Genetic and isotopic fingerprinting methods – practical tools to verify the declared origin of wood

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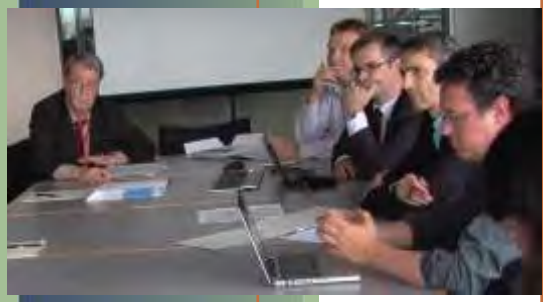
Summary



The International Conference "Genetic and isotopic fingerprinting methods – practical tools to verify the declared origin of wood" was organised by GTZ – Sector Programme International Forest Policy (GTZ-IWP) and WWF Germany. Together with their partners The Forest Trust (TFT), University of Hamburg / Johann Heinrich von Thünen-Institute (vTI) and TÜV Rhineland / AgroIsolab they have conducted two different projects to demonstrate the applicability of fingerprinting techniques for timber from managed natural forests on concession level in Central Africa (Cameroon) and for CITES-listed and other trade-restricted timber species worldwide. The GTZ project in Cameroon was kindly co-financed by the EU-Commission, the WWF project on Teak and Mahogany species was kindly co-financed by the Deutsche Bundesstiftung Umwelt (DBU). EU and DBU also supported this conference.

The objectives of the conference were to provide a forum for the transfer of experiences and results of the two projects, to discuss the potential of the different tracking methods, to discuss the potential and requirements for practical application and to analyse the technical and other requirements to set up and manage an international database.

69 participants from 19 countries attended the conference which was held in English and French language (simultaneous translation). Moderators were Dr Stefanie von Scheliha (GTZ-IWP) and Johannes Zahnen (WWF Germany).

The projects' results received very positive feedback from the audience. For all stakeholders – representatives from producer countries and buyer countries, ministries, companies of the wood sector, scientists, and NGOs – the presentations and discussions brought exciting news about the state of the art of fingerprinting methods and their applicability. The discussions about the application spectrum, overlapping and extension to regulations like EU illegal timber regulation but also discussions about the development status of the methods have been vivid and fruitful. Numerous recommendations for practical application and further scientific work were compiled. The atmosphere at the end of the conference was considerably optimistic that these methods can and will play a role in future control of wood trade and exclusion of illegal wood.

All presentations are attached to this documentation for further details.

Content

1. Opening of the Conference

Dr Stephan Paulus

Director of GTZ Division Environment and Climate Change

Johannes Zahnen

WWF Germany

Denis Koulagna

Secretary General of the Ministère de Forêts et de la Faune (MINFOF), Cameroon

The conference was opened by **Dr Stephan Paulus**, Director of GTZ Division Environment and Climate Change. He introduced the participants into the role of forests for human wellbeing and GTZs activities to promote sustainable forest management and forest governance. He thanked all partners and contributors, especially the EU-Commission, for their kind support of the conference.

Mr **Johannes Zahnen** from WWF Germany welcomed all participants. He highlighted the urgency to preserve existing native forests. Illegal logging is one of the drivers of forest loss, which results in loss of species and a massive contribution to global warming. WWF sees the chance that new regulations in the US and Europe to combat illegal wood will diminish the trade of wood based products from unwanted sources. Important puzzles missing up to now are methods that are able to verify the documents needed in connection with regulations. Back in 2004 WWF Germany started projects with the stable isotope method and later also in a combined project with stable isotopes and DNA fingerprinting with the goal to further develop the methods towards practicality and reliability in the wood sector.

WWF expressed its pleasure that so many people from all over the world showed interest in the conference to learn more about the methods and the results of the current projects. From WWF's perspective good improvements have been made. The goals for the future are the establishment of an international database and from the technical angle to come to reliable results from one single piece of wood.

Secretary General **Denis Koulagna** from the Ministère de Forêts et de la Faune (MINFOF) gave an overview on the efforts made by the Government of Cameroon to negotiate and implement the Voluntary Partnership Agreement on Forest Law Enforcement, Governance and Trade (FLEGT) with the EU. He emphasized that reliable and practical tracking and verification systems are a core element of the FLEGT legality assurance system (LAS) in Cameroon. MINFOF has supported the GTZ-fingerprinting project right from the beginning and expects to receive additional support in implementing the FLEGT-VPA and more effective timber tracking in the Congo Basin region.

