE**) for natural forests while a slightly updated version, the **SPF**, is used by the Ministry of Agriculture (**MAGAP**) to manage timber production from forest plantations (ITTO, 2014). The geographic element of the **SAF** database is used to validate the harvesting sites, which are then verified through a field inspection. The **SAF** also catalogues high-value species that have been extracted and transported to ensure that they cannot enter the system again (MAAE, 2012; TRAFFIC, 2014).

Both systems control forest product supply chains (Ordoñez Riofrío, personal communication, 2021) by:

- issuing licences to registered operators through a secure online system;
- cross-referencing input and output declarations (e.g. checking that the harvested volume matches the authorized volume in harvesting licences and that species transported match the species indicated on the transport licences); and
- cross-checking data in the integrated databases while in the field to ensure that transport permits are not used twice and that the data is reported correctly (wood stock, species, etc.).

Box 4 | Fraud and error risks in reporting

When establishing reporting requirements, consideration should be given to whether all private-sector actors, from small enterprises with low organizational and technological capacity to large and well-organized corporations, can comply with these requirements.

Based on the literature and observations gathered by the authors during the field visits, some of the risks and mitigation actions related to self-reporting and verification are detailed below.

Risks include:

- inaccurate reporting by private-sector actors, who may overdeclare volumes or claim they are harvesting a different species;
- corrupt authorities entering the system and changing data to launder timber through the system for their own financial gain;
- hackers who alter data for their own gain; and
- collusion between private-sector actors and the authorities.

To mitigate risk, system designers could:

- establish initial reporting requirements that are attainable with the current capacity of the users, but with an expectation—paired with capacity-building efforts—to increase capacities from the starting point to where they need to be in the long term;
- avoid requirements that are impossible to verify given the capacity of the authorities tasked with verifying the information entered into the system;
- establish clear and publicly available procedures on reporting requirements, including what data will be shared and how the data will be handled and verified;
- incorporate safeguards into the system to detect false or conflicting information or prevent data manipulation; and
- increase the transparency of forest product supply chains by making some self-reported data publicly available for third parties to monitor (Box 6).

Sources: BVRio, 2016; Greenpeace, 2015; Kleinschmidt *et al.*, 2016; Nellemann and INTERPOL Environmental Crime Programme, 2012; Urrunaga *et al.*, 2012.

Information sharing between government agencies is vital to the success of a traceability system, especially if it involves verifying the legality of the products. In **Honduras**, **SIRMA** is designed to communicate with information systems from other government agencies, rather than centralizing all the information in one database. This is expected to reduce the learning curve for government authorities who would have to learn how to use a completely new system in addition to managing the system they use to fulfil their own mandate. When the system is fully implemented, it is envisioned that key documents such as harvesting licences, transport permits and waybills, production reports "will be recorded in the **SNIF** and **SIRMA** [...] to calculate the volume of timber circulating in each stage of the supply chain" (European Union and Republic of Honduras, 2018).

All case studies included in this report rely on self-reported (see Box 4) information from producers, which is then verified by the government.

Verification activities

Just as there is a risk that private-sector actors will feed false information into the system, there is also a risk that government officials manipulate data. A strong data management system, with access limited to trusted officials only, can help raise red flags for potentially inaccurate information. Sophisticated systems, for instance, allow for percentage sampling based on past operator performance, flag higher sampling percentages or more frequent visits, or even identify which logs/batches to verify to reduce risk of collusion between officers and private-sector actors, and avoid bias from verification officers (De Smedt, personal communication, 2021). However, systems do not guarantee traceability if they do not include field verification activities. Field activities are critical in authenticating data declared by companies. Field verification can be a hard, time-consuming and risky process with its own inherent risks of data falsification. Based on literature (Urrunaga *et al.*, 2012; Kleinschmidt *et al.*, 2016; Nellemann and INTERPOL Environmental Crime Programm, 2012) and the authors' fieldwork, there are ways to protect agents in the field doing verification activities and to make it harder for actors to abuse their power and misuse the system. These include the following actions:

- Conducting field inspections in teams consisting of police, forestry staff and army personnel for increased security. If people come from different areas, this can help reduce the risk of collusion as people are less likely to know each other.
- Developing Standard Operating Procedures to determine which verification activity should be applied to a given context, and define from the outset how the sampling will be done.
- Allowing companies to declare information online to reduce contact between officials and the company. Through an online declaration, approvals are made through the database and can be recorded, meaning that any manipulation of the database can easily be tracked.

All systems included in this study follow different processes to verify the information reported by companies. In some cases, the verification activities are triggered by the system when differences are found in reconciling data along the supply chain. Other examples include road check points or field inspections (both at processing facilities and in the forest).

However, there is limited information available on supply-chain verification activities. In most countries, legislation often requires a field inspection prior to harvest, but most of the current systems do not capture information on such inspections, or this is not made public. While the reason for this is unclear, one assumption would be because the systems are at the early stages of implementation.

One exception to this is in **Peru**, where field verification activities for the implementation of forest management activities are carried out by a separate agency, OSINFOR. Through its **Sistema de Información Gerencial del OSINFOR** (SIGO), OSINFOR makes the results of all field verification activities available to the public.

While there may be information available on what permits have been approved, there is little to no information available on why a permit has been approved or rejected. Particularly in the resource allocation phase, this lack of information can lead to distrust of the system. Overall, based on these case

studies, the lack of public information on verification often seems to be related to a lack of resources for hiring and training field staff, preventing the government from fulfilling its verification role. This is a major threat to the credibility of the systems, and an area where researchers and experts would like to see some improvement.

As mentioned above, producers need to use official transport documents (*notas de envío* issued by INAB or *guias de transporte* issued by CONAP) when shipping raw materials. These documents cost USD 1–2.[6] *Notas de envío* are individually numbered forms comprising several anti-counterfeit measures (see Annex 4 for details on security features). Although experts state that this kind of document is by far not impossible to counterfeit, the barrier is perceived high enough to deter the largest proportion of intended fraud (personal interview with anti-counterfeiting experts and INAB officials). Printing will generate a QR code that enables fast access to the original, digital copy of the document in the database (A Samayoa, personal communication, 2021).

The increased demand for legal timber products in international markets has stimulated the development of technological applications that can support verification activities. These applications include the use of remote sensing, mobile technology and physical markers.

Remote sensing: Remote sensing allows authorities to monitor forests in near-real time to effectively target areas where illegality may be happening. In **Brazil**, the Brazilian Forest Service uses this technology to complement its **Chain of Custody** traceability system for operations in National Forests.

In partnership with the Brazilian Space Agency (INPE), the SFB uses satellite imagery to establish a baseline for the condition forests are in prior to any human activity. This information can be used by the concession holders to get a sense of the timber potentially available for extraction when developing forest management plans.[7] Once the area is under management, the SFB uses satellite imagery to monitor harvesting operations (e.g. establishment of logging roads and logging patios) and the quality of forest management by identifying and monitoring selective logging, as indicated by openings in the canopy. These satellite monitoring activities allow the SFB to verify and ensure compliance with approved forest management plans (SFB, 2018).

Obtaining accurate information about the timber available for logging helps ensure that the transport guides have accurate information. From the private-sector side, remote sensing data can also be used to demonstrate compliance and responsible forest management.

In addition, as of 2020, the SFB is collaborating with the Brazilian Agricultural Research Corporation (Embrapa) to test the use of drones for estimating volumes of extracted timber. In this process, the drone takes detailed pictures of the logs stored in patios to estimate log sizes and volumes. This emerging methodology can potentially help estimate harvested volumes more accurately, while significantly reducing staff time in the field (Embrapa, 2019).

The increasing availability and decreasing entry cost of mobile hardware and software for field data collection are driving the uptake of mobile applications. The combination of a digital clock, a GPS module, a gyroscope, a digital camera, a storage unit, a processing unit and connectivity to the internet in one or several devices facilitates data collection in the field. Mobile applications can collect data faster, more reliably, with less human bias and in a format ready for further processing and verification.

Mobile applications for field data collection can also be used to prevent data corruption. In addition to reducing human bias, mobile applications can automatically record when and where events took place, which registered users collected the data, and even take a picture to document the event as additional evidence. However, limited connectivity can be a problem. Devices will often be offline while collecting the field data and only upload it to the data management platform once they are connected to the internet. This can be problematic when the timber is being transported immediately and arrives at a check point before the data has been uploaded, as the checks will indicate that the timber has not been cleared yet. As satellite internet becomes more accessible, it will expedite the time it takes for verification data to be uploaded and analysed.

Box 5 | Piloting high-tech wood markers in Honduras

StarMark™, developed by Stardust Materials in the United States of America, is an invisible physical marker that can be authenticated at any point in the supply chain with a handheld device. The markers are highly engineered, optically active ceramic powder, which has unique spectral and elemental signals for the different clients. The markers are delivered in a concentrated solution ("concentrate") which can be diluted in a base liquid, such as paint, and applied to products.

To authenticate marked products, users rely on handheld tester devices for verification. The handheld device analyses the infrared signature of the marking based on the measurable decay rate of the particles and the wavelengths of the excited particles. Stardust pre-programmes the testers to accept readings associated with concentrate compositions unique to the user. The tester rejects all other readings. StarMark™ has been used in tax stamps, labels and other consumer products, but the pilot was the first application for timber.

THE PILOT

GreenWood and FMV piloted StarMark™ on mahogany supply chains in Honduras, using three methods for applying the diluted solution onto the wood: 1) spraying with a rechargeable pump; 2) using a small sponge; and 3) staff dipping their index fingers into the diluted solution and then applying it. The pilot team rejected the spray application method as the rechargeable hand pump got clogged after about 50 applications. While the sponge application was satisfactory, the pilot team preferred the finger application method, as this was the quickest, least expensive, and most practical.

The pilot ran from June to August 2016, during the dry season. The pilot team applied and later verified the StarMark™ diluted solution at four points along the supply chain: 1) the log landing in the forest, where partially sawn logs were gathered after harvest; 2) the primary sawmill; 3) an intermediate staging point; and 4) an FMV processing facility. When the pilot team tested the markers for authenticity along the supply chain, the handheld testing devices correctly verified the markings 100 percent of the time, both after the markings had been freshly applied and after drying.

To test the resilience of StarMark™ to water exposure during the rainy season, field staff poured water over both dried and freshly painted markings, immersed the painted ends in water for more than 90 minutes, and scrubbed the ends with household soap to remove all visible signs of the markings. In all cases, the testers correctly verified the solution. To test resilience when exposed to mud, field staff covered wood with markings in a thin coat of mud. While the mud was still wet, the testers provided incorrect readings, but after the mud had dried, the testers correctly verified the solution. The testers also correctly verified markings that had been applied to wood prior to kiln drying. The total cost to Greenwood for the StarMark™ concentrate was under USD 500, reflecting Stardust laboratory fees only. Greenwood and FMV also paid for shipping charges and customs brokerage fees. Stardust loaned three handheld testing devices, each having an approximate retail value of USD 225.

RESULTS

The handheld devices correctly verified markings 100 percent of the time during the pilot at low cost. The simulated resilience tests also showed encouraging results for the durability of StarMark™ markings.

However, the integrity of the system was perceived as requiring a high level of confidence and trust in the staff controlling and accessing the concentrate and diluted solution, and applying the markings. During the pilot, access to the concentrate and diluted solution was restricted to two FMV employees. Additionally, at the time of piloting, the pilot team used StarMark™ only for scheduled spot checks along the supply chain, aside from the marker resilience tests. The results of the verification readings were not recorded. Further, the handheld testing devices did not have the capability to log digital records. Tools like StarMark™ could complement traceability systems at relatively low prices. By authenticating products as they move through the supply chain, these tools can add assurance that the traceability systems are effective.

In **Panama** for example, mobile technology was used to compensate for the inaccessibility of the Darién Region where the government piloted the **SNTF** traceability system. The authorities implemented a comprehensive smartphone traceability system to maintain log traceability from the stock survey to entry in the mill. Using the application, data recorded from the forest is stored on the smartphone and once the phone is connected to the internet, the data is synchronized with the central database.

Physical markers: Physical markers help confirm the identity and source of individual logs or batches of timber, and they can be complementary to document-based traceability. An important consideration in the use of physical markers is the long-term supply and availability of the markers themselves, and the costs associated with using them. In addition to equipment, equally important are the costs associated with the time and training needed to employ the markers and the potential information management requirements, which should be assessed against the benefits of the system. In some cases, like in Honduras, the use of high-tech physical markers could be financially viable in the mahogany supply chain because of the high-end niche markets sourcing this species.

In **Honduras**, CSOs working with mahogany producers piloted StarMark™ (Box 5) and demonstrated its viability for large-scale implementation. **Ecuador** and **Colombia** considered using physical markers for tracking materials as part of the traceability system, which shows how much governments value this type of safeguard.

Data transparency

Many of the systems covered in this report have a public user interface that allows registered users, including civil society actors, to access information on titles and permits, validate individual transport documents and provide statistical data.

An appropriate level of data transparency can give credibility to the system and the information. Civil society actors can help improve supply-chain transparency in two main ways:

- Advocating for increased public access to supply-chain information.
- Supporting accountability by developing platforms that feature government information in formats easy to use by the public.

To provide targeted audiences and the public with legality–and timber traceability–related information, various private-sector and CSOs have implemented initiatives that rely on, and complement, government data and help visualize and monitor timber trade flows. These depend on access to comprehensive and continuous government data. Without this data, it is impossible to keep the systems up to date, which can potentially lead to incorrect and conflicting analytical results. This is a major challenge as government agencies often limit access to the data in terms of scope and frequency.

In **Brazil**, organizations like BVRio, UNIFLORESTA and IMAFLORA (Box 6) use the publicly available data and combine it with data from other sources to increase transparency in timber supply chains. This helps end buyers of forest products, especially in international markets, assess and manage the risk of illegal timber in their supply chains so that they can comply with legality requirements from international markets. By supporting buyers to assess and manage risk, these civil society initiatives can help promote legal timber products in legality-sensitive markets. In addition to legality requirements, supply-chain transparency can also contribute to compliance with buyer social and environmental commitments.

Governments need to define how the systems will be launched and deployed. Taking a phased or modular approach allows users to be trained gradually on each module, while testing the systems' applicability and feasibility before they are fully deployed. This approach can help create user buy-in because actors are not overwhelmed by the new requirements, which protects against system rejection and failure in the case of malfunctions. As well as planning how a modular approach could be deployed, developing a comprehensive training strategy is important. Such a strategy is required to ensure that all users, including those from government agencies and from the private sector, are able to meet the requirements and operate and monitor the system before it is deployed.

