Developing Integrated Timber Data to Enhance Legal Timber Trade of the APEC through Xylaria Networking

Final Report

APEC Experts Group on Illegal Logging and Associated Trade

October 2024

Asia-Pacific
Economic Cooperation

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The names of public or private institutions referenced in this document do not imply the political status of any APEC economy.

FOREWORD

The Project of Developing Integrated Timber Data to Enhance Legal Timber Trade of the APEC through Xylaria Networking was approved on 3 February 2023 by the Sponsoring Forum of APEC Experts Group on Illegal Logging and Associated Trade (EGILAT) under the committee of SOM Steering Committee on Economic and Technical Cooperation (SCE). With the proposition, the Project aims to address illegal logging and illicit timber trade in Asia and the Pacific region through the use of forensic wood identification techniques and the development of Xylaria Networking. Although the Project confronted many hurdles, successful completion with defined deliverables was achieved in due course. With the proposition, on this occasion, the Project Management Team, assisted by the consultant, is delighted to present a project completion report, which was open-published on the APEC Secretariat repository.

The report is the embodiment of the full summary of the interventions to accomplish outcomes and objectives as stipulated in the Project's Strategic Results Framework or Theory of Changes. The report portrays the ramifications of varied interventions of the Project, including three pivotal events and a research-based activity. Three events were successfully conducted, including a joint-research discussion (JRD) on Xylaria Networking, a focus discussion group (FGD) on Xylaria Networking, and a workshop on wood identification technologies, while a research-based activity was derived from the results of these two workshops (JRD and FGD) complemented with a systematic review and survey. All the results of these activities are offered respectfully in the report. Besides the above interventions, the Project Management Team (PMT) also developed templates of agreement documents, such as Letter of Agreement (LOA), Letter of Intent (LOI), Memorandum of Understanding (MOU), Plan of Operation (POO), and Material Transfer Agreement (MTA) for Indonesia as the Receipt and the Provider, used to support the development of Xylarium Networking. The template development is well-elucidated in the report, and its examples are also annexed.

We acknowledge all parties involved directly and indirectly in the Project, especially the BRIN, Ministry of Environment and Forestry (KLHK), APEC Secretariat, and APEC EGILAT. We also thank the project management consultants and team who rendered continuous support in managing the Project's lifecycle. Finally, referring to the self-improvement words: "When you voice an opinion, be just, even if it is against a relative", we would like to welcome input and recommendations for the improvement of the report. Thank you so much for your attention.

Bogor, 29 January 2024

Prof. Dr. Ratih Damayanti

Director of Scientific Samples Management, BRIN

On behalf of the Project Management Team - BRIN & KLHK

EXECUTIVE SUMMARY

The APEC Experts Group on Illegal Logging and Associated Trade (EGILAT) was established in 2012 and has committed to take concrete actions to combat illegal logging and associated trade, promote trade in legally harvested forest products, and support capacity-building activities in member economies. EGILAT also endorsed the EGILAT Multi-Year Strategic Plan 2018–2022, comprising six objectives with specific key performance indicators. In accelerating the above goals and the Strategic Plan, EGILAT approved the Project of Developing Integrated Timber Data to Enhance Legal Timber Trade of the APEC through Xylaria Networking on 3 February 2022. The Project is a one-year regional APEC member economies project led by BRIN and the Ministry of Environment and Forestry (KLHK) to increase the capacity building of industries, research scientists and the public sector from APEC member economies on wood identification technologies, and to promote Xylaria networking in the Asia-Pacific Region.

The Project consists of two pivotal interventions, namely research discussions and a capacity-building workshop in utilizing wood identification tools, with four deliverables, such as a research paper, Letter of Agreement (LOA)/Memorandum of Understanding/Letter of Intent and Material Transfer Agreements (MTA), integrated database that supports Xylaria networking, a list of traded timber in APEC member economies, and a final report. In terms of the joint research discussions, two consecutive discussions were successfully staged virtually, including 1) Joint-Research Discussion (JRD) on Developing Integrated Wood Identification System through Xylaria organized on 6-7 November 2023, with the attendees from 17 economies, and 2) Focus Group Discussion (FGD) on Developing Integrated Wood Identification System through Xylaria Networking, held on 16 January 2024, with the attendees from 16 economies. For the capacity-building workshop on 23-25 April 2024, the PMT successfully organized the Bogor Workshop on Wood Identification Techologies, with the attendees from 14 economies.

At the JRD, APEC member economies showcased different wood identification techniques that have been employed for screening and diagnostic forensic wood identification. They have distinct priorities in demanding wood identification for forensic timber. They also suggested the development of Xylaria Networking, which can be expedited through follow-up development actions, such as agreement documents (LOA/LOI/MOU, POO, and MTA), Xylaria Networking, and Regional Standards on Wood Identification. At the FGD, APEC member economies presented their readiness level and stakeholders mapping on implementing forensic wood identification. Most APEC member economies had a readiness level of research, indicating that some of the enabling factors for the implementation of forensic timber in APEC member economies are still being studied for piloting and excessive implementation. Wood identification is also observed to be integrated into their legality assurance systems of timber along the timber supply chain. The Bogor Workshop was to train customs officials, researchers, and representatives from forest industries and international organization on how to harness wood identification technologies to combat the illegal trade of wood and to exchange expertise among wood

identification experts on forensic timber. In the workshop, the participants also learned the set theories and practices on wood identification technologies. They also visited Xylarium Bogorienses, Botanical Garden, and Bogor Agricultural University Advanced Research Laboratory to learn how these places can contribute to the substantial operation of forensic timber in Indonesia. All these events engaged more than 280 participants from APEC members and non-APEC members.

APEC member economies that attended the JRD suggested with the development of Xylaria Networking, agreement documents (LOA/LOI/MOU, POO and MTA), and regional standards on wood identification. This Project successfully cooperated with eight member economies to develop the LOA/LOI/MOU and MTA, including Chile; Japan; Republic of Korea; Papua New Guinea; the Republic of the Philippines; Chinese Taipei; Thailand; and Viet Nam. The LOA, LOI, or MOU, which is accompanied by POO, provides a legally binding umbrella for wood identification collaboration, and the collaboration is concretely materialized into the development of the MTA, intending to exchange wood samples, wood identification technologies, and wood database among APEC members. The Xylaria Networking database is enriched through the actualization of the MTA by using two different means, namely, the exchanged wood samples characterized using various wood identification technologies to produce the Xylaria database and the shared wood identification databases from APEC member economies used to multiply and enrich the Xylaria database. The database is expected to be digitalized and openly accessed for APEC member economies and can be integrated with a machine learning-based wood identification tool.

Based on our project study, APEC member economies have applied varied wood identification techniques for both screening and diagnostic methods of forensic timber. The techniques comprise machine vision, wood anatomy, spectroscopy, mass spectrometry, stable isotope, radiocarbon, DNA barcoding, DNA fingerprinting, and genetics populations. Of these technologies, wood anatomy is commonly used for the APEC member economies for forensic timber. Wood anatomy that is combined with other methods, such as machine vision, DNA analysis, and mass spectrometry, is advised to be utilized for forensic timber identification. The use of forensic timber technologies should be fit-to-purpose and not based on a "one-size-fits-all" approach. The technologies can be applied to identify specific levels of risk, such as wood genus, species, provenance, individuals, and age, and can be selected based on their advantages and disadvantages.

APEC member economies mainly have applied forensic timber at the readiness level of the research stage, meaning most enabling factors, such as wood identification technologies and infrastructure, experts, legislations, databases, guidelines and standards, and finance, are still under study for piloting and extensive implementation. From the readiness level, APEC member economies also shared forensic timber practices, starting from research, project piloting, and extensive implementation. The practices harness various wood identification technologies, such as wood anatomy, machine vision (Xylotron, AIKO, Xylorix), mass spectrometry (DART-TOFMS), stable isotope, and DNA barcoding. Profiling wood species and origin is the most common risk that is investigated in the practices. APEC member economies also have integrated wood identification processes along their timber supply chain from the upstream to downstream and has

included them in the legality assurance system and other legislation-based systems to ensure the legality obtainment of harvested timber. The process of wood identification is dominantly placed at the entry point of import and export.

Key words: APEC EGILAT, research and capacity-building, forensic wood identification, Xylaria Networking, timber legality assurance system

1. INTRODUCTION

The Project of Developing Integrated Timber Data to Enhance Legal Timber Trade of the APEC through Xylaria Networking is the APEC EGILAT-endorsed wood identification project with the APEC EGILAT approval of 3 February 2022, which addresses the development of the integrated database system through Xylaria Networking to enhance timber trade legality in APEC member economies. By addressing the issues of timber trade, it is noted that an estimated 15-30 percent of all timber traded globally was from illegal logging and illicit timber trade. The illegal timber trade annually generates between USD51-152 billion, a significant loss in tax revenues (Interpol 2023). Regarding Asia and the Pacific region, the Environmental Investigation Agency (2012) reported that illicit timber trade within and from the region is estimated to be worth USD11 billion a year, equivalent to 30 percent of the total trade in wood products. In addition, in the international trade of wood, mainly at the export and import stage, there are about 800 million container movements globally, with less than 2 percent physically inspected (Tresya 2024).

The presence of domestic and international legislation has encouraged the assurance of timber legality. For instance, the Illegal Logging Prohibition Act issued in 2012 with amendments in 2021 (Office of Parliamentary Counsel 2021) and the Act on Promotion of Use and Distribution of Legally-Harvested Wood and Wood Products issued in 2016 (Government of Japan 2016) are examples of the domestic policies addressing the importance of timber legality traded. The legislation is also strengthened by the new rules from the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) taking effect in 2017, bringing hundreds of additional timber species under its legally binding global trade controls (CITES 2017). It forces economies to adopt their own domestic or domestic legislation to implement CITES treaties at the domestic level (CITES 2022). It also drives the high demand for the importance of profiling risks of timber exported or imported, which are required to be matched with timber legality documents. As a result, this has encouraged wood industries to provide more precise and reliable information on the subjects, such as wood species names and their origins.

The introduction of wood identification in profiling risks of traded timbers through field verification and laboratory verification is demanded. Wood identification can be placed along the timber supply chain to ensure the legality of traded wood and its products (Solikhin et al. 2023). Different technologies of wood identification have been mainstreamed into timber legality assurance systems. The integration of the technologies into the systems is aimed at tracing timber and its products, entering the lifecycle of the timber supply chains (Dormontt et al. 2018, Kaulen et al. 2023, and Brusselen et al. 2023). In addition, by profiling risks of wood species and origin through the field and laboratory using wood identification technologies, the traded timber can be verified its data correctness as stipulated in the harvest/export/import documents. Some examples of wood identification technologies, i.e. wood anatomy, dendrochronology, mass spectrometry, near-infrared spectroscopy, stable isotope, radiocarbon, DNA barcoding, population genetics, and DNA fingerprinting (Dormott et al. 2015), can be used for

identifying and verifying the legality of timber at a certain level, such as genus, species, origin, and provenance.

Besides the technologies, the presence of Xyalrium is also pivotal because the Xylarium plays a role as a collection site of authenticated wood specimens. In addition, Xylarium also facilitates wood identification and other scientific wood research, teaching, and environmental education. According to Jiao et al. (2018), there are 180 Xylaria with 1.5 million wood specimens. The presence of Xylaria can become the nerve of forensic wood identification systems, providing databases, technologies, expertise, capacity-building, and finance. However, some hampering factors are also present. For instance, the restraining factors are limited experts and capacity-building, lack of technologies, and limited investment and finance to support the application of wood identification technologies. Solikhin et al. (2024) also reported several factors hampering the application of forensic timber identification, including a lack of technologies and laboratories, limited wood identification experts, unavailable legislation and financial support, limited access to wood identification education and capacity-building given to the experts and enforcement officials, and unavailable standardized methods and protocol.

By referring to the above propositions, the Project of Developing Integrated Timber Data to Enhance Legal Timber Trade of the APEC through Xylaria Networking attempted to address the issues of timber legality by establishing Xylaria Networking in the APEC member economies for integrating timber data. Through joint research discussion, capacity-building enhancement, execution of material transfer agreement, and integration of wood identification techniques into timber legality system assurance, the objectives and deliverables of the Project were realized, as stipulated in the approved project proposal[1]. Furthermore, in this report, lessons learned and recommendations from the management of the Project to APEC member economies are also presented.

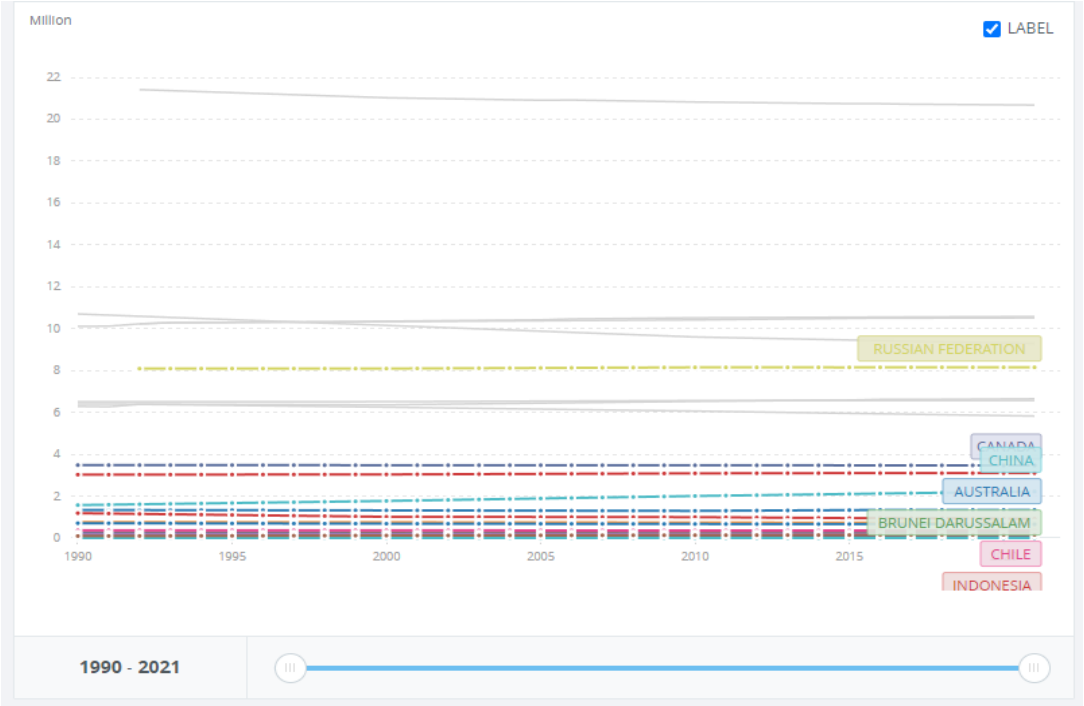
2. OBJECTIVES

The Project of Developing Integrated Timber Data to Enhance Legal Timber Trade of the APEC through Xylaria Networking, which was approved on 3 February 2022, by APEC EGILAT, had several outputs achieved, including a research paper, a commission of three workshops, signing and actualization of agreement documents (LOA/LOI/MOU, POO and MTA), and a project report. The Project defined objectives that were beneficial for achieving outputs and outcomes through the agreed interventions. The objectives of the Project include:

1) to increase the capacity building of industries, research scientists and the public sector from APEC member economies on wood identification,
2) to promote the development of Xylaria Networking (wood collection center) in the Asia-Pacific Region for enhancing the uses of the wood identification system,
3) to study the potential of developing a standardized wood identification system
4) to discuss opportunities for the integration of wood identification into the timber legality assurance systems and procedures of the APEC member economies to support international legal timber trade.

3. PROJECT RELEVANCE AND ALIGNMENT

The Project of Developing Integrated Timber Data to Enhance Legal Timber Trade of the APEC through Xylaria Networking has provided relevancies on the issues related to the forest and illegal logging state of APEC member economies. The Project is also made in alignment with the APEC Strategic Plans. In terms of the Project's relevance, the Project was developed to address illegal logging and associated trade.



(a)

(b)

Figure 1. Forest area (sq km) in APEC member economies: a) APEC member economies' forest area from 1990 to 2021 and b) estimated APEC member economies' forest cover in 2021 (World Bank 2024)

According to the World Bank (2024), since 1990, the world's forest area has been decreasing. However, the aggregated value of forest area has been increasing dramatically in APEC member economies since 1990 (Figure 1). One of the reasons for the significant loss of deforestation in the world, especially in Asia and the Pacific, is illegal logging and associated trade. One of the reasons for the significant loss of deforestation in the world, especially in Asia and the Pacific, is illegal logging and associated trade. According to EIA (2012), illicit timber trade both within and from the Asia-Pacific region is estimated to be worth USD11 billion a year, equivalent to about 30 percent of total trade in wood products. Interpol (2019) also reported that both illegal logging and international illicit trade of timber account for 15-30 percent of all timber traded globally, and illegal harvested timber trading has an estimated value of between USD51-152 billion of significant loss in tax revenues.

To address illegal logging and its associated trade, Xylarium plays an indispensable role as a wood samples collector, database repository, technologies provider, wood identification experts consortia, and education and capacity-building center. However, it is realized that the availability of these materials - most notably data, wood samples, technologies, and experts - in the Xylarium is limited and siloed, leading to difficulties in accessing them to overcome transnational forestry crimes, particularly illicit timber trade. For instance, in terms of technologies, various wood identification technologies have been used for forensic timber identification studies in APEC member economies, such as wood anatomy, genetics (DNA profiling), stable isotope, DART-TOFMS, GC-GC-TOFMS, NIR spectroscopy (Espinoza et al. 2015, Ng et al. 2016, Schmitz et al. 2020, Dormontt et al.

2020, Duchesne et al. 2023). As a result, the integration of these materials into the APEC member economies' Xylaria Networking is demanded. The Xylaria Networking is anticipated to increase and strengthen the connectivity among APEC member economies, which is in line with the APEC Connectivity Blueprint for 2015-2025, especially in resolving to advance work on cross-border science, technology, and innovation exchanges (APEC Secretariat 2015).

Besides the APEC Connectivity Blueprint for 2015-2025, the Project was developed to generally support the actualization of the strategic priorities stipulated under the Putrajaya Vision 2040, the Aotearoa Action Plan, and the La Serena Roadmap for Women and Inclusive Growth (2019-2030). In terms of the Putrajaya Vision 2040 and the Aotearoa Action Plan, the Project aligns with two economic drivers, namely trade and investment and innovation and digitalization (APEC Secretariat 2020, APEC Secretariat 2021), whereas in terms of the La Serena Roadmap for Women and Inclusive Growth (2019-2030), the Project translates a key priority of supporting women's education, training and skills development and access in a changing world of work (APEC Secretariat 2019).

The Project also explicitly supports the two plans of APEC EGILAT, especially the EGILAT Multi-Year Strategic Plan 2018–2022 and the EGILAT's Multi-Year Strategic Plan 2023-2027. It is noted that the Project was endorsed and approved to actualize the EGILAT Multi-Year Strategic Plan 2018–2022's vision, especially to enhance the efforts of its member economies to take concrete steps to combat illegal logging and associated trade and promote the trade in legally harvested forest products including through capacity building activities in member economies, according to the EGILAT´s Terms of Reference, and thereby contribute to APEC's primary goal to support sustainable economic growth and prosperity in the Asia-Pacific Region, including APEC Leaders aspirational goal to increase forest cover in the region by at least 20 million hectares by 2020. A year after the approval of the Project, the EGILAT's Multi-Year Strategic Plan 2023-2027 was adopted with its vision to enhance the efforts of its member economies to take concrete steps to combat illegal logging and associated trade and promote the trade in legally harvested forest products, including through capacity-building activities in member economies, according to the EGILAT´s Terms of Reference, and thereby contribute to APEC's primary goal to support sustainable economic growth and prosperity in the Asia-Pacific Region, including APEC Leaders aspirational goal to increase forest cover in the region by at least 20 million hectares by 2020.

4. PROJECT INTERVENTIONS

The Project has several interventions taken to achieve the outputs and outcomes. The interventions include:

- Joint Research Discussion (JRD) on Developing Integrated Wood Identification System through Xylaria Networking,
- Focus Group Discussion (FGD) on Developing Integrated Wood Identification System through Xylaria Networking,
- Bogor Workshop on Wood Identification Techologies,
- Development Process of Memorandum of Understanding (MOU), Letter of Intent (LOI), or Letter of Agreement (LOA), Plan of Operation (POO), and Material Transfer Agreement (MTA) with Indonesia as the Receipt and the Provider,
- Joint-Research on Forensic Timber Identification, and
- Process of Database Enrichment of Selected Wood Identification Instruments.

Outputs were realized in the Project are 1) a joint research report that will be published in the APEC repository, 2) the signed material transfer agreements (MTA) with APEC member economies, 3) the development of an integrated database for the selected wood identification tools, 4) policy recommendations for the APEC EGILAT, and 5) a final report of the Project.

4.1 Joint Research Discussion on Developing Integrated Wood Identification System through Xylaria Networking

The JRD on Developing an Integrated Wood Identification System through Xylaria Networking was conducted virtually and physically in Bogor, Indonesia, on November 6-7, 2023. The JRD Workshop discussed pivotal agendas, including 1) wood identification techniques/methods adopted for forensic timber, 2) the need for APEC member economies on forensic timber technologies, 3) a list of traded timber, 4) opinion on the development of Xylaria Networking and wood identification standards, and 5) development of MTA for database enhancement of the Networking. These agendas were presented by the nominated researchers or experts from APEC member economies.

4.2 Focus Group Discussion on Developing Integrated Wood Identification System through Xylaria Networking

The FGD on Developing Integrated Wood Identification System through Xylaria Networking was carried out on 16 January 2024, involving twenty-one APEC member economies. The FGD was undertaken virtually and physically in Bogor, Indonesia. The agenda of the FGD included various presentations from wood identification and timber legality assurance experts and position paper presentations from the APEC member economies representative, highlighting the current state of wood identification and its potential integration into the timber supply chain, the readiness level, and the stakeholder mapping of forensic timber application.

4.3 Bogor Workshop on Wood Identification Technologies

The Bogor Workshop on Wood Identification Technologies was conducted from 23 to 25 April 2024 in Bogor, Indonesia, inviting wood identification experts, customs, and APEC EGILAT officials. The Workshop provided various practices on wood identification technologies for forensic timber, such as wood anatomy, NIR spectroscopy, stable isotope, radiocarbon, and DNA-based solutions. Wood identification experts, customs, and APEC EGILAT representatives from APEC member economies attended the Workshop.

4.4 Development Process of Agreement Documents

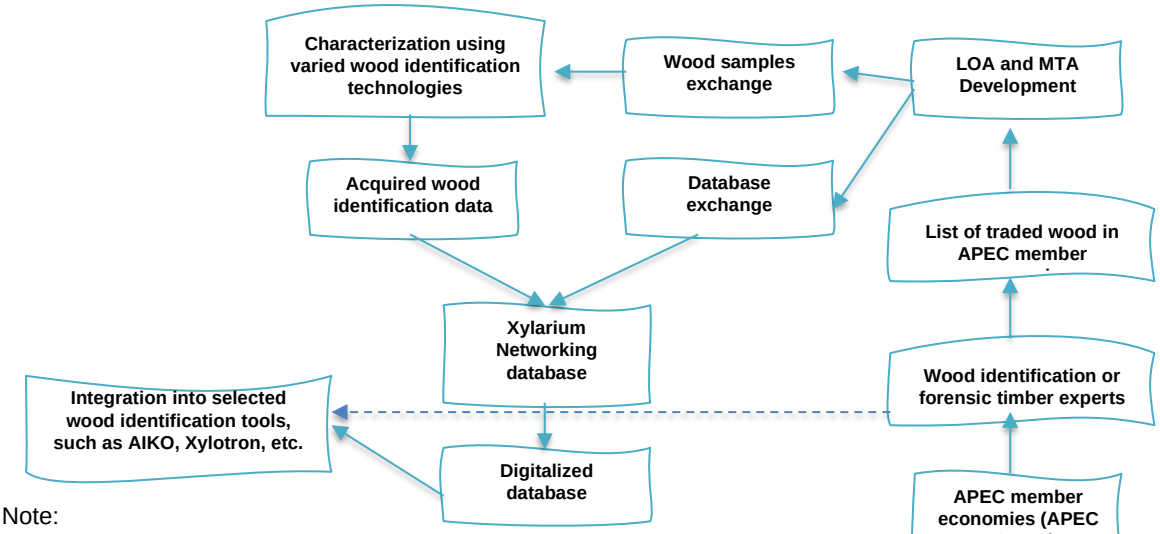
In accelerating the establishment and embodiment of Xylaria Networking, one of the key actions is performing collaborative activities through developing agreement documents. The documents include MOU, LOI, or LOA, POO, and MTA with Indonesia as the Receipt and the Provider, which were drafted as the main templates for APEC members to collaborate with the project implementing agency (BRIN, Indonesia). In terms of the defined deliverable of the APEC EGILAT Project, MOU/LOA/LOI and MTA are requested to be signed by the parties (BRIN and eight institutions in APEC economies), and the signed agreement documents are anticipated to be operationalized. The Project successfully developed engagement with eight APEC member economies on the establishment of LOA and MTA, namely Chile; Japan; Republic of Korea; Papua New Guinea; the Republic of the Philippines; Chinese Taipei; Thailand; and Viet Nam. The MTA exchanged three materials supporting the development of Xylaria Networking, such as databases, technologies, and wood samples. Only wood samples would be exchanged among the signed parties on this occasion.

4.5 Joint-Research Collaboration on Forensic Timber Identification

The Joint-Collaborative Research on Forensic Timber Identification was undertaken from July 2023 to January 2024, using the triangulation method, combining different approaches, such as systematic evidence evaluation, mini and quick surveys, and workshop validation from JRD and FGD. The research pertained to specific issues, including an inventory of wood identification technologies, forensic timber practices, traded timber, readiness level and stakeholder mapping on forensic timber application, material exchange agreement, regional standards development, and mainstreaming of wood identification into timber legality systems.

4.6 Process of Database Enrichment of Selected Wood Identification Instruments

Database enrichment in the Xylaria Networking was conducted by the development of LOA and MTA, exchanging three wood identification materials, including wood samples, technologies, and databases. The data acquired from the exchanged databases and characterized wood samples were utilized to enrich the selected wood identification tools. To date, APEC member economies have recommended digitalizing the acquired data for being accessed openly by the public. Figure 2 shows the proposed approach to enrich the wood identification database in the APEC member economies' Xylaria Networking.



Note:

*Dash line: recommendation from APEC member economies for the selected wood identification tool

**Straight line: direct flows of databases enhancement in Xylaria Networking system

Figure 2. Enhancement of Xylaria Networking's wood identification databases

5. RESULTS AND DISCUSSION

5.1 Joint Research Discussion Results

There are three indispensable activities performed to achieve the goals of the Project, namely:

- Joint Research Discussion on Developing an Integrated Wood Identification System through Xylaria.
- Focus Group Discussion on Developing an Integrated Wood Identification System through Xylaria Networking.
- Bogor Workshop on Wood Identification Technologies.

