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International experience in development of timber tracking systems

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Introduction

The problems of law enforcement in the forest sector comprise such important issues as illegal logging, including sale, transportation and processing of wood. Accumulated international experience shows that effective combating of this negative phenomena is possible where effective control over forest management is established; origin of wood that enters into circulation is identified; timber sale and wood processing are monitored; cooperation between public authorities, law enforcement agencies, designated business, environmental organizations and local communities is established to achieve sustainable forest management.

One of the objectives of the "European Neighborhood and Partnership Instrument (ENPI) East Countries Forest Law Enforcement and Governance (FLEG) II Program" is the development of timber tracking and tracing systems which could allow to follow the transformation process of wood during harvesting, processing, transportation, purchase, and sale on condition of its origin identification.

This report contains analysis of foreign timber tracking systems based on the study of legislative norms and regulations, instructions on the use of systems, scientific publications, reports of international organizations and national coordinators of international agreements, correspondence, and communications with the experts.

It consists of two parts. The first part of the report presents a general experience of use of the systems in tropical countries, which are the traditional wood exporters to ecologically sensitive timber markets. [The tropical countries were studied to highlight that institutional environment plays an important role in creation and functioning of a track and trace systems, which](#) provide a sharp contrast comparing to the European countries approach. It is supplemented with the information on enforcing the existing systems by introducing innovative information systems and biotechnology advances.

The second part of the report is devoted to analysis of electronic timber track and trace systems in Europe. These systems are the examples of modern management solutions in forestry and wood processing sectors aimed at improving the economic efficiency of companies, manufacturing operations, and ensuring transparency of business activities, etc.

The study could be useful in respect to making the choice after all relative systems are analyzed and compared to the national circumstances, meaning that the parts of different systems could be used to improve the system in Ukraine. Provided information could be valuable for the national decision makers.

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1. Background

During a long period of time, timber track and trace system has been developing as a subsystem of management and partly accounting activities of forest products. The main task of the subsystem was to ensure wood record keeping and monitor the movement from the harvesting place to the consumer along all technological and logistical chains. Thus, it was aimed at information support for timber flow from producer to consumer¹.

With the development of management systems in the context of ensuring different aspects of quality, the second component of the system, namely tracing, became significant. ISO 9001 provides a definition of **traceability** - the ability to trace the pre-history, use or location of the object².

St. Petersburg Ministerial Declaration (2005) on law enforcement in the forest sector was used as the legislative framework for the tracing systems development. In particular, recognizing the existence of problems with illegal logging, representatives of governments committed themselves for developing **systems of tracking wood origin** that can be verified by a third party.

A powerful stimulus for such systems development was European Union Regulation No 995/2010 from 20.10.2010 about obligations of operators who place timber and timber products on the market, which prohibits the placement of illegally harvested timber and products made out of it on the EU market. According to the Regulation, all timber importers to the EU (operators) have to introduce system for monitoring **legality of wood origin**. Thus, before importing timber to the EU territory, the importer has to trace its origin up to the country or region of harvesting [29].

This, in turn, led to the need to include tracing functions in the existing timber tracking systems.

Completeness and perfection of timber tracking and tracing depends on many factors, including its goals and objectives; system scale and its obligation; complexity of the supply chains; tracing methodological approaches, etc.

The diversity of existing systems can be systematized on the base of regulatory influence of the state: **state mandatory system** (developed and implemented by public authorities to control mainly state owned forest resources); **private voluntary system** (developed and introduced by socially and environmentally responsible forestry and wood processing companies or their associations); **independent voluntary system** (established by international or national forest certification schemes or certification bodies that offer a variety of verification programs); **combined system** (based on the use of several previous systems).

¹First component of the system – “track”

²Second component of the system – “trace”

Differences in private and independent voluntary systems is that responsibility for wood tracking and tracing in the first case is put on the timber companies or their associations interested in exporting timber to environmentally sensitive markets, and in the second case by independent specialized bodies that operate on the base of national or international accreditation.

So, trust towards the systems that are based on independent timber tracking and tracing verification is higher. Based on methodological approaches, they are divided into the **balance and individual identification systems**. Balance method lies in tracking wood movement without its physical identification. Information flows on the timber entry and exit and its transformation into finished products at all stages of movement to the final consumer serve as the base of the balance method. It is a basic method in the development of various models for timber tracing and tracking systems. The tracing unit in this method is timber with minor physical size (e.g., wood chips) or with low dimensional and quality features (wood fuel, technical raw stock). In this case, the reporting unit for the purpose of tracing is a timber batch.

Application of individual identification method involves physical tracing of each individual assortment which has high quality and dimensional features (plywood raw materials, industrial timber). Usually, the individual identification method is completed when the wood is transferred from the primary producer (forestry) to the secondary one (wood processing company). Later, further tracking and tracing steps involve the use of the balance method. Thus, in most cases, the systems that cover the entire supply chain from producer to consumer use both methods. The individual identification method involves the use of the following main types of marking:

- Application of marks with paint or special chalk;
- Application of the stamps using special hammer;
- Plastic tags (assigning individual numbers);
- Tags with barcode (assigning a unique number that is used for online registration and transfer of information to a database);
- RFID (radio frequency identification which in addition to identification includes information record. When the reader is close to the RFID, the information is automatically transmitted to the data bank);
- DNA analysis (verification of wood genetic material with the material of the original geographical area where it originates from or the original specific tree sample);
- Isotopic analysis [2,5,8].

Cost of timber tracing and tracking system can vary greatly depending on several factors. First of all, it depends on regulatory and methodological principles of the system, its scope (geographic and industrial), availability of appropriate infrastructure for its implementation, staff expertise, used technical devices and technology solutions, need for support and maintenance, level of law enforcement, etc.

The system cost in terms of cubic meters of harvested timber, which are widespread in the tropical countries varies in the range from \$2 to \$3. In some countries the cost can reach \$5

per cubic meter of harvested timber due to the lack of primary infrastructure and low training quality.