Several of the countries featured in these case studies

have chosen to deploy their national traceability system in a modular approach or within a limited geographic area. This is partly because of limited financial resources.

In most of the case studies, a gradual delivery process was implemented. In **Ecuador**, the first version of the **SAF** was based on transport permits. The system was deployed in this way for three years before being extended to remaining licences.

In **Panama**, the forest authority chose to develop the entire system at once and to test and implement it in natural forests in the Darién province before rolling it out at a national level. In **Colombia**, the system is also being built and rolled out in modules.

Along with the phased approach, a comprehensive training strategy involving a test phase to bring users in without penalizing them is useful for addressing users' concerns, helping them navigate the requirements of the system and building their capacity to implement the new requirements. The training strategy can include the development of training materials, in-person training sessions and other helpful resources. It should be updated regularly, as options for applying technological innovations evolve and new modules are deployed.

Box 6 | Examples of civil society organization efforts to increase supply-chain transparency in Brazil

Below are three examples of online platforms from CSOs to increase transparency of timber supply chains in Brazil. The descriptions are based on the information available on the websites listed for each platform.

BVRIO DUE DILIGENCE AND RISK ASSESSMENT SYSTEM AND RESPONSIBLE TIMBER EXCHANGE (WWW.BVRIO.COM)

Launched by the BVRio Institute, the Due Diligence and Risk Assessment System and Responsible Timber Exchange helps users identify legal or certified timber products, which are screened to assess the risk of illegality. To achieve this, the platform compiles and analyses data from SISFLORA and DOF along with other public, civil society and private-sector databases (e.g. public infraction and conviction records, and data on the distribution and frequency of commercial species). After entering a transport document identification code, the user receives a risk assessment based on detailed supply-chain data associated with the shipment in question. These details show the actors involved in the supply chain, enabling buyers to target risk mitigation activities, while ensuring that actors along the supply chain are accountable since their activities appear on the report.

BVRio's system includes an "export ledger" which collects reports by exporters showing the volumes in a shipment, with an identification code. Currently, the government-controlled system does not restrict exporters from associating a single identification code to multiple shipments, which would allow exporters to ship illicit products with an actual identification code.

UNIFLORESTA LEGAL VERIFICATION PROGRAMME (UNIFLORESTACONSULT.COM)

The private consulting company UNIFLORESTA developed a software program to provide a compliance service to buyers of Brazilian timber, based on analysing shipment-based information in the DOF and SISFLORA systems. Like BVRio, UNIFLORESTA complements government data by sourcing information from additional sources, such as from non-forestry public information platforms and scientific studies on species distribution. UNIFLORESTA also include field inspections in the legal verification process, and the program operates on a fee-for-service model mostly to facilitate exports. UNIFLORESTA is also developing a roundwood traceability system reliant on a smartphone or tablet to record data, along with labels featuring QR codes to support improved traceability efforts.

IMAFLORA TIMBERFLOW (TIMBERFLOW.ORG.BR)

Launched in 2017, Timberflow relies exclusively on data from SISFLORA 2.0 in Pará. The system features a public user interface for supply-chain mapping and trade flow analysis. Through the system, IMAFLORA has improved the accessibility of permit and transport document information collected through SISFLORA 2.0. Users can filter information by companies, municipalities, species and product types.

CONCLUSIONS

In the last decade, governments in tropical timber-producing countries around the world have developed and implemented national timber traceability systems for different reasons, including to improve control of the sector and respond to global market demands for timber products of legal origin.

While traceability systems bring additional requirements, private-sector actors can leverage these systems to increase their competitiveness, optimize management operations, enhance quality control and reduce their risk and exposure by complying with legality requirements. Having more control over timber supply chains, especially if it includes pre-forest management operations, can also support sustainable forest management, and help document best practices. All these things improve public perception of the forest sector in general.

Traceability systems often involve different government agencies, particularly in oversight and verification activities, and for information-sharing purposes, it is important to have clearly defined interagency collaboration mechanisms.

Most of the forest authorities developing and implementing traceability systems are relatively weak compared to other government agencies in their countries. To successfully implement traceability systems, forest authorities need the back up of high-level political will and a solid legal and regulatory framework. Continuing to provide technical, financial and political support to the forest authorities of Brazil, Colombia, Ecuador, Guatemala, Honduras, Panama and Peru is crucial, as is supporting their outreach and capacity-building activities, as they continue to roll out their traceability systems.

In Latin America, several countries have proactively begun implementing traceability systems, while demonstrating a relatively high capacity to implement such systems and leveraging technological applications to respond to the unique needs of their countries. At varying degrees of implementation, these experiences offer valuable insights for documenting and sharing with other countries who may develop timber traceability systems in the future.

Developing and implementing a traceability system can be challenging. This report analyses lessons and best practices from Brazil, Colombia, Ecuador, Honduras, Guatemala, Panama and Peru, and provides insights on how to address those challenges in practical terms. Because the status of implementation varied across the traceability systems reviewed, most of the lessons and best practices focus on the planning stage, from initial considerations to design and development.

To optimize the probability of success, various aspects of the system should be addressed early in the process, including the following aspects:

- Defining the purpose and expected benefits to government agencies and private-sector actors.
- Securing buy-in from key government agencies and private-sector actors through tailored communications, consultation and participative processes during the design and implementation of the system.
- Defining a financial strategy for the long-term sustainability of the system. While bilateral donors and international organizations can provide financial support to jump-start the process, in-country governments should be financially responsible for the system overall.
- Assessing the capacity and training needs of the government agencies involved in managing the system and the private-sector users expected to input data into it, and develop a training strategy.
- Defining data-sharing processes for the different

government agencies involved in managing or using the system.

- Defining whether to build the system from scratch or from existing processes and resources.
- Defining the traceability approach, i.e. whether to track individual pieces of timber or track timber volumes as they are processed through the supply chain.

All the systems highlighted in this report are being implemented in phased-in approaches. Testing the system without penalizing users at first allows governments to raise awareness of the changes, train users gradually on each module, test the applicability and feasibility of the system, and help navigate users' concerns. During this stage, it is useful to develop a comprehensive training strategy to ensure that all users can meet the requirements of the system before it is fully deployed.

All the systems featured in this report rely on databases to collect, manage and analyse supply-chain data. Databases constitute the backbone of traceability systems, and thanks to current internet technology, it is possible to access database functionalities from web and mobile interfaces. These modern information management technologies can be designed to protect the confidentiality and integrity of the data. Training to ensure that the staff who will be operating the database is well prepared is essential.

A robust database to manage supply-chain information can help identify inconsistencies and raise red flags for possible inaccurate information. But the system cannot guarantee traceability if it does not include data verification activities. Verification activities, including in the field, are critical in authenticating data self-declared by companies.

While the use of other tools such as remote sensing, mobile technologies and physical markers can be exciting and innovative, the implementation of these resources should suit local conditions. Further, developers should be realistic about the limitations of these tools and the capacity needs for their widespread use.

Civil society organizations have a role to play in that supply-chain transparency is becoming more important and timber buyers are increasingly required to assess and manage their risk of sourcing illegal timber in their supply chains. While government agencies can make information from their traceability systems accessible through their platforms, CSOs can help making non-proprietary information more user friendly, including for international stakeholders.

RECOMMENDATIONS

This report highlights experiences and best practices in key aspects of the pre-planning and planning stages of developing timber traceability systems. **Addressing these aspects early on in system pre-planning and planning creates the conditions for successful implementation, long-term sustainability and industry buy-in.**

In most of the countries highlighted in this report, the development and rollout of the systems has been backed up by the following aspects:

- **High-level political commitment** – For example, in Honduras, the system was developed as a result of the Voluntary Partnership Agreement between the Government of Honduras and the European Union.
- **Provision of technical support** – For example, through the involvement of the FAO-EU FLEGT Programme in Colombia, Ecuador, Honduras and Panama; also, through technical exchanges between the forest authorities in Guatemala and Honduras.
- **Financial support from international agencies and national governments** – For example, the development of the systems received financial support from the Government of the United States of America (Peru), ITTO (Guatemala), the FAO-EU FLEGT Programme (Colombia, Ecuador, Honduras and Panama) and federal and state governments in Brazil.
- **Legal and regulatory reforms** – For example, the regulatory framework in Peru was modified to support timber traceability.

All this support should continue as countries move forward rolling out their timber traceability systems, and until the systems are standing and running in a self-sufficient manner.

System developers and implementing agencies should plan, design and implement timber traceability systems in a phased-in approach without penalizing users at first. The experiences in Colombia, Guatemala, Honduras and Peru, where traceability systems were rolled out in modules, helped identify compliance challenges, understand the capacity gaps of stakeholders, and develop and deliver comprehensive, targeted communication and training strategies to ensure that all users could meet the requirements when they became mandatory.

When establishing compliance requirements, implementing agencies should ensure that all private-sector actors have the capacity to comply with them. The experiences in Honduras, Guatemala and Peru engaging private-sector actors through consultations, pilots and training offer insights and lessons in approaching and involving the sector. This approach ensures that the systems developed meet their needs and do not exceed their capacity levels. In Honduras and Guatemala, with time, this engagement also helped secure some level of buy-in from the sector during the system rollout.

System developers and implementing agencies can mitigate risks related to self-reporting and verification by establishing reporting requirements that can be fulfilled with current user capacities and are easy to verify, and making sure clear procedures are available for complying with these requirements. Another strategy is integrating safeguards to prevent fraud and data manipulation, and increasing transparency in the supply chain by making self-reported data publicly available for third-party monitoring.

System developers should use technologies that are appropriate for the country. While the use of remote sensing, information management systems, mobile technologies and physical markers can be exciting and innovative, developers should be realistic about what they can accomplish, and mindful of the capacity requirements and country legal framework required for the widespread use of any of these technologies. The use of satellite imagery and drones to validate forest baselines in forest management plans and verify harvesting activities in Brazil is an

example of the reach and potential of remote sensing technologies, while early work in Honduras piloting the use of physical markers for high-value, niche timber species is promising.

On the other hand, **the use of modern information management systems for the backbone of traceability systems can make all database functionalities accessible through mobile and web-based applications**, while allowing users to enter the data directly into the system. This guarantees data integrity and is useful for tracking user activities, minimizing the risk of manipulation. The use of a single online window to enter the data in Colombia, and the use of a mobile application in Panama offer valuable lessons and insights on integrating these technologies with traceability systems.

By facilitating access to supply chain information by buyers wanting to assess the risk of illegal timber entering their supply chains and comply with legality requirements in international markets, civil society initiatives can help promote markets for legal wood from tropical timber-producing countries. The experiences from BVRio and IMAFLORA in Brazil are examples of this. **Governments should make information from their traceability systems accessible**. Improving transparency of non-proprietary information provides an opportunity for CSOs to validate the information and make it more user friendly for the public.

ANNEX 1 – LIST OF INTERVIEWS CONDUCTED

While the interviews were conducted in different years, all the information from the case studies was reviewed by in-country government experts to update the information as of December 2020.

BRAZIL

1. Phone interview with BVRIO, January 2017
2. Phone interview with Greenpeace, February 2017
3. Phone interview with IMAFLORA, February 2017
4. Phone interview with the Brazilian Forest Service, April 2017

COLOMBIA

1. Interview with MADS, May 2017
2. Interview with IDEAM, May 2017
3. Interview with Environmental Secretariat of Bogotá, May 2017
4. Interview at Aglomerados de Cotopaxi, May 2017
5. Interview with CARDER, May 2017
6. Interview with Technical University of Pereira, May 2017
7. Interview with ONF Andina, May 2017
8. Interview with PEFC International, May 2017
9. Interview with CORNARE, May 2017

ECUADOR

1. Interview with FAO Ecuador, May 2017
2. Interview with UN-REDD, May 2017
3. Interview with MAE, May 2017
4. Interview with MAGAP, May 2017

GUATEMALA

1. Interview at Pine Planation, Chimaltenango, March 2016
2. Interview with INAB, Central Office, Guatemala City, March 2016
3. Interview at processing facility, Guatemala City, March 2016
4. Interview at INAB Regional Office, Region II, Cobán, March 2016
5. Interview at road checkpoint, La Cumbre, San Jerónimo, Baja Verapaz, March 2016
6. Interview with small holder, Flores, May 2016
7. Interview with CONAP, Guatemala City, May 2016

PANAMA

1. Meeting with Panama FAO Representative, June 2017
2. Meeting with Ministry of the Environment, June 2017
3. Meeting with Franklin Mezua, Darién Round Table on Forestry, June 2017
4. Visit to Yavisa police departments' checkpoints, June 2017
5. Visit to Panama Military Forces checkpoints, June 2017
6. Meeting with Carlos Espinosa, WWF Panama, June 2017
7. Meeting with Meteti, Yavisa and Darién timber enterprises, June 2017

PERU

1. Interview with SERFOR, Lima, October 2016
2. Interview with Regional Government, Pucallpa, Ucayali, October 2016
3. Interview with COMASAC, Pucallpa, October 2016
4. Interview with GIZ, Pucallpa, October 2016
5. Interview with OSINFOR, Regional Office, Ucayali, October 2016
6. Interview with DRFFS, Madre de Dios, October 2016
7. Interview with Otorongo, October 2016
8. Interview with AIDER, October 2016
9. Interview with USAID, October 2016
10. Interview with OSINFOR head office, October 2016
11. Follow-up phone interview with SERFOR, October 2018

ANNEX 2 – SAMPLE QUESTIONNAIRES

For system users

1. What raw materials do you use?
2. How do you source your raw materials?
3. What are your end products?
4. Please describe your production processes.
5. Please describe your markets.
6. Have you changed your operations to implement the traceability system? How?
7. What are the internal costs (in time and money) of implementing/complying with the traceability system?
8. What capacities did you develop (or do you need to develop) to be able to implement the system?
9. How have you benefitted from the system?
10. What are the major challenges in complying or implementing the system?
11. What do you think are the opportunities for the system to improve?
12. Any additional comments?

For system developers

1. Please describe the system, including:
   a. Main functionalities
   b. Status of implementation
   c. Scope
   d. Documentation required
   e. Data management
2. Why did the government develop the system?
3. What are the main government agencies overseeing the forest sector and how do they interact in the implementation of the system?
4. What are the legal requirements of the system?
5. How is the development of the system funded? How is the system going to be financed in the future?
6. How do system developers take advantage of technological advances?
7. What have been the main challenges in developing and implementing the system?
8. What are the opportunities for improving the system?