Under these activities, there are varied outputs and outcomes achieved. In addition, these activities are composed of different objectives, targeted participants, time execution, agenda discussed, and stakeholders involved.

The Joint Research Discussion on Developing an Integrated Wood Identification System through Xylaria was conducted online on 6-7 November 2023 through Zoom Platform, engaging more than 90 participants from different APEC member economies. Annex 10.1 shows the documentation of the JRD. The objectives of the Discussion were 1) to stocktake wood identification techniques and their challenges and opportunities as used for forensic timber in Asia and the Pacific region, 2) to list commercially traded woods in the region, and 3) to collect recommendations from the APEC member economies on MTA development and adopted wood identification standards for forensic timber. The agenda included member economy presentations on wood identification progress for forensic timber and an interactive discussion on the development of material transfer agreements (MTAs) and the adopted common wood identification technology for forensic timber in APEC region. These agendas generally examined the following key talking points:

1. wood identification techniques/methods adopted for forensic timber,
2. the need for APEC member economies on forensic timber technologies,
3. a list of traded timber,
4. opinion on the development of Xylaria Networking and wood identification standards,
5. Consideration for the development of MTAs for database enhancement of the Networking.

The Discussion was attended by 17 APEC member economies, with speakers from Australia; Canada; Chile; the People's Republic of China; Indonesia; Japan; Republic of Korea; Malaysia; New Zealand; Papua New Guinea; Peru; the Republic of the Philippines; Singapore; Chinese Taipei; Thailand; the United States; and Viet Nam. They represented different sectors, including government, industries, non-governmental organizations, and international governmental organizations. Below are the presentations of the APEC members representatives:

1. Chile was represented by Mr. Jorge Gonzales Campos, as a nominated delegate from the APEC member economy. His presentation was about the APEC member economy Initiative on Forensic Wood Identification. He briefly introduced his CITES

research team and his role as a researcher in conservation and genetic improvement. He also introduced the SIMEF Project, which focused on varied activities, such as developing a library of macro- and microscopic images for wood identification and spectroscopy for origin authentication. He also informed about the challenges and opportunities in forensic wood identification, especially with limited plant anatomy specialists, limited free public libraries, and complicated wood identification for similar anatomical species. He noted that most traded timber was 67.56% exotic and 32.43% native, and the most wood species traded in Chile are *Pinus radiata, Eucalyptus globulus, Eucalyptus nitens,* and *Sin especificar*. Wood identification technologies are demanded in Chile to support forest inspection and timber identification systems in ports. He also agreed on the development of Xylarium Networking and wood identification objects exchanges under MTA. He also concisely provided information on the mechanism for materializing MTA.

2. The United States was represented by Mr. Alex Wiedenhoeft, focusing on the APEC member economy Initiative on Forensic Wood Identification: the US Forest Service. He also provided information on the wood identification techniques already utilized in the United States. He also articulated the two categorized techniques for wood identification, including field deployable (field wood identification manuals, machine vision, and NIR spectroscopy) and laboratory techniques (traditional wood anatomy, DNA-based approaches, and spectroscopic approaches). He revealed that the US Forest Service International Programs Wood Identification and Screening Center (WISC) had used Direct Analysis in Real–time of Flight Mass Spectrometry (DART-TOFMS) to provide forensic timber analyses. He emphasized the demand for wood identification to provide rapid and reliable species-level botanical identification similar to geographic origin identification, information to the enforcement agencies, and emphasizing the modality-agnostic traits. He also highlighted the traded hardwood and softwood timbers in North America and the responsible agency maintaining the database of the traded wood. He also supported MTA, regional standards, and Xylarium networking.

3. Peru was represented by Mr. Jose Ugarte Olivia on the APEC member economy Initiative on Forensic Wood Identification. He mentioned only wood anatomy, machine vision, and mass spectroscopy that have been used for forensic timber identification. He also detailed their use and several agencies demanding wood identification technologies, such as the National Forest Service, the supervisory agency of forest resources, customs, regional government, timber companies, etc. He also detailed the progress in using Xylotron and DART-TOFFMS, which have been integrated into capacity-building activities, knowledge product development, and database enrichment. He listed about 44 wood species that are primarily traded in Peru, providing local names, scientific and international names, and their uses. He also agreed on the MTA, regional standards, and Xylaria networking development on wood identification.

4. Thailand was represented by Mr. Montri Intasen on the APEC member economy Initiative on Forensic Wood Identification: Royal Forest Department Wood Collection Center. He mentioned that only wood anatomy - including macroscopic and microscopic methods, which are also sometimes coupled with non-anatomical information -had been used massively for wood identification in Thailand, and the method functioned for studying wood structural properties and verifying wood types and quality. He informed that wood

identification is demanded for issuing wood export certificates, identifying the species, and providing academic knowledge. He also informed about 14 wood species that have been traded internationally. He agreed with the materialization of MTA and the development of regional standards on wood identification and Xylarium Networking.

5. Malaysia was represented by Mr. Lee Soon Leong on the APEC member economy Initiative on Forensic Wood Identification. He listed that wood anatomy and DNA analysis are the two most used wood identification technologies in Malaysia, whereas machine vision is still under development. He emphasized that these technologies have been used for species, geographic origin, and original stump identification. He mentioned that Xylarium Kepong in FRIM has collected about 10,036 specimens of wood from 108 families and 1,587 species. He also identified many Malaysian woods through DNA analysis, and their data has been deposited in the DNA Database Management System. He also informed that they developed a standard operation procedure for forensic DNA testing on plant species identification and wood tracking.

6. Singapore was represented by Ms. Jomaine Tang on the APEC member economy Initiative on Forensic Wood Identification: Industry Application of Forensic Testing on Timber. She informed three technologies used for wood identification, such as wood anatomy, DNA analysis, and stable isotope. She concisely introduced the DoubleHelix company, specializing in due diligence and timber verification solutions. She also stressed the importance of timber verification, combining conventional approaches and scientific methods, in which scientific methods were used for independently verifying claims along the timber value chain. She also provided some case studies on wood identification demand, such as European Oak flooring from People's Republic of China, Indonesian plywood sold to the United States, and DNA fingerprinting for Viet Nam teak.

7. Republic of Korea was represented by Ms. Anh Jiyoung on the APEC member economy Initiative on Forensic Wood Identification. She informed on using wood anatomy and population genetics for forensic timber analysis. She also provided the important roles of the Korea Forestry Promotion Institute for wood anatomy inspection, the National Institute of Forest Science for DNA analysis, and the National Instrumentation Center of Environment Management for AI microscopy. She emphasized the demands on wood identification for timber verification and identification of illegal logging. She mentioned that more than 55 species of traded wood. She also confirmed softly on the MTA with further discussions and the development of regional standards and Xylarium Networking.

8. Japan was represented by Mr. Akira Kagawa on the APEC member economy Initiative on Forensic Wood Identification. He informed that wood anatomy, dendrochronology, near-infrared spectroscopy, stable isotope, population genetics, and DNA fingerprinting have been used for forensic timber analysis. He also informed about FFPRI Xylarium collecting 30,000 wood samples from 8,000 tree species and his new and innovative method of pinpointing the geographic origin of timber using tree-ring isotopes. He emphasized that the increase in CITES-listed wood species for trading and the Clean Wood Act have driven the need for wood identification in Japan. He also informed that 300-400 genera have been traded their timber, of which 200 genera are from Southeast Asia. He also agreed on the exchange of wood identification materials for materializing MTA, and the development of regional standards and Xylaria Networking.

9. Chinese Taipei was represented by Mr. Chia-Chen Wu on the APEC member economy Initiative on Forensic Wood Identification. He informed that machine vision, wood anatomy, mass spectrometry, and DNA analysis have been used for forensic analysis in this economy. He mentioned that machine vision was integrated with the wood image database, and wood anatomy has served to identify wood and bamboo. In contrast, mass spectroscopy is still used for investigating wood chemical compounds and DNA analysis has been intensely studied and applied, such as the development of DNA markers for controlling wood products importation from four species, such as *Cinnamomum kanehirae, Calocedrus formosana, Chamaecyparis formosensis,* and *Chamaecyparis obtusa var. formosana*. He also demanded less labor, real-time, and faster wood identification tools. He also recommended the approval of bilateral Economies cooperation on MTA materialization, regional standards development on DNA testing, and Xylaria networking development.

10. The Republic of the Philippines was represented by Mr. Glenn B. Estudillo on the APEC member economy Initiative on Forensic Wood Identification. He informed that wood anatomy is the current tool used for forensic timber identification, but DNA barcoding is demanded because of his accurate abilities for wood identification. His institution plays a pivotal role in wood identification, and different projects are still being proposed to improve capacity-building on wood identification. He also needed much support in terms of finance to upgrade the quality of laboratories and capacity- building. He also mentioned the number and list of traded timbers in the Republic of the Philippines, and the timbers are primarily from natural-growth forests, exotic trees, and imported timbers. He also welcomed MTA, regional standards, and Xylarium Networking for wood identification in Asia and the Pacific.

11. Canada was represented by Ms. Isabelle Duchesne on the APEC member economy Initiative on Forensic Wood Identification. She briefly introduced her research team, and the Canadian Wood Identification Project, composed of three institutions with deliverables on wood identification tools for enforcement officers and traceability tools. She mentioned that machine vision, wood anatomy, and mass spectrometry have been used for forensic timber identification in Canada. She informed that the NRCan-CFS Scientific Wood Collection has 2,000 species with 5,000 microscope slides and her institution was registered as a CITES-based scientific institution. She has harnessed wood anatomy using light and confocal microscopy, and chemical analysis for genus-level identification of *Dalbergia* sp. used for Costa Ricann guitar instruments. She also used chemical signature instruments, such as AccuTOF-DART 4G and GC/QToF-MS, for identifying high-value timbers and CITES-listed wood species. She also recommended complementary wood identification methods, such as wood anatomy, chemical signature tools, and genomics for forensic wood identification. She also informed some principal tree species traded, imported forest products, and sources of Canada forest products imports. She also welcomed the development of Xylaria networking and the MTA process.

12. Indonesia was represented by Mr. Iskandar Siregar Zulkarnaen on the APEC member economy Initiative on Forensic Wood Identification. He informed the team of his wood identification project and noted that machine vision, wood anatomy, mass spectrometry, near-infrared spectroscopy, stable isotope, population genetics, and DNA

fingerprinting had been utilized for timber identification. He informed the pilot project on developing a reference database of ebony using multi-analysis methods, such as genetics, anatomy, NIR spectroscopy, and mass spectrometry; on developing DNA barcoding of vascular plants; on tracing forensic tropical timber, and on developing the Indonesian-based wood identification program. He also stressed the demands on wood identification for law enforcement, customs, quarantine centers, and conservation centers. He informed that there are 173 traded timbers from nine categories. He agreed on developing MTA, regional standards, and Xylarium Networking on wood identification.

13. Viet Nam was represented by Mr. Le Xuan Phuong, as a nominated delegate from the APEC member economy. He informed that machine vision, wood anatomy, dendrochronology, mass spectrometry, near-infrared spectroscopy, stable isotope, radiocarbon, and DNA analysis have been used for forensic timber identification. He also informed relevant projects on wood identification that have been undertaken, but challenges are still faced in using forensic timber instruments. He concisely concluded that wood identification is demanded for timber legality and combating illegal logging. He also noted that there were 837 imported timber species. He supported the materialization of MTA and Xylaria Networking but considered the development of regional standards on wood identification.

14. Peoples' Republic of China was represented by Mr. Yafang Yin on the APEC member economy Initiative on Forensic Wood Identification. He opened his presentation by introducing the Global Trade Questions for Timber Legality, comprising the individualization, species, and geographic origin. He briefly listed timber forensic technologies used, such as wood anatomy, machine vision, mass spectrometry, near-infrared spectroscopy, stable isotopes, and DNA analysis. He also informed some applications of wood identification techniques, such as to support Chinese customs in the import inspection of *Pterocarpus erinaceus, Guibourtia demeusei, Dalbergia oliveri, Dalbergia cochinchnensis, etc*. He informed the atlas of traded timbers listed in the CITES official repository. He also explained MTA and regional standards developed in the world and Peoples' Republic of China. He lastly recommended the importance of international collaboration with relevant institutions in developing an integrated wood identification system.

15. Papua New Guinea was represented by Ms. Serena Marie Gideon on the APEC member economy Initiative on Forensic Wood Identification. She informed that wood anatomy is the most used for wood identification. She also explained that the Papua New Guinea Forest Research Institute's domestic herbarium houses over 200,000 reference collections of plant specimens. She informed the demands for wood identification technologies were to address the illegal timber trade, contribute to scientific research, and improve the accuracy of wood identification. She also provided information on the list of traded timbers, such as Alstonia, Amberci, Beech, Callophylum, Cedar, Gum, Kwila, etc. She also supported the actualization of MTA, regional standards on wood identification, and Xylaria Networking.

16. Australia was represented by Mr. Charlie Watkinson on the APEC member economy Initiative on Forensic Wood Identification. He introduced Source Certain and its technology, which offers origin verification with conclusive and verifiable information. He

also mentioned various technologies for forensic timber analysis, such as wood anatomy, machine vision, mass spectrometry, near-infrared spectroscopy, stable isotope, and DNA analysis. He provided a case study on forensic timber application for teak wood from the Solomon Islands and identified its elemental analytes for provenance verification. He clearly explained the demands on wood identification in identifying the legality of wood, misrepresentation of timber origin, and fraudulence of timber supply, eradicating the grey market of timber and providing more achievable traceability. He also stated that at least 150 taxa were identified as traded timber in Australia, which were sourced from domestic forestry and importation. He agreed on the development of MTA, regional standards on wood identification, and Xylarium Networking.

17. New Zealand was represented by Mr. Llyod Donaldson on the APEC member economy Initiative on Forensic Wood Identification. He said that wood anatomy is the most used wood identification technique. He also introduced Scion, providing consultancy services for various clients on wood identification. He also provided some applications of wood identification for Polynesian canoes and buried forests, repair of historic buildings, investigation of wood contamination in milk powder, and analysis of plant stems suspected of Cannabis. He also listed timber traded in New Zealand, stemming from New Zealand, Australian, and imported timber species. He also supported the concept of Xylarium Networking in the Asia-Pacific Region.

18. The results of the collected presentation materials were presented by Timber Data Development of Xylaria Networking in Asia and the Pacific Region for Enhancing Legal Timber Trade. He introduced the backdrop of the study, especially due to 15-30% of illegal timber traded globally. He informed methods used for the study, including literature review, survey, and workshop validation. He informed that wood identification studies increase annually, and most of the wood identification technologies used were wood anatomy, DNA barcoding, and mass spectrometry, machine vision, near-infrared spectroscopy, and population genetics. He also informed that the demands for wood identification for policy compliance, certificate compliance, customer awareness, etc. He also recapped the number and sources of traded timbers in APEC member economies and informed that most of the economies supported MTA, Xylaria Networking, and regional standards on wood identification.

19. An interactive discussion was guested by Mr. Anto Rimbawanto, Mr. Hisashi Abe, Mr. Llyod Donaldson, and Mr. Victor Decklerk. The interactive discussion deliberated about the mechanism for materializing MTA and developing regional standards on wood identification. From the discussions, there were several key takeaways, including:

- The need to develop an OpenMTA for wood identification.
- The need to exchange specific objects under MTA, and the most practical thing is a digital database.
- The demand to develop a baseline framework for regional standards on wood identification.
- The demand to develop the standards referring to the published works and not creating redundant and duplicate standards and
- Follow up the next actions to embody these two propositions, namely MTA and regional standards by SMART actions, such as mapping institutions for MTA

materialization, designing specific sampling methods for wood identification that are approved by the economies, and so forth.

5.2 Focus Discussion Group Results

The Focus Group Discussion on Developing an Integrated Wood Identification System through Xylaria Networking was conducted on 16 January 2024 virtually through the Zoom platform (Annex 10.2). The objectives of the Discussion were 1) to share and follow up on the results of the previous Discussion staged on 6-7 November 2023, 2) to discuss the possibility and mechanism of integrating selected wood identification technology into the Timber Legality Assurance System (TLAS), and other existing systems, and 3) to determine the best wood identification tool that can be harnessed globally in the future. Two outputs that can be withdrawn from the Discussion are the recommended global wood identification system and the proposed mechanism for wood identification integration. The agendas adopted in the Discussion pertained to three pivotal points, such as:

1. Responses on the results of the JRD and its research paper,
2. Economies' responses on the potential recommendations in integrating selected wood identification technology into the timber supply chain and TLAS,
3. Economies' responses on the possibility of integrating the identification with other systems, which have been implemented globally,
4. position paper from the Economies on the forensic timber readiness level, stakeholder mapping, and current implementation of forensic timber identification into their legal supply chain systems.

Representatives from sixteen APEC members, which included Australia; Brunei Darussalam; Canada; Chile; People’s Republic of China; Indonesia; Japan; Republic of Korea; Malaysia; New Zealand; Papua New Guinea; Peru; the Republic of the Philippines; Chinese Taipei; Thailand; and the United States, attended the Discussion. Below are the following presentations delivered by guest speakers and the APEC member economies representatives:

1. The Meeting noted the opening remarks from Ms. Meaghan Parker Forney, who represented the World Forest ID on the wood identification tools and practices in APEC member economies. She highlighted the summary results of the JRD Meeting held on 6-7 November 2023. She also underscored and explained in detail wood identification resources, that can aid the APEC member economies, including 1) the EGILAT's Compendium of Resources for Advancing the Trade and Distribution of Legally Harvested Forest Products, 2) the 2023 Updated Global Directory of Service Providers and Wood Identification Experts, 3) Global Timber Tracking Network published SOPs, and 4) the World Forest ID data and analysis pipeline.

2. The Meeting noted a presentation from Mr. Charlie Watkinson from Source Certain, Australia, on the Advantages or Disadvantages of Different Systems and a Summary of Identified Best Practices. He informed varied wood identification tools used for screening and forensic purposes, the terminology of illegal timber, and the solutions to tackle the burden. He underscored that different economies have different resources, priorities, and

available tools along the timber value chain. He also stressed the differences between screening and forensic wood identification in terms of border and in-market interventions and types of technologies. He advised that the use of wood identification technologies depends on the real products tested as reflected from the Australian timber imports from 2019 to 2022.

3. The Meeting noted a presentation from Ms. Soon Leong Lee, who represented Forest Research Institute Malaysia (FRIM), Malaysia. His presentation was about DNA Technologies for Timber Forensic and Their Challenges. He explained the means to identify plant species, geo-origins, and original stump using wood identification tools. He specified the use of genetic methods, such as DNA barcoding, phylogeography, and DNA profiling, for the identification of Malaysian timbers. He also informed some Malaysian initiatives related to genetic approaches, including DNA database, SOP, testing laboratory, and its application for relevant stakeholders. He also explained the challenges in using the techniques.

4. The Meeting noted a presentation from Ms. Melita Low from the University of Adelaide, Australia, on the Advantages or Disadvantages of Different Systems and a Summary of Identified Best Practices. She briefly explained the distinction between population genetics, DNA individualization, and DNA barcoding. She also elucidated the advantages of DNA technology, such as small sample used, multiple-level identification, highly reproducible, not reliant on experts, short time training needed, and its use for forensic. She provided examples of DNA technology used to address forestry crimes. She also highlighted the disadvantages of DNA technology, including expensive, time-consuming, physical sample requirement, difficulty in determining wild and plantation, and no standard used for barcoding markers. She also emphasized the best practices for DNA technology uses and their future directions.

5. The Meeting also noted a presentation from Mr. Chen Hin Keong, who represented TRAFFIC, on the Importance of Wood Collection and Mechanism of Xylaria Collaboration in the Asia-Pacific Region. He reflected on the previous results of the JRD on wood identification demands and traded timber in the APEC. He illustrated the works of TRAFFIC in promoting legal, sustainable, and safe timber trade, requiring solid policies and regulations. He highlighted timber smuggling analysis done by TRAFFIC, such as concealment and misdeclarations, that happen and enter at any point of the timber supply chain. He encouraged the participants to identify the actors responsible for addressing the illegal timber trade. He briefed on the background of timber traceability and chain of custody and the importance of wood species identification to capture revenue, tackle fraudulent activities and illegal logging, and support domestic legislation.

6. The Meeting noted a presentation from Mr. Tetra Yanuardi, representing the International Tropical Timber Organization (ITTO), Japan on the Sustainable Pathway of Traded Tropical Timber in APEC member economies. He briefly explained the ITTO's mission, lines of action, policy work on SFM in the tropics, and pilot program lines. He introduced the ITTO Legal & Sustainable Supply Chains (SSC) with the purpose of achieving legal and sustainable tropical timber supply and value chain and enhancing the capabilities of the supply chain. He presented the Timber Tracking initiative with three

types, mass balance or inventory management, physical identification method, and chemical identification method, developed to respond to the domestic legislation on legal-sourced timber. He explained concisely the recent timber identification projects and the updated timber market and situation. He showcased the platforms on the ITTO's Global Green Supply Chains and ITTO-ETTF Timber Trade Portal. He concluded his presentation by contributing to trading tropical timber on sustainability and economic aspects.

7. The Meeting also noted a presentation from Mr. Yong Haur Tay, who represented Xylorix, Malaysia. He presented the Xylorix Wood Identification Platform. He familiarized the participants with Xylorix and its use for bridging experts and enforcement officers, and the simple use of the apps via Cut, Snap, and ID. He attested that the app can empower enforcement officers anytime and anywhere and can be used as an early warning tool, providing immediate solutions at levels 2, 3, and 4. He also informed that Xylorix has a feature of an enforcer tool suite for the enforcement team and designated users, with a web-based dashboard and customizable features. He also said that the app has been used for global adoption with some partners, such as the US Forest Service, Traffic, Norad, Forestry Commission, etc.

8. The Meeting also noted a presentation from Mr. Sigit Pramono, who formerly served the Ministry of Environment and Forestry, Indonesia on the development and implementation of Indonesian TLAS (the SVLK) and processes towards FLEGT VPA with partners. He presented the Integration of Wood Species Identification into the Timber Legality Assurance System (SVL). He recounted the chronicle of SVLK development and implementation since 2003 and review of the SVLK regulations. He illustrated the SVLK implementation along the supply chains from upstream in the forests to downstream in the processing industries and markets, including those related to implementation of wood identification. He further highlighted information on the wood species identification stipulated in the relevant SVLK regulations, as well as references on wood species identification in Indonesia, including development of Xylarium Bogoriense and automatic wood identification system, the AIKO. He furthermore provided information on potential use of instruments such as the AIKO. He concluded his presentation by providing some notes on challenges, and recommendations with the emphasize on the need for improving capacity of operators, the importance of integration of wood identification system into TLAS implementation, as well as the significance for strengthening collaboration on database collection wood identification system to support traceability of timber products from legal and sustainable sources.

9. The Meeting noted a presentation from Ms. Dewi Tresya from UNODC Indonesia. Her presentation is entitled Timber Identification to Combat Illegal Logging and Timber Trafficking. She informed the illegal logging occurrence and the UNODC response by issuing the Best Practice Guide for Forensic Timber Identification and the UNODC-WCO-Container Control Programme. She highlighted the main problems timbers traded in the containers and the offenses taken in the timber trade. He introduced the UNODC's new initiative on wood identification, namely, Portable Enforcement Laboratory Testing

Service, intending to address illegal wildlife and fish. It is still in the research and testing phase.

10. The Meeting noted the presentation from the United States, represented by Mr. Eric Rosenfield. He informed that wood identification has been applied and is expected to be implemented at the export/import stage of the timber supply chain. The United States proposed the engagement of the small private sector in integrating wood identification tools into TLAS. The United States also faces obstacles in accessing and acquiring enough reference samples from the origin economy and analyzing samples with limited time. Most of the readiness level of this economy's forensic timber implementation is at extensive implementation.

11. The Meeting noted Chile's presentation delivered by Mr. Jorge Gonzales. Chile has applied wood identification in logging permits, harvesting, and transportation levels in the timber supply chain. Chile agreed to integrate wood identification tools along the TLAS to increase transparency, and it required updated legislation, strengthened institutions, certification programs, and awareness campaigns. The readiness level of forensic timber in this economy was mainly at the level of research, although capacity-building and education were at the piloting level.

12. The Meeting noted a presentation from People’s Republic of China, Mr. Yafang Yin. He informed that wood identification technologies have been applied in the transportation, processing, export/import, and sale steps of the timber supply chain. The Chinese representatives agreed on the integration of wood identification into the TLAS by establishing appropriate cooperation mechanisms among Economies. Forensic timber's readiness level for People’s Republic of China was dominantly at the extensive implementation level.

13. The Meeting noted a presentation from the Republic of Korea, Ms. Ahn Jiyoung. She informed that wood identification had been applied at the logging permits and the sale stages of the timber supply chain. She noted that this economy required careful consideration to use wood identification in the timber assurance system, depending on the legal framework, complexity, and transparency of the timber supply chain. She also highlighted that this economy's readiness level for forensic timber application was dominantly at the level of research, although some of the parameters were at piloting and extensive implementation.

14. The Meeting noted a presentation from Mr. Chia-Chen Wu, a representative from Chinese Taipei. The Chinese Taipei has applied wood identification at the level of logging permits, harvesting, transportation, and export/import of the timber supply chain. This economy agreed to use wood identification into the TLAS through legal and institutional framework and awareness raising. The readiness level of this economy in forensic timber implementation was at the level of research.

15. The Meeting noted a presentation from the Republic of the Philippines representative, Mr. Glenn B. Estudillo. He stressed that the Republic of the Philippines has applied wood identification at the level of harvesting, transportation, processing, export/import, and sale stages. This economy agreed on the application of wood

identification along the timber supply chain. In the implementation of wood identification into TLAS, laws and policies were required to be enacted. Most of the Philippines' readiness level for implementing forensic timber was at the level of research.

16. The Meeting noted a presentation from Indonesian representative, Mr. Secunda D. Santoso. He presented that wood identification has been mainstreamed into logging permits, harvesting, transportation, processing, and export/import phases of the TLAS. This economy agrees that wood identification should be integrated with TLAS as a supporting tool and that its nature is voluntary. However, in terms of the readiness level of forensic timber application, this economy was still at the level of no consideration for financing, capacity-building, standardized tools integration, experts and policies availability, and at the level of research for its tools, standards, and database.