In developed countries, particularly in Europe, where the systems serve as a complement to the economic and financial accounting systems or act as part of a common information management system, the cost calculation is more complicated.

2. Use of timber tracking systems in the tropical countries

2.1. Malaysian timber tracking system

Depending on which forestry management unit (constant forest user in Ukrainian interpretation) the forest area belongs to, a corresponding marking system for harvested logs has been developed. All logs have their numbers and tags that indicate the place of harvesting and license number of forest loggers, i.e. it is possible to track by whom and where timber was harvested [9].

It should be noted that there are special timber inspection stations where workers check the allowable amount of timber harvested from a specific area. This assessment is carried out both based on the materials of forest management units reporting, and based on the random inspections of timber harvesting sites. According to the legislation of this country, all wood processing facilities (sawmills) receiving logs should keep record of incoming wood containing information on the quantity of raw materials received, the date of admission, wood species. Additionally, information about the amount of raw materials used in the production and output of finished products is gathered. Afterwards, data is sent to public inspection stations where the information is verified. Based on the compliance check results, "checked" mark will be put in the log confirming the legality of the whole chain from wood harvesting to processing [19]. Inspections can be both regular (monthly) and random (without processor notification).

Thus, timber tracking system developed by the state in Malaysia ensures the possibility to control and verify the origin of wood, its legitimacy from the plot to the already finished products and obligatory inspection of wood processing facilities, the number of received / output products [18]. The timber tracking system in Malaysia provides the following benefits and features:

- Logs origin identification by the tag and mark;
- Random timber processing facilities inspections by the independent experts allow obtaining an objective assessment of forest harvesting activities;
- Control over wood processing, checking incoming and outgoing products, and reduction in the likelihood that illegal material use.

Timber tracking system in Malaysia belongs to the **state mandatory systems** and is based on the **balance method**.

2.2. Indonesian timber legality assurance system

The Indonesian Legality Assurance System is built on the basic principles of forest certification and is implemented under FLEGT Voluntary Partnership Program with the European Union [15]. The system main idea is that conformity assessment bodies accredited by Indonesian accreditation bodies check legality of timber use by the forest users, sellers, processors and exporters. The inspection results are sent to the Ministry of Forestry of the country. So, independent inspection company on behalf of the government checks all wood supply chain, from the place of its harvesting in the forest to the export of finished products. Conducting random, unplanned inspections are considered to be a stimulating factor to comply with the requirements of forest and other legislation at all stages of the wood movement.

In case of detection of illegal harvesting activities, local residents have the right to inform inspectors, evaluate their work. In case of disagreement or detected irregularities on the part of conformity assessment bodies, they apply to accreditation bodies. Additionally, by the order of Minister of Forestry, a working group on monitoring and assessing the national legality assurance system has been created.

Summarizing the experience of Indonesia, we can make the following conclusions:

- The Legality Assurance System developed and introduced by the state allows to make control at all stages of creating, processing, transporting timber;
- To improve confidence to the system, the opportunity to involve third parties in its activity evaluation and monitoring has been provided (local residents, community activists);
- The system was recognized by European Union under the FLEG Voluntary Partnership Program;
- Credibility of the system is significant and allows an independent verification of all supply chain, which does not required special equipment and information technologies.

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Wood tracking system in Indonesia belongs to *independent voluntary* systems and is based on the *balance method*.

2.3. Timber tracking and tracing system in the Republic of Guyana

Timber tracking and tracing system starts with determining the critical checkpoints of illegal timber emergence in the supply chain and throughout the implementation of measures to prevent its occurrence. Guyana Forestry Committee, which is a state executive body, has established the following critical control checkpoints and forestry activities where there is a likelihood of illegal activity:

- Timber harvesting sites;
- Inventory of forest when assigning plots for logging;
- Timber harvesting;
- Transportation of wood;

- Primary wood processing;
- Sale of processed timber;
- Export.

The need to identify critical control checkpoints throughout the supply chain from the cutting area to the consumer is associated with organising information flow for timber tracking. Under this system, each cut down tree and stump must be marked with a special tag. Tag number must be applied to the log with paint in case that the tag is lost during transportation. All data on the harvested wood, including cutting permit number, are recorded in a special registration device (such as PDA). Afterwards, this information is transmitted to a central data repository of Guyana Forestry Committee [20]. The obtained data are used for logging inspection (a kind of cutting area inspection report). Forestry Committee expert checks the number of cut down trees with the permit, availability of markings on the stumps, the correlation of logs diameter and stumps diameter, damaged trees that are not planned to be cut, etc. In case of discrepancies, measures to eliminate inconsistencies should be taken.

The activities of woodworking enterprises are monitored. Sawmills are required to keep a special daybook of receiving material, make records of the amount and origin of timber, species of trees. The volume of received processed and sold product must be documented in a separate log which is checked monthly by the Forestry Committee employees. Thus, timber tracking system established in the Republic allows:

- To determine the critical control checkpoints that become objects for collecting information and carrying out inspections;
- To verify reported data with the inspection data;
- To duplicate tagging by painting logs;
- To check both incoming and outgoing volumes of processed timber.

Timber tracking in the Republic of Guyana belongs to the **state compulsory** systems and involves the use of both **balance** and **individual identification** method.

2.4. Timber tracking in Thailand

Traditional tools and means for forestry information recording (paper media) are used to develop timber tracking system.

According to the Forest Act of the country, permit (like a way bill) effective for 24-48 hours is required to transport wood. It is characterised by stops regulation at certain control checkpoints depending on the transportation distance for a check by the state forest department [14]. After documents checking, some of the logs are stamped with a special hammer confirming the inspection.

State forest department supports the operation of 38 checkpoints for inspections that operate 24 hours a day. They are located at the main intersections of roads used to transport timber. There are 249 checkpoints scattered around the country working from 8 am to 5 pm. Checkpoints do not congest traffic and are used for random inspections [14]. Illegal timber is usually transported in covered vehicles which are paid more attention to.