ANNEX 3 – FULL ANALYTICAL FRAMEWORK

PHASE	TOPIC	ASPECTS COVERED IN THIS ANALYSIS
Planning	Initial considerations	Defining objectives, benefits and indicators Financing Stakeholder and capacity mapping Legal requirements
	Scope	Geography and jurisdiction Forest resources Supply-chain network System boundaries
	Design and development	Building a new system versus adapting an existing system Ownership and data sovereignty Scope of information Data collection and reporting Data analysis Monitoring and verification
Design and Implementation		Priorities for roll out Target forest resources for implementation Target supply chain priorities for implementation Priority functionalities for implementation Securing buy-in from private sector for the implementation Alternative implementation strategies
Upkeep		Strategy review Performance tracking Alignment of allocated resources with goals Comprehensive internal audit External audits

Source: Adapted from Stäuble *et al.*, 2022.

ANNEX 4 – COUNTRY CASE STUDIES

The country case studies are presented in alphabetical order.

Brazil

THE FOREST SECTOR AND THE BRAZILIAN ECONOMY

In 2020, natural forests and plantations covered approximately 496 620 million hectares, representing nearly 60 percent of the national land area. Over 43 percent of the forest area consisted of primary forests and under 2 percent of plantations (FAO, 2020). The primary export markets for Brazilian wood products are the United States of America, China, Italy and Argentina (SFB, 2019). The forest sector is estimated to contribute 6.9 percent to the gross domestic product (GDP) of Brazil (FAO, 2016a).

Brazil is the country with the highest number of tree species in the world – over 9 000 – and has the second largest forest area worldwide, after Russia, according to FAO and the United Nations Environment Programme (UNEP) (2020).

FOREST AUTHORITIES AND TRACEABILITY SYSTEMS

In Brazil, the forests are managed by entities within the federal and state governments. With multiple systems operating at once, the verification activities needed to be done by one entity are limited. This means that each authority tasked with controlling the flows of timber products has a more focused and tailored set of producers, risks and products to deal with. However, having multiple and diverse control systems may increase the risk of illicit products entering the supply chain at the national level. Table 1A outlines each of the forest authorities involved, with their role and the traceability system managed within their jurisdiction.

The Brazil case study focuses primarily on four different federal and state systems. Various state-level governments and the Federal Government of Brazil have developed different timber traceability systems. In parallel, CSOs have developed complementary platforms, building on government traceability data to increase transparency of forest product supply chains.[8]

This case study covers federal-level and state-level traceability systems operating in the states of Amazonas, Pará and Mato Grosso for timber from natural forests. Pará and Mato Grosso are the largest producers of timber from natural forests in the Brazilian Amazon (Ramos *et.al*, 2017).

DEVELOPMENT OF THE SYSTEMS

In 2006 the Brazilian government began work on developing the DOF, the first timber traceability system to operate in Brazil. Since then, the Brazilian Forest Service has been at the forefront of developing timber traceability systems and leveraging remote sensing to monitor and verify forest management practices and supply chains originating in federal forest concessions.

The traceability systems have been developed by the government agencies that operate them using government funding. For the implementation of some aspects of SINAFLOR, funding has been leveraged from the Global Environmental Facility through the Inter-American Development Bank to create and disseminate training materials (IBAMA, 2019). All traceability systems are in operation. SINAFLOR is the newest system to be implemented, becoming mandatory in 2018, and state governments have been reported to be actively using SINAFLOR to issue forest management permits and other environmental licences (IBAMA, 2019). IBAMA has also used the system to issue forest management plans in forest concessions (IBAMA, 2019).

LEGAL REQUIREMENTS

Use of the traceability systems is required under national and subnational laws. However, the agencies that have implemented the traceability systems have legal authority over different jurisdictions. National-level authorities (SFB and IBAMA) have authority over federally managed forests, whereas subnational authorities (SEMAS-PA and SEMA-MT) have authority over forests within their jurisdictions and feed information into the national system (SINAFLOR).

Table 1A | Forest authorities and traceability systems in Brazil

JURISDICTION	AUTHORITY	ROLE	TRACEABILITY SYSTEM
National	**Brazilian Institute of Environment and Renewable Natural Resources** (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis [IBAMA])	IBAMA falls under the Ministry of Environment. IBAMA is responsible for enforcing the regulations on the use of natural resources and implementing national environmental policies under the jurisdiction of the federal government. These include environmental licencing, inspection and application of administrative penalties, as well as environmental monitoring and control (IBAMA, 2018).	The Document of Forest Origin (Documento de Origem Florestal [DOF]) established in 2006 was a first step in converting the Brazilian forest sector control system from a paper-based process into a semi-electronic system controlled by the federal authority. The DOF is operational at the national level, except in the states of Mato Grosso and Pará. At the time of the field research, IBAMA was at an early stage of rolling out the National Control System of the Origin of Forest Products (Sistema Nacional de Controle da Origem dos Produtos Florestais [SINAFLOR]), the umbrella system for integrating the DOF with all state-level systems.
	Brazilian Forest Service (Serviço Florestal Brasileiro [SFB])	The **SFB**, under the Ministry of Agriculture and Livestock, is responsible for managing public forests in the country, as well as providing training, research and technical assistance in forest management practices and forest product processing. The SFB is the supervisory body for federal concessions (Presidência da República, 2006).	The Chain of Custody System (Sistema de Cadeia de Custódia das Concessões Florestais [SCC]) of the SFB is a system developed to monitor material flows originating in concessions in federal forest areas, from harvesting through primary processing. For this case study, the focus is the State of Amazonas.
Subnational	**State of Pará and State of Mato Grosso** through their **State Secretaries for the Environment** (Secretaria de Estado de Meio Ambiente e Sustentabilidade do Pará [SEMAS-PA] and Secretaria de Estado de Meio Ambiente do Mato Grosso [SEMA-MT])	SEMAS-PA and SEMA-MT are state-level ministries in two states, Pará and Mato Grosso. They are both responsible for the overall management of forest resources in their respective states, including forest management licensing and forest product traceability	Both the State of Pará and the State of Mato Grosso implemented the System for Marketing and Transporting Forest Products (Sistema de Comercialização e Transporte de Produtos Florestais 1.0 & 2.0 [SISFLORA 1.0 & 2.0]) to increase control over forest products harvested, transported and/or transformed within their jurisdictions. In 2017, SEMAS-PA made improvements to the system, upgrading the software to a 2.0 version. However, Mato Grosso continues to operate SISFLORA 1.0 as the private sector deemed the requirements of version 2.0 to be too onerous to comply with (ITTO, 2017b). Plans to roll out the 2.0 version of the system were reported in December 2020 (STTC, 2020). For this case study, fieldwork was conducted in the State of Pará on SISFLORA 2.0, while the analysis of the SISFLORA 1.0 is based on literature and expert interviews only.

The establishment of SINAFLOR fulfils the need to close loopholes in the old systems, in which illegality would occur through counting volumes multiple times, overstating volumes, creating fraudulent census data and even hacking (Greenpeace Brazil, 2014; Grou, 2019; EBC, 2019).

HOW THE SYSTEMS ARE MEANT TO WORK

Table 3A shows a general description of how the different systems are meant to work at the various levels of the supply chain. SISFLORA and DOF have undergone improvements to reduce the chance of illegal materials entering the supply chain.

SUCCESSES, CHALLENGES AND OPPORTUNITIES

With the updates to the new systems, the harvesting, processing and transport of timber and wood products are more closely monitored in near-real time, allowing more control over the products throughout the supply chain. In practice this means that all roundwood can be traced back to the stump, and products that have undergone primary or secondary processing can be linked to the facilities and businesses where the transformation took place, and to a list of forest management units from where they originated.

Further, product transport documents can only be issued if the detailed harvesting and processing history of the product has been reported. Tracking this historical information makes SISFLORA 2.0 unique in that it enables users to map the entire supply chain of each timber shipment.

Continuous internet connectivity is necessary for system users. While some larger, more established operators reported that they have invested in satellite internet, the requirements for internet connectivity to access these systems in remote and inaccessible locations could be a barrier for smaller operations. Ensuring that all operators have the capacity to comply with the traceability requirements is critical to ensuring that all wood products can be tracked through the supply chain and avoiding barriers to legality for individual actors.

Monitoring and effectively enforcing regulations within the forest sector still pose challenges, especially with regards to preventing and detecting fraud and illicit activities. The availability of civil society—driven supply—chain transparency platforms to help buyers assess the risk of sourcing potentially illegal timber is further evidence of the innovative use of technological applications. Requiring highly detailed information on individual trees and loads will likely impede the introduction of illegal timber into the market, but the increased level of detail poses its own challenges with regards to the capacity of operators. Processors have criticized the new reporting requirements within the system, saying that it creates challenges for record-keeping, and authorities often struggle to maintain accounts of raw materials, and semi-finished and finished products, because translating internal processes into data usable by the system is often difficult.

Table 2A | How traceability systems in Brazil are meant to work

SUPPLY CHAIN	DOCUMENT USED	DESCRIPTION
Phase in the supply chain	*Document used to collect data which can be uploaded to the system and later used to verify legality before products are moved further down the supply chain*	*Description of the actions required by the producer (harvesting) and processor (processing) and how the information provided is verified by the forest authority*
Timber origin	**Forest management authorization documents** **Harvesting licence** (*Autorização de extração florestal*: AUTEF-Pará, AUTEX-Mato Grosso and elsewhere) **Sustainable forest management plan** (*Plano de manejo florestal sustentável* [PMFS])	1. Producers who submit information to SISFLORA 1.0, 2.0 or DOF will submit a forest management authorization document to relevant government authorities to secure the right to harvest. 2. All producers, other than those submitting information to SISFLORA 1.0, will complete a comprehensive census of all commercial trees, including each tree's GPS coordinates, diameter at breast height, estimated commercial height and unique tree identification code. The additional details help close a loophole where volume estimates, and hence transport and trade credits, could be inflated. 3. Once the documentation is approved, the information is later used to generate transport permits and "timber credits" in the system for trading timber. In accordance with forest management plans, the system allocates "timber credits," which indicate the maximum volume that can be extracted from the operation, based on estimated yields in the management plan. As the timber is extracted, traded and the transport permits are generated, the system deducts the volume traded from the timber credit (Adeodato *et al.*, 2011).
Harvesting	Daily reports are accessed through web portals for each of the systems.	4. Within the SFB SCC and SISFLORA 2.0, users enter their daily reports online. Once the trees are reported as harvested, transport documents for these trees can be issued from the system. In the DOF and SISFLORA 1.0 systems, operators report harvested volumes per species, and less data is collected as the reporting is done in batches rather than individual logs.
Transport	**Transport document** (*Documento de origem*)	5. Transport permits are issued based on the information reported during registration and after harvesting. Transport permits include information on timber origin, volume per species and product type, quantity and estimated value, and expected transport time. To receive transport permits under the SFB SCC and SISFLORA 2.0, producers must also provide a single log list with unique identifiers for each log and its dimensions, ground and water transport (vehicles and vessels information), as well as the destination and transport route. 6. This information is then verified through road check points and confirmed when the products are received at a processing facility.
Final sale[9]		7. In both systems, post-harvest field inspections are carried out, but the frequency and detail of these inspections are unclear. 8. Additionally, in the case of federal concessions, the SFB uses interpretations of remote sensing data to verify the implementation of forest management plans. 9. The system scope is limited to simple secondary processing (planing mills). Further trade and processing into finished products, such as for furniture and construction uses are not covered.

THE FOREST SECTOR AND THE COLOMBIAN ECONOMY

In 2020, natural forests and plantations covered around 59 142 million hectares, representing a little over half of the national land area. Approximately 20 percent of the forest area in Colombia is located within protected areas (FAO, 2020).

In 2011, it was estimated that the forest sector contributed about 0.6 percent to the country's GDP (Lebedys and Li, 2014). According to ITTO (2011), the low contribution of the forest sector to GDP is partly down to two factors: first, the absence of large-scale forest management operations and related processing industries, and, second, widespread uncontrolled deforestation and degradation, resulting in an abundant and sometimes illegal wood supply that suppresses timber and fuelwood prices. The lack of economic power within the forest sector has created a noticeable negative trade balance with more wood imported than exported. This trade imbalance was also exacerbated by the drop in country exports from more than USD 250 million in the 1990s to about USD 50 million in 2011.

FOREST AUTHORITIES AND TRACEABILITY SYSTEMS

In Colombia, multiple traceability systems and forest authorities work to ensure that only legal timber products are harvested and produced within the country. Table 3A outlines the authorities operating at national and subnational level, as well as the traceability systems they assist in managing.

In 2017, the forest authorities supported the development of a road map for timber traceability in Colombia and set the conceptual and legal foundation for the traceability system. This project helped produce protocols for the review and evaluation of forest management plans, together with the control of forest management activities in natural forests and transport of forest products. These became the basis for the national timber traceability system. Table 4A outlines the progress made on the road map and the documents to be used within the system to control the flow of timber products as they move through the supply chain.

Table 3A | Forest authorities and traceability systems in Colombia

JURISDICTION	NAME	ROLE	TRACEABILITY SYSTEM MANAGED
National	**Ministry of Agriculture and Rural Development** (Ministerio de Agricultura y Desarrollo Rural (MADR)	The MADR oversees timber harvesting from commercial plantations.	MADR uses a system called **Forestry Application** (Aplicativo Forestal) to track products from commercial forest plantations and industrial agroforestry systems. This tool will not be covered in this case study.
	Ministry of the Environment and Sustainable Development (Ministerio de Ambiente y Desarrollo Sostenible (MADS)	The MADS formulates policy on the environment and renewable natural resources, and establishes the broad guidelines, rules and criteria for the environmental regulation of land use, including forestry.	The **National Timber Traceability System** (Sistema Nacional de Trazabilidad para la Madera) is based on four modules and forms part of the **Integrated Online Environmental Procedures Window** (Ventanilla Integral de Trámites Ambientales en Línea [VITAL]). VITAL is the central system operating at the national level for managing environmental operations. All the modules that form part of the traceability system described in Table 4A are under implementation or are envisioned to be implemented through VITAL. Rather than having decentralized systems, all environmental permits and licences will be issued through VITAL. VITAL will centralize the various inputs from the CARs and automate their administrative procedures, leaving less room for fraud by both the government and the private sector. VITAL is managed by MADS. The CARs support MADS in managing the system by granting permits, authorizing harvesting in the forest and the transport of timber products. Further, in partnership with the police and military, the CARs oversee inspections to check whether forest policies are being implemented.
Subnational	**Regional Autonomous Authorities for Sustainable Development** (Corporaciones Autónomas Regionales para el Desarrollo Sostenible (CARs)	The CARs are local authority entities responsible for enforcing environmental laws in their jurisdictions. Out of 41 regional environmental authorities in Colombia, 34 are CARs and the remainder are environmental metropolitan authorities.	