17. The Meeting noted a presentation from Ms. Sami Fattah from Australia. She informed that Australia has not yet adopted wood identification use in the TLAS, but has expected to be applied at the processing and export/import level. This economy agreed to incorporate wood identification into TLAS for verifying due diligence claims, effectively monitoring/enforcing compliance, and helping private industry assess risks through their supply chain and meet TLAS requirements. Most of their readiness level was at the piloting stage for forensic timber implementation.

18. The Meeting noted a presentation from the Canada representative, Ms. Maude Couture Naud. She highlighted that wood identification had been applied in logging permits, harvesting, transportation, and processing levels of the export TLAS. This economy agreed on the proposal to integrate wood identification into TLAS, and this economy established its assurance system in the export system and to a lesser extent in the import system. In terms of forensic timber implementation, this economy had a readiness level at the research and piloting stage, dominantly.

19. The Meeting noted a presentation from Thailand by Mr. Montri Intasen. He informed that this economy has applied wood identification in the TLAS and agreed to apply the wood identification system at some parts of the TLAS. This economy proposes the importance of raising awareness, information sharing, and responsible agencies' determination in integrating wood identification into TLAS. This economy's readiness level for forensic timber implementation was mainly at the level of research and piloting.

20. The Meeting noted a presentation from Brunei Darussalam, delivered by Mr. Muhammad Azinuddin bin Baharin. He informed that Brunei Darussalam had applied a wood identification system at the level of logging permits, harvesting, transportation, and import/export through physical inspection only. This economy agreed on the integration of wood identification into TLAS through a certification system and monitoring and tracking system. This economy also provided information on the readiness level for forensic timber application, and the results showed that this economy had dominantly no consideration for the availability of laboratories, technologies, experts, policies, guidelines, and finance.

21. The Meeting noted the quick poll conducted for the APEC member economies on the readiness level of forensic timber implementation and the wood identification integrated into the TLAS. The readiness level surveyed included the availability of

laboratories, technologies, experts, financing mechanisms, database references, regulations, and standardized guidelines or protocols.

5.3 Bogor Workshop Results

The third activity undertaken by the Project is the organization of the Bogor Workshop on Wood Identification Techniques. The Workshop was conducted from 23 to 25 April 2024 in Bogor, West Java, Indonesia, attended by more than 93 participants from fourteen APEC member economies and varied institutions. The member economies attended the Workshop included Australia; Canada; Chile; People's Republic of China; Indonesia; Japan; Republic of Korea; Malaysia; Papua New Guinea; the Republic of the Philippines; the Russian Federation; Chinese Taipei; Thailand; the United States; and Viet Nam. Annex 10.3 shows the documentation of the Bogor Workshop activities.

The Workshop aimed to provide wood identification training and capacity-building enhancement for officials, customs, industries, and international organizations; and equip them with skills in utilizing wood identification technologies conveyed by wood identification experts. The agendas deliberated in the Workshop included 1) wood identification training for government officers and industries from APEC member economies and 2) education on various wood identification delivered by experts.

The Workshop provided several capacity-building exercises using different wood identification tools, such as machine vision, wood anatomy, NIR, mass spectrometry, DNA analysis, stable isotope, and radiocarbon. Besides practices on wood identification technologies, set theories were also given to the participants. The participants were also welcomed to visit some sites designated for assisting in the operationalization of forensic timber identification in Indonesia, such as Bogor's Botanical Garden, Xylarium Bogoriense, and the Advanced Research Laboratory of Bogor Agricultural University. The trainers were from various institutions with different expertise in these technologies. Below are the results of the Workshop:

1. The Meeting also reported the welcoming remarks from Dr. Krisdianto, Director of Forest Product Processing and Marketing Development, Ministry of Environment and Forestry, Republic of Indonesia. He welcomed the participants to Bogor City, which was famous for its rainy city, and he briefly introduced the city to some historical and tourist attractions. He also welcomed them to the Bogor Workshop on Wood Identification Technologies, which would be conducted in three consecutive days. He also introduced the Bogor Workshop to educate the timber supply chain actors on wood identification technologies and enhance their skills in identifying illegally traded wood and its derived products. He also highlighted that this capacity-building promoted various wood identification technologies, such as wood anatomy, spectroscopy, machine vision, stable isotope, and DNA-based approaches for officials, customs officers, researchers, and other private sectors. He briefly explained the previous events, such as the Joint Research Discussion and Focus Group Discussion, which were successfully conducted to produce a research paper. He encouraged strengthening cooperation to address illegal logging and illicit timber trade in APEC. He finally expressed appreciation to Indonesia, other APEC economies, and the APEC Secretariat, and he expected a fruitful discussion

in the Bogor Workshop. At the end of his remarks, he closed with funny and joyful Indonesian poems or pantun.

2. The Meeting noted the opening remarks from Dr. Ir. Agus Justianto, M.Sc, the Director General of Sustainable Forest Management, Ministry of Environment and Forestry, Indonesia. He welcomed and appreciated all the delegates' attendance from the APEC EGILAT to the Bogor Workshop, both online and offline. He shortly introduced the Bogor Workshop and its objective and thanked the APEC economies and sponsoring economies for the Project. He also informed us of the successful events: the Joint Research Discussion and Focus Discussion Group. He also highlighted that the Bogor Workshop would be conducted in the next three days as a follow-up to these events, and the Bogor Workshop would harness different theories and practices on the use of wood identification techniques, which would be taught to researchers, academicians, forestry officials, customs officials, industrial representatives, and others. He also noted that the Bogor Workshop could provide opportunities and benefits for the participants. He acknowledged the presence of all wood identification experts for their time to participate in the Bogor Workshop. He finally anticipated the fruitful discussions of the Bogor Workshop and opened the Bogor Workshop.

Workshop Day I on Wood Identification Theories and Practices, 23 April 2024

3. The Meeting noted the presentations from Prof. Dr. Ratih Damayanti, the Project Overseer of APEC EGILAT 02 2022A. She concisely presented the progress report for the Project on which her presentation was embarked, introducing the project rationale, objectives, interventions, outputs, and outcomes. She showcased the successful interventions and the status of the Project's deliverables. She notified us that two previous online events were staged, including the Joint Research Discussions on 6-7 November 2024 and the Focus Group Discussion on 16 January 2024, and she was delighted to announce that the Bogor Workshop as the final intervention is now being executed. She also introduced the status of deliverables, in which a research paper and agreement documents supporting the application of forensic wood were successfully produced. She affirmed that the Project was successful in engaging other relevant domestic and international organizations. In her last statement, she introduced the project team members and said that future collaboration was expected to sustain the project implementation. After her presentation, a video of the Xylarium Bogoriense was showcased. It is noted that the Xylarium established in 1915 is the largest Xylarium in the world collecting 192,395 wood samples.

4. The Meeting noted a presentation from Achmad Solikhin, an APEC EGILAT 02 2022A consultant. He explained the project research results of the Development of Integrated Timber Data for Enhancing Legal Timber Trade in the Asia-Pacific Region, which were obtained from the Joint Research Discussion and Focus Discussion Group. He outlined the background, objectives, and method of the study. He underscored that wood identification studies have been increasingly performed in APEC, and the most applied forensic timber technologies include machine vision, wood anatomy, stable isotope, dendrochronology, spectroscopy, mass spectrometry, radiocarbon, DNA

fingerprinting, DNA barcoding, population genetics and phylogeography. He also stated that each APEC member economy has a different demand for the use of forensic timber and informed that the readiness level of forensic timber is dominant at the research stage, with an increased interest in piloting and extensive implementation. He also highlighted a list of priority commercially traded timber species, and explained the importance of agreement documents (MOU, LOA, or LOI, POO, and MTA) to facilitate the development of Xylaria Networking. He stressed that to date, eight institutions in APEC member economies have been interested in realizing the actualization of these agreement documents. He informed some issues that were demanded to be harnessed for the development of Regional Standards, and the current state of forensic wood identification at the timber legality systems of APEC members. At the end of his presentation, he mentioned several recommendations from the Project study that APEC EGILAT could use for their policy considerations.

5. The Meeting noted a presentation by Prof. Yafang Yin, who represented the Chinese Academy of Forestry, People's Republic of China. His presentation was on the importance of wood identification to support legal timber trade and available methods/technologies/tools. He provided a short background on the importance of wood identification to address illegal logging, excessive logging, and trading in illegal timber among APEC members. He updated on the CITES-listed wood species and international/regional constitutions on timber trade, including CITES, Chinese Regulations, the Lacey Act, the Illegal Logging Prohibition Act, the EU Deforestation-free Regulation, and the Clean Wood Act. He provided global questions on timber legality for the identification of individualization, species, and geographic origin. He emphasized three wood identification technologies available, i.e.machine vision, genetics, and chemicals. He informed the principles of wood anatomy and its works for identification, including wood xylarium, experienced experts, inspection tools, standardization of testing, and specialized references. He also stressed the benefits of wood anatomy for simple and complicated identification of wood, starting from physical and chemical nature (color, odor, fluorescence), macro- and microstructure (softwood and hardwood differences, cell elements), and software-based wood anatomy (CITESwoodID). He introduced the genetic method, featured with plastid/nuclear genome level, high-resolution marker, big-data/genome, and higher cost and consuming time. He also informed some institutions working with the method, such as the University of Adelaide, Thunen Forest Genetic Research Institute, and Forest Research Institute Malaysia. He, at the last presentation, provided some examples of computer vision, such as Xylotron of the United States, iWood of People's Republic of China, and Image Acquisition IBAMA of Brazil; and detailed the use of chemical fingerprints for wood identification, such as by using mass spectrometry, NIR, and stable isotope. He recommended integrating these methods, using big data/database level, and close collaborating with other international forums.

6. The meeting noted a presentation by Prof. Jugo Illic from the University of Melbourne on Wood Identification. He presented the reasons for wood identification, including CITES and illegal trading, curiosity, processing problems, disputes between suppliers and customers, and timber alternatives. He stated several processes for wood identification, such as non-anatomy, anatomy, macroscopic, and microscopic

examination. He also provided several steps for conducting wood identification, including reference collection, observation, recognition of features, keying out, and comparison with authentic material. He detailed information about non-anatomical features, including some properties of wood color, density, fluorescence (UV fluorescence), and chemical tests (Chrome azurol-S test). He also informed the participants about the wood anatomy test, covering the analysis of rays, vessels (pores), axial parenchyma, cell inclusions, secretory elements, and geographical distribution. In this part, the practical sessions led by Prof. Yafang Yin and Prof. Jugo Illic with the assistance of Ms. Siti Holisoh was conducted. In this practice, the participants learned how to identify wood species using the wood anatomy method for macroscopic and microscopic procedures. He engaged the participants interactively to try identifying macroscopic structures of wood samples provided by BRIN using a loop. In keying out the wood samples, he provided two types of methods, such as archaic methods (dichotomous lists and card keys) and computer programs (InsideWood and AI machine learning). He also informed that in the comparison phase, the identification is advised to reduce possibilities, look for similarities and or differences, compare unknowns with authentics, and decide which fits best. At his last presentation, he provided some relevant published knowledge products on timber properties and identification and provided a means to make sections for microscopy.

7. The Meeting noted a presentation by Prof. Yafang Yin and Mr. Zhiping Ding on machine learning development in People's Republic of China for wood identification. Mr. Zhiping Ding said that traditional wood identification could identify genus levels but it is time-consuming, high costs, demands human experiences, and lacks wood anatomists. He introduced People's Republic of China's new portable intelligent machine vision technology for wood identification, namely Wood AI developed by the Zhangjiagang Customs. He elaborated on the technology app, which consists of a toolset, mobile app, and web platform; and provided the information on how to use it, including sanding, snapping, and identifying. he explained the advantages of the apps, such as having a portable lens, equivalent to microscope magnification and high definition, small size and long battery life, suitable for most mobile phones, abundant training images, used in more than 20 ports, and 2,000 tests with 80% accuracy. The next presentation on the iWood App was brought by Prof. Yafang Yin. He informed about the founding of the Chinese Academy of Forestry on iWood Apps with several benefits, such as a large number of images, rapid development of AI, interdisciplinary integration, and economy-level and international-level collaboration. He also informed us that iWood consisted of fusion and visualization, having varied models, such as fool-proofing, multi-model fusion, feature saliency analysis, and multi-sample fusion. The iWood mobile could identify more than 100 common trade species, high accuracy of above 99.3%, a recognition time of below 3 sec, be an easy-to-use device, and apply to multiple scenarios.

8. The Meeting noted a theoretical explanation and practice from Prof. Dr. Yong Haur Tay on the Implementation of Xylorix for Wood Identification. He introduced the Xylorix app, which is used by government and customs agencies as an immediate action to address deforestation and illegal logging. He also informed that the World's Forests in peril with the presence of unsustainable deforestation and illegal logging exacerbated by climate change, loss of biodiversity, and loss of resources. He stressed

that the Xylorix apps are a powerful state-of-the-art technology on hand and easy to use, providing solutions at varying levels of accessibility that tackle challenges faced by agencies. He explained that Xylorix has five wood identification technology empowerment levels: level 0. no tools or references provided, level 1. physical reference, level 2. digital references, level 3. online and interactive system, and level 4. artificial intelligence. He provided practical means of using the app, such as making a clean cut of wood, snapping a picture, and returning the ID results. He also offered future partnering and collaborations to leverage each involved party's expertise, knowledge, and outreach to achieve the best-tailored solution for the end user. At the end of his presentation, he provided some success stories of using the app by other agencies in other economies. He also requested the participants to take roles in fighting illegal logging and timber trade through collective endeavors from various parties and stakeholders, by adopting practical technology.

9. The Meeting noted a presentation by Dr. Melita Low from the University of Adelaide on DNA for Wood Identification. She briefly introduced her biography and provided differentiation among DNA-based approaches, such as DNA barcoding, DNA individualization, and population genetics to profile species, stump, region/population/concession. She explained the advantages of DNA, such as small quantities of materials used, highly reproducible results, not relying on expert opinion, staff can be trained in a relatively short timeframe, and DNA identification established forensic method. Genetic variation, discriminatory DNA markers, DNA quality and quantity, and a reference database are needed to identify wood using DNA successfully. She also described the obtainment of DNA from mitochondrial DNA, chloroplast (plastid) DNA, and nuclear DNA, with four nucleotide bases, namely adenine, thymine, cytosine, and guanine. She explained genetic variation among species and populations and the geographical structuring of genetic variation. She emphasized the importance of having discriminatory DNA markers for acquiring promising genes, ddRAD sequencing, targeted sequencing, and whole genome sequencing. She also emphasized the parts of wood used for extracting DNA and utilizing the reference database from various sources. At the end of her presentation, she reported several cases using DNA to identify illegal logging and anticipated future directions in DNA development by infiltrating a multidisciplinary approach and collaborative approach.

10. The Meeting noted a presentation by Dr. Lee Hong Tnah from the Forest Research Institute Malaysia. Her presentation was entitled SOP of Forensic DNA Testing on Plan Species and Wood Tracking. She informed that illegal harvesting of wood threatened the sustainability of the forest ecosystem, and to address the issues; timber tracking identification tools can be used. She informed me that since 2007, his institution had developed a DNA profiling and barcoding database and successfully developed a DNA-based timber tracking system for important timber in Malaysia. She also informed us that DNA-based solutions for wood tracking can be done through DNA extraction, DNA barcoding, phylogeography, and DNA profiling. Her institution has also successfully created a DNA Database Management System consisting of four main modules: MyDNA, MyMARKER, MyBARCODE, and MyTRACK. His institution also has a forensic testing laboratory accredited by ISO/IEC 17025, with a scope of testing on 1) identification and authentication of plant species with DNA barcodes and 2) wood tracking with forensic

DNA. Lastly, her institution also developed an SOP on the timber tracking system to provide forensic evidence for the conviction of illegal loggers under Section 15, National Forestry Act 1984 (amended 1993), and for timber certification to meet international regulations. The SOP consisted of four chapters, including sample collection in the field, DNA isolation and purification from cambium & wood, DNA sequencing for species and population identification, and short tandem repeat (STR) genotyping for population and individual identification. She also provided information on the forensic timber application for enforcement, plantation industries, food industries, and insurance industries.

Workshop Day II on Wood Identification Practices, 23 April 2024

11. On the second day of the Bogor Workshop, the Meeting was moderated by Dr. Serena Marie Gideon from the Papua New Guinea Forest Research Institute. The second day of the Workshop focused on sharing best practices for the implementation of wood identification systems in APEC member economies, including Canada; Peoples' Republic of China; Papua New Guinea; and Viet Nam. In addition, other wood identification techniques, such as stable isotope, radiocarbon, NIR, DART-TOFMS, and Xylotron were also presented.

12. The Meeting reported the best practices on forensic wood identification in Canada shared by Dr. Isabelle Duchesne from the Canadian Forest Service. She informed about exotic timber control in Canada conducted by the Canada Border Services Agency (CBSA), Canadian Food Inspection Agency (CFIA), Environment and Climate Change Canada (ECCC), and Wildlife Enforcement Directorate (WED). Under the Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act, some criteria of wild animal and plant species are considered important in the legislation, such as exported illegally from the wild in other economies, CITES, transport into or out of a province or administered area, and harmful to indigenous species. She also informed the ECCC legislations enacted related to timber, especially import and export, which are in contravention of any law of any foreign state and without the proper permits; detention under inspection power; and seizure. She informed that there were many ways to find illegal timber shipments in Canada, such as referral from CBSA, international trade, complaints, targeting, and ECCC intel division analysis. She updated the wood identification guide for frontline officers and its technologies used, including UV light on wood, chemical and physical features, and end grain. She informed that there is a wood identification process sheet as stipulated in the Guide, consisting of economy of origin, species, color, odor, UV light on wood, ethanol test, Xylotron identification test, end grain, and ethanol test. She showcased the Canadian Forensic Laboratory for Wood Identification at the Pacific and Yukon Laboratory for Environmental Testing, providing legal analysis and standardized biological and chemical methods. She informed that wood identification technologies are used for timber identification, such as chemical signature (AccuTOF-DART) wood anatomy, and InsideWood. In partnership with the Canadian Forest Service, ECCC, and CBSA; they provided tools for enforcement officers to prevent imports of illegal wood and traceability tools for forest certification for market access. A study using GCxGC-TOFMS complemented with wood anatomy, DART-TOFMS, and

genomics was conducted under the CFS Wood Identification Research Project. She wrapped up the presentation by providing remarks on the collection of reference samples of North American species, the use of reference samples from existing Xylaria, and the optimization/standardization of scientific protocol.

13. The Meeting continued with a presentation by Prof. Yafang Yin from the Chinese Academy of Forestry on the Implementation of Wood Identification System in People's Republic of China. He showed the wood collection at the Chinese Academy of Forestry developed in 1928, with 9,600 species and 40,000 specimens. He informed that People's Republic of China has 20 wood collections with more than 230,000 wood specimens in some universities, institutes, and so forth. He also stated that there are 12 CITES forensic laboratories around the world and currently wood laboratory of the Chinese Academy of Forestry is the only one in People's Republic of China. In People's Republic of China, wood anatomy, machine vision, mass spectrometry, near-infrared spectroscopy, and DNA barcoding have been used, whereas dendrochronology, stable isotope, radiocarbon, and DNA fingerprinting have not yet been used. AI-based computer vision was introduced in People's Republic of China with the names iWood System and Wood AI System. DART-MS, GC-MS, and stable isotopes are commonly used for chemical fingerprinting in People's Republic of China whereas genomics was well developed for DNA barcoding method and stable extraction protocol. He provided information on the Atlas of Traded Timber in People's Republic of China, deposited in the CITES official repository, and on the Chinese standards for wood identification. He informed the participants of the examples of wood identification applications (computer vision and DNA barcoding), which addressed the issues of illegal timber trade in Peoples' Republic of China through criminal case solving and training courses. The Genetics method was also used to solve the mystery of Nanmu wood in the Forbidden City and wood cargo of logs submerged at 1500 meters depth undersea. Lastly, he recommended the importance of reconciliation of various methods of wood identification with keeping wood anatomy as one of the main methods and the use of informatics methodology.

14. The Meeting noted a presentation on the ITTO's responses to emerging timber market requirements, which Dr. Tetra Yanuariadi from the International Tropical Timber Organization delivered. He emphasized the importance of tropical forests for planetary wellbeing, supporting sustainable management of tropical forests, and noted that the continued deforestation in the tropics due to land use issues, market failure, illegal logging, and climate change. He underscored the benefits of sustainable tropical forestry for capturing 13 billion tonnes of carbon and its interlink with the goals of SDGs. He explained the trends in tropical timber production and consumption and trade from the 2000s to 2023, with some major economic shock effects (financial and economic crisis, COVID-19 pandemic, and ongoing global conflicts). He updated the tropical roundwood production, tropical sawn wood production, tropical plywood production, secondary processed wood products, and their international trade. He stressed three important factors affecting market developments of tropical timber and timber products, such as economic trends, building and construction indicators, and market policy trends and access. With the above background, he introduced the ITTO's mission for sustainable management and conservation, and expansion and diversification of trade; and noted that ITTO is the sole

IGO focusing on tropical forest resources with 76 members. ITTO always continues updating timber markets through Annual Market Discussions, Global Legal and Sustainable Timber Forums, and the ITTO's Tropical Timber Market Reports. He updated shortly about the Regulation on Deforestation Free Products (EUDR), which will replace fully EUTR and was applied from 29 June 2023 for all wood harvested. He also noted that the EUDR will harness satellite images, official documents, certification, and own audits to address deforestation and forest degradation; and with EUDR, producers must be equipped with some information/evidence related to legally harvested wood, non-originating from deforestation and forest degradation plot, geo-coordinates, date and time range of harvest, products specification, and additional information and risk mitigation measures. He informed also that with the EUDR, there would be several consequences of non-compliance, such as customs will not allow import if no geo-coordinates information, companies could be sued by authorities if no legality of the imported wood, false information could cause a serious problem, blacklisting of companies violating the regulation, high level of penalties (4% of turnover), environmental NGOs would make critical interventions and exclusion from public procurement and seizure of products. At his last presentation, he informed that the EUDR is pivotal in boosting the collection and forwarding the necessary proof of wood legality and free deforestation, providing sufficient information for importing wood and its products, and excelling forestry enterprises and relevant institutions with some technologies that could provide evidence for fulfilling the compliance.

15. The Meeting noted a presentation by Dr. Paul Marai from the Papua New Guinea Forest Research Institute on the implementation of wood identification in Papua New Guinea. He described Papua New Guinea, which is rich with 3,000 tree species and less than 200 designated commercial timber. He also informed the importance of forest resource management, especially in log export monitoring and control processes, conducted by the PNG Government and with the Société Générale de Surveillance (SGS) (PNG) Limited. He informed the importance of surveillance services in decreasing significantly the log export discrepancies. He also noted that over the past six years, a dramatic increase in logging happened, and the solution was the establishment of the PNG Timber Legality Standard gazetted in 2023 to ensure legal and sustainable forest management. He emphasized the pivot of accurate identification for ensuring sustainability, legality, and integrity in the use and conservation of wood resources. In the presentation, he explained the historical methods of wood identification, which mostly used botanical species identification featuring morphological characteristics of wood, the challenges of the implementation of systematic wood identification due to species lumping, and the need for a standardized and reliable wood identification system. He notified that PNG is currently developing and implementing the wood identification system through several phases, such as research and planning, design, and implementation. He provided some explanations about the benefits, impacts, and challenges of implementing a wood identification system in PNG. The benefits included a) improved accuracy and efficiency in wood identification, b) enhanced traceability, c) supporting sustainable forest management, and d) increased economic benefits whereas the challenges comprised 1) financial and resource limitations, 2) technical challenges, 3) resistance to change and

adoption, and lack of strategies for maintenance of the system. Lastly, he provided notable breakthroughs through promoting forest law compliance (PNG Timber Legality System, economy-specific guideline, FSC, photomicrograph ATLAS) and the development of initiatives or projects supporting forest law compliance; as well as demanded future directions in expanding the wood identification system to other sectors in PNG, integrating the system with international timber tracking and certification, and conducting research and its development.

16. The Meeting noted a presentation by Dr. Hisashi Abe from the Forestry and Forest Products Research Institute, Japan. His presentation document was entitled Utilizing NIR Light for the Non-Destructive Identification of Wood Species. He briefly mentioned several wood identification technologies and introduced NIR technology, specifically applying statistical analysis of absorbance and non-destructive analysis. He informed us that wood could be identified with NIR due to varied absorption spectra depending on the chemical composition; it needs several steps to use the application, such as establishing models (spectra acquisition, statistical analysis, and verification) and applying them to the field. He reported that his institution has Xylarium and database of wood samples from about 30,000 individual trees of 8,000 species which was later used to establish NIR analysis models. His institution has harnessed three different types of NIR devices: Bruker Optics, Kubota, and Shimazu. He also provided some cases of wood identification in wood specimens and wooden statues about 1000 years old. He reported that softwood statues are more accurately classified into the softwood than hardwood statues into hardwood. He resumed that for applying NIR to wood identification, selection of devices was advised for the analysis, with a demand of identification of wood species. Lastly, he emphasized the importance of wood identification to provide appropriate labelling and an accurate identification system, for promoting appropriate wood product declarations.

17. The Meeting continued with the presentation by Prof. Lina Karlinasari from Bogor Agricultural University on the Discrimination and Determination of Extractive Content of Ebony from Celebes Island by NIR. She briefly reintroduced NIR and its advantages and disadvantages. She informed us that NIR has been used to predict wood properties with a level of identification at species, and to date, NIR species identification reference data has yet to be lacking (94%). She introduced the use of NIR for the ITTO-CITES Project on Mahogany wood monitoring and provided an example of NIR use for Ebony wood identification. Using multivariate data analysis, she used NIR to identify Ebony wood from different locations in Indonesia. In her concluded presentation, she informed that sawdust samples could be used for extractive content's NIR spectral analysis, PCA-DA was successfully used to differentiate the NIR spectrum based on the growth of Ebony, samples from West Sulawesi had different trends compared with other parts of Sulawesi; and NIR had the potential to differentiate the origin of wood as well as wood properties.

18. The Meeting noted a presentation from Viet Nam on the application of wood identification (DART-TOFMS). Prof. Dr. Nguyen Tu Kim delivered the presentation from the Vietnamese Academy of Forest Sciences. He showed data on wood export in Viet Nam with an increasing trend in quantity, value, and supplying economy, and most of the imported logs and sawn timber were not from positive economies having free illegal logging. He also informed that Viet Nam has committed to removing illegal timber

throughout the timber supply chain and established the Viet Nam Timber Legality Assurance System under Decree 102/2020/ND-CP. He stated that imported timber had risks associated with customs risk assessment and wood species and origin. He detailed the profiling risks in wood species and geographic origin based on the Viet Nam Timber Legality Assurance. He presented the wood identification technologies that have been used in this economy, such as wood anatomy, DNA, isotope, DART-TOFMS, NIR, and machine vision. He informed that in 2023, Viet Nam, in partnership with the US Forest Service, established the Viet Nam Wood Identification and Screening Center with a main wood identification tool of DART-TOFMS. He also introduced DART-TOFMS and its chemical finger, which was used for timber tracking. He highlighted the use of wood anatomical analysis for cross-checking in some cases, DNA accommodating 85 timber species, and machine vision of I.D.Wood. Lastly, he identified some priorities and opportunities for tackling illegal wood in Viet Nam and APEC, including specimen sharing, capacity-building, and application of advanced wood identification technologies.