2. Background and history of conference

Matthias Schwoerer

Head of the European and International Forest Policy Division in the German Federal Ministry of Agriculture and Consumer Protection (BMELV)

Mr **Matthias Schwoerer**, Head of the European and International Forest Policy Division in the German Federal Ministry of Agriculture and Consumer Protection (BMELV), gave an overview on the history of German support for fingerprinting techniques for timber tracking. Back in 2001 the first international workshop was held at the Federal Forest Research Institute in Hamburg with the aim to examine the potential of physical, chemical and genetic means to identify the origin of timber. Motivated by discussions in the G8 and existing examples in the food sector (wine barrels) the main purpose was to further develop techniques to falsify reported origins of timber in cases of doubts on the declaration of origin. In 2007 BMELV and WWF organised a scientific workshop in Koenigswinter / Germany to take stock of new methods of identifying timber species and timber origins and to develop and manage reference data bases.

All actors involved agreed on the proven potential of these techniques that required additional work for refinement and upscaling. As a next step, Germany supports an ITTO pre-project implemented by the von-Thuenen Institute Section of Forest Genetics that aims to develop and implement a species identification and timber tracking system with DNA fingerprints and stable isotopes in Central and East Africa.

Johannes Zahnen

WWF Germany

Mr. **Johannes Zahnen** highlighted WWF surveys in Germany showing that companies know little about the origin of wood and wood products they are trading with. Knowingly or unknowledgeably they declare the wrong origin and wood species.

He introduced into the logic and aim of wood tracking technologies like e.g. paint and chisel labels, magnetic strip cards, radio frequency identification labels (RFID) and fingerprinting methods (DNA, stable isotopes). One weak point of wood tracking technologies is that because they follow the product through the chain of custody misuse including intentional fraud cannot be excluded totally. Main differences between wood tracking technologies and fingerprinting methods are that in most cases wood tracking technologies are used only in the first step(s) of the chain of custody and they are following the product itself. This is a crucial difference to fingerprinting methods (DNA and isotopes) because these methods can be used totally independent at any point of the chain of custody to verify if the declared origin or wood species is right or not. The information fingerprinting methods are using is fixed in the wood itself and cannot be changed any more. He stressed that DNA and isotope fingerprinting techniques cannot and shall not substitute existing tracking systems or other accompanying paper works like certificates. Instead, fingerprinting techniques allow verifying existing mechanisms and jointly building a much more reliable system.

WWF expects finger printing methods to become an important tool to control EU or US regulations in future and a tool for companies to control their suppliers. Fingerprinting methods are a fast way to verify accompanying documents. WWF hopes that these methods will also play a role in future to shelter protected areas.

3. Presentation of recent project results

3.1. Introduction into genetic fingerprinting

Dr Bernd Degen

Head of the Institute for Forest Genetics at the Johann-Heinrich-von-Thuenen Institute (vTI)

Dr Bernd Degen, Head of the Institute for Forest Genetics at the vTI, introduced the participants into the background of genetic fingerprinting. The genome of trees has regions that are highly variable among individuals of the same species. The parts of genes (consisting of DNA) where these differences are observed are called microsatellites. The genetic composition of tree populations shows a spatial pattern which is caused e.g. by extinction and recolonisation in the past glacial times or spatial limited pollen and seed dispersal. The spatial genetic pattern is visible by a correlation of genetic differences and spatial distances between tree populations. For a given landscape the genetic pattern can be identified based on a scientifically planned sampling of plants. The timber origin can be controlled by comparing the genotypes of wood samples with the genetic pattern observed in sampled populations.

3.2. Project results – genetic fingerprinting – WWF/DBU (Teak, Mahogany)

Dr Aki Höltken

vTI

Dr Aki Höltken from vTI presented the results of the WWF-project funded by DBU. To ensure that international timber trade does not threaten the survival of many tropical tree species, more than 40 timber species are listed in the current CITES regulations (Convention on International Trade in Endangered Species). In many cases, however, the power of discrimination proves to be difficult or even impossible, particularly on lower taxonomic levels (within genera or families). Macro- and microscopical limits of resolution necessitate the development of additional identification systems. The prerequisite for successful application of molecular markers is variation in the molecular traits to be analysed. The highest resolution power is provided by molecular markers directly based on DNA sequences. This type of marker recognises small changes in the DNA sequence and is therefore called “Single Nucleotide Polymorphism” (SNP). Furthermore, the genomic regions to be screened for SNPs should be conserved within but differentiate between species. From all cell compartments containing DNA, chloroplast DNA has been shown to be the ideal source of genetic information. 22 fragments of the chloroplast ring chromosome have been chosen to search for species specific variation. From these, the most suitable fragments will be selected for later routine checks. In cooperation with WWF and DBU the first DNA based identification systems in the *Meliaceae* familiy was successfully developed to differentiate between the protected mahogany species *Swietenia macrophylla*, *S. mahagoni* and *S. humilis*, listed on CITES II, and exchange timbers (*Khaya sp.*, *Entandrophragma sp.* and *Carapa guianensis*). Further, barcoding markers were developed for Teak (*Tectona grandis*), bearing wood anatomical analogies to *Cedrela odorata* (Spanish cedar, CITES-listed and also belonging to the *Meliaceae* family). The developed markers are already applicable to the above mentioned species. To carry out independent controls in several countries of the world, tools will be designed that could be applied and managed with low-cost equipment without the need for sequencing or cappilary electrophoresis techniques.