Table 4A | Implementation status of traceability systems

SUPPLY CHAIN/ MODULE	IMPLEMENTATION STATUS	MODULE DESCRIPTION
Stage of the supply chain covered by this module	*Status of module implementation*	*Description of how information is collected*
Timber origin	Implemented	Once the forest management plan is approved, the regional environmental authority records the data from the harvesting permit in VITAL. The national forest authority then provides reference numbers to the regional authority to be used when they issue each transport permit.
Harvesting	The development of this module is planned for 2021 and will focus on tracking timber from the forest source as it moves along the transport and processing stages of the supply chain.	
Transport	Module implemented in 2018	By law, all forest product shipments transported within the country, from the forest to a site for processing, trade, or export, or import must be accompanied by a **national unique online pass** (*salvoconducto único nacional en línea* [SUNL]) to protect and guarantee the origin of the product.
Primary processing	Under development	The Government of Colombia is currently working on this tool with the support of the FAO-EU FLEGT Programme. The **online forest operations book** (*libro de operaciones forestales en linea* [LOFL]) will be used as a tracking system for primary and secondary processing to record key information about the flow of legal wood products and facilitate their traceability.
Secondary processing	Under development	
Final sale	This module is currently under development.	

DEVELOPMENT OF THE SYSTEMS

The European Union, since 2007, and the FAO-EU FLEGT Programme, since 2017, have supported the Government of Colombia through various governance projects. In 2015 they supported the development of a road map for timber traceability in Colombia and set the conceptual and legal foundation for the traceability system. This project helped produce protocols for the review and evaluation of forest management plans, together with the control of forest management activities in natural forests and transport of forest products. These became the basis for the National Timber Traceability System.

LEGAL REQUIREMENTS

The main objective for implementing the National Timber Traceability System is to guarantee the legal origin of timber forest products. When the system is fully implemented, many of the verification and oversight responsibilities of MADS will be streamlined. Furthermore, the national system will help connect the various traceability systems operating at the regional level, which, until recently, were not connected to a national platform. By implementing the system and taking advantage of VITAL, the national forest authority saw an opportunity to streamline and connect different timber traceability systems operated separately by regional authorities.

Further, VITAL offers an incentive for the private sector to declare information online instead of applying directly to regional forest authorities for the required licences. This is expected to make the process more efficient for producers while reducing opportunities for illegal activities.

HOW THE SYSTEMS ARE MEANT TO WORK

Table 5A outlines how the system works at each step along the supply chain, and describes the roles of the various governing authorities, as well as the documents used to collect data for tracking the products.

Table 5A | How the national traceability systems in Colombia are meant to work

SUPPLY CHAIN	DOCUMENT USED	DESCRIPTION
Phase in the supply chain	*Document used to collect data which can be uploaded to the system and later used to verify legality before products are moved further down the supply chain*	*Description of the actions required by the producer (harvesting) or processor (processing) and how the information provided is verified by the forest authority*
Timber origin	**Forest management authorization documents** **Forest management plan** *(Plan de manejo forestal)* **Harvest licence** *(Licencia de aprovechamiento)*	1. Producers submit their forest management plans to the CAR (regional authority) for approval. 2. The CAR reviews the information and carries out field visits to ensure that the data was reported accurately. 3. Once the forest management plan is approved, the regional authority issues a harvesting licence and records it in VITAL.
Harvesting		4. Pre- and post-harvest inspections are completed by the CAR to verify that the operation is consistent with the information recorded in the harvesting licence. 5. The producer harvests the trees and moves them out of the forest to be transported.
Transport	**Transport permit** *(Salvoconducto unico en línea* (SUNL)	6. The producer applies for a SUNL through the CAR. 7. After checking whether the name of the operator and volume and species details match the information in VITAL, the CAR issues the SUNL and sends it to the producer. 8. The CAR carries out inspections at road check points to check the validity and authenticity of the SUNL and transported products.
Processing	**Operations book** *(Libro de operaciones,* LOFL)	9. At the primary or secondary processing facility, the processor must record all products entering or exiting the facility. Secondary processors are only allowed to process wood with a valid SUNL. They are also required to record their inputs (based on transport licences) and outputs (based on sales invoices recorded in the operations book or LOFL). 10. The CAR inspects the facility to ensure proper records are being kept based on timber registration records. Some regional authorities use paper-based documents (physical records), while others have digitized this process. In the future, the operations books will be centrally managed like the transport licences.
Secondary processing	Under development	
Final sale	Not yet developed	11. When a product is ready to be sold on the domestic market, the retailer will report the volume and invoice number in the LOFL once fully implemented. For exported products, the customs systems are currently not integrated with the traceability systems, as exported volumes are relatively smaller than volumes for domestic consumption.

SUCCESSES, CHALLENGES AND OPPORTUNITIES

Colombia has made significant progress in the past few years on the development of its timber traceability system.

While the implementation of the overall timber traceability system is on track, several challenges are currently being addressed by the national forest authority to ensure successful rollout of the system. While internet connectivity has improved across the country overall, several regional authorities are still reluctant to transition to the online transport permit system. Uptake of this system is critical to the successful implementation of the system.

During the planning phase, efforts should be made to engage with the system's various users to ensure that they understand how the system benefits them and how to use it properly.

Today, both private-sector and government actors benefit from the increased centralization of forest sector data. Private-sector operators benefit from more efficient transport and processing, while the regional environmental authorities have access to VITAL, and MADS can use the data entered from these modules to produce statistical information on the forest sector at the national level.

THE FOREST SECTOR AND THE ECONOMY OF ECUADOR

In 2020, natural forests and plantations covered around 12 498 million hectares, representing a little over half of the national land area. Approximately one-quarter of the forest area is located within protected areas (FAO, 2020). Most of the timber produced in Ecuador is consumed on the domestic market (ITTO, 2017). In the past couple of years, the forest sector has contributed with a constant 1.9 percent to GDP (FAO, 2016b).

FOREST AUTHORITIES AND TRACEABILITY SYSTEMS

Table 6A shows the two government departments that manage traceability systems for timber from two sources (natural forests and forest plantations) and feed information into the **National Forest Traceability System** (Sistema Nacional de Trazabilidad Forestal, [SNTF]). The FAO-EU FLEGT Programme supported the implementation of these systems.

In developing the SAF system, the government agreed that it would be more effective for Ministry of Agriculture (Ministerio de Agricultura, Ganadería, Acuacultura y Pesca [MAGAP]) to be responsible for the management of forest plantations (ITTO, 2014). The SPF system is in many ways a more updated version of the SAF, and as the two systems are able to share many tools and are hosted on a common platform, there is no loss in information during collection or analysis, which could be expected when systems are run by two different government agencies (ITTO, 2014).

This case study focuses on the SAF. With separate authorities controlling timber from different sources, this limits the risk of illegal timber entering the supply chain. Since MAGAP manages timber products from plantations, the national forest authority (MAAE) does not need to focus verification efforts on these products and is in a position to better target their resources at controlling timber from natural forests. These face a greater threat from illegal logging.

Since 2013, the SAF has generated a Geographic Information System (GIS) database, which allows MAAE to collect information from the areas where forest management has been authorized. This provides MAAE with all the geographic information needed to manage natural forests and the products coming from them. The geographic element of this database is used to validate the harvesting sites, which are then verified through a field inspection. The SAF also catalogues high-value species that have been extracted and transported to ensure that they cannot enter the system again (MAAE, 2012; TRAFFIC, 2014).

Both the SAF and the SPF systems control forest product supply chains by issuing licences to registered operators through a secure online system, cross-referencing input and output declarations (e.g. checking that the harvested volumes match the authorized volumes in harvesting licences, that the species being transported match the species indicated on the transport licences, etc.) and cross-checking data in the integrated databases while in the field, to ensure that transport permits are not used twice and that the data is reported correctly (e.g. wood stock and species).

Table 6A | Forest authorities and traceability systems in Ecuador

JURISDICTION	AUTHORITY	ROLE	TRACEABILITY SYSTEM
National	**Ministry of the Environment and Water** (Ministerio del Ambiente y Agua de Ecuador [MAAE])	The MAAE oversees monitoring of the production, tenure, exploitation and commercialization of forest raw materials. The **Directorate of Forests** (Dirección Forestal [DF]), under the MAAE executes the **National Forest Control System** (Sistema Nacional de Control Forestal [SNCF]), which is tasked with controlling and monitoring timber activity in natural forests, forest plantations, and trees under agroforestry systems.	The **Forest Administration System** (Sistema de Administración Forestal [SAF]) has been deployed at the national level and uses web-based databases, available online. The information is used to administer forest management programmes and monitoring activities on roads and in processing facilities, and to generate statistical information about the sector. The SAF applies only to wood sourced from natural forests.
	Ministry of Agriculture, Livestock Farming, Aquaculture and Fisheries (Ministerio de Agricultura, Ganadería, Acuacultura y Pesca [MAGAP])	The MAGAP is responsible for managing timber products sourced from forest plantations and commercial agroforestry production systems.	The **Forest Production System** (Sistema de Producción Forestal [SPF]) is managed by the MAGAP and applies to commercial forest plantations.

DEVELOPMENT OF THE SYSTEMS

The main objective of the SNTF is to monitor the national timber supply chain and guarantee the legal origin of timber products, while promoting sustainable forest management.

According to TRAFFIC (2014), the SAF was developed by the MAAE with support from ITTO under the project *Establishment of a National Forest and Timber Marketing Statistics System (Establecimiento de un Sistema Nacional de Estadísticas Forestales y Comercialización de la Madera*). In 2009, the initial budget for this project was USD 569 401, with most of the funding coming from ITTO. By 2012, the budget had increased to USD 700 447, with all the additional funds coming from the national government. In 2014, when an evaluation of the project was done, it was estimated that once the ITTO funding had ended, the government had spent around USD 1 million on the project, including on maintaining the SAF (ITTO, 2014b). The primary objective of this project was to create a system that would give the national authority the information needed to better manage forest resources as they move from forest to market (ITTO, 2014b).

As part of this project, the SAF was released to users as a digital system and integrated into all the technical offices across the country tasked with reviewing and approving harvesting plans and operations. By connecting the harvesting plans to a central database, the national authority was able to connect the SAF to a system generating transport licences. This helps the tracking of wood from the forest to processing facilities (ITTO, 2012).

LEGAL REQUIREMENTS

The development of the SAF began in 2009 with the goal of collecting information that would be useful for the government and the private sector, and international investors interested in the sector. In 2009, the first version of the SAF released was primarily dedicated to issuing forest management licences and transport permits. Since then, in addition to issuing forest management licences and transport permits, the system manages the registration of forest operations at national level.

The current version of the SAF was launched in 2012. It consists of a central database structure that manages most of the data related to the timber chain of custody, from pre-harvesting to commercialization, the issuance of secure timber harvesting licences through the database, and frequent field and road check-point inspections. More specifically, the SAF allows for:

- registration of operators involved in natural forest harvesting (producers, transporters, log yards at final destinations);
- validation of forest management plans and related documents

in natural forest and non-commercial plantations;

- harvesting licences to be issued in natural forests and agroforestry systems; and
- transport licences to be issued for wood from natural forests and agroforestry systems.

The SAF is also an important tool for forest inspections and road check-point controls (ITTO, 2014b).

HOW THE SYSTEMS ARE MEANT TO WORK

Table 7A below outlines how the system is meant to work in practice, including the responsibilities of the private sector and government, and the documents used to trace the products.

Table 7A | How the Forest Administration System is meant to work

SUPPLY CHAIN	DOCUMENT USED	DESCRIPTION
Phase in the supply chain	*Document used to collect data which can be uploaded to the system and later used to verify legality before products are moved further down the supply chain*	*Description of the actions required by the producer (harvesting) and processor (processing) and how the information provided is verified by the forest authority*
Timber origin	**Integrated management plan** *(Plan de manejo integrado)*	1. Producers submit all required management plans to the MAAE and if approved they will receive a harvesting licence.
Harvesting	**Forest management plan** *(Plan de manejo forestal)* **Harvesting licence** *(Licencia de aprovechamiento)*	2. To ensure that the harvest operation is consistent with the harvesting licence, a pre-and post-harvest inspection is completed by the MAAE. 3. Results of the post-harvest inspection are uploaded to the SAF.
Transport	**Transport permit** *(Guía de movilización)*	4. Using the SAF online portal, producers apply for a transport permit. 5. The SAF issues transport permits if no issues were identified during the MAAE post-harvest inspection. Transport permits are printed with QR codes that can be read at road control points. 6. MAAE inspects the validity and accuracy of the permits and the products being transported at road check points throughout the country.
Processing	Users enter information directly into the **Forest Administration System** (Sistema de Administración Forestal [SAF])	7. Once the wood has been transported to the sawmill, the input materials are recorded through the SAF before processing. 8. After the products have been processed and documented, MAAE checks that the volumes are consistent with the records. 9. Primary and secondary processors are only allowed to process wood with a valid transport licence, a copy of which is filed with their own records. 10. Before the wood is processed, the processor requests permission to transport their products a second time, and if granted, they will use a sales invoice as legal documentation. 11. MAAE verify wood stocks in the processing facilities.
Final sale		12. When a product is ready to be sold, the retailer will report the volume and invoice number to the SAF.

SUCCESSES, CHALLENGES AND OPPORTUNITIES

The National Timber Traceability System of Ecuador (SNTF) is innovative and consists of two systems, the SAF (natural forests) and the SPF (commercial forest plantations). An ITTO evaluation of the project in 2014 concluded that the implementation of the SAF to target and control wood products from different sources, paired with the ability of the systems to generate statistics and information at the national level should be hailed as a success and used as an example by other countries interested in implementing a timber traceability system at the national level (ITTO, 2014b).

To complement the SAF, the national forest authority is assessing ways of enhancing the system with additional technological tools suitable for the forest and forest sector in Ecuador, including physical markers. The implementation of physical markers would allow the national authority to physically link a piece of timber to its tree of origin in the forest, expanding the document-based traceability offered by the SAF. This would also allow the national forest authority to issue certificates of origin for the wood that can be traced back to the forest. Some of the considerations include:

- identifying the best cost-effective timber marking solutions and scanning tools;
- identifying incentives to promote wood with a certificate of origin, including analysing the national wood market and investigating the possibility of using SAF as a marketplace; and
- analysing national wood flows and adapting road check-points and legislation on wood transport.