19. The Meeting noted a presentation from Dr. Victor Decklerk from World Forest ID on Global standards in collecting timber species and origin verification. He informed the participants about the World Forest ID guide on collecting samples, analyzing them, and interpreting and modeling the results. He noted several samples used for testing, such as wood, soy, cocoa, oil palm, and coffee. He provided specifications of samples used for origin verification, sizes, parts of wood (heartwood or sapwood), parts of trees (sawdust, leaf, seeds, etc.), wood types, and sample types (core samples, verification samples, and sawn block samples). He continued with the mechanisms to perform navigation, selecting trees, marking cores, sampling with the increment borers, sampling with core drills, sampling for sawn blocks, collecting leaves, verifying samples, packaging, and labeling processes. He introduced the World Forest ID App and the ways to use it for observing collected samples and or developing a sample database. He continued with a procedure for completing the proforma, where all samples must be sealed in the bag and from the same tree. Different drying processes are used for sample collection, such as using silica, sun drying, controlled ember drying, dehydrator and oven drying, and air drying, with keeping controlling the moisture levels. He underscored that Wood ID consisted of species and location ID as a result of the verification and determination process. In terms of location ID, the process requires classification and spatial sampling. He briefly explained the Eastern European Timber Supply Chain Project to create reference material, pilot data modeling, and layering of techniques to increase the accuracy of tools to determine the geolocation of harvest. He benefited from creating Gaussian element landscapes for spatial propositions, and through the Project data, several forestry crimes were addressed.

20. The Meeting proceeded with a presentation by Prof. Dr Akira Kagawa from the Forestry and Forest Products Research Institute, Japan. His presentation was about the Use of Tree-Ring Isotopes in Wood Forensics. He explained the importance of geographic origin determination in decreasing forest cover and the provenance of timber and noted that microscopic wood species are the cheapest way to estimate geographic origin. He questioned the participants on their ability to prove wood without using tree rings, and responded that oxygen and carbon isotope ratios were the most effective fingerprints for estimating timber geographic origin. He also informed that every timber had the isotropic

fingerprint characteristics of its geographic origin. He showed several studies on dendroprovenancing using ring-width chronologies and stable isotopes and reported that stable isotopes showed higher coherence than ring widths. He also explained how to prepare samples for isotope analysis and methods for provenancing, such as the climate correlation method and tree-tree correlation. He stated that oxygen and hydrogen isotopes are effective in provenancing timber from humid regions, and automating isotope analysis of tree rings at high resolution will be important for provenancing tropical species. At the end of his presentation, he provided a simple and efficient wood sampling method using smart socket system.

21. The Meeting continued with the presentation by Prof. Alex Wiedenhoeft and Prof. Jorge Rafael E. Arevalo from the Center for Wood Anatomy Research in the United States. Dr. Arevalo introduced the Forest Products Laboratory, which had a Center for Wood Anatomy Research. In the Center, the Xylarium should have a scientific wood reference collection consisting of standard specimens, correctly identified and properly labelled, digital databases, and geo-referenced wood reference collections supported by herbarium vouchers. He also informed me about the Madison Wood Collection, having 50,000 specimens with 90% hardwoods and 8% softwoods, and the microscope slide collection had reference wood anatomical slides linked to wood collection, databased, and digitized and images made available. They introduced continued research in botanical wood anatomy, wood science, and forensic science. Prof. Alex continued the presentation; he told the story of the genesis of Xylotron, which started with the development of the CITES Manual Saga and led to the awareness of developing a technology that could replace fast training for people to make a difference. He provided some information about the evolution of the Xylotron started from 2011 to 2021. He informed me that the XyloTron could demonstrate wood, charcoal, mushrooms, textiles, etc., equipped with Xyloref, Xyloinf, and Xylopeek and could be used for screening processes in the field before going to the diagnostic forensic analysis. He informed that XyloTron 2.0 had been used for identification models, such as CITES-controlled woods, Ghanaian hardwoods, Colombian hardwoods, Philippines hardwoods, North American hardwoods, and commercial charcoals. He also stated that the XyloPhone should be attached to a laptop and lens, and no software should be added to identify wood. He also provided a demonstration on the XyloPhone and informed us that the Xylo platform was used to verify supply chains for compliance efforts and establish probable cause for law enforcement. Dr. Alex provided lessons from the development of XyloTron, such as gaining best practices for wood identification technologies and not all groups of research following the research best practices. As a result, he and his colleagues produced a baseline quality standards checklist for AMWID: 1) use of multiple unique wood specimens, 2) consistent, repeatable, and adequate preparation of specimens, 3) use of an imaging sensor with a sufficient spatial resolution, 4) acquisition of in-focus images, 5) not overlap among multiple images, 6) label space design, 7) evaluation of trained models at specimen level, and 8) parsing of model evaluation results. Prof. Alex Wiedenhoeft continued his presentation on Garbage in Fiction Out: On the - potential and pitfalls - of automated microscopic wood identification systems. He informed that there were two premises of AMWID: wood identification based on wood anatomy is valid and repeatable when constrained to

appropriate taxonomic limits, and automating this process using machine learning and images of wood will capitalize on the substantially similar variation that humans use. AUMWID was considered low cost, real-time, field deployable, comparatively objective, repeatable results, minimal human training, and the hardware could easily be applied to other materials or contexts.

Workshop Day III on Wood Identification Field Visits, 25 April 2024

22. On the third day, the Meeting was moderated by Dr. Satria Oktarita, the Project Consultant. The Meeting continued with a field visit to Xylarium Bogoriense and Bogor Agricultural University (IPB University), where the participants were urged to practice their wood identification skills, especially using DNA analysis. At the IPB University, the Meeting continued with field visits to the IPB University's Advanced Research Laboratory.

23. The Meeting noted a presentation by Prof. Iskandar Siregar Zurkarnaen on Wood Identification: Introduction to Laboratory Works for Genetic Analysis. He provided a background on the threat of tropical forests, especially the valued trees, and the importance of preserving genetic resources (diversity and origin) for income, food, and environmental services. He questioned the participants on the wood identification technologies that could be used for taxonomic identification and origin identification. He briefly introduced the best practices for several forensic timber projects, such as the Shorea (2002-2007), Ebony (2012-2023), and WoodID Project (2020-2025). In the Shorea Project, his research team conducted DNA analysis from wood and wood products derived from Shorea wood, and DNA barcoding analysis of vascular plants. In the Ebony Project, he conducted sampling sites for reference databases, field works for wood collection, wood collection using Pickering punch, and population genetic analysis. The WoodID Project, Project was based on the Indonesia-based Wood Identification Program, covering varied activities, such as sampling sites for 380 targeted individuals, fieldwork in Kalimantan, wood collection kit for fieldwork, and benchmarking to FRIM. He concluded with several key takeaways, such as international collaboration is necessary in the face of global challenges such as climate change, biodiversity loss, forest crimes etc., scientific advancements resulting from international collaboration could facilitate evidence-based decision making and policy formulation to tackle problems of illegal logging in Indonesia, and the importance of SOPs development and Laboratory's standards and accreditation.

24. The Meeting continued with a practical session on DNA analysis led by Dr. Fifi Gus Dwiyanti from Bogor Agricultural University. Her practice consisted of several activities, including collecting core wood sample demos from standing trees (increment 3 mm & hollow steel punch) and science molecular laboratory wood DNA extraction. She engaged the participants to use the Wood DNA Isolation Protocol. The Protocol provided thirteen points of means in isolating wood for DNA analysis. In the practice, research laboratory assistants helped her, including Irsyad Kamal, S. Si, Dhika Syaputra, S. Hut, Esti Nurianti, S. Hut, and Bambang Hermawan, S.Bio., M.Si.

25. The Meeting noted a presentation material on the Identification of Wood's Geographical Origin Using Chemical Components delivered by Prof. Dr. Mohamad Rafi. He shortly introduced his biography and the background of the importance of wood

identification, which included illegal logging, illegal timber trade, and the issuance of illegal logging legislation. He clarified some techniques used for the identification of species and geographical origin of wood, such as wood anatomy, wood chemistry, and wood molecular biology. In terms of chemistry, wood identification can comprise chemical profiling, chemical fingerprinting, and isotope analysis. He detailed mass spectrometry-based wood identification, which can harness DART-TOFMS and LC-MS/GC-MS/MS, with the advantages of fast testing and non-destructive testing but still challenged with limited references. He informed that in the Ebony Wood ID, he conducted LC-MS/MS for ebony wood from different provinces of Sulawesi, supported by multivariate analysis and putative metabolite identification and classification. He also briefly detailed the introduction of DRAT-TOFMS, with the advantages of quick and easy sample injection, minimal sample preparation, tolerating high-concentration samples, and no contamination, and producing fingerprints quickly. He also provided the strengths of DART-TOFMS, including very small samples, versatile sampling, low cost, tailor-made software, high throughput screening, and a curated reference database. In addition, he also noted the limitations of the tool, such as extreme physical and chemical processes, possible interference of chemical contamination, difficulty in identifying wood panels and plywood, few signals in some tree species, and different profiles in sap and heartwood.

26. The Meeting continued with a presentation by Dr. rer. nat. Rahadian Pratama on the Oxford Nanopore Technologies Sequencing and Bioinformatics from DNA to Genome. He informed about the DNA Sequencing Techniques that use Oxford Nanopore Technologies (ONT), equipped with MinION breakthrough. He informed that a MinION flow cell contains 512 channels with 4 nanopores in each channel, a motor protein control ssDNA/RNA translocating through nanopores, and a characteristic current change used to determine the corresponding nucleotide. He also informed me that the MinION accuracy can be increased over new chemistry and with 1D, 2D, and 1D2 strategies with sequencing reads. He updated information on the improvement of single reads accuracy above 99% with a ligation kit with Q20+. He delivered procedures on the common workflow for MinION sequencing, including sample preparation, gDNA isolation, DNA library preparation, load sample, and sequencing; and he emphasized the importance of protocol optimization due to the distinct characteristics of each sample. He also emphasized that gDNA isolation decided the sequencing process, in which DNA sequencing needs high-quality DNA input with a good DNA purity ratio of A260/A280: 1.8-2.0, minimum total concentration of 1 microgram and 400 nanogram DNA for amplicon. After the sequencing, the process was continued with the end-preparation, barcode ligation, adapter ligation, priming flowcell, and starting sequencing. In terms of bioinformatic analysis flow, he informed that the MinION bioinformatic pipeline is processed through the following procedures, such as raw data obtainment, base calling, quality control and filtering, assembling, annotating, and downstream analysis. He lastly recommended some ways to achieve good sequencing such as making sure the DNA purity ratio is close to 1.8, measuring DNA concentration with a fluorometer, making sure HMW DNA is not fragmented, increasing pore occupancy, adjusting flowcell temperature, and performing multiplexing sequencing.

27. The Meeting noted the closing remark from Prof. Dr. Ratih Damayanti. On behalf of BRIN and KLHK Indonesia, she would like to thank the participants, APEC Secretariat, APEC EGILAT, and the Project Management Team for succeeding in the Bogor Workshop. She noted that the workshop was anticipated to understand the importance of forensic timber analysis and its application for addressing illegal logging and its associated trade. Her remark was thoughtful and intimate because the Bogor Workshop conducted in a three-consecutive day program was very short but the program could gather the participants with a spirit of friendship, loving, caring, and cooperation. She expected that the Bogor Workshop could continue its baton through the same project and or other APEC member economies project. She also acknowledged the strong, scientific, practical, and powerful presentation delivered by all speakers from APEC member economies. Finally, she stated a beautiful quote: Friends never say goodbye to each other. Because, deep inside the heart, they know that they'll be in touch forever! Best wishes for our future. She also closed the meeting.

5.4. Material Transfer Agreement Development

Material Transfer Agreement is a contract that governs the exchange of tangible research materials between two institutions. The exchange can be samples, databases, technologies, and other research-supporting materials. According to Cervo et al. (2016), MTA is the best option, as it governs the transfer of one or more materials from the owner or authorized licensee to third parties for research purposes and regulates what is done when a third party asks to supply material to outside sources (MTA-out) or obtain material from such sources (MTA-in). MTA is one of the deliverables targeted to be achieved in the Project between BRIN and other selected agencies in APEC member economies.

The development of MTA templates in the Project was processed by the successful organization of the JRD, which was held virtually on 6-7 November 2023. It is observed that many APEC member economies are eager to develop an open MTA, exchanging different materials for collaboration, such as wood samples, databases, wood identification technologies, and other capacity-building actions. However, it is noted that each APEC member economy had particular mechanisms to proceed with MTA. As a result, the Project Management Team only developed sixteen bilateral MTAs. Since MTA is conducted bilaterally, wood samples transferred not only from the engaged parties in APEC members to BRIN, but also the transfer of wood samples are from BRIN (Indonesia) to other APEC members. This resulted in the development of two MTAs, in which BRIN takes two roles: receipt and provider of transferred wood samples. To date, sixteen bilateral MTAs have been developed, consisting of eight MTAs for providers (Indonesia) and eight MTAs for recipients (eight APEC economies). However, four out of sixteen MTAs were successfully signed, comprising two MTAs for Indonesia-Chile and two MTAs for Indonesia-the Philippines.

In addition, some APEC member economies required a Memorandum of Understanding (MOU), Letter of Agreement (LOA), or Letter of Intent before signing MTA. BRIN developed two types of agreement documents templates, namely MOU, LOI, or LOA and MTA, to resolve the issue. Another document, which will be annexed to operationalize the LoA, is the Plan of Operation (POO). The document guides the parties

in actualizing interventions or activities under the agreed-upon work plan and the signed LOA. For instance, in the LOA, it is mentioned that there will be a joint research collaboration under Article 2 (Project Activities) and the signing of MTA under Article 5 (MTA). These articles are correlated because the joint study will harness wood samples with high commercial values to identify their characteristics for enhancing the Xylaria Networking database.

As captured in Figure 2, a proposal for a database enhancement mechanism is given. It shows that the leading implementing agency is APEC EGILAT, with the support of wood identification or forensic timber experts. These agencies will focus on two documents to access the traded timber and wood identification database. However, technologies are also expected to exchange, if possible, among APEC members. These exchanged materials are anticipated to facilitate the wood identification database enrichment process. LOA and MTA are two pivotal documents that could assist the enrichment of the wood identification database in the Xylaria Networking. These documents can list commercial, high-economical value, or CITES-listed timber from the other APEC member economies known as the provider. The listed wood can be exchanged with or transferred to Indonesia as the receipt of the samples, which are afterwards identified as their properties data. The properties data will then be continued for database enrichment. In addition, the remaining samples can be stored at the Xylarium Indonesia.

Table 1 shows the potential institutions under APEC member economies that intend to collaborate with BRIN in developing LOA and MTA. There are about eight APEC member economies represented by prominent forestry-based institutions, including Chile; Japan; Republic of Korea; Papua New Guinea; the Republic of the Philippines; Chinese Taipei; Thailand; and Viet Nam.

Table 1. Potential APEC member economies interested to develop LoA and MTA with BRIN*

Economies	Name of Institution	Signed documents**	Materials exchanged	Names of wood species	Signing status and date
Chile	Instituto Forestral	LOA, POO, and MTA	Wood samples	*Nothofagus pumilio, Nothofagus obliqua,* and *Weinmannia trichosperma*	25 April 2024
Japan	Research Institute for Sustainable Humanosphere, Kyoto University	LOA and MTA	Wood samples	*Chmaecyparis obtuse*, *Chmaecyparis pisifera*, *Cryptomeria japonica*, *Cryptomeria japonica*, *Picea jezoensis*,	6 September 2024

				Thujopsis dolabrata, *Pterocarya rhoifolia*, *Betula grossa*, *Quercus mongolica*, *Cinnamomum camphora*, *Prunus subhirtella*, *Acer mono,* *Cornus controversa*, *Celtis sinensis,* *Trochodendron aralioides*, *Podocarpus nagi*, *Melia azedarach*, and *Fagus crenata*	
Republic of Korea	Chungbuk National University	LOA, POO, and MTA	Wood samples	*Abies holophylla*, *Alnus sibirica*, *Betula schmidtii*, *Castanea crenata*, *Celtis sinensis*, *Fraxius rhynchophylla*, *Juglans mandshurica*, *Juniperus chinesis*, *Morus australis*, *Picea jezoensis*, *Pinus densiflora*, *Pinus koraiensis*, *Platycarya strobilacea*, *Priunus serrulata*, *Quercus acutissima*, *Quercus*	23 April 2024

				serrata, and *Salix koreensis*	
Papua New Guinea	Papua New Guinea Forest Research Institute	LOA, POO, and MTA	Wood samples	*Instia bijuga, Homalium foetidum, Pometia pinnata, Pterocarpus indicus, Toona sureni,* and *Anisoptera thurifera.*	In progress
The Republic of the Philippines	Forest Products Research and Development Institute	LOA, POO, and MTA	Wood samples	*Hopea acuminata, Anthoshorea virescens, Palaquium luzoniense, Dipterocarpus gracilis, Pterocarpus indicus,* and *Diospyros blancoi.*	25 April 2024
Chinese Taipei	Taiwan Forestry Research Institute[1]	LOI, POO, and MTA	Wood samples	Not yet identified	In progress
Thailand	Forest Research and Development Bureau	MOU, LOA, POO, and MTA	Wood samples	Not yet identified	In progress
Viet Nam	Viet Nam National Forestry University (VNFU)	LOA, POO, and MTA	Wood samples	Not yet identified	In progress

Note:
* LoA and MTA that are developed do not involve APEC Secretariat
**Template of Letter of Agreement appears in Annex 10.4
**Template of Letter of Intent appears in Annex 10.5
**Template of Memorandum of Understanding appears in Annex 10.6
**Template of Material Transfer Agreement for Indonesia as the Receipt appears in Annex 10.7
**Template of Material Transfer Agreement for Indonesia as the Provider appears in Annex 10.8
**Template of Plan of Operation appears in Annex 10.9

Most materials exchanged are wood samples with different species from the selected APEC member economies. The wood samples transferred to BRIN are at least three samples per species, and they will be used for two purposes: scientific collection at the Directorate of Scientific Collection Management and the studies of wood properties using different wood identification techniques. The extracted databases are subsequently harnessed wood studies to enrich the Xylarium Networking databases. Furthermore, BRIN also provides 21 wood species that belong to commercially valued wood, such as*Shorea hopeifolia*, *Vatica nitens*, *Tetrameles nudiflora*, *Rhus taitensis*, *Dipterocarpus eurynchus*, *Swietenia* sp., *Durio* sp., *Artocarpus heterophyllus*, *Nephelium* sp., *Mangifera* sp., *Anisoptera* sp., *Shorea* sp., *Intsia bijuga, Dryobalanops* sp., *Koompassia malaccensis*

[1] The names of institutions referenced in this report do not imply the political status of any APEC economy.

Acacia mangium, *Gmelina* sp., *Pterocarpus indicus*, *Pinus* sp., *Tectona grandis*, and *Calophyllum* sp. As stipulated in the signed MTA, these species are expected to be used for wood collection and research.

5.5. Wood Identification Practices in APEC Member Economies

Table 2 shows APEC member economies' wood identification techniques used for forensic timber identification. Represented by experts of the relevant forestry and forest products-based agencies, the APEC member economies have distinct methods that have been in place.

Table 2. Technologies used for forensic timber application in APEC member economies

Economies	Expert/s	Institutions	Wood identification techniques
Australia	Mr. Charlie Watkinson	SourceCertain	Machine vision, wood anatomy, mass spectrometry, near-infrared spectroscopy (NIR), stable isotope, DNA barcoding, population genetics/phylogeography, DNA fingerprinting, fiber analysis in MDF and pulp & paper
Canada	Ms. Isabelle Duchesne	Canadian Wood Fibre Centre	Machine vision (Xylotron), wood anatomy, and mass spectrometry (AccuTOF-DART)
Chile	Mr. Jorge González Campos	Instituto Forestral	Wood anatomy and NIR
People's Republic of China	Mr. Yafang Yin	Chinese Academy of Forestry	Machine vision, wood anatomy, mass spectrometry. NIR, stable isotope, DNA barcoding, population genetics/phylogeography, and mineral elements analysis
Indonesia	Mr. Iskandar Z. Siregar and Ms. Fifi Gus Dwiyanti	Bogor Agricultural University	Machine vision, wood anatomy, mass spectrometry, NIR, stable isotope, DNA barcoding, population genetics/phylogeography, DNA fingerprinting, trace elements analysis, and capacitance analysis
Japan	Mr. Akira Kagawa and Mr. Hisashi Abe	Forestry and Forest Products Research Institute	Wood anatomy, dendrochronology, NIR, stable isotope, DNA barcoding, population genetics/phylogeography, DNA fingerprinting, and chemotaxonomy
Republic of Korea	Ms. Ahn Jiyoung, Mr. Park Soyeon, and Mr. Kwon Ohkyung	National Institute of Forest Science, Korea Forestry Promotion Institute, and National Instrumentation Center	Wood anatomy and DNA barcoding

		of Environment Management	
Malaysia	Mr. Lee Soon Leong and Ms. Nordahlia Abdullah Siam	Forest Research Institute Malaysia	Machine vision (prototype: MyWoodID), wood anatomy, DNA barcoding, population genetics/phylogeography, and DNA fingerprinting
New Zealand	Mr. Lloyd Donaldson	Scion	Wood anatomy
Papua New Guinea	Mr. Paul Marai and Ms. Serena Marie Gideon	Papua New Guinea Forest Research Institute	Wood anatomy
Peru	Mr. Jose Ugarte Olivia, Mr. John Bartolo Cuba, and Mr. Paola Janampa Arroyo	CITEmadera Lima	Machine vision, wood anatomy, and mass spectrometry
The Republic of the Philippines	Mr. Glenn B. Estudillo	Forests Products Research and Development Institute	Wood anatomy
Singapore	Ms. Jomaine Tang	Double Helix	Wood anatomy, stable isotope, DNA barcoding, and DNA fingerprinting
Chinese Taipei	Mr. Chia-Chen Wu	Taiwan Forestry Research Institute[2]	Machine vision, wood anatomy, mass spectrometry, DNA barcoding, population genetics/phylogeography, and DNA fingerprinting
Thailand	Mr. Bangrak Chadthasing	Wood Collection Center of Royal Forest Department	Wood anatomy
The United States	Mr. Alex C. Wiedenhoeft and Mr. Rafael Arevalo	Forest Service, Department of Agriculture	Machine vision, traditional wood anatomical identification, dendrochronology, mass spectrometry, NIR, stable isotope ratio analysis, radiocarbon dating, DNA barcoding/hybridization probes, population genetics/phylogeography, DNA fingerprinting, and LIBS
Viet Nam	Mr. Le Xuan Phuong	VNFU	Machine vision, wood anatomy, dendrochronology, mass spectrometry, NIR, stable isotope, radiocarbon, and DNA barcoding

Source: APEC Secretariat (2023)

The use level of the technologies is observed for the screening and diagnostic forensic application (Table 3). In terms of screening methods, it is expected to become a field deployable tool, providing near real-time results or field wood identification manuals. However, diagnostic forensic approaches are expected to be undertaken in laboratories, processing time days to week to acquire results. Techniques used for screening and

[2] The names of institutions referenced in this report do not imply the political status of any APEC economy.

forensic analysis are combined to acquire more accurate, reliable, and reproducible results. That is because forensic techniques are expected to validate the fast and near real-time results, which might have any errors occurring.

It can be seen from Table 2 that the most utilized technology for forensic timber identification is wood anatomy, which is subsequently followed by DNA barcoding, machine vision, mass spectroscopy, and population genetics/phylogeography. It is also recognized that these technologies have been adopted for specific forensic timber applications. For instance, in Chile, NIR was used for research to identify the phylogeographic origin of Araucaria Araucana seedings. In People's Republic of China, DNA barcoding was used to support the Tianjin Customs in the import inspection of *Pterocarpus erinaceus*. The United States uses mass spectrometry (DART-TOFMS) to provide information relevant to enforcing the US Lacey Act and other laws. As referred to Australia, New Zealand, and Singapore, these Economies represented by SourceCertain, DoubleHelix, and Scion have provided services on forensic timber. Many cases have been resolved using varied technologies, such as wood anatomy, elemental analysis, stable isotope, and DNA-based approaches.

Table 3. Examples of screening and forensic wood technologies

Screening technologies	Forensic technologies
• Like a roadside breathalyser	• Like the breathalyser at the police station
• Field deployable – near real-time results or field wood identification manuals	• Laboratory techniques – processing time of days to week
Examples: • Machine Vision wood ID Xylorix Xylotron • Spectroscopy Near Infrared Laser Induced Breakdown Spectroscopy (LIBS)	Examples: • Wood anatomy Fibre analysis Quantitative wood anatomy µCt volumetric wood anatomy • DNA Fingerprinting Barcoding Population genetics • Mass spectrometry DART-TOF-MS IRMS ICP-MS / ICP-AES LC-MS

Source: Watkinson (2024), Wiedenhoeft et al. (2023), and APEC Secretariat (2024)

These technologies are expected to profile different risk levels, such as genus, species, origin, geographical provenance, age, and individual. In addition, these technologies are looked forward to addressing the needs of end-users and the traded forest products. As a result, wood identification techniques cannot be like a "one-size-fits-all approach" and must be fit for the purposes. The results of the JRD showed that wood anatomy is the most affordable, applicable, open, and demanded wood identification technology. However, the technology must be complemented with a machine vision-based

approach, mass spectrometry (DART-TOFMS), and DNA-based solutions for field deployable and laboratory modalities.

According to Brusselen et al. (2023), there are five driving demands on wood identification utilization: a) compliance with policy/legislation, b) certification compliance, c) customer awareness, d) procurement requirements, and e) reputation management. In the Project, demands for using wood identification for forensic analysis vary among APEC member economies, depending on their purposes, risks profiled, and availability of technologies and expert resources. Besides these premises, with the availability of different forensic timber instrumentations, the advantages and disadvantages of wood identification tools are also considered pivotal in selecting the appropriate tool. However, all the demands aim to address the illegal trading of wood and illegal logging in APEC member economies.

With reference to their experiences in forensic wood identification, seventeen APEC member economies have provided information on the driving demands of the utilization of forensic timber identification.