In addition to monitoring traffic, wood processing sites are also checked. Appropriate logs which are numbered and stringed together by the representatives of the State Forest Department are kept. The amount of received raw materials and output processed products is mainly compared; if there are significant differences – a detailed inspection is carried out.

Thus, the said state wood circulation monitoring system ensures:

- Control and inspection of vehicle which transports timber;
- Inspection of woodworking enterprises through the verification of incoming and outgoing products.

Timber tracking in Thailand belongs to the **state mandatory systems** and involves the use of **balance** method with some elements of individual identification.

2.5. Timber tracking in the Lao People's Democratic Republic

Following the forest stand inventory by the forestry employees and logging, the logs are stored at a specific facility for further transportation (looks like log deck). Forestry Inspection Department staff check inventory materials, perform reconciliation of the actually harvested timber with the inventory materials. At the facility, logs are marked with special chalk and paint [3]. The information on the log includes the place of harvesting, wood species, facility for storage.

Afterwards, wood is transported to the next wood gathering facility. It stores wood from all related sites so that the representatives of the regional forest office could measure it and prepare information on harvested timber which is subsequently transferred to the Industry and Commerce Office for further sale of wood at the auction.

Representatives of the Forestry Inspection Department, while at wood gathering facility, carry out reconciliation of incoming volumes of wood together with all accompanying documentation (inventory, logging contracts, timber transport permits) [3].

When transporting wood for further processing, waybill indicates the location of sawmill production. The inspectors are in charge of scheduled and unscheduled processors inspections. They study the incoming and outgoing information of the log, review the composition of raw materials and supporting documents.

Authorities identified the limited number of woodworking enterprises for each province of the country. Forestry Inspection Department offices in the provinces check incoming and outgoing flows of wood, determine needs for wood and prepare appropriate reports.

Timber tracking system in Lao has the following features:

- Control along the timber movement chain is exercised over by a separate body - Forestry Inspection Department;
- Authorities identified the number of processing enterprises in the country, they determine the need for wood;
- Special chalk and paint are used for the purposes of tagging.

Timber tracking system in Lao belongs to the **state mandatory** systems and involves the use of a **balance** and **individual identification** method.

Further development of timber tracking is associated with the transition to electronic and semi-electronic tracking systems or their use in addition to the existing ones. This is usually accompanied by further development of the individual identification method.

2.6. Electronic and semi-electronic timber tracking systems

National timber monitoring and verification system in Liberia

The country has introduced a national mandatory timber tracking system at all stages of the chain from the place of harvesting to supplying products for export or places of sale in the domestic market [5].

The computer system LiberFor has been developed on the basis of software Helveta Platform CI World. The main functional components include:

- Logging sites mapping using GPS and GIS, evaluation of wood stock;
- Development of a supply chain by marking each log and transferring information using PDAs to the central database, and then - their tracking at all stages of wood transportation and processing;
- Data verification, automatic reconciliation of volumes, random checks and inspections;
- Registration of concession agreements, invoices and other documents, tags circulation control etc.

The system implements the tracking function - "back to the stump" with appropriate data validation and is integrated into the network for state statistics and tax reporting. So, it ensures full timber tracking throughout the supply chain and collection of the taxes and duties from the timber companies to the state budget.

The system is managed by the Forestry Development Department and the independent auditors of the certification body SGS.

The cost of creating the system was \$1.5 million. Funds were allocated by the US government as part of technical assistance.

Timber tracking system in Liberia belongs to the **state mandatory** ones and involves the use of the **individual identification** method.

DNA check of supply chain in Indonesia

DNA check of the chain is an additional and independent element of the Indonesian Legality Assurance System³ aimed at its reinforcement, detection of wood substitution cases and falsification of documents. It helps to win confidence and contributes to cheapening rather than replaces the system for supply chain control.

The system is based on collecting genetic material from trees prior to logging and production of primary (verification) samples. Re-sampling occurs at different stages of the supply chain (round wood or pre-cut timber) based on the records during the wood transformation from a tree into the finished product. Match of the repeatedly collected samples with the verification samples will point to the correct functioning of the timber tracking system [5].

The cost of implementation and operation of the DNA checking system is \$0.5-1.5 per cubic meter of wood.

Timber tracking system in Indonesia belongs to **independent voluntary** systems and is based on **individual identification** method.

Certificates of forestry origin in Brazil

Certificate of forestry origin (DOF) is the electronic timber tracking system. The system introduced in 2006 is **mandatory** for all entities engaged in harvesting, transportation and processing of wood and is supported by the Federal Environment Agency [11]. Registration and system use is **free of charge**.

Wood is transported at all stages of the supply chain (harvesting places, handling, storage, processing) if the carrier enters information about its origin (harvesting site), species, the type of product, quantity and value of timber, transportation route to the central database. Further activities related to the processing and use of wood must appear in the system by entering relevant information [22]. To this effect, relevant conversion factors for semi-finished or finished products output should be entered into the system.

A necessary step in issuing a certificate for the timber transportation by the seller to the buyer is a mandatory transaction confirmation by the buyer.

Hard copies of the certificate must accompany timber, while information entered into the database is checked against the amount of wood allowed for harvesting according to forest management plans [34]. In the process of logging, the system reduces the amount of "timber credit" that may be registered on the certificate receipt.

The certificate is required for the transportation of all wood and non-wood forest products with the exception of final consumption goods (carpentry, furniture, etc.) and some semi-finished products (cellulose).

The issued certificate is valid for a limited period of 5 days – for intra-province road transportation; 10 days – for inter-province road transportation; 30 days - in the case of river floating [24].

Certificate of forestry origin has replaced the previous licensing system which included preparation of transport documents on special paper. Thus, significant cost savings for businesses has been achieved, which is estimated at \$11 million annually.

The cost of systems development is \$261,000 excluding hardware acquisition costs and its maintenance [5].

The software is a management system of state authorities and, in particular, a tool for law enforcement agencies providing them with information in real time used for planning of field inspections. The system provides automated analysis procedures and monitoring wood circulation stages.