The Ministry of the Environment and Water is continuously adapting the SAF to local contexts to reduce the administrative burden for companies. Both MAAE and MAGAP are trying to increase security features in the transport permits issued by the SAF and SPF even though they are printed in the forest management units by forest managers (with valid management authorizations). Several elements must be declared by companies to generate licences, such as the driver's name or trip duration. Many operators choose to outsource the transport of their products to a third-party provider and may not always obtain all the information required to apply for the transport permits (such as vehicle or driver details). This means that in the event of any changes within the transport companies between the time of application and the time of transport, the logging company must apply for and obtain a new licence, making the process time-consuming.

To continuously improve the forest product traceability systems, MAAE and MAGAP are evaluating forest laws and regulations to simplify bureaucratic processes.

THE FOREST SECTOR AND THE GUATEMALAN ECONOMY

In 2020, natural forests and plantations covered around 3 528 million hectares, representing a little over 30 percent of the national land area. Approximately 18 percent of the forest area consists of primary forests and over half is located within protected areas (FAO, 2020). In 2019, a little over 1.5 million cubic metres of timber were harvested in Guatemala, all from non-protected areas (SIFGUA, 2020). In total, the forest sector accounts for around 2.5 percent of total GDP in Guatemala (World Bank, 2014). The vast majority of timber produced is consumed in the domestic market. For example, out of 773 000 cubic metres of logs produced, nearly 99 percent were consumed domestically (ITTO, 2017a).

FOREST AUTHORITIES AND TRACEABILITY SYSTEMS

The forest authorities overseeing the timber traceability systems in Guatemala are outlined in Table 8A.

Regardless of the institution issuing the transport permit, the national forest authority is responsible for overseeing the flow of products through the supply chain, including forest products extracted from protected areas (NEPCon, 2017a). Once timber from protected areas enters a sawmill for primary processing, INAB becomes the authority tasked with overseeing the flow of timber through the supply chain.

Table 8A | Forest authorities and traceability systems in Guatemala

JURISDICTION	NAME	ROLE	TRACEABILITY SYSTEM MANAGED
National	**National Forest Institute** (Instituto Nacional de Bosques [INAB])	INAB is responsible for issuing and overseeing the implementation of forest management permits in the country, except for harvesting timber within protected areas.	The primary timber traceability system examined for this report was the **Electronic Information System for Forest Enterprises** (Sistema Electrónico de Información de Empresas Forestales [SEINEF]). This is a semi-electronic timber sector monitoring system, with volume tracking and transaction verification functionalities. It was launched in 2014 and developed by the national forest authority. SEINEF does not cover permit approval, but the law requires any enterprise issued with a permit or which processes, stores, sells or distributes timber or wood-based products to register in SEINEF every year.
	National Council on Protected Areas (Consejo Nacional de Áreas Protegidas [CONAP])	CONAP is responsible for timber sourced from protected areas.	With support from the FAO-EU FLEGT Programme, CONAP is developing an automated platform for forest management in protected areas called the **Electronic System for Forest Administration in Protected Areas** (Sistema Electrónico para la Administración Forestal en Áreas Protegidas [SEAF-CONAP]). This tool provides an important contribution to efficient and effective forest management, consolidating national forest databases and improving the traceability of timber products from areas under CONAP management. This system will also be able to automatically connect with other electronic systems, such as the electronic management system for the issuance of CITES permits, which is also administered by CONAP.

DEVELOPMENT OF THE SYSTEM

In order to grow the market for Guatemalan wood products and put an end to illegal logging, the government launched SEINEF in 2014. The government hoped that the system would help curb some of the main drivers of deforestation and forest degradation in the country, which are linked to the commercialization of illegal wood products in domestic and international markets (CIF and FIP, 2017). The implementation of SEINEF has strengthened the forest sector by guaranteeing the legal origin of forest products as they move through the supply chain since it does not allow timber from unregistered or undocumented sources to enter the supply chain (FAO-EU FLEGT Programme, 2020).

SEINEF was created as part of the country's 2010 national plan to prevent and reduce illegal logging. It was designed to reduce illegal logging and associated trade, prevent tax evasion and facilitate national and international trade of legally harvested forest products. In developing SEINEF, INAB sought to focus on compliance incentives rather than on penalties (INAB, 2015).

The 2010 plan estimated that two-thirds of timber processed in Guatemala originated from uncontrolled sources and that 76 percent of fuelwood was traded in the informal sector. The plan also recognized informality in the forest sector as both a major deforestation driver and important source of tax evasion. One of its recommendations was to develop an advanced information system for monitoring volume flows in timber processing to prevent illegal logging and foster the development of a socially and economically viable forest sector (INAB, 2010).

In developing SEINEF, the national forest authority sought to incorporate lessons from other countries that were developing VPA timber legality assurance systems. However, these systems were perceived to be too technologically ambitious for Guatemala, and a fully electronic traceability system would have faced financial, technological and cultural barriers. Thus, SEINEF was designed as a semi-electronic system with a central database, populated with information collected from online forms, spreadsheets and physical paper-based documents.

The strategy was to set up SEINEF as a first step towards the uptake of electronic data management to build trust. The system's electronic components cover the registration of harvesting operations and processing facilities throughout the supply chain. Transport permits, in contrast, are paper based, designed as such because of the expectation that loggers and truckers would not necessarily have adequate smartphone or internet connectivity capabilities.

The SEINEF system was developed by the national forest authority with financial support from ITTO and USAID, the former being the main financial partner supporting the establishment of the Guatemalan **Forest Information System** (Sistema de Información Forestal de Guatemala [SIFGUA]).[10] This is the data

Box 1A | How inputs are tracked in SEINEF

Once registered, sites continuously report their inputs and outputs through the quarterly report for forest enterprises (*informe trimestral de empresas forestales* [ITEMAS]) either by directly feeding the data into the online platform or by submitting a Microsoft Excel file. The ITEMAS must be submitted at least every three months; the first one is due by end of March.

The ITEMAS differentiates three categories of inputs. In Excel, these are represented as different sheets:

- **Inputs of raw materials** (*ingresos de materia prima* [IMP]): this category includes all products that originate directly from forests or plantations from protected areas and non-protected areas, as well as a range of products that have undergone primary processing (at the point of harvest, e.g. with a mobile sawmill).
- **Inputs originating from other companies** (*ingresos provenientes de otras empresas* [IMAS]): users report inputs of products they bought from other users who are not primary producers (INAB, 2014).
- **Imported inputs** (*ingresos provenientes de importación* [IMAI]): participating sites report inputs imported from foreign countries. The transactions have to be referenced to official import/export documents.

backbone for SEINEF (ITTO, 2014). The Guatemalan Government invested approximately USD 200 000 from ITTO funds to set up SEINEF. Funding from USAID was used for the dissemination of the system through TV and radio advertisements, as well as for training private-sector users (A. Samayoa, personal communication, December 2018).

LEGAL REQUIREMENTS

In February 2015, registering for SEINEF became a legal requirement for forest enterprises (ITTO, 2017). If an enterprise chooses not to register, it is assumed to be illegal, and it can be fined and prosecuted. Registration rates have varied from year to year, but in general there has been a positive trend since the SEINEF was released (NEPcon, 2017a). Every five years, producers register within the national forest registry, where they have the option to register as a forest operator, a processing facility or both. Producers must register all sites where their company is doing business. Once the businesses have registered in the national forest registry, they will automatically be registered in SEINEF. As of October 2020, the total number of businesses registered is 1 941 (Renaldo, 2020). This process costs about USD 15 (A. Samayoa, personal communication, 2020).

HOW THE SYSTEMS ARE MEANT TO WORK

Table 9A outlines the role of producers, as well as the roles of the national forest authority and the protected areas authority at each step along the supply chain, while also highlighting the documents involved at each step and how they are verified. Registered SEINEF users rely on the system for legality verification of their inputs as they have been verified by the system before they are transported.

Table 9A | How SEINEF is meant to work

SUPPLY CHAIN	DOCUMENT USED	DESCRIPTION
Phase in the supply chain	*Document used to collect data which can be uploaded to the system and later used to verify legality before products are moved further down the supply chain*	*Description of the actions required by the producer (harvesting) and processor (processing) and how the information provided is verified by the forest authority*
Timber origin	**Electronic report of initial loading** (*Informe electrónico de carga inicial* (IECAI)	1. Producers submit a forest management plan to INAB or CONAP. In addition, producers declare any balance remaining backed up by documentation from their suppliers. Information about the balance includes name of the supplier, species and volumes. 2. Forest enterprises register at the national forest registry (*registro nacional forestal*) to start using SEINEF. 3. Once they are ready to begin their harvesting operation, the producer or enterprise will submit an IECAI for the first time. To submit the IECAI, they must download the Microsoft Excel template, fill it out and upload it to the platform. 4. Enterprises with an IECAI create a user profile to enter information into SEINEF.
Harvesting	**Quarterly forest enterprises report** (*Informe trimestral de empresas forestales* (ITEMAS)	5. INAB reviews the information to ensure it is accurate. 6. Each quarter, producers are required to submit an ITEMAS, which triggers the creation of transport permits. Reporting can be done directly on the web platform or via an electronic spreadsheet template.
Transport	**Transport permit** (*Nota de envio* (INAB) *& guía de transporte* (CONAP)	7. The relevant forest authority will issue a transport permit after verifying the information uploaded SEINEF. Once the document has been issued, this is only valid for 24 hours, creating an incentive for the truck driver to move the timber to its reported destination. 8. Transport permits contain a unique QR code, which INAP and CONAP personnel may scan to confirm the shipment at road check points.
Processing	(Within SEINEF)	9. Processors will scan the transport permit, which automatically uploads the data to the system. 10. Based on the timber credits issued, processors can convert materials into primary or secondary products. The products should match with the inputs based on determined yield factors.
Final sale	*Nota de envío*	11. When the seller is ready to make the sale, they will report the volume and number from the *nota de envío.*

SUCCESSES, CHALLENGES AND OPPORTUNITIES

The implementation of SEINEF has been a success so far, allowing authorities to capture data on timber volumes from registered sites and to track those volumes as they move along the supply chain. From 2014 to June 2020, 942 500 transport permits have been issued through SEINEF, and about 8 485 952 cubic metres have been sold through the platform (Renaldo, 2020). In 2014, when the system was launched, about 855 000 cubic metres of wood products were traced, and about 73 000 transport permits were issued. These numbers have increased steadily since the launch of the system: in 2020, for instance, 132 560 transport permits were issued (INAB, 2021). This shows that there has been greater investment in the Guatemalan forest sector and an increased uptake of the system (A. Samayoa, personal communication, 2020).

Moreover, digitizing this information into a central database has enabled the authorities to be notified when sites report questionably high conversion factors. The authorities can then confirm whether, for example, the volume entering primary processing is consistent with the volume of the allowable cut (A. Samayoa, personal communication, December 2018).

Officials from the national forest authority interviewed for this case study estimate the potential error in the volume captured by the system to be plus or minus 15 percent, due to unit conversion and measurement issues. Furthermore, since the scope of SEINEF does not currently include monitoring or reporting at the level of the forest management unit, over-reporting of harvest volumes can facilitate the introduction of illicit timber into the system.

The maintenance of users' accounts mitigates the risk of non-compliance with national forest and tax regulations, and SEINEF provides a formalized link to international trade in its database through a designated export sheet in the reporting file. This means that international and domestic buyers are able to access data at the macro level on exports, including information on trading partners and volumes.

With the implementation of SEINEF in Guatemala, the promotion of legal trade, transparency in management and the application of the forest law and implementing regulations have been strengthened. The total number of companies is also continuously monitored by the system, which generates alerts when companies should be investigated (Renaldo, 2020).

However, challenges in implementation and design gaps remain. The volume-based approach of SEINEF does not include batch traceability. As in other volume-based tracking systems, actors source timber from processors with the implicit understanding that materials, once registered in SEINEF, are de facto compliant since they cannot be traced back to the forest management unit. While this approach may be considered effective for the pine plantation sector, for high-value tropical hardwoods from natural forests, a higher level of traceability would be beneficial. Also, pine from natural forests can enter the mostly plantation-based supply chain, but should in fact be considered separately by the traceability system. In 2021, INAB launched a new system, the **Electronic Forest Management System** (Sistema Electrónico de Gestión Forestal [SEGEFOR]), initially for softwoods (pine) and then expanding to hardwoods in 2022.

To address these challenges, INAB is considering several potential approaches for improving SEINEF and expanding its scope, especially for legality verification efforts. INAB is currently upgrading SEINEF from a semi-electronic system to a fully electronic system by deploying additional technologies, including mobile devices. For instance, INAB could link SEINEF to INAB's own geospatial data for more comprehensive and detailed information on timber origin. Technological innovation is seen as an opportunity to increase system functionality and reduce human errors, which can potentially enable illegal activities.

THE FOREST SECTOR AND THE HONDURAN ECONOMY

In 2020, natural forests and plantations covered around 6 359 million hectares, representing a little over half of the national land area. Approximately one-third of the forest area is located within protected areas (FAO, 2020). According to ITTO (2017a), timber produced in Honduras is primarily consumed in the domestic market. In 2017, for instance, 99.9 percent of annual logs produced (700 000 cubic metres) and 75 percent of sawn wood produced (293 000 cubic metres) were consumed in domestic markets. In 2016, the value of forest product exports rose to USD 81.38 million, with a positive balance of trade of USD 27.08 million. All together the forest sector in Honduras contributes about 0.8 percent to the country's GDP (Lebedys and Li, 2014).

Forest products from Honduras originate from two distinct types of forests, each of them with different forest management regimes and traceability needs (Box 2A).

Along with Guyana, Honduras is one of just two countries in the Americas who have negotiated a VPA with the European Union. The VPA between Honduras and the European Union was signed and ratified in 2021. As a part of the VPA, the Honduran Government is developing a TLAS, which includes the establishment of a timber traceability system to track products along the supply chain and help assess and demonstrate their legality. This case study focuses on the Timber Traceability Information System (Sistema Informático de Rastreabilidad de la Madera [SIRMA]).

Box 2A | Forest types in Honduras

There are two distinct types of forest in Honduras, coniferous and broadleaf forests, whose management is regulated by slightly different regulatory frameworks (e.g. slightly different harvesting authorizations and transport rules for broadleaf timber) which, in turn, impact management approaches.