3.3. Project results – genetic fingerprinting – GTZ/EU (Cameroon)

Dr Celine Jolivet
vTI

Dr Celine Jolivet from vTI presented the results of the GTZ-project funded by the EU-Commission on using genetic fingerprints to verify the origin of timber on concession level. The project was conducted in Cameroon for two timber species: Sapelli (*Entandrophragma cylindricum*) and Iroko (*Milicia excelsia*). In the target concession (1,937 square kilometers = 193,700 hectares) a total of 5 populations of Sapelli and 1 Iroko population were sampled, of which 303 samples of Sapelli and 50 samples of Iroko were taken. Additionally, 62 samples of Sapelli and 123 samples of Iroko were taken outside the target concession from other concessions within Cameroon to identify the spatial pattern. In the concession there was a huge difference for the abundance / density of Sapelli and Iroko: Sapelli is very abundant whereas Iroko is very rare and occurred in aggregates (clumps). Due to the height of the tress leaf material was not available so all samples were taken from the Cambium of the trunks and stored in Silica-Gel.

Results: The scientists were able to identify microsatellites that reveal a spatial pattern between the target concession and outside that area.

A blind test was conducted for both species. For Iroko only two different types of blind samples were available: from very distant (Ivory Coast), this sample was identified as definitely not deriving from the target concession. The other blind samples stem from a concession area less than 100 km distant from the target concession. These could not be excluded from the target concession. For Sapelli seven different blind test samples were available. Five of them truly identified if the origin was the target concession (2 samples) or not (3 samples). It is worth noting that one of these samples was not a Sapelli sample but from Sipo timber which is closely related with Sapelli and contained the same microsatellite. Only one sample that stemmed from the target concession was identified as having a different origin.

The results for Iroko show that for the distinction on regional level the existing markers can be used. For the distinction on local level (less than 100 kilometres) additional markers are needed for a reliable distinction.

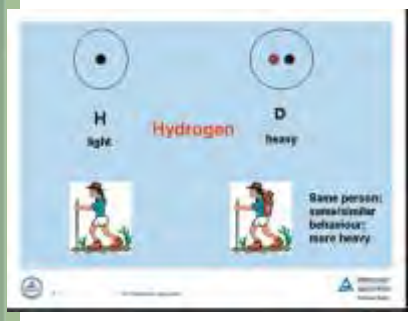
For Sapelli the results show that the markers identified can be applied for the distinction on all levels. The two blind test samples that did not match need additional analysis to find the root causes for that misinterpretation.

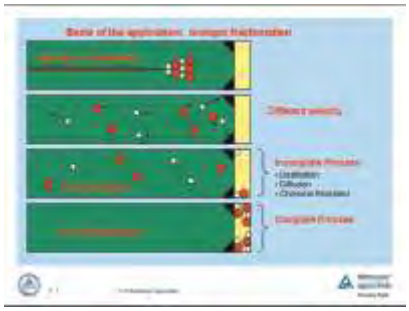
Additional samples from the fields will not be helpful since the density of samples seems to be appropriate.