1. Australia: Australia shows that the demands on wood identification are primarily for investigating the legality of traded wood; avoiding the misrepresentation of the origin of timber, resulting in significant fines in demand-side economies; averting fraudulent over-supply resulting in price suppression (dumping effects on the market); offering unfair advantages for business, using illegal/grey market timber; and providing less expensive and more achievable process than implementing traceability from harvest to retail.
2. Chile: Similar to Australia, Chile has utilized wood identification for forensic analysis due to various demands, such as a) to safeguard and manage Chile's forestry sector sustainably, b) to provide alternatives to the reliance on conventional wood identification, such as microscopy and macroscopy, c) to address the issue of the limited supportive tools for forest inspection, d) to provide wood identification systems in port, and e) to nudge wood identification specialists for developing wood identification tools.
3. Indonesia: In Indonesia, referred to the projects related to forensic timber, the demands on wood identification are mostly for investigating illegal trading of high commercial value timber, addressing large-scale illegal logging, and offering solutions on the proper wood identification.
4. Japan: Japan has demanded wood identification for identifying CITES-listed wood species that have been increasingly demanded, conducting archaeological studies by determining the growth years and geographic origin of wood, especially when specific harvest years and regions are deemed illegal, supporting the upcoming enforcement of the revised Clean Wood Act in Japan by 2025, and providing accurate customs declaration of wood species, because the import tax rate depends on the species.
5. Republic of Korea: The Republic of Korea has demanded wood identification technologies for addressing some issues, including: a) providing and enhancing the transparency system by verifying timber and its products according to the information on the legality documentation, promoting clean trade by assuring the

exact product information for all subjects on the market, and identifying the spots of illegal logging and production of related items happened in the supply chain, b) undertaking forensic analysis of the wood species of mixed products, and c) identifying the wood species of a damaged domestic treasure.

6. Malaysia: Malaysia has also provided information on its demands for forensic timber identification, such as for addressing illegal logging, complying with the CITES regulation, and providing the request of plantation industries and wood industries (timber trade, quality control in building construction, trade disputes, restoration and conservation of historical building).
7. New Zealand: New Zealand uses wood identification technologies, which have been triggered by significant demands, mainly to document the timbers used or, in some cases, to facilitate repairs, to identify the potential origin of wood contamination in products such as milk powder about customer complaints, and to confirm the identity of plant stems suspected to be Cannabis as part of police investigations.
8. Papua New Guinea: Papua New Guinea demands the use of wood identification because this economy wants to control illegal timber trade, to shift the research roadmap within this economy to ensure impactful scientific contributions that yield effective and informed decisions on forest policy in Papua New Guinea, and to employ efficient and cost-effective techniques and technology through a standardized protocol for wood identification that is critical to help improve accuracy of wood identifications and aid in our economy's overall efforts towards reducing illegal logging in this economy.
9. Peru: Peru has utilized wood identification technologies for studies and forensic timber applications. Wood identification demands are intense, especially for training and capacity-building for law enforcement and non-law enforcement agencies on wood identification and forensic timber.
10. The Republic of the Philippines demands wood identification technologies because they play an essential role in providing wood identification references in identifying confiscated wood from the agencies above, investigating unauthentic samples at the different levels, such as genera and species, and extracting DNA material from its current collection that will serve as a database of DNA material that could be used for a more accurate wood identification up to species level.
11. Singapore: Singapore has demanded wood identification technologies to verify the origin or species of harvested woods and to confirm forests of origin (plywood is high volume, so factories source from multiple concessions and traders).
12. Chinese Taipei: Chinese Taipei demands wood identification technologies that are faster, more accurate, and more efficient. In addition, this economy has demanded wood technologies to provide several types of wood identification technologies with several advantages and to track the traceability of wood origin.
13. Thailand: Thailand demands wood identification technologies to comply with the missions of the Royal Forest Department in issuing wood export certificates and to serve people who want to know the wood species to use them. The technologies can urge the government to provide training and education for operating staff and

to provide academic knowledge to interested citizens regarding the structure of wood and the identification of wood types.

14. The United States: The United States has intensely harnessed wood identification technologies, which are anticipated to provide rapid and reliable analysis of species-level botanical identification that is similarly reliable verification/determination of geographic origin. The technologies are expected to provide information relevant to enforcing the US Lacey Act and other laws. The offer in wood identification technologies is considered inherently modality-agnostic; however, 1) field deployable screening technology *must* scale with laboratory forensic capacity, and 2) laboratory forensic capacity *must* support and scale with field screening.
15. Viet Nam has benefitted from wood timber identification technologies that are versatile to investigate timber legality, strengthen chain of custody, and combat illegal logging because Viet Nam is the leading exporter of wood, and to strengthen wood identification capacity for customs, forest protection department, university, and research institutes.

5.6 APEC Member Economies' Readiness Level and Best Practices on Forensic Timber

As portrayed in Table 4, APEC member economies have already applied forensic timber identification, although several issues have been found. At the JRD, significant gaps in forensic timber implementation are still found, leading to challenges in translating wood identification studies for the operation of forensic practices. Some of the challenges that need to be resolved to narrow down the gaps are 1) lack of sustainable financing mechanisms and support, 2) limited wood identification experts, 3) lack of infrastructure, laboratories, and technologies, 4) unavailable policies and legislation enforcement, 5) limited of standards and guidance on wood identification technologies, 6) unavailable standardized wood identification methods, 7) lack of education, capacity-building, and training, and 8) lack of databases integrating wood identification data from various instrumentations.

From these challenges, a readiness level for applying forensic timber into the ground is imperative to measure and to provide an overview of how APEC member economies and APEC EGILAT can address the challenges in embodying the actualization of forensic timbers into more sustainable operations. The results of this assessment will provide recommendations for the APEC EGILAT for their further actions. Figure 2 shows that each indicators have different responses by APEC member economies. Some of the Economies have different readiness level in the availability of sustainable financing mechanisms and support, wood identification experts, infrastructure, laboratories, and technologies, policies and legislation enforcement, standards and guidance on wood identification technologies, standardized wood identification methods, education, capacity-building, and training, and databases.

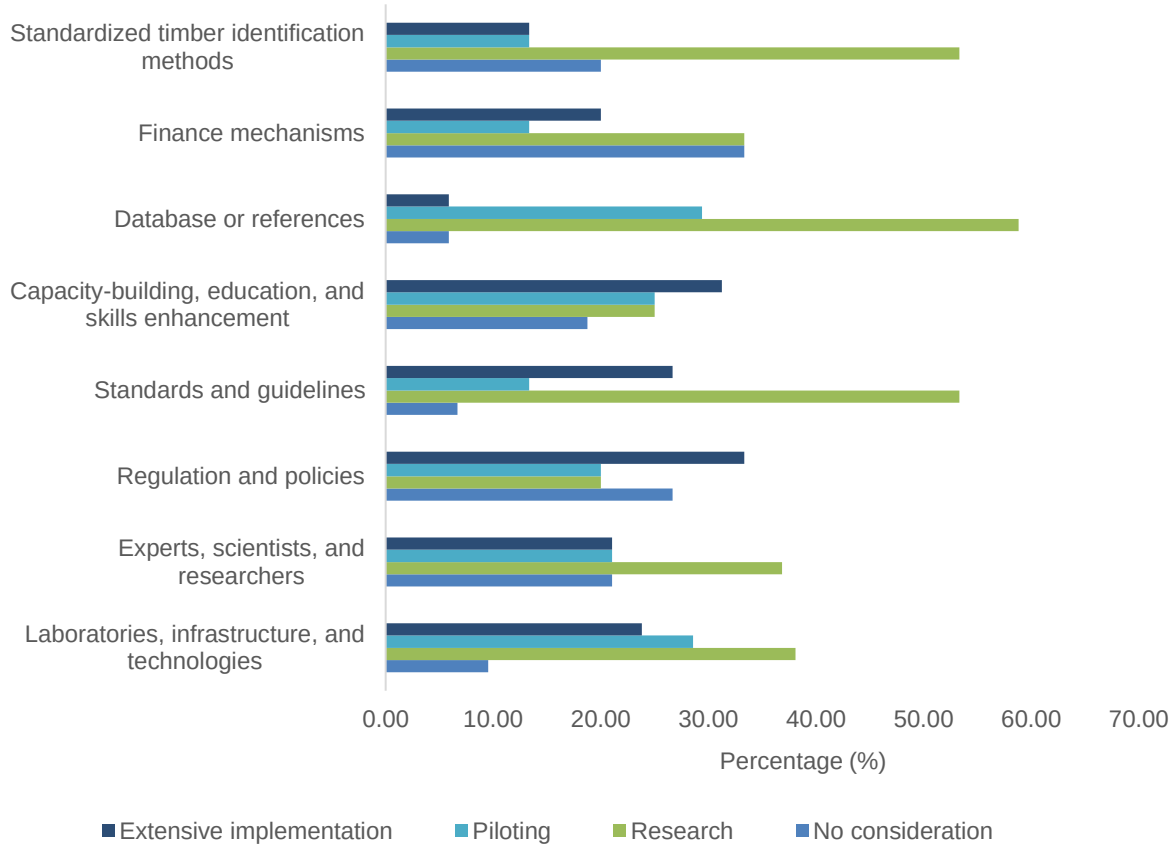


Figure 2. Readiness level of forensic timber identification in APEC member economies

Most of the APEC member economies have a readiness level at research, especially for standardized timber identification, databases, standards or guidelines, expertise, and technologies. It indicates that these indicators have been studied to support the piloting and extensive implementing of wood identification for forensic timber analysis. In order to pilot and extensively apply forensic timber, these parameters are anticipated to be well-equipped with strong support from relevant stakeholders. During the FGD, quick polls on forensic timber readiness level was conducted and the results (Figure 3) aligned with the mini-survey results highlighted in Figure 2. For instance, at the FGD, it is also clear that policies and legislation are present and at the level of extensive implementation. It also aligns with the results of the readiness level depicted in Figure 2. It indicates that domestic and international policies have supported the intensification of forensic timber applications by prohibiting illegal logging and illicit timber trade. For instance, the United States; the European Union (EU); Australia; Republic of Korea; and Japan have implemented regulations to ban illegal timber in their respective markets (Apeti et al. 2023).

Every APEC member economy has different stakeholders responsible for operationalising forensic timber identification. The most dominant stakeholders include the ministry/department of forestry, environment, agriculture; ministry/department of

Figure 3. FGD's quick polls on readiness level of forensic timber identification

transportation; ministry/department of customs; justice and law department; universities or research institutes; consulting agencies, and industries. For instance, the United States has extensively applied forensic timber identification by engaging several departments, such as the US Department of Agriculture, Forest Service, US Customs and Border Protection (including Homeland Security Investigations), US Department of Agriculture, Animal Health and Plant Health Inspection Service - Plant Protection and Quarantine (APHIS PPQ), and US Department of Justice, Environment and Natural Resources Division.

Table 4. Detailed forensic timber applications

APEC member economies	Forensic identification tools	Tested samples	Risks profiled	Forensic cases
Australia	Elementals analysis	*Tectona* sp.	Origin verification	About 108 samples of teak were collected by Kolombangara Forest Products Ltd in a demonstration with World Forest ID. The samples were analysed using elementals techniques where about 60 elemental analytes per sample were measured.
Canada	Field inspection, wood anatomy, and chemical analysis	*Dalbergia* sp.	Species	The Environment Climate Change Canada's Wildlife officers performed the field inspection with Canada Border Services Agency, Canadian Food Inspection Agency, and NRCan-Canadian Forest Services, with the total of wood sampling of 11. The sampled wood was continued to be tested their anatomical properties by the Canadia Forest Service, showing its identified species of *Dalbergia* sp. The samples were also continued to be investigated their chemical properties by Environment Climate Change Canada.
Chile	Spectroscopy techniques	*Araucaria araucana*	Phylogeographic origin	Spectroscopy techniques in different infrared range and

	(different infrared ranges and chemometric methods)			chemometric methods were utilized to profile phylogeographic origin of *A. araucana.*
People's Republic of China	DNA barcoding	*Pterocarpus erinaceus* and *Guibourtia demeusei*	Species	DNA barcoding was used to provide support the Tianjin Customs in the import inspection in identifying some wood species of *Pterocarpus erinaceus* and *Guibourtia demeusei.* First DNA barcoding identification report of wood sample was available in 2017 in People's Republic of China.
Indonesia	Multi-analysis: genetics, anatomy, near-infrared spectroscopy, and mass spectrometry	*Diospyros ebony*	Species and origin	Different wood identification analysis was used to identify wood species and origin of ebony from Sulawesi. These techniques were used to develop reference database.
Japan	Tree ring oxygen stable isotope	*Quercus* sp.	Geographic origin	A forensic wood study was carried out by Forestry and Forest Products Research Institute. The study analyzed the geographic origin of oak wood estimated using tree-ring oxygen isotope ratios.
Republic of Korea	DNA analysis	*Chamaecyparis obtusa* and *Chamaecyparis pisifera*	Species	The National Institute of Forest Science conducted some forensic analysis of the mixed wood products of *Chamaecyparis obtusa* and *Chamaecyparis pisifera*. In addition, the Institute also conducted some analysis of the damaged domestic wood treasure (Sungnyemun).
Malaysia	Phylogeography and DNA profiling	*Neobalanocarpus heimii, Shorea platyclados, Shorea leprosula, Shorea curtisii, Koompassia malaccensis, Intsia palembanica,*	Species and provenance	The Forest Research Institute Malaysia developed a phylogeography and DNA profiling database for 13 important timber species, using 398 populations and 12,656 samples. Various scientific publications have

		Gonystylus bancanus, Aquilaria malaccensis, Rhizophora mucronate, Rhizophora apiculata, Dryobalanops aromatica, Dryobalanops oblongifolia, and *Dipterocarpus cornutus.*		been produced from the development of databases.
New Zealand	Wood anatomy	*Phyllocladus trichomanoides*	Species	The Scion Research facilitated the identification of discovered small log, which was later used for making a musical instrument. The Scion Research examined the cell structure and compared it on a microscopic level to their database. The identified log was Tanekaha (*Phyllocladus trichomanoides*), apparently one of the most elastic timbers in the world.
Papua New Guinea	Wood anatomy	Tropical wood	Genus	The Forest Research Institute over the years has used mainly botanical specimens to identify wood samples given their wood anatomy laboratories have ceased operations since the early 2000s primarily due to lack of funding. Most clients are advised to bring in a leaf specimen for identification by the Institute's senior botanists.
Peru	Xylotron and DART-TOFMS	Peruvian wood species	Species	CITEmadera conducted various trainings for customs, justice operators, domestic forest service, and regional government on how to utilize Xylotron. The Institution utilized DART-TOFMS to develop database, conduct timber

				proficiency test, and provide forensic timber services for stakeholders.
The Republic of the Philippines	Wood anatomy, machine vision, and DNA barcoding	Philippines wood species, such as *Swietenia* sp.	Species	The Department of Science and Technology, Forests Products Research and Development Institute is currently developing projects that that will help improve its capability in wood identification such as: 1. The development of database and digitization of the Institute's Herbarium and Xylarium's Philippine Tree Species; 2. Development of a Mobile Application (APP) based platform for wood identification of commonly used indigenous and plantation species in the Philippines; and 3. DNA barcoding of selected Philippine mahogany species.
Singapore	DNA fingerprinting, DNA barcoding, wood anatomy, and stable isotope	*Tectona* sp., *Quercus* sp., and *Shorea* sp.	Species, origin, and provenance	There are some example cases that were solved by DoubleHelix. Stable isotope was used to profile species and origin of European oak flooring. Wood anatomy and DNA barcoding were utilized to identify woos species used for Indonesian plywood marketed in the United States, and the study showed that species utilised in meranti plywood was much broader than thought. Lastly, DoubleHelix benefited from DNA fingerprinting to identify the traceability of origin of teak, and DNA testing confirmed genetic matches between three sets of wood samples

				taken from forest stump (prior to cutting), log and sawn timber (after cutting) for 3 individuals.
Chinese Taipei	DNA barcoding	*Cinnamomum kanehirae, Calocedrus formosana, Chamaecyparis formosensis* and *Chamaecyparis obtusa var. formosana~~C. obtuse~~*	Species	Chinese Taipei announced the Precious Wood Products Export Control in 2022, and the exportation of wood products made from *Cinnamomum kanehirae, Calocedrus formosana, Chamaecyparis formosensis* and*Chamaecyparis obtusa var. formosana ~~C. obtuse~~* should get permit from the Ministry of Agriculture.
Thailand	Wood anatomy	Commercial wood	Species	Wood identification technology, especially wood anatomy, has been used for supporting the missions of the Royal Forest Department. For example, the technology is used to issue a certificate of exported wood.
The United States	DART-TOFMS	Traded wood	Species	The US Forest Service International Programs Wood Identification and Screening Center uses DART-TOFMS to provide forensic analyses of timber to both verify supply chains and to identify the presence of illicit timber for US Government law enforcement agencies. DART-TOFMS can be used for species-level identification and is a well-researched method that is accepted in the US court of law.
Viet Nam	DNA barcoding, machine vision, and DART-TOFMS,	Commercial wood	Species	Several activities were carried out to support the implementation of forensic timber identification. For instance, the Viet Nam National University of Forestry in partnership with the University of Washington

				collected image database for enhancing the Xylotron data. They also developed smartphone-based application for 85 species of wood, and built DART-TOFMS database for local timber species.

Source: APEC Secretariat (2023)

APEC member economies have been applying forensic timber in three categories, primarily in studies, pilot projects, and extensive implementation, as shown in Table 4. Several traditional and advanced wood identification technologies have been utilized at the studies level to profile risks of traded, commercial, lesser-known, and CITES-listed timbers. Various publications are also produced from the studies, with several intentions, such as to showcase the effectiveness and efficiency of these technologies, to commence an initiative in developing a reference database, and to narrow down the gaps that retain the application of forensic timber in the field. At the piloting stage, some APEC member economies have started integrating wood identification technologies and study results into a project, helping to address several hindering factors in the extensive implementation of forensic timber. For instance, several donors from dialogue partners, international organizations, and development banks are identified to support capacity-building, provide instrumentations, and adopt new technologies in forensic timber. Forcing drivers, such as policies/legislation, availability of reliable wood identification technologies, and the presence of illegal timber trade cases, are some of the significant reasons for nudging the operationalization of forensic timber in APEC member economies. For instance, in the United States, DART-TOFMS is the only wood identification technique accepted by the US Court of Law in identifying wood species.

5.7 Advantages and Disadvantages of Wood Identification Techniques

Understanding the advantages and disadvantages of wood identification technologies will be a pivotal indicator to harnessing the technology that fits the purpose of forensic timber analysis. There are ten common forensic timber technologies that APEC member economies have utilised. They include machine vision, wood anatomy, mass spectrometry, near-infrared spectroscopy, stable isotope, radiocarbon, DNA barcoding, DNA fingerprinting, and phylogeography or population genetics. They have strengths and limitations that can be considered when selecting them as tools for forensic timber.

1. *Machine vision* is a wood identification tool developed based on artificial intelligence featuring digital wood images from wood anatomy identification. This tool can provide near-real-time data of tested wood, and the tool is easily installed and used on smartphones. As a non-destructive technique, this tool does not require skilled individuals to use it and sometimes requires simple and additional tools, such as a loop, handphone, knife, and database reference. However, this tool needs more accuracy, especially for identifying anatomical properties of wood that have an anatomical resemblance. Other drawbacks of using this technique are the low

frequency of images, limited database references, difficulties in identifying modified or stained wood samples, and the requirement for expertise in developing machine vision applications and digitalization.

2. *Wood anatomy* is the most traditional and common wood identification technology in APEC member economies used to identify wood's macroscopic and microscopic properties at the genus and species levels. This technology is the oldest and most commonly known by wood anatomists to identify illegally harvested or traded timbers. Due to its long use and studies to explore the technique, it is sometimes integrated with digital technologies to produce Android-based applications, and there have been many documented databases on wood anatomical features available in online and printed versions. This technology can investigate fibres, pulp, papers, and engineered wood products. Like machine vision, this technique makes it slightly difficult to identify a similar anatomical property of wood and analyse engineered wood products composed of different wood fibres.
3. Known as tree ring dating, *dendrochronology* measures wood age or the period of wood formation by gauging the annual growth of wood. This technique is also beneficial for retrospective biomonitoring with reliable and ubiquitous archives for dating past events and paleoenvironmental reconstruction. Due to this excellent use, this tool also has the potential for measuring age, individual (origin), and provenance, considering the local condition variation. However, due to unclear growth rings of tropical timbers, it is still difficult to identify the rings. In addition, preservation and additional treatments to wood might be required to obtain readable growth rights of wood.
4. *Mass spectrometry* consists of several types, including DART-TOFMS, GC-MS, LC-MS, ICP-MS, TOF-SIMS, and FTICR-MS. This tool is used to measure both qualitative and quantitative analysis of the chemical substances of wood. This tool has a non-destructive nature, requiring a piece of wood for testing, and has a fast characterization of tested woods. This tool can analyze different levels of risks, such as genus, species, and provenance, but the limitation focuses on the limited references or databases, and most of the phytochemical profiles are very species-specific.
5. *Near-infrared spectroscopy* is sometimes used as a screening tool for forensic timber analysis. This tool provides a rapid, noninvasive, and cheap chemometric method used for profiling the chemical composition of wood under the near-infrared region from 780 nm to 2500 nm. This tool is considered non-destructive and inexpensive, with rapid obtainment of results. However, this technique requires many reference databases and standardized methods to address some variable accuracy.
6. *Stable* isotope is one of the advanced wood identification tools used to identify the isotopic compositions of wood in order to verify its geographical origin, with common bio-elements of $\delta 18O$, $\delta 2H$, $\delta 13C$, $\delta 15N$, and $\delta 34S$ used for timber tracing. Limited studies have been reported harnessing this tool for forensic timber analysis. This method is able to investigate the provenance or the origin of tested wood. This tool is considered nontoxic, has no radiation hazard, and has no decay over time. However, the stable isotope ratios fluctuate a lot due to climatological, biological, and

geological variables and require the high expense and sophistication of instrumentation and intensive labour analysis.

7. *Radiocarbon* is a wood identification tool for measuring the time and date of objects of wood using the decay of a radioactive isotope of carbon (^{14}C). This method is very advanced and limited studies have been found to investigate the age of the timber formed over the past 55,000 years. This tool provides high accuracy and precision, depending on sample size, preservation state, and features of the calibration curve. With modern technologies, this tool can be operated remotely, but it is destructive and costly; it can analyze organic materials, not inorganic materials.
8. The last approach for identifying wood is by using *DNA-based methods.* This approach consists of three methods: *DNA barcoding, DNA fingerprinting,* and *phylogeography* or *population genetics.* These methods have almost similar strengths and limitations. Regarding the strengths, the methods provide invaluable and handy tools for detecting errors in the wood genus and species and occasionally provenance and do not require expert taxonomic knowledge to identify specific samples as a well-established solid reference database. The methods provide high efficiency and accuracy of wood identification and complement the field deployable wood identification. However, the challenges are the importance of pure and high-quality DNA isolation, difficulties in DNA extraction, high sampling and proper homogenization, limited reference database, and high cost for use. In addition, the instrumentation process requires highly skilled human resources.

5.8 Development of Wood Identification Regional Standards and Xylaria Networking in Asia-Pacific Region

It is pronounced that the results of the Joint Research Discussion, representative of APEC member economies have demanded the establishment of Xylaria Networking. 100% of workshop participants the desire to benefit from the Networking for various purposes:

1. to share valuable wood identification knowledge, resources, technologies, and collaboration among Economies,
2. to unite wood identification scientists across economies with a common purpose,
3. to address common challenges in implementing forensic wood timbers,
4. to assist the development and management of wood identification databases, especially in making it available online and publicly accessed,
5. to exchange expertise and continuous funding on operationalizing wood identification,
6. to serve comprehensive plans for capacity-building, skill sharing and transfer, data sharing, research collaboration, and others,
7. to contribute to the assembly of information on wood identification that should underpin management plans aiming at sustainable production of goods and services,
8. to advance our effort towards improving our effectiveness in providing accurate and reliable wood identifications to relevant organizations and institutions locally and within the region,

9. to strengthen the wood identification capabilities of APEC member economies to contribute against illegal logging, and
10. to match the names of traded wood species (scientific, local, and commercial names).

However, several hindering factors are also observed in the establishment of Xylaria Networking. These factors include 1) finite vouchered specimens, 2) unclear access and benefit sharing, 3) lack of CITES support, including laboratories, research, and human resources, 4) unavailable letter of authority, corroborating the prohibition of illegally traded wood, 5) unavailable logistics guideline on timber trade, 6) lack of sustainable financing, infrastructure, capacity-building, databases, and technologies, 7) complex policy and regulations, 8) issues in biopiracy and assurance, 9) bureaucratic systems in obtaining export and import licenses, 10) lack of skilled wood experts, 11) disparities among Economies ability, and 12) problems in language issues.

As one of the actualizations of the Xylaria Networking plans, the development of Regional Standards on Wood Identification is also expected. The development of the Standard can also nudge the normalization of forensic timber analysis in APEC member economies. However, there were many responses from APEC member economies on how the standards address common challenges and issues in applying wood identification for forensic purposes. Below are the recommended Regional Standards requested by APEC member economies to be developed:

1. Standard guidance on shipping and logistics,
2. Harmonization of domestic standards on names of main woods imported and exported to APEC member economies and wood identification methods,
3. Wood identification for commercial, high-value, and CITES-listed timbers,
4. Standardization of wood identification system, integrating various techniques that are considered affordable, quick, time efficient, and reliable,
5. Development of a compendium of tools/methods for wood identification – enlisting the contact of management authority/ institute, available tool/method, and expertise for wood identification technology,
6. Protocols or mechanisms to ensure proper wood identification management,
7. Mechanisms to verify and ensure the skills of wood identifiers,
8. Resources to maintain the management of wood identification systems,
9. Standardization on collecting official wood references and developing integrated traded wood,
10. Establishment of standard protocols, documentation, and reporting,
11. Proficiency-based blind testing to establish “accreditation”,
12. Developing evaluation metrics to validate new identification technologies (see also blind testing),
13. Establishing an economy-independent review body to update standards, and
14. Establishing a regional consortium to support information exchange and development, training, and capacity-building.

5.9 Integration of Wood Identification into Timber Legality Assurance System

The results of the FGD carried out on 16 January 2024 indicated that all APEC member economies have different mechanisms to ensure the legality of harvested and traded timbers. The lawfulness of timbers can be tracked along the timber supply chain, including logging permit issuance, harvesting, transporting, processing, exporting, and selling (Interpol 2023). As a result, there is the potential to mainstream and integrate wood identification technologies along the supply chain. From the mini-survey, each APEC member economy reported that wood identification technologies have been adopted in the supply chain at certain stages. Figure 4 shows that at the current state, APEC member economies have dominantly integrated wood identification at the export/import levels. Besides being applied at the export/import stage, wood identification is also implemented at logging permits, harvesting, transportation, processing, and selling. APEC member economies still expect to strengthen the integration of wood identification into the timber supply chain in the future, with three dominant votes in processing, export/import, and selling segments.