Coniferous forests constitute about a third of the country's forests. Roundwood production from these forests is mainly concentrated in private lands in the centre-north part of the country. Although the area of coniferous forests is smaller, the volume of roundwood production is traditionally higher than production from broadleaf forests. Tree harvesting involves clear-cutting within a defined cutting cycle while protecting seed trees.

Broadleaf forests (humid and deciduous) cover little over half of the territory and extended mostly throughout the west and north, as well as the central valleys of the country. These forests are generally managed under a selective logging regime, where a minimum diameter for harvesting is determined by species, and the timber is processed at the felling site before being extracted from the forests.

Coniferous timber is processed in mass and has a lower value. Individual traceability is not economically feasible compared to, for instance, mahogany from broadleaf forests, which is usually sold in niche markets willing to pay higher prices for the timber. Mahogany (a CITES-protected species) is tracked using paint until primary processing.

Sources: based on ICF, 2017a; EFI, 2019; MiAmbiente and ICF, 2020.

FOREST AUTHORITIES AND TRACEABILITY SYSTEMS

The National Institute for the Conservation and Development of Forests, Protected Areas and Wildlife (Instituto Nacional de Conservación y Desarrollo Forestal, Áreas Protegidas y Vida Silvestre [ICF]) is the forest authority responsible for the development and implementation of SIRMA. SIRMA depends heavily on another previously existing platform for monitoring timber flows (Table 10A).

DEVELOPMENT OF THE SYSTEMS

SIRMA has been in development since 2016. In designing and developing SIRMA, the forest authority attempted to incorporate lessons from Guatemala through exchanges of information (FAO Guatemala, 2016a; FAO Guatemala, 2016b). At least USD 55 000 have been invested in the development of the online platform (FAO, 2017).

LEGAL REQUIREMENTS

As required by the Forest Law and the Administration Guide for Pine Forest Harvesting Plans (Cannon and Oqueli, 2012), the information required to support traceability includes:

- an exhaustive forest inventory for creating an annual operating plan;
- the application of paint for individual tracking from the forest to primary processing facilities for mahogany;
- the use of transport permits (*guias de movilización*) for transporting wood between the forest and the log yard and/or primary processing facility; and
- the use of operations books inside sawmills to keep up-to-date input and output records.

SIRMA is still under development, but it is expected to connect with information systems from other government agencies, including the Automated Customs Revenue System of Honduras,

Table 10A | SIRMA and other Forest Information Systems in Honduras

NAME	ROLE	FOREST INFORMATION MANAGEMENT SYSTEMS
National Institute for the Conservation and Development of Forests, Protected Areas and Wildlife (Instituto Nacional de Conservación y Desarrollo Forestal, Áreas Protegidas y Vida Silvestre (ICF)	ICF is the government authority responsible for managing the nation's forest resources and controlling the timber traceability system. Through its central office as well as regional and local offices, ICF is responsible for approving forest management plans and annual operation plans, monitoring the forest harvesting process, audits of forests and facilities, and inspections at mobile check-points. From now on, the ICF will be referred to as the national forest authority.	The National Forestry Information System (Sistema Nacional de Información Forestal [SNIF]) was launched in 2008 as a centralized data platform that allows the national forest authority to maintain records related to forest tenure, harvesting licences, forest industries and trade businesses, forest management authorizations, forest management and forest operation plans, as well as ICF-certified management operations. Through the SNIF, the national authority exercises control on supply-chain actors and provides for a more agile and transparent document approval process. The Timber Traceability Information System (Sistema Informático de Rastreabilidad de la Madera [SIRMA]) is a centralized online tool for monitoring timber flows. SIRMA uses SNIF data as the basis for issuing transport permits, and managing and analysing data submitted by timber processing industries through monthly reports. Through SIRMA, the national forest authority can compare and reconcile inputs and outputs at every step of the supply chain, allowing control of inventories, production and trade. Like with the SNIF, the central, regional and local offices of the national forest authority play a role in analysing data from the timber producers under their jurisdiction through SIRMA. For the purpose of reviewing the development of the TLAS in Honduras as it relates to the tracing of wood products, the research team focused only on SIRMA for this case study.

to provide the supply-chain controls needed to meet the legality definition in the VPA. Key documents such as harvesting licences, transport permits and waybills, and production reports "will be recorded in the SNIF and the SIRMA [...] so that the volume of timber circulating in each stage of the supply chain can be calculated" (European Union and Republic of Honduras, 2018).

HOW THE SYSTEMS ARE MEANT TO WORK

There are eight modules in SIRMA (Figure 1A), including the forest industry module, which is a user interface. Other modules are used to upload or record transactions or generate reports based on the activities recorded in the system.

SIRMA is designed to monitor timber flows based on the use of transport authorization documents (*guías de movilización*), and the ingoing/outgoing timber and production declarations (*libros de operaciones*) submitted by sawmilling companies (Table 11A).

SUCCESSES, CHALLENGES AND OPPORTUNITIES

As of 2020, while the system is still under development, SIRMA has been officially launched and is being implemented by the national forest authority. Technical staff from the 12 forested regions in the country have been trained to use the system. One implementation success is that SIRMA facilitates the centralization of information about forest management and productive activities on the forest sector (e.g. inputs, production, outputs and sales) in a transparent way (CLIFOR, 2018). This allows the forest authority to generate more up-to-date statistics about forest management and forestry activities, which can also be used to better manage and support the development of the sector (ICF, 2017a).

The Government or Honduras has focused particularly on training smallholders in the use of SIRMA. With financial support from the FAO-EU FLEGT Programme, for example, the forest authority conducted a pilot to promote the use of SIRMA by cooperatives from the Honduran Federation of Agroforestry Cooperatives (FEHCAFOR). The pilot helped participants understand the value of using SIRMA for reporting data on their products, optimizing response times and structuring the information to report to the ICF.

Figure 1A | SIRMA modules

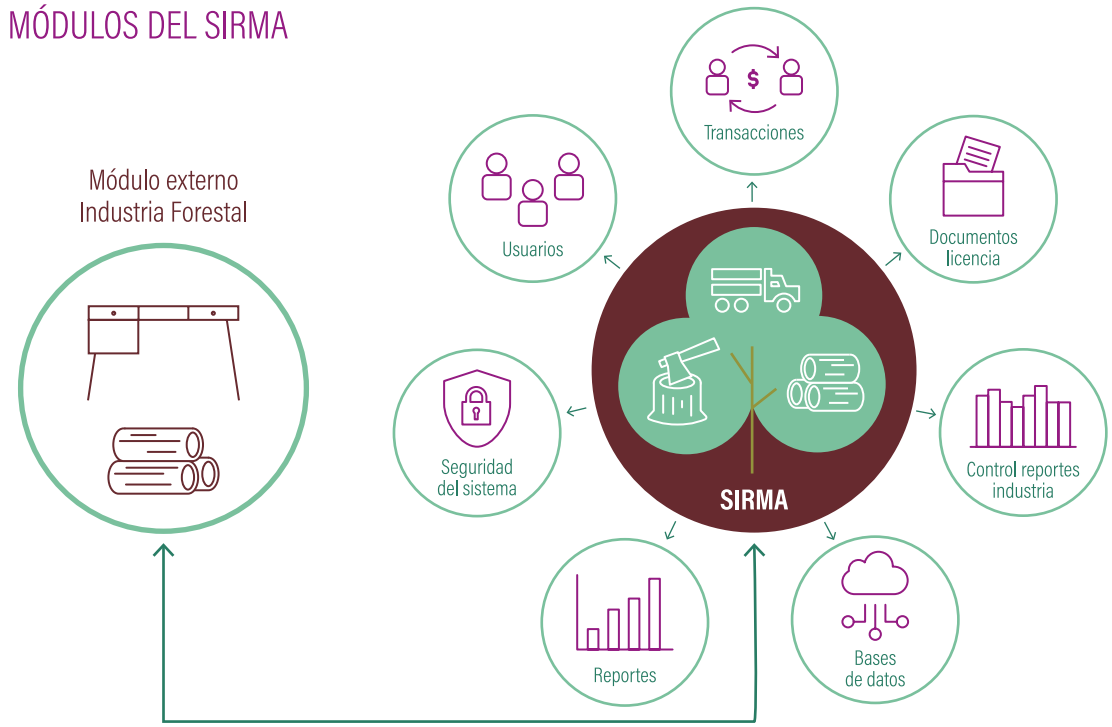


Table 11A | How SIRMA is meant to work

SUPPLY CHAIN	DOCUMENT USED	DESCRIPTION – PRODUCER/AUTHORITY ROLE
Phase in the supply chain	*Document used to collect data which can be uploaded to the system and later used to verify legality before products are moved further down the supply chain*	*Description of the actions required by the producer (harvesting) and processor (processing) and how the information provided is verified by the forest authority*
Timber origin	**Forest management plan** (*Plan de manejo forestal*) **Harvesting licence** (*Licencia de aprovechamiento*)	1. Producers submit their forest management plan and annual operation plan to the ICF for approval. 2. The ICF reviews the information and carries out field visits to ensure that the data was reported accurately. 3. Once approved, the ICF issues a harvesting licence and records the licence data in the SNIF. The ICF sells transport licences to the producers for the volume of wood to be harvested.
Harvesting		4. In close coordination with the Public Ministry in Honduras, the ICF conducts field verifications and takes any actions necessary based on the requirements of forest law and any other applicable law. 5. In the case of broadleaf forest, trees are felled, delimbed and bucked in the forest before being transported to the roadside.
Transport	**Transport licence** (*Guía de movilización*)	6. ICF allocates transport permits for up to 80 percent of the annual coupe. Producers fill out a transport licence with the volumes being mobilized and return it to ICF with all the information needed. The timber volume mobilized is recorded in SIRMA. ICF issues more licences to the producer if needed. If the producer does not return the transport licences, ICF withholds further sales of licences. Each transport licence is used for the transport of around 20–30 cubic metres of timber and timber products. 7. ICF cross-checks the information reported by producers with other recorded data to identify red flags for inspection and verification. 8. In close coordination with other government authorities (e.g. the police, the Public Ministry or the military), ICF can validate the authenticity of transport licences and transported products at road check points.
Processing	**Monthly production reports** (*Libros de operaciones*)	9. The primary processor is only allowed to process wood with a valid transport licence. Transport licences can be used only once. 10. The primary processor records wood inputs (based on transport licences) and outputs (based on sales invoices) in SIRMA each month. 11. ICF conducts technical audits to verify wood stocks in the processing facilities.
Final sale		12. The primary processor is only allowed to process wood with a valid transport licence.

The validation and reconciliation of data in the TLAS is critical to proving the legality of the products. A fully implemented SIRMA will be crucial to support the forest authority in gathering and reconciling data from other systems.

To encourage all forest operators to register with SIRMA and thus avoid data irregularities and inconsistencies, the forest authority is considering designing two modules to strengthen its monitoring system:

- Adding functionalities to SIRMA to allow sawmills to request and generate transport licences online (with QR codes on the documents to improve security). Currently, companies receive these documents in bulk for 80 percent of the entire annual coupe and when used, they are returned to the ICF with all the information about the timber transported. This process does not allow the volume of wood removed from the forest to be tracked in real time. This change would make it possible to follow the action taken by each forestry operator and ensure that the volume awarded has not been exceeded.
- Creating mobile applications, especially for forest censuses, the generation of transport licences, and field and road inspections.

Further, the forest authority is exploring opportunities to leverage SIRMA for promoting the trade in legal forest products.

The experience in Honduras is a good example of government efforts to incorporate lessons from other countries' experiences to design a traceability system that fits the realities of the forest sector on the ground and leverage technological advances in information management systems.

THE FOREST SECTOR AND THE ECONOMY OF PANAMA

In 2020, natural forests and plantations covered around 4 214 million hectares, representing a little over half of the national land area. Nearly 50 percent of the forest area is located within protected areas (FAO, 2020). In 2011, the forest sector contributed 0.3 percent to the country's GDP (Lebedys and Li, 2014). In 2016, an estimated 197 000 cubic metres of roundwood and 33 000 cubic metres of sawnwood were produced in Panama. One explanation for this could be the poor condition of the country's wood industry, and the high demand for unprocessed wood (teak logs) from China.

Within the country, the Darién province has faced a particular threat from illegal logging. This province produces between 75 and 85 percent of the timber produced in Panama. Out of the timber that comes from Darién, 67 percent is estimated to be of illegal origin (Arguelles, 2010). WWF and the national forest authority received support from the FAO-EU FLEGT Programme and ITTO to tackle the high deforestation rate and illegality in the Darién province.

FOREST AUTHORITIES AND TRACEABILITY SYSTEMS

Table 12A shows the authorities involved in traceability in Panama.

Table 12A | Forest authorities and traceability systems in Panama

JURISDICTION	NAME	ROLE	TRACEABILITY SYSTEM MANAGED
National	**Ministry of the Environment** (Ministerio de Ambiente [MiAmbiente])	**MiAmbiente** regulates and monitors the harvesting, transport, processing, possession and sale of forest products. Henceforth, MiAmbiente will be referred to as the national forest authority.	**Forest Traceability and Monitoring System** (Sistema de Trazabilidad y Control Forestal [STCF]). With respect to traceability, the national forest authority is responsible for coordinating the technical implementatio]] n and monitoring of the system; providing information technology support for the STCF; training STCF users; overseeing harvesting operations; and, carrying out inspections at felling sites.

DEVELOPMENT OF THE SYSTEMS

As of October 2019, the system had been launched as a first prototype in eastern Panama and Darién province in an initial test phase (Rodriguez, 2019). The STCF is currently in the process of scaling up implementation in the pilot areas to the national scale. Once in place, the STCF will trace wood from its source through to processing and commercialization, using a physical marking system on standing trees and logs. The STCF will be the only system in the region to allow wood to be traced from point of origin to place of export.

The FAO-EU FLEGT Programme, ITTO and WWF supported a Round Table on Forestry, which was set up as a multisectoral forum bringing together representatives of timber companies, small producers, local and traditional authorities, and local communities linked to the forest sector in Darién and eastern Panama (FAO Panama, 2017). This round table was an opportunity to increase the national forest authority's capacity to pursue its objective of reducing illegal timber harvesting and trade. As such, it set the basis for the implementation of the traceability system.