3.4. Introduction into isotopic fingerprinting

Prof Hilmar Förstel
TÜV Rhineland / Agroisolab

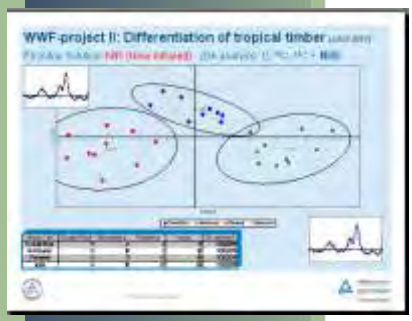
Prof Hilmar Förstel from TÜV Rhineland / Agroisolab gave a brief introduction into the background of isotopic fingerprinting. Stable isotopes of atoms are natural variants which are not radioactive. They only differ in their specific masses. Due to their different weights they react a bit differently (are fractionated), illustrated by a different velocity of their molecules in the gaseous phase. Analytically they can be measured reproducible in mass spectrometers and natural variations can be observed. Plants take up different chemical elements through water (Hydrogen, Oxygen), nutrition from soil (Sulphur, Strontium, Nitrogen) and by photosynthesis (Carbon, Oxygen). The distribution of isotopes shows different patterns whereby different elements are used for different levels. The best known pattern is the fractionation of Hydrogen and Oxygen in the global water cycle. The ratios of Hydrogen and Oxygen isotopes are used for wider regions, for presently declarations consider the national level only. The ratios of Carbon isotopes as a climate and Strontium isotopes as a geological parameter differ on regional level. For the local level Sulphur and Nitrogen isotopes and their ratios can be used because they reflect geological / soil identities. Through the combination of elements it is possible to check the declaration of the origin of a product. The method has been successfully applied with over 70 different farm products and food (e.g. potatoes, wheat, fruits, onions). The European Community and the International Office of Vine and Wine have accepted the stable isotope method to control wines. The method is used by big retailers to control their food suppliers and is already accepted by court.





3.5. Project results – isotopic fingerprinting – WWF/DBU (Teak, Mahogany)

Dr Markus Boner
TÜV Rhineland / Agroisolab



Dr Markus Boner from TÜV Rhineland / Agroisolab presented the project results. The objective of the WWF-DBU project was to build up a first stable isotope database to differentiate the origin of Teak and Mahogany species. For the differentiation a combination of different stable isotopes were used including the stable isotopes of hydrogen, oxygen, carbon, nitrogen and sulphur, representing the bio elements, and the stable isotope of strontium as a possibility for the higher stable isotopes. In the first step the sampling of reference timber (Teak) was concentrated on the Asian regions, including Java, Laos and Burma.

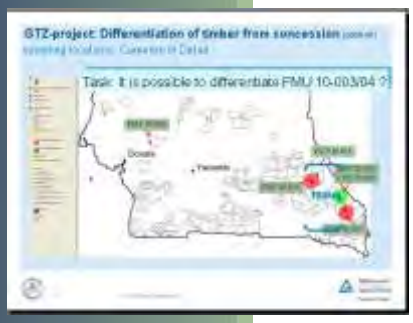
Particularly in regards to Java the sampling was able to arrange a representative overview of the whole landscape. At the current state of knowledge, the stable isotopes deliver a significant differentiation rate for timber out of Java (100%) and Laos (97.5%). Burma shows slight overlapping in the physical fingerprint with a discrimination rate of 80%, but overall sufficient to control the European ban of timber from Burma. In the second step the sampling concentrates on Latin America including reference samples from Teak and Mahogany species out of Brazil, Costa Rica, Honduras and Panama.

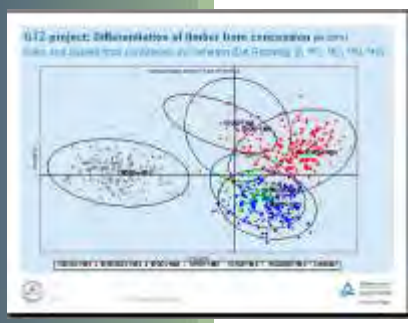
Using Teak reference samples of this region, in the beginning only samples from Honduras could be differentiated completely. After adding the analysis of strontium isotopes, it was possible to also differentiate samples from Brazil (100%). The most challenging problem in this project was to differentiate Panama and Costa Rica. Normally significant changes of isotope concentration can be expected in a wider range > 100 km. In this case the samples sites had a distance of about 50 km. The problem was solved in using NIR (Near Infrared) in addition to the isotopes listed above. In combining stable isotopes and NIR it was possible to completely differentiate timber from these neighbouring countries.

The blind test of this project demonstrated the potential of the stable isotope fingerprint method. In summary 13 blind samples out from 15 were evaluated correctly. One false result was solved later with NIR (see above). The other false evaluation was due to the fact that reference data were not available at that point of time (Ghana). A special challenge of the blind test was that WWF provided only small and single pieces of wood. With that WWF wanted to create a blind test constellation that is as close as possible to practice. The positive results of the blind test show the strength of the stable isotope method in verifying the declared origin of wood.