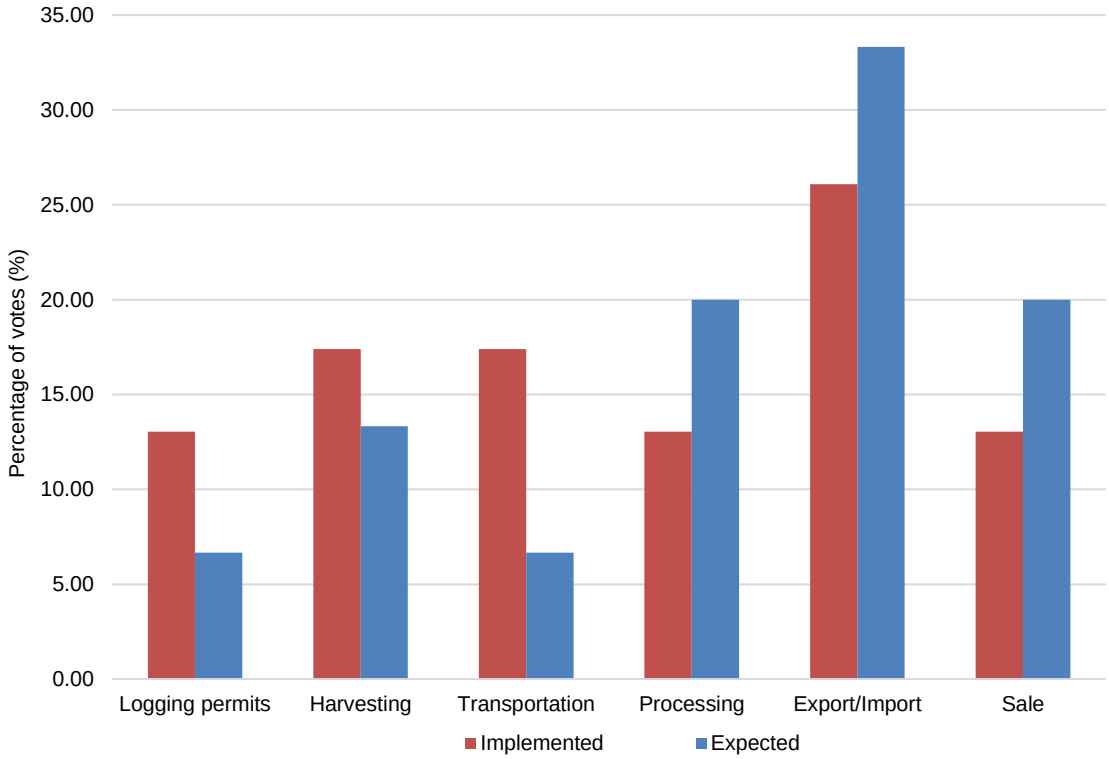


Figure 4. Integration of wood identification in the timber supply chain

One of the standard timber legality systems applied in some APEC member economies is the Timber Legality Assurance System, which has been introduced and adopted in Indonesia; Malaysia; Papua New Guinea; and Viet Nam. In the system, there are some documents that require the importance of stating the correct species name and origin of timber products. As a result, wood identification technologies can be utilized with the assistance of skilled wood identification experts to verify these parameters. In addition, the presence of domestic and international legislation, such as the CITES Regulations,

the Japanese ‘Goho-wood’ /Clean Wood Act policy, the U.S. Lacey Act, the EU Timber Regulation and the Australian Illegal Logging Prohibition Act, nudges APEC members to consider not importing of illegally harvested wood, leading to direct impacts on major wood processing Economies (Zeitlin et al. 2020, Kindji 2021). The legislation requires the Economies to provide correct information, such as name of species and origin, for the legal timber assurance documents. Wood identification is anticipated to be indispensable in providing and clarifying the information. In terms of wood species and origin verification, wood identification technologies that have been used in APEC member economies can be optimized for their usage for screening and diagnostic forensic wood identification, including wood anatomy, machine vision, mass spectrometry, near-infrared spectroscopy, stable isotope, radiocarbon, DNA barcoding, DNA fingerprinting, phylogeography or population genetics, and dendrochronology. Considering the purpose and risks profiled, it is also expected that these methods can be combined and not only an individual technology.

6. CONCLUSION

The Project of Developing Integrated Timber Data to Enhance the Legal Timber Trade of the APEC through Xylaria Networking, managed by BRIN and KLHK Indonesia, was successfully completed. The Project had three interventions: a joint research discussion conducted virtually on 6-7 November 2023 with the attendees from 17 APEC members, a focus discussion group conducted virtually on 16 January 2024 the attendees from 16 members, and a Bogor workshop conducted physically on 23-25 April 2024 the attendees from 14 APEC members. Four out of eight agreement documents (LOA/LOI/MOU, POO, and MTAs) were successfully developed with eight APEC member economies, which allowed the exchange of wood samples, wood identification technologies and databases, and other research and capacity-building-based activities. At the JRD and FGD, the Project produced a research paper highlighting several propositions about forensic timber application in APEC member economies. The participants from APEC member economies also enhanced their understanding and skills in forensic timber implementation during the Bogor Workshop.

APEC member economies demand wood identification technologies to address illegal logging and associated trade. Various wood identification has been utilised, including wood anatomy, machine vision, mass spectrometry, spectroscopy, stable isotope, radiocarbon, dendrochronology, and DNA-based solutions. These technologies have also been applied along the timber supply chain, with the dominant usage at the gate of import/export, and have been observed to profile wood species and origin. Each APEC member economy also has a system to ensure the legality of timber harvested and traded, and wood identification has the potential to be integrated into the system voluntarily. Forensic timber identification has been studied and practiced in APEC member economies, but several challenges are still observed. It aligns with the readiness level analysis on forensic timber, showing that these challenges have positioned APEC member economies at certain levels, such as no planning, research, piloting, and extensive implementation.

7. RECOMMENDATIONS

At the final closure of the Project, lessons learned were successfully extracted by the Project Management Team, APEC Secretariat, APEC EGILAT, and APEC member economies as the targeted beneficiaries. Deliverables were also attained, and the impacts of the Project interventions were acquired. Ensuring the sustainability of the Project matters, especially in terms of the financial, socio-economic, institutional framework and governance, and the environment because it is interlinked with the likelihood of continued benefits after the Project ends. In this section, recommendations for the APEC EGILAT are given for their consideration:

- The Project is successfully completed, but some policy recommendations for APEC Secretariat, APEC EGILAT, and APEC member economies on developing regional standards on wood identification, establishing Xylaria Networking, and creating an open LoOA and MTA have yet been to be carried out. As a result, the extension of the Project is advised.
- Open LOA and MTA are effective methods for APEC member economies to exchange wood samples and databases to accelerate the plan of action of the Xylarium Networking.
- Studies and publications on forensic timber identification have been extensively conducted. The translation and implementation of the studies are encouraged, along with mapping and engaging relevant stakeholders in projects or operationalizations.
- In using wood identification technologies, the selection must not be based on the principle of a one-size-fits-all approach. However, it should rely on and fit the purposes, considering the testing purposes, profiled risks, advantages and disadvantages of techniques, traded wood types, and analyzed products.
- Wood identification techniques that are used for forensic timber identification are expected to combine multiple analyses, including at the screening process (wood anatomy/macroscopic analysis and machine vision), and diagnostic forensic analysis (wood anatomy, machine vision, DART-TOFMS, stable isotope, and DNA-based solutions).
- The establishment of Xylaria Networking and the development of Regional Standards on Wood Identification are advised strongly by APEC member economies, and these require actualization, with support from APEC EGILAT
- APEC member economies have applied wood identification at a particular stage of the timber supply chain, and the application needs to be strengthened and scaled up throughout the supply chain.
- APEC member economies have different systems for ensuring the legality of timber harvested and traded. Wood identification can be voluntarily applied in the systems.
- Mutual engagement with other related APEC sub-forums, such as the Sub-Committee on Customs Procedures, is strongly advised. The results of the Project study on forensic timber identification in APEC can be used by the Sub-Committee

and its customs administrations of the region as regional information in deciding whether to release or detain wood cargo.

- There is a strong demand from APEC member economies to continue the interventions of the Project, especially in conducting capacity-building and collaborative research, which can enhance and equip the skills of relevant stakeholders.
- APEC members have different agencies and stakeholders who are responsible for the operationalization of forensic timber. They can be stakeholders-mapped to assist in the integration and seamless connectivity of the forensic timber process.

8. ACKNOWLEDGEMENTS

The Project Management Team (PMT), composed of BRIN and KLHK, would like to acknowledge the kind assistance and cooperation from the APEC Secretariat and APEC EGILAT in supporting this project's completion. The PMT also would like to thank all the nominated researchers and experts representing their respective Xylarium for providing data and information during the APEC EGILAT joint research discussions and workshops. All excellent praises are also given to the prominent team members and partners (Bogor Agricultural University, Xylarium Bogoriense, and Bogor Botanical Garden) who have contributed to finalising and achieving the project deliverables.

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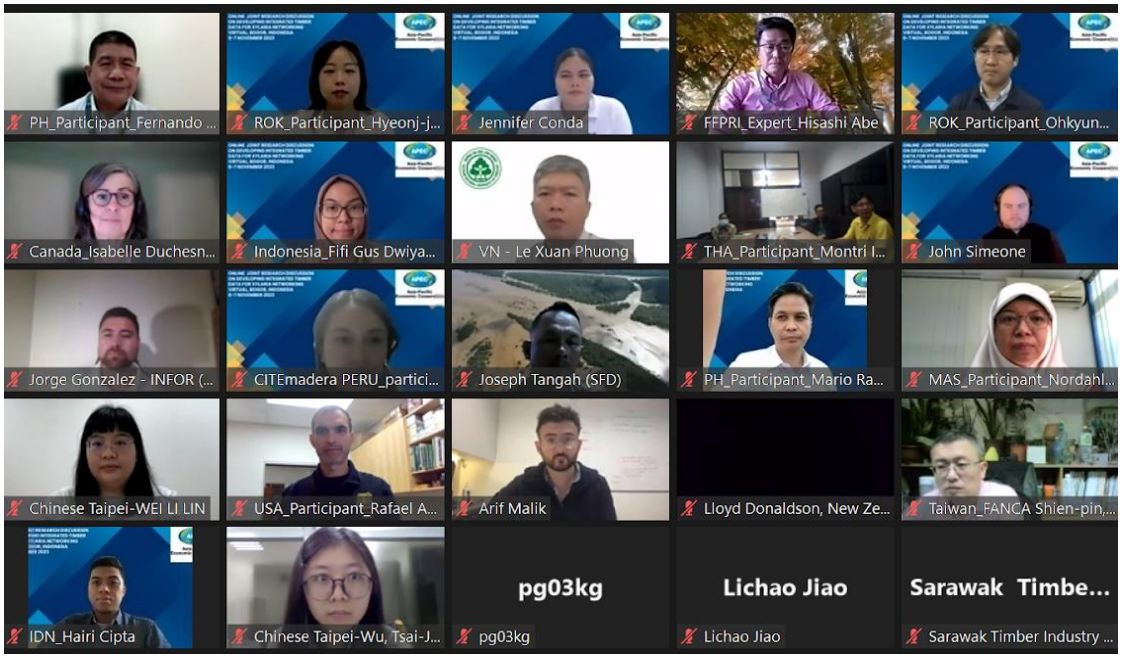
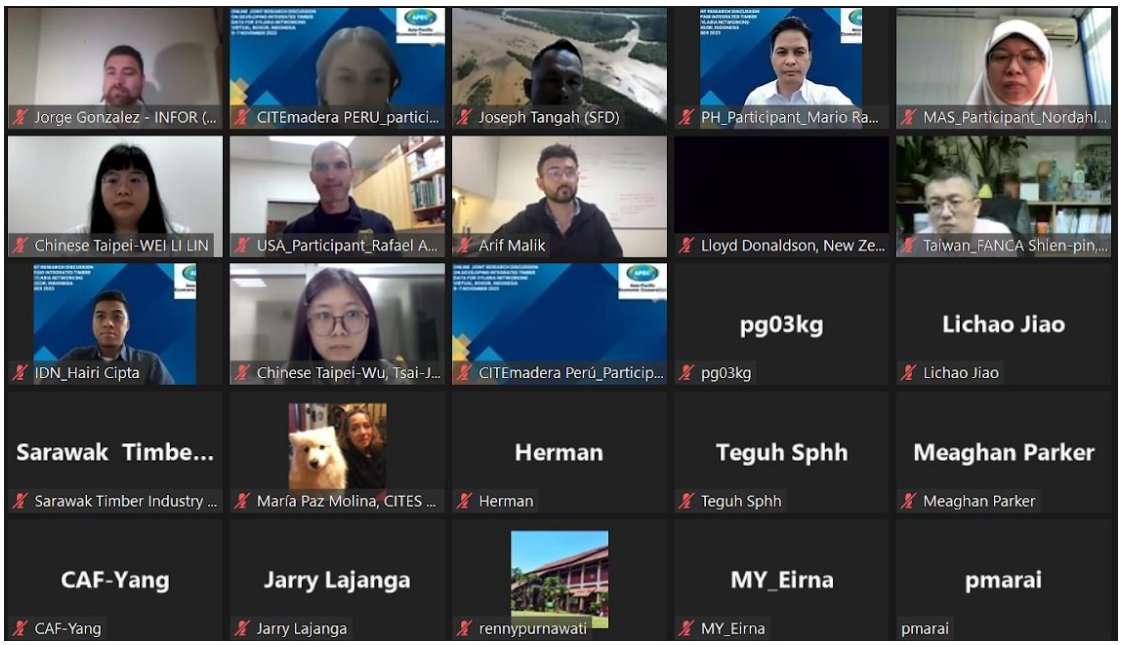
10. ANNEXES

10.1 Photo Documentation of the Joint Research Discussion





10.2 Photo Documentation of the Focus Discussion Group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JPN/Hisashi Abe
Jorge Gonzalez - INFOR (...
JPN/Akira Kagawa_FFPRI ...
TRAFFIC / Chen Hin Keong
UNODC/Dewi Tresya
PHL/Glenn B. Estudillo
US/Alex C. Wiedenhoeft
PHL/Mario Ramos
CT/Wei Li LIN
New Zealand, Lloyd Dona...
MAS/Soon Leong LEE_FRI...
CDA/Maude Couture Naud
PHL/Fernando C. Pitargu...
Jarry Lajanga
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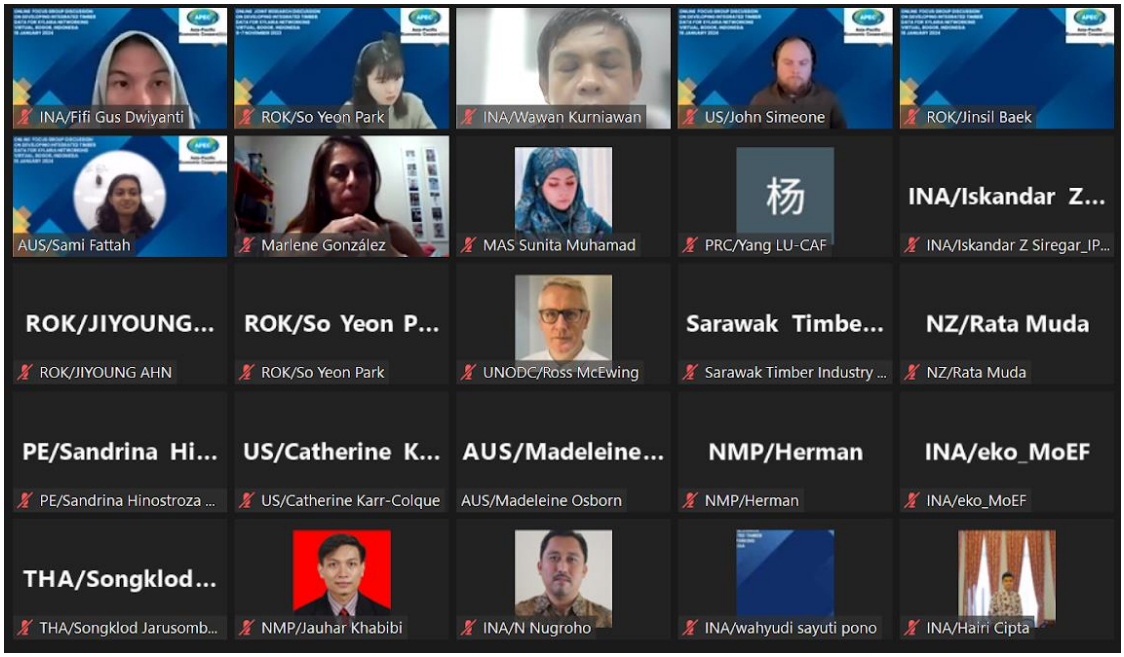
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US/John Simeone
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AUS/Sami Fattah
Marlene González
MAS Sunita Muhamad
杨
PRC/Yang LU-CAF
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ROK/JIYOUNG...
ROK/JIYOUNG AHN
ROK/So Yeon P...
ROK/So Yeon Park
UNODC/Ross McEwing
Sarawak Timbe...
Sarawak Timber Industry ...
NZ/Rata Muda
NZ/Rata Muda
PE/Sandrina Hi...
PE/Sandrina Hinostroza ...
US/Catherine K...
US/Catherine Karr-Colque
AUS/Madeleine...
AUS/Madeleine Osborn
NMP/Herman
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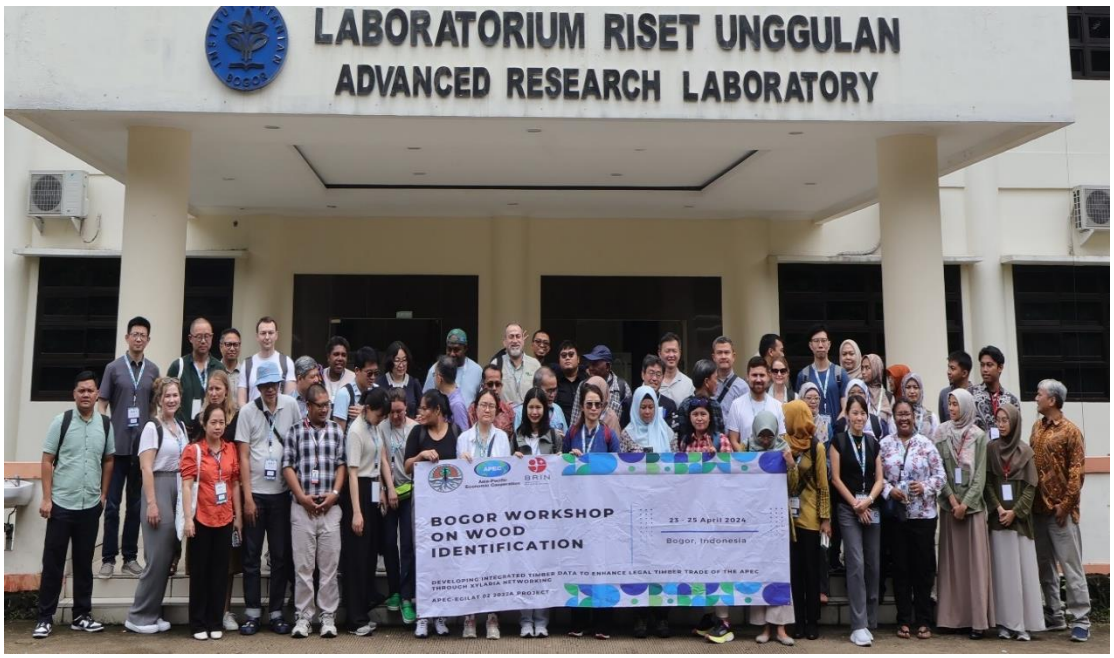
10.3 Photo Documentation of the Bogor Workshop


LABORATORIUM RISET UNGGULAN
ADVANCED RESEARCH LABORATORY
BOGOR WORKSHOP ON WOOD IDENTIFICATION
23 - 25 April 2024
Bogor, Indonesia
DEVELOPING INTEGRATED TIMBER DATA TO ENHANCE LEGAL TIMBER TRADE OF THE APEC THROUGH XYLARIA NETWORKING
APEC ECILAT 02 2022A PROJECT

10.4 Template of Letter of Agreement

LETTER OF AGREEMENT

BETWEEN

DIRECTORATE OF SCIENTIFIC COLLECTION MANAGEMENT, DEPUTY FOR RESEARCH AND INNOVATION INFRASTRUCTURE, BRIN, THE REPUBLIC OF INDONESIA

AND

[NAME OF COLLABORATOR]

CONCERNING

DEVELOPING WOOD IDENTIFICATION SYSTEM THROUGH XYLARIA NETWORKING

This Agreement is made by and between:

The Directorate of Scientific Collection Management, Deputy for Research and Innovation Infrastructure, BRIN, the Republic of Indonesia, hereinafter referred to as "DSCM-BRIN".

and

[Name of Collaborator], hereinafter referred to as "[Abbreviation of Collaborator]".

DSCM-BRIN and [Abbreviation of Collaborator] hereinafter referred to individually as the "Party" and collectively as “the Parties";

Considering their common interest on scientific and academic cooperation in a spirit of equality and mutual benefit;

Desiring to establish relations between the Parties, to strengthen their scientific and academic cooperation in the approved wood identification system on the principle of mutual benefits, concerning scientific and academic cooperation and as an implementation arrangement of the collaborative activity entitled Developing Wood Identification System Through Xylaria Networking, hereinafter referred to as the “Project”;

Pursuant to the prevailing laws and regulations in their respective economies, as well as the respective government's procedures and policies on international technical cooperation;

HAVE AGREED AS FOLLOWS:

ARTICLE I
OBJECTIVE OF THE PROJECT

The objective of the Project under this Agreement is to develop wood identification system through Xylaria Networking in order to enhance the legality of timber traded among Asia and the Pacific economies.

ARTICLE II
PROJECT ACTIVITIES

In pursuant to the above objective, the cooperation under this Agreement but not limited to:

a. to study the characteristics of traded timber using varied wood identification techniques and deposit the extracted data from the wood identification and integrate the acquired data into the Xylarium Networking system;

b. to enrich the digital and physical Xylarium Networking system into a selected wood identification tool to be used by Asia and the Pacific economies for investigating traded woods;

c. to conduct a capacity-building workshop on wood identification with the Asia and Pacific Economies officials, researchers, customs, and other relevant officials.

d. other activities that are deemed as in line with the implementation of this Agreement and agreed upon by the Parties

ARTICLE III
IMPLEMENTATION

1. The terms of cooperation for each specific activity implemented under this Agreement, including but not limited to the details of the activities such as scope of activities and program or project schedule, personnel involved, financial aspects, responsibilities undertaken by the Parties and other necessary matters that are not covered by this Agreement shall be mutually discussed and agreed upon in writing by the Parties on the Plan of Operation(s) individually and separately prior to the initiation of that activity and shall form an integral part of this Agreement.

2. The Parties agree that the activities under this Agreement will be carried out in Indonesia and Chile, specifically as follows:

a. wood sample exchange will be carried out between BRIN, Indonesia and [Abbreviation of Collaborator], [APEC Economy of Collaborator];

b. wood identification and digital system enrichment will be conducted in Indonesia;

c. capacity-building and or workshop on wood identification will be carried out in Indonesia, in partnership with other relevant institutions;

d. other activities that are deemed as in line with the implementation of this Agreement and potentially will increase the benefit of the Agreement the Parties will be implemented following the Plan of Operation(s).

3. For the purpose of communication related to this Agreement, the following persons are designated as contact representatives as follows:

a. **DSCM-BRIN** : [Name of Representative]
Address : [Representative Address]

Phone : [Representative Phone]
E-mail : [Representative Email]

b. **[Abbreviation Of Collaborator]** : [Name of Representative]
Address : [Representative Address]
Phone : [Representative Phone]
E-mail : [Representative Email]

4. The contact representatives of the Parties agree to communicate in good time to discuss and shall maintain regular contact and regular report to their director.
5. All notices to be given under this Agreement should be in written form and shall be deemed delivered when delivered in person or received by email, certified mail, return receipt requested, addressed to the recipients designated above, subject to any change of address, written notice of which will be promptly provided.
6. Relevant changes regarding the Parties' contact representatives will not require an amendment of this Agreement. The Parties will keep each other informed about the details of their contact representatives.
7. Activities under this Agreement may need other institutions or agencies from the Government of the Republic of Indonesia and/or the [APEC Economy of Collaborator], which shall be approved by the Parties.
8. Participating institutions and/or agencies referred to in Paragraph 7 shall provide a letter of statement that they shall comply with all provisions pertaining to this Agreement.

ARTICLE IV
FINANCIAL ARRANGEMENT

1. All funding, according to the Project budget agreed by both Parties for activities specified in the research proposal (Plan of Operation) will be covered by both Parties depend on case-by-case basis.
2. When appropriate, both Parties are committed to explore and seek any possible funding from both side and other additional funding from external sources upon written consent by the Parties.

ARTICLE V
CONTRIBUTION BY DSCM-BRIN

Subject to available resources and with agreement of the Parties, **DSCM-BRIN** shall:
a. encourage direct contact and cooperation between existing research teams and scientists, and explore new opportunities;
b. drafting and applying LOA, MTA, POO and other supporting documents;
c. transferring selected wood species from Indonesia to [APEC Economy of Collaborator];
d. preserving the exchanged timber from the [APEC Economy of Collaborator] and

investigating it with varied wood identification techniques;
e. integrating the resultant data into the Xylarium Networking system, and applying the selected wood identification tools for analyzing illegal timber traded,
f. conducting a capacity-building for Asia and the Pacific Economies.

ARTICLE VI
CONTRIBUTION BY [Abbreviation of Collaborator]

Subject to available resources and with agreement of the Parties, **[Abbreviation of Collaborator]** shall:
a. encourage direct contact and cooperation between existing research teams and scientists, and explore new opportunities;
b. drafting and applying LOA, MTA, POO and other supporting documents;
c. transferring selected wood species from [APEC Economy of Collaborator] to Indonesia;
d. preserving the exchanged timber from the Republic of Indonesia and investigating it with varied wood identification techniques (optional);
e. facilitating the signing of LOA, MTA, and POO processes.

