Verifying timber in Africa

An ITTO project has helped develop DNA fingerprinting and other tools for verifying claims about timber species and geographic origin in tropical Africa

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Fingerprint: Wood samples are taken from a tree in southwestern Ghana during a training workshop in May 2014.
Photo: Bernd Degen, Thünen Institute, Germany

Illegal logging and associated trade is the cause of many economic and environmental problems in both timber producer and timber consumer countries. An estimated 50% of timber exports from the Amazon Basin, Central Africa, Southeast Asia and the Russian Federation originate from illegal logging (Li et al. 2008; Goncalves et al. 2012), and an estimated 7–17% of the global timber harvest (100–300 million m^3 of logs per year) is from illegal sources (Dieter et al. 2012). Illegal logging reduces the tax income of timber producer countries, and illegally harvested timber also competes unfairly in the marketplace with legally and sustainably produced timber. The World Bank Group (Goncalves et al. 2012) estimated that illegally harvested timber results in annual losses in governmental and private-sector revenues and assets of US$10–15 billion. The illegal timber harvest causes forest degradation, excessive greenhouse gas emissions and the loss of biodiversity, and it increases the likelihood of deforestation.

Legal instruments such as the European Union Timber Regulation (EUTR) and the United States' Lacey Act have been established to combat illegal logging and the trade of illegally sourced timber by requiring importers to conduct due diligence on the legality of the timber they import. But practical mechanisms for identifying the tree species and geographic origin of wood and wood products are still lacking. DNA fingerprinting and stable isotope techniques use characters inherent to the timber and are impossible to falsify; they could be useful mechanisms for timber traders in meeting their due-diligence obligations, and they could greatly assist authorities tasked with ensuring legality.

Developing wood identification tools

With a view to demonstrating the applicability of DNA fingerprints and stable isotopes, ITTO financed Project PD 620/11 Rev.1 (M): "Development and implementation of species identification and timber tracking in Africa with DNA fingerprints and stable isotopes". This project, which is now in the final stages of implementation[1], is being implemented by the Thünen Institute of Forest Genetics in Germany, supported by 14 collaborative agencies in Africa, Asia and the Pacific, and Europe. It operates in seven African countries: Cameroon, the Republic of the Congo, the Democratic Republic of the Congo, Côte d'Ivoire, Gabon, Ghana and Kenya; all these countries except Kenya are ITTO members.

Selection of focus species

In 2011, representatives of participating African countries who attended a workshop in Yaoundé selected three species—iroko (*Milicia excelsa*), sapelli (*Entandrophragma cylindricum*) and ayous (*Triplochiton scleroxylon*)—for the development of DNA fingerprinting and stable isotope reference databases as tools for verifying the declared geographic origin of wood. These species were selected because they are harvested and traded in significant volumes, they occur widely in the participating countries, and they are economically important in tropical Africa. The yearly timber production of these three species in natural forests in the above-listed countries is estimated at more than 10 million m^3, of which more than 1 million m^3 is exported.[2]

1 Donors to the project are the German Federal Ministry of Food and Agriculture and the governments of the United States and Australia. The project is expected to conclude in July 2015.

2 These volumes are estimated based on documents received from the ministries in charge of forests in the participating African countries.

Development of reference databases

DNA fingerprinting

The project collected more than 5400 leaf, cambium and wood samples as reference material over the distribution areas of the three species (Figure 1). For each species, more than 1000 gene markers (single nucleotide polymorphisms—SNPs[3]) were developed, and all samples were genotyped for at least 70 SNPs.[4] Groups of individuals with similar genetic composition ("genetic clusters") were identified based on these data and set in a geographic context to create genetic geographic reference maps that are now available to tests claims of geographic origin (Figure 2).

Testing such claims involves extracting DNA from wood samples and comparing the genotypes with the genetic reference material. It is now possible, for example, to use the database to verify a claim that a wood sample is sapelli from Cameroon by determining whether the genotype of the sample matches the genetic clusters in the reference data for Cameroon. This process is referred to as DNA fingerprinting.