3.6. Project results – isotopic fingerprinting – GTZ/EU (Cameroon)

Dr **Markus Boner** also presented the results for the isotopic analyses in the case of verifying the origin on concession level (GTZ-project in Cameroon). Here, the scientists were also able to identify spatial patterns using Hydrogen, Oxygen, Carbon, Nitrogen and Sulphur isotopes. Not surprisingly, the closer the sample plots (concessions) are the more overlaps were observed in isotopic composition. Nevertheless, in the blind test with samples stemming from the concession (2 sets of samples), areas close by (8 sets of samples) and very distant from the concession (7 sets of samples) only 3 were not attached correctly. All of them were samples from outside the concession that were identified as likely from the concession. There was no difference in significance between the different timber species Sapelli and Iroko. This is an interesting and exciting result indicating that isotopic results might be exchangeable between these wood species. If this comes out positive after more tests the set up of reference data could become easier in future.





3.7. Discussion of project results

Participants acknowledged that both methods have made big steps forward. The two blind tests show that the methods are able to solve practical questions. The techniques have been already accepted as proof in court cases. Nevertheless, many details remain to be solved. Especially the design of sampling for the reference maps is a practical problem to solve because accessibility of natural forests is limited, location of single trees of a specific species must be known and public and private allowances are needed to enter the concessions and to take and analyse samples. FAO proposes to combine field sampling with national inventories undertaken by national forest authorities and FAO. The proposal to use samples from herbaria for further analytical work is discussed critically since information on species and origin is not always fully reliable. Participants learned that analytical capacities can be established anywhere but that experience and expertise in analysing data are more important than (expensive) technical equipment. Fresh material for samples with GPS data of origin is needed to set up reliable reference maps. For the blind tests the requirements for samples are lower, also to simulate the conditions of practical situations in timber trade.

4. Reflections on fingerprinting techniques

Susanna Lohri, Germain Yene

The Forest Trust

Ms **Susanna Lohri** and Mr **Germain Yene** from The Forest Trust (TFT) reported on their experiences of motivating the private sector in participating in such projects and practical challenges of sampling in the fields and at timber traders. While taking samples in forest concessions a certain mistrust of companies must be overcome, the company must be convinced to allocate staff for introducing the sampling team. Samplers should organise logistics for transporting and housing themselves as companies are usually not willing to provide this service. Further, storage of samples must be coordinated with the company. Taking samples for blind tests faces other challenges such as time constraints of timber traders, availability of timber from certain concessions and species and logistical problems to take the number of samples required for statistically sound tests. Financial incentives help to lower the burden for companies to participate in such exercises.

Dr Noel McGough

UK CITES Scientific Authorities for Plants

Dr Noel McGough from the UK CITES Scientific Authorities for Plants outlined the principles and related challenges in practice of the Convention on International Trade in Endangered Species (CITES). The convention regulates the international trade in animal and plant species that are listed in one of three appendices. Appendix II contains by far the biggest number of species and allows the trade in wild and "artificially propagated" species for commercial and non-commercial purposes. In order to bring these species under effective control, look-alike species also have to be controlled. For the countries implementing the convention, methods for identifying species could certainly ease their work. The fact that not all CITES-listed tree species are traded as timber – some are traded as derivative specimens – increases the requirements for control mechanisms. If fingerprinting methods can assist in tracking the origin of timber, they could be a major boost to ensuring that international trade does not endanger the survival of populations in the wild.

Prof Andy Lowe

Double Helix Tracking Technologies

Michael Momme

Max Bahr

Prof Andy Lowe, Chief Scientific Officer at Double Helix Tracking Technologies, presented the companies' DNA-based solutions to verify the origin of timber and wood products. Their services are designed to validate existing documentation such as Chain-of-Custody documents used by certification systems, or declarations of origin and species required under the United States Lacey Act. The application to date is facilitated with funding support from the International Tropical Timber Organisation (ITTO). To track timber, DNA samples are taken from trees at the point of harvest and again from the same logs further down the supply chain. Validation of the Chain-of-Custody is given, if the two samples match. To track the origin of timber, a sufficient number of DNA samples across a region have to be taken first. Within the identification process, there is a technical border when it comes to composite products or highly processed timber due to degradation of cells by heat and chemical treatments.

Mr **Michael Momme** presented the practical use of such new techniques for the German timber retailer Max Bahr. Wood and wood products constitute one of the largest shares of the assortment of the building supplies stores Max Bahr. The company is engaging in the origin of timber within their risk management, their marketing as well as their corporate philosophy. In order to assure the legality of timber within their assortment, that is to establish a transparent sourcing of wood, Max Bahr is using the commercial documents and own investigations to revise their correctness. Awareness-raising on unsustainable use of natural resources and the consequential growing demand for certificates, assuring more than legality, has been a trend during the last years particularly on the consumer side. From a retailer's point of view the use of fingerprinting methods could be used to check the data of their suppliers also of their (FSC) certified wood. Therefore the method would have to be scientifically secure, workable in a short time, cost efficient and easy to handle.