ARTICLE VII
LIMITATION OF PERSONNEL ACTIVITIES

1. The Parties shall ensure that their personnel(s) engaged in activities under this Agreement will:
a. observe, respect and comply with the laws and regulations, and policies of the Government of the Republic of Indonesia and those of the Government of [APEC Economy of Collaborator].
b. Respect the integrity of the Republic of Indonesia as well as that of the [APEC Economy of Collaborator] and refrain from supporting any separatist movements;
c. Respect the customs, traditions, and religions of the local community;
d. Refrain from engaging in any political and commercial activities;
e. Refrain from conducting any religious propaganda;
f. Refrain from involving in any intelligence/clandestine activities;
g. Refrain from conducting any activities other than those agreed upon by the Parties.
2. The Parties agree to be responsible for the negligent acts or omissions of their own researchers, staff, and its associates while acting within the scope of their employment during the term of this Agreement.
3. Violation of this Article may result in revocation of permit of stay of the personnel concerned by the competent authorities as well as other necessary measures in accordance with the prevailing laws and regulations of the host economy.

ARTICLE VIII
CONFIDENTIALITY

1. In the event either Party provides information marked as “confidential” to the other Party in any form whatsoever for the purpose of carrying out activities under this Agreement, including but not limited to information in written, oral, visual and electronic form, which (i) has been or will be disclosed to the other Party, or (ii) may otherwise be

obtained by such persons in any site visits in connection with this Agreement (the "Confidential information"), the Party receiving or otherwise obtaining any Confidential information (the “Receiving Party”) hereby undertakes, acknowledges, represents and warrants to the Party disclosing or otherwise from whom the Confidential information is obtained or accessed (the “Disclosing Party”) as follows:

a. The Receiving Party shall maintain the Confidential information in strict confidence and, save as provided otherwise herein, shall not divulge the Confidential information, in part or in whole, to any other party;

b. The Receiving Party shall not communicate, indicate or inform to any other party the existence of the Confidential information or disclose the contents of Confidential information to any other party, except as provided otherwise herein;

c. All Confidential information shall be used solely for the purposes of this Agreement. The Parties shall not use the Confidential information for any other purposes other than for the purposes of this Agreement or use the Confidential information for its own or any other party’s benefit.

2. The provisions as stipulated in this Article shall not apply to Confidential information which:

a. is or lawfully becomes public information, not as a result of the default of the Receiving Party;

b. is already known to the Receiving Party prior to receipt of the same hereunder from the Disclosing Party which can be proven by written evidence and was and is not acquired from the Disclosing Party or other Party under an obligation to maintain the confidentiality of the information obtained from the Disclosing Party;

c. can be proven by written evidence to have been independently developed by the Receiving Party without using any Confidential information disclosed by the Disclosing Party; or

d. is required to be disclosed by the Receiving Party under the applicable laws and regulations or by a governmental instruction, decree, regulation or through court process. With regard thereto, the Receiving Party shall promptly notify the Disclosing Party of such request or demand.

3. The Parties agree that the provisions of this Article shall not prejudice the prevailing laws and regulations applicable to the Parties.

ARTICLE IX
PUBLICATION

1. The Parties agree that each may publish the existence and nature of activity under this Agreement provided that either Party does not indicate in writing that a specific matter should remain confidential and those who would publish should have obtained the written consent of the other Party.

2. The Parties will ensure that any publication about the relationship between the parties is accurate. Only the approved name and logo of the other Party may be used in any such materials.

3. The Parties have the right to review proposed publications of results obtained under this Agreement prior to publication.

4. The Parties agree not to publish scientific results gathered under this Agreement without the other party’s consent.

5. The Parties shall contribute in authorship of every publication resulted from this collaboration.

6. The Parties agree to acknowledge the Government of Indonesia as the source of

the Materials in all publications.
7. The results and data gathered as part of the research under this Agreement shall be published in suitable international or the Parties' scientific journals.

ARTICLE X
INTELLECTUAL PROPERTY RIGHTS

1. Any Intellectual Property (IP) including know-how, methods, and technical information brought by one of the Parties for the implementation of activities under this Agreement shall remain the property of that Party. However, that Party is liable for ensuring that the IP is not the result of the infringement of any third party's legitimate Intellectual Property Rights (IPR). Further that Party shall be liable for any claim made by a third party on the ownership and legality of the use of the IP which is brought in by the aforementioned Party for the implementation of the cooperation activities under this Agreement.
2. Any IP generated as a result of research activities conducted under this Agreement, including know-how, methods, and technical information, shall be jointly owned by the Parties, and the Parties shall be allowed to use such property for non-commercial purposes free of royalty. Should the IP, data and information resulting from collaborative activities under this Agreement be used for commercial purposes by one Party, the other Party shall be entitled to royalties on the principle of equitable contribution, based on (i) the contribution of the party and (ii) materials that include genetic resources, traditional knowledge and folklore of the economy of origin or contribution of The Parties representing their economy of origin (iii) any income arising from the research activity. The value of the object materials of collaboration as part of contribution will be measured by taking into account the following factors:
a. The scarcity of the object (the rarer the object is, the higher its value will be);
b. The commercial value of the result of the research (the higher its commercial value is the higher its worth);
3. Referring to Paragraph 2, any IP related to data and information which include, but are not limited to, photographic images, video and recording shall be jointly owned by the Parties and the Parties shall be allowed to use such properties for non-commercial purposes free of royalty and shall put Credit of source of photo/video.
4. The utilization of the IP of any research activities under this Agreement outside the territories of the Republic of Indonesia and the [APEC Economy of Collaborator] a by one of the Parties requires prior written approval from the other Party on a case-by-case basis.

ARTICLE XI
GENETIC RESOURCES AND TRADITIONAL KNOWLEDGE

1. Genetic Resources and Traditional Knowledge (GRTK) shall be defined as follow: a Genetic resource is organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity; whereas Traditional Knowledge is content or substance of knowledge that is the result of intellectual activity and inside a traditional complex, including the know- how, skills, innovations, practices and learning that form part of traditional knowledge systems.
2. The Parties shall recognize the value of GRTK and recognize the rights of holders of GRTK to the effective protection over GRTK against misuse and misappropriation by the Parties.

3. Any acquisition, appropriation or utilization of GRTK by unfair or illicit means constitutes an act of misappropriation. Misappropriation may also include deriving commercial benefit from the acquisition, appropriation or utilization of GRTK when the person using that GRTK knows, or is negligent in failing to know, that it was acquired or appropriated by unfair means, and other commercial activities resulting in inequitable benefit from GRTK and contrary to honest practice.
4. Subject to compliance with its obligation referred to in Paragraph 3, the Parties shall, in respect of the intellectual property protection of GRTK, give the same treatment that it accords its own economies to persons who, in the administered area of any of the Parties, have real and effective means for the creation, production and transaction of GRTK.
5. Any access to and use of GRTK of the respective Party under the implementation of this Agreement shall require prior consent permit from the relevant authorities of the Party. The Parties shall ensure that prior [Abbreviation of Collaborator]med consent is obtained from relevant local communities regarding access to GRTK and keep them [Abbreviation of Collaborator]med with results derived from such GRTK from activities carried out under this Agreement.
6. When the cooperative and/or collaborate activities under this Agreement utilize GRTK for commercial purpose, The Parties, on behalf of its local communities concerned, shall be entitled to the right of intellectual property, where appropriate, and associated benefit sharing.
7. The benefits of protection of GRTK to which its holders are entitled include the fair and equitable sharing of benefits arising out of the commercial or industrial use of that GRTK.
8. Legal means should be available to provide remedies for holders of GRTK in cases where the fair and equitable sharing of benefits as provided for in Paragraph 7 has not occurred.
9. Any application for Intellectual Property related to GRTK must acknowledge the economy of its origin.
10. Any GRTK must be registered and recorded at the government of the economy of its origin in accordance with the laws and regulations applicable in the economy. Such registration and recording must be completed prior to any publication made by the Parties using the GRTK.

ARTICLE XII
DATA MANAGEMENT

Primary data and the output of the research, as well as its development, assessment, and application obtained or resulted during the implementation of this Agreement, both in digital and/or physical form, must be kept in accordance with the prevailing laws and regulations of each respective contries regulations, in this case, for Indonesia shall be kept in the National Scientific Repository, BRIN and for [APEC Economy of Collaborator] shall be kept in the [Name of Collaborator], [Abbreviation of Collaborator].

ARTICLE XIII
MATERIALS

1. Materials as referred to in this Agreement are objects of research encompassing:
a. Materials that are collected and used by the Parties during the implementation of this Agreement according to Project Activities under this Agreement.

b. Materials that are resulting from the activities under this Agreement.
2. All materials provided by DSCM-BRIN are the property of the Government of the Republic of Indonesia represented by DSCM -BRIN.
3. All materials provided by [Abbreviation of Collaborator] are the property of the Government of the Republic of Chile represented by [Abbreviation of Collaborator].
4. [Abbreviation of Collaborator] recognizes the prior right of DSCM-BRIN to ultimate possession of all Indonesian Materials obtained in the course of field works in the Indonesian boundaries within the project. In the commitment thereof:
a. DSCM-BRIN is allowed unchallenged to control of all Indonesian materials collected by the Parties.
b. DSCM-BRIN shall own all materials collected from this collaboration which includes, but is not limited to, tissues, skins, skeleton, and parts and/or whole organism preserved as dry or wet specimens.
c. Subject to the prevailing Indonesian laws and regulations and with approval of DSCM-BRIN in accordance with Article XIV, [Abbreviation of Collaborator] may have access to the materials collected in accordance to activities listed in Article II.

ARTICLE XIV
MATERIAL TRANSFER AGREEMENT

1. All research materials used in the collaboration will be transferred using the Material Transfer Agreement (MTA) and will be approved by the Parties before the commencement of the activities provided in Article II of this Agreement.
2. In the case that materials originating from DSCM-BRIM are needed to be transferred from DSCM-BRIM to [Abbreviation of Collaborator], the regulations from DSCM-BRIM will apply.
3. In the case that materials originating from [Abbreviation of Collaborator] are needed to be transferred from [Abbreviation of Collaborator] to DSCM-BRIM, the regulations from [Abbreviation of Collaborator] will apply.

ARTICLE XV
FORCE MAJEURE

1. In the event that either Party is delayed or impeded in the performance of its obligations under this Agreement by reason of natural disaster (such as floods, storms, earthquake~~,~~ strikes, lockouts, riots, sabotage, battles, wars, embargo, civil commotion, labor dispute, fire explosions, failure of utilities, mechanical breakdowns, material shortages, disease, pandemic, failure of any governmental approval required for full performance or other causes beyond its control of the Parties (“force majeure”) shall not be deemed to be a breach of this Agreement, provided that the Party so prevented from complying herewith shall not have procured such force majeure, shall have used reasonable diligence to avoid such force majeure or ameliorate its effects, and shall continue to take all actions within its power to comply as fully as possible with the terms of this Agreement.
2. In the event of such Force Majeure occurred, each Party promptly inform the other Party of the nature of the relevant cause and of the expected duration of the relevant delay or impediment no later than 7 (seven) calendar days from the occurrence of a state of compulsion supported by a statement from the competent authority.
3. After the Parties agree on the occurrence of Force Majeure, the implementation of

the cooperation under this Agreement shall then be re-determined by the Parties.

ARTICLE XVI
SETTLEMENT OF DISPUTES

Any dispute as to the interpretation and implementation of this Agreement shall be settled amicably by mutual consultation between the Parties based on the principles of cooperation, equality, and sincerity.

ARTICLE XVII
MONITORING AND EVALUATION

1. The Parties shall conduct joint monitoring and evaluation on the implementation of activities under this Agreement, at least 1 (one) time a year.
2. The Parties shall deliver the monitoring and evaluation result to their respective high-level officials within 1 (one) month after the completion of the field evaluation and such result may be used as a consideration to extend or terminate this Agreement.

ARTICLE XVIII
AMENDMENT

Each Party may request in writing an amendment or modification of any part of this Agreement. Any amendment or modification shall be agreed upon by the Parties in writing and shall constitute part of this Agreement. Such amendment or modification shall form an integral part of this Agreement and shall enter into force on such a date as may be determined by the Parties.

ARTICLE XIX
ENTRY INTO FORCE, DURATION, AND TERMINATION

1. This Agreement shall be in effect from the latest date of its signing and shall remain in force for a period of 3 (three) years.
2. Either Party may terminate this Agreement at any time by giving written notification to the other, at least 3 (three) months prior to the intended date of the termination.
3. The termination of this Agreement shall not affect the contract or activities made during the validity of this Agreement until completion of such contracts or activities, unless otherwise decided by the Parties.
4. Article VIII, IX, X, XI, XIII, and XIV shall survive upon the termination of this Agreement.

IN WITNESS WHEREOF, the undersigned, have signed this Agreement.

DONE in duplicate in English language. Each copy which has been provided to the Parties is considered as being equally authentic. Any translations are for convenience only and will no force or effect on the interpretation hereof.

FOR Directorate of Scientific Collection Management, BRIN, the Republic of Indonesia,	FOR [Institution Name of Collaborator], [APEC Economy of Collaborator]
Prof. Dr. Ratih Damayanti, S.Hut, M.Sc Director Date : [Date of Signing] Place : [APEC Economy of Collaborator]	[Named of the Head of APEC Economy Collaborator] [Position of APEC Representative] Date : [Date of Signing] Place : [APEC Economy of Collaborator]

10.5 Template of Letter of Intent

LETTER OF INTENT

BETWEEN

DIRECTORATE OF SCIENTIFIC COLLECTION MANAGEMENT, BRIN

AND

[Name of Collaborator], [APEC Economy of Collaborator]

ON

DEVELOPING WOOD IDENTIFICATION SYSTEM THROUGH XYLARIA NETWORKING

This Letter of Intent (hereinafter referred to as "LoI") is made by and between:

Directorate of Scientific Collection Management , Republic of Indonesia (hereinafter referred to as “DSCM-BRIN").

And

[Name of Collaborator], [APEC Economy of Collaborator], (hereinafter referred to as "[Abbreviation of Collaborator]")

Hereinafter referred to singularly as "The Party" and collectively as "The Parties",

DESIRING to establish collaboration and explore opportunities to develop, support and enrich the development of research in the fields that will be beneficial to the Parties on the basis of reciprocity in areas of mutual interest;

PURSUANT to the prevailing laws and regulations in their respective parties as well as their respective governments' procedures and policies on international technical cooperation;

HAVE REACHED a consensus and commitment on the intention to exercise their best efforts to develop cooperation between the Parties on the following points:

1. The two parties will promote in particular the following activities:

a. Exchange of scientific materials (wood samples, technologies, and database), publications, and information
b. Exchange of curators, researchers, and technicians
c. Research and publication
d. Joint activity and scientific meetings
e. Capacity building

2. These activities are to be carried out after mutual consultation between the two parties or the divisions concerned thereof.
3. All financial arrangements to pursue any of the above activities are to be negotiated for each specific case.
4. The two parties agree that, in the event of research collaboration leading to patent rights, copyrights, or other intellectual property rights, a further agreement must be negotiated in each case in accordance with the policies of the two parties on intellectual property.
5. This LOI serves as an initial step with a view to make further arrangements for the implementation of the cooperation with particular focus on aforementioned activities.
6. This LOI is a non-binding expression of the current intentions of the Parties, and does not create any rights or obligations to the Parties until definitive agreements have been negotiated, approved by the necessary management levels of each Party and executed and delivered by representatives of the Parties.
7. Amendment of this LOI is to be effected upon deliberation by the two parties.
8. This LOI shall be effective upon signature by the two parties and shall remain in force for a period of three years. Thereafter, it may be reviewed and extended upon agreement by the two parties.
9. Termination of this LOI may be effected upon deliberation by the two parties. Either party has the right to terminate the agreement without liability by giving six months' notice in writing of such intent.
10. This LOI is written and executed in English.

lN WITNESS WHEREOF, The Parties have signed this LOI.

Signed in Duplicate in Jakarta, The Republic of lndonesia on [Date of Signing] in English Language. Each copy, which has been provided by the parties, is considered as being equally authentic. Any translations are for convenience only and will have no force or effect on the interpretation hereof.

Date: [Date of Signing]	Date: [Date of Signing]
[Name of Focal Point] [Position] [Name of Collaborator] [APEC Economy of Collaborator]	Dr. Ratih Damayanti Director of Scientific Collection Managemen, BRIN

10.6 Template of Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING

BETWEEN

DEPUTY FOR RESEARCH AND INNOVATION INFRASTRUCTURE, BRIN, THE REPUBLIC OF INDONESIA

AND

[Name of Collaborator], [APEC Economy of Collaborator]

CONCERNING

DEVELOPING WOOD IDENTIFICATION SYSTEM THROUGH XYLARIA NETWORKING

This Memorandum of Understanding (hereinafter referred to as the “MOU”) is made by and between:

Deputy for Research and Innovation Infrastructure, BRIN, the Republic of Indonesia (hereinafter referred to as "DRII-BRIN");

and

[Name of Collaborator], [APEC Economy of Collaborator], (hereinafter referred to as "[Abbreviation of Collaborator]").

DRII-BRIN and [Abbreviation of Collaborator] hereinafter collectively referred to as the “Parties” and individually referred to as “Party”;

Considering the common interest of the Parties in promoting and fostering science and technology development in the spirit of equality and principle of mutual benefit;

Desiring to establish relations between the Parties, to strengthen their scientific and academic cooperation in the approved wood identification system on the principle of mutual benefits, concerning scientific and academic cooperation and as an implementation arrangement of the collaborative activity entitled Developing Wood Identification System Through Xylaria Networking;

Pursuant to the prevailing laws and regulation in their respective economies, as well as the respective government’s procedures and policies in international technical cooperation;

NOW THEREFORE, in consideration of the terms and conditions hereinafter set forth, the Parties agree as follows:

ARTICLE 1
PURPOSE

The purpose of this MOU is to develop wood identification system through Xylaria Networking in order to enhance the legality of timber traded among Asia and the Pacific economies.

ARTICLE 2
AREAS OF COOPERATION

The cooperation under this MOU shall include, but not limited to the following areas:

a. environment sciences and technology;
b. agriculture and forestry;
c. biomass management and valorization;
d. material identification technology;
e. digitalization and knowledge products management.

ARTICLE 3
FORM OF COOPERATION

The cooperation between the Parties may be executed in the following forms:

a. scientific collection management;
b. joint research and publication;
c. project management lifecyles;
d. capacity-building and skills enhacement.

ARTICLE 4
IMPLEMENTATION

1. For the purpose of the implementation this MOU, the Parties will formulate the arrangements for each specific project in separate arrangement(s), the contents of which may include, but are not limited to, the details of the activities, such as scope of activities, program or project schedules, details of the personnel involved, the funding scheme responsibilities undertaken by the Parties and other necessary matters that are not covered by this MOU.
2. For the purpose of communication related to this MOU, the following persons are designated as contact points:

   a. **DRII-BRIN** : [Name of Focal Point]
      Address : [Address of Collaborator]
      Phone : [Phone of Collaborator]
      E-mail : [Email of Collaborator]

   b. **[Abbreviation of Collaborator]** : [Name of Focal Point]
      Address : [Address of Collaborator]
      Phone : [Phone of Collaborator]

E-mail : [Email of Collaborator]

3. All notices related to the implementation of this MOU shall be in written form and shall be deemed delivered when delivered in person or received by email, certified mail, return receipt requested, addressed to the recipients designated above, subject to any change of address, written notice of which will be promptly provided.
4. Any changes regarding the contact points of either Part shall be communicated in writing to the other Party and will not be regarded as an amendment.
5. Representatives of the Parties shall be in good coordination and communication to discuss and agree on the strategic direction of the cooperation under this MOU.

ARTICLE 5
FINANCIAL ARRANGEMENT

1. The Parties agree that all financial arrangements for the implementation of this MOU is subject to the availability of funds of the Parties and in accordance to the applicable laws and regulations of their respective economies.
2. All related cost of programs or project under this MOU should be agreed by the Parties on a case-by-case basis.
3. Either Party may facilitate and find appropriate financial support from legitimate third party to support their collaborative programs or projects under this MOU upon written consent from the other Party (which consent shall not be unreasonably withheld).

ARTICLE 6
INTELLECTUAL PROPERTY

1. Any Intellectual Property (hereinafter referred to as “IP”) brought by one of the Parties for the implementation of activities under this MOU shall remain the property of that Party. However, the Party shall indemnify that the IP has not resulted from the infringement of any third party’s legitimate rights. Further that Party shall be liable for any claim made by a third party on the ownership and legality of the use of the IP which is brought in by the aforementioned Party for the implementation of the cooperation activities under this MOU.
2. Any IP, arising out of the implementation of this MOU, including know-how, methods, and technical information, shall be jointly owned by the Parties, and the Parties shall be allowed to use such IP for non-commercial purposes free of royalty. Should the IP resulted from the cooperation activities under this MOU be used for commercial purposes by either Party, the other Party shall be entitled to the royalties obtained from the exploitation of such property on the basis of the principle of equitable contribution. In such case, the object of the research activities conducted under this MOU shall constitute a part of contribution of the Party from which the object derives. The value of the object as part of contribution will be measured by taking into account the following factors:
   a) the scarcity of the object (the rare the object is, the higher its value will be); and

b) the commercial value of the result of the research (the higher its commercial value is, the higher its worth).

3. The detailed provisions on benefit-sharing from the commercial use of any IP, data, and information resulting from research activities conducted under this MOU will be specified in a separate written arrangement which becomes an integral part of this MOU.
4. Either Party may register the IP resulting from collaborative activities under this MOU in their respective economies with prior written consent from the other Party.
5. Either Party may utilize the object of the research activities and their findings under this MOU outside the territories of the Republic of Indonesia and of [APEC Economy of Collaborator] by one of the Parties upon prior written approval from the other Party on a case-by-case basis.

ARTICLE 7
GENETIC RESOURCES, TRADITIONAL KNOWLEDGE AND TRADITIONAL CULTURAL EXPRESSIONS

1. The Parties shall recognize the value of Genetic Resources, Traditional Knowledge and Traditional Cultural Expressions (hereinafter referred to as “GRTK&TCE”), and recognize the rights of holders of GRTK &TCE to effective protection over their GRTK&TCE against any misuse and misappropriation by either Party.
2. Any acquisition, appropriation, or utilization of GRTK&TCE by unfair or illicit means constitutes an act of misappropriation. Misappropriation may also include deriving commercial benefit from the acquisition, appropriation, or utilization of GRTK&TCE when the person using that GRTK&TCE knows, or is negligent in failing to know, that it was acquired or appropriated by unfair means or through commercial activities contrary to honest practices that gain inequitable benefit from the GRTK&TCE.
3. Any access to and use of GRTK&TCE by the Parties under the implementation of this MOU shall require prior consent permit from the relevant authorities of the economy or municipal jurisdiction in which the GRTK&TCE is found. The Parties shall ensure that the local communities concerned shall give prior informed consent to the access and be informed of the access and of the results of the cooperative and/or collaborative activities under this MOU using such GRTK&TCE.
4. When the result of cooperative and/or collaborative activities under this MOU that utilize GRTK&TCE is used for a commercial or industrial purpose, the Party located in the economy in which the GRTK&TCE in question is found, on behalf of its local communities concerned, shall be entitled to the right of intellectual property arising from such usage, where appropriate, as well as fair and equitable benefit sharing.
5. Legal means should be available to provide remedies for holders of GRTK&TCE in cases where the fair and equitable sharing of benefits as provided for in paragraph 4 of this Article has not occurred.
6. Any application for IP Rights related to GRTK&TCE shall acknowledge the economy of its origin.

7. Any GRTK&TCE shall be registered and recorded at the government of the economy of its origin in accordance with the laws and regulations applicable in the economy. Such registration and recording must be completed prior to any publication made by the Parties using the GRTK&TCE.

ARTICLE 8
CONFIDENTIALITY AND PUBLICATION

1. Either Party shall treat as confidential any and all technical data and information related to the project conducted under this MOU which has been or may hereafter be made available to it, directly or indirectly, by the other Party, including any information made available in writing, orally, or by assembly embodying the technical and commercial information. Such information shall not be used except for the purposes as provided in Article 1 of this MOU.
2. In the event either Party wishes to disclose any confidential data and information supplied for or resulted from the implementation of this MOU, the disclosing Party shall have prior written consent from the other Party.
3. The Parties agree that each Party may publish the existence and nature of activity under this MOU provided that either Party does not indicate in writing that a specific matter should remain confidential.
4. The Parties shall ensure that any publication about the relationship between the Parties is accurate. Only the approved name and logo of the Parties may be used in any such materials.
5. Each Party shall comply with the other Party's reasonable requests about publishing this relationship with a view to promoting the cooperation with integrity and accuracy.
6. The Parties agree that the provisions of this Article shall not prejudice the prevailing laws and regulations of respective economies of the Parties.

ARTICLE 9
MATERIAL TRANSFER AGREEMENT

Research materials originating from either economy of the Parties used for the collaboration activities under this MOU, to the fullest extent possible, be dealt with in the economy of origin. In the event that such research materials need to be transferred outside the administered area of the economy of origin, the transfer shall be conducted using Material Transfer Agreements concluded between the Parties in accordance with the prevailing laws and regulations as well as policies of the economy of origin.

ARTICLE 10
DATA MANAGEMENT

Primary data as well as output of the research, including development, assessment and application data obtained and/or resulted during the implementation of this MOU will be stored in accordance with the laws and regulations in the respective economies. In this

case, such data originating from Indonesia will be stored in the National Scientific Repository of BRIN.

ARTICLE 11
LIMITATION OF PERSONNEL ACTIVITIES

1. The Parties shall ensure that their personnel(s) engaged in activities under this MOU will:
   a) observe, respect and comply with the laws and regulations, and policies of the host economy;
   b) respect the integrity of the Republic of Indonesia as well as that of the Government of [APEC Economy of Collaborator] and refrain from supporting any separatist movement;
   c) respect the customs, tradition and religions of the local community;
   d) refrain from engaging in any political and commercial activities while engaging with this MOU;
   e) refrain from conducting any religious propaganda while engaging with this MOU; and
   f) refrain from involving in any intelligence/clandestine activities while engaging.
2. The Parties agree to be responsible for the negligent acts or omissions of their own researchers, staff and its associates while acting within the scope of their employment during the term of this MOU.
3. Violation of this Article may result in revocation of permit of stay of the personnel concerned by the competent authorities as well as other necessary measures in accordance with the prevailing laws and regulations of the host economy.

ARTICLE 12
FORCE MAJEURE

1. A Party shall not be liable for failure to perform its obligations under this MOU, nor be liable to any claim for compensation or damage, nor be deemed to be in breach of this MOU, if such failure arises from an occurrence or circumstances beyond the reasonable control of that Party (hereinafter referred to as “Force Majeure Event”).
2. If a Party is affected by a Force Majeure Event which causes a delay of three (3) months or more, and if such delay may reasonably be anticipated to continue, the Parties shall, discuss whether continuation of the project is viable, or whether the project under this MOU shall be terminated.

ARTICLE 13
SETTLEMENT OF DISPUTE

Any disputes arising from the interpretation and/or implementation of this MOU shall be settled amicably through consultation or negotiation between the Parties.