This was developed by the Brazilian company AnimalTag, with financial support from the FAO-EU FLEGT Programme. Overall, development cost USD 100 000. The national forest authority led the development and deployment of the system with technical support from WWF. The STCF is operational in the Darién province and is expected to be rolled out across the country by 2020 (Government of Panama, 2019).

In developing the system, the government chose to integrate the use of mobile technology. When a tree is cut, a blue chip is attached to the stump and yellow tags are assigned to the log and any subsequent logs. As the logs move out of the forest and through the supply chain to various control points, the chips can be read using a mobile application, and the data can be captured to create a strong chain of custody (El Economista, 2019).

LEGAL REQUIREMENTS

The timber monitoring system in Panama is currently being implemented under Resolution DM-0068-2018 dated 2018. The information required to support traceability includes the following aspects:

- A detailed forest inventory of the annual harvesting area, including information on tree species for harvesting. During the inventory, trees are identified using ID tags.
- The use of permits to transport wood between the forest and the storage yard and/or the primary processing facility.
- Annual processing and reporting plans, which include information on timber owner, facility location and product types.

HOW THE SYSTEMS ARE MEANT TO WORK

Table 13A below describes the traceability system in Panama.

The traceability system in Panama is the only one covered in this report that is not volume based, meaning that wood information uploaded onto the system can be used to trace logs back to the forest they came from. Box 3A outlines how trees and timber must be marked to comply with the law.

Table 13A | How the STCF is meant to work

SUPPLY CHAIN	DOCUMENT USED	DESCRIPTION – PRODUCER/AUTHORITY ROLE
Phase in the supply chain	*Document used to collect data which can be uploaded to the system and later used to verify legality before products are moved further down the supply chain*	*Description of the actions required by the producer (harvesting) and processor (processing) and how the information provided is verified by the forest authority*
Timber origin	**Annual operating plan** *(Plan de operaciones annual)*	1. An inventory of the annual harvesting area is conducted to prepare an annual operating plan. 2. Trees to be harvested are identified using an electronic device. The trees selected based on their species are identified and tagged during this process. 3. Approved sites for harvesting are registered into the system.
Harvesting		4. A digital application to which this data has been uploaded alerts the national authority that it needs to approve the annual harvesting plan. 5. Once the trees have been cut, QR codes are attached to the base of the tree with information on tree origin.
Transport	**Transport permit** *(Guía de transporte)*	6. Transport permits (*guías de transporte*) for transporting wood between the forest and the storage yard and/or primary processing facility are generated through the application. 7. Permits are verified electronically at control posts.
Processing	**Annual sourcing and processing reporting plan** *(Plan de abastecimiento y reporte de procesamiento anual)*	8. Owners of primary and secondary processing centres must submit an annual sourcing and processing reporting plan through the STCF website, with information on the types of products manufactured at the site.

Box 3A | Marking requirements in Panama

Article 81-A of Resolution 0068 sets out how trees and timber should be marked (Ministry of the Environment, 2018):

- There are two types of tags. Blue tags are used during the census to mark the trees to be harvested, seedlings, remnants, natural monuments, as well as protection, fallen, dry and burned wood, and yellow tags are used for harvested logs.
- Blue tags can be read using near-field communication (NFC) technology and QR codes. Yellow tags only have a QR code.
- Commercial trees under the AOP are marked with tags and associated with a parcel of land. Each tree is defined by its UTM coordinates, species, commercial height, diameter, tree type and bole quality, as well as by whether there are any vines or damage on it. This allows the calculation of projected harvest volumes per species.
- After felling, the logs and stumps are marked with tags associated with the original tree tags.

SUCCESSES, CHALLENGES AND OPPORTUNITIES

In 2018, a national law was passed requiring the use of the STFC in eastern Panama and the Darién province, starting in January 2019. It was then planned that the system would be fully implemented across the country in the next 24 months (ITTO, 2017a).

Based on the interviews conducted for this study, the STCF was designed through a participative approach, and its web and mobile platforms seem to be user-friendly and well suited to current needs and conditions.

Under the STCF, trees and logs must be physically marked for identification purposes. Since 2019, plastic ID tags have been used, but there are ongoing discussions about whether these inputs will still be available in the future.

Currently, the STCF includes forest management and harvesting, timber transport, monitoring, security, as well as reporting modules. In addition, since 2019, smartphone applications have been developed for declaring wood inputs and outputs (for forestry companies), forestry inspections and issuing transport permits.

Once implemented across the country, the system is expected to be one of the few that provides comprehensive traceability between the forest source and mill entrance at the national level in Latin America. The STCF is already operational in the Darién province. Since 2019, the FAO-EU FLEGT Programme has contracted the services of an IT expert and AnimallTag to test, upgrade and implement the STCF in other regions of the country. To support this process, MiAmbiente forestry personnel have been trained in relevant areas.

The deployment strategy observed in Panama is different from the strategies described for the other case studies presented here. Instead of deploying modules at national level, Panama pilot tested a comprehensive traceability package in a selected region. The fact that many companies were actively harvesting in Darién allowed the "full system" to be tested on a wide range of operators. Also, the Round Table on Forestry involved all stakeholders in the Darién timber sector, and this was useful for ensuring that the results of the field tests were widely communicated and appropriate decisions were taken at short notice about the implementation of the system. The system implemented in the Darién province is expected to be deployed in the rest of the country, and sawmills will have to communicate their timber supply plan to the national forest authority, which will need to demonstrate coherence with the allocated forest resource for each harvesting permit.

Deployment of the system at national level, from the forest to timber processing, will represent an important and ambitious step in the reinforcement of timber legality in Panama.

THE FOREST SECTOR AND THE PERUVIAN ECONOMY

Peru is one of the countries with the highest level of forest cover in the world. In 2020, natural forests and plantations covered around 72 330 million hectares, representing a little over half of the national land area. Approximately one-third of the forest area is located within protected areas (FAO, 2020). Nevertheless, the forest sector contributes only approximately 1 percent to the national GDP (FAO, 2016c; Lebedys and Li, 2014).

Table 14A | Forest authorities and traceability systems in Peru

JURISDICTION	NAME	ROLE	TRACEABILITY SYSTEM
National	**Ministry of the Environment** (Ministerio del Ambiente [MINAM])	MINAM is the national environmental management authority. MINAM is responsible for the formulation and implementation of the country's environmental policy, as well as for enforcement actions to ensure compliance with the policy.	While MINAM is not directly involved in the MC-SNIFFS, they are responsible for other modules within the SNIFFS.
	Peruvian Forest Service (Servicio Nacional Forestal y de Fauna Silvestre [SERFOR])	**SERFOR** sits under the Ministry of Agriculture. SERFOR is the national forest authority and main forest governance body at the national level. SERFOR is responsible for the planning, oversight, control and implementation of forest law at the national level, as well as for the management and oversight of forest resources.	**Control Module of the National Forest and Wildlife Information System** (Sistema Nacional de Información Forestal y de Fauna Silvestre [MC-SNIFFS]) SERFOR is responsible for the implementation of this system. In conjunction with the regional authorities, they also approve management plans, inspect operations, issue transport permits and more.
	Agency for the Supervision of Forest Resources and Wildlife (Organismo de Supervisión de los Recursos Forestales y de Fauna Silvestre [OSINFOR])	OSINFOR is responsible for supervising and overseeing the implementation of forest management plans approved by SERFOR and the regional governments.	Details about OSINFOR field audits to verify compliance with forest management plans are released to the public through OSINFOR's SIGO Observatory (OSINFOR, 2018).
Subnational	**Regional governments** (*Gobiernos regionales* [GOREs])	As part of the decentralization process, some GOREs are responsible for the management of forest resources within their jurisdictions.[11] Oversight activities in the decentralized regions are carried out through GOREs' offices for forest and wildlife. In the regions where the decentralization process has not been completed, forest sector oversight and control fall under regional SERFOR offices.	Responsibilities include the authorization, control and oversight of forest management activities, as well as oversight of forest product primary processing and trade within their respective regions.

FOREST AUTHORITIES AND TRACEABILITY SYSTEMS

A new forest law in Peru came into effect in 2015. It defines the current forest sector governance structure and the various roles of the agencies tasked with overseeing and managing state forest resources (see Table 15A).

One important element derived from this legislation is the timber traceability system, which is a module within a national-level information management system, known as the National Forest and Wildlife Information System (Sistema Nacional de Información Forestal y de Fauna Silvestre (SNIFFS) (see Box 4A).

The Control Module of SNIFFS (Modulo de Control del Sistema Nacional de Información Forestal y de Fauna Silvestre [MC-SNIFFS]), the forest products traceability system in Peru, begins with forest zoning and the approval of management rights (e.g. allocating concessions). It covers the preparation and approval of operational plans, forest management activities, processing and manufacturing, as well as transport and trade.

The MC-SNIFFS is being developed and rolled out as a portfolio of mobile applications to collect, track, control and analyse supply-chain information (see Table 15A for a summary of MC-SNIFFS components).

Box 4A | The National Forest and Wildlife Information System

The SNIFFS is envisioned as an information management platform for housing and distributing forest and wildlife information to facilitate decision-making processes and the monitoring of forest and wildlife management activities. The information system is meant to facilitate and coordinate the flow of forest and wildlife information between different government agencies involved in the management, promotion, control and oversight of the sector, as well as with private-sector actors and the public.

The SNIFFS encompasses six modules and four components (SERFOR, 2019):

1. Inventory Module (under development) – compiles and manages forest inventory data and wildlife population assessments.
2. Forest Monitoring Module (in operation) – monitors land-use change, forest loss and degradation. This module includes an early warning deforestation alert system and reference scenarios for reporting on climate change commitments. The National Forest Conservation and Climate Change Mitigation Programme of MINAM plays a leading role in the implementation of this module.
3. Forest Assets Monitoring Module (under development) – builds on forest monitoring and zoning data to provide information and analyses, including economic valuation analyses and modelling, to support decision-making and actions to address impacts on forests and fragile ecosystems stemming from illegal land-use changes and fires.
4. Promotion and Competitiveness Module – (under development) provides information to promote the forest sector and its products in domestic and international markets. Information includes market trends, forest certification, market opportunities and investment opportunities, among other data.
5. Information Management Module (under development) – provides information about national forest policies, reports and data from other SNIFFS modules.
6. Control Module (in implementation) – compiles, manages and disseminates forest-based supply-chain information to facilitate the verification of forest product legality.

In addition to the six modules above, SNIFFS includes four transversal components that are expected to provide a variety of data, including statistics, SERFOR regulations, educational materials and geospatial data.

Table 15A | Components of MC-SNIFFS

SUPPLY CHAIN PHASES	IMPLEMENTATION STATUS	PROCESS AND COMPONENT DESCRIPTION
Timber origin	Partially implemented	Before harvesting can begin, the title holder for the forest management area must have a forest management plan approved and the relevant authority (SERFOR, GORE or OSINFOR) must complete a visual inspection. Processes to implement these steps are in place.
Harvesting	Electronic application rolling out	By law, forest managers are required to use a forest management operations book (*libro de operaciones*) to keep information about the flow of timber throughout the forest management operation, including forest census, harvesting, hauling, storage and dispatch to the primary processing centre. Forest managers are also required by law to use labels or physical markers on the timber, so that they can record the control codes in the operation books, along with information about the operation (e.g. concession, permit and authorization). Forest managers can use a physical, paper-based book or SERFOR's electronic application, which is being rolled out. A copy of the book must be submitted to the regional government, SERFOR and OSINFOR after harvesting. OSINFOR has jurisdiction and a mandate to conduct inspections during and after harvesting to verify compliance with the terms of the authorized management plan. Inspection results are released by OSINFOR through its SIGO platform.
Transport	Electronic application rolling out	As in the operations book above, the required forest transport permit (*guía de transporte* [GTF]) can be issued in paper or electronic format. SERFOR's electronic application for transport permits is being rolled out, and its use is voluntary at the moment. The GTF app includes information from the forest management operations book, including all the logs included in the shipment by species, forest management plan, and the codes and markings used in the forest management operation. The application includes mobile components to allow consultation and to support GTF verification. The mobile components can be used at field check-points. Key data related to the shipment is encrypted in a QR code on each GTF, which can be read with mobile devices. This enables field officers to verify whether the information on the document is consistent with the information in the database, even when they are offline. Discrepancies can lead to partial or full confiscation of the shipment. Trucks have to stop at every check-point on their route to collect a stamp on the GTF. The information in the GTF is displayed in a geographic module of the MC-SNIFFS, where users can track the movement of the logs covered by the transport permit, the control points where it passed by dates, and link to and display the legal resolutions associated with the approved forest management plan or the authorizations for the processing centres to operate. The transport permit application is functional at control posts in various departments in Peru, including Madre de Dios, Puno, Arequipa and Lima (SERFOR, personal communication, 2018).
Primary Processing	Electronic application rolling out	As with the forest management operations book and the GTF above, the primary processing operations book is required, and it can be issued in paper or electronic format. SERFOR's electronic primary processing operations book application is being rolled out, and its use is voluntary at the moment. The timber enters the primary processing centres along with the GTF. Processing centre managers are required to record timber inputs (based on the GTFs) and outputs after processing, in the primary processing operations books. The outputs are recorded in another GTF for processed products when they exit the facility. The electronic app automatically connects all this information and allows users to issue digital GTFs.

Table 15A | Components of MC-SNIFFS (Cont'd)

SUPPLY CHAIN PHASES	IMPLEMENTATION STATUS	PROCESS AND COMPONENT DESCRIPTION
Information management platform	On hold (as of January 2021)	A functional database with user interfaces was soft launched in 2017 (Synergy, 2017), but adjustments need to be made for it to be fully implemented.
Secondary processing	This phase of the supply chain falls under the jurisdiction of the Ministry of Production. Secondary processing centres are required to track inputs and outputs in books similar to the operations books. SERFOR is working with the Ministry of Production to establish these traceability mechanisms.	
International trade	The forest authority has developed an application to support control activities for export timber, although it is not currently in operation. It is envisioned that the application will combine information from the GTF, inventories from processing centres and all the documentation required to export timber.	

If actors use the electronic apps developed by SERFOR and have internet access, information from the forest and processing operations books and the GTFs is uploaded in real time to the SERFOR database. If users do not have internet access in the field, they can still use the application and synchronize the data when they have access to the internet. SERFOR has transferred the electronic applications to the forest authorities in the regional governments, including the Regional Governments of Loreto and Madre de Dios, which actively promote the use of the tools among forest management title holders in their respective regions.