³Check the subsection 2.2

Among other things, it is integrated into other national conservation permit registration systems.

The disadvantages include the low level of enforcement in the country, corruption, bureaucracy, lack of cooperation and coordination between different authorities, which largely neutralized the positive effects of implementation. Abuse, in particular, includes entering false information into the system, such as overstating the size of the permitted forest management, and thus creating possibility for legalizing illegally harvested timber [10, 6].

Attention is drawn to the fact that by the content, the information system of forestry origin certificates is similar to certificates of origin in Ukrainian legislation. The difference lies in the fact that in Brazil the data is entered by the applicant, the certificate is issued without personal contact with the authorities, while in Ukraine, the exporter must provide several documents to the regional authority and receive the original paper certificate. The possibility of obtaining certificate in electronic form on the basis of the exporter declaration without having to apply to the representatives of the authorities personally is useful for Ukraine in terms of reduction of corruption risks.

Timber tracking system in Brazil belongs to the **state mandatory** ones and involves the use of **balance method**.

3. Overview of timber tracking systems in the EU in the context of their possible use for Ukraine

3.1. State Forests Information System in Poland

The State Forests Information System in Poland (SILP) is a software complex which serves as a business tool integrating all information flows including issues of accounting, control and reporting of the State Forests Holding at all organizational levels: forestry – supra-forestry - other related production units - Regional Directorate - General Directorate [7].

Historical Background

In December 1990, State Forests Holding Board made a decision on establishing information system. Software was developed by the Austrian company Schnelldatenservice-SDS Austria, hardware was supplied by Hewlett-Packard.

In January 1, 1997, the order of the State Forests General Director about the introduction of the information system into all structural units of the holding came into effect.

Most supra-forestries (forest enterprises) were not ready for the system introduction. In particular, the primary stages included feeding forest management data into information system (taxation description and projected measures) and work on a laptop (recorder). Unfortunately, expertise of the foresters, who had extensive practical experience and long employment history, was insufficient to independently learn to work with the recorder. Then, an open letter of the Polish foresters was published in the media (1000 signatures were

collected) stating that the introduction of electronic record keeping system worsened the work of the foresters rather than facilitated it.

Analysis of foresters' work arrangement conducted by the General Directorate showed its imperfections such as: performance of not typical or not necessary functions of the forester; number of recorders was small; laptop skills were not sufficient. As a result of this work, job descriptions have been reviewed, foresters' activity has been improved. Sufficient (optimal) number of recorders has been procured. The first PDAs used were PSION CE.

Practical experience has shown that the best option is when one recorder serves 1.5 thousand hectares of forest. Also, two instructors, who trained foresters and were system administrators in the supra-forestry, were assigned to each supra-forestry. Over time, permanent training programs were developed. Under these programs, new employees are trained and forestry workers with experience are retrained. The training course is permanent and is organized at the forest colleges.

Currently, the information system of state forests in Poland serves about 15,000 users, including 5,500 in forestries, 430 in supra-forestries, 17 in the regional directorates, and 28 in other units.

A brief description of the system

The structure of the information system of state forests in Poland includes subsystems integrated with each other: LAS - economic activity; Marketing - control over the wood turnover; Reports - a system that allows the use of information contained in the LAS subsystem in the form of reports; ACER – timber harvesting planning, development of the implementation plan; DLUZNIK - planning and proceeds from the sale of goods, works and services; PLATNIK - unit that displays the status of taxes, social contribution.

LAS is the basic unit which reflects economic activity in the State Forests. It contains forest management information (taxation description, designed forest management measures, monitoring over their implementation), current information on all economic activities carried out in the forestry [12].

LAS information unit is conditionally divided into 7 major subsystems that reflect fundamental economic accounting processes in the State Forests: planning; forestry; salary and personnel; finance and accounting; commodity production; general information; statements.

Subsystems are integrated with each other so that when the original document is registered in one of them, the information from the document is automatically displayed in all other related documents and any subsystems and is available for use.

LAS information unit differs from other information systems in that it is constructed according to the specialized legislation requirements - Forest Code (Ustawa o lasach państwowych), which, in addition to purely economic objectives imposes on the forestry the task of ensuring transparency in the environment preservation and conservation. System functions are based on cartographic data on the basis of forests map (Mapą Leśną) and taxation descriptions. Cartographic materials are available on mobile recorders of the foresters whose duty includes amending taxation descriptions. LAS system is a central component of the State Forests information system since none of the other subsystems can function independently.

The first version of the information system LAS appeared in 1994 and was merely a text document, eventually the system was transformed and improved, and started to operate in 2005 as an online resource. At first, the system was not centralized and operated separately in each of 17 regional directorates. In December 2010, practical implementation of the information system was completed. It became centralized.

The main technical means of the LAS information system is a laptop computer - "Recorder". PDA is based on operating system Windows CE .NET 5.0 or Windows MOBILE 5/6. The following software is installed at the recorder: Leśnik, Brakarz, Notatnik, eLAS. Portable computer is bundled with the field printer. At present, the following recorders are used: Psion Workabout Pro 4; Psion Omni XT15; Intermec CK70; Motorola TC55.

The following field printers are used: Seewo LK53; Voyager 2000; Zebra QLn420; Datamax Apex 4.