ARTICLE 14

MONITORING AND EVALUATION

1. The Party shall conduct joint monitoring and evaluation on the implementation of activities under this MOU as well as to discuss and agree the strategic direction of cooperation under this MOU.
2. The monitoring and evaluation as referred to in paragraph (1) of this Article shall be conducted at least once a year.
3. The result of the monitoring and evaluation may be used as a consideration to extend or terminate this MOU.

ARTICLE 15
AMENDMENT

Any amendment of this MOU shall be agreed upon by the Parties in writing. Such amendment shall be constituted as an integral part of this MOU and shall enter into force on such date determined by the Parties.

ARTICLE 16
ENTRY INTO FORCE, DURATIONS AND TERMINATIONS

1. This MOU shall enter into force on the latest date of its signing and shall be valid for a period of 3 (three) years.
2. Either Party may terminate this MOU at any time by giving written notification to the other Party of its intention to terminate this MOU at least 3 (three) months prior to the intended date of the termination.
3. Termination and/or expiration of this MOU shall not affect the completion of ongoing programs or projects activities carried out under this MOU, unless the Parties decide otherwise.
4. Article 6, 7, 8, 9, and 10 shall survive the expiry and termination of this MOU.

IN WITNESS WHEREOF, the undersigned have authorized to sign this MOU.

DONE in duplicate in the Indonesian and English language, both texts being equally authentic. In case of any divergence of interpretation, the English text shall prevail.

FOR Deputy for Research and Innovation Infrastructure, BRIN, the Republic of Indonesia	FOR [Name of Institution]
Dr. Yan Rianto, M.Eng. Acting Deputy Chairman Date : [Date of Signing] Place : [Place of Signing]	[Echelon I of the Collaborator] [Position] Date : [Date of Signing] Place : [Place of Signing]

10.7 Template of Material Transfer Agreement for Indonesia as the Receipt

BRIN

THE REPUBLIC OF INDONESIA

MATERIAL TRANSFER AGREEMENT (MTA)

NO: / / /

This Biological Material Transfer Agreement is made on Tuesday, April 23rd, 2024 by and between:

Provider Scientist	:	[Name of Representative/Focal Point] [Position],
Provider Organization	:	[Name of Collaborator], [APEC Economy of Collaborator]
Provider Address	:	[Address of Collaborator]
		(hereinafter referred to as the PROVIDER)

Recipient Scientist	:	[Name of Representative/Focal Point], [Position],
Receipt Organization	:	[Name of Collaborator], [APEC Economy of Collaborator]
Receipt Address	:	[Address of Collaborator]
		(hereinafter referred to as the RECEIPT)

In Consideration of the Receipt's covenant and premises contained herein, the Provider intents to transfer wood species from the [APEC Economy of Collaborator] categorized as "Traded Value Species" to the Republic of Indonesia, with a total number of [6 wood species with minimal 3 samples]. The detailed wood species is annexed in Table 1. Any transfer of materials under this agreement from the Provider to the Receipt should refer to

the signed umbrella documents of the Letter of Agreement (LOA) and Plan of Operations (POO).

These biological materials are used for supporting the Project of the Developing Wood Identification System through Xylaria Networking.

In response to the Receipt's request for the above-transferred biological materials from the [APEC Economy of Collaborator] to Indonesia, the Provider and Receipt agrees to the following terms in consideration of receipt of the biological materials:

1. Biological Material shall mean the above-referenced biological material plus unmodified derivatives and any accompanying know-how or data. All materials transferred to the Receipt by the Provider are the property of the Government of the [APEC Economy of Collaborator], represented by [Abbreviation of Collaborator], which will be used and deposited only for scientific collection purposes in Indonesia.
2. The biological material and its derived products, genetic parts, or components will not be further distributed to others, whether affiliated or not affiliated with the Receipt's laboratories, without information and permission of the Provider.
3. The Biological Material will be used for the project of Developing Wood Identification System through Xylaria Networking, especially for collection, capacity-building materials, and possible wood identification studies, using varied methods, such as wood anatomy, dendrochronology, mass spectrometry, spectroscopy, stable isotope, radiocarbon, and or DNA-based approaches.
4. Any remaining biological material used in the studies and capacity-building processes will be deposited in the Receipt as part of the Xylarium collection. Any uses and purposes of the materials that are not stipulated in this agreement, other will be regulated using a separate agreement.
5. Any publication resulting from studies, which use the materials, shall be a joint publication between the Provider and the Receipt, with the authorship according to the appropriate share of the publication. The proposed organization shall jointly inform the other organization of any publication, which will be made. The finished report on the study results, if any, will be sent to the Provider and the Receipt, as the national scientific reference.
6. If the Receipt organization wishes to patent and modify the material, the Receipt will contact the Provider. Both organizations should agree upon and arrange it in separate agreements prior to such use. Ownership will be negotiated in good faith by the organizations here depending upon:
   a. the ownership of biological material will recognize contributors to the patent process;
   b. relative contribution to the creation of said modifications and derivatives, and
   c. any applicable laws and regulations relating to inventorship.

7. The biological material is experimental and provided with any warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.
8. The organizations shall exchange, in confidence, any and all data, records, and results derived from the exchanged materials, including detailed records of direct use of materials. Any and all data, records, and results derived from the depository of materials, and the Research Plan/Protocol must be shared at a mutually agreeable time following a request from the organizations.

9. The organizations have agreed to safely archive the transferred materials perpetually under the conditions in this agreement. As this agreement also includes the exchange and store-save of the materials, the materials will belong to the Provider after the project's termination and will be deposited permanently in the Receipt's Xylarium

The Recipient organization and or its representatives will sign three copies to indicate acceptance of the above terms. Three original signed documents should be returned to the Provider for signature and routing to regulatory compliance.

PROVIDER SCIENTIST REPRESENTATIVE: Signature:
[Name of Representative/Echelon II],
[Position],
[Name of Collaborator],
Date: [Date of Signing]

PROVIDER ORGANIZATION'S
AUTHORIZED OFFICIAL: Signature:
[Name of Focal Point/Echelon I],
[Position],
[Name of Collaborator],
Date: [Date of Signing]

RECIPIENT SCIENTIST REPRESENTATIVE: Signature:
Dyah Ayu Agustiningrum
Researcher
Deputy of Research and Innovation Infrastructure,
BRIN,
Date: April 23rd, 2024

RECIPIENT ORGANIZATION's
AUTHORIZED OFFICIAL: Signature:
Dr. Ratih Damayanti, S.Hut, M.Sc
Director of Scientific Collection Management,
Deputy of Research and Innovation Infrastructure,
BRIN,
Date: April 23rd, 2024

Table 1. List of exchanged wood specimens

No	Trade Name	Scientific Name	Family	Sample dimension (cm)
1.	Yellow Meranti	*Shorea hopeifolia*	Dipterocarpaceae	7,5 x 12,5 x 2,5
2.	Resak	*Vatica nitens*	Dipterocarpaceae	8 x 10 x 2,5
3.	Winong	*Tetrameles nudiflora*	Tetramelaceae	5,5 x 10 x 2
4.	Sumac	*Rhus taitensis*	Anacardiaceae	5,5 x 10 x 2
5.	Keruing Minyak	*Dipterocarpus eurynchus*	Dipterocarpaceae	7,5 x 12,5 x 2,5
6.	Mahoni	*Swietenia* sp.	Meliaceae	6 x 10,5 x 1
7.	Durian	*Durio* sp.	Bombaceae	6 x 10,5 x 1
8.	Nangka	*Artocarpus heterophyllus*	Moraceae	6 x 10,5 x 1
9.	Rambutan	*Nephelium* sp.	Sapindaceae	6 x 10,5 x 1
10.	Mangga	*Mangifera* sp.	Anacardiaceae	6 x 10,5 x 1
11.	Mersawa	*Anisoptera* sp.	Dipterocarpaceae	6 x 10,5 x 1
12.	Meranti	*Shorea* sp.	Dipterocarpaceae	6 x 10,5 x 1
13.	Merbau	*Intsia bijuga*	Leguminosae	6 x 10,5 x 1
14.	Singkil	*Dryobalanops* sp.	Dipterocarpaceae	6 x 10,5 x 1
15.	Kempas	*Koompassia malaccensis*	Leguminosae	6 x 10,5 x 1
16.	Akasia	*Acacia mangium*	Leguminosae	2 x 10,5 x 2
17.	Gmelina	*Gmelina* sp.	Lamiaceae	6 x 10,5 x 1
18.	Sonokembang	*Pterocarpus indicus*	Leguminosae	8 x 10,5 x 1,5
19.	Pinus	*Pinus* sp.	Pinaceae	6 x 10,5 x 1
20.	Jati	*Tectona grandis*	Lamiaceae	2 x 10,5 x 2
21.	Nyamplung	*Calophyllum* sp.	Clusiaceae	8 x 10,5 x 1

10.8 Template of Material Transfer Agreement for Indonesia as the Provider

BRIN

THE REPUBLIC OF INDONESIA

MATERIAL TRANSFER AGREEMENT (MTA)

NO: / / /

This Biological Material Transfer Agreement is made on Tuesday, April 23rd, 2024 by and between:

Provider Scientist	:	[Name of Representative/Focal Point], [Position]
Provider Organization	:	[Name of Collaborator], [APEC Economy of Collaborator]
\Provider Address	:	[Address of Collaborator]

(hereinafter referred to as the PROVIDER)

Recipient Scientist	:	[Name of Representative/Focal Point], [Position]
Receipt Organization	:	[Name of Collaborator], [APEC Economy of Collaborator]
Receipt Address	:	[Address of Collaborator]

(hereinafter referred to as the RECEIPT)

In Consideration of the Receipt's covenant and premises contained herein, the Provider intents to transfer wood species from the Republic of Indonesia categorized as "Traded Value Species" to the [APEC Economy of Collaborator], with a total number of [3 wood

species with minimal 3 samples]. The detailed wood species is annexed in Table 1. Any transfer of materials under this agreement from the Provider to the Receipt should refer to the signed umbrella documents of the Letter of Agreement (LOA) and Plan of Operations (POO).

These biological materials are used for supporting the Project of the Developing Wood Identification System through Xylaria Networking.

In response to the Receipt's request for the above-transferred biological materials from Indonesia to the [APEC Economy of Collaborator], the Provider and Receipt agrees to the following terms in consideration of receipt of the biological materials:

1. Biological Material shall mean the above-referenced biological material plus unmodified derivatives and any accompanying know-how or data. All materials transferred to the Receipt by the Provider are the property of the Government of Indonesia, represented by DSCM-BRIN, which will be used and deposited only for scientific collection purposes in [APEC Economy of Collaborator].
2. The biological material and its derived products, genetic parts, or components will not be further distributed to others, whether affiliated or not affiliated with the Receipt's laboratories, without information and permission of the Provider.
3. The Biological Material will be used for the project of Developing Wood Identification System through Xylaria Networking, especially for collection, capacity-building materials, and possible wood identification studies, using varied methods, such as wood anatomy, dendrochronology, mass spectrometry, spectroscopy, stable isotope, radiocarbon, and or DNA-based approaches.
4. Any remaining biological material used in the studies and capacity-building processes will be deposited in the Receipt as part of the Xylarium collection. Any uses and purposes of the materials that are not stipulated in this agreement, other will be regulated using a separate agreement.
5. Any publication resulting from studies, which use the materials, shall be a joint publication between the Provider and the Receipt, with the authorship according to the appropriate share of the publication. The proposed organization shall jointly inform the other organization of any publication, which will be made. The finished report on the study results, if any, will be sent to the Provider and the Receipt, as the national scientific reference.
6. If the Receipt organization wishes to patent and modify the material, the Receipt will contact the Provider. Both organizations should agree upon and arrange it in separate agreements prior to such use. Ownership will be negotiated in good faith by the organizations here depending upon:

d. the ownership of biological material will recognize contributors to the patent process;

e. relative contribution to the creation of said modifications and derivatives, and

f. any applicable laws and regulations relating to inventorship.

7. The biological material is experimental and provided with any warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.
8. The organizations shall exchange, in confidence, any and all data, records, and results derived from the exchanged materials, including detailed records of direct use of materials. Any and all data, records, and results derived from the depository of materials,

and the Research Plan/Protocol must be shared at a mutually agreeable time following a request from the organizations.

9. The organizations have agreed to safely archive the transferred materials perpetually under the conditions in this agreement. As this agreement also includes the exchange and store-save of the materials, the materials will belong to the Provider after the project's termination and will be deposited permanently in the Receipt's Xylarium

The Recipient organization and or its representatives will sign three copies to indicate acceptance of the above terms. Three original signed documents should be returned to the Provider for signature and routing to regulatory compliance.

PROVIDER SCIENTIST REPRESENTATIVE: Signature:
Dyah Ayu Agustiningrum
Researcher
Deputy of Research and Innovation Infrastructure,
BRIN,
Date: April 23rd, 2024

PROVIDER ORGANIZATION's
AUTHORIZED OFFICIAL: Signature:
Dr. Ratih Damayanti, S.Hut, M.Sc
Director of Scientific Collection Management,
Deputy of Research and Innovation Infrastructure,
BRIN,
Date: April 23rd, 2024

RECEIPT SCIENTIST REPRESENTATIVE: Signature:
[Name of Representative/Echelon II],
[Position],
[Name of Collaborator],
Date: [Date of Signing]

RECEIPT ORGANIZATION'S
AUTHORIZED OFFICIAL: Signature:
[Name of Focal Point/Echelon I],
[Position],
[Name of Collaborator],
Date: [Date of Signing]

Table 1. List of exchanged wood specimens [Name of wood specimens from Collaborator]

Number of samples	Name of species	Organism samples and size
3		Yes, wood with a size of 10 cm x 10 cm x 5 cm
3		Yes, wood with a size of 10 cm x 10 cm x 5 cm
3		Yes, wood with a size of 10 cm x 10 cm x 5 cm
3		Yes, wood with a size of 10 cm x 10 cm x 5 cm
3		Yes, wood with a size of 10 cm x 10 cm x 5 cm

10.9 Template of Plan of Operation

PLAN OF OPERATION

CONCERNING

DEVELOPING WOOD IDENTIFICATION SYSTEM THROUGH XYLARIA NETWORKING

DIRECTORATE OF SCIENTIFIC COLLECTION MANAGEMENT, DEPUTY FOR RESEARCH AND INNOVATION INFRASTRUCTURE, BRIN, THE REPUBLIC OF INDONESIA

AND

[Name of Collaborator], [APEC Economy of Collaborator]

APRIL 2024

PLAN OF OPERATION

CONCERNING

DEVELOPING WOOD IDENTIFICATION SYSTEM THROUGH XYLARIA NETWORKING

BACKGROUND

According to the UN Environment Programme and Interpol, illegal logging contributes about 15-30% of the global timber trade and is estimated to increase about 50-90% of the trade from tropical economies. The Environmental Investigation Agency reported that illegal timber trade in Asia and the Pacific is estimated to be worth USD 11 billion yearly, or about 30% of the total regional trade in wood products. Illegal logging and illicit timber trade can happen along the global timber supply chain. However, due to the siloed compartment of the timber supply chain, it is challenging to track the legality of timbers. As a result, wood identification data extracted from different uses of technologies needs to be integrated into the Xylarium Networking, especially by the Economies of Asia and the Pacific region. One of the ways to embody the mission is through the collaborative Project of the Developing Wood Identification System through Xylaria Networking, which will be conducted between the Government of Indonesia and Asia and Pacific Economies.

The Project is a regional project on wood identification technologies and capacity-building in Asia and the Pacific region, supported by the parties, to strengthen wood identification systems and improve documents' accuracy in legal timber trading. The Project is managed by the Directorate of Scientific Collection Management of the BRIN in partnership with the Indonesian Ministry of Environment and Forestry (KLHK). The Project focuses on joint research and capacity-building workshops on utilizing wood identification tools for forensic analysis in addressing transnational forestry crimes of illegal logging and associated trade. The Project also intends to observe the potential use of the Asia-Pacific Xylaria Networking to integrate the wood identification data with the respective Asia and Pacific Timber Legality Assurance Systems (TLAS) or other timber legality systems in Asia and the Pacific Economies. Besides that, the Project also supports wood identification capacity-building for wood identification experts, officials, customs and forestry Bureaurs directly connecting with forensic timber.

On 6-7 November, the Joint Research Discussion on Developing Integrated Timber Data for Xylaria Networking was virtually undertaken in Bogor, Indonesia. This Discussion aimed to deliberate pivotal points of wood identification in Asia and the Pacific region, such as commonly used wood identification tools, a list of traded timber, the potential development of Xylaria Networking, regional standards, and material transfer agreements. The Discussion has taken several key takeaways, which could be policy recommendations for Asia and the Pacific Member, such as:

- The need to develop an open Material Transfer Agreement (MTA) and a Letter of Agreement (LOA) for wood identification.
- The need to exchange specific objects under MTA, and the most practical thing is digital data development.
- The demand to develop a baseline framework for regional standards on wood identification.

- The demand to develop the standards referring to the published works and not creating redundant and duplicate standards and
- Follow up the subsequent actions to embody these propositions, namely MTA and regional standards, by SMART activities, such as mapping institutions for MTA materialization, designing specific sampling methods for wood identification approved by the Economies, etc.

It is noted that the LOA and MTA are two pivotal agreements that help facilitate the embodiment of Xylaria Networking through the exchange of collaborative activities supporting forensic timber application and the exchange of wood identification materials. Regarding MTA, there will possibly be an exchange of traded timber or technologies in Asia and the Pacific. To accelerate the LOA and MTA processes, a Plan of Operation is developed to detail and provide guidance on how to actualize the SMART (Specific, Measurable, Achievable, or/and Assignable, Relevant or/and Realistic and Time-Bound) activities stipulated in these two agreements.

OBJECTIVES

The objectives of the Project that will be conducted under the LOA and MTA ratification are:

- to study the characteristics of traded timber from Asia and the Pacific using varied wood identification techniques, and deposit the extracted data from the wood identification and integrate the acquired data into the Xylarium Networking;
- to enrich the digital and physical Xylarium Networking system into a selected wood identification tool to be used by Asia and the Pacific Economies for investigating the legality of traded woods;
- to conduct a capacity-building workshop on wood identification with Asia and the Pacific Economies officials, researchers, customs, and other relevant officials.

SCOPE

The scope of this research covers three parts:

1. ratification of LOA and MTA with the exchange of wood samples between DSCM-BRIN and [Abbreviation of Collaborator],
2. identification of wood sample properties using varied wood identification techniques and integrating the extracted data into the selected wood identification tool for further applications,
3. conducting a physical capacity-building on wood identification and its application between DSCM-BRIN and [Abbreviation of Collaborator] as well as other Asia and the Pacific Economies.

STAGES

As stated in the scope of the Project, there will be three stages that will be carried out to achieve the objectives and the deliverables:

1. Ratification of LOA and MTA between DSCM-BRIN and [Abbreviation of Collaborator],
2. Identification of traded timber properties from Indonesia and [APEC Economy of Collaborator], and integrating wood properties data into Xylaria Networking,
3. Conducting a capacity-building workshop on wood identification.

These stages are depicted in detail as follows:

Stage 1. Ratification of Letter of Agreement (LOA), Material Transfer Agreement **(**MTA) and Plan of Operation (POO) between DSCM-BRIN and [Abbreviation of Collaborator],

1. Drafting MTA, LOA, and (POO)
    - Legal scrubbing for LOA, MTA and POO.
    - Finalizing the drafted LOA, MTA and POO.
2. Selecting traded timbers that will be included in MTA.
3. Signing and ratifying LOA, MTA, and POO.

Stage 2. Identification of Traded Timber Properties from Indonesia and the [APEC Economy of Collaborator], and Integrating Wood Properties Data into Xylaria Networking

1. Identifying wood properties that will be characterized.
2. Characterizing wood species from the Asia and the Pacific Members and interpreting the data.
3. Analyzing and interpreting the resultant data.
4. Depositing the data into a digital drive for the enrichment of wood identification data.
5. Enriching and integrating the data into a selected wood identification tool/tools in Xylaria Networking.

Stage 3. Conducting a capacity-building workshop on wood identification

1. Organizing capacity building through the Bogor Workshop for representatives of the Parties.
2. Testing and piloting the recommended tool for investigating illegal traded wood in Indonesia after the Bogor Workshop.
3. Reporting the results of capacity-building and piloting the recommended tool to the wood identification tool provider and Asia and the Pacific Economies.

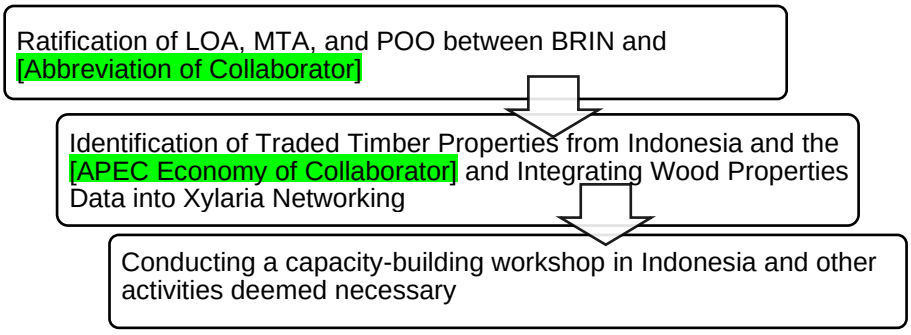


Figure 1. Stages of research framework on Xylaria studies among Asia and the Pacific Economies

OUTPUT

Outputs that will be generally attained from the actualization of LOA and MTA on the Xylaria study include: 1) the signed LOA and MTA and the endorsed supporting documents (POO), 2) the enhanced traded timber system on wood identification with different properties and a selected wood identification tool/tools deposited with the enhanced system, and 3) actualization of a capacity-building workshop. Under these

outputs, some specific results per stage will be generated to be achieved within the defined project or this study's lifetime.

Stage 1. Ratification of LOA, MTA, and POO between DSCM-BRIN and [Abbreviation of Collaborator]

1. Drafted LOA, MTA, and POO.
2. Signed LOA, MTA, and POO between DSCM-BRIN and [Abbreviation of Collaborator].
3. List and number of traded timbers exchanged in MTA.

Stage 2. Identification of Traded Timber Properties from Indonesia and the [APEC Economy of Collaborator], and Integrating Wood Properties Data into Xylaria Networking

1. Traded timber with its properties.
2. Enhanced Xylaria Networking system with identified timber properties.
3. A selected wood identification tool/tools that will be used for forensic timber.

Stage 3. Application and Capacity-Building on Wood Identification

1. Improved human resources skills on wood identification through Bogor Workshop.
2. Application of the wood identification tool/tools in Asia and the Pacific Economies.

CONTRIBUTIONS OF BOTH INSTITUTIONS

The Directorate of Scientific Collection Management, Deputy for Research and Innovation Infrastructure, BRIN, Indonesia shall:

1. encourage direct contact and cooperation between existing research teams and scientists, and explore new opportunities.
2. drafting and applying LOA, MTA, POO and other supporting documents.
3. transferring selected wood species from Indonesia to [APEC Economy of Collaborator].
4. preserving the exchanged timber from the [APEC Economy of Collaborator] and investigating it with varied wood identification techniques.
5. integrating the resultant data into the Xylarium Networking system, and applying the selected wood identification tools for analyzing illegal timber traded, conducting a capacity-building for Asia and the Pacific Economies.

The [Name of Collaborator], [Abbreviation of Collaborator], the [APEC Economy of Collaborator] contributions include:

1. encourage direct contact and cooperation between existing research teams and scientists, and explore new opportunities
2. drafting and applying LOA, MTA, POO and other supporting documents,
3. transferring selected wood species from [APEC Economy of Collaborator] to Indonesia,
4. preserving the exchanged timber from the Republic of Indonesia and investigating it with varied wood identification techniques (optional),
5. facilitating the signing of LOA, MTA, and POO processes.

PERSONNEL

Table 2. Research Management Team Members from BRIN:

No	Name	Position
1	Prof. Dr. Ratih Damayanti	Principal Researcher
2	Dr. Krisdianto	Vice Principal Research
3	Ms Dyah A Agustiningrum	Assistant Researcher
4	Ms Setiowati	Assistant Researcher
5	Ms Erlina Aini	Assistant Researcher
6	Mr Wawan Kurniawan	Assistant Researcher
7	Ms Sarah Andini	Assistant Researcher
8	Ms Mutia H Ningrum	Assistant Researcher
9	Dr Djarwanto	Assistant Researcher
10	Dr Listya Mustika Dewi	Assistant Researcher
11	Dr Raden G Rahmanto	Assistant Researcher
12	Dr Rohmah Pari	Assistant Researcher
13	Dr Imran A Sofianto	Assistant Researcher
14	Ms Satria Oktarita Nugraha	Consultant
15	Mr Achmad Solikhin	Consultant

Table 3. Research Team Management Members from the [Abbreviation of Collaborator]:

No	Name	Position
1		
2		
3		
4		
5		
6		

LOCATION

Research activities and collaboration will be conducted at:

a) The laboratory of BRIN, Cibinong Science Center, Indonesia,

b) The laboratory of [Abbreviation of Collaborator], the [APEC Economy of Collaborator].

FINANCIAL ARRANGEMENT AND BUDGET

1) The Parties, DSCM-BRIN and [Abbreviation of Collaborator], agree to seek finance to support the Project on Developing Wood Identification System through Xylaria Networking.
2) The Parties, DSCM-BRIN and [Abbreviation of Collaborator], agree to provide in-kind contributions during the implementation of this LOA and MTA. For instance, DSCM-BRIN and [Abbreviation of Collaborator] will provide free wood samples for material exchanges.
3) The budget will be allocated for a meeting arrangement for a capacity-building workshop, collecting and transporting wood samples (in-kind contribution), administrative regards (in-kind contribution), and project management (in-kind contribution).

Table 4. Proposed budget for operationalization of the Project

No.	Activities	Source
1.	Meeting arrangement for a wood identification workshop (Bogor Workshop)	APEC EGILAT Project 02 2022A
2.	Collecting and transporting wood samples	in-kind contribution
3.	Characterization of wood samples	in-kind contribution
4.	Administrative regards	in-kind contribution
5.	Project management	in-kind contribution

CLOSING REMARKS

This POO provides a detailed research roadmap and framework for Xylaria studies, as the signed LOA and MTA stipulated. This statement is made truthfully and to be used accordingly.

First Party	Second Party
BRIN	**[Name of Collaborator]**
By:	**By:**
Name: Prof. Dr. Ratih Damayanti	**Name: [Name of Focal Point]**
Title: Director of Scientific Collection	**Title: [Position]**

Note: Green-highlighted words in brackets indicate "the information that is required to be filled out by the collaborated APEC member economy."