The SERFOR databases have a public interface where users can look up transport licences and access information about the volumes and species transported, vehicle details, scanned copies of the forest management operation authorizations, including authorized harvesting volumes by species. Further, the database has a map-based interface where users can visualize transport routes and control points where shipments were inspected, together with inspection dates.

DEVELOPMENT OF THE SYSTEMS

Traceability in Peru has been required as part of a bilateral partnership between the Governments of Peru and the United States of America, in the context of the 2009 United States of America–Peru Trade Promotion Agreement (PTPA). To support the large-scale reform of the forest sector required to implement and fulfil the commitments of the Peruvian Government, USAID launched two forestry-focused initiatives: the Peru Forest Sector Initiative (PFSI) in 2009, implemented by the Forest Service of the United States of America, and the Peru Bosques Project, implemented by the private-sector consultancy Chemonics, in 2011. The Peru Bosques Project led the development of the information management platform, building on prototypes and stakeholder consultations developed by the PFSI (Byers, 2017). A version of the information management platform was handed over to SERFOR, and it was road-tested in 2017 in the Loreto-Ucayali-Huanuco-Lima corridor (SERFOR, 2017b).

All current applications, transport permits and forest and processing operations books, are being developed by SERFOR. Producers are free to implement their own information management systems (paper- or computer-based, see Box 5A) to compile and report the data required in the operations books. However, a paper copy is required to be on site, and if the producer uses an electronic system, hard copies need to be printed and kept on site. Copies of the forest operations books must be submitted to the regional government, SERFOR and OSINFOR after harvesting. Currently, producers that use the applications can report harvesting to the online portal through the operations books.

Box 5A | DataBosque

DataBosque is a an open-source software created by the German development agency GIZ through its ProAmbiente Programme, to provide managerial support for forest operations. DataBosque allows users to compile and manage information about each of the forest management activities (census, harvesting, hauling, storage, transport and up to when an operator has received a shipment) up to the issuance of a GTF. The tool supports operations management because it compiles real time information in a systematic manner, which allows users to evaluate and monitor performance, identify gaps and inefficiencies, and define steps to improve processes.

DataBosque is available through SERFOR, and it is completely compatible with SERFOR's operations book formats and requirements. This data can be printed and exported as a registry showing dates, where the timber came from, species, volumes and more. Type of data captured in DataBosque includes:

- Courtyard/patio:
  - Load code
  - Selection number
  - Log correlative
  - Species
  - Maximum diameter in centimeters
  - Minimum diameter in centimeters
  - Width in meters
  - Courtyard/patio
- Transportation:
  - Log correlative number
  - Species
  - Volume in cubic meters
  - Volume in pt
- Log reception:
  - Log correlative number
  - Species
- Dragging:
  - Species
  - Code/tree
  - Load
  - Maximum diameter in centimeters
  - Minimum diameter in centimeters
  - Width in meters
  - Volume in cubic meters
  - Courtyard/patio
- Logging:
  - Species
  - Code/plate number
  - Load
  - Maximum diameter in centimeters
  - Minimum diameter in centimeters
  - Width in meters
  - State

Source: https://www.serfor.gob.pe/databosque/

LEGAL REQUIREMENTS

Based on SERFOR's technical document *Timber Forest Products Traceability* (SERFOR, 2020), the following tools are available to trace timber forest products:

- Forest management plans, which include a forest census with species and location of trees to harvest.
- Operations books for forest management operations, which are also available in electronic format, to maintain the identity of the trees and the logs derived from it.
- Transport licences, also available in electronic format, to track the movement of logs from the extraction area to the processing facility.
- Operation books for processing centres, which are also available in electronic format.

HOW THE SYSTEM IS MEANT TO WORK

Figure 11A outlines the different tools that are being implemented, the documents and information that producers are expected to collect, track and submit. The information management system is still under development. These tools are specifically for tropical hardwood products, which constitute the largest proportion of Peruvian timber production (compiled from SERFOR, 2017c; SERFOR, 2018a; SERFOR, 2018b).

Table 16A | How MC-SNIFFS is meant to work

SUPPLY CHAIN	DOCUMENT USED	DESCRIPTION – PRODUCER/AUTHORITY ROLE
Phase in the supply chain	*Document used to collect data which can be uploaded to the system and later used to verify legality before products are moved further down the supply chain*	*Description of the actions required by the producer (harvesting) and processor (processing) and how the information provided is verified by the forest authority*
Timber origin	▪ Forest zoning: GEO-SERFOR ▪ Enabling titles:[12] concession contract, permit authorization ▪ Planning: forest management plan	1. Once an enabling title has been approved, the information about the holder and the authorization is registered within the MC-SNIFFS. The GORE uploads the areas in the title to their regional spatial data platform, which are planned to connect to the national forest authority's geospatial platform (GEO-SERFOR). Enabling titles approved by the national forest authority are uploaded to GEO-SERFOR by staff in SERFOR's regional offices. 2. After the enabling title has been allocated, title holders work with the relevant authority and a licensed forest regent to draft their forest management plan. The management plan includes a forest census, which allocates a code to each tree.
Harvesting	**Forest operations book** (*Libro de operaciones*)	3. Once the forest management plan is approved, title holders begin harvesting and must record the cut trees in the system in order to generate a GTF with a unique identification code, using the operations book. 4. At the end of the harvesting operation, a copy of the book should be submitted to the regional government, SERFOR and OSINFOR. 5. OSINFOR conducts a post-harvest inspection to ensure the operation was in line with the forest management plan.
Transport	**Transport licence** (*Guía de transporte forestal*)	6. The creation of a GTF triggers a payment request for the harvesting fee while the system will register the respective trees as harvested. 7. Payment of this fee is one of the criteria used at the control points, along with a visual inspection of the shipment to check if the species, number of logs, log codes and dimensions match with the information on the GTF.
Processing	**Processing operations book** (*Libro de operaciones*)	8. Having passed the transport control points, the logs enter a mill and the mill user registers them in their raw material account after delivery controls have been completed. If the GTF does not have the necessary stamps, they cannot accept the materials. 9. Acceptance by a mill will set the primary GTF to invalid status in the system to prevent multiple uses. Processors use an operations book. 10. Processors involved with secondary processing are regulated by the Ministry of Production and are required to use an inputs and outputs control book equivalent to the operations book. However, these tools are not fully implemented yet. 11. Rather, the processors report raw material inputs and stock, raw materials used for production, outputs sold and outputs stock to the system. Procedures for conversion factors are not defined yet. Products that have undergone secondary processing do not need a GTF.
Final sale	CITES documentation	12. Export permits will be issued based on the information the platform has collected as the products travelled through the supply chain. This is one of the benefits of a centralized platform that pulls together data throughout the supply chain. 13. For CITES-listed species, supporting documents will also be uploaded and can be given to buyers at the time of commercialization.

SUCCESSES, CHALLENGES AND OPPORTUNITIES

From the beginning, the vision for the control module has been ambitious. It has been designed to sit nested within a larger information management system that encompasses information about forest species, while combining geospatial components. Further, the control module is tied not only to the commitments of Peru to the United States of America through the PTPA, but the Government of Peru has declared the implementation of the MC-SNIFFS an issue of national interest (Government of Peru, 2017). This is because the system will be used to monitor the implementation by Peru of its voluntary commitments to reducing greenhouse gas emissions associated with deforestation and degradation (Government of Peru, Government of Norway and Government of Germany, 2017). Framing and designing all these components have required interagency coordination among national and subnational governments and multi-stakeholder consultation, as well as changes to the legal framework.

Thus, while the design and rollout of the information management system have taken years to complete, substantial work and investment have also been made in multi-stakeholder consultations, test runs and capacity building to support the design of the platform.

While MC-SNIFFS is a work in progress, the Peruvian Forest Service has focused on building up and rolling out the application system for transport licences and operations books. Eventually, after successful rollout, forest managers are expected to be able to upload and share data with the authorities in near-real time, expediting many of the time-consuming administrative processes.

Besides overcoming technical and infrastructure limitations (e.g. lack of internet access, lack of equipment), capacity gaps on the ground remain a significant challenge. High turnover and low capacity of subnational government officials and forest sector actors require continuous training to ensure that the required operational processes are implemented so that the data in the operations books can be successfully traced. As the central information management platform is deployed, additional training will be required.

Although the stakes and expectations for the MC-SNIFFS are high, another challenge is to secure stakeholder buy-in and overcome resistance from some actors due to false perceptions about the financial burden and reduced competitiveness in using traceability tools, while these tools can, in fact, reduce costs through reducing exposure to offences and improve operations management.

ENDNOTES

1. The 2016 technical report provided an overview of different traceability approaches, including systems used by community foresters in Gabon, a system implemented by a private company in Cameroon, and a national-level system deployed by the Liberian Government.
2. See Annex 3 for the full framework proposed by Stäuble et al. (2022).
3. Article 64 of the Forest Law.
4. Internal traceability refers to traceability within a process or stage in the supply chain, such as record-keeping within a sawmill for keeping track of timber batches associated with a log or batch of logs from a specific operation.
5. For shipments transported from a protected area to a processing facility, operators use a guia de transporte, administered by the National Council for Protected Areas (Consejo Nacional de Áreas Protegidas [CONAP]).
6. As of the end of 2020, a nota de envio costs USD 1 and the guia de transporte costs USD 2 (A. Samayoa, personal communication, 2021).
7. By having a more accurate sense of the potential timber volumes available for extraction from the beginning, the BSF addresses the overestimation of timber volumes available for extraction. This is one of the major forms of illegal logging in the world.
8. See Box 6 in the main report.
9. This table appears in all case studies. "Final sale" refers to either domestic retail or international export.
10. The SIFGUA (http://www.sifgua.org.gt) is designed to collect, analyse and disseminate official information about the forest sector in Guatemala. Data tracked by SIFGUA covers information on forest management (inside and outside protected areas) and on the domestic and international trade in forest products.
11. The decentralization process has been completed in the regions of Amazonas, Loreto, Madre de Dios, San Martin, Ucayali, La Libertad, Ayacucho, Tumbes and Huanuco.
12. Enabling titles are government authorizations granted to companies and individuals for conducting forest management activities on public and private land.

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GLOSSARY

Certification: When an independent and accredited certification body attests that a product, service, or system meets agreed-upon requirements. In the forest sector, certification is often related to legality (certification of legality) or sustainability (certification of sustainable forest management).

Chain of custody: Originally a term that refers in a legal context to documenting the history of evidence from the point it is obtained until it is presented at court. The term was adopted by forest certification schemes for certifying that labelled products only contain eligible inputs. Chain of custody certification defines the minimum requirements for internal and external traceability for forest-based products and does not generally achieve full traceability.

CITES: The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement seeking to ensure that international trade in wildlife species does not threaten their survival (CITES, 2020).

Concession: An area defined by the government in which land and use rights to the forest are given to a non-public actor if that actor complies with laws and regulations ensuring that the forested area is sustainably managed and harvested.

Conversion factors: Conversion factors are ratios used in the forest sector to determine or estimate the volume of outputs after industrial processing based on known inputs and ratios (UNECE and FAO, 2008). For instance, they can be used to compare the roundwood volume required to manufacture different products after industrial manufacturing. Conversion factor ratios can be calculated through a direct estimation of the amounts of raw materials at the entrance of the mill and of related final products when accurate data is available. Conversion factor ratios can also be calculated by indirect estimation by process analysis. This includes analysis of all by-products and losses generated by the manufacturing process (Thivolle-Cazat, 2008).

Forest authority: Government agency tasked with overseeing the management of a country's forest.

Natural forest: A forest composed of indigenous trees and not classified as forest plantation (FAO, 2018).

Governance: The process by which decisions are made and implemented or not implemented. Governance can apply to corporate, international, national and local levels of action or to interactions between sectors of society. Aspects of good governance include accountability, capacity, coordination, participation and transparency.

Private forest: Forest that is owned and managed by a private entity or actor.

Plantation: There are various definitions of forest plantations. For the purposes of this report, the term *plantation* is used generically to mean areas of planted trees that are managed intensively for timber production and that include one or more tree species.

Primary processing: For the purposes of this report, primary processing refers to the initial conversion of logs required to produce sawn timber, veneer, plywood and chips, as well as by-products.

Public forest: Forest that is owned, administered and managed by the government on behalf of the public.

Secondary processing: For the purposes of this report, secondary processing refers to all conversion that occur after primary processing to produce value added products including panels, engineered wood products and furniture.

Traceability: According to the International Standards Organization (2015), traceability relates to the origin of the materials and parts of a product, its processing history and the distribution and location of the product after delivery. For the purposes of this report, traceability is the ability to trace the history of a forest product back to its point of origin, to the extent that this is possible.

Traceability approach: For the purposes of this report, a traceability approach refers to the decision to use volume-based tracking or comprehensive, item by item traceability. The second provides more detailed information on origin.

Traceability system (also, supply chain control system): A traceability system is a system designed to collect, organize and analyse supply-chain information. It supports its users in tracing all components of a product, through all steps in the supply chain, back to their origin. In this study, the term is used as a general term covering systems of different scope and functionalities, including systems for full traceability, supply-chain mapping and volume tracking.

Transparency (supply chain transparency): Supply-chain transparency requires companies to accurately know their supply chains and what is occurring around them to be able to communicate this knowledge externally and internally (Bateman and Bonanni, 2019). Supply chain transparency is often considered a prerequisite for traceability.

Verification: Activity to confirm that processes—or product attributes (claims)—meet required standards. Verification often involves third parties. Different verification techniques can be applied for verification of different processes or features at different points in the supply chain: legal or sustainability compliance of forest management practices can be verified via an audit; compliance with transport rules can be verified via a road check; the species or origin of materials can be verified with scientific wood identification techniques and methodologies. While traceability systems can capture information on the entire material flow in their scope, verification activities are usually performed on a sample, since they are costly and time-consuming. In the context of Voluntary Partnership Agreements between the European Union and other countries, verification assures that the requirements of the legality definition and supply-chain controls, as defined in the timber legality assurance systems, are met.

Volume-based traceability (also volume tracking or inventory balancing): A supply-chain monitoring concept where there are internal and external traceability gaps, and where the total of outputs corresponds to the total of inputs. In volume-based government traceability systems, all actors in the supply chain periodically report stocks and input and output volumes based on established conversion factors for each process. With this data, governments monitor whether industrial outputs match the allowable cuts and conversion factors.

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ABOUT FAO

The Food and Agriculture Organization (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger.

Our goal is to achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, healthy lives. With over 194 member states, FAO works in over 130 countries worldwide.

ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

Count It

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

Change It

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

Scale It

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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