5. The way ahead: a new international facility / database

Thorsten Hinrichs

German Federal Ministry for Food, Consumer Protection and Agriculture (BMELV)

Mr **Thorsten Hinrichs** from the German Federal Ministry for Food, Consumer Protection and Agriculture (BMELV) informed the audience about concrete next steps to establish a new international facility "Identification of Timber Species and Origins" at the organization *Bioversity International* in Malaysia (formerly: IPGRI). Objectives are to coordinate work on research, standard setting and to establish an international open access database *inter alia* through networking among research and implementing institutes. A scientific coordinator will be hired and a steering committee will give further guidance. The project will run until the end of 2013 and may also be extended. Another new project with ITTO deals with practical implementation of timber tracking in Africa. Consumer and producer countries as well as organisations are invited to participate actively and to support research on methods that can be applied for control in practice.

Two panel discussions further deepened the challenges and potentials of applying fingerprinting techniques and working with an international facility for the private sector and for public FLEGT- and CITES-administrations. Participants in the Panel "Potential and Challenges for the Private Sector" were **Didik Budi Purwanto** (Perum Perhutani Indonesia), **Susanna Lohri** (The Forest Trust) and **George White** (Global Forest Trade Network).

Participants in the Panel "Potential and Challenges for the FLEGT- and CITES authorities" were **Dr Suchitra Changtragoon** (CITES Scientific Commission Thailand), **Chris Beeko** (Forestry Commission Ghana) and **Rob Parry-Jones** (TRAFFIC).

6. The way ahead: discussion and recommendations

Private companies from producer and consumer countries show interest in fingerprinting methods. From the producers' point of view, fingerprinting methods would give them the chance to offer their customers an added value through proof of origin as one indispensable step to proof legality of harvest / production. This could also apply to certified timber. However, the implementation of these systems is expensive so financial incentives must be set for participating in such new system. From the consumers perspective the new techniques help to implement new EU FLEGT- and illegal-timber regulations and to improve risk management. However, methods must be cheap, fast and reliable before widely applied. To be of real practical value they should become more precise in distinguishing between origins on local level. To create ownership amongst all national stakeholders and to avoid the impression that this is "just another European thing like certification they want from us and we have to pay for it" it is necessary to inform all stakeholders about pros and cons of these new techniques for the national application.

Producer countries showed interest to combine / strengthen their Legality Asurance System (LAS) with fingerprinting methods. There was a clear signal that these countries can build on national capacities but need additional support (know how transfer, labs, consultancy how to combine the LAS with fingerprinting methods). The new techniques can help to settle disputes and to ensure good reputation on international and regional markets. To integrate fingerprinting techniques in existing national systems for legality assurance the local preciseness and significance must be improved. There was some uncertainty about the different levels: legality, sustainability, FLEGT/VPA, certification obviously there is a need to have better explanations what's behind all this, the different levels and how these things fit together.

Participants agreed that the **database** is a sensitive but important topic. Discussions and negotiations are needed with all stakeholders on the database design, quality and standardization of input, sustainable financing, access to and management of information. Lessons learned from similar databases in the food sector should be taken into account. Cooperation with existing databases (GENEBANK, Barcode of Life) should be sought. One important problem to solve with a view to create ownership is how to motivate companies / producer countries to support the idea of an international database. Obvious benefits for producer countries who deliver data are priority entry into the EU-market and capacity building within their countries. One possibility could be to combine a concession with the duty to deliver wood samples but this might be difficult to request. To help out it would be helpful if fingerprinting techniques would be required by an international binding agreement such as CITES. GFTN (Global Forest and Trade Network) offered to use the contacts to partner companies that are willing to collect samples. It seems that the IAEA (International Atomic Energy Agency) is funding projects to set up isotope labs in developing countries. IAEA has experience in standard setting and ring tests with laboratories. They also fund projects. Thus, it is recommended to organize a meeting together with IAEA to learn and maybe find out possibilities of cooperation.