Functionality of LAS subsystem

LAS subsystem contains several software modules with the core one Leśnik. This module displays:

- The action plan determined in forest management;
- Monitoring of works performed and expenses on each item of the plan;
- Information on contractors (individuals and businesses);
- Record of timber harvested during logging for each forest area, contractor, species, assortments, etc. (created on the basis of the tags register);
- Record of timber that is skidded from the forest plot to the log deck is formed in one document for each batch of wood based on tags register (document title - Kwit zrywkowy, KZ);
- Record of timber that is skidded (transported from the log deck to the reloading-and-sorting yard) is formed similarly to the tags register in one document for each batch of wood (document title - Kwit podwozowy, KP);
- Record of timber sold to consumers from the log deck or log collection checkpoint – is formed similarly from the tags register in one document for each batch of wood (document title - Kwit wywozowy, KW);

Note: *specification on timber products (Specyfikacja manipulacyjna) and tax invoice (Asygnata) are attached to the shipping documents issued by the forester at timber sale (Kwit wywozowy).*

- Record of VAT for each wood batch sold and consumers (VAT);

Note: *the forester is responsible not only for the volume of wood, he/she also makes sure to avoid over-weighting. Therefore, in the same software, simultaneous record of wood weight in kilograms is kept. Cargo weight is marked in shipping documents (KW) signed by the forester. The driver is not responsible for loading products in excess of the norm.*

- Record of carriers which transport the wood to the customers;
- Sale of Christmas trees, seedlings, plants and other non-wood products;
- Worker's log (time tracking, payroll, bonuses record, record of sick leaves and holidays);

- **Certificate on the legality of the origin of wood** harvested in the forests that do not belong to the state property. By the Order of the Minister of Environment, Natural Resources and Forestry, obligations on the record of timber harvested in the forests of other users and forest owners were entrusted with the territorial units (forestries) of public forests. They mark the timber and issue the document certifying the legality of the harvested timber. This document contains tags numbers, information on size and quality of wood, it declares the legality of its origin and is signed and sealed by the forester.

Moreover, Leśnik unit includes reference materials loaded from the information unit LAS: standards (specifications) on wood products, timber products price list, technical specifications on each consumer, and Leśnik user manual.

A separate section in Leśnik unit is Private Forest section. This section includes information on each administrative unit in the context of forest owners - taxation description, planned forestry activities. In addition, it includes information about the existence of agreements between the private forest owners and supra-forestry on state supervision for the forest management.

Leśnik ensures electronic record keeping of harvested wood. Forest Code stipulates that all wood that is harvested is subject to registration. By the order of the Minister of Environment, Natural Resources and Forestry of February 24, 1998 No.201, algorithm for timber record keeping and samples of documents certifying its legality were determined.

Wood marking provides for long-term placement of graphic, alphabetic or numerical designation on the harvested timber, as well as the current assortments or stacks number.

Tools used for marking include: hammers with logos on one end (pictures, letters or numbers), license tag with Arabic numerals; stamps.

Timber is recorded in the state forests and forests of other users in the places where timber is harvested simultaneously with harvesting. Graphic black mark is applied to wood with a special hammer ("LP" - for state forests or other - for forest of other users). In addition, red tag with the current number is nailed to the timber. In the forests of other users, tags may have a different colour. For example, in the forests of the national parks they are green [30].

Harvested timber record keeping is 3-stage: initial record of harvested wood; record of wood that is skidded or transported to the log deck or reloading-and-sorting yard, record of wood that is exported (sold).

Initial wood record is performed on site, at the cutting area, by the forester or assistant. Timber is recorded in the "wood receipt" section. First, a particular forest area where according to the forest management timber harvesting is planned is chosen from the LAS database. Using tips, appropriate electronic form is filled out. Further work is conducted as follows:

- Tags are nailed to the prepared assortment;
- Tag number is fed in the recorder manually or using a barcode reader;
- Information on the assortment species, quality class, diameter and length is filled out;
- Assortment volume is determined;

- Assortments recorded in cubic meters are put in stacks, volume is determined by entering information about height, width, length in the recorder; stack as a separate batch of wood is nailed one tag.

- Thus tags register with information about the available timber is formed.

Information on the site as of a specific date is combined into one electronic document which can be printed out - Kwit zrywkowy. In Ukraine, harvesting log is an analogue to this document.

When skidding timber or transporting it to the log deck or reloading-and-sorting yard, the forester forms the timber batch information on which is grouped in the document entitled Kwit podwozowy. When preparing the electronic version of the document, only tag numbers are fed into the recorder while other information on the assortment is downloaded automatically.

Similarly, wood batch to be exported (sold) is formed. Information is displayed in a document entitled Kwit wywozowy.

Brakarz unit represents specialized software for the forester which has practical application in the selection of tree for felling using graphical forms. This software defines quality and quantity of round assortments from the trees that are to be cut in the current or future years. Methods for harvesting, skidding felled trees, estimated logging timing are simultaneously determined. The result represents a quantitative and qualitative plan for timber harvesting according to actions defined within the forest management plan. The information is used as the basis for the preparation of industrial and financial plan and timber sale plan.

The algorithm of the unit for selecting trees for felling⁴:

- Recorder user (forester or his/her assistant) using information unit LAS (ACER subsystem) transforms data from a plan for clear cutting and selective cutting on specific forest areas in the forestry which is specified within forest management. This information is the plan of works on cutting areas allotment;

Note: allotment of clear cutting areas is done by February in the year of felling and allotment of selective cutting areas is finished by May.

- Using tips, electronic version of a blank form for listing report is formed (information on taxation features of forest plot and trees species to be cut is filled out here);

- Trees at a height of 1.3 m are measured using callipers, the trees are divided into four categories by quality class - A, B, C, D. Class A trees are considered to be the best in terms of quality;

- Information is also entered in the graphical form: species, quality classes in 1-centimeter thickness levels;

Note: this software performs self-control to prevent forester from intentional (or unintentional) inclusion of high class trees to the lower class of trees and vice versa. The main criterion is the tree diameter. Moreover, for specifically defined diameters and quality classes, software provides tips on the determination of trees with hollows, growths or other deficiencies.

⁴ Cutting area allotment in Ukrainian legislation

These are so-called "environmental" trees important for biodiversity conservation.

- At clear-cut areas trees are not marked;
- In areas with selective cutting, trees intended for harvesting are marked on both sides with red paint using aerosol cans or blaze;
- Boundaries of the areas for all types of logging are marked with white paint using aerosol cans;
- For each species and the average diameter, height of trees allocated for cutting is measured;

Note: software monitors whether the actual measurements of trees correspond to data in the taxation description.