Figure 1: Distribution of sampling locations for the three tropical African timber species

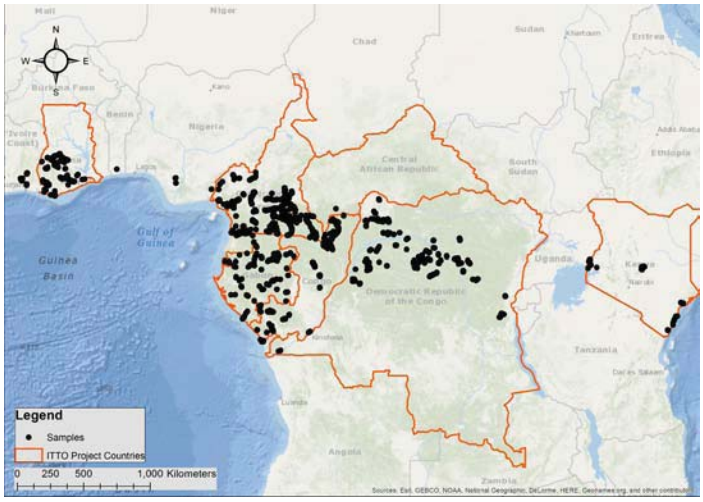
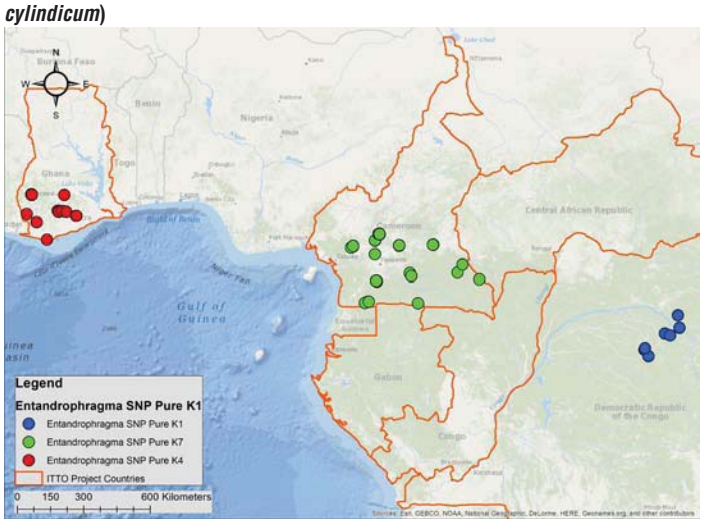


Figure 2: Distribution of genetic clusters for sapelli (*Entandrophragma cylindicum*)



Note: Each colour represents a genetic cluster that can be compared with the declared genetic cluster found in wood samples.

3 SNPs are variations in the genetic code caused by the change of a single base (i.e. one of four alternative letters of the genetic code). This variation is caused by point mutations.

4 The genetic reference data were developed by the Thünen Institute of Forest Genetics, the University of Adelaide (Australia) and the University of Brussels (Belgium).

Stable isotopes

A similar approach was taken to developing a database of stable isotopes.[5] The methodology involved screening 3–6 stable isotopes of carbon, hydrogen, nitrogen, oxygen, strontium and sulphur for each of the three target species. The resultant reference database can be used to determine the region of origin of a sample.[6]

Additional databases

Another collaborating agency, Plant Genetic Diagnostics GmbH (Grosshansdorf, Germany), identified differences in DNA sequences that can be used to help identify, to the species level, 21 important timber taxa in Africa. For example, wood anatomy alone cannot distinguish between species within the *Khaya* genus, but DNA sequencing can.

Blind tests are being run in the final stages of the project to evaluate the power of the various timber identification tools—DNA fingerprinting, stable isotopes, DNA sequencing and the more conventional approach of using anatomical characteristics—and the potential for combining various techniques.

Technology transfer to Africa

To help build capacity and transfer technology, the project established three reference laboratories in tropical Africa: at the Forest Research Institute of Ghana in Kumasi for West Africa; at the Institut de Recherche en Ecologie Tropicale in Libreville, Gabon, for Central Africa; and at the Kenya Forestry Research Institute in Nairobi for East Africa. Staffs at these labs and elsewhere in Africa are being trained to apply DNA fingerprinting and wood anatomical tree species identification techniques and to perform simple DNA fingerprinting and stable isotope tests for determining origin. In the future it is envisaged that these labs will do DNA testing directly on timber products, either to ensure legality before export or to check claims of timber designated for domestic markets. The idea of regional labs implies that neighbouring timber-producing countries are also able to access and make use of these facilities.