7 Results and recommendations from two parallel working groups

7.1. Recommendations for practical application in producer and consumer countries

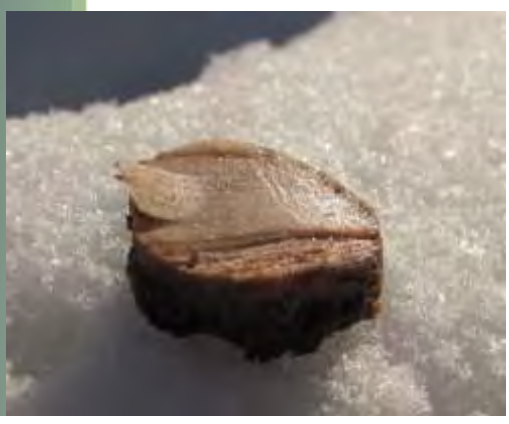
National activities:

- **Awareness rising and communication**: to create ownership and support amongst all national stakeholders (including administrations, private sector, NGOs) more information must be created and communicated e.g. through publications, in-country-workshops and conferences. These can be the starting point for further implementing activites and platforms to agree on next steps such as national listing of priority species. National pilot projects with nationally identified timber species are needed to build confidence in these innovative techniques amongst stakeholders. For the private sector business-to-business-dialogue is most useful to raise awareness.

- **Priority setting**: producer countries already carry a heavy burden to comply with existing requirements such as CITES, FLEGT and forest certification. The fingerprinting techniques have a significant potential to contribute to existing verification and monitoring systems for timber harvest and trade. But their establishment also creates extra work, so priorities must be set. Since timber species relevant for national, regional and international trade differ from country to country, the priorities for timber species to be covered by the fingerprinting techniques must be set nationally within a consultative process with all relevant stakeholders. The results of such exercise are national lists of timber species for which genetic markers should be identified and genetic and isotopic spatial differences should be mapped.

- **Integration into national monitoring and tracking systems**: the sampling for the genetic and isotopic reference maps could be done in the course of collecting data in the fields for national forest inventories. Such piggyback-procedure will reduce sampling costs and can help to incorporate genetic and isotopic spatial differences into national forest maps and inventories. The integration of fingerprint techniques into tracking systems requires more in-depth analysis especially on the costs.

- **Capacity Development**: national capacities for genetic and chemical analyses exist in many producer countries especially at universities. Further transfer of knowledge and technology is needed e.g. through scholarships, exchange of experts, study trips and investment projects to build national capacities. This will also help to reduce costs of implementing these new techniques and accelerate the availabilty of results since samples do not need to be shipped to analytical facilities in Europe, the US or Asia.



Part of a punched-out bark: In the sample a layer of cambium is visible. It will now be dried in silica gel for further analysis.

Regional support activities:

! **Coordination through regional organisations**: national activites and priority setting should be complemented by regional bodies such as COMIFAC. This will accelerate transfer of information and coordination of activites such as identifying genetic markers for priority timber species and sampling for setting up reference maps.

International support activities:

! **Regular stock-taking**: to identify the current status of existing knowledge, to leverage mutual support and to tap the potential for synergies, there should be a platform for regular exchange e.g. through conferences like this. To that end, it will be appreciated if Bioversity International as the new inter-national facility for fingerprinting will com-municate a roadmap of planned activities and actors involved.

! **Establishment of database, transfer of knowledge and know-how**: before an international database is established it should be clarified who has access to the system and how. It also needs to be discussed which technical and intellectual capacities are needed and how their transfer can be ensured and coordinated. This work will be started by the international coordination facility at *Bioversity International*.

! **CITES**: the new techniques have a high potential to be used by CITES authorities. To make them available to the competent authorities information about fingerprinting should be transferred to the CITES Plants Committee. Its next session will be in April 2011, input papers are accepted until February 2011, and parties can request to discuss these new techniques as a single topic on the Agenda of this Technical Committee. Once it is acknowledged by the Committee fingerprinting is likely to become an element of the "pool of implementation tools" which is communicated and transferred through CITES-related trainings and publications.

! **Cooperation with international organisations**: CITES, ITTO and FAO are already cooperating with a view to ensure that international trade in CITES-listed timber species is consistent with their sustainable management and conservation. They could pick up the integration of fingerprinting techniques into their activities by e.g. establishing a working group. The FAO Commission of Forestry (COFO) holds a meeting biannually which is one major international platform for transfer of knowledge. Fingerprinting techniques could be presented in a side-event at the next COFO in 2012.

7.2. Recommendations for further scientific work

Species identification:

- Develop anatomical and microscopic approach and develop DNA barcoding approaches for species differentiation aiming to differentiate the 1,000 most important species.

Region of origin – requirements for isotopes:

- Improve spatial resolution by clarifying the use of other isotopes, multi-element / chemical / near-infrared profiling (Mass Spec) and their combination for timber.
- What are the important variables for isotopes, within tree, between tree, environment, mycorhyza, dry climate, local microclimate, air pollution, height of sampling in tree, light exposure, species (literature review and experiment)?
- Validation and normalization (repeatability and reproducibility), need to standardize measurements around the laboratories worldwide (appr. 15), develop new wood standards (develop from food standards), examine impact of processing method.
- Scientific work needed to find out more about the transferability of results from one species to another.