- When allocating sites for clear-cutting, forester counts seedlings distributed by altitude (up to 1 m, 1.2 m, over 2 m);
- Forester determines skidding tracks, places for timber storage, skidding distance, and area harvesting difficulty depending on the terrain;
- All information is stored in an appropriate electronic form.

The result is represented as information that can be printed as reports:

- Distribution of designated trees in terms of species, diameter, quality class as a percentage;
- Distribution of designated trees in terms of species, diameter, quality class in pieces;
- Distribution of the amount of allocated trees in terms of species, diameter, quality class in cubic meters;
- Comparison of allocation data with data from the forest management material;
- Logging history (works executed on a specific date).

All information is transmitted to a supra-forestry central server over the Internet.

Notatnik unit is used to create business plans and to record works performed by the entrepreneurs in state forests.

The system also includes eLAS unit which is a cartographic database. Maps contain different layers - soils, extinguishing facilities, logging areas, forest cultures, recreation, protected forests, and other information. Each State Forests information system user can upload cartographic materials he/she is interested in and work with them individually.

Thus, timber track and trace system is a part of the overall software-information complex that provides document flow across the forestry, including record keeping, control and reporting of economic, financial and economic activity of the holding.

The information system includes not only wood marking for the purpose of electronic registration, but also provides proof of the legality of its origin by all permanent forest users. Thus, holding is authorized by the state authorities to carry out a series of record keeping and control functions.

Further timber tracking along the supply chain is not available. Thus, the system is limited to the timber tracking at the stage of its transfer from the manufacturer (supra-forestry) to the consumer (woodworking company).

SILP introduction caused significant impact on the forestry arrangement and the entire forestry sector as a whole.

Firstly, computerization of all processes in the forestry has improved work arrangement by reducing costs and therefore improving productivity. Improvement in the arrangement and management of the holding through, in particular, SILP introduction has reduced the number of employees by 32% and simultaneously increased timber harvesting volume by 37%.

Secondly, access of the scientific, educational institutions and non-governmental organizations to the system served as a testimony to the openness and transparency of the State Forests Holding and as a result ensures increased confidence in the forestry sector as a whole.

Thirdly, effective functioning of the system in the State Forests Holding allowed distributing it to other regular users (national nature parks, nature reserves) and private owners. Harvested timber is tagged by holding foresters, information on marked products is stored in the system, and forest owner receives a document on the harvested timber legality.

Attention is drawn to the similarities in misstep of Poland and Ukraine that have been made in introducing electronic timber registration. The main mistakes included failure to take into account management system inertia, lack of employees motivation to obtain new knowledge and skills in the use of information technology, lack of technical means to ensure efficient operation.

Useful for Ukraine is the approach where electronic timber records are key component but only one of the elements of the general information and management decisions support system. Accordingly, it is necessary to consider the transformation of the unified state system for state timber record keeping into the information system of the forest sector which would include subsystems such as cutting areas allocation and material and monetary valuation, forest mapping, wood sale at the electronic trading, etc.

Timber tracking and tracing subsystem in Poland belongs to the **state compulsory** systems and involves the use of both **balance** and **individual identification** method.

3.2. The timber transportation monitoring in Romania

In order to prevent illegal logging and illegal timber turnover in Romania, timber tracking through the **mandatory** use of **free** integrated information system SUMAL was introduced [4,33].

Government Resolution No. 470 of September 10, 2014 introduced its use to comply with the requirements of the EU Timber Regulation No.995/2010 with regard to establishing a system for timber tracking and due diligence.

The information system SUMAL is a tool for tracking timber from the place of its harvesting to the consumer (processing company, dealer warehouse, place of goods delivery to the importer, etc.) in real time through the use of a unique documents numbering system and work with the state database.

System was working since 2008, and has been fully operational since 2014 [13,21].

System users include forestry and harvesting companies, woodworking companies, intermediaries, , traders, regulatory authorities, Interaction with SUMAL is possible through complex software solutions covering all aspects of the above types of users [23, 36]. Operations related to the procurement, movement and processing of wood are recorded in the system within the deadlines set by the legislation by entering information into a single server of the Ministry of Agriculture and Rural Development of Romania both by the forestry staff during logging and entrepreneurs when exporting timber. Wood that is not fed into the system is considered illegal and can be removed.

The central element of the system is timber tracking during transportation (Figure 1).

However, it is based on the initial information about the allowed timber harvesting volume. The document entitled APV includes listing report on the trees to be logged and physical assessment of the cutting area including its assortment structure. When entering information about trees that are to be logged, the system calculates the amount of timber permitted for logging and generates a unique reference number. Actually this is a harvesting card. When implementing all subsequent operations with the timber unique permit number serves as ID.

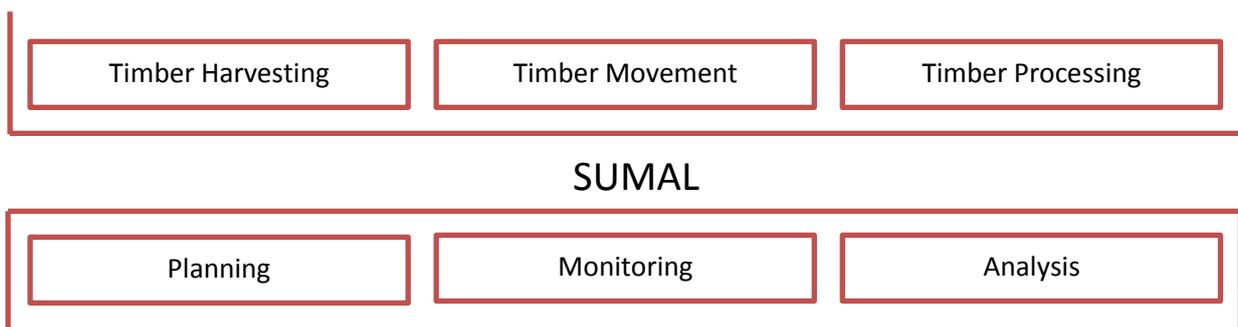


Fig. 1. SUMAL scheme

Permit for timber harvesting contains other information, for example place (farm, quarter, allotment), cutting type, its dates, etc. Logger is obliged to submit information on the volume of timber shipping to the buyers (woodworking companies, intermediaries, etc.) to the system on a monthly basis. Nevertheless, online monitoring of the product batch transportation is performed. To this end, when shipping timber the carrier must receive a unique code generated by the system. Information about the origin of timber is recorded both in the system and accompanying documentation.