Practical application of DNA tests in the timber sector

Tests for timber products using DNA fingerprinting and wood anatomical approaches are common practice at the Thünen Centre of Competence on the Origin of Timber in Germany.[7] Such tests are available for an increasing number of species (Degen et al. 2013; Jolivet and Degen 2012; Höltken et al. 2012).

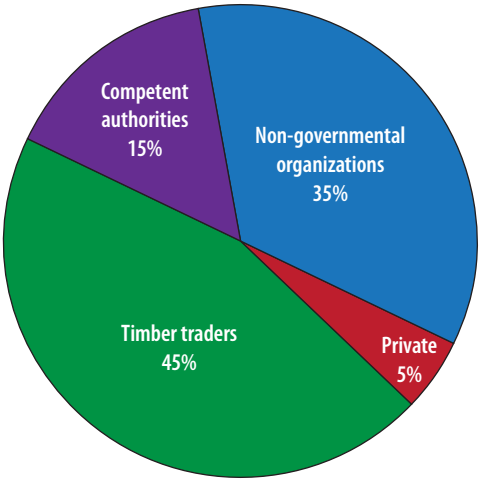
5 Isotopes are non-radioactive variants of the same chemical element—they have the same number of protons but a different number of neutrons. The isotope ratio for a given element shows a geographic pattern.

6 The isotope reference database was developed by Agroisolab GmbH in Jülich (Germany), Josephinum Research in Wieselburg (Austria) and the Department for Environment, Food and Rural Affairs (United Kingdom).

7 www.ti.bund.de/en/infrastructure/the-thuenen-centre-of-competence-on-the-origin-of-timber.

The coming into force of the EUTR in March 2013 more than tripled the number of DNA tests conducted at the Thünen Centre of Competence on the Origin of Timber—from 136 in 2013 to 436 in 2014. Figure 3 shows the percentage of wood samples submitted for testing in 2014, by organization type. Timber traders wanting to verify the claims made by suppliers on the species and origin of their timber submitted nearly half (45%) of the samples. Another 35% of the samples were submitted by non-governmental organizations running campaigns to sensitize the public about the trade of illegally harvested timber. Authorities in European Union member countries responsible for overseeing the implementation of the EUTR—including the Federal Institute for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung) in Germany and the National Measurement Office in the United Kingdom—as well as the Department of Economic Affairs (Eidgenössisches Departement für Wirtschaft, Bildung und Forschung) in Switzerland submitted 15% of samples, and private entities wishing to clarify the species and origin of their timber purchases submitted the remaining 5%.

Figure 3: Percentage of wood samples submitted for testing at the Thünen Centre of Competence on the Origin of Timber, by organization type, 2014



Note: n = 436.

Several institutions in addition to the Thünen Centre of Competence on the Origin of Timber have the capacity to test claims on the species and origin of timber. The Global Network of Timber Tracking[8] provides an overview of these; it is also developing a reference database and standards for the application of the tools.

Since the EUTR came into force, many timber traders have reinforced their efforts to verify the chains of custody of their products through paper-based certificates. Nevertheless, cases have arisen in which chain-of-custody-certified wood products have been shown to have false claims about species or geographic origin; this highlights the importance of the independent auditing of claims using DNA fingerprinting and wood anatomical testing (to determine species) and DNA fingerprinting and stable isotope testing (for geographic origin).

Costs

The verification of a species claim using macro and microscopic inspection of wood anatomical traits costs around €100 per sample. The cost of DNA fingerprinting and isotope tests to verify claims of origin is €150–400, and it takes from three days to three weeks to obtain results.

The same quality assurance processes should be applied to DNA and isotope tests as for other aspects of the timber production process. Thus, tests should be applied using a sampling approach, as required in the norms of the International Organization for Standardization.

Conclusion

The project developed reference databases for three African timber species that can be used to verify claims about the origin of timber consignments. Reference databases for other species also exist or are being developed. In the longer term, the development of three testing laboratories in Africa should help build local expertise in the verification of timber species and origin.

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8 www.globaltimbertrackingnetwork.org.