Region of origin – requirements for DNA analysis:

- Develop new markers for broad range of species, across ranges of investigation from DNA bar-coding, through phylogeography to population genetics
- Review literature to identify which markers are more applicable for which scale of study.
- Focus on being able to differentiate between concessions/stands sampling and marker requirements.
- Look at new sequencing technologies and how they can be used for marker search and genotyping.

For both techniques:

- Review literature.
- Additional scientific work needed especially on processed wood.
- Scientific work needed on simulation / predictability of regions without sampling so far.
- Develop protocols which touch upon:
  - common size standards and some cross comparison
  - DNA extraction out of wood (impact of processing method)
  - high throughput methodologies
  - quick and cheap methodologies.

Methodologies and database:

- Make sure that the data is reliable; ring tests have to involve at least 15 labs on an international level.
- Bring together the statistics of both methods; first interpretation needed of the results of each method (ITTO project will cover this question).
- Develop library of common reference samples for both methods.
- Clarify the use of work with single samples “single piece of wood Goal”. In practice there will be in most cases only one piece of wood that can be analyzed

(n=1). That's a statistical problem and methods have to work on it to become also reliable in this case.

- Regular blind tests are needed to police methods.
- Further clarify how fingerprinting methods can be integrated into other supply chain control methods.
- Improve implementation of techniques towards easy and safe procedures.
- Clarify transfer of technology and knowledge.
- Develop statistics for expressing matching confidence in results, is it possible to use the same or do we need to develop different analyses for each method.

Simulation modeling for:

- Design scales and intensity of sampling and likely strength of genetic structure considering geographic / geological variation.
- Prediction of cellulose content (Oxygen isotope) from environmental and geological data alone.

Communications and funding:

- Newsletter / Webpage – network contacts and activities in different areas.
- Yearly and internationally rotating meetings should focus on different methods and their combination.
- Lobbying EU and IAEA, FAO and others for funding and cooperation, needs coordination.

Because of a lack of time it was not possible to discuss more in details about the database. There was a wish to have an extra meeting about this, e.g. once the coordination person at *Bioversity International* has commenced its work.

ATTACHMENTS

(1) CONFERENCE AGENDA
(2) PARTICIPANTS LIST

(1)

CONFERENCE AGENDA

Wednesday, 03 November

08:30	Registration
09:00	**Opening adress GTZ** Dr Stephan Paulus, Director of GTZ Department Environment and Climate Change **Opening adress WWF** Johannes Zahnen, WWF **Introductory note MINFOF Cameroon** Secretary General Denis Koulagna
09:40	Introduction into day 1
09:45	**German support for fingerprinting techniques** Matthias Schwoerer, Federal Ministry for Food, Consumer Protection and Agriculture **Introduction into timber tracking and role of fingerprinting** Johannes Zahnen, WWF Germany
10:20	Coffee break
10:50	**Short introduction into genetic and isotopic fingerprinting** **Presentation of project results** Dr Bernd Degen, Johann-Heinrich von Thünen Institute, Forest Genetics Dr Markus Boner, TÜV Rhineland / Agroisolab Questions and answers
13:15	Lunch
14:00	**Lessons learned in the development of timber tracking systems** Germain Yene, Susanna Lohri, The Forest Trust **Reflection from CITES-authority** Dr Noel McGough, UK CITES Scientific Authority for Plants **Practical experience with applying fingerprinting techniques** Prof Andy Lowe, Doublehelix **Use of fingerprinting techniques: a timber retailers' view** Michael Momme, Max Bahr
15:30	Coffee break
16:00	Discussion
17:00	Dinner reception

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CONFERENCE AGENDA

Thursday, 04 November

09:00	Introduction into day 2
09:05	**The way ahead: a new international facility for coordination (research, standards, database)** Thorsten Hinrichs, Federal Ministry for Food, Consumer Protection and Agriculture
09:35	**Panel discussion "Potential and challenges of fingerprint techniques for private companies"**
10:50	Coffee break
11:20	**Panel discussion "Potential and challenges of fingerprint techniques for FLEGT- and CITES-authorities"**
12:35	Lunch
13:45	Two parallel working sessions: **1. Scientific discussion of results and perspectives** **2. Exchange between producer countries, private sector and consumer countries on questions and possible next steps**
15:15	Coffee break
15:45	Feedback from working groups
16:15	Final discussion, conclusions
17:00	End of conference

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