The last element implies that the timber processor also enters information on the volume of the used timber on a monthly basis. As a result, it becomes possible to control timber circulation in the primary market and automatic checking of the actual scope and size-quality features of wood against the limited ones according to the APV.

To ensure prompt entering of information by the users, various work algorithms have been developed for each activity.

Thus, for timber transportation is using the mobile application "Wood Tracking" which is the part of SUMAL system and can be downloaded to a smartphone or tablet, based on operating systems such as Windows, and Android for free [23,36,37]. After the application installation, the user has to log in the system by entering login and password. The mobile application interface contains the required fields for data about the user to be sent to the server. These include: series and number of the document for the transport carrying timber, choice of loading point, number of logging permit, final destination, the registration number of the vehicle and assortment structure of the wood that is transported. After the user enters data, device location will be determine through the GPS data and assigning CodOffline and CodOnline codes if there is access to the Internet. In its absence, CodOffline valid for 6 hours after the data collection and storage is generated. During this period, the application must be connected to the Internet to transfer information to a server and receive CodOnline.

Timber origin legality can be verified both by regulatory authorities, inspectors - using specialized software, and the public - by requesting information on the vehicle transporting wood by the number 112. To get detailed information regarding transported wood, the inspector can use codOnline. Request with the code is sent to the server and a report with necessary information is sent in response.

The advantage of the system includes the ability to control timber transportation in online mode. However, unlike the Polish SILP system which includes identification of each individual assortment, timber consignment serves as the system control unit.

As well, we should note the additional potential strengths of the system.

Firstly, based on the information on the tree to be logged fed into the system, permit (harvester card) is automatically generated.

Secondly, part of the general statistical data accumulated in the system is open to the public which will contribute to its promotion and increase in confidence in the forestry sector.

Thirdly, there is possibility for controlling wood transportation by both law enforcement agencies and ordinary citizens.

Fourthly, the system was used as the basis for government decisions on the implementation of EU Timber Regulation 995/2010. Thus, timber tracking and proving its origin legality are possible through entering information on all movements and transactions. This greatly facilitates due diligence system setup.

For Ukraine, the use of such a system to meet the requirements of Article 294 of the Association Agreement between the EU and Ukraine and the Law of Ukraine "On peculiarities of state regulation of business entities associated with the sale and export of timber" to confirm the legality of timber origin along all supply chains - from producer to consumer - is recommended.

In the context of improving the unified state system of electronic timber record, we should consider its supplementing with material and monetary evaluation and automatic harvesting card generation.

Given the increasing civic activity, low credibility to the forest sector, introduction of online timber registration for its shipment and control during transportation is feasible.

Timber tracking and tracing in Romania belongs to the **state mandatory** systems and involves the use of **balance method**.

3.3. Timber tracking system in Austria

Austrian Federal Forest Company uses Felixtools software for its logistics solutions [17]. Specialized software installed on the driver's tablet and operator PC allows systematizing timber transportation by dividing it into separate stages, from route planning to shipping products to the consumers. So, timber transportation is based on a clear algorithm set by the PC operator. It should be noted that the driver also takes pictures of the timber immediately after loading. Information is sent to the server over the Internet and can be viewed immediately after entering data at each stage. Hence, the operator controls the timber transportation in online mode.

System drawbacks include the use of electronic document flow only, which provides for constant synchronization via the Internet. In the absence of coverage, monitoring and confirmation of the transported wood origin legality becomes complicated.

The idea of taking pictures of the cargo is useful because it simplifies visual check of its integrity. In the future, using the software, we will be able to determine the cross-sectional area and wood volume.

Timber tracking and tracing of Federal Forest Company belongs to **private voluntary** systems and involves the use of **balance method**.

3.4. Timber record keeping and tracking system in Sweden

Analyzing the timber record keeping and tracking system in Sweden, we should note that the union of almost 50 timber companies has set up special and independent IT company that ensures record keeping of agreements on timber, its measurement and transportation using modern information technology - Skogsbrukets Datacentral (SDC) [31]. This system is a centralized repository of information about transactions between wood owners, its customers, carriers, sawmill factories and independent organizations that carry out measurement and determination of wood quality.

The basic system component is a wood record keeping subsystem VIOL working in online mode via the Internet. The system is used for the collection, storage, processing and receiving information on the timber operations in Sweden.

"Wood Order" service is central to the timber record keeping information system. It helps to create a document used to identify the origin of wood and track its movement from the forest to the woodworking companies. This document has a unique identification number for each business transaction (wood purchase and sale) [1]. It should also be noted that "Wood Order" consists of several parts and is created by wood buyer who has pre-registered in the system and has created an "order"². In fact, this is a business contract between the buyer and the seller which allows selling wood at the beginning, from the log deck or reloading-and-sorting yard. The contract also states information about the seller and the buyer, volume, delivery terms, location of forest areas, delivery distance, methods for assortments measuring, etc. With a view to tagging wood batch, a paper tag is attached to it with the

seller, buyer and carrier code. The tag must be formed for each timber batch - usually one for each section of the timber truck.

It should be noted that during transportation cargo can be checked by a third party. Another important aspect in timber tracking is harvesting itself conducted by harvesters. The fact is that operator's payroll calculations are made depending on the amount of timber harvested in accordance with the metering system of the machine. Therefore, harvester operator is disinterested in carrying illegal logging, moreover, all information about harvesting volumes is collected electronically. Then, timber is sold through the SDC through which the buyer can request data on the harvested timber and through which timber will be tagged during transportation, which together forms a vicious circle in the system of timber tracking. By the "order" number, all the supply chain can be traced: timber is transported by a timber truck to a woodworking company where the source of its origin is determined by the number, control measurements of the delivered are performed and timber quality is determined (timber can be supplied to timber mill from several consumers). Record keeping system takes into account the entire supply chain, even if it includes intermediate wood buyers. Information on the "Order" is available to the buyer, the seller, SDC. Timber volume is measured by independent companies using methods stipulated in the agreements, which reduces the likelihood of illegal activities and fraud. Another feature of timber record keeping and tracking in Sweden is its measurement at the woodworking company in accordance with the standards developed by the Forestry Agency.

All information is recorded and transmitted to the SDC Centre where it is stored for two years. Final calculation between the seller and the buyer is the results of the measurement.

Thus, peculiarities of the timber harvesting process exclude the feasibility of timber release by forestry bodies. They only control the payment of taxes and reforestation fee. The main work is done by independent companies (measuring timber volumes, compliance with trade agreements and functioning of the system and services).

Timber tracking and tracing in Sweden belongs to **private voluntary systems** and involves the use of **balance method**.

3.5. Pilot timber tracking and tracing projects in Germany

Hessen

Development of the tracking system to prevent illegal logging is not an urgent task in Germany. However, cases of timber batches theft (mainly wood for heating) located near roads for ease of loading and export led to testing of timber tracking by the Civil Service Hessen Forest [32].

The system is based on a tracking device called Forest tracker. This is a tiny GPS transmitter with battery and motion sensor which is invisibly attached to the observation object (timber batch intended for export). In the event that the theft is made, the device will trip and send its coordinates to the observation point. The main disadvantage of this approach is the high cost of the device - €300.

Bavaria

By mid-2015, Bavarian State Forestry is planning to introduce electronic document flow for timber transportation [16]. The project is still under development, its aim is to speed up information processing and reduce the number of errors when filling out transport documents.

Fraunhofer-Gesellschaft

Researchers at the Fraunhofer-Gesellschaft Institute in Germany have developed a timber tracking system prototype using RFID tags that are attached to the timber [35]. In particular, devices contain detailed information on the origin, amount, type and destination of the products. Since data contained in the RFID tag can be read at small distances, such an approach was proposed to be used for wood registration at the vehicle when crossing loading and unloading points.

4. Conclusions and proposals

1. In developing countries, where timber exports plays a significant role in shaping gross domestic product, tracking and tracing systems are obligatory, are introduced and supported by public authorities. Along with the obligatory systems, voluntary independent supply chain monitoring systems are being developed.
2. The traditional and dominant method for timber tracking is a balance method. With the requirement to ensure products traceability from the consumer to the place of harvesting, electronic and semi-electronic systems that are based on the individual identification method are becoming more and more common.
3. In developing countries, significant role in monitoring supply chains is played by the representatives of the inspectional and law enforcement authorities. Special attention is paid to the definition of critical control checkpoints where illegal timber can emerge, including during transportation.
4. Incentive factors behind the introduction of timber tracking and tracing in export oriented countries are compliance with legislation requirements of importing companies, international agreements and intergovernmental voluntary commitments guaranteeing the legality of logging, including through the confirmation of timber origin.
5. Increased requirements for such systems result in widespread introduction of objective monitoring means with the possibility of verification by the independent third party.
6. In Europe, introduction of electronic timber tracking and tracing systems is associated with management and organizational solutions aimed at improving the economic efficiency of forestry and timber industries, improvement in the production and logistics processes based on the latest information technology.
7. In the post-socialist European countries with many state forests, timber tracing and tracking systems are mostly mandatory, while in Western Europe, the introduction of such systems is a part of business decisions of public or private companies.
8. The general trend in the development of electronic timber tracing and tracking systems is the creation of automated tools for the timber circulation analysis and monitoring at all stages of its transformation and integration with related government and commercial record keeping, reporting, permits issuance, agreements registration systems.
9. Successful implementation of any innovations related to the introduction of new techniques and technologies depends on serious preparatory work, including awareness raising and clarification on the goals and objectives of the system, staff training and advance training, training of new personnel, material incentives, etc.
11. Experience in developing national electronic timber tracking and tracing systems based on the registration of batch of products along the supply chain is stimulating for Ukraine. The EU Timber Regulation 995/2010 and the Law of Ukraine "On peculiarities of state regulation of business entities associated with the sale and export of timber" which provides for the issuance of certificates of origin should serve as motivation for the development and functioning of such a system.

12. We should also consider online registration of each timber batch shipping which will enable us to assess the legality of origin without stopping the vehicle and engage in inspection activities of public activists and private citizens.

13. Complaints of other permanent forest users about the lack of funds, knowledge and skills necessary for the spread of a Unified State System of Electronic Accounting of Wood (USSEAW) can be eliminated if empowerment of state forest enterprises employees take place to carry out such work.

14. Given the negative experiences in the USSEAW introduction at state forest enterprise, we should change individual registration method and timber identification in the system (separate assortment) for the balance method (transport timber batch).

15. USSEAW should be considered as a basic component of the forest complex information system which will include the following elements: cutting areas allotment and issuance of harvesting card; mapping for forest management purposes; electronic timber trading, etc.

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IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges. IUCN's work focuses on valuing and conserving nature, ensuring effective and equitable governance of its use, and deploying nature-based solutions to global challenges in climate, food and development. IUCN supports scientific research, manages field projects all over the world, and brings governments, NGOs, the UN and companies together to develop policy, laws and best practice. IUCN is the world's oldest and largest global environmental organisation, with more than 1,200 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 45 offices and hundreds of partners in public, NGO and private sectors around the world.

<http://www.iucn.org>



WWF

WWF is one of the world's largest and most respected independent conservation organizations, with almost 5 million supporters and a global network active in over 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

www.panda.org